

Brussels, 13.6.2018
SWD(2018) 344 final

COMMISSION STAFF WORKING DOCUMENT

EVALUATION

Accompanying the document

**Report from the Commission to the European Parliament and the Council
on the evaluation and implementation of the EU nuclear decommissioning assistance
programmes in Bulgaria, Slovakia and Lithuania**

{COM(2018) 468 final}

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Glossary

Term or acronym	Meaning or definition
2011 IA	the 2011 NDAP impact assessment - SEC(2011)1387
AWP	Annual Work Programme
CEF	Connecting Europe Facility - a key EU funding instrument to promote growth, jobs and competitiveness through targeted infrastructure investment at European level
CPI	Cost Performance Index – indicator used by the Earned Value Management method
CPMA	Central Project Management Agency – national agency in Lithuania
D&D	Dismantling and Decontamination
detailed implementation procedures	Commission Implementing Decision C(2014)5449 of 7 August 2014 on the rules of application for the nuclear decommissioning assistance programmes for Bulgaria, Lithuania and Slovakia for the period 2014-2020
EBRD	European Bank for Reconstruction and Development - an international financial institution
EIA	Environmental Impact Assessment
EQ	Evaluation Question
EVM	Earned Value Management - a management methodology for objectively measuring project performance and progress
IAEA	International Atomic Energy Agency
INEA	Innovation and Networks Executive Agency
INPP	Ignalina Nuclear Power Plant – the decommissioning operator for the Ignalina programme
ISDC	International Structure for Decommissioning Costing - a standard itemisation of decommissioning costs
JAVYS	Jadrová a vyrad'ovacia spoločnosť – the decommissioning operator for the Bohunice programme
KNPP	Kozloduy Nuclear Power Plant – the company operating the Kozloduy nuclear units 5 and 6
ESIF	European Structural and Investment Funds
ESIF Major Projects	Large-scale infrastructure projects implemented under European Structural and Investment Funds
MFF	Multi-Annual Financial Framework
NDAP	Nuclear Decommissioning Assistance Programmes

2013 NDAP Regulations	Council Regulations 1368/2013/Euratom and 1369/2013/EU on Union support for the nuclear decommissioning assistance programmes in Bulgaria, Slovakia and Lithuania
NPP	Nuclear Power Plant
PMU	Project Management Unit – temporary team, usually constituted in part by external consultants, assisting an organisation with project management competences
RBMK	A type of graphite-moderated nuclear power reactor designed and built by the Soviet Union
SERAW	Държавно предприятие „Радиоактивни отпадъци“ or State Enterprise Radioactive Waste - the decommissioning operator for the Kozloduy programme
SIEA	Slovak Innovation and Energy Agency - national agency in Slovakia
SME	Small and Medium Enterprises
SPI	Schedule Performance Index – indicator used by the Earned Value Management method
VVER	A type of pressurised water reactor designs originally developed in the Soviet Union

SUMMARY

The mid-term evaluation of the Nuclear Decommissioning Assistance Programme (NDAP) for the period 2014-2020 provides robust evidence, analysis and conclusions with regards to i) the results of the programmes against the NDAP objectives, as well as the irreversibility of nuclear plants' shut-down, enhancement of nuclear safety, changes in organisational structures of decommissioning operators and management systems, ii) the efficiency of the use of resources, and iii) the EU Added Value of the programmes. Other evaluation criteria (e.g. relevance & coherence) and the indirect impacts of the NDAP were also examined.

Having begun the process of decommissioning at different points in time and with each national decommissioning programme subject to unique factors and challenges (e.g. type and size of units, existence of necessary waste management infrastructure, major delays etc.), the programmes have attained different levels of advancement to date. The expected decommissioning end dates range from 2025 for Bohunice to 2030 for Kozloduy and 2038 for Ignalina. By 2020, some EUR 2 995 million in EU financial assistance is expected to have been committed within the framework of the NDAP since 1999 for nuclear decommissioning, of which EUR 671 million for Bohunice (SK), EUR 731 million for Kozloduy (BG) and EUR 1553 million for Ignalina (LT). This amount is in addition to national contributions mobilised through dedicated funds and/or programmed budgets. The total allocated amount of national contributions currently amounts to EUR 1 086 million. EU already disbursed EUR 1366 million to date.

Main findings & conclusions

The NDAP remains a relevant & coherent instrument

The NDAP remains a relevant instrument for supporting the three decommissioning programmes and is well embedded in the wider policy and regulatory context. On the general level, the objective set out for the programmes in the Regulations remains relevant: the NDAP continues to support a stepwise reduction in the level of risk and radiological hazard at the three sites concerned. Current decommissioning strategies for the three programmes and on-going activities also remain at present fully aligned with the specific and detailed objectives set out for each programme. Coherence with the Euratom Treaty's acquis in the area of nuclear safety and management of spent nuclear fuel and radioactive waste has been ensured through the legal base of the NDAP, even if the programme constitutes an exception to some underlying principles enshrined in the Euratom acquis.

Programmes are generally on track to achieve objectives for the current MFF

Programmes can generally be considered to be on track towards reasonably achieving the principal objectives set for this programming period. However, satisfactory achievement of the objectives will in some cases require proactive management or projects and programmes to recover delays and mitigate present and future risks.

Actual physical dismantling of equipment is progressing relatively quickly compared to previous programming periods. Dismantling & Decontamination work in the turbine halls and auxiliary buildings is winding down at Bohunice and progressing well at Ignalina and Kozloduy. The Bohunice programme has embarked on important physical works in the Controlled Area, whereas the Ignalina and Kozloduy programmes remain at different stages of the preparatory phase. Delays and challenges during this phase will need to be managed closely to avoid longer-term delays with the beginning of major physical works.

This progress reflects the nature of nuclear decommissioning programmes, which require significant upfront investment in planning and supporting infrastructure. Investments under previous programmes have thus laid the foundation for the progress being achieved today. In

particular, the completion of key waste management infrastructure projects has laid the groundwork for accelerating work at Ignalina and Kozloduy. At Ignalina, for example, the commissioning of the Interim Spent Fuel Storage Facility puts the programme on track to complete the critical task of defueling.

Finally, progress against waste management targets has been slow to date, although programmes should be able to recover delays. This underperformance has mainly been the result of uncertainties concerning radiological inventory and / or lack of anticipation of regulatory procedures leading to under or overestimations of target values, slower than planned progress with D&D activities, technical challenges related to specific legacy waste streams and some delays in the commissioning of waste management facilities.

Reduction of radiological hazards

Since reactors' final shutdown, the level of risk at each site has been reduced in a stepwise manner, notably with the defueling of reactors and the decontamination, dismantling and disposal of contaminated and irradiated equipment and materials. At Kozloduy and Bohunice, the remaining radiological hazard concerns primarily workers inside the nuclear facility. The most significant risk reduction was achieved in the previous programming period and the level of risk to the surrounding environment and general population has been highly diminished. In comparison, a relatively significant level of risk remains at Ignalina prior to the completion of defueling activities. During the period covered by this mid-term evaluation, the NDAP has contributed to a risk reduction associated with the Ignalina site with the beginning of defueling activities. This contribution will continue to increase significantly in the coming five years as the process follows its course.

Improved Monitoring & Control framework

With the current programming period, significant progress has been achieved compared with previous generations of the programme in terms of articulating clear objectives and translating those objectives into a robust monitoring framework. The introduction of Earned Value Management has also enhanced the quality of programme monitoring. New templates were developed for key monitoring and programming documents that are reviewed at new programme-level Monitoring Committees. The Commission also continues to conduct regular monitoring missions. While these developments represent an important step forward, some continued progress is desirable in terms of improving the quality of certain indicators, adjusting and streamlining the contents of Monitoring Reports and Annual Work Programmes and continuing to perfect the implementation and use of the Earned Value Management system.

Programme governance & management structures

The programme governance and management system is generally considered to be fit-for-purpose. It provides for a clear and logical division of roles and responsibilities and is adapted to the specific constraints of the programme. In practice, however, some divergences can be observed between the intended and actual functioning, which may impact its effectiveness and efficiency.

Programme Coordinators have assumed an increasing ownership of the implementation of decommissioning programmes thanks to political and procedural efforts to strengthen their role as well as a now high level of buy-in; however, there remains further margin for continuing to strengthen their role to varying extents, in particular through stronger technical capacity. Moreover, the current detailed implementation procedures afford only limited latitude to Programme Coordinators to assume a more active role in programme governance.

The national contribution levels achieved appear suitable for sustaining proper efficiency; however, they are not established in the legal basis, which creates residual uncertainties. Increasing national relative to EU contributions and defining a clear and formalised framework

for 'co-financing' (either at programme or project level) would very likely continue to encourage greater national ownership.

Cost performance has been satisfactory, but margins for improvements have been noted

The cost performance of all three programmes has generally been satisfactory to date. This stands in contrast to difficulties with some programmes faced in the previous MFFs. At the time of the study, the 2014 programme cost estimates are expected to be maintained or decrease slightly for Ignalina and Bohunice respectively. The recent revision of the Kozloduy decommissioning overall cost estimate shows an increase (+23%) which does not affect the size of the funding gap because the national contribution has been increased as well in response to the outcome of the plan's revision.

Some of the largest increases in project budgets over the years are in fact a result of revised planning and cost estimation or simple uncertainty rather than cost increases per se. Following poorly made initial estimates, project cost estimates naturally increased as the technical design, planning and regulatory uncertainties became clearer. However, decommissioning operators have strengthened their planning and cost estimation methodologies, notably at Kozloduy and Ignalina. The stronger management allows for further transfer of risks (cost overruns, delays) to the respective Member States, which in turn would empower the beneficiaries to seek increased cost performance.

EU Added Value

The NDAP has been important to supporting the decommissioning processes in the current MFF. Continued progress of decommissioning would likely have been negatively impacted to varying degrees in absence of the NDAP during the current programming period. Nonetheless, the added value of the programme is naturally declining as implementation progresses.

The EU added value of the NDAP from its beginning has been cast in terms of financial mitigation and nuclear safety. With a finite level of radioactivity on site, however, each additional euro of investment provides decreasing rates of return. The EU added value of the programme is thus naturally decreasing over time. Moreover, the funding gap for two of the three programmes (Kozloduy and Bohunice) has been closed to small amounts that do not pose risks for State finances.

The question of the continued added value of the programme can thus be raised on the basis of the diminishing rate of return observed at present; however, other types of EU added value could be further leveraged to justify an adequate 'return on investment' for Europe for future EU assistance. Of the more than 90 nuclear reactors currently permanently shut down in Europe, only three have been completely dismantled. The level of experience in the dismantling of nuclear reactors in Europe (as well as internationally) is thus limited. The NDAP's contribution to securing the shutdown and immediate dismantling of these reactors has led to the generation of a highly significant amount of experience that can be of benefit to other decommissioning projects. However, the large part of this added value remains confined to the companies benefiting from NDAP contracts and the decommissioning operators. While these actors are well placed to disseminate and apply this knowledge in the future, there are no mechanisms in place to ensure this knowledge is diffused into the public domain for use by relevant actors, other NPPs, decommissioning operators, national authorities, research actors, etc.

1 INTRODUCTION

1.1 Purpose and scope

When they acceded to the EU, Bulgaria, Slovakia and Lithuania committed to shutting down eight nuclear reactors before the end of their scheduled lifetime:

- Kozloduy nuclear power plant in Bulgaria (units 1 to 4);
- Bohunice V1 nuclear power plant in Slovakia (2 units); and
- Ignalina nuclear power plant in Lithuania (2 units).

The EU itself committed to providing financial assistance for decommissioning those reactors.

The Nuclear Decommissioning Assistance Programmes (NDAP) as defined in the relevant Council Regulations^{1, 2} (the 2013 NDAP Regulations) were set up to provide support to these decommissioning programmes in the Multiannual Financial Framework (MFF) 2014-2020, continuing the assistance provided in previous periods.

This mid-term evaluation of the NDAP focuses on the current setup and refers to the period 2014-2017 unless specified otherwise.

This evaluation supports the Commission's report³ to the European Parliament and the Council. The evaluation also addresses the scope for modification of the detailed implementation procedures.⁴ Finally, the conclusions of this evaluation have fed in the preparation of the programme proposals for the next MFF.

1.2 Main issues

The evaluation focuses on the following topics:

- **Safety** – enhancement of nuclear safety and safety standards for public health and environment.
- **Governance** – impact of the changes introduced in 2014 and scope for possible further improvement.
- **Programmes output** – the irreversibility of the plants shut-down and their decommissioning as well as overall progress and performance of the decommissioning programmes.
- **Knowledge** – know-how development, knowledge sharing / codification with potential for positive effects in the general EU decommissioning market.

The evaluation also touches the economic, social and environmental impacts stated in the 2011 NDAP impact assessment⁵ (hereafter the "**2011 IA**").

¹ [Regulation \(Euratom\) 1368/2013](#)

² [Regulation \(EU\) 1369/2013](#)

³ Under Article 9 of the NDAP Regulations, the Commission is required to establish a mid-term evaluation report on the achievement of the objectives of all the measures related to the Kozloduy, Bohunice and Ignalina programmes.

⁴ [C\(2014\)5449](#)

⁵ [SEC\(2011\)1387](#)

1.3 Evaluation criteria

In line with the requirements of the Better Regulation guidelines⁶, the mid-term evaluation of the NDAP has assessed the effectiveness, efficiency, relevance, coherence and EU added value of the assistance programmes.

The progress of the implementation has been evaluated against the specific and detailed objectives of the 2013 NDAP Regulations and more generally against the detailed decommissioning plans and the successive annual work programmes that set the basis for the monitoring of the programmes.

In addition the issues of risk, sustainability, simplification, complementarity, coordination, and communication have been considered even though no specific objectives were defined in those domains.

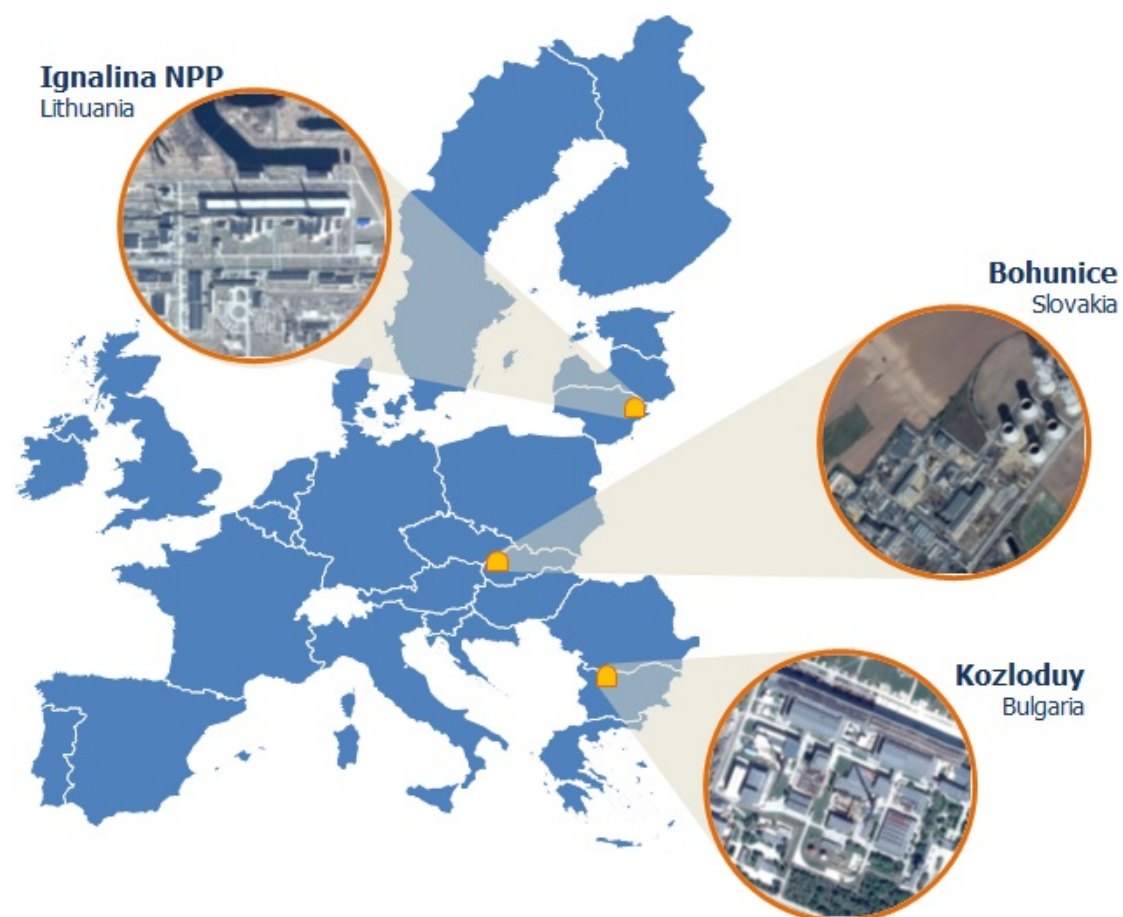
2 BACKGROUND TO THE INTERVENTION

2.1 Historical development of the NDAP

The 1986 Chernobyl disaster and its cross-border impact generated broad concern in Europe and beyond with regard to the operation of some first generation nuclear reactor types. At the 1992 Munich summit, the G-7 heads of state and government committed to supporting the countries of Central and Eastern Europe with Soviet-designed nuclear power plants requiring safety upgrades. As part of these efforts the EU provided financial and technical assistance to partner countries through the TACIS and PHARE programmes.

⁶ https://ec.europa.eu/info/better-regulation-guidelines-and-toolbox_en

Figure 1 - EU map with nuclear plants included in NDAP



In the framework of their EU accession negotiations, Bulgaria, Lithuania and Slovakia made a formal commitment to close eight reactors located on their territories.

Table 1: Nuclear reactors included in NDAP

Member State	Reactor unit / type	Envisaged operational lifetime	Closure date
Bulgaria Kozloduy NPP	Unit 1: VVER- 440/230	1974 - 2004	2002
	Unit 2: VVER- 440/230	1975 - 2005	2002
	Unit 3: VVER- 440/230	1981 - 2011	2006
	Unit 4: VVER- 440/230	1982 - 2011	2006
Slovak Rep. Bohunice V1	Unit 1: VVER- 440/230	1980 - 2008	2006
	Unit 2: VVER- 440/230	1981 - 2010	2008
Lithuania Ignalina NPP	Unit 1: RBMK 1500	1984 - 2013	2004
	Unit 2: RBMK 1500	1987 - 2017	2009

Source: 2011 IA

It is to be noted that on the Kozloduy site there are also two reactors in operation (Kozloduy units 5 & 6) and on the Bohunice site there is also another reactor in decommissioning (Bohunice A1) and two reactors in operation (Bohunice V2 units 3 & 4); decommissioning of these facilities is not eligible under this assistance programme. When this document further refers to Kozloduy and Bohunice, it refers to Kozloduy units 1 to 4 and Bohunice V1 units 1 & 2 respectively.

Recognising the financial burden due to the closure of these reactors on the economies of Bulgaria, Slovakia and Lithuania (hereafter the concerned Member States, unless specified otherwise), the EU committed to provide assistance, to support the decommissioning process as well as support for mitigation measures to address the consequences of early closure. In all three cases, the reactors were shutdown, as per the timescales set out in the Accession Treaties.

The Union assistance, provided through the Nuclear Decommissioning Assistance Programmes can be divided into four distinct periods beginning during the pre-accession period and stretching to the current Multi-Annual Financial Framework (MFF):

- During the pre-accession period (up to 2004 for Slovakia and Lithuania and 2007 for Bulgaria), the three countries received funding through the instruments targeted at candidate and partner countries (PHARE and later the Instrument for Pre-accession Assistance).
- Financial assistance over the second period (2004 - 2006 for Slovakia and Lithuania and 2007 – 2009 for Bulgaria) was provided under the protocols to the countries' accession acts.
- Since 2007 for Slovakia and Lithuania and 2009 for Bulgaria, Council regulations have ensured the continuation of assistance for decommissioning assistance programmes until 2013.
- Two Council Regulations were adopted on 13 December 2013 to provide support to these decommissioning programmes in the period 2014-2020, continuing the assistance

but restricting its scope to decommissioning activities only and excluding mitigation measures in the energy sector that were supported in previous periods.

The overall EU financing made available to the three programmes for decommissioning (and mitigation measures in the energy sector until 2013) are summarised in the table below.

Table 2: NDAP financial allocation 1999 – 2020

Programme	1999 – 2013 (M€)	2014 – 2020 (M€)	Total 1999 – 2020 (M€)
Kozloduy (BG)	868	293	1 161
Bohunice (SK)	612	225	837
Ignalina (LT)	1 367	451	1 818
Total	2 847	969	3 816

Source: Commission financing decisions

Early political resistance in the Member States in past MFFs has given way to acceptance and greater ownership. The political commitment obtained by the EU for the early closure of the reactors in the three Member States was met with some domestic resistance in early years, with negative impacts on both the political and technical levels. Already before the end of the previous programming period, this resistance had progressively given way to widespread acceptance of the irreversible nature of the shutdown of the reactors and resulted in positive developments at technical level. Increasingly, this has also been translated into increased ownership over the decommissioning process on the part of national governments.

2.2 Intervention logic

The underlying need, which constitutes the starting point of the intervention logic, is to contribute to the safety of citizens by ensuring that all nuclear plants in the EU meet the high level of safety standards required in the EU. It is this need that has been at the heart of the Union action in this domain from the very beginning.

The NDAP answers the need for the timely availability of funds for ensuring the safe and immediate decommissioning resulting from the decision to prematurely shutdown the nuclear reactors in question.

2.2.1 Objectives

The 2013 NDAP Regulations define the general objective (article 2.1) and the specific objectives (article 2.2) for each programme. The general objective is to *assist Member States in implementing the steady process towards the decommissioning end state of the reactors in question in accordance with their respective decommissioning plans, whilst maintaining the highest level of safety.*

The 2013 NDAP Regulations required a number of ex-ante conditionalities to be met prior to the start of the programming period. These required the set-up and agreement of the detailed decommissioning plans that would later serve as the baseline of the programmes against which progress would be measured and eligibility would be determined. In 2014, the three Member States submitted their detailed decommissioning plans. The plans describe the decommissioning end state, a schedule for all tasks required to reach this situation, and the related cost estimates. They constitute a clear and comprehensive baseline for assessing the progress of the implementation globally and at the level of each project.

It should be noted that unlike in previous programming periods, the current NDAP did not include further support to mitigate the consequences of the early closure of the nuclear power

plants. It restricted EU support to the tasks described in the approved detailed decommissioning plans, so focussing on safety related activities.

The specific objectives for each programme are summarised in the table below.

Table 3: Specific objectives of NDAP

Plant	Specific Objectives (as per Article 2.2 of the 2013 NDAP Regulations)
Kozloduy (BG)	<ol style="list-style-type: none"> 1. Performing dismantling in the turbine halls of units 1 to 4 and in auxiliary buildings; 2. Dismantling of large components and equipment in the reactor buildings of units 1 to 4; and 3. Safely managing the decommissioning waste in accordance with a detailed waste management plan.
Bohunice (SK)	<ol style="list-style-type: none"> 1. Performing dismantling in the turbine hall and auxiliary buildings of reactor V1, to be measured by the number and type of systems dismantled; 2. Dismantling of large components and equipment in the V1 reactor buildings, to be measured by the number and type of systems and equipment dismantled; and 3. 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.
Ignalina (LT)	<ol style="list-style-type: none"> 1. Defueling of the reactor core of unit 2 and the reactor fuel ponds of units 1 and 2 into the dry spent fuel storage facility; 2. Safely maintaining the reactor units; and 3. Performing dismantling in the turbine hall and other auxiliary buildings and safely managing the decommissioning waste in accordance with a detailed waste management plan.

Source: 2013 NDAP Regulations

Additionally, detailed objectives, targets, milestones and performance indicators have been defined for each programme and each specific objective in annexes to the detailed implementation procedures.

To achieve these objectives, inputs such as EU and national financial resources and expertise are translated into programme activities. These activities are defined in the annual work programmes prepared by the concerned Member States, and further detailed in project documentation.

The results and impacts naturally mirror the objectives of the NDAP as presented above.

2.2.2 Management of the NDAP

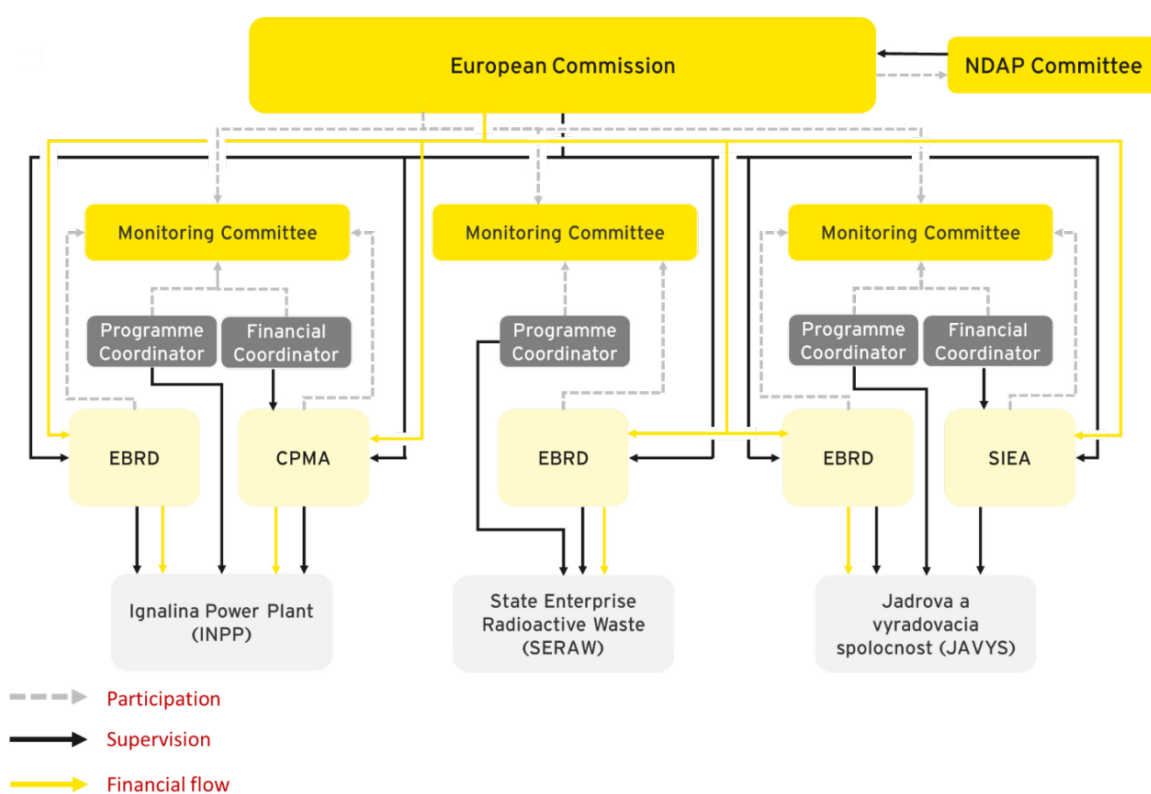
Due to the high level of technical capacity and expertise necessary to implement decommissioning activities and within the historical context at that time, in 2001 implementation tasks were delegated to the European Bank for Reconstruction and Development (EBRD). The accession of the three countries to the EU has given access to additional options. In Lithuania, the Central Project Management Agency (CPMA), a national public-sector body, has been selected and approved by the Commission to act as an Implementing Body since 2003. Since 2015, Slovakia has also formally established a national implementation channel, the Slovak Innovation and Energy Agency (SIEA), which implements all new projects. The first project to be implemented by the SIEA was approved in May 2017. Thus in Lithuania and Slovakia the implementation of union budget is progressively being transferred to national bodies.

Each concerned Member State appoints a Programme Coordinator (ministerial or state secretary rank) to be responsible for the overall programming, coordination and monitoring of the decommissioning programme.

In Bulgaria and Slovakia, the facilities to be decommissioned were transferred from the nuclear plant operator to separate organisations; respectively State Enterprise Radioactive Waste (SERAW) and Jadrová a vyradovacia spoločnosť (JAVYS). In Lithuania, the Ignalina Nuclear Power Plant (INPP) organisation has been maintained but with a new mission. The three decommissioning operators are the owners of the nuclear licenses and they implement the decommissioning programme under the supervision of the Programme Coordinator and of the Implementing Bodies.

For each programme, a Monitoring Committee ensures a coordinated monitoring of all measures and financial assistance under the decommissioning programme. It is chaired by the Programme Coordinator and a representative of the Commission. The other members are the Financial Coordinator and representatives of the Implementing Bodies.

Figure 2: NDAP key stakeholders and their relations



Each of the three Member States concerned submits to the Commission an annual work programme which updates the implementation schedule of the detailed decommissioning plans, taking into account the latest developments in the implementation of the projects. The annual work programmes must however remain within the objectives and scope of the decommissioning plans as initially adopted by the Commission.

The Commission reports annual progress on the NDAP to the Council, the European Parliament and the general public. This annual reporting concludes the annual planning and monitoring cycle for that year and constitutes the basis for the adoption of the following year's annual work programmes.

2.3 Baseline and points of comparison

The 2011 IA framed the Commission initiative in these terms: *'to eliminate as far as possible the source of radiological hazard, the closed reactor units must remain closed, be defueled and safely dismantled. In the context of 'early closure' and considering the related economic consequences for the three concerned Member States this closure must become irreversible. At present this stage is not yet reached'*.

By the end of the previous financing period, JAVYS, the decommissioning operator in Slovakia, had obtained its first decommissioning license for Bohunice V1. In Bulgaria, the Kozloduy units 1 and 2 were defueled and transferred from the plant operator to the decommissioning division of SERAW. In Lithuania, the defueling operations of the reactor of unit 2 in Ignalina were on hold while the construction of the Spent Fuel Safe Storage Facility had to be completed. In all three concerned Member State, the political movements demanding the restart of the reactors were losing influence.

The Commission's initial proposal⁷ for a single NDAP Regulation foresaw an extension of financial support from the Union with the general objective to reach an irreversible state within the decommissioning process of Kozloduy units 1 to 4, Ignalina units 1 and 2 and Bohunice V1 units 1 and 2, in accordance with their respective decommissioning plans, while keeping the highest level of safety. During the legislative process of adopting the NDAP Regulation, there was a broad consensus in the Council in recognising the need for continued financing of decommissioning of the nuclear reactor units. Accordingly the Legislator intervened on the initial Commission proposal, in particular by increasing the budget for all three Member States and the duration of the assistance for LT and SK.

The baseline is defined by the detailed decommissioning plans submitted by each concerned Member State in 2014 and adopted by the Commission as annexes to the detailed implementation procedures. The programmes overall cost estimates were thereby included and updated with respect to previous issues; in one case the estimates were revised slightly downwards (-1% for the Kozloduy programme), whereas in the other two cases the estimates increased (+40% and +24% for the Ignalina programme and the Bohunice programme respectively). The increase of the Ignalina programme cost estimate came along with a nine-year extension of its overall duration.

The Commission assessed that the detailed decommissioning plans were complete, relevant, comprehensive, and the overall cost estimations were generally appropriate, as further supported by an independent review⁸. Thus both the limits of the scope of EU support and the baseline costs to monitor cost-effectiveness have been clearly drawn. The work breakdown structure and the schedule form the base for assessing the timeliness of the implementation.

3 IMPLEMENTATION / STATE OF PLAY

The decommissioning operators are all fully working on decommissioning activities. Slovakia has advanced the most and is currently carrying out Dismantling & Decontamination (D&D) in the reactor building at the Bohunice site. D&D is well advanced in the auxiliary buildings at the Kozloduy and Ignalina sites. In addition, the key safety-related project in Lithuania to remove the spent nuclear fuel from the RBMK reactor (similar to that used in Chernobyl) is now well underway. Defueling of Unit 2 reactor core was finalised on 25 February 2018 (i.e. 15 months ahead of schedule).

⁷ [COM\(2011\)783](#)

⁸ [Deloitte 2016](#)

The programmes are generally on track to achieve the specific objectives of the Regulations with the funding provided in this MFF. A clear trend towards increased efficiency has been observed throughout the monitoring activities, as confirmed by independent experts. In some areas, the risk of delays needs further mitigation and close follow-up.

At Kozloduy and Bohunice, the removal of spent fuel from the reactors and adjacent reactor pools and its transfer to an external dedicated interim storage facility (i.e. defueling) was completed during the 2007 – 2013 period. Defueling is currently underway in Lithuania at Ignalina. In February 2018, the second reactor has been completely defueled and the transfer of the remaining spent fuel from the ponds in the reactor building to the new safe storage facility is expected to be completed by July 2022.⁹

Important waste management infrastructure projects have recently been commissioned or are being commissioned at Kozloduy and Ignalina. Most of the other final key waste management infrastructure projects are approved and under procurement or implementation. This infrastructure is critical to the functioning of the ‘waste management systems’ set up for each programme and has been the object of much of the investment in the early years of the programmes. Slovakia already possessed much of the requisite infrastructure prior to decommissioning and the development of its waste management system is highly mature.

Actual physical dismantling of equipment is progressing quickly at all three sites compared to the first decade of programme implementation. This reflects the nature of nuclear decommissioning programmes, which requires significant upfront investment in planning and waste management infrastructure development as explained above. Dismantling & Decontamination (D&D) work in the Turbine Halls and Auxiliary buildings outside the Controlled Area has advanced substantially and is expected to be largely completed by 2020 at Kozloduy and Ignalina and significantly sooner at Bohunice.

Except for Bohunice, limited D&D work has been undertaken in the reactor buildings to date, reflecting the varying timelines of programmes. The Kozloduy & Ignalina programmes are currently preparing the technical design for the dismantling of the reactor cores / primary circuit, which will begin in the coming years. The Bohunice programme is advancing well in D&D of the primary circuit, with key projects well underway.

4 METHOD

4.1 Previous evaluations and other reports

The latest Commission's evaluation report dates back to 2011¹⁰. In the same period the European Court of Auditors realised a performance audit¹¹. Their recommendations were taken up in the 2014-2020 NDAP legal bases.

The European Court of Auditors has conducted a follow-up audit of the NDAP in 2015. The conclusions of the Special Report¹² issued on 20 September 2016 have been taken into account in the design of this evaluation.

A complete list of reports analysing the situation of the NDAP can be found in Annex 1.

⁹ Annual Work Programme 2017

¹⁰ [COM\(2011\)432](#)

¹¹ [ECA Special Report No 16/2011](#)

¹² [ECA Special Report No 22/2016](#)

4.2 Evidence from monitoring

The programme benefits from an intense monitoring process leveraging the strong managerial competences of the main stakeholders (Implementing Bodies, programme coordinators and decommissioning operators). The main stakeholders report to the Commission the progress of the technical and financial implementation in detail every six-month in a comprehensive quantitative monitoring report. It presents a comprehensive overview of the implementation including a comparison of the actual performance relative to the baseline schedule and progress made in achieving the objectives of the programme. Monitoring reports are reviewed and approved by the respective Monitoring Committees.

Based on the internal assessment of the results of periodic monitoring actions and the documentation provided by stakeholders the Commission drafts an annual report. Three such reports 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 have been issued so far: in 2015,¹³ in 2016¹⁴ and 2017.¹⁵

Besides the scheduled monitoring activities, the Commission commissioned an external study¹⁶, which included an evaluation of the programmes' global cost estimations, an overall risk assessment, an analysis of the national funds and other sources, and an analysis of the robustness of the state budgets. In addition in 2017, an auditor verified the conditions under which procurement procedures have been carried out by the Implementing Bodies under the NDAP.

4.3 Specific evaluation actions

In 2016, the Commission started the preparation for the mid-term evaluation by publishing the evaluation roadmap¹⁷ and by procuring in 2017 an external study¹⁸ to complement the existing body of evidence. The contractor's report addresses directly the evaluation questions and is based on in depth desk research, interviews with targeted stakeholders, field visits, analysis of the general public consultation and a targeted consultation, a benchmarking exercise with comparable instruments, and an expert panel. Annex 3 provides a detailed description of the contractor's activities.

The Open Public Consultation¹⁹ has been accessible for an extended period of 14 weeks from 23 June to 29 September 2017 and has elicited 20 contributions from the public.

The main stakeholders of the programme have been directly involved in the evaluation with regular reporting of the progress to the three Monitoring Committees and the Nuclear Decommissioning Assistance Committee.

4.4 Limitations and robustness of findings

Stakeholders with a deep knowledge of the programme are limited in number and generally directly involved in the programme in some way – e.g. Implementing Bodies, decommissioning operators and Programme Coordinators. This is due primarily to the technical nature of the programme and the limited circulation of detailed information outside this circle. This also likely

¹³ [COM/2015/078](#)

¹⁴ [COM/2016/0405](#)

¹⁵ [COM/2017/0328](#)

¹⁶ [Deloitte 2016](#)

¹⁷ [ENER - PLAN/2016/249](#)

¹⁸ [EY 2018](#)

¹⁹ <https://ec.europa.eu/energy/en/consultations/consultation-mid-term-evaluation-nuclear-decommissioning-assistance-programme>

contributed to the limited response received to the Open Public Consultation launched by the Commission or the targeted e-survey consultations launched by the evaluation contractor to external actors on the national level. Indeed, a number of stakeholders contacted for the targeted consultation responded that they did not feel adequately informed to respond to the survey.

The assessment of the efficiency of the assistance programme was rendered more difficult by a lack of relevant cost data from comparable decommissioning projects. Indeed, there are real barriers to sharing cost data publicly. At the moment, numerous cost estimates are available for decommissioning projects worldwide but few actual cost reports for completed projects have been made public.

Some challenges were faced in the analysis of efficiency internally within each programme and through comparison between programmes due to varying approaches for project / financial management. Each decommissioning operator has developed different work breakdown structures, cost structures and modalities for monitoring expenditure and results that are not entirely comparable between programmes, nor do they always align neatly internally within programmes. This presented challenges in analysis, in particular of efficiency, and limits comparison between programmes or with other decommissioning programmes. While it did not significantly impact the validity of findings, it limited the extent to which quantitative data from different sources could be fully integrated within and compared across programmes.

The introduction of the Earned Value Management (EVM) System in the three programmes from 2014 delivered valuable results. A full implementation of the system requires modifications in the procedures and organisations involved, from the decommissioning operators to their contractors and sub-contractors. While considerable progress has been noted, the progressive adoption of the methods and tools provided by the EVM System is still relatively recent; therefore the evaluation met some limitations in measuring actions and contracts started before the EVM System introduction.

The initial analysis of the intervention logic clarified that the possible social and economic impacts of the intervention, while considered explicitly in the 2011 IA, had not been associated to any objectives in the 2013 NDAP Regulations adopted by the legislator. These impacts have eventually been analysed in less detail than planned in the evaluation roadmap.

5 ANALYSIS AND ANSWERS TO THE EVALUATION QUESTIONS

The evaluation was conducted against the five main criteria set up by the Better Regulation guidelines and toolbox²⁰: relevance, coherence, effectiveness, efficiency and EU added value. The eight evaluation questions covering the five evaluation criteria are summarised in Annex 4. Unless otherwise specified, the answers and analysis refer to the period 2014-2017 and are based on the study prepared in support of this evaluation.²¹

²⁰ https://ec.europa.eu/info/better-regulation-guidelines-and-toolbox_en

²¹ EY 2018

5.1 Relevance

5.1.1 Evaluation Question 1

To what extent are the general and specific objectives of the NDAP still appropriate in relation to the existing needs?

5.1.1.1 The programme objectives at general and specific levels remain relevant

The general objective to *assist Member States in implementing the steady process towards the decommissioning end state of the reactors in question in accordance with their respective decommissioning plans, whilst maintaining the highest level of safety* and the specific objectives (see Table 3: Specific objectives of NDAP) set out for the programmes in Bulgaria, Lithuania and Slovakia in the 2013 NDAP Regulations remain relevant. Indeed, the underlying need to safely remove or reduce radiological hazards through decommissioning remains as long as all highly radioactive materials have not been treated; as well as the need for continued assistance to provide funds at the right time ensuring the uninterrupted decommissioning of the nuclear power plants in question.

Continued progress in the decommissioning at the three plants would likely have been impacted in the absence of EU support. The NDAP thus continues to support a stepwise reduction in the level of risk and radiological hazard at the three sites concerned, in particular at Ignalina where defueling operations are ongoing. Current decommissioning strategies for the three NDAP programmes remain aligned with the specific objectives set out for each programme.

5.2 Coherence

5.2.1 Evaluation Question 2

Is the NDAP coherent with the Euratom Treaty's acquis in the area of nuclear safety and responsible management of spent fuel and radioactive waste? and with the EU acquis in other relevant areas?

The assessment focused primarily on the extent to which the 2013 NDAP Regulations are themselves coherent with EURATOM / EU acquis.

5.2.1.1 The NDAP is coherent with the Euratom Treaty's acquis in the area of nuclear safety and constitutes an exception to the financial responsibilities for the management of spent nuclear fuel and radioactive waste

Coherence with the Euratom Treaty's acquis in the area of nuclear safety and management of spent nuclear fuel and radioactive waste has been embedded in the legal base of the NDAP. The preamble of the 2013 NDAP Regulations states that *the decommissioning of the nuclear power plant covered by this Regulation should be carried out in accordance with the legislation on nuclear safety, namely Council Directive 2009/71/Euratom, [and] waste management, namely Council Directive 2011/70/Euratom.*

The decommissioning activities have also been implemented in coherence with radiation protection law, covering basic safety and emergency preparedness and response. Reporting issued by Regulators between 2014 and 2016 has not signalled any exceeding of dose limits for staff and contractors working on site. Radiological activity surrounding sites is monitored in all countries and has shown no abnormal levels of radiological release to the surrounding environment. More generally, Regulators' reports and company policies of decommissioning operators indicate that requirements on the health and safety of workers are fully respected.

While the legal base ensures coherence, the NDAP itself constitutes an exception to some underlying principles enshrined in the Euratom acquis. On the one hand, the support provided by the NDAP has played an important role in accelerating decommissioning efforts in a safe

manner and avoiding the passing on of an undue burden to future generations, a fundamental principle in international and EU law. However, the NDAP derogates to the principle, sanctioned by the Council Directive 2011/70/Euratom, that the costs for the management of spent fuel and radioactive waste is borne by those who generated those materials. The exceptional nature of this programme is due to the specific historical context recognised by the Accession Treaties.

The Council adopted Directive 2011/70/Euratom on the safe and responsible management of spent fuel and radioactive waste management. Within this framework, complementary efforts are undertaken by the Commission to encourage and support all Member States in the development of solutions for long term management of spent fuel and high level radioactive waste in line with legal obligations, as communicated in its 2017 report²². These actions are highly complementary to the NDAP in that they provide support to the three Member States for aspects of decommissioning not covered by the NDAP (e.g. the final disposal of spent nuclear fuel).

5.2.1.2 The NDAP has also ensured coherence with other relevant EU acquis, in areas such as environmental and social protections

The implementation of the NDAP has been coherent with the principles and obligations of the Environmental Impact Assessment Directive.²³ Environmental Impact Assessments have been conducted across all programmes for both decommissioning programmes and /or individual projects in compliance with national law.

The NDAP has also been implemented in compliance with relevant social protections in EU law. The decommissioning process has entailed a process of organisational transformation, creating in some cases collective redundancies. These cases have been managed in compliance with relevant EU legislation, such as the Collective Redundancies Directive concerning the situation of workers affected by decisions of employers to lay off a group of employees or the Transfer of Undertakings Directive protecting employees' rights in the event that an undertaking is transferred from one employer to another.

While the NDAP was coherent with the relevant social acquis, stronger linkages could have been assured with some EU instruments, namely the European Structural and Investment Funds (ESIF). National authorities remained solely responsible for designing strategies to mitigate the socio-economic impact of plant closure. However, in none of the three Member States did the relevant authorities adopt formal strategies as is recognised as best practice.

5.3 Effectiveness

5.3.1 Evaluation Question 3

To what extent have the objectives of the NDAP been achieved for each of the three programmes?

The aim of this question was to measure the extent to which the NDAP's objectives, general, specific and detailed, have been achieved to date and are on track to be achieved. In the evaluation framework, this question has been addressed through five sub-questions assessing overall progress achieved and risks of non-achievement (EQ3.1), the factors influencing positively and negatively progress (EQ3.2), the extent to which the level of risk at each site has been improved (EQ3.3), the adequacy of the monitoring & control systems (EQ3.4) and the effectiveness of communications actions (EQ3.5).

²² [COM/2017/0236](#)

²³ [Directive 2011/92/EU](#)

5.3.2 Evaluation Question 3.1

Overall, what level of progress has been made towards the objectives of each national programme? Is the progress in line with the decommissioning baseline adopted by the Commission? If not, what is the risk that objectives will not be achieved?

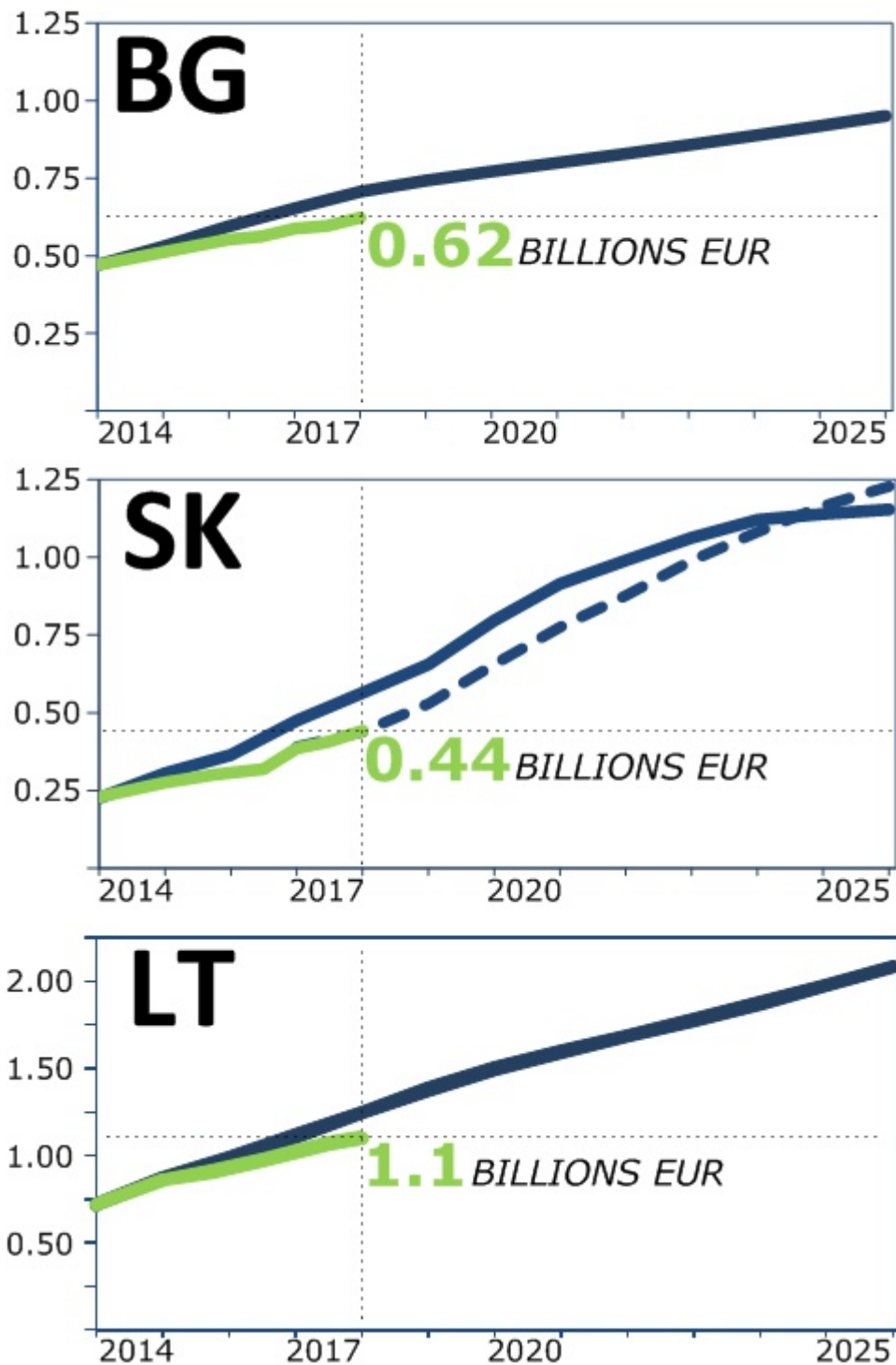
5.3.2.1 Programmes overall are making reasonable progress towards objectives, but continued proactive efforts will be necessary

Major achievements have been reached in the Ignalina and Kozloduy programmes with regards to key waste management infrastructure projects that had been hampered by serious setbacks in the past financial framework. In Lithuania, the commissioning of the Intermediate Spent Fuel Storage Facility puts the programme on track to complete the critical task of defueling. In Bulgaria, the on-going commissioning of the Plasma Melting Facility and the Size Reduction & Decontamination Workshop open the way to ramping up D&D activities and clearing out waste backlog.

Programmes can generally be considered to be on track towards achieving the objectives set for this programming period – with some delays to recover. In particular, the Bohunice programme has worked proactively to optimise programme implementation in the final years in light of some technical challenges previously faced. The Kozloduy programme will also need to define a path for recovering delays, partly due to issues faced in the previous MFF, which have impacted the pace of advancement in the Controlled Area. The generally satisfactory progress, as well as the room for improvement, is reflected in the key performance indicators, including the physical progress indicators (presented in the following subsections) and the Schedule Performance Indicators. The critical path analysis shows that it remains possible to achieve the NDAP objectives and to complete the decommissioning programmes within the planned time. However, the Schedule Performance Indicators show that the programmes are accumulating delays in projects which are not on the critical path. Figure 3 shows how the Earned Value (green line), a global indicator of progress across the whole of activities making up each programme, is lagging slightly behind the Planned Value (blue line) as determined in 2014 by the decommissioning plan. The dashed blue line represents the mitigating actions for the implementation of the Bohunice programme (see section 0) confirming the programme end date by 2025. See Annex 5 for a short introduction to the main EVM indicators and to the principles of critical path analysis.

Figure 3 Evolution of Earned Value Management indicators

EARNED VALUE VS BASELINE, *BILLIONS EUR*



Source: Monitoring reports 2017-H2

At present, there is not an immediate risk that the status of on-going waste management infrastructure projects – e.g. the Near Surface Repository and Landfill Facility at Ignalina and the Near Surface Repository at Kozloduy – will impact wider decommissioning efforts, because temporary storage facilities are sufficient. These particular projects should continue to be monitored carefully. In addition, the capacity in treating waste streams appears adequate at this point in time, but it shall be monitored against D&D objectives.

5.3.2.2 Progress against waste management targets has been slow to date, although programmes should be able to recover delays

The physical performance indicators demonstrate lower than expected progress to date across all three programmes. This underperformance has mainly been the result of uncertainties concerning radiological inventory and / or lack of anticipation of regulatory procedures leading to under or overestimations of target values, slower than planned progress with D&D activities, technical challenges related to specific legacy waste streams and some delays in the commissioning of waste management facilities. These delays remain largely recoverable at present (during the current MFF).

5.3.2.3 D&D works in the turbine halls and auxiliary buildings come to an end in Slovakia and are progressing well in Lithuania & Bulgaria

At Bohunice, this stage of decommissioning is currently winding down with the final projects approaching completion. At Kozloduy and Ignalina, D&D work is advancing well or even ahead of schedule in the turbine halls and other auxiliary buildings. Monitoring reports show that decommissioning operators have successfully managed to identify and address inefficiencies and remove bottlenecks as they have been identified. This represents the culmination of significant efforts on the part of decommissioning operators, in particular in Lithuania by virtue of the relatively large volume of equipment to be dismantled and the fact that the equipment in the Ignalina Turbine Hall is subject to a higher degree of contamination and thus requires relatively greater effort.

5.3.2.4 The Bohunice programme has embarked on major physical works in the Controlled Area, whereas the Ignalina and Kozloduy programmes remain in the preparatory phase

Since the beginning of the current MFF, significant D&D work has begun in the Controlled Area in Bohunice. Some early technical challenges have been met, but the decommissioning operator has sorted them out and set out an optimised implementation strategy to avoid impact on time and minimise impacts costs. This activity will form the largest part of works during the remainder of the current MFF and drives the critical path of the overall programme in its final stages.

Minor works have been conducted to date in the Reactor Buildings and other auxiliary buildings in the Controlled Area at Kozloduy and Ignalina. Both programmes remain at different stages of the preparatory phase for D&D work in this area. At Kozloduy, an important study is underway to develop the technical approach for D&D of large components in the Controlled Area. During the current MFF, early physical works have not advanced entirely as foreseen in the baseline schedule due to late delivery of the Decommissioning Licenses linked to difficulties in the previous MFF with regards to the approval of the Environmental Impact Assessment. At Ignalina, the technical design work is at a relatively earlier stage. While this work has made significant progress, some difficulties have been encountered with a potential impact on the start of large-scale physical works (in any case scheduled beyond the current MFF). In this area the Ignalina programme faces technical challenges associated with its first-in-kind nature, whereas the Kozloduy programme can draw on lessons learnt from Bohunice and Greifswald NPP in Germany.

The following sub-sections provide a more detailed assessment of progress achieved for each programme, as well as the main risks identified.

5.3.2.5 Bulgaria

The three specific objectives for the Kozloduy Programme are:

- Performing dismantling in the turbine halls of units 1 to 4 and in auxiliary buildings;
- Dismantling of large components and equipment in the reactor buildings of units 1 to 4;
- Safely managing the decommissioning waste in accordance with a detailed waste management plan.

D&D activities are progressing well outside of the Controlled Area, in particular in the Turbine Hall (Specific Objective 1)

The first dismantling work of non-nuclear equipment was initiated in 2010, but dismantling only commenced at full pace at the beginning of the current MFF due to late transfer of Units 3 & 4 to SERAW management during the previous MFF. One of the key objectives of the current programming period is to finalise dismantling of the Turbine Hall for Units 1 – 4 (and other auxiliary buildings). This includes the dismantling of approximately 40 400 tonnes of metal from 160 main and auxiliary systems. SERAW is currently on track to accomplish this objective by August 2019, despite facing some early issues. By the end of 2016, 21 628 tonnes of metal had been dismantled from the equipment of the Turbine Hall. This represents 96% of the planned target to date as per the Annual Work Programmes. In addition, 7 744 tonnes of civil structure have been demolished in the turbine hall by the end of 2016 – 122% of planned progress to date.

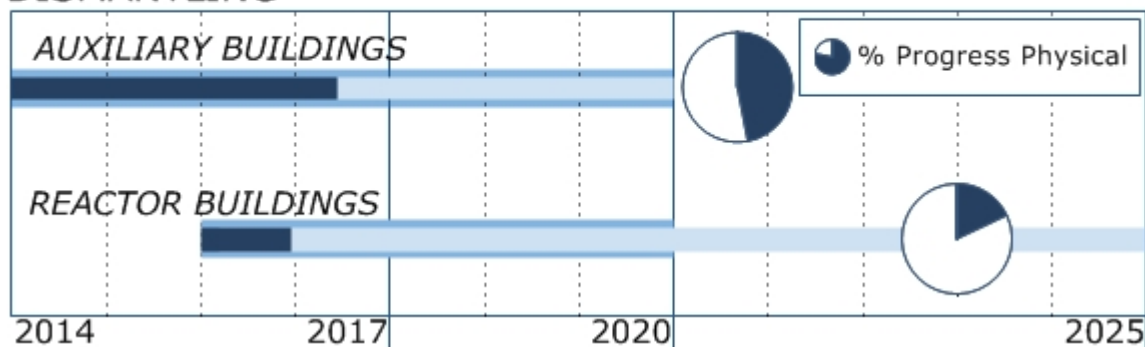
Progress has been slower than expected thus far in the Controlled Area (Specific Objective 2)

Initial physical dismantling work in the Controlled Area has been undertaken in serviced and semi-serviced areas since 2014. By the end of 2016, 299 tonnes of material in the Controlled Area had been dismantled – 75% of planned target to date as per the Annual Work Programmes. In order to avoid a build-up of dismantled material in the Controlled Area awaiting subsequent decontamination, the pace of dismantling was decreased in 2016 until commissioning of the SRDW planned for 2017 in the 2017 Annual Work Programme. The delay in the commissioning of the SRDW was due to mainly to procurement delays stemming largely from the previous MFF. Recovery measures are planned to be taken to increase capacity through work in shifts once the SRDW is operational.

More significant D&D works in the Controlled Area started in 2016, approximately two years later than planned. This is largely due to delays in the delivery of the Decommissioning Licenses that stem from the previous MFF.

Figure 4 Kozloduy Programme dismantling physical progress

**OBJECTIVES / MAIN ACHIEVEMENTS
DISMANTLING**



Source: Monitoring reports 2017-H1

Figure 4 shows the physical progress of the dismantling activities. It illustrates the ratio between the actual quantity of dismantled materials (dark blue) to the total quantity to be dismantled (light blue) and put it in relation to the scheduled duration of those activities.

Waste management infrastructure projects are on a positive trajectory, with key infrastructure expected to be commissioned in 2018 (Specific Objective 3)

The construction of the National Disposal Facility will allow for disposal of low and intermediate level short lived radioactive waste. The absence of a disposal path for the waste produced would eventually block decommissioning activities. The transboundary Environmental Impact Assessment started in the previous MFF resulted in significant delays. It affected the approval of the technical design and issuance construction permits. SERAW took mitigation measures to minimise the impact of delays by restructuring the project scope. In an important milestone, the Regulator approved the National Disposal Facility technical design in March 2017 and the construction permit was issued shortly thereafter.

The Plasma Melting Facility relies on an innovative technology to significantly reduce the volume of radioactive waste to be disposed of. This allows reducing by the same factor the disposal costs. In the past MFF, this project suffered from a number of difficulties and delays, which have been eventually resolved during this MFF. The commissioning of the facility is on-going.

Progress in those two key projects and other projects like the construction of the Size Reduction & Decontamination Workshop is critical for removing bottlenecks, in particular for processing contaminated materials arising from the decommissioning operations, and to expand the capacity of SERAW to match future expected waste flows from decommissioning.

Performance of radioactive waste management activities has also been impacted by wider delays in the decommissioning process. Technical issues faced with the removal of legacy waste from Auxiliary Buildings, for example, has impacted waste management activities. Similarly, delays in work in the Controlled Area can explain the low level of progress achieved to date. Performance gaps can also be noted with free release of materials. While the level of progress achieved against the detailed objectives in the detailed implementation procedures has been low to date, the programme has consistently performed in a satisfactory manner against annual targets set in the Annual Work Programme, suggesting that the waste management system is capable of performing when progress with dismantling allows.

5.3.2.6 Slovakia

The three specific objectives for the Bohunice programme are:

- Performing dismantling in the turbine hall and auxiliary buildings of reactor V1, to be measured by the number and type of systems dismantled;
- Dismantling of large components and equipment in the V1 reactor buildings, to be measured by the number and type of systems and equipment dismantled;
- 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.

The dismantling of the Turbine Hall is completed and the last auxiliary structures (cooling towers) are under demolition (Specific Objective 1)

By 2016, the dismantling of non-active systems had been almost achieved: the Diesel Group and Electric Power Supply Systems, the Technical Equipment in the Turbine Hall and the external buildings. The last project remaining under implementation is the dismantling and demolition of the V1 NPP four cooling towers. The project is planned to be completed in 2018.

Work in the Reactor Buildings has started, initially with some technical difficulties, and preparatory work on the dismantling of large components is expected to start by the end of 2017 (Specific Objective 2)

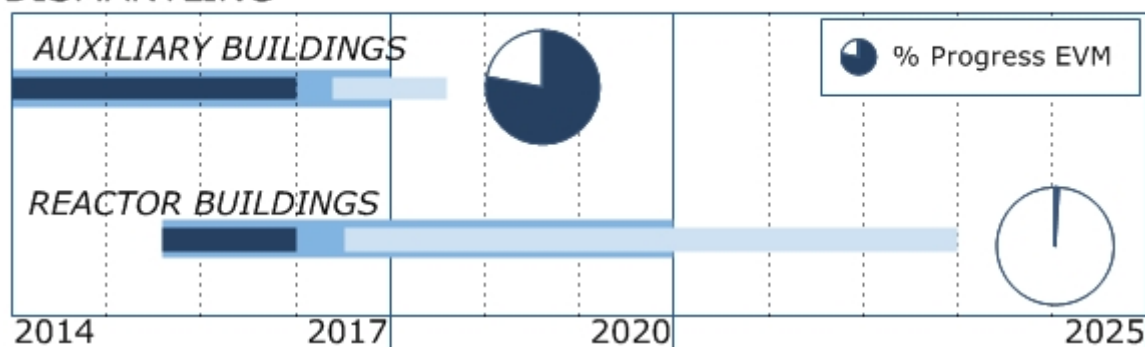
JAVYS received the license for the stage 2 of decommissioning (Controlled Area) in December 2014 which gives the green light to begin the dismantling process in the Reactor Building. One project has already been completed: the dismantling of insulation in Controlled Area with the dismantling of the technological equipment and piping systems.

Difficulties with the implementation of the decontamination of the primary circuit have delayed subsequent projects. The decontamination of the primary circuits is a pre-condition for the dismantling of the primary circuits of Bohunice V1 NPP. After several months of implementation, including the establishment of the decontamination circuit technology on the reactor vessel, the original contractor faced severe technical difficulties and was unable to finalise the project. The contract was terminated in 2016 in what constituted an important setback. JAVYS however developed a full revision of the project and the technology implemented by the original contractor to learn from this experience and gain know-how. The decision was taken to select a new contractor through direct tendering and the decontamination process restarted in 2017. The project has now been successfully completed.

Most of the subsequent dismantling projects are on the programme critical path and depend on successful completion of the decontamination. In consequence, the dismantling of the reactor coolant system large components has been rescheduled for completion in 2022 (compared with 2020 in the baseline schedule). In order to optimise the final steps of the programme and ensure the completion of the activities by 2025 despite the delays incurred, JAVYS has reorganised the scope of some projects to allow their simultaneous implementation and developed a new strategy for the implementation of the three final projects concerning the Reactor and Auxiliary Building decontamination, building decommissioning, backfilling and site restoration so that they are implemented under one contract. These changes should allow to recover the incurred delay at the expense of an increased complexity in projects interfaces and tendering process.

Figure 5 Bohunice Programme dismantling physical progress

OBJECTIVES / MAIN ACHIEVEMENTS DISMANTLING



Source: Monitoring reports 2017-H1

Figure 5 shows the physical progress of the dismantling activities. It illustrates the ratio between the actual quantity of dismantled materials (dark blue) to the total quantity to be dismantled (light blue) and put it in relation to the scheduled duration of those activities.

Most legacy waste and waste produced by the decommissioning of non-Controlled Areas have been safely stored and the last storage facilities are under construction (Specific Objective 3)

The Bohunice programme has benefited from the availability of existing waste management infrastructure for several contextual reasons (operation of several other reactors on site, shutdown and decommissioning of the A1 reactor prior to the V1 reactors). The last two waste management projects are about to be brought to operation. The Interim Radioactive Waste Storage facility was opened in August 2017 and additional radioactive waste disposal capacity at the Mochovce disposal site will be available in 2018.

The quantities of processed waste reported in the Monitoring Reports are significantly lower than the overall targets. This is however not a signal of underperformance in waste processing. It is rather mainly due to the time shift of projects concerning the primary circuit dismantling and demolition of V1 NPP cooling towers resulting in a less waste being produced up to 2017.

5.3.2.7 Lithuania

The three specific objectives for the Ignalina Programme are:

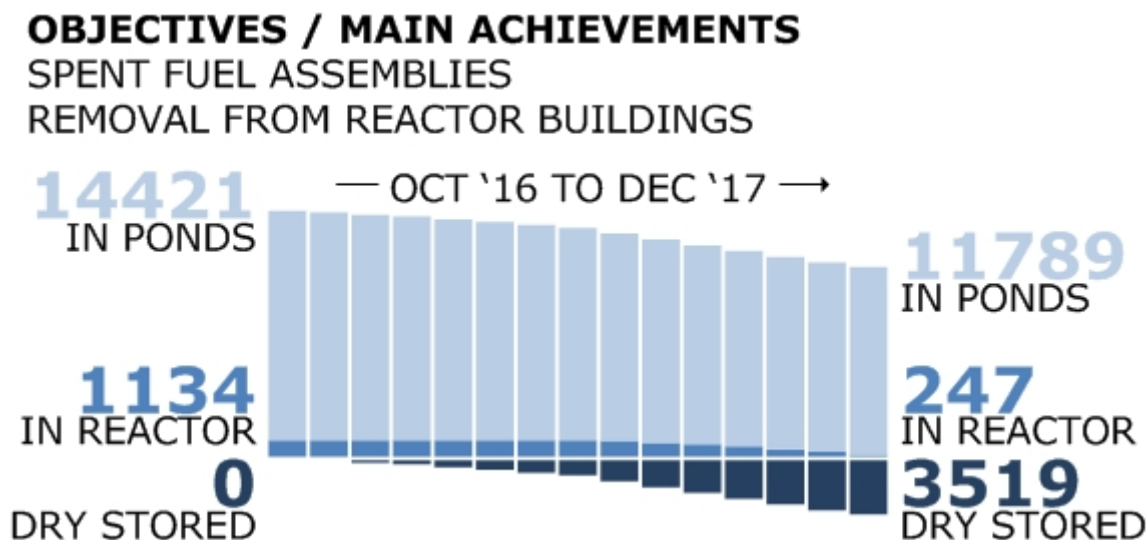
- Defueling of the reactor core of unit 2 and the reactor fuel ponds of units 1 and 2 into the dry spent fuel storage facility;
- Safely maintaining the reactor units; and
- Performing dismantling in the turbine hall and other auxiliary buildings and safely managing the decommissioning waste in accordance with a detailed waste management plan..

Defueling operations are proceeding well following the commissioning of key waste management infrastructure (Specific Objective 1)

With the start of operation of the Interim Spent Fuel Storage Facility in October 2016 a major milestone has been met allowing for the critical process of defueling to start. In addition, defueling of Unit 2 reactor core has been completed on 25 February 2018, 15 months ahead of schedule.

The Interim Spent Fuel Storage Facility project had accumulated significant delays in previous programming periods due to a variety of factors that eventually led to a suspension of disbursements in January 2013. These delays had a direct impact and contributed significantly to the extension of the overall duration of the decommissioning programme in the latest version of the detailed decommissioning plan. In 2013, a new management of INPP started working quickly to resolve outstanding issues with the contractor. Significantly, pending commercial issues were resolved in November 2015 with no increase in the contract price.

Figure 6 Ignalina Programme progress of defueling operations



Source: Monitoring reports 2017-H2

Figure 6 shows the progress of the transfer of the spent fuel from the reactor core to the fuel ponds in the reactor building and finally to the dry storage in the Interim Spent Fuel Storage Facility, the end stage in the scope of the NDAP. Since 2011, as the pre-existing dry storage facility was fully occupied, 1134 spent fuel assemblies remained in the reactor of unit 2 and the spent fuel ponds were fully filled with 14421 assemblies.

INPP has ensured continued safe maintenance of Units 1 & 2, as well as the safety of decommissioning activities (Specific Objective 2)

The continuing presence of nuclear fuel in the reactor and spent fuel ponds requires the maintenance of a high level of safety including: i) sub-criticality of spent nuclear fuel; ii) heat removal from the reactor's core and spent nuclear fuel pools; and iii) confinement of radionuclides, installation of barriers suppressing ionising radiation and control over release of radionuclides.

Since 2014, INPP staff has ensured safe maintenance of Units 1 & 2 without any incident as classified by the INES scale.²⁴ The national nuclear safety authority, VATESI, carries out regular inspections and technical checks at INPP predominantly focused on safety requirements during maintenance, fire safety and ageing management of structures, systems and components important to safety. VATESI also monitors INPP's safety culture through a safety culture index evaluating the less obvious factors that could have an impact on safety. The indicator has been maintained at an acceptable level during the period under evaluation.

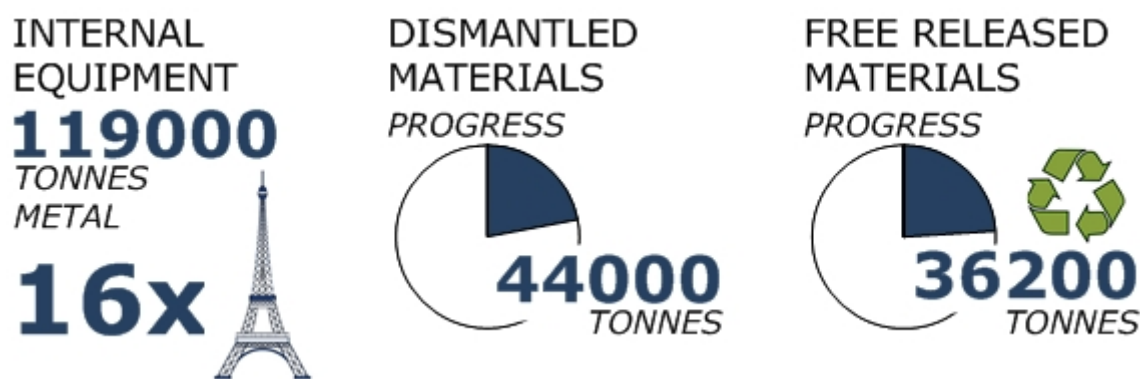
²⁴ The International Nuclear and Radiological Event Scale (INES) is a tool for communicating the safety significance of nuclear and radiological events to the public. It goes from 1 ('anomaly') to 7 ('major accident').

D&D activities are progressing well in the Turbine Hall and auxiliary buildings (Specific Objective 3)

Dismantling activities are currently ahead of schedule in terms of overall number of tonnes of equipment dismantled in the Turbine Hall. By the end of the first semester of 2017, 26 862 tonnes of equipment had been dismantled in INPP – 107% of the planned total to date as per the Annual Work Programmes and 66% of the 2020 target. Equipment dismantled from the Turbine Hall made up the large majority of this tonnage – approximately 85%. Work in the Turbine Hall is currently expected to be completed by June 2019 in line with the baseline schedule.

Decontamination activities are progressing well, with 2 901 tonnes dismantled and decontaminated from 2014 to the end of 2016. Fragmentation and decontamination facilities in the Turbine Hall entered routine operation in 2014. Due to the higher-than-expected progress in dismantling, some challenges were initially faced with the quantity of wastes generated. In 2015, INPP formulated a plan for the more efficient use of space within the Turbine Hall as buffer storage in order to more effectively decouple dismantling/fragmentation activities from the decontamination line. In addition, the decontamination capacity is being expanded to ensure higher decontamination throughput in coming years.

Figure 7 Ignalina Programme progress of dismantling activities



Source: Monitoring reports 2017-H2

As shown on Figure 7, the total amount of material is equivalent to 16 times the weight of the Eiffel tower. At present, over 25% has been dismantled and a large part of that material could be decontaminated to a level that allowed its recycling outside of the nuclear industry (free release).

Important achievements in key waste management infrastructure, but other key infrastructure projects underway should be monitored closely (Specific Objective 3)

The Ignalina programme achieved important milestones with the on-going commissioning of the Solid Waste Management and Storage Facility (SWMSF). This progress represents an important achievement for the Ignalina programme having in mind the criticality of this infrastructure for the decommissioning process and the level of difficulties that had been faced in previous programming periods with these large projects.

A number of other key infrastructure projects remain in early stages of implementation and have faced difficulties resulting in delays in their preparation. The award of the contract for the landfill facility for short-lived very low level waste was delayed in the tendering process for several months. The schedule for the Near Surface Repository (NSR) for low & intermediate level short-lived waste has slipped due to delays incurred during the design phase during previous programming periods and a protracted approval process under the current MFF. Finally, progress on the bituminised waste storage facility remains dependent on a number of unknown variables due to close proximity with other facilities and upgrade works.

While slippage in project schedules can be noted, delays do not risk creating significant bottlenecks in waste streams in the medium-term at the time of the evaluation.

Challenges faced during the preparatory design activities for D&D in the Reactor Building will not significantly impact programme performance during the current MFF, but create the risk of delays after 2020

Although not an objective included in this programming period, the start of physical D&D activities in the Reactor Buildings may be delayed due to challenges faced in the preparation of design work

The Ignalina programme initially called on external expertise for the development of the technical design and safety documentation for a number of pilot D&D projects. However in 2011 INPP has made the decision to conduct much of the preparatory technical design work for D&D in house. Since, the programme has largely used internal resources to leverage expertise of former plant staff and reduce the cost of this activity.

Delays in preparatory design activities for D&D in the Reactor Buildings have resulted from technical challenges and inadequate internal expertise. As a result, the programme is currently behind the projected schedule for those activities. However, these delays should be largely recovered during the current MFF once works begin given current project timelines. Preparatory work for D&D in the reactor shaft has lagged behind due to a lack of qualified personnel and overall rethinking of the general approach. INPP has also come to the conclusion that preparatory work for the dismantling of the irradiated graphite from the core cannot be completed relying only on in-house resources. Technical Specifications for the procurement of technical support to complete this work is currently underway over seven years after the procurement for the original project was cancelled.

These challenges should have limited impact on the achievement of objectives for the current MFF, but may lead to a delayed start of large-scale physical works in the post-2020 period.

5.3.3 Evaluation Question 3.2

What external and internal factors influenced (positively and negatively) the progress of the decommissioning programmes?

5.3.3.1 The (on-going) commissioning of key waste management infrastructure projects is supporting a ramping up in decommissioning activities

The construction of waste management infrastructure is often not thought of as being part of the decommissioning process itself. However, this infrastructure is a necessary pre-condition for decommissioning to begin. As such, it is included in the detailed decommissioning plan where existing infrastructure is not adequate or available. The three Member States had varying level of pre-existing infrastructure in place. Slovakia, where decommissioning of Bohunice A1 had begun before Bohunice V1 decommissioning started, had a well-developed infrastructure already in place, whereas Bulgaria had some existing waste treatment and disposal facilities, and, for historical reasons, Lithuania had almost none of the required infrastructure on its territory.

For this reason, the three programmes started in radically different conditions, with new infrastructure requiring years for design, construction and commissioning. Adding to this, major infrastructure projects in Bulgaria and in particular Lithuania were delayed for years in past programming periods. Notably the lack of Interim Spent Fuel Storage Facilities contributed to slowing down the overall decommissioning process at Ignalina.

Consequently, the start of operations of key waste management infrastructure in these two countries since 2014 has had and will have a significant positive impact on the pace of decommissioning work.

5.3.3.2 Recent years have seen an acceleration of organisational transformation, providing a strong support framework for decommissioning programmes

The transition from operation to shut-down and finally decommissioning requires that the necessary organisational support systems be put in place to manage these complex processes. This transition, as with all organisational transitions requires time, clear objectives and the deployment of effective change management efforts. Previous audits and assessments²⁵ have underlined the importance of organisational issues in effectively supporting the decommissioning programmes and found that organisational changes in some cases had been too slow. This issue is over at this point in time.

The transition process at Kozloduy has been successfully completed with the handover of ownership of Units 1 – 4 from the power plant operator (KNPP) to the decommissioning operator (SERAW) in 2013. The hand-over of responsibility, including the transfer of project ownership and some plant personnel, was a complex and time-consuming process that diverted energies away from the overall programme management duties.

At Ignalina, a new leadership team was put in place at INPP in 2013 bringing positive changes. In addition to quickly addressing commercial disputes that affected the construction of the Interim Spent Fuel Storage Facility, the new management team has embarked upon a number of important organisational reforms. A Project Management Department was re-established in 2014 in order to concentrate decommissioning project management functions and improve planning, execution and control of activities.

At Bohunice, the share of internalised expertise had strongly increased over years. Indeed, the support by external consultant was progressively reduced; having successfully transferred mainly the project management know-how. This was reinforced by experience gained from the decommissioning of the Bohunice A1 reactor also implemented by JAVYS but without EU support.

5.3.3.3 International experience in the decommissioning process remains low, in particular for the final stages of decommissioning

As underlined in the Nuclear Illustrative Programme of the European Commission²⁶, only three of more than 90 shut-down reactors in the European Union are completely decommissioned. Hence decommissioning is not considered a fully mature industry. If decommissioning has been proven to be entirely feasible, R&D efforts are continually leading to improvements in methods and technologies and hold significant potential to reduce the cost and uncertainty. Yet, many of these technologies are starting to be implemented on an industrial scale. In this context, the possibility of unexpected technical difficulties or project failure remains an inherent part of the decommissioning process.

As programmes progress towards the critical step of dismantling in and around the reactors, the technical challenges become more complex. The experiences in the Bohunice programme, as well as experiences at similar facilities such as Greifswald, have illustrated that decommissioning operators must be prepared to rethink or reorganise their approach when confronted with unexpected challenges. In the Kozloduy and the Ignalina programmes the design for this stage of decommissioning is being formulated, thus important open questions remain. While the Kozloduy programme can rely on existing experience (in particular Bohunice), in the case of Ignalina these challenges are further compounded by the first-in-kind nature of this undertaking: no reactor of the RBMK design has yet been dismantled and open questions remain amongst international experts concerning processing solutions for irradiated graphite.

²⁵ [ECA Special Report No 16/2011](#) and [IP/D/CONT/IC/2013_054](#)

²⁶ [COM/2017/0237](#)

5.3.3.4 *Administrative issues have also impacted programme effectiveness*

The effectiveness of programme implementation has also been impacted by risks in the administrative realm that could have been completely or at least partially avoided. For example in Bulgaria, the delay in ratification of the Nuclear Indemnity Agreement for the Plasma Melting Facility created a significant risk for the project. More generally the decommissioning operators have also had difficulties correctly anticipating some regulatory issues.

These challenges reflect in part the limited experience with the regulatory and administrative aspects of decommissioning at the national level. This has entailed a strong learning curve for decommissioning operators and national authorities. This capacity building aspect constitutes an asset especially for Slovakia and Bulgaria which will be faced in the future with other decommissioning projects.

5.3.4 Evaluation Question 3.3

To what extent has the level of risk at each nuclear site been improved thanks to the NDAP support?

5.3.4.1 *Since reactors final shutdown, the level of risk for the general public at each site has been reduced in a stepwise manner.*

The radiological hazard has been reduced notably with the defueling of reactors and the decontamination, dismantling and disposal of contaminated and irradiated equipment and materials. The choice of an immediate dismantling strategy, made possible by the EU financial support, implies that the radiological hazard are being reduced without undue delay, along with the risks related to aging facilities after shut-down and loss of expertise at the facility.

More than 99% of the overall level of radioactivity in nuclear reactors is associated with the spent nuclear fuel; removal of the spent fuel from the reactor buildings and storage into an interim storage facility drastically reduces the potential impact of radiological hazards.

Under the previous programming period, the NDAP supported the construction of interim spent fuel storage facilities in Kozloduy and Ignalina (operational since 2016) utilising the best available technology on the market to ensure long-term safe storage until final disposal. The NDAP supported the defueling activity in Kozloduy and Bohunice which resulted in a significant risk reduction. The remaining radiological hazard concerns primarily workers inside the nuclear facility. In comparison, a higher level of risk remains at Ignalina until the completion of defueling activities planned for 2022. Current defueling work, financed by the NDAP, will bring the overall risk levels for Ignalina in line with those that can be observed presently in Bulgaria and Slovakia.

5.3.4.2 *Monitoring of safety-related issues at EU level can be strengthened to better reflect the overall purpose of the programme*

The driving factor behind the NDAP from its beginning has been the reduction of the risk to the general population posed by these facilities. It has also sought to ensure that decommissioning is conducted in a safe manner. It can be noted that these aspects have not been well captured in the high level monitoring framework that is the basis for communication of the results to external parties. High level safety indicators could include for example, the evolution of the inventory of radiological material on site.

5.3.5 Evaluation Question 3.4

To what extent are Monitoring & Control systems in place to measure the progress of the decommissioning programmes?

5.3.5.1 The NDAP follows clearly defined objectives, with detailed work breakdown structures, schedules and costs

In 2011 the ECA observed²⁷ that, *'the Commission did not ensure that the broad priorities...were translated into a coherent set of detailed targets and indicators....None of the [stakeholders] has established a system to monitor and assess the progress towards the achievement of the overall objectives...Monitoring and reporting on programme achievements at all levels were therefore difficult'*.

The Commission responded to these findings by strengthening the clarity of the general and specific objectives for each programme in the 2013 NDAP Regulations. These were further elaborated in detailed objectives in the detailed implementation procedures. On the operational level, all Member States have developed robust detailed decommissioning plans – which also form part of the legal base of the programme. These plans are broken down to the level of decommissioning activities, including a schedule and corresponding costs structure based on internationally recognised standards for the estimation of decommissioning costs.

The decommissioning plans were reviewed by the Commission at the outset of the programme and then by an independent consortium of consultants²⁸. The critical review found that the detailed decommissioning plans were complete, relevant and comprehensive - i.e. include all necessary activities to reach the defined decommissioning end-state.

5.3.5.2 An adequate monitoring framework has been developed

The programme's objectives and decommissioning plans provide a clear baseline and framework for the monitoring and control of programme implementation. The monitoring framework further includes performance indicators, targets and milestones for each of the detailed objectives. In total, 37 indicators are set out in the detailed implementation procedures of Kozloduy (10), Ignalina (13) and Bohunice V1 (14). Besides they are complemented by 18 other common indicators. All beneficiaries maintain detailed, activity and project-level schedule performance milestones and report twice per year (to the Commission) against this framework.

This framework has been further enhanced since 2014 through the roll out of the EVM. Schedule Performance Indicators (SPI) are now reported systematically at the project level and at the global programme level. This provides for a simplified analysis of schedule performance, and provides useful aggregate-level indicators for strategic decision-making.

The performance monitoring framework for the NDAP is generally in line with best practice observed in other EU programmes. Result indicators are directly relevant to the detailed and specific objectives for each programme. Their limited number focuses on the most relevant results sought by the programme.

The quality and relevance of some NDAP specific indicators, including the use of targets and milestones, could be further improved. While no evolution in the context or decommissioning strategies would merit changes to the specific objectives, some of the targets, milestones and performance indicators as they are presently formulated for the programmes should be adapted or updated to ensure effective monitoring until 2020 and for several years after. This follows from the evolution of the activities organisation within the scope of the detailed decommissioning plan; from the opportunity to take full advantage of the improvements

²⁷ [ECA Special Report No 16/2011](#)

²⁸ [Deloitte 2016](#)

introduced in the reporting framework and from the fact that funds committed up to 2020 will continue to be disbursed over a period of several years following the last commitment due to the multi-annual nature of decommissioning projects. Additionally, further simplification in the comparability of the indicators throughout the three programmes is desirable.

5.3.5.3 Adequate mechanisms have been put in place to produce monitoring data but reporting and programming documents can be further streamlined

Decommissioning operators for all three programmes have continued efforts to enhance monitoring and control systems. Beneficiaries have put in place mechanisms to produce internal monitoring reports for the use of managers covering schedule and cost performance. They have also ensured adequate capacity to produce mandated EU-level monitoring reports and provide necessary monitoring information to the Implementing Bodies, even if reporting procedures could be further streamlined to improve efficiency according to some stakeholders.

Programmes have generally defined adequate performance frameworks and are capable of producing the requisite monitoring data; better structuring and filtering of information in monitoring reports would provide additional strength in a simplified manner. In particular, the evaluation assessed the quality of the bi-annual monitoring reports and the annual work programmes. Overall, these documents are very comprehensive and allow assessing the programme implementation. Nonetheless, a number of areas for improvement were identified, including the heterogeneity of the reports and their length.

5.3.5.4 The rollout of EVM has contributed to strengthening programme monitoring, but continued efforts can be made to perfect its use in practice.

The use of EVM represents a significant progress towards strengthening the monitoring framework and creating a common progress measurement framework. It provides for a greater degree of objective comparison of the performance of the three programmes and supports strategic oversight at EU.

The implementation has been gradual from 2014 and driven top-down by the Commission. Whilst all programmes are now systematically reporting using EVM, the implementation process has been and continues to be a learning experience and fine-tuning has been on-going. At the time of evaluation, EVM schedule and cost performance indicators were provided by all programmes for most projects and activities. Indicators are computed both against the annual work programmes and the detailed decommissioning plan baseline. It is thus possible in most cases to assess progress against annual targets, but more importantly identify any longer-term slippages against the decommissioning baseline and in this way take appropriate and timely action.

More generally, the EVM system is not designed to function as an additional layer of reporting. Rather, best practice is to fully embed EVM in the management system – e.g. the processes, tools, practices and culture – of an organisation. This is necessary to ensure the robustness of performance indicators, but also the impact of EVM as a management tool. In general, INPP appears to have in place the most mature level of implementation of EVM within the three decommissioning operators. This is due largely to the fact that the organisation made the decision to implement the tool independently of and previous to the Commission's decision to adopt this tool. Decommissioning operators would derive long-lasting benefits from fully embedding this cutting-edge tool into their management systems. The use of EVM in the decommissioning programmes and the lessons learned from its application will thus have return on investment beyond the scope of the NDAP.

5.3.6 Evaluation Question 3.5

Are the communication actions addressed to the stakeholders and the public effective, adequate and accurate?

The adequacy of communication activities was assessed primarily in so far as they contributed to the effectiveness of the decommissioning process. The extent communication activities may have fulfilled other objectives was secondary.

Communication activities are primarily undertaken by decommissioning operators as the primary stakeholders involved in decommissioning activities. These activities are focused on both local and national audiences. They include communication on safety and environmental aspects of interest by local populations, as well as general awareness-raising about decommissioning activities.

All sites have close ties with local communities and other relevant stakeholders. Local communities had very close ties to the plants by virtue of many (generations of) residents being employed by the plants. They are thus generally aware of safety aspects of nuclear power and used to living in the vicinity of a nuclear facility.

Communication activities respected EU visibility rules. Local populations are highly knowledgeable of the EU assistance provided to decommissioning. The power plants have traditionally been the main employer in the surrounding areas and the population is thus well aware of developments with regards to decommissioning. This was also supported by the politically sensitive nature of the closure of the reactors and the attention received in the national press.

Communication activities within the framework of the NDAP at EU level related to the statutory reporting required by the legal base (e.g. reporting to the Council and the Parliament and to the Member States through the NDAP Committee). The Commission's website provides the statutory reporting documents and a brief description of the programme with little information beyond this. The publicly available annual reporting informs the European public on the progress and the state of play in the implementation of the programmes.

5.3.7 Evaluation Question 4

Aside from the financial assistance provided, what other types of results and impacts can be attributed to the NDAP?

Going beyond the effectiveness of the NDAP in terms of making progress against the decommissioning plans, this evaluation question seeks to measure other types of positive and negative effects and impacts that have been generated by the NDAP in each country.

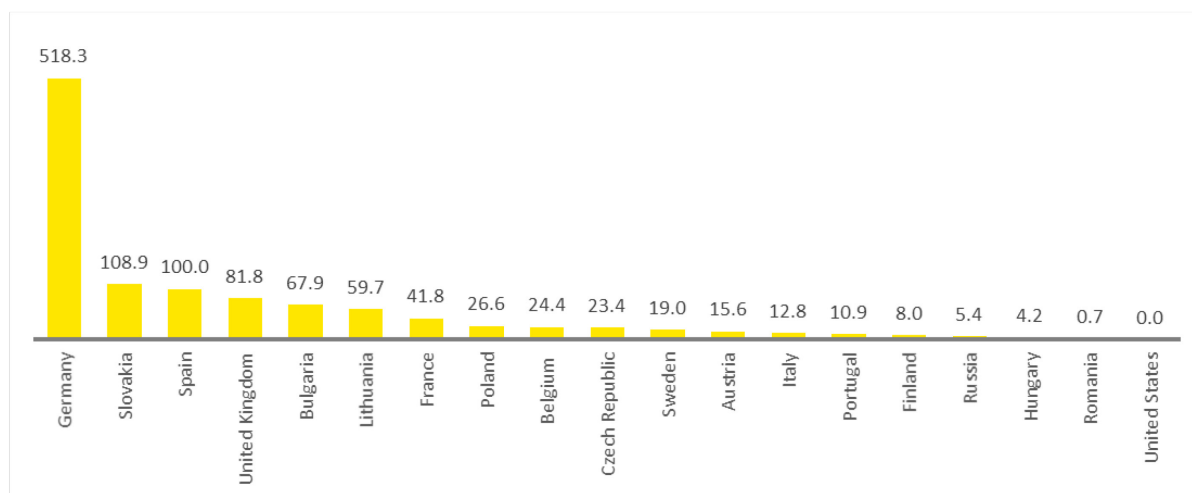
5.3.7.1 *Economic impact is mainly related to the direct impact of NDAP-funded contracts*

As of 2017, approximately 350 procurement contracts have been signed in execution of NDAP financed projects, representing approximately EUR 1.1 billion injected into the decommissioning market.²⁹ An indicative repartition of contract value has been made based on the simplistic assumptions that the contract value is equally divided amongst consortia partners, shares going to subcontractors are ignored and that the nationality of the contracting entity is counted rather than that of the ultimate parent company.

²⁹ This excludes contracts under the annual support projects for INPP in Lithuania, mainly for maintenance and general running costs. This amount has been included in the overall amount reported to the European Commission in the context of the programme reporting, representing approximately EUR 27 million since 2010.

The largest beneficiaries were large nuclear consultancy / engineering firms, such as NUKEM Technologies (Germany), GNS (Germany), Iberdrola (Spain), Empresarios Agrupados (Spain) or NNC (UK) amongst others. These firms provided extensive project management and engineering support to programmes, in particular through external project management assistance contracts for EBRD-financed projects.

Figure 8: Indicative repartition of contract value by Member State from programme beginning to present (EUR million)



Source: EBRD, CPMA contract data

Local industry in Bulgaria, Lithuania and Slovakia has benefited significantly from contracts funded through NDAP. These are generally smaller companies providing works and services, as well as engineering and consultancy services to a smaller extent. Significant amounts of contracts awarded to foreign companies can actually remain in the country. Data provided by decommissioning operators provides a picture of the significant amount of benefit sub-contracting represents. For the Bohunice programme, a total for EUR 54 million from recent contracts awarded to foreign companies remained in the country – benefiting 62 Slovak consortia partners. This represents approximately 28% of the total value of these contracts. A similar trend can be noted with some examples in Bulgaria. In Lithuania, the decommissioning operator conducted analysis for EUR 404 million in projects (including the ISFSF and the SWTST) and found that approximately 35% (EUR 136,8 million) likely benefited local contracts.

However, few local companies in Bulgaria, Lithuania or Slovakia took part in business opportunities in other programmes. If Slovakia had the highest level of national participation in its programme, only one Slovak company has won work in Bulgaria or Lithuania so far. The Lithuanian firm Specialus montažas-NTP was the only local companies in Lithuania to implement work in the other two NDAP countries to date.

Finally, it can be noted that significant business opportunities were captured by leading EU nuclear consultancy and engineering firms, which have the potential to serve as repositories and transfer mechanisms for knowledge and experience developed during these projects as they assist other decommissioning projects in the future. While it is important that knowledge be retained and transferred in the public sphere (as an EU-financed project), private companies can also play a role in this process.

5.3.7.2 Innovation gain

The programmes have allowed showcasing advanced or new technologies, providing EU companies with valuable references. At Kozloduy, for example, the plasma melting facility

represents only the second application of this technology in the domain of nuclear waste management in the world. Demand for such cost-effective technologies can be expected to grow in coming years with the expected growth of the wider decommissioning market.

The process of decommissioning is also an opportunity to collect knowledge and experience. There is a significant need for reliable data about decommissioning process to improve the accuracy of plans and properly assess the cost of it. Valuable information includes: the evaluation and optimization of decommissioning options, the modelling of dismantling techniques, the evaluation of safety in decommissioning; and waste management scenarios.³⁰ It allows for further development of specific codes for decision making process and planning in decommissioning, which can be considered as an additional important impact of the NDAP with economic dimension.

Apart from the above, no other examples were found of truly innovative technology developed by companies or decommissioning operators as part of NDAP; nor do decommissioning operators conduct extensive R&D. The Ignalina programme holds the highest potential for the development of innovative technologies as the conditioning and storage of irradiated graphite is subject to extensive R&D in the world and no clear solutions are yet available.

5.3.7.3 Experience gain

All three decommissioning operators are considering leveraging the experience gained into future commercial opportunities. For example, JAVYS has made concrete steps in this direction at present. The experience and credential gained through the NDAP may thus contribute to an additional return on investment for the European economy through the emergence of new decommissioning companies active on the European and international market, in the same way that it has contributed to developing the expertise and experience of large engineering firms as previously described.

5.3.7.4 Social impact

The process of decommissioning is linked with a decrease in the number of employees, which may have a negative impact on the economic development of particular regions³¹. Indeed, the early closure of the eight units concerned by the NDAP has inevitably had some negative socio-economic impact on the areas where these NPPs are located. The NPPs were important sources of employment in these regions, even the most important local employer. However significant differences from one Member State to another can be noted, depending on the existence of other working reactors on site (Slovakia, Bulgaria) or not (Lithuania).

In this context, the NDAP has helped to mitigate these negative impacts, notably by influencing the decommissioning strategy of Member States. The NDAP exercised a strong influence on the choice to pursue an immediate dismantling strategy in Bulgaria and Lithuania.³² This created a logical opportunity for former NPP staff, with strong knowledge of the facilities, to participate in the decommissioning process. Under the alternative scenario of deferred decommissioning, staffing requirements would have dropped much more precipitously. In these Member States, the decommissioning process has leveraged the skills and expertise of a significant number of former NPP staff. The NDAP has thus supported employment of these staff for decommissioning work, whereas this employment may have otherwise been lost in absence of EU support.

³⁰ Innovative and Adaptive Technologies in Decommissioning of Nuclear Facilities; Final report of a coordinated research project 2004-2008; IAEA, 2008

³¹ Managing the Socioeconomic Impact of the Decommissioning of Nuclear Facilities, IAEA <http://www-pub.iaea.org/books/IAEABooks/7782/Managing-the-Socioeconomic-Impact-of-the-Decommissioning-of-Nuclear-Facilities>

³² In Slovakia, this strategy had been selected independently from NDAP.

However, it should also be noted that the preservation of employment to the extent that it is not indispensable to decommissioning and safety is at odds with the objective of supporting cost-effective programme delivery. Indeed, desires to minimise social impacts on the national level contradicts the effort for the cost-effectiveness of the decommissioning process.

5.3.8 Evaluation Question 5

How effective is the governance and project management framework at EU and national levels?

The study³³ of comparator instruments and programmes allowed taking stock of some of the advantages and disadvantages of the different approaches that could be used to implement the NDAP. It concluded that indirect management is an appropriate tool and that changing management mode for delivery of the NDAP at present would induce costs not compensated by the expected benefits.

Due to the high level of capacity and expertise necessary to implement the NDAP and the historical context, indirect management was chosen and implementation tasks were delegated to the EBRD. The EBRD had a recognised expertise and experience delivering similar programmes. Since their accession and with the encouragement of the Commission, two Member States have subsequently decided to establish national implementing channels. These 'national agencies' thus coexist alongside the EBRD in Lithuania and Slovakia during a transition period. Indirect management has the advantage of ensuring the requisite level of expertise and capacity while avoiding the necessity to increase headcount in the Commission and it is appropriate for the size and type of the given programmes. The flexibility offered by this management mode has also contributed to gradually developing national ownership of the programmes through the subsequent creation of the national agencies.

Alternatively, the Commission could have managed the programme directly, in particular with the growing recourse to Executive Agencies to manage the implementation tasks of large EU programmes. While legally distinct entities, Executive Agencies are very close to the Commission in terms of their regulatory framework, business processes and working practices. In-sourcing management, either to the Commission or an Executive Agency, could lead to reducing some of the natural transaction costs of the indirect management model. However, such a decision would also require the development of an adequate level of internal expertise, in addition to the necessary capacity.

The other alternative, shared management, would offer the advantage of shifting greater responsibility to the Member States and possibly increasing the level of 'ownership'. This is the setup being used for the management of ESIF. However, this alternative is more relevant for large programmes and not for programmes of the size of NDAP, it would be disproportionate in the NDAP case.

While changing management mode in a future programme could potentially lead to some benefits as discussed above, it should also be recognised that it would imply a period of overlap during which new projects would be implemented under the new management mode, while on-going projects would continue to be implemented under the previous regulatory framework. Past experience has shown that the co-existence of regulatory frameworks creates significant administrative complexities and engenders inefficiencies in programme management.

³³ [EY 2018](#)

5.3.9 Evaluation Question 5.1

How well are roles defined and effective at EU level in terms of planning, monitoring and reporting?

5.3.9.1 The roles and responsibilities of the Commission are clearly defined and appropriate

The roles and responsibilities of the Commission are clearly set out and provide for a logical division of responsibilities when considered alongside the roles and responsibilities set out for other actors. The evaluation study³⁴ considers them appropriate for supporting effective programme implementation while safeguarding the Union interests. The Commission has retained largely strategic oversight responsibilities in line with its available internal resources, with administrative implementation tasks delegated to specialised bodies with strong technical and administrative competencies.

5.3.9.2 The Commission fulfils obligations with regards to the annual programming cycle, but the time-lines have not proven realistic.

The Commission plays an important role in the annual programming cycle. It approved the decommissioning plans (baselines) and reviews and adopts, after seeking the opinion of the NDAP Committee, the Annual Work Programmes. On this basis, it adopts annual Financing Decisions and provides funding to the respective Implementing Bodies. At the end of the year, a Progress Report is transmitted to the European Parliament and the Council, which serves as the basis for the adoption of the next Annual Work Programme.

In practice, timely delivery in this process has proven difficult. The importance of addressing the issue is recognised by all actors and the Commission has initiated reflection on possible solutions, notably modifications to the detailed implementation procedures. Specifically, the timeline should be re-thought, as well as the sequencing of and linkages in processes and streamlining or otherwise adapting the content of programming documents.

The Commission also has the authority to decide on the eligibility of individual projects (and any amendment thereof) and to grant conditional approvals as it deems necessary for safeguarding Union interests. Most projects are approved within 4 to 6 weeks, nonetheless stakeholders underlined the need for clearer timelines for project approval as the time necessary for approval can be prolonged in some rare cases when the Commission deems necessary to obtain specific guarantees before approving a project (e.g. co-financing of near surface repositories at Kozloduy and Ignalina). More generally, the process for approval of projects at EU level may also be rethought.

5.3.9.3 The NDAP Committee is acting as defined by its mandate, but the timeliness and relevance of information provided to Committee members could be improved

The NDAP Committee is a "comitology committee" set up in accordance with Article 291 of the TFEU and Regulation 182/2011, to control the Commission's exercise of implementing powers.

By its own account, the NDAP Committee is fulfilling its mandate as described in EU legislation. However, NDAP Committee members interviewed³⁵ reported the issue of timeliness in managing the programming cycle and that Monitoring Reports should focus on issues relevant to high level oversight.

³⁴ [EY 2018](#)

³⁵ [EY 2018](#)

Beyond its statutory purposes, the NDAP Committee meetings have also provided the opportunity for Member states to share their knowledge on the decommissioning process. In the first years of the programmes (before the current MFF), this flow of knowledge came from ‘experienced’ Member States to programme beneficiaries, whereas now the flow has been reversed and decommissioning operators are sharing their experiences with other Member States. This is perceived as a positive aspect by the Committee members interviewed and a strong incentive for attendance.

5.3.9.4 *Implementing Bodies are fulfilling their responsibilities and playing a technical oversight role*

The Implementing bodies are responsible for the proper performance of activities as fund manager and the sound financial management of projects. This includes establishing thorough monitoring and control systems, requesting funds from the Commission, supporting the development of programming and project documentation, monitoring of implementation, control of procurement, assessment of cost eligibility, payments and financial management and recovery of irregularities.

Overall, the evaluation contractor³⁶ found that Implementing Bodies (i.e. EBRD and CPMA, with SIEA having recently commenced their activities at the time of the evaluation) were effectively fulfilling their responsibilities as per the framework described above. These organisations have been subject to the required pillar assessments³⁷ and various external verification/audits in recent years that confirm their aptitude and performance.

In practice, Implementing Bodies were also found³⁸ to be playing an important role in providing strategic technical oversight to programme implementation. They can rely on internal nuclear expertise and extensive experience with implementation of complex projects.

The transition between implementing bodies – in this case from an international organisation (EBRD) to national agencies (CPMA and SIEA) – implies a transition period with multiple active Implementing Bodies. Coordination challenges that have been observed in previous programming periods are now being avoided with clear boundaries between projects attributed to different implementing bodies, adequate integration of programming activities at the monitoring committee, and enhanced cooperation between the relevant stakeholders. The installation of a national agency was promoted by the respective Member States and is considered a good practice for enhancing ownership of the programme and increasing capacity at national level.

5.3.10 Evaluation Question 5.2

At national level, how well are the roles of the Programme Coordinator defined and effective in terms of: planning; monitoring; and reporting?

Early political resistance in Member States in past MFFs has given way to acceptance and greater ownership at present. The political commitment obtained by the EU for the early closure of the reactors in the three Member States was met with some domestic resistance in early years, with negative impacts on both the political and technical levels. Already before the end of the previous programming period, this resistance had progressively given way to widespread acceptance of the irreversible shutdown of reactors, which has also become a technical reality in the present MFF. Increasingly, this has also translated into an assumption of greater ownership over the decommissioning process itself on the part of national

³⁶ [EY 2018](#)

³⁷ https://ec.europa.eu/europeaid/funding/about-funding-and-procedures/audit-and-control/pillar-assessments_en

³⁸ [EY 2018](#)

governments. This process is recognised by the Commission as a necessary condition of continuing to consolidate the governance of the NDAP.

While clear progress has been made in raising the profile and role of national governments in the NDAP, the findings of the evaluation study³⁹ also point to the need for further progress. National ministries in Lithuania and, in particular, Bulgaria, could continue to strengthen their levels of technical capacity in order to exercise stronger technical oversight of programmes – i.e. acting as informed clients.

If the detailed implementation procedures gives to the Programme Coordinator overall responsibility for drawing up the Annual Work Programme, their role in practice mostly focuses on the administrative aspects of the programming process – e.g. coordination and formal submission of the documents. The decommissioning operators retain a large degree of influence on the programming in practice – and subsequent development of projects - even if it is developed within the strategic framework of the detailed decommissioning plans.

The case of Bulgaria merits a separate discussion as these issues have been further aggravated in recent years by political instability. At the time of the evaluation, a new government was formed following several months of a caretaker government. The Bulgarian administration has also had difficulties addressing administrative issues in a timely manner, which has impacted the advancement of the programme.

Regardless of the technical capacity of national ministries and other obstacles faced, the detailed implementation procedures also limit the extent of the involvement of Programme Coordinators. The introduction of Monitoring Committees presided over by the Programming Coordinators is an important step in designating a more strategic role of national ministries in the NDAP governance framework. However, the role of this committee is confined to formally validating Monitoring Reports. While stakeholders participating in these committees have reported quality dialogue on progress and good coordination between stakeholders, the scope of this committee's role is ultimately limited. Greater scope to make decisions, with regard to project approval, for instance, may provide greater impetus for Programme Coordinators to make further investments in strengthening their role in the programme. However, such procedural changes would be dependent on also strengthening the technical capacity of Programme Coordinators. They would also be supported through continuing to develop the financial buy-in of Member States in the programmes.

5.3.11 Evaluation Question 5.3

How effective is the governance system of the decommissioning programmes?

This question addresses the effectiveness and of the governance system and extent it is fit-for-purpose, with regards in particular to its ability to: i) develop robust and coherent work programmes, and ensure adequate ii) monitoring, iii) coordination and communication, and iv) project management.

5.3.11.1 Programming documents

The NDAP programming documents are generally robust, coherent and developed in line with the detailed implementation procedures. The strengthening of the clarity of objectives and the incorporation of the detailed decommissioning plan baseline schedule has also contributed to improving the quality of programming documents under the current programming period. The Annual Work Programmes are thus by definition closely aligned with the detailed decommissioning plans developed by the Member States, helping to ensure the relevance of EU assistance.

³⁹ [EY 2018](#)

However, the timeline and process set out in the detailed implementation procedures has not been tenable in practice despite the best efforts of all stakeholders (see 5.3.9.2). Beyond modifying the detailed implementation procedures to make the process more practical, a more radical move could also be envisaged to adopt a multi-annual programme as is common in other EU programmes.

5.3.11.2 Strengthened monitoring framework

As previously discussed, the monitoring of programme implementation has been significantly enhanced under the current MFF addressing weaknesses identified in previous programming periods. The complementary use of Earned Value Management has also contributed to strengthening monitoring and the overall accountability framework. These efforts have contributed to strengthening the Commission's strategic oversight role, whereas in the past the European Court of Auditors⁴⁰ has criticised it for focusing too much on financial implementation at the expense of programme effectiveness and efficiency.

5.3.11.3 Implementing bodies and Programme coordinators

Implementing Bodies have played a key role in supervising day-to-day implementation of the decommissioning programmes. As noted, they can notably rely on extensive internal experience, relevant expertise and capacity. In this way, they also play an important technical oversight role in the context of relatively weaker supervision and oversight by national governments notably Lithuania and Bulgaria. Nonetheless, as this role is somewhat beyond their legal responsibilities.

However, Programme Coordinators have increasingly taken a stronger role in programme oversight and ownership. Recognising the importance and positive impact of greater national ownership⁴¹ on supporting effective and efficient programme delivery, the Commission has encouraged this process on both the political and procedural level. Today, Programme Coordinators are active in the programme governance, but some still require additional technical capacity to provide stronger oversight of programmes and their role in the governance framework could be further enhanced to promote stronger ownership and leadership.

5.3.11.4 Coordination and communication

The Programme Coordinator role has also evolved to increasingly emphasise the responsibility for coordination and communication with relevant national stakeholders, as well as complementary sources of national financing contributing directly and indirectly to the decommissioning programmes. As national governments have become more engaged in the NDAP governance, this aspect has been naturally strengthened. As a positive sign of this evolution, the participation in Monitoring Committees has widened to regularly include relevant national stakeholders, such as regulatory bodies and relevant sectoral ministries.

5.3.11.5 Project management capabilities have progressively been strengthened

Previous evaluations and audits⁴² have underlined the need to strengthen project management practices at the level of beneficiaries. Closely connected with this are the wider questions of the organisational transformations necessary to support the decommissioning process. As discussed previously and as reported in previous progress reports, decommissioning operators have progressively put in place more robust project management systems and taken steps necessary to adapt their organisations to the needs of the decommissioning process. This has been

⁴⁰ [ECA Special Report No 16/2011](#)

⁴¹ [COM/2016/0405](#)

⁴² [ECA Special Report No 16/2011](#)

reflected in the quality of project management structures and, increasingly, stronger project management cultures.

5.4 Efficiency

5.4.1 Evaluation Question 6

To what extent is the management of the decommissioning programmes cost effective and efficient?

The objective of this question is to measure the extent to which the desired outcomes of the NDAP are achieved at a reasonable cost. Efficiency will therefore measure how the resources/inputs are converted to results and how the systems in place, including the monitoring and reporting systems and governance, assist in efficiency.

5.4.1.1 The last revision of cost estimates (2014) resulted in small decrease for one programme and an increase for the two others

At the outset of the current MFF, the concerned Member States formally submitted updated nuclear decommissioning cost estimates as part of their updated detailed decommissioning plans. The new cost estimates resulted in a relative stability for the Kozloduy programme with a variation of EUR 11.1 million (-1%), and an estimated cost increase for the Bohunice and Ignalina programmes of EUR 289 million (+24%) and EUR 1 643 million (+40%) respectively. This comprehensive revision of the detailed decommissioning plans answered the 2011 recommendation of the ECA⁴³ that required a detailed assessment of the needs showing the progress of the programmes so far and the activities still to be performed.

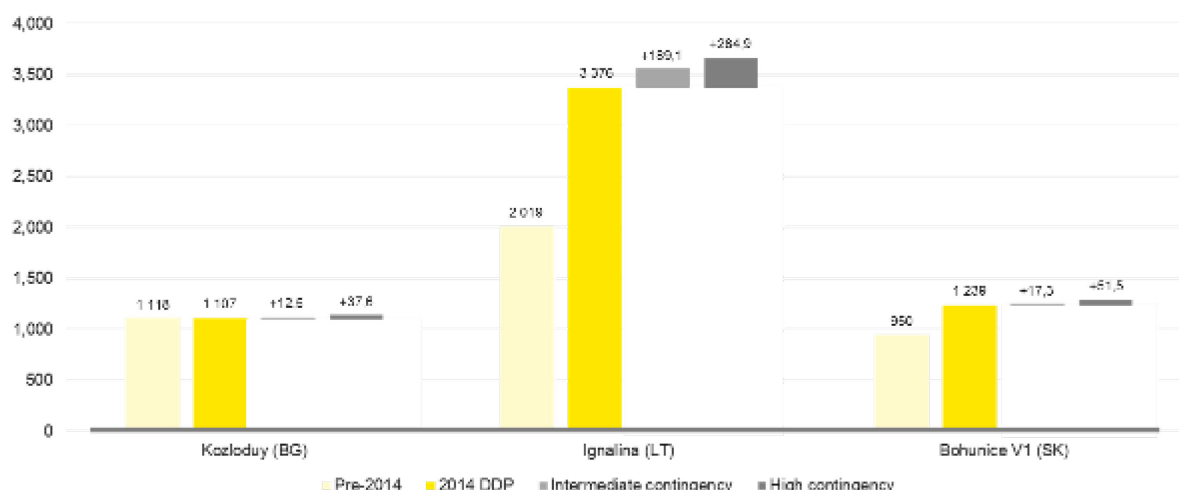
The increase in cost estimate for the Ignalina programme came in the context of a nine year extension of its overall duration; not surprisingly, a large part of the cost increase can be attributed to time-dependent costs associated with project duration, such as energy resources and personnel costs. The cost increase also reflected project costs escalation and the inclusion of additional costs identified by a more detailed analysis.

An independent review was undertaken of the detailed decommissioning plans and cost estimations in 2016⁴⁴. The study confirmed that the overall base cost estimations for the three programmes, as stated in the detailed decommissioning plans, are generally appropriate. However, the report also underlined that cost estimation may benefit from further adopting cost estimation methodologies in line with evolving international experience. In particular, it was found that the allowances made for contingencies in the cost estimations for all three programmes did not entirely follow best practice methodologies. Allowance for contingencies were consequently on the lower end of international practice for similar projects. The revised contingency scenarios calculated by the consultants may thus provide a more robust estimation of the potential total cost of the decommissioning programmes taking into account risks in line with best practice (see figure below).

⁴³ [ECA Special Report No 16/2011](#)

⁴⁴ [Deloitte 2016](#)

Figure 9: Evolution of cost estimates for decommissioning programmes and revised contingency scenarios (EUR million)



The total decommissioning cost numbers include inflation and contingency or risk

Source: Decommissioning plans, Deloitte 2016

5.4.1.2 All three programmes currently remain on track to implement decommissioning programmes according to current cost estimates

Notwithstanding the independent assessment of the adequacy of contingencies, the updated (2014) programme cost estimates were expected to be maintained at the time of the evaluation. The analysis of programme implementation (section Effectiveness5.3) would also suggest that programmes remain broadly on track when compared against the baseline schedule and that there is no major risk at present of further cost increases due to time delays, as least for what concerns the achievement of the objectives defined under this MFF. This is considering that slippages against the schedule may reasonably be recovered through proactive and close management.

However, Bulgarian authorities are in the process of revising the cost estimate as outcome of a review of their decommissioning programme. This is part of the regular three-year review cycle of the decommissioning plan. As a consequence of this review, the total cost estimate for completing the Kozloduy decommissioning programme is going to increase by 23%. However, the national contribution has been correspondingly increased to cover an important amount of the funding gap.

5.4.2 Evaluation Question 6.1

To what extent has the NDAP been cost-effective when considering each activity and cost category compared against performance indicators?

5.4.2.1 EVM indicators point to satisfactory cost effectiveness to date

The implementation of EVM in the three programmes has provided for the first time a means for an easier monitoring of cost performance at project and programme level and for making cost performance comparisons between the programmes. Since 2014, the earned value of the programmes has been largely aligned with or in excess of actual costs. This is usually expressed by the Cost Performance Index which is calculated by dividing the 'earned value' of progress achieved to date by the actual costs incurred. Earned value is the baseline budget for the work actually completed by the specified date. In the case of the three decommissioning programmes the resulting cost performance indicator is approximately 1 or higher. This demonstrates that

programmes have been achieving the outputs at the expected costs or less. No other cost-efficiency indicators are used in programme management at programme or EU level.

5.4.2.2 A detailed assessment of cost-effectiveness and comparison between the programmes is difficult

A previous study⁴⁵ sought to assess the cost-effectiveness of programmes on a more granular level considering individual activities and expense categories against relevant performance indicators. However, this task is rendered difficult by the differences in the approach to budgeting, programming, tracking expenditure and monitoring results within each programme. Indeed, the budget structure for cost estimates does not always align with the work breakdown structure used for planning and programming, which itself is not always possible to align with the headings used for tracking budget implementation or results monitoring. It is thus not possible to fully integrate the quantitative data from the budgeting, programming, expenditure or monitoring documents in any sort of robust and systematic manner.

One can also note the inherent difficulties in comparing decommissioning programmes. Even if all three programmes have relied on the International Structure for Decommissioning Costing (ISDC) standardised cost structure for developing their budgets, the methodology allows for enough flexibility for the programmes to be difficult to compare. This limitation of the ISDC methodology is recognised in publications by its promotor, the Nuclear Energy Agency,⁴⁶ for example in Costs of Decommissioning Nuclear Power Plants.⁴⁷

5.4.2.3 Programmes have generally been implemented in a cost-effective manner

To overcome the difficulty to identify univocally cost per activity and compare the programmes amongst themselves an ad hoc and qualitative approach has been adopted. In the study supporting this evaluation⁴⁸, each programme has been analysed for good practices and sources of inefficiencies. **This analysis supported the overall conclusion that programmes have generally been implemented in a cost-effective manner.** However, looking at the principal areas of activities and cost categories, some variation can be noted in function of the different challenges faced. More generally, the findings also pointed to the need to continue to rebalance resources towards core decommissioning tasks to improve cost effectiveness.

5.4.3 Evaluation Question 6.2

What are the major factors impacting the efficiency of the assistance programmes? What are the root causes of these factors?

As described in the previous section, the cost performance of all three programmes has generally been satisfactory to date. This stands in contrasts to difficulties with some programmes faced in the past. As noted in ECA audits⁴⁹, until 2013 many of the key decommissioning infrastructure projects have experienced delays and / or cost increases. The successful completion or current positive trajectory of projects having faced chronic problems in the past, such as the Interim Spent Fuel Storage Facility in Lithuania or the Plasma Melting Facility in Bulgaria, would seem to suggest that decommissioning operators have successfully integrated lessons learnt and built up internal capacity. Some good practices have also been identified that are helping to ensure the general cost-effectiveness of the programme implementation. Despite these positive signs, delays and budget slippages in some projects can

⁴⁵ [Deloitte 2016](#)

⁴⁶ <https://www.oecd-neo.org/>

⁴⁷ <http://dx.doi.org/10.1787/9789264255555-en>

⁴⁸ [EY 2018](#)

⁴⁹ [ECA Special Report No 16/2011](#) and [ECA Special Report No 22/2016](#)

still be noted since 2014. A number of different issues impacting efficiency are identified in this section.

On a more structural level, the strength of the incentive framework put in place through co-financing and its potential impact on the overall cost-effectiveness of the programme is analysed. The overall programme governance framework on the other hand, can generally be considered to be supporting programme cost effectiveness.

5.4.3.1 Defining an adequate co-financing level

The three Member States have contributed (and will continue to contribute) a significantly to their decommissioning programmes. At present the already disbursed and committed national funding represent EUR 458 million for Bulgaria, EUR 476 million for Slovakia and EUR 478 million for Lithuania; that is respectively 34%, 38% and 14% of the estimated cost of the decommissioning programmes. The ECA has called for increasing the level of co-financing in order to support ownership by Member States and create a stronger incentive for cost-effectiveness.

All three Member States have established dedicated Funds, which provide part of the financing. Other national resources come from the national budgets.

Creating an adequate level of economic self-interest is an important factor in encouraging economy-seeking behaviour in beneficiaries in the context of EU assistance programmes. Recognising this, the legal base notes that full financing of activities should be limited to "*well-founded exceptional cases and that every effort should be made to continue the co-financing practice established under the pre-accession assistance and the assistance provided over the period 2007-2013*". This brief mention in the preamble to the 2013 NDAP Regulations refers to a practice of co-financing that was never clearly established under previous programming periods. Notably, the NDAP has not formally set a maximum level of EU co-financing or formalised a framework defining how national resources can or should contribute (e.g. at project or programme level, to certain types of projects or activities, etc.). Nonetheless the Commission has continued efforts to raise the level of national contribution, both at the project and programme levels. It has also introduced stronger conditionalities requiring risk-sharing in the event of increase in project cost and requirements to offset any cost increases through reductions in other areas of the programme. These efforts have been met with varying levels of cooperation on the part of the three Member States. Slovakia has notably committed to increase programme funding from national resources by 28% from EUR 372 million to EUR 476 million. Similarly Bulgaria has set an amount for national contribution at EUR 458 million, and Lithuania at EUR 478 million.

In order to assess this issue/aspect in a broader context, the study supporting this evaluation⁵⁰ has considered a comparison with other programmes. Two of them, the Connecting Europe Facility (CEF)⁵¹ and ESIF Major Projects⁵², have clearly defined frameworks for co-financing, with EU co-financing rates clearly set out in the legal base. For the CEF, grants for works included co-financing levels varying between 20% - 75%. For ESIF Major Projects, the co-financing rates reflect those defined for European Structural and Investment Funds and vary between 50% - 85% (95% in exceptional cases). A comparison was also made with budget support operations⁵³ where the practice of 'co-financing' was similar in some ways to the NDAP. Budget support operations support partner countries' development strategies, often in a specific sector, for which national resources are also mobilised. However, the idea of co-financing strictly speaking

⁵⁰ [EY 2018](#)

⁵¹ [Regulation \(EU\) 1316/2013](#)

⁵² [Regulation \(EU\) 1303/2013](#)

⁵³ [EuropeAid Guidelines N°7](#)

does not exist. For budget support operations, the level of Union funding allocated is based on a number of needs and performance criteria following a more qualitative than mechanistic assessment.

The CEF and ESIF Major Projects thus ensure that an adequate incentive structure is in place through a clear framework for co-financing. If a cost increase is accepted, the beneficiary contribution for a project automatically increases. On the other hand, budget support creates incentives to perform through the use of variable tranches based on actual performance against pre-agreed performance indicators.

5.4.3.2 Performance of co-financed projects

Increased levels of national contribution would very likely continue to encourage greater national ownership and economy-seeking on the part of beneficiaries. However, the performance of the few co-financed projects to date does not suggest that these are consistently more efficient or effective than those financed entirely through EU support.

A review of Grant Agreements has identified ten projects for which an explicit 'co-financing' has been agreed. This includes eight projects at Bohunice and two at Kozloduy. The majority of projects concern waste management infrastructure where the rationale for co-financing has not been to share responsibility and risks, but to exclude infrastructure capacity that will also serve other national needs from the scope of the NDAP.

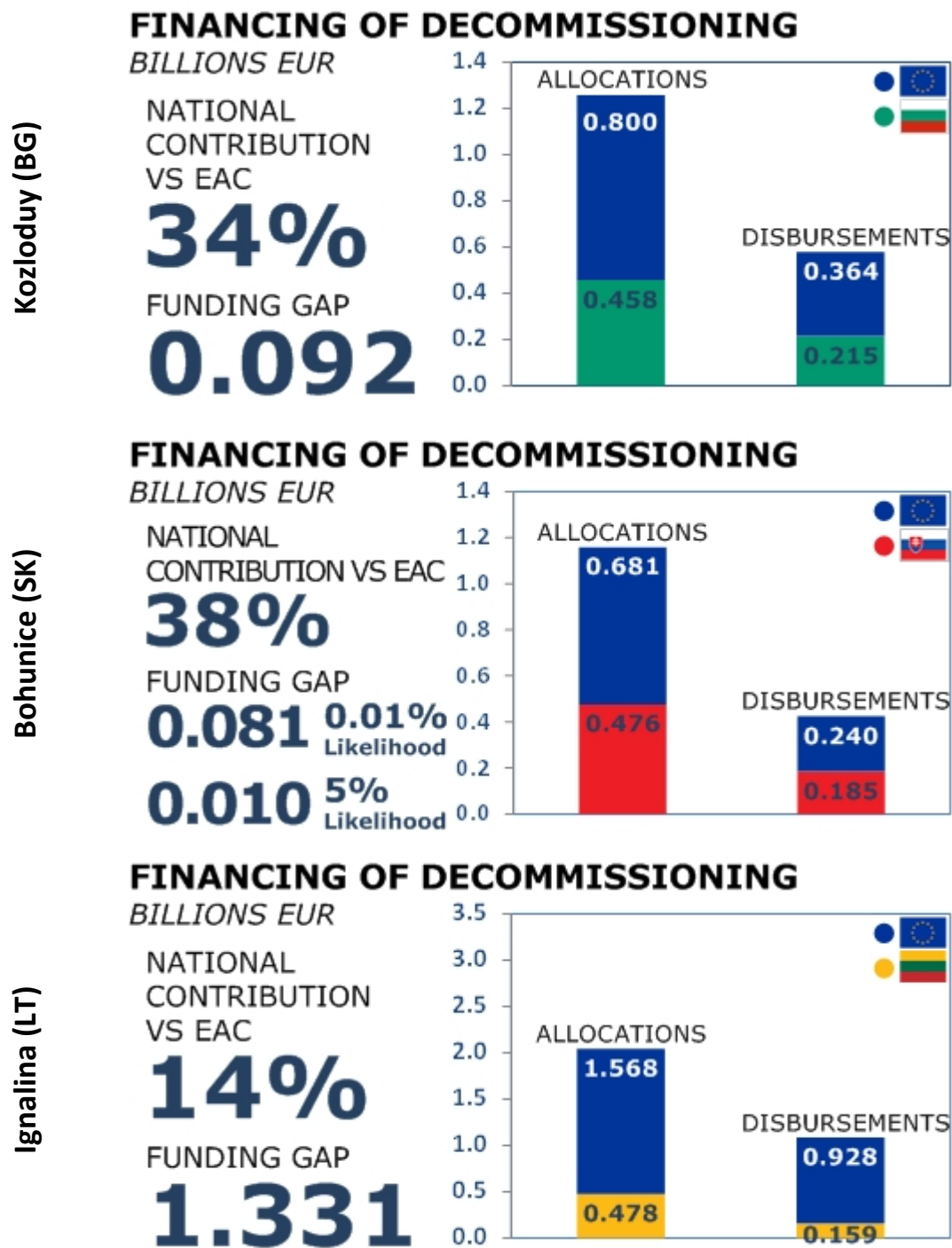
The list of co-financed projects is small in absolute terms, providing only limited evidence upon which to draw conclusions. Looking at the general performance of these projects, they do not demonstrate a significantly higher performance (to the extent to that would allow to infer causation) than the general project portfolio. Most have faced difficulties or delays at some point, and some have also faced cost increases. For example, the "Dismantling of Reactor Coolant system Large Components" (project D4.2) in Slovakia and the "Design, Supply, Installation and associated Services of Equipment (including EIA) for conditioning of solid radioactive waste with High Volume Reduction Factor" (project 5b) in Bulgaria notably saw their cost increase significantly from the first estimates (largely due to inadequate market analysis).

5.4.3.3 Funding gap

A more fundamental issue that appears to have weakened the overall accountability framework was the open-ended nature of EU assistance. An upfront financial commitment to the three Member States as a counterpart to the closure of the units was never fixed. Until the adoption of the detailed decommissioning plans as baseline for the NDAP in 2014, the EU support has remained a *de facto* open-ended commitment for the decommissioning programmes and related activities. This did not install the adequate background for confronting the toughest issues immediately nor to seek the most efficient choices.

The *funding gap* is the difference between the total decommissioning programme cost and the already identified funding. This *funding gap* is closing in Slovakia and Bulgaria, but is still important to Lithuania given the size and nature of the project.

Figure 10 Funding gap in BG, SK and LT



5.4.3.4 Project delays are often synonymous with cost increases

Project delays can be cited as amongst the most often found reasons for cost increases in all three programmes. As in other sectors, many of the costs associated with the decommissioning programmes are time dependent, meaning they will automatically increase in the occurrence of delays. For example, significant resources continue to be allocated to facility shut down and post-operation activities during the current MFF at the Ignalina programme in order to maintain safety systems and support the defueling process. Therefore delayed defueling had significantly impacted the cost of these activities by extending their duration.

5.4.3.5 Support tasks

Decommissioning activities are directed towards D&D and waste management tasks (including defueling) that directly result in physical progress towards reduction of radiological hazards. However they are always accompanied by enabling support tasks (management, maintenance, security, etc.). This includes seemingly dissociated activities, such as ‘railroad maintenance’ for example, which upon further examination can logically be traced back to critical decommissioning activities. In this case, a short railroad network at Ignalina is used to transport spent fuel during defueling operations. As another example, radiation protection staff, personal dosimetry devices and even specialised laundry services are necessary to ensuring safe working conditions in Controlled Areas.

Overall, the analysis of monitoring reports show that a significant level of resources continue to be devoted to ancillary decommissioning tasks – or support tasks. The Commission has continuously pushed decommissioning operators to improve the cost-efficiency of support activities in order to direct EU support towards high value added (in terms of physical progress) decommissioning activities. The Commission has signalled that it will no longer finance certain support activities, such as energy costs, in the future.

For example, according to INPP reporting, post-operation activities continued to consume 32% of man-hours during the second half of 2016. Given the importance of this activity in the budget, INPP maintains a high level of efforts to improve cost-effectiveness in this area, recently through the reorganisation and reduction of maintenance teams or the make-or-buy strategy aiming to ensure costs are at market value.

Another interesting approach can be observed in the Bohunice programme. Due to factors specific to the programme, output-based contracts have been used to finance waste management activities (e.g. X euros for X tonnes of waste processed), rather than financing based on inputs (e.g. salaries of personnel). This inherently creates greater incentives for the operator to seek maximum efficiency to avoid potential economic losses due to cost increases. It also puts the financial risk of time delay on the operator. Such an approach could potentially be piloted in other programmes in order to create greater incentives for cost-effectiveness, while also focusing management activities more on outputs and inputs.

5.4.3.6 Externalisation versus internalisation

Due to the decision to rely extensively on internal staff of the decommissioning operators, in particular in Lithuania and Bulgaria, delays in the decommissioning programme can easily lead to a sub-optimal use of human resources within the organisation. This includes under-utilisation of resources where delays have caused a stop in works, or over-utilisation of resources (with the additional overtime costs entailed) in order to make up lost time.

The limited externalisation of site maintenance activities points to some margin for enhancing cost effectiveness in this area. As mentioned, INPP is implementing a make-or-buy strategy in order to identify activities not part of its core business that it would be advantageous to externalise. Such measures could also be considered for the Kozloduy programme in the future.

5.4.3.7 Technical uncertainties remain an inherent part of the decommissioning process, both supporting and detracting from cost-effectiveness

The decommissioning market remains in a developmental stage due to the level of world-wide experience. These technical challenges are further compounded in the case of decommissioning early-generation reactors. These characteristics have proven both a facilitator and obstacle to cost effectiveness. New technologies and approaches that are developed in the context of such decommissioning activities can contribute to significantly reducing costs. On the other hand, contractors can sometimes fail to deliver on contract deliverables due to technical difficulties.

The monitoring reports show several instances of contractor non-performance due to technical challenges. In addition, decommissioning operators have also struggled with technical issues internally. In the most high profile case to date, the initial contractor selected to implement the decontamination of the primary circuit of the Bohunice reactors did not have the full knowledge to achieve the task. In this case, JAVYS was able nonetheless to minimise cost increase through reuse of part of the deliverables of the first contractor and rescheduling the wider decommissioning programme.

On the other hand, the dynamic nature of the decommissioning market holds potential for improving cost effectiveness through the leveraging of new or novel technologies and approaches. For example, the market response to tendering for the Plasma Melting Facility at Kozloduy resulted in a significant increase in the estimated upfront cost of the project; however, the volume reduction factor offered by the application of plasma melting technology should save tens of millions in the long-term – e.g. storage costs.

Ignalina is the first large graphite moderated nuclear reactor to be decommissioned in the world. Due to its first-in-kind nature and the limited experience available worldwide on the handling of irradiated graphite, larger technical uncertainties are unavoidable (see also section 5.4.4.1). As the actual dismantling work will only be started after the end of the current programming period, the present evaluation does not address this issue in more details.

These factors point to the importance of a careful balancing of risks when going to market and making strategic decisions on internalisation vs. externalisation. It also underlines the necessity to develop strong public procurement and contract management capacity. Lessons learnt, in particular at Kozloduy, point to the importance of establishing extremely close working relationships with contractors, to navigate technically demanding projects and address challenges as they arise. In the Kozloduy programme, this has been achieved through establishing open and continuous communication with contractors and mobilising internal resources to support contractors when necessary. Finally, these lessons also underscore the usefulness of sharing knowledge and exchanging best practices between the three programmes, which collectively represent Europe's most ambitious nuclear decommissioning undertaking to date. A recent example concerns Slovak and Bulgarian exchanges of experience with regards to management of legacy (wet) radioactive waste.

5.4.3.8 Administrative and regulatory issues

The cost-effectiveness of programme implementation has also been impacted by issues in the administrative realm that could have been completely or at least partially avoided. National administrations, in particular in Bulgaria, have not always made all reasonable attempts to remove administrative obstacles to cost-effective programme implementation. For example, the design and construction of the Plasma Melting Facility has been slowed and faced with unnecessary risks due to administrative capacity and efficacy issues (e.g. complying with regulations, managing contracts, administrative approvals, etc.) during the previous and current MFF. During the previous MFF, repeated challenges to Environmental Impact Assessments have also led to the accumulation of important delays in projects and the programme as a whole that must now be made up. It is assumed that these difficulties were mostly due to the fact that these are new regulatory activities, leading to an inadequate understanding of regulatory requirements and adequate quality control measures.

Delays and cost increases have been noted due to inadequate anticipation of modifications to regulations and underestimation of the time necessary for regulatory approval or fulfilling regulatory requirements. While some isolated examples were identified at Ignalina and Bohunice, this issue has impacted most strongly the Kozloduy programme. Safety decisions in the nuclear domain should always be made independently of specific economic factors; however, questions can be raised as to the extent that decommissioning operators are adequately working with regulators to anticipate such evolutions in the regulatory domain and

adequately account for regulatory processes in project planning. At the same time, it can be acknowledged that some difficulties have been faced due to inadequate capacity on the part of regulators and other administrative entities involved in the regulatory approval process.

To not overstate the problem, it can be acknowledged that the situation has shown continuous improvement since the beginning of the programme. Decommissioning operators are becoming more experienced with navigating these processes, planning accordingly and taking mitigation measures. Contact and cooperation between decommissioning operators and regulators was generally reported to be good (and improving). Moreover, as underlined in section 2.8, the regulators as much as the decommissioning operators have benefited from experience, as well as the technical assistance provided through the NDAP.

5.4.3.9 External technical assistance

Expenditure on project management and technical support activities represents a significant portion of overall costs and number of staff. In total, this support amounts to EUR 175,7 million for all three programmes since their outset. This total does not include other consultancy contracts outside of the Grant Agreements for PMU services. Decommissioning operators have made extensive use of consultancies and engineering firms for similar services through separate contracts or as part of large project contracts.

Considering issues identified with regard to inadequate planning and project management capacity in some programmes, the cost-effectiveness of these investments, in particular the large amount funnelled to external consultancies and engineering firms, can be questioned. This would point to a continued need to ensure the assessment of the cost and benefit of contracting technical support (versus use of internal resources) and enhanced management of contract implementation to ensure consultants are delivering added value. The EBRD has conducted capacity assessments to assist with decisions on the sizing of the PMUs. Finally, continued high spending on external support contracts would point to a need to better ensure knowledge transfer and internal capacity building through these investments.

5.4.4 Evaluation Question 6.3

What factors can explain differences in costs (and possibly benefits) arising between Member States?

The table below provides an overview of the current total estimated costs for the decommissioning programmes, as well as the number of units, nominal capacity and duration of the decommissioning programme. A cursory glance at the cost estimations between programmes will find the notable difference in the overall cost between the Ignalina programme and the Kozloduy and Bohunice programmes. However, a number of other variables must also be taken into account before drawing conclusions, such as the size of the reactors, the reactor technology or duration of the decommissioning process.

Table 4: Comparison of decommissioning programmes / plant characteristics

Programme	Total budget (EUR million)	Units	Nominal capacity (MW)	Reactor technology	Duration	End state
Kozloduy (BG)	1 107	4	1 760	VVER	27 years	Brownfield
Bohunice (SK)	1 245	2	880	VVER	22 years	Brownfield
Ignalina (LT)	3 377	2	3 000	RBMK	38 years	Brownfield

Source: Detailed decommissioning plans

Overall, exogenous variables can explain in large part the cost variations between the three MS more so than variations in cost effectiveness. Nonetheless, an important nuance to this overall conclusion can be made for the Ignalina programme. The extension of the duration of the programme as a result of issues faced with critical waste management infrastructure projects in the last MFF significantly contributed to the increased overall decommissioning cost. Combined with cost differences arising from historical factors and the innate characteristics of the facility itself, these increases have largely driven the rise in overall costs.

5.4.4.1 Size of facilities and complexities for dismantling

The primary factor explaining the differences in costs between the three programmes is the size of facilities and complexities for dismantling. Using nominal capacity as a rough proxy of the overall volume of equipment and civil structures it becomes clear that part of the price disparity can be attributed to the larger size of the plant. Looking at the cost of decommissioning per Megawatt of nominal capacity as a very rough indicator of cost performance, Ignalina (EUR 1.13 million per MW) fits well between the Bohunice V1 decommissioning programme (EUR 1.42 million per MW) and the Kozloduy programme (EUR 0.63 million per MW).

Looking at some specific comparisons, one can appreciate the difference in size and its impact on cost. The amount of steel from equipment to be dismantled at Ignalina (157 000 tonnes), for example, is more comparable to that of the six unit 2 640 MW Greifswald NPP (116 000 tonnes)⁵⁴, which is itself triple the size of the Bohunice V1 NPP and 50% larger than the Kozloduy NPP. Interestingly, the cost of decommissioning at Ignalina is significantly lower than the current cost estimates for the decommissioning of Greifswald (EUR 5 750 million).⁵⁵ Concerning the reactor core structures, Ignalina dwarfs the mass of VVER reactors, with 17 100 tonnes of steep graphite and shielding (serpentine / sand) to be dismantled and disposed of. Finally, it should also be noted that the RBMK produces higher quantities of operational waste than its VVER counterpart. Compared to its VVER counterpart, the RBMK-type reactor can also be noted for the larger extension of the contamination by the water flowing through the reactor core. At Ignalina an estimated 91% of steel from equipment to be dismantled is contaminated, compared with 59% at the Greifswald plant for example. This inevitably requires greater efforts and planning during the decommissioning process.

The technical challenges for the decommissioning of Ignalina are significantly more complex than the other two programmes due to its first-in-kind nature and the fact that a larger percentage of the equipment is contaminated. Ignalina is the first RBMK to be decommissioned in the world. This means there is no precedence or experience that the decommissioning operator can rely on. While technically beyond the scope of the decommissioning programme, open questions remain in particular with regard to the management and disposal of irradiated graphite waste. Some useful experience can potentially be provided by other graphite moderated reactors currently being decommissioned; however, none of these has been completely decommissioned. Governments, such as the UK and France, have tended to favour SAFSTOR strategies.

5.4.4.2 Economic factors

One can also note that the cost estimate for Kozloduy is relatively low compared to the estimated cost of Bohunice V1 decommissioning, in particular considering that the installed

⁵⁴ The similar reactor technology at Greifswald makes it useful for comparison with the decommissioning programmes of Kozloduy and Bohunice

⁵⁵ According to approximate figures provided by EWN, the total cost of Greifswald decommissioning is EUR 6 600. To make a rough comparison with the cost estimate for Ignalina, it is necessary to subtract EUR 650 for the final disposal of spent nuclear fuel and 200 for the demolition of the RAW repository at Rheinsberg NPP (the equivalent costs are not included in the Ignalina cost estimate).

capacity of Kozloduy is double that of Bohunice V1. However, a previous analysis⁵⁶ of the cost estimates demonstrated that correcting for the relatively lower labour costs in Bulgaria gives a comparable revised cost.

Other local economic factors affect the total cost to a lesser extent. The attractiveness of the site for highly qualified and skilled staff, due notably to the geographic situation of the plants and local quality of life. The strength of the local (non-nuclear) supply chains weighs on the prices of consumables and services.

5.4.4.3 Pre-existing waste management infrastructure

The construction of waste management infrastructure is often forgotten as an integral part of the decommissioning process. However, this infrastructure is a necessary pre-condition for decommissioning to begin. The three Member States had varying level of existing infrastructure in place. Slovakia, where decommissioning of Bohunice A1 had already begun before V1 & V2 decommissioning started, had a large part of the necessary infrastructure already in place, whereas Bulgaria had some existing waste treatment and disposal facilities. Lithuania had almost none of the required infrastructure due to the fact that the country found itself in possession of the facility, which it has not been responsible for constructing or managing, at the moment of its independence.

For this reason, **the three programmes exhibited drastically different upfront investment costs before decommissioning activities could begin.** Slovak authorities estimated that national contributions to necessary pre-existing waste management infrastructure (thus outside the decommissioning plan cost estimates), amounted to EUR 300 million. The corresponding waste management infrastructures had still to be built in Lithuania and partially in Bulgaria.

5.4.5 Evaluation Question 7

**How does the governance and management system of the NDAP compare to other programmes managed by the Commission (or other actors)?
Do these comparators provide any best practices in terms of governance or management?**

The purpose of this question was to develop comparative case studies focused on governance and finance structures and examine advantages and disadvantages compared to the NDAP. .

Three ‘comparator’ instruments were selected for analysis as part of the benchmarking exercise: Connecting Europe Facility (CEF), Budget Support aid delivery mechanism and European Structural and Investment Funds (ESIF) Major Projects. These three comparators were selected because they represent a variety of different approaches for programme implementation and are used to deliver large-scale projects, including notably in the energy sector. Nonetheless, the comparator programmes remain very different from the NDAP in terms of their objectives, types of projects supported and timescale (e.g. lifespan of projects is much shorter than decommissioning). Due to the unique nature of the NDAP, overall comparability is limited.

With comparability limited, rather than focusing on comparing performance metrics, the benchmark was focused on the identification of relevant best practices.

⁵⁶ [Deloitte 2016](#)

Table 5: Presentation of comparator programmes / instruments

Programme		Short description	Rationale for the selection of this programme in the benchmark
Connecting Europe Facility		Facility for the delivery of large infrastructure (energy, transport & ICT) projects across Europe (direct management)	As NDAP projects, CEF also finance large size infrastructure projects with large European budget (including in energy sector). Moreover some of these projects are very specific actions and include the development of innovative technologies. They are also implemented by a large number of contractors with very specific skills and various areas of expertise.
Budget support aid delivery modality		Instrument primarily used for delivering aid and capacity building support to third countries (direct management)	The budget support instrument has a number of potential benefits that make it an interesting comparative case study. While budget support has little precedent for being used in the 'domestic' Union context, it is increasingly being considered for wider, including internal, use.
ESIF - Projects ⁵⁷	Major	Mechanism for approving and implementing large projects (>50M) (shared management)	ESIF Major Projects are large scale complex projects with some commonalities with NDAP projects such as the part of innovation, the involvement of specific knowledge, the work with contractors,... Some of them are in energy and infrastructure sectors. However ESIF Major Projects are implemented under the shared management mode and so are very different from the NDAP projects.

⁵⁷ While ESIF Major Projects represent an interesting case study compared with NDAP, it should be noted that it is expressly forbidden for these funds to be used for the purpose of supporting decommissioning (Article 3 (3) of the ERDF Regulation & Article 2(2) of the Cohesion Fund Regulation)

The table below provides a summary of the main findings for each of the case studies. These are discussed in further details below.

Table 6: Overview of the findings of the benchmarking exercise

Connecting Europe Facility	Budget Support	ESIF Major Projects
Promotes strong national ownership through Member State approval of European 'corridors' and individual projects	Promotes strong national ownership through national development of strategy Strong focus on political & technical dialogue with the beneficiaries	Promotes strong national ownership through Member State programme and implement projects in high autonomy
Multi-annual framework for project implementation	Multi-annual framework for project implementation	Multi-annual framework for project implementation
Strong, harmonised project management procedures through centralised management at INEA		Strong assessment of projects necessary prior to approval, including cost estimates
Clear co-financing framework	Use of performance incentives Less burdensome financial management controls and contribution to strengthening national capacity	Clear co-financing framework Strong incentive to ensure effective implementation through risk of decommitment
Use of online system for production of annual monitoring reports Development of programme level results-based monitoring indicators	Use of results-based performance indicators	

Source: EY 2018

In comparison to the NDAP, some overall interesting practices can be underlined:

The performance monitoring framework for the NDAP is generally in line with best practice, in particular practices in budget support operations– given that a results-based performance monitoring is in place. In this respect the NDAP could be improved by linking additional funding to the achievement of pre-defined targets.

As sought by the current NDAP, all 'comparator' instruments seek to ensure strong national ownership of project implementation through early buy in and strong Member State involvement. Member States are involved early on in the development of the projects or programmes and have input at key phases.

CEF and ESIF have a clearly defined framework for EU co-financing, with minimum and maximum EU co-financing rates set out in the legal base. Unlike these two programmes, the NDAP has no formalised framework for EU co-financing at the moment.

All instruments, the current NDAP inclusive, offer a fully multi-annual rather than annual framework for programming. While 'comparator' instruments all imposed annual monitoring and reporting requirements (similar to NDAP), none had in place an annual cycle for

programming and commitments (in contrast to NDAP). Projects are implemented in line with their approved work plans. For CEF and ESIF major projects, specific approval is necessary prior to funding as well as for substantive deviations from the approved programme of works or approved budget.

The defining feature of ESIF major projects is the specific approval procedure to which they are subject to. This includes a number of analyses carried out by the Commission services with the aim to ensure the quality of the project proposal, its feasibility, maturity and its utility. The NDAP delegates this role to the Implementing Bodies that are entrusted budget implementation tasks via a Delegation Agreement.

5.5 EU Added Value

5.5.1 Evaluation Question 8

What would be the likely result of ending the NDAP in the three Member States concerned?

This transversal question sought to measure the EU added value of the NDAP. EU added value is additional to the value created by actions of individual Member States, which may result from different factors, such as coordination gains, legal certainty, greater effectiveness or complementarities, economies of scale, promotion of best practice, benchmarking, etc.

5.5.1.1 NDAP has contributed to facilitating the immediate and safe decommissioning

The NDAP represented an important commitment by the EU to the three Member States during negotiations to shut down the reactors. EU support to decommissioning (and to mitigating the impacts of closure) represented a politically and financially significant offer that helped enable the EU to obtain a commitment on the part of the three Member States to permanently shut down the reactors. The shutdown of these reactors, considered unsafe and un-upgradable by the international community, was a politically contentious issue in all (then candidate) Member States, which relied on these reactors for a significant (or in the case of Lithuania the quasi-totality) of their electricity production needs. Moreover, the early shutdown before the end of their envisaged operational lifetime, combined with specific historical factors, meant that inadequate financial resources existed to finance decommissioning.

Beyond obtaining the commitment to shutdown, EU support clearly influenced the timescale for decommissioning. Both Lithuania and Bulgaria had initially (briefly) envisaged pursuing a strategy of deferred dismantling. The immediate availability of EU assistance factored significantly into the decision to change to an immediate dismantling strategy. In Bulgaria, EU support has also contributed to the government's decision to further shorten the duration of decommissioning, bringing forward the envisaged end-date to 2030 from 2035 as initially foreseen. Compared to deferred dismantling / safe enclosure, EU support has thus allowed for the level of radiological hazard to be reduced more rapidly and to avoid passing on a significant financial burden to future generations, in line with internationally accepted principles of management of nuclear waste and decommissioning. Indeed, deferred dismantling / safe enclosure by its very nature entails leaving part of the radiological hazard on site for a period of 30 years or longer. It also defers the major part of the costs and the total costs may in some cases be higher overall.

The EU added value of financial support to the Ignalina programme appears the most significant of the three programmes. While it is difficult to confidently predict the counterfactual, a lack of EU support for the current MFF would in all likelihood have resulted in a disruption of programme implementation and a change in the decommissioning strategy (likely to deferred dismantling). The financing shortfall for Ignalina prior to the EU commitments for the current MFF were significantly higher than the other two programmes at EUR 2 012

million. The assessment by Deloitte⁵⁸ found that fully funding post 2020 remaining allocation (of EUR 1 561 million) from state finances 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. At the same time, there remains a staunch public and political resistance in the country to supporting the costs of decommissioning without EU assistance due to the unique historical factors and perceived promises made at the moment of accession. Recognising these concerns, stakeholders interviewed were unanimous in affirming that a disruption of EU funding would have entailed a dramatic and immediate change in the decommissioning strategy for the current period.

In Bulgaria, EU support appears to be important to continuing decommissioning activities during the current programming period. The absence of such funding may have resulted in a change of strategy for national authorities or an extension of the timeline. Even if the EUR 321 million funding gap prior to the current MFF could be considered to be reasonably within the limits of Bulgarian public finances, a lack of continued EU funding may have put the project at risk of political obstacles in a Member State that has been marked by the instability of government and nuclear policy in particular in recent years.

Due to the relatively advanced nature of the decommissioning process at Bohunice and the size of the financial shortfall, the current EU added value of support in the current MFF is relatively lower than in the other two Member States. Considering the hypothetical funding gap of EUR 317 million prior to the current MFF, full financing from national coffers can be considered to have been very reasonably within the limits of Slovak public finances. The decommissioning operator is experienced and highly capable. Moreover, the operator hopes to leverage this experience into future economic opportunities on the international decommissioning market. The absence of EU funding during the current programming period could potentially have slowed the pace of progress, but would very likely not have significantly impacted progress all other things held constant. Nonetheless, Slovak authorities interviewed⁵⁹ maintain that EU support during the current MFF has been important to ensuring that the decommissioning programme continues without disruption.

5.5.1.2 EU added value naturally declining as programme implementation advances

The EU added value of the NDAP from its beginning has been cast in terms of nuclear safety and financial mitigation. The NDAP has contributed over previous MFFs and continues to contribute to a stepwise decrease in the level of radiological hazard and risk to the general public. With a finite level of radioactivity on site, however, each additional euro of investment provides decreasing rates of return. The EU added value of the programme is thus naturally decreasing over time. Moreover, the funding gap has been closed to relatively small amounts for two of the three programmes.

With the exception of Lithuania, where defueling remains ongoing, the level of radiological hazard on the sites has been reduced to approximately 1% of original levels and correspondingly the level of risk to the general public practically highly diminished. During the remainder of the current MFF, the Bohunice programme will remove much of the final significant sources of radioactivity in the technically challenging process of dismantling the reactor cores and the Kozloduy programme will embark upon this process.

5.5.1.3 Knowledge sharing a source of continued added value

Of the 90 nuclear reactors currently permanently shut down in Europe, only three have been completely dismantled. The level of experience in the dismantling of nuclear reactors in

⁵⁸ [Deloitte 2016](#)

⁵⁹ [EY 2018](#)

Europe (as well as internationally) is thus highly limited. The NDAP's contribution to securing the shutdown and immediate dismantling of these reactors has led to the generation of a highly significant amount of experience that can be of benefit to other decommissioning projects and ensure this way increased level of safety within the EU.

First and foremost, the knowledge and experience gained can be of use to the three national programmes. To this end, the Commission has continually encouraged stakeholders to share experience and best practice, in particular between Slovakia and Bulgaria due to the similarity of the plants.

Beyond the three programmes, the knowledge and experience generated may also prove of use to other decommissioning projects in Europe. However, the knowledge sharing and capitalisation process is not currently structured and is largely organic. Member State representatives on the NDAP Committee noted that their attendance was in part motivated by this knowledge-sharing aspect, although it is not fit to this purpose. Decommissioning operators have also shared their experiences in various international fora, such as the IAEA or NEA. European companies benefiting from contracts through the NDAP will also serve an important role in transferring knowledge and experience accrued from the NDAP to other decommissioning programmes. There thus appears to be scope for a more structured organisation of the knowledge sharing process. The Commission can facilitate this process, but Member States should also recognise the value of the information generated and ensure relevant stakeholders are informed and able to take part.

6 CONCLUSIONS

6.1 Assessment by evaluation criteria

6.1.1 Relevance

As far as the MFF 2014-2020 is concerned, the general and specific objectives of the programmes remain highly relevant for responding to the needs that were identified during that MFF preparatory stage (i.e. progress in decommissioning past the point of no return and accomplishment of enhanced safety).

6.1.2 Coherence

The Regulations are coherent with EU policies aiming at ensuring the highest level of nuclear safety. The EU support through the NDAP ensures that the immediate dismantling strategy in Lithuania is steadily pursued and prevents that undue burden is transferred to future generations, while it partially derogates for historical reasons to the ultimate responsibility of the Member State to ensure adequate financial resources for nuclear decommissioning and radioactive waste management.

6.1.3 Effectiveness

To date, progress has been made in all three programmes, and long-standing issues that were carried over from the previous financial framework were eventually resolved. Key infrastructures for managing spent fuel and radioactive waste either became operational or are in the final stages of commissioning, injecting fresh momentum into decommissioning activities.

In all three sites, D&D in the turbine halls and auxiliary buildings has progressed well. The decommissioning operators have successfully managed to identify and remove bottlenecks in the processes.

Progress has been made on D&D in the reactor buildings (controlled area) at the three sites, consistent with the respective programme schedules and end dates.

The main outputs of decommissioning programmes are materials to be either reused or recycled and conditioned radioactive waste to be either stored temporarily (interim waste store) or disposed of. For the three programmes, these outputs have been lower than planned to date for several reasons: (i) inherent uncertainties in the characterisation of the plants caused the target values to be overestimated; (ii) lower input to waste management facilities from dismantling activities; and (iii) technical challenges related to specific legacy waste streams. Nonetheless, the waste management processes have proved to be generally capable of providing the necessary productivity throughput with the highest safety standards.

6.1.4 Efficiency

The preparation and endorsement in 2014 of the decommissioning plan was a major milestone and clarified the scope, schedule, and budget of the decommissioning programme. Between 2014 and 2016, the Commission has analysed this baseline and concluded that it is based on a complete and comprehensive plan, and on a sound overall cost estimate which could be improved further by considering a higher level of contingencies

The analysis shows that the programmes have generally been implemented in a cost-effective manner in the current financial framework, and that the programming process has a much higher level of maturity.

Financial benchmarking of decommissioning activities remains a challenge worldwide. This limitation is reflected in the difficulties involved in comparing the three programmes with each other and with other decommissioning programmes despite the wider use of the International Structure for Decommissioning Costing.

The analysis also identified the main factors that influence cost-effectiveness:

- The governance in place since 2014 has steered the programmes towards increased efficiency, and organisational changes have had a positive impact on cost-effectiveness.
- The achieved levels of national contribution appear fit to sustain proper efficiency; nonetheless, co-financing is not established in the legal basis, thus creating continued uncertainties. Moreover, the analysis showed that an adequate level of national contribution is a necessary but not a sufficient condition to set the right incentives for timely and efficient decommissioning. To this end, the explicit transfer of risks (cost overruns, delays) to the Member State would have a greater impact. This practice has been already introduced to a certain extent under the current MFF where possible.
- Timely implementation is key to cost-effectiveness. The removal of roadblocks carried over from the previous financial framework and the recovery, when possible, of accumulated delays has contributed to cost-effectiveness (e.g. resolution of long-standing contractual disputes in Ignalina).
- Labour costs are a substantial and inherently time-dependent component of decommissioning costs. When labour is provided mainly by the decommissioning operators' staff, incurred delays may impact on the cost, especially when they affect the critical path, i.e. the programme's end date. To mitigate this risk, externalisation strategies provide adequate flexibility to adjust needs and efforts. The implementation of such strategies is well developed in Bohunice and is progressing in Ignalina, where a structured 'make or buy' plan was established in 2017.
- On the other hand, the deployment of plant staff (who were employed during the operational life of the reactors) is a good knowledge management practice as it ensures that relevant experience is carried over to reduce the time of implementation. However, this

practice entails the risk of having too much staff and limiting the flexibility of the organisations, especially where alternative opportunities are not available.

- Some technical challenges remain intrinsic to the decommissioning process, and the decommissioning market is still in a developmental stage. This has led to instances of setbacks among contractors.
- Cost increases have been noted with regard to modifications in legislation, and delays have increased during regulatory approval processes in all three countries. Safety decisions in the nuclear domain must be made independent of specific economic factors; the decommissioning operators should therefore work with regulators to anticipate such developments in the regulatory domain and adequately account for regulatory processes in project planning. While some good practices were identified in Lithuania and Slovakia, this issue has impacted the Kozloduy programme.

6.1.5 EU added value

The added value of the programmes, as it has historically been perceived, naturally declines as implementation advances. From the beginning, the programmes' added value has been cast in terms of financial mitigation and nuclear safety.

- Beyond 2020, estimated financial gaps in Bulgaria and Slovakia do not endanger finalisation of the programmes by the planned end dates.
- In Lithuania, the financing gap beyond 2020 has also decreased thanks to the further engagement of Lithuania. However, the gap remains sizeable (EUR 1.331 billion).
- While the three Member States' economies are clearly capable of absorbing the financial needs through national financial resources, the impact of doing so would be more significant for Lithuania.
- The programmes have contributed to a substantial decrease in the level of radiological hazard and risk to the general public. The most important nuclear safety related risks have been eliminated in Slovakia and Bulgaria. In Lithuania, removal of spent fuel from reactor buildings is ongoing — by the end of this process (scheduled for 2022), the residual radiological hazard will be substantially reduced by orders of magnitude and will be represented mainly by the irradiated graphite cores.

The EU nuclear industry is firmly moving into a new phase characterised by increased activities in the back-end of the lifecycle. However, only a few decommissioning programmes have made significant progress, including the Kozloduy, Ignalina and Bohunice programmes. It is therefore apparent that the decommissioning industry has not yet reached full maturity. In this context, EU support to the decommissioning programmes in Bulgaria, Slovakia and Lithuania has provided additional value to the entire EU decommissioning industry in terms of knowledge and expertise. Knowledge sharing and capitalisation aspects of the programmes therefore serve as a basis for ensuring continued EU added value. This process might be further exploited in managing irradiated graphite, which is a technical challenge worldwide⁶⁰.

6.2 Scope for modification of the detailed implementation procedures

The 2013 NDAP Regulations explicitly require that the evaluation also addresses the scope for modification of the detailed implementation procedures.

⁶⁰ No power reactors with graphite cores have been dismantled yet, although many of them were shut down several years ago. Besides Lithuania, other Member States have to undertake similar projects as they own significant inventories of irradiated graphite: United Kingdom (86 000 t), France (23 000 t), Lithuania (3 800 t), Spain (3 700 t), Italy (3 000 t), Belgium (2 500 t), Germany (2 000 t).

6.2.1 Roles and responsibilities

In general, the role and responsibilities of the actors are well defined and need not to be changed. However, the tasks of the Monitoring Committee and of the Programme Coordinator could be reinforced. That would reinforce their oversight of the programme implementation through the NDAP and further increase national ownership of project implementation. Further benefits could be obtained from this setting by extending the scope of the committee to discuss and decide on programming and planning aspects. Explicitly describing the role of the decommissioning operators would set clear expectations for their contribution and reinforce the accountability framework.

6.2.2 Programming and Monitoring

The best practice observed in all comparator programmes is a multi-annual rather than annual framework for programming while maintaining annual monitoring and reporting requirements. The role of the decommissioning plans should be more explicitly explained as it provides a point of reference for monitoring progress over the entire duration of the nuclear decommissioning assistance programmes. The annual work programmes serve as a way of updating the implementation schedule of the multi-annual decommissioning plans, taking into account the latest developments in the implementation of the programmes.

Performance indicators should be improved and updated where needed in order to increase the level of accountability and provide a granular view of the physical progress; also taking stock of past accomplishments to recalibrate the indicators.

As implementation of many projects will continue after 2020, a monitoring framework that sets out milestones and targets for at least five years following the end of the current MFF would thus ensure adequate monitoring of projects implementation until completion.

The comparability of indicators across programmes should be perfected as all programmes pursue similar goals, with some specifics. This would make inter-comparison across the three programmes straightforward.

6.2.3 Simplification

Re-designing the timeline, sequencing and linkages in processes and streamlining or otherwise adapting the content of programming and monitoring documents could support enhancing the timeliness of the yearly programming/reporting cycle.

Most projects are approved within a short period of time nonetheless stakeholders underlined the need for clearer timelines and a streamlined procedure for project approval.

Indicators to monitor the governance system's efficiency, in particular at the EU level, would introduce the possibility to evaluate quantitatively margin for improvement.

6.2.4 Co-financing

The lack of a legal base as concerns national contributions has created residual uncertainties in the past that should be mitigated in this MFF through the revision of the implementation procedures. A solution would be to clearly demarcate the boundaries of EU support (e.g. specific projects). The explicit transfer of risks (cost overruns, delays) to the concerned Member States would provide a reinforced incentive for timely and efficient decommissioning.

6.3 Opportunities for improvement

This section identifies further opportunities to improve the Nuclear Decommissioning Programme.

6.3.1 Knowledge sharing

Reflecting the advancement of the programmes and the wider context of decommissioning in the EU, the underlying rationales of the NDAP should be adapted to provide stronger added value in terms of knowledge generation and sharing in view of the immense financial and technical challenge represented by nuclear decommissioning in the EU.

Establishing mechanisms to identify, structure and disseminate relevant knowledge and experience gained in the three programmes to all other relevant users across the EU would provide a beneficial support in tackling the immense challenge of decommissioning, maintaining the highest levels of safety and positioning the EU internationally as the leader in decommissioning.

The sharing of knowledge generated by the programmes could cover more widely the objectives and achievements of the NDAP. Where relevant, communication activities should reach beyond the scope of the NDAP, engaging with EU-level civil society, industry and public actors on questions of decommissioning in view of the expected strong increase in the number of decommissioning projects across Europe in coming years. It could also go beyond the technical activities and extend to the positive impacts of the NDAP on the EU decommissioning market and local communities.

6.3.2 Waste-led decommissioning

Adopt a more robust “waste-led approach” to programme implementation through stronger prospective analysis.

Decommissioning operators at Kozloduy and Ignalina should maintain close monitoring of waste management infrastructure projects still under implementation / to be launched in order to proactively identify and address any issues that could have an impact on the decommissioning process.

A carefully examination and regular report on expected capacity levels and projected flows for waste management streams would allow to identify risks of bottlenecks and to proactively address them.

Annex 1 Procedural information

1. Lead DG, Decide Planning/Commission Work Programme references

This evaluation of Council Regulations 1368/2013/Euratom and 1369/2013/EU on Union support for the nuclear decommissioning assistance programmes in Bulgaria, Slovakia and Lithuania is led by DG Energy. It is recorded in the Commission's Agenda Planning under the reference PLAN/2016/249.

2. Organisation and timing

In August 2016, DG Energy invited the Secretariat-General, the Legal Service, DG Budget, DG Economic and Financial Affairs, DG International Cooperation and Development, DG Employment, Social Affairs and Inclusion, DG Environment, DG Internal Market, Industry, Entrepreneurship and SMEs, DG Regional and Urban Policy and the Joint Research Centre to join a new inter-service steering group to steer the evaluation process. The group met five times (14 September 2016, 16 May 2017, 27 July 2017, 9 February 2008 and 15 March 2018).

In parallel the Commission informed and collected feedback from the Nuclear Decommissioning Assistance Programme Committee⁶¹ during the meetings organised on 23 September 2016, 12 July 2017 and 11 October 2017 and from the Monitoring Committees in their meetings of October 2016, May-June 2017 and October 2017.

The evaluation roadmap was published on 15 February 2017.

The Open Public Consultation has been organised for an extended period of 14 weeks from 23 June 2017 to 29 September 2017.

The ground work of the evaluation was carried by an external consultant – Ernst & Young France in the period from 5 April 2017 to 11 December 2017. The key deliverables were the inception report (30 May 2017), the draft final report (18 December 2017) and the final report (9 March 2018).

3. Exceptions to the better regulation guidelines

There were no exceptions to the Better Regulation Guidelines.

4. Consultation of the Regulatory Scrutiny Board

Not applicable.

⁶¹ <http://ec.europa.eu/transparency/regcomitology/index.cfm>

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SEC(2011)1387	Commission Staff Working Paper: Impact assessment Accompanying document to the Proposal for a Council Regulation on Union support for the nuclear decommissioning assistance programmes in Bulgaria, Lithuania and Slovakia. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52011SC1387
COM(2011)783	Proposal for a Council Regulation on Union support for the nuclear decommissioning assistance programmes in Bulgaria, Lithuania and Slovakia. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52011PC0783
Regulation (EU) 1316/2013	Regulation (EU) No 1316/2013 of the European Parliament and of the Council of 11 December 2013 establishing the Connecting Europe Facility, amending Regulation (EU) No 913/2010 and repealing Regulations (EC) No 680/2007 and (EC) No 67/2010 http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013R1316

Regulation (EU)
1303/2013

Regulation (EU) No 1303/2013 of the European Parliament and of the Council of 17 December 2013 laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund and repealing Council Regulation (EC) No 1083/2006
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013R1303>

Annex 2 Stakeholder consultation

1. Open public consultation

The public consultation on the mid-term evaluation of the NDAP relied on a survey available online on the Commission's website from 23 June 2017 to 29 September 2017.

Identification of the respondents

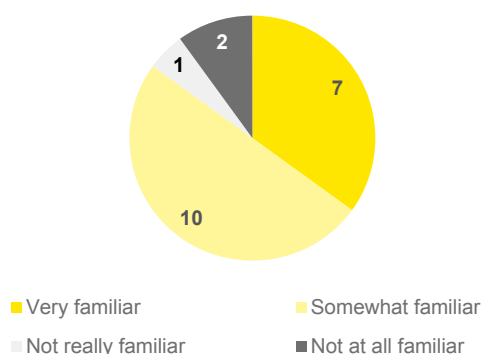
20 contributions to the open public consultation have been registered. The respondents mainly answer in their personal capacity (13) rather than in their professional capacity or on behalf of an organisation (7). Most of the answers came from Lithuania (11). Regarding the other two Member States which directly benefit from the EU support, only one answer was registered from Bulgaria and no answer from Slovakia. Respondents from other Member States also participated in the survey: Germany (3), Spain (1), Italy (1), Austria (1), France (1) and Finland (1). Among all respondents, 5 indicated that they were involved in public authorities, 2 in Member States authority, 2 in private organisations, 1 in non-governmental organisation and 4 as Citizens.

Overall the participation to the consultation can be considered as very low which can be explained by two main factors:

- A large part of programme stakeholders have directly been consulted during the study through interviews;
- There are no strong supporters or opponents to the programme.

The respondents are generally familiar with the NDAP (17) and only three respondents indicated that they are not familiar with the programme. However, few respondents are directly involved in the programme (3 respondents) but eight respondents learned about NDAP because they are working in the nuclear sector or interested out of professional interest. Among them two respondents indicated that they are also concerned because they have a link with the concerned geographical area. Finally, four respondents indicated that they only learned about NDAP out of personal interest.

Figure 11 What is your level of awareness regarding the Nuclear Decommissioning Assistance programme and the nature of assistance it is providing?

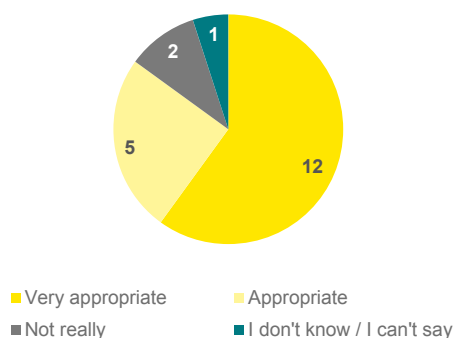


Source: Replies to the open public consultation

Main findings of the consultation

17 respondents considered that the general objective of the NDAP is still appropriate to the current needs. These needs have been identified by the respondents as the removal of the safety threat posed by the concerned reactors until their final safe decommissioning stage (18 answers) and the sharing of the financial burden of the decommissioning of the nuclear power plants (11 answers).

Figure 12 To what extent is the general objective of the Nuclear Decommissioning Assistance Programme still appropriate in relation to the current needs?



Source: Replies to the open public consultation

13 respondents considered that the NDAP is fully coherent with the Euratom acquis while 5 respondents did not provide answer to this question.

The respondents have overall a good opinion on the effectiveness of the NDAP (17 respondents) and most of them considered that the level of safety of the EU citizens have been improved as a consequence of the NDAP (14 respondents).

Regarding the impacts of the NDAP, the large majority of respondents considered that the NDAP had a positive impact on the local economy and brought a rather or very positive change for local people and society. Other types of impacts at local or national level were acknowledged by the respondents including two position opinions (Implementation of dialogues and kind of responsibility towards European citizens regarding nuclear power, Positive development for decommissioning service providers and consultants) and 2 negative opinions. The respondents also considered that the NDAP generated impacts that could not have been achieved otherwise, according to the additional information provided by some respondents this is mainly due to the fact that the Member States concerned would not have been able to financially support the decommissioning of the nuclear power plant and so ensure the safety of the nuclear sites concerned.

Diverging views

Only few of the consultation answers showed diverging views and non-consistency with one another. The main points underlined by the respondents in the responses to the open questions are related to the following statements:

- The main risk in the nuclear power plants was related to the spent nuclear fuel and the NDAP should only cover this aspect;
- The NDAP conducted to reinforce a sad image of the nuclear energy rather than encourage competitiveness of nuclear sector;
- More national responsibility and ownership has to be taken;

- An increase in the supervision and monitoring of the European Commission and a higher implication of the Member States in the decisions are needed to ensure higher efficiency of the programme and limit the cost increase.

2. Targeted Consultation

The section below is describing the results of the targeted consultation launched by EY regarding the NDAP. Invitation was sent by mail to approximately 90 members of targeted organisations. The survey was available online between 4 July and 15 September

Identification of the respondents

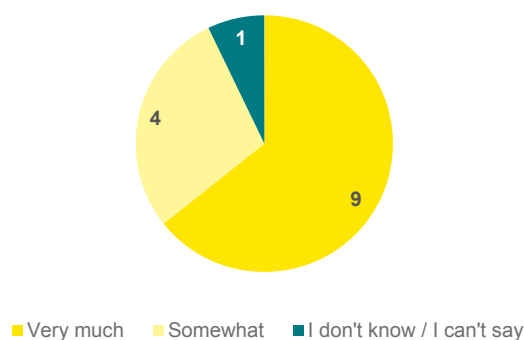
17 answers were registered to the online survey including 4 from Lithuania, 1 from Bulgaria and 12 from Slovakia. 10 respondents indicated that they were familiar with the programme but 3 indicated not to be really familiar with the NDAP and 4 not familiar at all. Three respondents only answered to the identification questions and did not provide answers to the main part of the survey. These answers are not included in the following analysis.

Relevance

Most of the respondents considered that the programme remains relevant to the needs of each Member State considering that:

- EU has to continue supporting the decommissioning of the plants because it required their closure (9 answers),
- National authorities do not have adequate capacities to manage the decommissioning safely and effectively without EU assistance (9 answers),
- Adequate national funding is not available to ensure the timely decommissioning of the reactors (8 answers) and the safe decommissioning of the reactors (6 answers) creating a risk for the general public.

Figure 13 To what extent do you believe that the programme remains relevant to the needs of Lithuania/Bulgaria/Slovakia today?

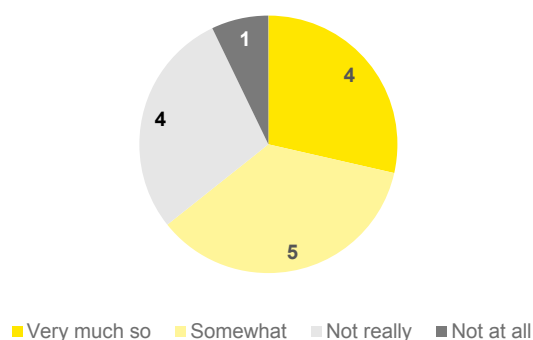


Source: Replies to the open public consultation

Effectiveness

The respondents are divided regarding the fact that authorities are on the right track to achieve expected results in line with decommissioning plans.

Figure 14 Considering the achievements since 2014, do you believe that authorities are on the right track to achieve expected results in line with the decommissioning plans?



Source: Replies to the open public consultation

However, all the respondents considered that nuclear safety has been adequately taken into account in the implementation of the NDAP in the three Member States.

Efficiency

9 respondents out of 14 considered that the efficiency of programme implementation has been a primary concern of national authorities whereas 3 assessed that the programme implementation was not really efficient and 1 that the programme was not at all efficient. The respondents identified the nuclear power plant owner/operator (7 answers), the Implementing Bodies (5 answers), the national ministries (5 answers) and the European Commission (2 answers) as organisations assuming primary responsibility for the implementation of decommissioning activities.

Impacts

The respondents considered that the NDAP implementation had a positive impact on the development of knowledge and expertise, the capacity of national authorities and operators to manage decommissioning of spent fuel and radioactive waste. However, the respondents are more divided regarding the economic impacts at local and national level.

Five respondents considered that the NDAP also led to unintended negative impacts but were not able to precisely describe them.

Added Value

All respondents considered that the NDAP has provided added value to the Member States. However, only one respondent described the types of added value provided, underlining the experience and knowledge gain for the EU companies and positive impact on safety of people and environment.

Annex 3 Methods and analytical models

1. Phasing

The Evaluation was executed under three main phases, organised as follows:

- **Phase 1: Inception Phase.** The aim of this Phase was to ensure the complete structuring of the Evaluation, including the evaluation framework.
- **Phase 2: Data collection Phase.** The data collection phase allowed to focus on both primary and secondary data research.
- **Phase 3: Analysis and reporting phase.** This phase allowed the Evaluation Team to analyse the collected data in order to formulate answers to the Evaluation questions.

2. Work undertaken

The following table presents in detail the data collection work undertaken during the data collection phase.

Task	Work undertaken
Documentary review	<ul style="list-style-type: none"> • In-depth desk research was undertaken by the Study Team prior to the field visit with the objective of ensuring a thorough understanding of the respective decommissioning programmes and better adapting the general topic guides to the context of each programme. • Documents reviewed included the Decommissioning Plans, Monitoring Reports, annual programming documents of Implementing Bodies and selected project documentation (Project Identification Fiches, etc.). Additional documents were gathered during the field visits and reviewed by the Study Team.
Interview programme	<ul style="list-style-type: none"> • Interviews with the European Commission • Interviews with other EU and international organisations • Interviews with a sample of NDAP Committee members
Field visits	<ul style="list-style-type: none"> • Four field visits were organised during the month of June 2014: • London – United Kingdom, 12 – 14 June 2017 (Observation of the Assembly of Contributors meetings and a workshop hosted by the EBRD, interviews with key stakeholders of the EBRD) • Vilnius and Visaginas – Lithuania, 18 – 23 June 2017 (24 interviews with INPP, CPMA, national authorities and regulatory authorities) • Bratislava and Bohunice – Slovak Republic, 26 - 30 June 2017 (14 interviews with SIEA, JAVYS, the Nuclear Regulatory Authority of the Slovak Republic (NRA) and the Ministry of Economy of Slovakia) • Sofia and Kozloduy – Bulgaria, 27 - 30 June 2017 (12 interviews with the Ministry of Energy, SERAW and the Bulgarian Nuclear Regulatory Authority)
Public consultation	<ul style="list-style-type: none"> • Open public consultation launched on 23 June 2017 gathered 17 responses • Targeted public consultation launched on July 2017 gathered 10 Responses
Benchmark exercise	<ul style="list-style-type: none"> • In-depth online desk research • Complementary interviews undertaken with programmes stakeholders
Expert panel	<ul style="list-style-type: none"> • The Expert panel was organised on the 22th September 2017 base on the intermediate version of the draft final report in order to validate conclusions and discuss recommendations.

3. Public Consultation

The public consultation consisted of both a general public consultation launched by the Commission in line with the Better Regulation Guidelines and a targeted consultation launched by EY through the use of the EY Online survey tool. Both are described in further detail below.

General Public Consultation

In line with the Commission's Better Regulation Guidelines, a public consultation of 12 weeks duration shall was launched between July and September. The aim of this consultation was to provide an opportunity for all interested members of the public to provide their input to the Evaluation.

Targeted Consultation

In addition to the public consultation, EY launched an online survey through the use of the EY Online Survey Tool which targeted small and medium sized enterprises, regional/local/municipal authorities and national organisations representing not for profit interests.

4. Benchmark

Following the data collected through interviews and on-site visits, a benchmark exercise was undertaken in order to respond to questions relating to the governance structure and financial management of the NDAP, as well as prospective questions on potential simplification. This benchmarking exercise consisted of undertaking a comparative analysis of other comparable instruments / programmes managed by the EU. In particular, analysis focused on the governance and management structures, as well as financial management modalities.

The benchmarking exercise was conducted on the following programmes.

Programme	Short description	Rationale under the selection of this programme in the benchmark
Connecting Europe Facility	Facility for the delivery of large infrastructure (energy, transport & ITC) projects across Europe (direct management)	As NDAP projects, CEF also finance large size infrastructure projects with large European budget (including in energy sector). Moreover some of these projects are very specific actions and include the development of innovative technologies. They are also implemented by with large number of contractors with very specific skills and various areas of expertise.
Budget support aid delivery modality	Instrument primarily used for delivering aid and capacity building support to third countries (direct management)	The budget support instrument has a number of potential benefits that make it an interesting comparative case study. While budget support has little precedent for being used in the 'domestic' Union context, it is increasingly being considered for wider, including internal, use.
European Structural and Investment Funds for Major	Mechanism for approving and implementing large	ESIF Major Projects are large scale complex projects with some commonalities with NDAP projects such as the part of innovation, the

Projects	projects (>50M) (shared management)	involvement of specific knowledge, the work with contractors,... Some of them are in energy and infrastructure sectors. The management of project implementation is however very different as the NDAP projects.
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5. Expert Panel

The Expert Panel was organised in EY Office in Paris on 22 September 2017. The objective was to discuss main findings and recommendations before the submission of the final report. The following experts attended to this meeting:

- Przemyslaw Zydak (Executive director / Nuclear expert, EY Poland)
- Georgij Krivosein (Senior manager / Nuclear expert, EY Ukraine)
- Andrzej Strupczewski (Chairman of the Nuclear Safety Commission (NCBJ) / Nuclear Safety expert)

Birute Bobrovaite-Jurkone (Nuclear Engineer, EY Lithuania) also contributed to the final discussions on the report although she could not attend the meeting.

Annex 4

Overview of the Evaluation Questions

Proposed evaluation question	Sub-questions (if applicable)
Relevance	
EQ1. To what extent are the general and specific objectives of the NDAP still appropriate in relation to the existing needs? Do these objectives need to evolve to take into account present and future needs?	
Coherence	
EQ2. To what extent is the NDAP coherent with relevant EU acquis?	EQ2.1 Is the NDAP coherent with the Euratom Treaty's acquis in the area of nuclear safety and responsible management of spent fuel and radioactive waste?
	EQ2.2 Is the NDAP coherent with the EU acquis in other relevant areas, in particular the environment?
Effectiveness	
EQ3. To what extent have the (general, specific & detailed) objectives of the NDAP been achieved for each of the three programmes?	EQ3.1 Overall, what level of progress has been made towards the objectives of each national programme? Is the progress in line with the decommissioning baseline adopted by the Commission? If not, what is the risk that objectives will not be achieved?
	EQ3.2 To what extent are control systems in place to measure the progress of the decommissioning programmes?
	EQ3.3 What external and internal factors influenced (positively and negatively) the progress of the decommissioning programmes?
	EQ3.4 To what extent has the level of risk at each nuclear site been improved thanks to the NDAP support?
	EQ3.5 Are the communication actions addressed to the stakeholders and the public effective, adequate and accurate?
EQ4. Aside from the financial assistance provided, what other types of results and impacts can be attributed to the NDAP (e.g. (economic, environmental, social impacts)?	
EQ5. How effective is the governance and project management framework at EU and national levels?	EQ5.1 How well is the Commission supervisory role defined and effective in terms of: planning; monitoring; and reporting
	EQ5.2 At national level, how well are the roles of the Programme Manager and Implementing Bodies defined and effective in terms of: planning; monitoring; and reporting.
	EQ5.3 How effective is the governance system of the decommissioning programmes? In particular does it allow to effectively: <ul style="list-style-type: none"> a) prioritise measures with reference to the NDAP objectives? b) mitigate or avoid risk?

Proposed evaluation question	Sub-questions (if applicable)
	c) minimise or recover from delays? d) overcome administrative bottlenecks?
Efficiency	
EQ6. To what extent is the management of the decommissioning programmes cost effective and efficient?	<p>EQ6.1 To what extent has the NDAP been cost effective when considering each cost category compared against performance indicators? Are there adequate indicators for measuring efficiency?</p> <p>EQ6.2 What are the major factors impacting the efficiency of the assistance programmes? What are the root causes of these factors?</p> <p>EQ6.3 What factors can explain differences in costs (and possibly benefits) arising between Member States?</p>
EQ7. How does the governance and management system of the NDAP compare to other programmes managed by the Commission (or other actors)? Do these comparators provide any best practices in terms of governance or management?	
EU added value	
EQ8. What would be the likely result of not having EU assistance for decommissioning in the three Member States concerned? What is the added value resulting from the NDAP, compared to what could be achieved at national level without such intervention?	

Annex 5

Earned Value Management and critical path analysis

Earned Value Management (EVM) and critical path analysis are complementary in exposing risks for delays in the implementation of the programme.

1. Earned Value Management

Earned Value Management⁶² (EVM) is a structured method used to provide a performance measurement system for review of past and forecasted performance of a project or programme. It integrates scope, schedule, and resources, and for objectively measuring project performance and progress.

A central element of the EVM implementation is the performance measurement baseline providing the reference points against which actual programme progress is compared. It includes;

- (1) Project plan that identifies work to be accomplished in a hierarchy of activities, called the work breakdown structure,
- (2) Schedule for the work which identifies for all activities their durations and interdependencies,
- (3) Budget assigned to planned work, called Planned Value (PV), and
- (4) Pre-defined “earning rules” (also called metrics) to quantify work performance, called Earned Value (EV),
- (5) Accountancy and reporting of the actual expenditures, Actual Cost (AC).

In the case of the NDAP, all these elements are included in the annual work programmes.

Baseline schedule and current schedule

The baseline schedule is the official plan against which schedule performance is measured and reported

The current schedule is used to manage all project activities. It is used to enter the current status of schedule performance. This current schedule provides the road map for all future activities on the project.

When compared to the baseline schedule, the current schedule provides a measure of how well the project is progressing against the original plan. At the beginning of the project, the baseline and current schedules are the same. Once the status update process begins, the current schedule reflects the current conditions on the project.

Performance indicators

EVM implementations generally include indicators of schedule performance (behind schedule or ahead of schedule) and cost performance (over budget or under budget).

The former ones are defined as:

- Schedule Variance, $SV = EV - PV$,
- Schedule Performance Index, $SPI = EV / PV$.

⁶² ISO 21508:2018 Earned value management in project and programme management

The latter ones are defined as:

- Cost Variance, $CV = EV - AC$,
- Cost Performance Index, $CPI = EV / AC$.

At any given point in time, reported information on the Earned Value and the Actual Cost can be used to calculate performance by means of the aforementioned indicators.

Schedule	SV	SPI	Budget	CV	CPI
behind of	< 0	< 1	Over	< 0	< 1
on	= 0	= 1	On	= 0	= 1
ahead of	> 0	> 1	Under	> 0	> 1

The key feature of these indicators is their reference to value (€), so that they clearly reply to the questions:

- Is the programme producing the value that was planned in a determined period of time?
- Is the programme impacted by cost overruns?

Finally, EVM is not intended for non-discrete (continuous) effort, so called "level of effort". If a project plan contains a significant portion of level of effort, and the level of effort is intermixed with discrete effort, EVM results will lose of their informative value.

2. Critical path analysis

Considering the planned duration of each activity and dependencies between the activities, the critical path is the longest path of planned activities to the end of the programme. This determines the shortest time possible to complete the programme.

The critical path analysis also determines the earliest and latest that each activity can start and finish without making the programme longer. This process determines which activities are on the critical path (any delay in those activities will delay the end of the programme) and which activities can be delayed without making the project longer.