Review of Jacobs MCM Report Commercial Model

South Australian Joint Parliamentary Committee on Findings of the Nuclear Fuel Cycle Royal Commission (the Committee)

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I. Introduction

Nuclear Economics Consulting Group (NECG) has been retained by the South Australian Joint Parliamentary Committee on Findings of the Nuclear Fuel Cycle Royal Commission (the Committee) to conduct a review of the Jacobs MCM Report.

This report provides the findings from NECG's review:

- Section I – Introduction
- Section II – Multinational Repository Concept
- Section III – Review of Jacobs MCM Report Paper 5
- Appendices

A. NECG Review team

NECG's review was conducted by a panel of experts:

- Edward Kee of NECG;
- Paul Murphy of Gowling WLG (Canada) LLP;
- Xavier Rollat of Alet Business Services Ltd;
- Edward Davis of the Pegasus Group (NECG Affiliate);
- Melissa Hersh of Hersh Consulting (NECG Affiliate); and
- Ruediger Koenig of QENIQ Advisory (NECG Affiliate).

Appendix A provides more information on this team of experts.

B. Our understanding of Committee objectives

The Nuclear Fuel Cycle Royal Commission (the Royal Commission) was established by the South Australian Government on 19 March 2015 to undertake an independent and comprehensive investigation into the potential for increasing South Australia's participation in the nuclear fuel cycle.

The Royal Commission, having duly considered among other things the Jacobs MCM Report, provided a report to the Governor of South Australia on 6 May 2016, with the following recommendations for the South Australian Government:

> *"The Commission has therefore recommended that the South Australian Government pursue the opportunity to establish used nuclear fuel and intermediate level waste storage and disposal facilities in South Australia consistent with the process and principles outlined in Chapter 10 of this report. This includes suggested immediate steps, and those that may arise in the future. The immediate steps are for the government to:*
>
> *a. Make public the Commission's report in full*
>
> *b. Define a concept, in broad terms, for the storage and disposal of international used fuel and intermediate level waste in South Australia, on which the views of the South Australian community be sought*
>
> *c. Establish a dedicated agency to undertake community engagement to assess whether there is social consent to proceed*
>
> *d. In addition, task that agency to:*
>
> *i. prepare a draft framework for the further development of the concept, including initial siting criteria*
>
> *ii. seek the support and cooperation of the Australian Government*
>
> *iii. determine whether and on what basis potential client nations would be willing to commit to participate.*

NECG understands that the Committee's Terms of Reference are:

> *"A Joint Committee of the South Australian Parliament has been established to consider the findings of the Nuclear Fuel Cycle Royal Commission, focusing on the issues associated with the establishment of a nuclear waste storage facility, and to provide advice, and report on, any South Australian Government legislative, regulatory or institutional arrangements, and any other matter that the Committee sees fit."*

NECG's review of "Radioactive Waste Storage and Disposal Facilities in South Australia, Quantitative Cost Analysis and Business Case, April 2016"[1] (the Jacobs MCM Report) will inform the Committee in relation to its Terms of Reference.

C. Scope of Review

The Committee retained NECG to undertake a high-level review[2] of Paper 5 in the Jacobs MCM Report. Paper 5 provides a summary of the potential commercial viability of the Project.

NECG examined key factors determining commercial viability/profitability, including revenue, capital and operating cost, discount rates, risks, and the financial model used to evaluate Project inputs, assumptions, and scenarios.

1 This report is at http://nuclearrc.sa.gov.au/app/uploads/2016/05/Jacobs-Report.pdf.

2 A high-level review is not meant to be a comprehensive or exhaustive audit but measures general compliance with key international policies and with sound business practices. The objectives of this review are to provide an unbiased understanding of the results and to determine the nature of detailed testing that may be needed in certain areas. Procedures for this review consist primarily of inquiries and analytical review concerning significant matters relating to information being reviewed.

NECG's high-level review covers the items identified by the Committee and provides comments and suggestions on related issues.

D. Documents reviewed by NECG

The NECG team considered several documents related to the Project and to the Jacobs MCM Report.

NECG's high-level review was focused on Paper 5 in the Jacobs MCM Report. However, it also required a consideration of Papers 1 to 4 in the Jacobs MCM Report, to more fully understand Jacob's underlying premises related to the scenarios, inputs and assumptions, and other items discussed in Paper 5.

For further context, NECG also considered information from:

- The final report of the Nuclear Fuel Cycle Royal Commission dated May 2016 and other information from the Royal Commission web site including reports that were developed by or prepared for the Royal Commission;
- The Committee Joint Standing Orders, the Transcript of Evidence Heard (Official Hansard Report) by the Committee, and published submissions to the Committee; and
- Other relevant publicly-available information.

II. Multinational Repositories

This NECG report is provided in the context of what the NECG team believes is likely to be needed to successfully establish a multinational repository.

In this brief introductory section, we outline our general views on multinational repositories and on the Project as a proposed multinational repository.

A. Concepts

The disposition of radioactive waste arising from the operation of nuclear power plants, including spent nuclear fuel (SNF), has been and remains an important long-term nuclear power industry issue. The long-term disposition of SNF and radioactive waste remains a contentious issue, with few examples of actual successful repository projects. Nevertheless, it is an issue that must be solved by this or future generations.

Currently, the disposition of radioactive waste is being addressed separately in each country with operating or planned nuclear power plants. These countries typically intend to pursue a national repository and the status of these national repositories varies widely - a few countries are close to having an operational repository, some countries have taken steps to develop a repository, some countries have plans for a repository, and other countries have only taken preliminary steps.

The cost and difficulty of developing a national repository is likely to be high, but may be disproportionately higher for countries with small nuclear power programs that are unable to achieve economies of scale. The cost of a national repository will also be high if the country has geographical, geological, political, or security issues that make siting, developing, constructing, and operating a repository difficult.

A multinational repository, such as the Project, may offer a way for some countries to meet objectives for disposition of radioactive waste with (a) a lower cost, (b) more certainty, and/or (c) a faster schedule than a separate national repository. These countries will likely see the Project as a viable alternative that should be investigated, especially if a national repository is expensive or difficult.

For example, the establishment of separate national repositories for managing radioactive waste will most likely lead to economic inefficiencies. A multinational repository used by multiple countries would only require one siting and licensing process and could be designed with a large capacity to take advantage of economies of scale related to capital and operating costs.

Any repository, national or multinational, will face a range of challenges. Some of these challenges may be exacerbated or mitigated with multinational concepts.

A multinational repository project will involve managing a set of highly complex technical, legal, political, operational, and commercial challenges.

B. The Project

The Project would be the first serious effort to develop a multinational repository by a democratically-elected government. The Project may be able to provide a viable and beneficial solution to many countries now having to rely on separate national solutions for their radioactive wastes, and may be able to provide a significant share of the world requirement for radioactive waste repository capacity.

At the same time, the Project may be a viable and profitable investment for South Australia.

The Royal Commission process and the Project are innovative and, if successful, the Project could be the first significant multinational repository.

The Jacobs MCM Report is the first of multiple analyses and assessments of the Project that will be required. The Jacobs MCM Report has sufficiently defined options and parameters for the Project to allow an initial assessment of Project economics. The scenarios developed in the Jacobs MCM Report show that under certain assumptions the Project could be economically viable.

NECG considers the Jacobs MCM Report as providing a reasonable basis for the Committee to undertake additional investigation and activity.

III. Review of Jacobs MCM Report Paper 5

NECG's high-level review of the Jacobs MCM Report is intended to help the Committee identify issues and actions needed to move the Project concept to the next stage of development.

The Jacobs MCM Report is a "preliminary opportunity assessment" that:

- Describes the Project opportunity;
- Develops relevant Project parameters;
- Provides an initial assessment of the potential market;
- Identifies some earlier projects to guide price and cost analysis;
- Develops a set of assumptions, inputs and scenarios; and
- Conducts an initial economic assessment.

NECG's summary of the Jacobs MCM Report Scenarios is provided in Appendix B.

The Jacobs MCM Report can serve as a useful basis for future work to be done[3]. Figure 1 provides a schematic that illustrates NECG's high-level assessment of what the Jacobs MCM Report does and does not address in its proposed Project development scenario process.

[3] In line with Royal Commission suggestion to "Define a concept, in broad terms, for the storage and disposal of international used fuel and intermediate level waste in South Australia, on which the views of the South Australian community be sought."

Figure 1 – Context of Jacobs MCM Report

Jacobs MCM Report:	Is: Preliminary Opportunity Assessment	Is not: Actionable Business Plan
Objective	Outlines potential business opportunity	Establishes a program baseline
Method	"Outside In" – Project complexity is reduced to simplified scenarios.	"Inside Out" – defines value proposition and plan for implementation
Quantitative Results	Averages inputs related to highly uncertain or variable parameters	Assesses preliminary practical and financial viability.
PRO/Strength	Delivers an analysis of possible outcomes, sensitivities and risks	Delivers a credible reference case for project development
CON/Weakness	May not deliver reliable prediction of outcomes	Tests and re-confirms impact of wide range of assumptions on results over time
Next step	Building on this Assessment, refine details of Project approach to develop an Actionable Business Plan	Define Project and test assumptions with key stakeholders (public/political, client countries, financial community, etc.) to validate investment decision
Decisions	"Should we consider this opportunity?	"Should we make (initial/progressive) commitments to the Project?"

Critical steps to be taken to progress from the Opportunity Development to Project Development phases require the program sponsors (e.g. the Committee) to:

- Decide on vision/mission statements, defining goals and objectives as a well as limitations and exclusions[4] ("no-goes");
- Identify program concept, necessary decision gates and corresponding gate criteria, which includes parametrizing stakeholders' risk appetite; and
- Establish a program management office, program governance structure, and corresponding budgets.

The Jacobs MCM Report provides suitable initial input for the decisions that will be necessary in that context.

Further Project development towards a more detailed Project assessment will be an iterative process that covers economic viability, legal feasibility, concept of operations, public participation and acceptance, and other key issues (see Section III.I.1 below).

A. Overall Conclusions

NECG finds that the Jacobs MCM Report:

- Provides a useful indication that the Project, a radioactive waste storage and disposal business in South Australia, could be profitable under certain conditions and assumptions; and

4 For example, whether reprocessing options would be included; see Section III.I.2 below.

- Is an acceptable starting point for further detailed, in-depth analysis.

At the same time, NECG considers it would be premature to decide on the commercial viability of this Project based only on the Jacobs MCM Report. Informed decision making will require a more extensive assessment that includes what was explicitly excluded in the Jacobs MCM Report, and generally, will require more work to:

- Better define the Project concept of operation;
- Better define a Project execution plan;
- Assess the market potential for client countries in more detail;
- Address a range of other Project definition and planning issues;
- Consider broader economic benefits to South Australia;
- Consider alternative ownership, funding and financing models;
- Refine the commercial viability assessment; and
- Develop a detailed Risk/Opportunity Register.

Due to the preliminary nature of the Jacobs MCM Report, a critical review at this stage will naturally identify a multitude of detailed assumptions that can be questioned in different ways or even suggest different assumptions. This does not mean that the Jacobs MCM Report is not useful or relevant or that the Project is not a potentially attractive opportunity.

Rather than provide an exhaustive critique of all such issues, NECG has focused at this stage on important issues that should be considered in the next steps:

- Development of work specifications and limiting factors for an Actionable Business Plan by the Committee or other entities appointed by Government or Parliament; and
- Work to develop an Actionable Business Plan.

Accordingly, NECG identified the following **five high-level issues** that are discussed in more detail later in this document.

1. Simplistic view of Project

Consistent with the nature of the Jacobs MCM Report, there are a range of simplifying assumptions made in that Report about the nature of the Project, the potential market size, prices that can be charged, costs of the Project, timing, and other factors. These assumptions are used to develop multiple scenarios, with results presented for a single baseline scenario.

Reducing complexity in this way tends to underestimate factors that could increase costs, limit the prices that can be charged, and/or reduce or limit market size. Building on the Jacobs MCM Report, considerable work on Project details is needed to develop a credible value proposition and an actionable business plan.

Developing such a value proposition would consider additional details related to the types of waste, timing of waste availability, country and regulatory factors (i.e., in Australia and in client countries), political considerations, and a range of other factors to develop an optimal target market, to scope an appropriate Project configuration and operational concept, and to estimate the corresponding scope and size of the necessary facilities.

More work needs to be done to assess "economies of scale" due to replacing multiple national repositories with a single multinational repository. This analysis should provide a better reference point to assess Project costs and client country willingness to pay.

2. Gaps in political, legal, and regulatory issues

The Jacobs MCM Report includes assumptions (explicit and implicit) about the political, legal and regulatory context of enabling the Project. As a general matter, the report does not fully explore the time and costs related to these issues. These issues have significant serious potential to adversely impact the Project and its commercial outcomes:

- May have a significant impact on the time and resources needed to implement the program in Australia (i.e., where Commonwealth Government involvement is required), in South Australia[5], and in client countries;
- May present constraints that have the potential to slow or stop the development of the Project both in terms of Project execution (i.e., whether Project milestones can be achieved) and market capture (i.e., whether the Project can meet contractual commitments to client countries and whether client countries will be able to meet Project timelines);
- Present hurdles and requirements that must be overcome to allow (in terms of Australian, international, and client countries) radioactive waste to be exported from client countries, shipped to Australia, and accepted at an interim storage facility in South Australia; and
- Will involve significant involvement and support of the Commonwealth Government, principally in the arena of international treaty commitments[6], national laws, nuclear safety regulatory oversight and licensing, and as insurer of last resort.

While there are no prohibitions[7] under existing international treaties to the transport of nuclear waste and spent fuel across international boundaries, certain coordination will need to occur between the originating country and Australia to comply with such international treaty commitment, along with supporting actions by Australia to support its existing international treaty commitments (see Appendix G for examples). Further, current legislation at the national and state levels would need to be implemented (as well as existing legislative prohibitions repealed, such as provisions contained within the *Nuclear Waste Storage Facility*

[5] The NECG report has assumed that the Project facilities will be in South Australia, but note that engagement with the Commonwealth Government may make open the possibility of sites in other States.

[6] The role of the IAEA and other international organizations will be important for this multinational repository project.

[7] Prohibitions are found in national laws, which we discuss later in the report.

(Prohibition) Act of 2000) to permit the development of this Project and the importation, storage, and final disposition of the nuclear waste and spent fuel. In addition, new regulations and treaty commitments will need to be developed to support the Project. Overall, this presents a complex set of issues that involve multiple stakeholders:

- Coordination between Australia and the originating country will occur more so in the contractual space than in the political space. This will limit stakeholder engagement, but it will also be a time-consuming and intense process, driven by commercial, technical, and legal considerations. The Project Company will need to develop a standard "form" contract, which will then be negotiated with each potential client country. Considering that the Project will need multiple clients to be economically viable, sufficient time and resources will need to be committed to implement such contracts.

- Legislative developments at the national and state levels are quite straightforward, in terms of enacting key provisions and repealing "blocking" provisions; however, such activities are fully within the public eye, which will necessitate significant coordination and stakeholder engagement. Given democratic processes, such activities will not lend themselves to expedited treatment, and the overall Project development schedule will need to give due consideration thereto.

- Further to the legislative points, significant coordination will need to occur between South Australia and the Commonwealth Government, recognizing that national and state actions must be aligned; and certain actions can only be taken at the national level. Examples of such national actions include nuclear liability coverage and further development of ARPANSA. These initiatives would not occur without a strong commitment to the Project at both the state and national levels. Accordingly, state and national commitment must <u>precede</u> these activities and this will need to be reflected in the Project development schedule:

    - With respect to nuclear liability, it is recommended that Australia accede to the Convention on Supplementary Compensation for Nuclear Damage, which would require implementing legislation at the national level and final accession to the treaty with the International Atomic Energy Agency to support the principles contained in the treaty (legal channeling, strict liability, etc.). Absent a clear solution on third party nuclear liability exposure, it will be impossible to develop this Project on an economically viable basis. *See* Appendix F for a further discussion on nuclear liability concepts.

    - With respect to the regulation of nuclear safety, Australia will need to expand the capabilities of ARPANSA, in terms of both funding and human resources development (people and subject matter knowledge), recognizing that ARPANSA has never regulated a project with the type or scale of the Project. ARPANSA will need to develop clear and definitive regulations, a licensing process (e.g., site license, construction license, operating license, etc.) for the Project, and commit to a reasonable schedule for its review of Project submissions.

Failure to successfully resolve these key constraints may preclude development of the Project, even if other aspects are favorable. The resolution of these issues needs immediate action.

3. Omits Economic Benefits

The commercial model mentions but does not include the economic impact of potential benefits to the State of South Australia arising from employment at the facilities and from personal and corporate taxes. These economic benefits will be important for justifying South Australia's support for and investments in the Project.

The economic benefits would include employment, indirect economic activity, and direct income tax receipts imposed on third party contractors during the construction and operation phases of the Project.

These economic benefits mean that the South Australian Government may see overall net public benefits from the Project even if the direct financial returns are small. Many of these benefits are projected to occur in the early phases of the Project (engineering, licensing, construction of facilities and infrastructure, potentially manufacturing storage and transport containers and vehicles) at the time when significant Project costs are being incurred.

To capture such benefits, an early "localization strategy" must be developed, as there will be opportunities and trade-offs, e.g. in relation to potential target markets and suppliers, that must be clarified and negotiated during Project development.

4. Assumes, rather than reflects, market needs

A significant implicit assumption in the Jacobs MCM Report is that the Project provides a product/service that meets the needs of a significant number of client countries.

Assumptions about the Project product/service offering, Project timing, and estimates of the potential market served are needed to define the Project to further refine the initial assessment in the Jacobs MCM Report.

However, as the Project is considered in more detail, it is important to note that the Project product/service offering may not reflect the actual requirements, needs, or preferences of some or all potential client countries.

Deep geologic permanent repository disposal of spent nuclear fuel appears to be the solution to HLW disposition in some (or even most) countries. However, other approaches, including long-term surface storage of HLW in dry casks, reprocessing of HLW to recover useable fissile and fertile materials (i.e., uranium and plutonium) and reduce the amount of HLW for disposition, and the use of HLW as fuel in advanced power reactor designs, are being considered.

Project timing in the baseline scenario (i.e., commencing deliveries of HLW in year 11) may not fit well with the needs or requirements of some client countries. In many instances, spent nuclear fuel may be safely and inexpensively stored in spent fuel pools and/or dry casks at a nuclear power plants until the end of power operations and for some time after the end of power operations. Some decommissioning approaches assume that spent nuclear fuel can be safely stored at the reactor site for decades after power operations have ended.

It is important that South Australia starts discussions with client countries as soon as possible to better understand client country needs and to replace these general assumptions with actual client country requirements and preferences. Ideally, these discussions would result in expressions of interest by client countries and would start the process of scoping contract terms and conditions.

Client country discussions might also investigate interest in a Project development model that would include client country investment in the Project. This approach might provide a way to fund (i.e., from client country investments of funds that would have been used for planning and developing a national repository) the Project at an early stage, with client countries sharing investment risk and making strong commitments to the Project. This approach might also provide South Australia with outside input into Project concepts and might reduce the need for an ISF as part of the Project, with interim storage being performed at existing facilities in client countries.

The Jacobs MCM Report notes that such discussions are important, but suggests that these discussions are relevant to timing, volumes and Willingness-to-Pay (WTP), not to the overall Project concept/approach.

> *"…Should South Australia decide to pursue plans for hosting an international storage and disposal service, one of the immediate tasks will be to have specific discussions with potential client countries in order to clarify their requirements and assess demand on a country by country basis, including their timing and volume requirements as well as their willingness to pay level…"*

NECG's view concurs with the Royal Commission recommendation that engagement with potential client countries is an essential and important next step that can and should cover a much wider set of issues.

5. Project Profit Margin

Project economics can be illustrated by an estimate of Project margins.

The largest factor driving Project profitability is the profit margin for HLW storage and disposal.

In this review, NECG defines "margin" as the difference between the assumed Price to Charge (PTC) for HLW and the total Project costs (i.e., capital and operating costs over the entire Project life) per tonne of heavy metal to store and dispose of that HLW.

Comparisons of PTC, Project cost, and margins in the same units provide a high-level view of Project economics based on total undiscounted cash flows that is an indication of potential Project profitability that may be useful to the Committee.

The margin helps understand a key aspect of the Project that is independent of market share (i.e., so long as Project size, cost, and timing are unchanged), even though margin may not reflect the impact on Project NPV from the timing of cash flows.

The Jacobs MCM Report does not present margin information. NECG developed Project cost estimates in units of AUD/tHM using information provided in the Jacobs MCM Report.

Table 1 provides the margins for the Baseline Configuration Scenario 4, with high, base, and low PTC amounts.

Table 1 – HLW Margin Summary (2015 million AUD/tHM)

PTC	Project costs / HLW capacity[8]		Margins	
	Without Royalty payments	With Royalty payments	Without Royalty payments	With Royalty payments
$2.5 (high)	$1.053	$1.446	**$1.447**	**$1.054**
$1.75 (baseline)	$1.053	$1.333	**$0.697**	**$0.417**
$1.0 (low)	$1.053	$1.220	**($0.053)**	**($0.220)**

The margins are relatively high in the high PTC and base PTC scenarios, with and without Royalty payments to the State Wealth Fund. If PTC is even higher than the high scenario, a potential that is discussed in the Jacobs MCM Report, and costs remain the same, margins will be higher and the Project is projected to be even more profitable.

On the other hand, margins are negative in the low PTC scenario and a modest increase (i.e., about 30% with Royalty payments) in Project cost could mean negative margins in the baseline PTC scenario.

This high-level view of Project margin shows the importance of PTC and Project cost estimates.

B. Revenue

Project estimated revenue is based on the PTC and the size of the market (i.e., quantity of HLW and ILW shipped for storage and disposal to South Australia). We discuss each of these factors.

[8] NECG used information from Page 1 of the Jacobs MCM Report (i.e., in bullets 6 and 7) for total Project cash cost of AUD145.3 billion,[8] total Royalty payments of AUD38.6 billion,[8] and HLW volume of 138,000 tonnes to develop Project Cash Costs in units of 2015 AUD/tHM. This summary only included Royalty amounts for the base PTC of 1.75 million/tHM; NECG used the Jacobs financial model to develop total Royalty amounts for the high and low PTC scenarios. This simplistic approach may slightly overstate HLW costs because the relatively small ILW costs are included in total costs.

1. PTC

PTC in the base scenario is AUD1.75 million/tHM for HLW delivered to a port in South Australia, with client countries paying for transport to South Australia.

PTC is calculated as the estimated WTP amount less an estimate of the cost a client country would incur to process, package, transport, and ship radioactive waste to South Australia.

a. WTP

NECG's view is that the current WTP estimates are overly general and optimistic.

The Jacobs MCM Report WTP estimates are based on the amount a client country might pay to avoid the cost of developing and implementing a national repository by shipping the radioactive waste to South Australia.

The Jacobs MCM Report implicitly assumes that WTP is roughly equal to the estimated cost of cost of developing and implementing a national repository, with some discussion of factors that may suggest even higher WTP amounts or premiums. As an initial approach, this is acceptable, but is not sufficiently detailed to support an actionable business plan.

The Jacobs MCM Report implicitly assumes that client countries view the Project as a solution to their own local issues with developing a national repository. The potential for the Project to be delivered at lower costs due to economies of scale or favorable geological conditions for a South Australian site compared to sites in the client country is not considered. The market might be expanded if the Project would be presented as a lower cost option for client countries that do not place a significant value on avoiding national repository development issues.

i. Disparate national repository cost estimates

The Jacobs MCM Report uses several different national repository cost estimates as one basis for WTP estimates. These national repository cost estimates may not be directly comparable to one another because the different national repository cost estimates:

- Were independently developed in different countries and at different times;
- May include different assumptions, different constraints and local conditions, and different national requirements;
- May not be reported in the same manner as costs for the Project (i.e., undiscounted total Project costs); and
- May not provide a reasonable estimate of the costs (or the perceived costs) of a national repository in client countries, because the Jacobs MCM Report uses data from countries that may not be potential client countries.

The Jacobs MCM Report notes this lack of comparable information, but does not fully resolve this issue. If these international repository cost estimates are to be used as the basis for WTP estimates, more work is needed to understand the details of the estimates and to adjust, if needed, the estimates to allow comparisons.

ii. Differences in WTP across client countries

The second issue is the assumption that a client country would be willing to pay South Australia an amount based on the entire cost of a national repository program avoided by the client country. WTP will differ substantially across client countries, for reasons unrelated to the estimated cost of a national repository. Each client country has a unique perspective on the value offered and risks associated with the Project service/product offering. There are several reasons[9] for these differences, including:

- Each client country has its own financial considerations, anticipated national repository program timelines, and interest rate/foreign exchange rate expectations;
- Actual "avoided cost" for each potential client country depends on what activities a client country has already undertaken with respect to a national repository and how much has been spent on those activities[10];
- The extent that client country funds accrued for national disposition of HLW can be used[11] to pay for the Project and whether such funds are accessible (i.e., are in a segregated account, as opposed to approximated by asset values);
- The relatively low difficulty of negotiating an arrangement with the Project compared to the likely higher difficulty, contention, and time involved in developing a client country national repository;
- Each client country's views on the appropriate or required approach to HLW disposition, based on national laws, political positions, and international treaty obligations, underscoring the importance of developing the Project in compliance with international best practices;
- Each client country's expectations about the services that they expect or require from the Project;
- The extent that a client country compares the value of the Project service/product offering to competitive offerings from other countries (e.g., Russian nuclear fuel leasing) that offer lower costs and simpler approaches or options to develop new advanced nuclear reactors that can dispose of spent fuel as fuel;

[9] Jacobs points out these issues, but does not reflect them in its further analysis. These issues will be important in developing a more nuanced and country-specific WTP estimates.

[10] Amounts already spent on existing national solutions (e.g. interim storage in dry casks) would reduce the value provided by the Project.

[11] National laws usually preclude the use of such funds for anything other than a stated purpose (e.g. a national repository) and changes to laws may be required to allow use of the funds to pay for the Project, as a foreign activity.

- The risk discount assessed by a client country to reflect the risk that the Project may fail for some reason prior to HLW delivery or prior to waste being placed into the GDF, with residual liability for the client country;

- A client country's views on the cost, risk, and other issues associated with moving radioactive waste from current approved locations (e.g. at a nuclear power plant site) to South Australia;

- The client country assessment that transferring, or signing contracts to transfer, HLW to South Australia would mean that real options for HLW disposition (i.e., as better future information become available on approaches and costs[12]) are lost; and

- Assessment of economic impact of the investment and jobs lost by the client county in accepting the Project approach[13].

b. WTP compared to national estimates and Project costs

To put the WTP amounts in perspective, Figure 2 shows three sets of data that are used in the Jacobs MCM Report:

- The international repository project costs (i.e., used to develop WTP estimates and scenarios);

- Three WTP scenarios[14]; and

- The Project cash costs with and without Royalty payments for the baseline Configuration Scenario and the baseline PTC scenario.

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[12] Examples include better information on repository costs or a global shift toward lower cost long-term storage of dry casks as an alternative to more expensive deep geological repositories.

[13] In effect, the Project is a way for South Australia to import jobs and economic benefits to the local economy. A client country will likely consider how participation in the Project will reduce jobs and economic benefits to the client country's economy.

[14] These are the same three PTC scenarios presented in Table 1, with WTP equal to PTC plus the assumed transport costs of AUD 0.195 million/tHM.

Figure 2 – Comparison of WTP sources, WTP Scenarios, and Project costs (2015 million AUD/tHM)

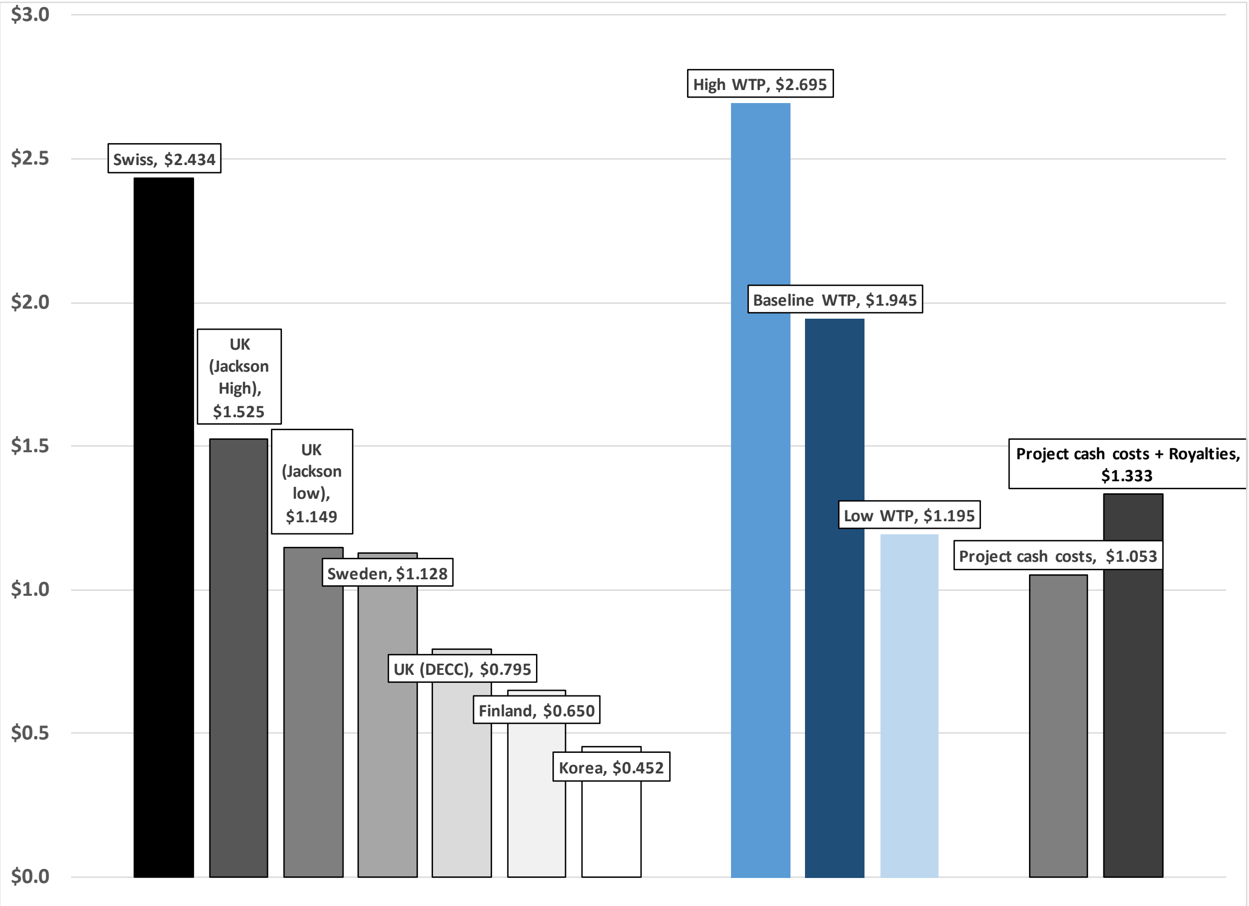

Figure 2 shows that High and Baseline WTP estimates have amounts that are higher than most or all national repository cost estimates noted in the Jacobs MCM Report and that the Low WTP estimate has prices that are higher than some of the national repository cost estimates.

This comparison suggests that the selection of a baseline WTP amount may not be supported by the national repository cost estimates and that a lower baseline WTP scenario may be more appropriate. The same comparison suggests that some client countries may seek a WTP that is lower than the low PTC scenario, especially if these countries see the low national repository estimates as indicative of their own national repository costs.

On the other hand, the low WTP scenario has prices that are close to estimated Project cost. If WTP amounts are overstated, Project profitability is seriously at risk.

c. Transport costs

In NECG's opinion, separating PTC from the cost of transporting waste to South Australia is a sensible approach.

This approach assumes that client countries are responsible for arranging and paying for transporting waste to South Australia. This approach keeps the focus of the Project on activities in South Australia, but may mean that the Project must be able to accept a range of waste containers and conveyances.

This transportation cost is estimated in the Jacobs MCM Report to be AUD0.195 million/tHM. This amount seems to be a reasonable high-level estimate. The actual cost to transport radioactive waste to South Australia varies, perhaps significantly, from country to country due to different locations and other factors.

If a client country's costs to transport radioactive waste to South Australia is higher, PTC for that client country is lower, reducing margins and projected Project profits.

Accordingly, country-specific transportation cost estimates should be used to define PTC.

2. Market Size

The Jacobs MCM Report includes a very preliminary approach to estimating market size and the share of that market captured by the Project. While the market scenarios are a reasonable approach in this preliminary assessment, significantly more work is needed to examine each potential client country in detail. An outline for a more systematic approach has been mentioned in Figure 3.

The situation in each potential client country must be examined in more detail to develop a more detailed country-by-country estimate of market size. This is a critical next step[15]. The profitability of the Project depends on the size of the market, which, in turn, drives Project capacity and total cost estimates. More importantly, Project approaches and costs depend on client country needs and requirements.

There are three issues with the market capture approach in the Jacobs MCM Report:

- Some "accessible countries/volumes" are included for client countries that are unlikely to participate[16];
- The simple market share (i.e., percent of total market) approach combines various independent factors (e.g. probability of future nuclear generating capacity and the spent fuel expected to be produced, and timing of availability of wastes, competition by other repositories or repository alternatives, alternative uses of waste); and
- The complexity of addressing the large range of political, operational, contractual, regulatory, and technical issues arising from such a broad market approach (e.g. different fuel vendors, shapes, burn-up rates, storage requirements, and storage containers) do not seem to be adequately recognized.

The first two issues might be addressed by Jacob's use of market scenarios (i.e., MS1, MS2, MS3, MS4) because the ultimate outcome of these market share scenarios is a quantity of HLW. The third issue, however, has serious implications for the Project that are not reflected

[15] This is not to suggest that this would begin with formal bi-lateral discussions. Important preliminary work can and should be done to identify key clients and their key issues (e.g. see III.D.1), by analyzing public domain information and in a dialogue with international institutions and organizations such as IAEA, IFNEC, and WNA.

[16] For example, Germany has adopted a "no export" policy which is about to be enacted in law, but represents about 10% of the accessible market in the Jacobs MCM Report; Pakistan may be disinclined to a multinational repository solution, in the same way as the other nuclear weapons states.

in the Jacobs MCM Report, where spent nuclear fuel disposal appears to be considered a commodity.

a. Market scenarios

The Jacobs MCM Report adopts the MS2 scenario (i.e., a 50% capture of the available market) as the baseline market capture scenario with little support or justification as to why 50% is a better baseline than 25% or 75% (or any other assumption). NECG considers this approach acceptable for an initial Opportunity Assessment. However, it is not a reliable assessment of realistic currently accessible markets on the one hand, nor of likely future nuclear power capacity (and potential Project market) on the other hand.

- It appears that an average operating life of 60 years has been applied to existing reactors but it is not clear that this would be a reliable estimate when considering not only lifetime extensions but also early shutdowns and new build in current nuclear countries.

- The list of planned reactors appears to be somewhat theoretical, based on disparate national announcements. More work should be done to assess the feasibility of these plans and the likelihood that the reactors will be built. Some of the countries on the list would not be considered as having credible nuclear power plans.

- On the other hand, by focusing on announced nuclear programs, the Jacobs MCM Report may be underestimating the growth of new nuclear power projects. As nuclear power is increasingly seen as a critical tool in lowering carbon emissions[17] in the electricity sector, more nuclear power projects may be built. In some instances, having a viable multinational repository (e.g. the Project) available may increase the potential for new reactor projects. Disposition of spent nuclear fuel is a challenging requirement for a country considering nuclear power that might be resolved by participation in a multinational repository. It may be useful to develop a high growth case that reflects more favorable outcomes for new nuclear power plants.

Jacobs mentions but does not quantify other factors that affect waste arising, for example:

- Significant HLW volume reductions due to higher burn-up rates and reprocessing; for example, Japan has set aside half of its spent fuel for reprocessing and its future nuclear energy plans are uncertain.

- Expanded on-site spent fuel pool storage and on-site dry cask storage capabilities for operating and new nuclear power plants. The capability to store spent nuclear fuel at the reactor site with little incremental cost has large implications for the amount and timing of the potential Project market.

The planned reactor list may also under-estimate the countries that are considering or that have agreed to use Russian nuclear power plants designs that are bundled with a long-term nuclear fuel leasing agreement. This fuel leasing approach takes back spent nuclear fuel, resolving the nuclear power plant host country’s HLW disposition issues. Other countries

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17 As discussed in the December 2015 COP21 meetings that resulted in the Paris Agreement.

competing to sell nuclear power plants in the international market, such as China, may offer similar nuclear fuel leasing arrangements.

b. Market Complexity

If the Project were to "capture" a large market share (i.e., as in the MS2 scenario selected as the base case), it would be required to have agreements with many client countries with different political, contractual, technical, regulatory and other issues:

- Multiple negotiations and legal/contractual arrangements are needed for contracts with multiple client countries, all of which will take considerable time;
- Transport and storage solutions would have to accommodate a range of nuclear fuel types and transport/storage casks;
- A single standardized design/approach to transport and storage of spent fuel and other HLW may not be possible and each approach used would need to be licensed/certified in relevant client countries and in Australia;
- Specifications for ILW (treatment, matrix/packaging) from different national programs would have to be accommodated in Australia; and
- The Project would need technical infrastructure to handle and manage the range of spent fuel and high-level waste types and storage/transfer container types

These issues have implications on Project licensing, timing, capital and operating costs, revenues, and profitability.

The Jacobs MCM Report financial model might be used to develop a set of "break-even market volume" scenarios for various assumptions about cost and pricing. This approach would help assess the sensitivity of the Project to assumptions about market volume.

C. Program Costs

There are three major issues:

- Vague Project concept – The assumptions for market capture, client country requirements, and timing scenarios suggest that the Project would require a larger, more complex infrastructure than has been assumed in the streamlined cost scenarios;
- Optimistic cost assumptions - The cost assumptions made (and the benchmarks used to develop these assumptions) are optimistic, especially in the context of a new large, first-of-a-kind, radioactive waste storage and disposal facility in Australia. Although not clearly substantiated (duly noting the implications of the Class 5 estimates), the various costs under consideration appear to be based on a set of "most favorable" assumptions (e.g. simple facility, streamlined operations, low licensing requirements, supportive foreign exchange rates, favorable cost escalation, etc.); and
- Economies of scale - Potential for economies of scale due to the relatively large size of the Project are not well developed and substantiated.

The challenge is to develop a "right sized" Project that achieves economies of scale and favorable economic outcomes.

One way to do this is to focus on the "right" clients to provide a more appropriate and more fully defined scope and function for the Project.

1. Focus on Target Market

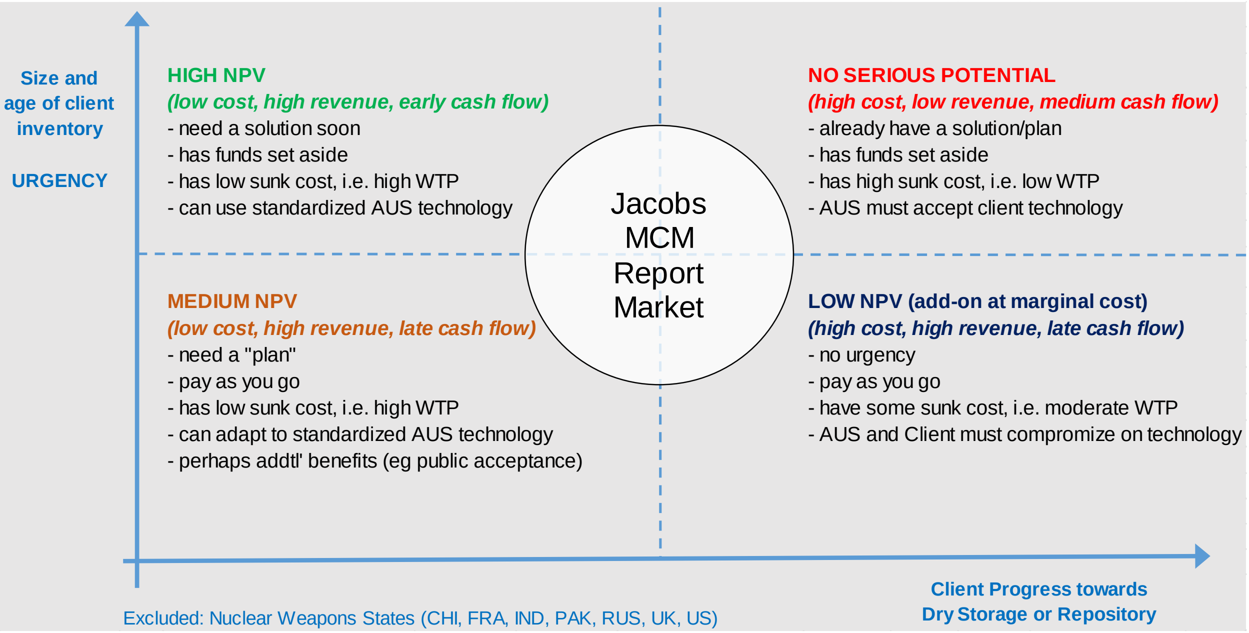
Project cost is strongly linked to market size and the issues associated with each client country.

Using broad assumptions about the type, amount, and timing of waste that might be included in the Project and delivered to South Australia is an acceptable approach to a preliminary Project viability assessment. However, a more detailed assessment of the market will likely mean that Project cost, timing, and revenue are very different from Project parameters based on broad assumptions.

A more reliable approach to planning the Project could categorize the target market, for example as shown in Figure 3, in terms of:

- Likelihood that potential client countries could be interested in the Project proposition;
- How client countries would contribute to realizing economies of scale (benefit to the Project) and/or to the complexity/cost of the program (detrimental to the Project); and
- Actual timing of client country waste transfers and payments.

Figure 3 – Market segments



Such an approach may lead to a smaller overall volume, at least initially, but should result in a better cost/revenue ratio and/or less risky program.

2. Other cost issues

NECG notes some other issues with Project costs as estimated in the Jacobs MCM Report.

The reliance on Class 5 estimates allows significant latitude. Even so, the Jacobs MCM Report notes that the cost estimates do not consider regulatory risk, something that is (and has been) a very significant issue in every nuclear industry project to date and that has been a significant issue in other national nuclear waste repository projects.

A 25% contingency was added to the base Class 5 cost estimates, based on experience with delays and cost overruns in actual non-nuclear Australian projects. The delays and cost overruns arising in nuclear projects are likely to be much greater than in non-nuclear projects, due to safety regulation, public approval, and related issues. It is also important to distinguish between different types of nuclear projects, with the issues leading to potential delays and cost overruns for nuclear power plant projects being different than the issues related to the siting, construction and operation of radioactive waste storage and disposal projects.

The cost estimates include "*a notional amount expected to be spent on obtaining various licensing and permitting approvals.*[18]" This is likely to understate Project licensing and permitting costs. Australia's nuclear safety authority[19] may not currently have the appropriate skills, staff, experience, etc. to consider applications for the required Project facilities and for the over-land handling and transport of radioactive waste in a timely manner. Putting the necessary suite of laws, regulations, and treaty commitments into place, enhancing the capabilities and procedures of the nuclear safety regulator, and the licensing process for Project facilities and activities will take considerable time and will require Commonwealth Government support and actions.

A summary of two other national repository projects (i.e., Germany and USA/Yucca Mountain) is in Appendix C.

D. Financial Assumptions

The Jacobs MCM Report provides an acceptable approach to assessing the financial outcome of the Project at this preliminary stage of Project definition.

1. Cash Flow Timing

Project financial outcomes have a direct and strong implicit link to Project concepts.

A significant Project assumption in the baseline scenario that has an impact on the timing of Project cash flow and NPV is that client country payments will be received on delivery of waste (i.e., starting in year 11), but major Project expenditures to develop and build the ILW and GDF facilities will be made much later.

[18] Jacobs MCM Report, Paper 3, Section 3.6, on page 135.

[19] Australian Radiation Protection and Nuclear Safety Agency (ARPANSA).

If Project revenue is delayed until the repositories are completed and placed into operation, as in Configuration Scenarios 2 and 3, Project profitability is negative in the Jacobs MCM Report and financial model.

2. Discount rates

The 4% and 10% real discount rates used in the Jacobs MCM Report financial assessment and financial model are, as a matter of principle, acceptable for this preliminary assessment. However, details about Project ownership and financing must be decided to determine whether these discount rates are appropriate and which discount rate should be the primary one.

The range of 4% and 10% covers likely Project ownership and financing options. The use of the 10% discount rate as the primary approach to estimating Project NPV appears to be conservative, because the financial model NPV of real Project cash flows is lower (i.e., as compared to the NPV using a 4% discount rate). Presenting the lower NPV may serve to lower the expectations of Project profitability and offset other Project assumptions and scenarios that are optimistic (i.e., increase Project net cash flow and Project NPV).

The Jacobs MCM Report does not clearly explain the role envisaged for the South Australian Government in the Project (i.e., whether the Project is a government agency, a government-owned corporation, a private corporation with government funding and/or guarantees, or something else), a key factor in developing an appropriate discount rate.

Key underlying principles for developing a more definitive conceptual framework for discount rates are outlined in Appendix D.

3. Inflation/Escalation Assumptions

The Jacobs MCM Report has adopted an inflation/escalation rate (i.e., "CPI") assumption of 2.5% that is a reasonable amount for use as an assumption for inflation, but may be low for cost escalation in nuclear projects (i.e., that may be greater than inflation).

The Jacobs MCM Report approach is to develop costs in real AUD, but to use a CPI estimate of 2.5% to escalate costs in the financial model.[20] The financial model starts with real costs, escalates these using the CPI assumption to develop nominal cash flows, then uses the same CPI assumption to convert these to real cash flows.

4. Reserve Fund

The Reserve Fund is a critical feature in the program, as a means of securing the very long-term stewardship cost of the Project. From an ethical and public acceptance perspective and for regulatory purposes there must be a high level of certainty that the Reserve Fund will be sufficient to fund Project costs for future generations.

[20] Jacobs MCM Report, Paper 3, Section 2.8, page 130.

The Jacobs MCM Report defines a Reserve Fund that will provide an adequate level of funding to pay for Project costs for 1,000 years. The Reserve Fund is assumed to earn a real return of 2.4% for a very long period of time.

The returns on the Reserve Fund appear to be higher than returns available in the market, but the 2.4% long-term return is an acceptable assumption at this point. Given the importance of the Reserve Fund, the expected returns over the very long periods of time should be considered more closely.

The Project Reserve Fund, in the baseline scenario, does not commence accruals until year 45, well after the commencement of Project operations. If Project revenue stopped for any reason after year 45, the Reserve Fund may not provide sufficient funding and any costs not covered by the Reserve Fund would need to be covered by the State.

Common international practice[21] requires set-asides from the start of revenue-generating operation. The alternative approach for funding the Reserve Fund described in the Jacobs MCM Report (i.e., Section 4.7 starting on page 211) appears to do this, but with a corresponding reduction of Project NPV. These alternative approaches should be used as the baseline approach.

Despite the presence of the Reserve Fund, consideration will also need to be given to the need for State or Commonwealth government guarantees for the Project. These guarantees are contingent obligations that will need to be evaluated for budgeting purposes.

5. State Wealth Fund

The State Wealth Fund is funded by contributions from Project Revenue (i.e., even if the Project is not profitable, the Wealth Fund contributions are made). The State Wealth Fund is assumed to earn a 4% real return for a long period of time. This return appears to be a neutral assumption for a very long-term fund.

The primary impact of the State Wealth Fund on the Project is on profitability, with contributions coming from gross receipts, thus reducing profits. The returns on the State Wealth Fund do not have an impact on the Project profitability, but indicate the extent to which the State of South Australia will benefit from the amounts paid into it.

E. Risk issues

The Jacobs MCM Report appears to ignore the potential costs (or risks) to the Project and/or to the State and Commonwealth Governments related to third party liability, Project default, or other events.

Some of these risks can be more easily quantified than others. However, many of the risks considered are reputational, and while the potential knock-on impacts of these risks could feasibly be modelled, this would require further significant work and analysis.

[21] For example, in the United Kingdom recent "Funded Decommissioning Programme Guidance for New Nuclear Power Stations."

Appropriate and adequate management, allocation, and mitigation of Project risks will have an impact on costs and timing for the Project, especially during the licensing and development phases.

NECG recommends that a prudent "next step" in the Project development process would be to create a detailed "Risk Register" for the Project, which identifies material Project risks, categorizes their significance, and then identifies possible risk allocation and risk mitigations strategies in respect thereof.

Additional discussion of risk issues is presented in Appendix E.

Four important risks are understated in the Jacobs MCM Report. These risks must be assessed in a more detailed study of the Project.

1. Delays and cost increases

The risk of delays and/or cost increases in the Project may not be fully reflected in the Jacobs MCM Report analysis. In addition to delays and/or cost increases due to natural hazards, almost all nuclear industry projects have experienced delays and/or cost increases due to public acceptance, regulatory approvals leading to a license to start construction of ILW and HLW repositories, political issues, and nuclear safety oversight of construction.

The potential for delays and/or cost increases in the Project is significant, due to the Project's location in Australia, a country with limited experience with such facilities, and to the potential complexity of the overall arrangements.

2. Variety of waste types

The risk and complexity of accepting spent nuclear fuel, HLW and ILW from a wide range of reactor designs, reactor types (i.e., both light water reactors and heavy water reactors), and countries, with this radioactive waste packaged in a variety of storage and transportation containers, is not discussed in detail in the Jacobs MCM Report. The variety of radioactive waste types may require additional facilities, may increase capital and operating costs, and may delay the movement of HLW to Australia and within South Australia.

3. Reputational Risk

Reputational risk at the local, State, Commonwealth, and international level is important but difficult to quantify. The Jacobs MCM Report assumes that community engagement and consultation will proceed with little uncertainty as to timing or outcomes.

The reputational risk with respect to South Australia, where major economic activity is based on tourism and wine production, has not been assessed or modelled.

Reputational risk also relates to the perception of the Project and the need to implement Project-related activities to the highest standards. Australia is not a party to any international nuclear liability conventions and the Australian Nuclear Safety Regulator has not regulated complex nuclear projects, creating perception issues that may go well beyond commercial considerations.

4. Nuclear accident/incident

Although it is unlikely, there remains a possibility of a nuclear incident or accident related to the Project that results in the release of radioactivity. Readiness to respond to such an accident or incident would require the Project to have law enforcement and emergency response personnel, facilities, and protocols in place (i.e., as appropriate for a waste storage or repository facility) and developing this would increase Project cost.

In addition, the Jacobs MCM Report does not provide an outline of:

- What type of nuclear incident/accident could (theoretically) happen;
- What risk mitigation programs, including insurance and limits on liability, could (should) be considered;
- Who the key stakeholders under a nuclear incident/accident scenario would be; and
- What role the State Government and/or the Commonwealth Government would play (i.e., insurer of last resort).

F. Timing

An important factor in the Project NPV is the timing of revenue and costs.

Client countries are assumed to pay PTC when radioactive waste is delivered (i.e., starting in year 11, when the ISF is completed in the base CS4 scenario). On the other hand, the CS4 scenario schedule assumes that major Project expenditures for permanent ILW and HLW repositories are delayed for years (or decades).

Radioactive waste is stored in the ISF until the ILW and HLW repositories are completed and placed into operation.

This approach requires Australia and client countries to agree on a transfer of waste ownership/title and a transfer of liability before facilities to dispose of this waste are licensed or built. South Australia will need to consider the implications of this transfer of title from a risk/liability perspective, recognizing the inherent differences between the ISF and the permanent repository.

If this approach would be at acceptable to client countries, South Australia, and the Commonwealth, the time that will be needed to develop and build the repositories for ILW and HLW may take longer than expected or assumed in the Jacobs MCM Report. The assumed timeline for these facilities is very ambitious and not supported by international experience in other major nuclear industry projects.

Project economics will be better if the repositories and the capital costs of these facilities are delayed, assuming the ISF is completed and deliveries commence in year 11. However, South Australia must be prepared to accept interim storage at the ISF for longer time periods than currently anticipated and must be prepared to explain to client countries that this is a real possibility.

The various Project timelines would need to be validated and verified as the details of the Project concept are refined, since they have a major impact on Project costs and overall feasibility / profitability.

G. Legal, Regulatory, treaty and third-party liability

The commercial viability of the Project depends on the extent to which client countries see the Project as a legally viable, ethical, and publicly acceptable alternative to a national repository. Considerations include:

- Commitment and alignment at the State and Commonwealth levels must support the Project concept, development plan, and schedule;
- Legal and regulatory arrangements must be fashioned to allow for the development of the Project and the importation of the spent fuel and nuclear waste into Australia;
- Legal and regulatory issues in the client country as well as third-country consents will need to be adjusted to allow participation in the Project (or any multinational repository), rather than a national repository;
- Nuclear liability will need to be addressed in Australian law, and Australia will need to accede to certain international liability treaties;
- Contractual rights and remedies will need to be established that will provide recourse to both client and host for non-performance;
- Coordination with the IAEA and other relevant international/regional organizations will need to occur;
- Insurance will need to be placed to cover both third-party liability (which may require the development of an Australian nuclear insurance pool) and damage to any Project asset;
- Government guarantees will need to be considered; and
- Funding and other financing arrangements will need to be implemented.

South Australia and the Commonwealth Government will need to establish a new legal regime for this Project. The Australian Nuclear Safety Regulator will need to establish (or update) regulations and regulatory processes needed to license the facilities and activities that are a part of the Project.

At present, Australia is not party to an international nuclear liability convention[22], nor does Commonwealth law set limits on nuclear liability. The Australian position on nuclear liability will affect the feasibility and commercial aspects of negotiating Project agreements with potential client countries.

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22 Australia signed the Convention on Supplementary Compensation for Nuclear Damage (CSC) in 1997, but has not ratified it or implemented national laws needed to reflect the CSC.

1. Underdeveloped legal, political, regulatory and contractual framework

Development and analysis of a legal, political, regulatory and contractual framework for the Project has not been completed.

This leaves a serious gap, in that many of the assumptions made in the Jacobs MCM Report that must be adjusted to reflect the legal, political, regulatory and contractual framework that would be necessary to support the Project. This gap means that the assumed timelines for decision making, siting, and establishing a suitable infrastructure, agreeing on terms for waste transfer with client countries and obtaining international consents, and other activities may not be reasonable or even feasible (unless the law changes). How such issues are sorted will then have an impact on risk allocation and ultimate Project costs.

An overview of third party liability issues that will be important for this Project is discussed in Appendix F.

2. Legal Basis for permanent transfer of HLW

The Project concept assumes that ownership and liability transfer (and payment by the client country) occur when nuclear waste is transferred to the land facilities in Adelaide. This is a central and essential part of the Project value proposition, but may be controversial.

This assumed approach, depending on the PTC and Project details, could provide benefits to a client country, because South Australia will assume all risk and cost upon delivery. The arrangement may also provide benefits to South Australia if the Project is well developed and takes advantage of economies of scale to deliver a positive margin.

If the legal and treaty issues, including nuclear liability limits and insurance, can be resolved, the Project can contemplate commercial contracts between the Project and client countries that are consistent with relevant international treaties.

A key issue in these commercial contracts will be the type and level of support by the State and/or Commonwealth Government for Project obligations. This will be especially important when client countries are paying upon delivery of radioactive waste that will be stored prior to disposition of waste into repositories that will not have been built yet.

The recourse of client countries if there are Project issues will be important. These issues may include:

- Schedule delay (either schedule to complete ISF and accept waste or the schedule to move waste to permanent repository);
- Failure to complete (either the ISF or the GDF or other key parts of the Project);
- Failure to accept the waste (i.e., after contractually committing to do so and after the client country incurs costs to transport and package and deliver waste); and
- A breach by the Project of any covenants relating to handling (and usage) of the waste.

There is also an overarching reputational aspect to the Project, which will need to:

- Meet highest international and all client country standards for safety, security, and safeguards;
- Meet international standards on transparency and nuclear materials inventory accounting;
- Be technically sound, demonstrating industry best practices;
- Factor sustainability (social and environmental) considerations into the Project development and execution plans; and
- Demonstrate an enduring commitment by State and Commonwealth Governments.

Relevant international treaties do not preclude a transfer of radioactive waste to South Australia. A discussion of international treaties and other legal issues is in Appendix G.

A note on other legal issues and restrictions related to nuclear waste is in Appendix H

3. Long Term Financial Liability of Government

The Jacobs MCM Report does not clearly explain the role envisaged for the South Australian Government in the Project (i.e., whether the Project is a government agency, a government-owned corporation, a private corporation with government funding and/or guarantees, or something else). The financial arrangements for the Project will be important and options should be considered in more detail, including the extent to which the State or Commonwealth government will have liabilities or guarantees.

Commitments will be required from State and/or Commonwealth Government to take on any financial liability that might arise in the future. The State and/or Commonwealth Governments must be willing (and obligated) to backstop the Project if things go wrong. The resulting long-term obligations and liabilities are not discussed in the Jacobs MCM Report.

Once nuclear waste is delivered to South Australia and ownership/liability has been transferred to the Project Company, the nuclear waste cannot be returned and the client country may have no contractual obligations to assume any financial or other obligations.

Some of these issues can only be addressed by the Commonwealth Government, and the State Government will need to work closely with the Commonwealth Government to ensure that appropriate and timely action is taken.

H. Jacobs MCM Report Financial Model

NECG was asked to review the Jacobs financial model. The aim of this review was to assess the technical integrity of the financial model.

NECG was also asked to develop a capability to assess financial model output under different inputs and assumptions.

1. Technical Review

NECG has reviewed the financial model.

The NECG review was not a complete audit of the model and, therefore, we cannot state that all aspects of the financial model are correct, that the output of the model is robust under all inputs, or that there are no errors in the model.

NECG assessed the integrity of the financial model by assessing the change in output when there are changes in various inputs and assumptions. Based on this assessment, we find that the financial model appears to properly reflect the inputs and assumptions.

The Jacobs MCM Report financial model is complex and appears to be an adaptation of a larger and more complicated financial review model (i.e., there are tabs that are included but not used) for the purposes of this analysis. The Jacobs MCM financial model provides long-term projection of cash flows under multiple Project scenarios and assumptions. The Jacobs MCM financial model does not provide Project financial outcomes and financial reports that will be needed to better understand the Project investment opportunity.

For example, the Jacobs MCM Report seems clear and consistent about the financial model being a "pre-tax" model. However, the financial model includes tax liabilities and related calculations (e.g., depreciation), a calculation of after-tax NPV, and a sheet dedicated to tax calculations.

Charts in the final Jacobs MCM Report are generally consistent with the charts in the financial model, but some charts have differences in format, labels, scale, and data format/color. As noted in a separate email exchange, the version of Figure 4.10 in the Jacobs MCM Report was not updated to reflect the data in latest version of the financial model.

The Jacobs MCM Report model was provided in the form of five separate spreadsheets in MS Excel format. The financial model includes macros. The financial model spreadsheet uses more than 300 named ranges, with some of these not used in the Project evaluation. Data Tables are used to provide scenario outputs for charts.

Initial opening of the models resulted in errors. The "NFCRC - ALL Options - Order of Cost V1 - Sensitivities.xlsx" spreadsheet has circular formula reference errors.

2. Model Output under alternative assumptions and inputs

a. Delay revenue until repositories are in operation

One of NECG's concerns is that it may be difficult to convince client countries to deliver and pay in advance for radioactive waste storage and disposition starting in year 11 (i.e., when port facilities and ISF are completed), while ILW facility is not ***scheduled*** to start accepting delivers until year 24 and the GDF is not ***scheduled*** to start accepting HLW until year 28.

NECG used the financial model to assess how the economics of the Project would change if client countries only started delivering ILW and HLW when the permanent facilities were completed and accepting deliveries.

Using the Jacobs MCM Report financial model with baseline scenario inputs and assumptions gives a Project NPV of AUD 11.52 billion pre-tax if the HLW and ILW deliveries and revenues start in year 11.

When the HLW deliveries are started in year 28 (i.e., delayed for 17 years from the original timing), the Project NPV drops to a negative AUD 1.01 billion.

If the ILW deliveries are also delayed to start in year 24 (i.e., delayed for 13 years from the original timing), the Project NPV drops to a negative AUD 1.802 billion.

This revised estimate results are similar to the results for the CS2 and CS3 scenarios, where the Project has no ISF and deliveries start after the repositories are operating. However, the CS2 and CS3 scenarios adopt a different annual profile of waste deliveries than the annual deliveries under the CS4 scenario and CS2 and CS3 scenarios have different costs (i.e., because the ISF is not built).

It is important to note that the results for this analysis and for the CS2/CS3 results presented in the Jacobs MCM Report reflect a complex set of assumptions. The Project concept and assumptions could be adjusted to reflect this direct delivery approach in a manner that resulted in profitable operation.

I. Responses to other questions from the Committee

1. Initial Project costs and activities

The Committee asked about the activities in the first six years and whether the high-level estimate of the cost of these activities in the Jacobs MCM Report is reasonable.

a. Jacobs MCM Report initial Project activities and costs

The baseline CS4 scenario has about AUD 600 million[23] in capital expenditures in the first six years. These costs appear to be related to the "Facilitation" activities in the timeline in Figure 3.1 (page 201) in the Jacobs MCM Report.

The activities described in the Jacobs MCM Report for this period include (with various starting points in the first six years):

- Define Project mission, services offered, organisations and responsibilities;
- Establish legislative framework;
- Establish financial provisions;
- Establish and incorporate commercial bodies;
- Develop and formalize regulatory standards for all facilities/activities;

[23] The Jacobs MCM Report financial model for CS4 scenario includes AUD 571 million in nominal cash flow to the end of year 6.

- Scoping desk studies on ISF;
- Siting of ISF;
- ISF design development;
- ISF EIA and licensing of ISF system and site;
- Scoping desk studies for GDF and IDR;
- Scoping desk studies on LLW facility;
- Siting of LLW facility; and
- Design development of LLW facility.

All these activities are likely to be required, at a minimum, to support a Financial Investment Decision (FID) under the current view of the Project and the total cost estimated for these activities seems reasonable. Under some Project approaches, even more activities and costs may be required. Reaching a greater level of certainty regarding the licensing and construction of the GDF and IDR are likely to be required and would add cost and time.

However, NECG is concerned with a view of the Project development process that has two simple steps:

- Commit all the activities described in the Jacobs MCM Report for the first six years (i.e., at an estimated cost of AUD500 million);
- Decide at the end of the six years to invest in the Project or not.

A more nuanced, incremental and detailed approach to Project initial activities should be developed, in line with established practice in comparable major undertakings internationally.

b. Alternative approach to initial Project activities

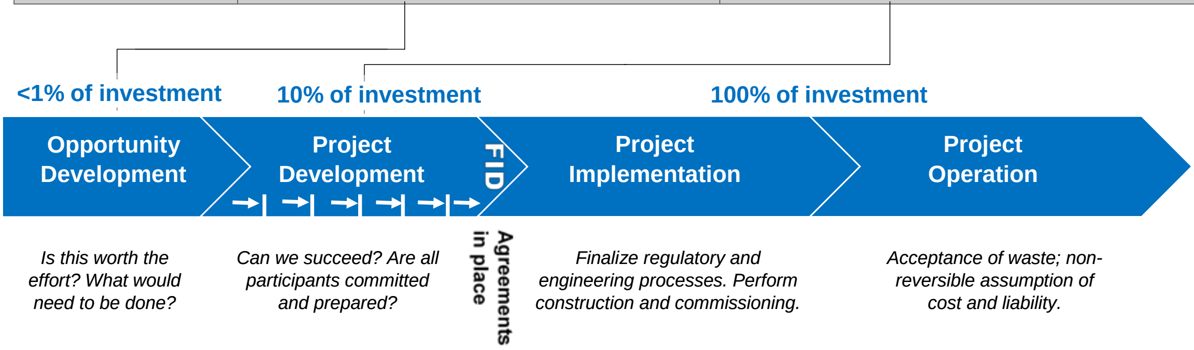
NECG believes that a better approach is possible to advance the Project from a potential opportunity to an implementable business plan.

Such an approach would involve a series of Project "decision gates" that must be passed before additional commitments are made. Focusing near-term activity and expenditures on resolving important issues early (i.e., successfully passing the decision gates for these issues) will allow the Committee to better manage Project assessment and development.

In effect, the next steps would be focused on developing an Actionable Business Plan, as outlined in Figure 4. A priority is placed on Project issues that (a) are essential for Project feasibility and (b) that could be investigated at relatively low cost.

Figure 4 – Actionable Business Plan development

Jacobs MCM Report:	Is: Preliminary Opportunity Assessment	Is not: Actionable Business Plan
Objective	Outlines potential business opportunity	Establishes a program baseline
Method	"Outside In" – Project complexity is reduced to simplified scenarios.	"Inside Out" – defines value proposition and plan for implementation
Quantitative Results	Averages inputs related to highly uncertain or variable parameters	Assesses preliminary practical and financial viability.
PRO/Strength	Delivers an analysis of possible outcomes, sensitivities and risks	Delivers a credible reference case for project development
CON/Weakness	May not deliver reliable prediction of outcomes	Tests and re-confirms impact of wide range of assumptions on results over time
Next step	Building on this Assessment, refine details of Project approach to develop an Actionable Business Plan	Define Project and test assumptions with key stakeholders (public/political, client countries, financial community, etc.) to validate investment decision
Decisions	"Should we consider this opportunity?	"Should we make (initial/progressive) commitments to the Project?"



Focusing on these mission-critical steps before undertaking relatively expensive studies of costs, sites and licensing, will allow the Committee to uncover any potentially fatal flaws or significant deficiencies in the Project concept before spending significant amounts of money.

To implement this "decision gate" approach, the Committee should:

- Develop a detailed list of all topics and issues that must be considered and resolved to reach a FID;
- Consider the order in which these topics should be investigated;
- Consider the costs of these activities; and
- Organize these topics (and the activities to resolve the issues) in a phased process/workplan with clear stop/go decision gates.

An example (i.e., not comprehensive or exhaustive) of initial activities and decision gates is included in Table 2.

Table 2 – Initial Outline of Decision Gate approach

Topic	Activities	Decision gate

Commonwealth Government role and commitment	South Australian discussions with the Commonwealth Government about • expansion of ARPANSA's scope of responsibilities to support the Project (staffing, funding, etc.) • repeal of national laws prohibiting nuclear waste project; • developing and approving national laws to implement the CSC Treaty; • ratification of the CSC Treaty; and • accepting a role as ultimate insurer for third party nuclear liability claims above limits.	Commonwealth Government commitment to these actions is necessary for a feasible Project
Client country views of the Project concept	South Australian discussions with potential client countries to better understand the waste volumes, PTCs, and other issues (including possible "expressions of interest").	Responses from potential client countries will help define Project concept, size, PTC, and timing.
ARPANSA role and commitment	Discussions with the Australian nuclear safety regulator (ARPANSA) to determine what will be needed to enhance capabilities to review and approve the various facilities and activities of the Project.	ARPANSA plans and requirements may have implications for Project schedule and cost.
IAEA support	Engagement with IAEA to integrate international best practices into the Project development plan and establish framework for IAEA coordination and review.	IAEA involvement (support and validation) will be important from an international "reputational risk" assessment of the Project and support needed from the international community.

The downside of this approach may be that some activities are undertaken in a series fashion, resulting in a longer initial development period.

The upside of this decision gate approach is that key issues can be resolved early, and the Project can be defined and shaped to reflect these key issues. This decision gate approach will also provide flexibility to reflect new insights and changing conditions over time. If one or more key issues cannot be resolved in a manner that allows the Project to proceed, the sunk costs should be lower than the costs incurred if all activities start immediately.

2. Potential for reprocessing

The Committee asked about how the costs in the period leading up to a Financial Investment Decision might change if the Project concept included the reprocessing of SNF.

In principle, the potential for future re-use of SNF is an important consideration that has a place in any discussion about nuclear waste management strategies. A key driver of reprocessing of SNF is the recovery of fertile and fissile materials, but the prices of these materials and the enriched minded uranium that these materials would compete with are at historic lows, removing economic incentives to undertake reprocessing. However, the potential for these fertile and fissile materials to be valuable in the future may suggest that reprocessing be retained as an option.

At the same time, the strong link between reprocessing of SNF and nuclear weapons programs may create political, security, defense, and related issues in Australia, in some or all potential client countries, and in other countries in the Asia-Pacific region. For these and similar reasons there may be sufficient potential client countries who prefer to forego the option of reprocessing entirely; in this case the Project could be designed to either serve these clients exclusively or not at all.

NECG's initial view is that including reprocessing (or even the option of reprocessing) in the Project would require a complete re-assessment. The Jacobs MCM Report scenarios and assumptions assume that deep geological permanent disposal is the only option.

Adding the option of reprocessing will require an assessment of multiple factors that are not now considered in the Jacobs MCM Report. To prudently maintain an option to reprocess, the SA multinational repository project would likely be required to assess the following during the initial six-year project planning period:

- **What are the technology risks associated with reprocessing?** Reprocessing facilities are complex industrial facilities with approaches that are not mature or established. Many advanced nuclear countries have had difficulty in designing, building, operating, and maintaining these facilities.

- **What is the current and projected market for fissile and fertile materials?** The uranium and plutonium recovered from SNF in a reprocessing facility may be valuable, but the market for these materials must be assessed if the South Australian reprocessing facility will sell these products into the world market. In some projects, an advanced reactor is co-located with the reprocessing facility to use the uranium and plutonium as fuel to make electricity.

- **What do current and projected economic cost/benefit analyses look like?** From a business case perspective, a significant effort should be undertaken to better understand the trade-offs, costs, and benefits of reprocessing as well as perform capital cost benchmarking for the required facilities, including front-end facilities, separation facilities, mixed oxide fuel fabrication facilities, and vitrification facilities;

- **What does the current legal and regulatory landscape look like, and what would be the projected needs to accommodate a reprocessing option?** Further investigation and analyses of all legal and regulatory requirements required to be met to be compliant with all international law and regulatory requirements as well as the establishment of necessary siting, design and engineering requirements;

- **Are current siting and co-location analyses sufficient for considering the reprocessing option?** Further siting work would be required to explore and understand the various tradeoffs in co-locating the reprocessing and MOX fabrication facilities, with the ISF and GDF. For example, what is the best location for a reprocessing facility? Should that reprocessing facility be co-located with the ISF site or the GDF site?

- **Are the systems engineering considerations required to make a reprocessing option viable sufficiency covered by the existing studies?** Additional engineering work would likely be required to identify the requirements and specifications and sizing of the related reprocessing and fabrication complex and the interfaces with the ISF, IDR and GDF facilities,

- **Are existing considerations for canister and encapsulation solutions sufficient to address reprocessing requirements?** Further work would likely to be required in terms of determining the tradeoffs in the various canisters and encapsulation approaches that would be incorporated into the project's system engineering requirements and specifications;

- **To what degree do existing repository engineering design considerations need to be re-configured to permit reprocessing?** Additional engineering work would likely be required to determine the optimum design of the repository thermal management design which is affected by the heat generation of the encapsulated canisters; and

- **What additional requirements – engineering, safety, security, labour, and financial – will be needed to ensure that Safeguards and Security requirements are met or exceeded?** The separation and inventorying of stocks of fissile materials including plutonium will require a comprehensive assessment and analysis of the integrated system and facilities to determine design requirements for material accountability, safety and safeguards. It would be necessary to include the Australian military in this decision.

In line with NECG's assessment in Section III.I.1 above, these factors would be considered in an incremental project development effort: the cost incurred would be determined and justified by the extent to which the reprocessing option is necessary, commercially viable, and desirable.

Appendix A Experts involved in this Review

NECG[24] provides this report that includes the findings of a review from a panel of experts. A short biography the NECG team of experts is provided here. Each of these biographies has a link to more detailed information, including a full CV.

NECG and the team of experts have worked together in two earlier consulting engagements to provide advice to the U.S. Department of Energy (DOE) related to the International Framework for Nuclear Energy Cooperation (IFNEC[25]) and the IFNEC Reliable Nuclear Fuel Service Working Group (RNFSWG[26]).

The experts on this team have also provided advice on a range of issues related to multinational repositories. Our advice included a discussion of technical issues, legal issues, criteria for host countries and client countries, potential commercial and contractual arrangements, risks for all parties, and lessons from earlier multinational nuclear efforts.

The team of experts included:

A. Edward Kee

Mr. Kee[27] is an expert on nuclear power economics. He is the founder and principal consultant at Nuclear Economics Consulting Group (NECG) and is also an Affiliated Expert at NERA Economic Consulting[28].

Mr. Kee provides strategic and economic advice to companies and governments on nuclear power and electricity industry issues. His work included acting as Economic Advisor to the Government of South Australia during electricity industry restructuring/privatization and the start of the Australian National Electric Market.

He has testified as an expert witness in US and international legal and arbitration cases.

Prior to founding NECG, Mr. Kee held senior consulting positions at NERA Economic Consulting, CRA International, PA Consulting Group, Putnam, Hayes & Bartlett, and McKinsey & Company.

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24 See www.nuclear-economics.com.

25 See https://www.ifnec.org/ifnec/ for more information.

26 See https://www.ifnec.org/ifnec/jcms/g_5334/ifnec-reliable-nuclear-fuel-services-working-group-rnfswg-summary for more information.

27 More information on Edward Kee is at http://nuclear-economics.com/biography/.

28 See http://www.nera.com/experts/edward-kee.html.

B. Paul Murphy

Paul M. Murphy[29], Managing Director for Gowling WLG[30], has over twenty years of experience as a transactional attorney. He is a three-time selection to the Who's Who Legal / Energy for 2013 - 2015 and a member of the International Nuclear Law Association.

Paul Murphy's practice focuses on multiple aspects of the nuclear industry – from legal and policy matters, including international regulatory and treaty frameworks and issues regarding nuclear liability, to strategies for creating and financing nuclear power programs and the identification and mitigation of associated risks – representing developers/owners, investors, lenders, and contractors on nuclear projects internationally. Mr. Murphy is recognized as an expert in the development and financing of nuclear power programs by the International Atomic Energy Agency (IAEA), the OECD's Nuclear Energy Agency (NEA), the International Framework for Nuclear Energy Cooperation (IFNEC), and the US government.

Mr. Murphy was supported by colleagues from Gowling WLG as needed. Gowling WLG is a leading international law firm, with more than 1,400 legal professionals in 18 cities across 10 countries, spanning North America, the UK, Continental Europe, the Middle East, and Asia. Gowling WLG provides clients with legal advice in a range of areas, from complex cross-border transactions and intellectual property matters to high-stakes litigation and disputes.

The firm's Nuclear Energy Group is at the forefront of the industry's revitalization. Its global team of experienced legal professionals delivers hands-on legal and strategic guidance in all aspects of nuclear power operations at every stage — from project development, contracting, and financing to regulatory affairs and decommissioning.

C. Xavier Rollat

Mr. Rollat[31] is a seasoned financier with extensive experience in procuring and delivering structured and multi-sourced balance sheet-, asset- and project-based debt-financed solutions to support capital-intensive investments in the electricity sector in emerged and emerging countries.

During his 26-year career in banking and financial advisory, he has developed an in-depth understanding for the economics of the power industry, developed with clients on the corporate side, special-purpose project companies, governmental agencies and suppliers, and for the procurement and the financing of a broad range of transactions in the power sector around the world. He also worked for two years at SGN, an engineering company of the Cogema (now Areva) Group, where he delivered financial solutions to support the financing of nuclear waste (interim) storage projects.

Mr. Rollat has developed a detailed expertise in the advising and the structuring of nuclear investments, e.g. new-build generation projects, and more recently waste storage facilities. He is recognized as an expert in the development and financing of nuclear power programs

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29 More information on Mr. Murphy is available at https://gowlingwlg.com/en/canada/people/paul-murphy?lang=en-CA.

30 More information on the Gowlings firm is at *https://gowlingwlg.com/en/global/global-reach* with the nuclear practice at *https://gowlingwlg.com/en/canada/sectors-services/sectors/energy/nuclear.*

31 More information on Mr. Rollat is at http://nuclear-economics.com/xavier-rollat-cv/.

by the International Atomic Energy Agency (IAEA). He has contributed to the preparation of various documents from the OECD's Nuclear Energy Agency (NEA) and the European Nuclear Energy Forum (ENEF).

D. Edward Davis

Mr. Davis[32] is a senior nuclear industry executive with 40 years of nuclear industry experience, including engineering, management, business development, strategic planning, project finance, and government affairs. Subject matter expertise includes technology and risk assessments, nuclear energy project development, energy and electricity economics, state utility rate making, uranium enrichment supply/demand, project finance and NRC regulation, spent fuel and waste management. Specific expertise includes NRC Part 50 & 52 licensing process as well DOE Nuclear Power 2010, DOE Loan Guarantee as well as DOE spent fuel and nuclear waste programs. Extensive experience in conducting economic and market assessments.

Currently serving as President and Managing Partner of the Pegasus Group as well as the Nuclear Energy Infrastructure Council (NIC) Senior Fellow and Policy Advisor. Also, served in a number of senior management positions, including President of the American Nuclear Energy Council, President and Chairman of the NAC International and President and CEO of the Pegasus Group.

E. Melissa Hersh

Melissa S. Hersh[33] brings 20 years of experience operating at the nexus of commercial and public sector policy and operations. Her areas of expertise include: global public health and biosecurity, Unmanned and Counter-Unmanned Systems (drones), disaster preparedness and response, and nuclear energy. As a noted risk expert, Ms. Hersh regularly advises governments, IGOs and Fortune 500 companies on risk across a variety of sectors. She comes to the Stimson Center while serving as the Principal of Hersh Consulting, LLC, a boutique risk consultancy based in Washington, DC advising clients in aerospace, defense, and security, nuclear energy and extractives, transport and logistics and global health issues including CBRNE.

F. Ruediger Koenig

Rudy Koenig[34] is an interim manager and executive advisor to international investors and suppliers: supporting corporate strategy and business development; structuring complex business transactions and programs; designing corporate governance for new enterprises; leading restructuring and change management processes; managing lean business operations.

Mr. Koenig has nearly 30 years of experience in global clean energy markets, where he has held executive offices in Germany and the United States, in the nuclear and renewables

[32] More information on Mr. Davis is at http://nuclear-economics.com/edward-davis/.

[33] More information on Ms. Hersh is at http://nuclear-economics.com/melissa-hersh/.

[34] More information on Mr. Koenig is at http://www.ruediger-koenig.com/en/.

sector, at engineering, manufacturing, and service companies as well as in trading and with a large utility/investor.

In nuclear, he has been a key player in the European new build program where he helped develop, implement and ultimately sell several new build projects, with a potential capacity of 6 GWe, in several countries for a utility investor. He has also served as Chairman of the New Build Task Force at FORATOM, the European nuclear industry association.

His international nuclear experience spans the front- and backend of the fuel cycle, new build, as well as decommissioning and remediation. This includes responsibilities as Managing Director of the leading global supplier of dual-purpose casks for SNF and HLW.

Appendix B Jacobs MCM Report Scenarios

The Project is to be a state-owned enterprise, with profits benefiting the state of South Australia.

In Paper 5 of the Jacobs MCM Report, a baseline scenario (combination of various scenarios for inputs) for the waste company is discussed. The basis for the selection of baseline scenario assumptions is not clear. This baseline scenario assumptions include:

- Configuration Scenario 4 (CS4);
- Timing scenario 1 (TS1);
- Market Capture (or "share") scenario 1 (MS1);
- A high-level waste (HLW) PTC of AUD1.75M/tHM;
- An intermediate level waste (ILW) PTC of AUD40,000/cubic meter;
- Discount rate (pre-tax real) of 10%; and
- Royalty Payments of 15% of Project revenue

Each of these assumptions is developed and justified within its own context in Papers 1-4 of the Jacobs MCM Report. However, there seems to be no underlying concept of operation for these scenarios and little discussion of whether or how each scenario:

- Meets the same overall objectives and outcomes; and
- Can be compared directly with other scenarios.

Each of the Scenario factors are discussed below.

A. Configuration Scenarios

See Tables 3.1 and 3.2 on page 198-199 of the Jacobs MCM Report. In these Tables:

- ISF - interim storage facility (a surface storage approach for both HLW and ILW, near docking/port facility);
- LLWR – low level waste repository;
- IDR – intermediate depth repository, for "long-lived" ILW;
- GDF – "deep underground" (i.e., permanent) geological disposal facility for HLW (i.e., SNF) with on-site repackaging of spent nuclear fuel into permanent disposal containers.

The Inland location is not specified, but may be a different site for the LLWR, IDR, and GDF facility, unless noted in the table. Figure 5.1 on page 85 of the Jacobs MCM Report provides a glimpse of how these facilities and sites might be linked.

Configuration Scenario (CS)	**Costal location**	**Inland location**	**Inland location**	**Inland location**
CS1: standalone facilities	ISF	LLWR	IDR	GDF
CS2: no ISF		LLWR	IDR	GDF
CS3: no ISF, co-locate GDF & IDR		LLWR	GDF & IDR	
CS4: co-locate GDF & IDR, 'baseline' case	ISF	LLWR	GDF & IDR	
CS5: all facilities at coastal site	All four facilities			
CS6: co-locate 000 and LLWR	ISF	LLWR & IDR		GDF
CS7: ISF & LLWR co-located, GDF & UDR co-located, 'optimised' case	ISF & LLWR		GDF & IDR	
CS8: LLWR co-located with GDF & IDR	ISF		GDF, IDR & LLWR	
CS9: all facilities at inland site			All four facilities	

CS4 appears to have been selected because among those with the highest NPV under timing scenario TS1, it offers the most “reasonable” technical case (i.e., see Figure 4.1 on page 204 of the Jacobs MCM Report).

It is unclear why Figure 4.1 on page 204 of the Jacobs MCM Report only shows NPV for CS4 under timing scenario TS2.

B. Timing Scenarios

The first three timing scenarios are described in the report. A fourth timing scenario (TS4) appears in Figure 4.1 on page 204 of the Jacobs MCM Report and in the spreadsheet. This fourth timing scenario is a “direct to disposal” timing scenario, used in CS2 and CS3 where there is no ISF and all waste is delivered only after the HLW/ILW repositories are completed and in operation.

TS1	Waste commencing in Project year 11	Baseline	Figure 3.1, page 201
TS2	Waste commencing in Project year 8	Aggressive	Figure 3.2, page 202
TS3	Waste commencing in Project year 15	Conservative	Page 203
TS4	Direct to disposal	CS2 and CS3	Page 204

C. Market Capture Scenarios

The first three market capture scenarios are listed on page 203 of the Jacobs MCM Report. More detail on the market scenarios is in Paper 2 (pages 105 to 115 of the Jacobs MCM Report), where an estimate of world total ILW and HLW is made.

The Market Capture Scenarios appear to assume that a percentage of the estimated inventory of ILW and HLW for selected countries is sent to Australia.

The MS4 Scenario assumes that the only wastes that can be confidently assumed to be available are the stockpile at the time of FID plus the waste arising from fuel that is already in use in operating reactors. Sub-scenarios have been modelled to look at varying fractions of this waste that can be contracted by the time of FID.

MS1	50% capture of target countries' waste – the baseline
MS2	25% capture
MS3	75% capture
MS4	Financial Investment Decision (FID)

D. Cost Overrun Scenarios

There are three cost overrun scenarios, described on page 203 of the Jacobs MCM Report. These cost overruns are applied to the capital cost estimates discussed in Paper 3 (pages 127 to 149 of the Jacobs MCM Report):

- Capex only - 50%
- Opex only - 50%
- Capex and Opex both - 50%

E. PTC value ranges

The "willingness to pay" and Price to Charge (PTC) concepts are presented on pages 116-125 of the Jacobs MCM Report. The approach appears to estimate the amount a client country would pay based on a mix of (a) costs of similar facilities, (b) value to utilities to divest SNF, and (c) cost to reprocess SNF.

PTC is lower than willingness to pay, reflecting the costs incurred by client countries in storing, preparing and delivering waste to South Australia.

PTC ranges considered on page 203 of the Jacobs MCM Report:

- HLW - AUD1 million per tHM[35] to AUD2.5 million per tHM

[35] tHM = [metric] tonnes of heavy metal.

- ILW – AUD20,000 per cubic meter to AUD100,000 per cubic meter

NECG notes that the Jacobs MCM financial model includes a wider range of PTC levels for HLW and ILW.

The baseline Price to Charge (PTC) assumptions are described on pages 123-125 of the Jacobs MCM Report and page 204:

- HLW – AUD1.75 million per tHM
- ILW – AUD40,000 per cubic meter

F. Discount rate

Two discount rates are used as discussed on pages 196 and 219 (and elsewhere) of the Jacobs MCM Report:

- 4% (“social rate”)
- 10% (real pre-tax)

G. Royalty

The state-owned waste company will also make royalty payments to a “State Wealth Fund” that is composed of 15% of gross revenue. See page 219 of the Jacobs MCM Report.

Appendix C Other waste disposal program cost benchmarks

The Jacobs MCM Report refers to various international repository cost estimates used to develop cost estimates for the various elements that add up to the capital and operating cost scenarios. It is beyond the scope of the NECG high-level review to verify the Jacobs MCM Report "bottom up" cost estimate approach. Instead, we consider two other international repository cost estimates as top-down benchmarks. [36]

A. German case study

A particularly useful benchmark is the recent (October 2015) "Stresstest[37]" of German nuclear back-end funding performed on behalf of the German Federal Government as well as the ensuing (May 2016) findings and recommendation[38] by a Special German Parliamentary Commission ("Commission Recommendation") which offer a comprehensive, up-to-date review of nuclear back-end cost estimates.[39]

It is important to realize that Germany has a long-standing policy, which will now also be cast into law, that mandates disposal of all radioactive wastes domestically[40]. This policy prohibits exports, so Germany is unlikely to be a potential client country for South Australia.

However, insights from the German case study are useful to the Committee for several reasons:

- German data is based on substantial, empirical and practical experience. Due to the Government-mandated shutdown of the entire fleet by 2022, relevant data can be well delineated.

- The Stresstest and Commission Recommendation are the basis on which German Government intends to take liability for interim storage and final disposal, which previously rested with utilities, against payment in cash (agreement with utilities and lawmaking expected in Q4 2016). This undertaking is being negotiated in a context where both sides and their vested stakeholders have strong opposing interests. The

[36] NECG's benchmark analysis is based on public domain information and should be considered an informal third party evaluation.

[37] Gutachterliche Stellungnahme zur Bewertung der Rückstellungen im Kernenergiebereich („Stresstest") (für das Bundesministerium für Wirtschaft und Energie); Warth&Klein Grant Thornton; 09. Oktober 2015.

[38] Verantwortung und Sicherheit - Ein neuer Entsorgungskonsens; Abschlussbericht der Kommission zur Überprüfung der Finanzierung des Kernenergieausstiegs (KFK); 25. MAI 2016.

[39] NOTE this review will be based on waste volumes and cost for the utility owned, commercial reactors which represent less than 96% of HLW and less than 65% of ILW; this is deemed acceptable for the present purposes because (i) utility data does represent a large and significant portion of the totals and (ii) the Stresstest standardized this utility data. The Stresstest does not provide data on volumes, this data is being cross-referenced from other government sources. Some difference in accounting of volumes, waste categories (e.g. HAW vs. HLW, used interchangeably for the present purpose) and dates may occur.

[40] In the context of NECG'S review of a Commercial Model, the recent work and findings of the national German Commission on Storage of High Level Waste are not considered here: due to the special, confrontational historic context of the nuclear debate in Germany the Commission has designed an exceptionally long-term approach towards finding and establishing a repository. Abschlussbericht der Kommission Lagerung hoch radioaktiver Abfallstoffe of July 05, 2016.

German government is concerned about taxpayers and negative public opinion, while the nuclear utilities are concerned about shareholders and the financial markets.

- It provides insights regarding cost of nuclear waste disposal, price to charge, and related financial modelling.

To place the German case study in context, Germany has operated numerous nuclear reactors and facilities since the late 1950s. NECG's benchmarking effort refers to the 23 commercial reactors operated by four German utilities. As of 31 Dec 2014, these German utilities had accrued approximately €38.3 billion for their future backend costs[41].

Due to concern that the utility provisions and accruals might be insufficient or that utilities might not be able to secure funding of these provisions over the long-term, the German government commissioned a so-called Stresstest and the German Parliament established a special Commission.

1. German costs

The Stresstest reviewed and calibrated the individual utility assumptions. It confirmed the cost estimates at current prices amounting to €48.5 billion were a reasonable base for further analysis. The Stresstest went on to spend considerable effort analyzing different scenarios for cost escalation and discounting of future cash-flows:

in billion €	Cost (12/31/2014)	NPV (12/31/2014)
Decommissioning and Dismantling	19.719	17.784
Packaging, Transport, Conditioning	9.915	7.370
Interim Storage	6.823	4.305
Final Disposal	12.071	9.023
	48.528	38.482

- The German utilities used a nuclear specific cost escalation of 3.57% p.a. (1.6% inflation +1.97% for nuclear specific) and an average discount rate of 4.58% p.a. resulting in a real rate of 1% p.a.

- The Stresstest applied various scenarios based on: (i) varying assumptions following financial market practice for very long durations; (ii) varying assumptions on nuclear specific cost escalation; and (iii) comparable approaches applied in other European nuclear programs. This resulted in a range between €32.4 ~ 68.9 billion.

With respect to the implications of the German experience to Project estimates of WTP/PTC, it is important to note that applying different countries' national interest rate assumptions to German cost data and timeline resulted in values ranging from €27.8 ~ 59.7 billion. This shows that even with constant base data, WTP (and, therefore PTC) will likely vary from one potential client country to another.

[41] In addition, by that date they had already incurred several billion Euro cost, both for actual decommissioning and waste management activities such as interim storage facilities at all reactor sites and in central locations as well as for down payments towards future expenses, including app. €3.5 billion on ILW and HLW repository development by the Federal Government.

Based on these findings and extensive hearings with further expert testimony, the Special German Parliamentary Commission concluded with recommendations to:

- Split responsibility for (i) decommissioning and packaging of waste that should remain a utility responsibility and (ii) long-term liabilities that should become a Government responsibility;

- Utilities should transfer to Government the corresponding cash (to be held in a special fund); and

- Utilities should pay a risk premium.

	TOTALS		SPLIT		
in €billion per 12/31/2014	NPV	Risk Fee	Utilities	Government	Total
Decommissioning and Dismantling	17.784		17.784		17.784
Packaging, Transport, Conditioning					-
Packaging	*3.500*		*3.500*		3.500
Transport, Conditioning	*3.870*	*1.355*		5.225	5.225
Interim Storage	4.305	1.507		5.812	5.812
Final Disposal	9.023	*3.158*		12.181	12.181
	38.482	6.019	21.284	23.217	44.501
		44.501			
Risk Fee		*35,0%*			

Based on these findings, the estimated total cost for the German nuclear waste (HLW/ILW) disposal pertaining to utility wastes was €23.217 billion as of December 2014. It is important to note:

- This does not address other German radioactive waste volumes (see below);

- This does not include sunk costs already incurred for:
    - Down payments for repository site development, app. €3.5 billion. Of this, app. 1.8 billion may be considered "lost money" as it was invested in the Gorleben HLW site, but €1.7 billion for Konrad ILW site may be included when considering total cost.
    - Costs mainly for interim storage, e.g. packaging which would be part of WTP but not PTC.

2. Volumes

Total expected waste volumes for German utilities are 10,550 tHM plus app. 1500 cubic meters HLW from reprocessing and app. 170,000 cubic meters ILW. Of these, large quantities are already packaged and in interim storage.

HAW/SNF		
Spent Fuel	tHM	cubic meters
Discharged by EOY 2014	15.047	
Sent to Reprocessing	-6.662	
Current Inventory	8.385	
of which in dry store (site ISFS)	*40%*	
of which in wet store	*60%*	
Discharge expected thru 2022	2.165	
Subtotal	10.550	21.000
Disposal Factor		*1,96*
HAW from Reprocessing		
Inventory	6.244	1.435
Expected	418	96
Subtotal	6.662	1.531
Total HAW/SNF Disposal Volume		22.531

ILW		
	tonnes	cubic meters
Untreated (2014)	21.800	
Treated/Packaged 2014		36.278
Expected by 2041		132.722
Total		169.000

Non-Utility Volumes (in cubic meters):	
HAW/SNF	5.710
ILW:	
EOY 2014	80.800
by 2080	135.000
Total	215.800

Source: Bundeasmt für Strahlenschutz http://www.bfs.de/DE/themen/ne/ne_node.html

It is important to note that the utility nuclear waste volumes do not account for the entire German national nuclear waste volume.

By comparison, the Jacobs MCM Report assumed the following volumes for Germany.

Jacobs: Germany	HLW	ILW
through 2014	15.119	46.378
2015-2018	6.667	21.053
Total	21.786	67.431
	tHM	cubic meters

Substantial differences are seen between the Jacobs MCM Report estimates and the actual German data. The Jacobs MCM Report has higher HLW volumes but significantly lower ILW volumes. There are several reasons for this:

- The reactor data is not identical, as the German benchmark is based on commercial reactors alone, but the Jacobs MCM Report uses the IAEA PRIS data which includes other reactors as well.
- In the case of HLW, the Jacobs MCM Report points out that (i) they do not account for reprocessing volumes and (ii) they use assumptions for reactor efficiency based on average data. Both factors explain why HLW volumes would be overestimated by the Jacobs MCM Report.
- In the case of ILW, it is important to note that the “waste volumes” will be either reduced or increased compared to raw volumes arising, depending on the treatment and packaging methods, which depend on (expected) ILW repository acceptance criteria and other local factors. For example, in Germany treatment methods include grouting which may explain the extremely large difference in volume per MW for Germany compared to the volume per MW estimated in the Jacobs MCM Report.

In conclusion, as discussed in the Jacobs MCM Report, there are significant differences between their base case assumptions and the "real world" situations that will exist with respect to individual clients. This has at least two consequences:

- The case by case differences between individual client country conditions lead to a large spread around Jacobs' base case; and
- Such differences must be considered in the technical and licensing framework in Australia.

B. Yucca Mountain case study

In 2008, the DOE issued its Analysis of Total System Life Cycle Cost (TSLCC) of the Civilian Radioactive Waste Management Program, which represents DOE's updated total system cost estimate for the disposal of U.S. spent fuel and high-level radioactive waste. The TSLCC analysis provides a basis for assessing the adequacy of the Nuclear Waste Fund Fee and provides a basis for the calculation of the U.S. Federal Government's share of disposal costs for government-owned and managed spent nuclear fuel and high-level waste. The TSLCC estimate includes both historical costs and costs projected through decommissioning of the Yucca Mountain repository in 2133, 50 years after repository closure.

The TSLCC estimate spans the period of 1983 to the assumed closure date of 2133 and totals USD 96.18 billion in constant 2007 dollars. Assuming an inflator adjuster of 2.0 percent per year for 8 years (1.172) and converting 2007 dollars into 2015 dollars, the total TSLCC estimate is USD 112.7 billion 2015 dollars or AUD 147.7 billion 2015 dollars. The TSLCC estimate is shown below:

Table ES-1. Summary of the 2007 TSLCC Estimate – 2007 Dollars (in Millions of 2007$)

Cost Element	Historical Costs (1983 – 2006)	Future Costs (2007 – 2133)	Total Costs (1983 – 2133)
Repository	9,910	54,820	64,730
Transportation	780	19,480	20,250
Balance of Program	2,860	8,340	11,200
Total	**13,540**	**82,640**	**96,180**

NOTE: Row and column totals may not add due to rounding.

The Yucca Mountain Project (YMP) TSLCC estimate is based on the acceptance, transport and permanent disposal in the Yucca Mountain Repository of all currently projected U.S. civilian and defense wastes, estimated to be 122,100 Metric Tons Heavy Metal (MTHM) of SNF and HLW. The estimated total of civilian SNF is 109,300 MTHM, based on data that includes discharge projections from the 47 reactor license extensions granted by the Nuclear Regulatory Commission (NRC) as of January 2007. Any discharge from potential new reactors is not assumed. As more utilities receive reactor license extensions and additional reactors are built, the discharge projections will increase and be reflected in future TSLCC estimates. It is assumed that the Civilian Radioactive Waste Management Program will dispose of the full inventory of approximately 12,800 MTHM of government-owned SNF and HLW.

As such, the Yucca Mountain Repository is similar in scale and scope to the Project, but with some important differences that are worth noting. First, the YMP TSLCC estimates contain historical development costs which are not embedded in the Jacobs capital cost estimates, and second, the YMP TSLCC includes transportation costs to the repository from nuclear power plants sites. The Jacobs capital cost estimates assume the owners of the spent fuel and high level waste will be the shippers and will pay for the costs of transporting the SNF and HLW to the South Australia port of entry.

In addition, the YMP TSLCC estimate includes some storage at the repository site in what is called Aging Pads but that is limited to something less than 20,000 MTU, which is far less than 70,000 MTU contemplated for the South Australian Project. Finally, under the YMP estimate, operating costs of the repository are added to the TSLCC, so the estimate includes both capital and operating costs.

Notwithstanding these differences, the YMP TSLCC represents a useful benchmark for comparing the storage and disposal costs in the Jacobs MCM Report.

At the topline, the YMP TSLCC equates to amount a charge of AUD 1.21 million per MTHM, but this includes prior development costs of AUD 20.79 billion (USD 13.54 billion 2007 dollars). Backing out prior development costs, the YPM TSLCC modified estimate is AUD 1.039 million per MTHM, but this also includes transportation costs. Backing out the YMP TSLCC both prior development and transportation costs, the YPM life cycle cost becomes AUD 96.97 billion or AUD 0.794 million per MTHM.

In terms of comparing cost estimates and programs between the U.S. and the Jacobs MCM Report, several observations come to mind.

1. Development costs

It is unclear whether the Jacobs MCM Report cost estimate adequately includes development costs in the total capital cost estimate for the GDF.

When the YMP started, it was assumed that the potential underground repository sites could be adequately characterized from the surface through test bore holes. This proved not to be the case, and in 1987, only five years after Congress passed the NWPA which was based on multiple sites being characterized as suitable, the U.S. program became focused on one site (Yucca Mountain).

Site characterization costs which were estimated at the time to be only in the millions based on standard mining techniques now were estimated to be several billion dollars or approximately USD 2 billion (1987 dollars) per site. In addition, it was determined that for the YMP repository, a wide diameter exploratory shaft would be required that would cost approximately USD 2 billion.

The Jacobs MCM Report assumes that the development costs of the GDF can be avoided through learning transfer from the national repository programs in other countries, reducing the outlay for development costs to about AUD 1 billion. This appears to be a questionable assumption considering the U.S. experience.

2. Spent fuel and HLW types

The Jacobs MCM Report cost estimates appear to be based on Northern European cost estimates that are for relatively small in-country national repository programs where the spent fuel and HLW forms are relatively homogenous.

A multinational repository accepting HLW from multiple countries must accept and manage SNF and HLW in a range of shapes, sizes, ages, etc. that would be delivered to the South Australian port of entry (and from there to the ISF and ultimately, to the GDF) in a range of transport/shipping containers.

This issue was a major problem for the YMP, even in the relatively homogenous US nuclear power industry. The YMP design included a complicated and expensive front-end facility that was equipped to take bare fuel and all varieties and combinations of fuel types and conveyances. This led to a very expensive set of front-end facilities co-located at the repository.

Significantly, the US DOE became so concerned about the ramifications of fuel failures and associated radiation releases, that the DOE changed the strategy and design of the repository system. Instead of an approach to receive fuel types of various types and sources at the repository, the DOE implemented a concept of a multi-purpose transportation, aging and disposal (TAD) canister approach that would standardize the SNF container system that eventually would be received and placed into the repository.

The YMP TSLCC estimates that a total of 17,500 canisters will be required for disposal. Spent fuel and high level waste can either be loaded into disposal canisters at nuclear plant sites or at the disposal site.

3. Other issues

As reported in the YMP TSLCC report, major cost drivers for the repository include the cost of surface facility construction, repository facility operations, drip shields and waste package costs. The major repository surface facilities included in this estimate include:

- Initial Handling Facility - Naval SNF and HLW canister receipt and waste package loading/closure;
- Wet Handling Facility – receipt of commercial SNF not in canisters and TAD canister loading/closure;
- Canister Receipt and Closure Facility 1 - HLW, DOE SNF and TAD canister receipt and waste package loading/closure;
- Canister Receipt and Closure Facility 2 - TAD canister receipt and waste package loading/closure;
- Canister Receipt and Closure Facility 3 - TAD canister receipt and waste package loading/closure; and

- Receipt Facility—Receive rail transportation casks with TAD canister or DPC and transfer to aging pads or another waste handling facility.

In addition to these facilities, the estimate also includes costs for site infrastructure and balance-of-plant facilities, including offsite access roads, onsite and offsite utilities, equipment maintenance facilities, a central control center and administration building, security and emergency (fire, rescue and medical) facilities and systems, and aging pads to allow for proper cooling of waste prior to emplacement.

It is not clear that the Project cost estimates include similar types of facilities.

Appendix D Discount Rates

A. General Issues

As a general introductory statement, it must be noted that the Jacobs MCM report does not outline clearly the fact that the role envisaged for the South Australian Government in the Project. The potential roles may lead to different perspectives on its definition of, and its requirement for profitability, for the investment under consideration.

This is because, in principle, the South Australian Government would be expected first to act as a "typical" investor, through a state-owned company for example, seeking to deliver a target return on investment (ROI) on its assets. However, it is likely that, due to the nature of the business under consideration, the South Australian Government (not only acting as owner, but also, and likely foremost, as the public authority potentially acting as last resort back-stop) would also seek to ensure certainty about the funding of the long-term liability it will incur because of its hosting and managing a nuclear spent fuel repository on its territory.

In that context, the South Australian Government might take more of a "socially-minded" than a "profit-minded" approach vis-à-vis its return expectations for the assets[42]. Any source and degree of conflict between those two approaches would need to be carefully analyzed by the South Australian Government. In the analysis below, the "typical" point of view of a yield-seeking investor has been adopted.

B. Investor view

From an investor's point of view, investing is about allocating resources, including financial ones, upfront with a view to drawing benefits in the longer term. It consequently begs the question of what the "best" allocation of his resources could be for the investor. A key objective for the discount rate to be used by said investor is, therefore, to provide some guidance to assess the feasibility and the merits of an investment proposal, and to subsequently give him some benchmarking before making his investment decision.

C. 10% Discount Rate Assumption

The Jacobs MCM Report refers to a 10% pre-tax discount rate. However, clarity as to the concept and the integrity about the use of that discount rate do not come across clearly in the wording. That may lead the South Australian Government to an insufficient degree of comfort before taking the decision to pursue Project analysis further, and ultimately to make an investment decision. In the following paragraphs, key underlying principles for developing a conceptual framework are being outlined.

The discount rate typically refers to the interest rate used in discounted cash flow (DCF) analysis to determine the present value of future cash flows. It does not only consider the time value of money, but may also reflect the risk, or uncertainty of future cash flows (the

[42] In other words, instead of acting as a "typical" yield-seeking investor (seeking shorter-term profit), the South Australian Government would give as much value to cash-flows to be received in the very long term as to the ones it would receive in the near future. This is based on the fact that those streams of cash would have the same (social) "value" for each generation throughout the economic life of the Project.

greater the uncertainty of future cash flows, the higher the discount rate)[43]. That begs the question of the choice of an appropriate discount rate to assess an investment project. This supposes a fair understanding of what the cost of capital[44] of that investment is likely going to be.

Investors (e.g. companies) would typically use the weighted average cost of capital (WACC), if the risk profile of the investment proposal is similar to the risk profile of the investing company. But if the investment's risk profile is likely to be substantially different from that of the company making the investment, the capital asset pricing model (CAPM) is used to calculate a project-specific discount rate that more accurately reflects risk. In that context, it could be argued that a relevant discount rate for the Project would be based on the WACC[45] for the South Australian Government, acting as an investor[46].

D. OECD/NEA/IEA

In a recent study ("*Projected Costs of Generating Electricity - 2015*", dated 31 August 2015), the International Energy Agency (IEA) and OECD Nuclear Energy Agency (NEA) provided three discount rates of reference (e.g. 3%, 7% and 10%) to calculate the levelized cost of electricity (LCOE[47]) of different energy sources, including nuclear[48]. Although the Jacobs MCM Report did not substantiate the choice of its discount rate, the underlying background appearing to support their choice is arguably subject to challenge. This is primarily because the IEA / OECD-NEA study outlines discount rates that can be used for the calculation of the LCOE, a measure which fundamentally attempts to compare different methods of electricity generation on a comparable basis[49].

To the extent that such metrics would be the most appropriate one to assess the financial profitability of an investment, it would likely be more relevant in the context of a nuclear (new-build) power plant than of a waste and spent fuel repository. Further analysis would be required to ascertain that view.

E. WACC for State-Owned Enterprise

The assessment of a WACC for an SOE may be subject to interpretation. However, certain guiding principles that have been in use in Australia[50] for some time provide a clearly defined

43 From Investopedia (http://www.investopedia.com/terms/d/discountrate.asp).

44 A simple definition would be the cost of the funds (e.g. debt and equity) used for financing a business.

45 It is understood that the Office of Government Owned Corporations (Australia)'s preference is that SOEs undertake investment analyses and calculate WACC in nominal terms.

46 As owner of the SOE implementing and managing the project.

47 It is defined as the ratio of the net present value of total capital and operating costs of a generic plant to the net present value of the net electricity generated by that plant over its operating life (Department of Energy & Climate Change, 2012).

48 That study is based on generation costs of more than 180 plants in 22 (OECD and non-OECD) countries.

49 The LCOE demonstrate electricity generation costs only, and thus do not represent the total cost of electricity supply such as grid connection or balancing costs for integration of volatile and intermittent RES (World Energy Perspective, "*Cost of Energy Technologies*", World Energy Council).

50 "*Government Owned Corporates - Cost of Capital Principles*", The State of Queensland (Queensland Treasury), February 2006.

and duly tested basis. Those guiding principles should help set a relevant conceptual framework for of the choice of an appropriate discount rate before deciding on the opportunity to invest in the Project.

In that context, and to derive a relevant rate to be used as its WACC, the South Australian Government (acting as an investor) could use the CAPM to assess the equity component of the SOE in charge of the investment. Although it is acknowledged that certain parameters would still be subject to some discussion (e.g. choice of market risk premium or Beta), others would be provided by the market (e.g. market risk-free rate) or be factual (e.g. corporate tax rate) - hence would lead toward a higher degree of "certainty", or at least a wide(r) form of consensus. As far as the debt component of the WACC formula is concerned, market input could also be sought in a relatively straightforward way, e.g. through the addition of a margin onto the risk-free rate.

Finally, it could also be noted that, should the South Australian Government investigate the opportunity to invest directly in the Project (instead of through its shareholding in an SOE), the cost at which it would raise long-term money on the markets[51] could be a reasonable input assumption for calculating its WACC.

F. Benchmarks for discount rate

Based on the above, it could be considered in the Project analysis that a reasonable (arguably simplistic) proxy for this early stage would be to look at the issue price of long-dated AUD denominated sovereign bonds. It would provide guidance for a floor, upon which a price step-up would need to be added[52] - this to reflect the remuneration for, *inter alia*, the use of its balance sheet by the South Australian Government[53], the risk of the Project, the length of the economic life of the Project, etc. In that context, it is to be noted that Australia's first 30-year bond (March 2047) has been successfully issued during the week of 10 October. Priced at 3.27%, the bond issuance allowed the government of Australia to raise AUD 7.6 billion, while the order book was more than AUD13 billion[54].

The Project's anticipated economic life spans out over a much longer horizon (200 years, or longer), and a 30-year tenor may not provide the necessary degree of comfort and guidance that would be required for that long an economic horizon. However, (academic) research tends to conclude that the level of accuracy that can be reached to define an appropriate discount rate for very long-dated maturities (e.g. an intergenerational context) is limited overall. A suggestion could be, therefore, that a ''certainty-equivalent rate'' be computed[55],

[51] This is assuming that the South Australian Government would not specifically increase the taxes paid by the public to finance the investment.

[52] It is acknowledged that the magnitude of said step-up in price could be subject to debate. However, its components could certainly be analyzed -hence assessed- following a fact-based approach and subsequently benchmarked.

[53] As of July 2016, Australia's rating remains strong: AAA (S&Ps / negative and FITCH / stable) and Aaa (MOODY'S / stable).

[54] Source: Australian Office of Financial Management.

[55] Using both random walk and mean-reverting models.

that would summarize the effect of uncertainty and support the measurement of an appropriate forward rate of discount in the future.

Appendix E Risk Issues

This Appendix provides comments on two articles that were submitted to the Committee:

- "Risks, ethics and consent: Australia shouldn't become the world's nuclear wasteland;" and
- "Shunning nuclear power but not its waste: Assessing the risks of Australia becoming the world's nuclear wasteland."

A. Article: Risks, ethics and consent

Risks, ethics and consent: Australia shouldn't become the world's nuclear wasteland" was published in *The Conversation*.

There are several statements in this article that are not supported by facts, including:

- ISF storage would involve gradual erosion and leaking of dangerous contents over several decades of interim storage dry casks above ground; and
- That the 'expansion of an energy technology (i.e., nuclear)' …has 'risks…. possibly comparable in magnitude to those of global climate change.'

The author applies flawed logic to the risk of transferring radioactive waste by sea. Transfer of radioactive waste by sea is not likely to experience more issues than the transport of a wide range of equipment and materials. If anything, the current requirements for shipping radioactive materials by sea and the specialized ships to do this will result in lower risk.

The author has a stated agenda to reduce the impact of uranium exports on the global economy. There is little link between the proposed Project and the export of uranium by companies based in Australia.

This short paper does not explain issues well, makes unsupported assumptions, and does not make a credible case that the Project should not proceed.

B. Article: Shunning nuclear power but not its waste

"Shunning nuclear power but not its waste: Assessing the risks of Australia becoming the world's nuclear wasteland" published in *Energy Research & Social Science*.

The premise of this article is based on two issues:

- The Royal Commission based its economic analysis on "many unsubstantiated assumptions"; and
- The Royal Commission analysis has a "questionable ethical basis".

The article suggests that South Australia and the entire Commonwealth can have a credible goal of electricity from 100% renewable sources, something that is both unsupported and contentious.

> *"The mainland state of South Australia is powered by wind, natural gas, imports of brown coal electricity from Victoria and rooftop solar in that order of importance, demonstrating a pathway towards a 100% renewable energy future for the whole country."*

Further, there is no link between the Project and Australian electricity production. There is also no suggestion that the Project would have any link to the large Australian uranium mining and export business.

The article makes a valid point that long-term underground disposition of radioactive waste is not a fully proven, but fails to acknowledge that lessons learned from global repository projects (e.g., Sweden, Finland, US, etc.) could be used as the basis for a repository in South Australia.

The author raises valid questions about the Project:

- Could Australia, with no experience, safely manage radioactive waste?
- What are the costs of the scheme and how much would countries be willing to pay to send their wastes in Australia?
- What are the risks to clients and the Australian taxpayer?
- Would Australians consent to such a risky and expensive project?

However, the article also makes some less valid questions about whether the Project would encourage the growth of a dangerous technology (i.e., nuclear power) by providing waste management?

The article raises valid issues about the need for and extent of Commonwealth/sovereign guarantees related to the Project.

The article appears to have an overt bias against multinational corporations and the nuclear power industry.

Appendix F Third Party Liability Concepts

Since the beginning of the nuclear power industry, there has been concern that a severe nuclear accident could have large and widespread consequences. These consequences may lead to damages and claims for damages that extend outside a nuclear power plant or nuclear facility in addition to losses and damage to the nuclear power plant or nuclear facility itself.

In the context of a nuclear accident, people or companies that are outside the nuclear power plant or facility are referred to as "third parties." Such a designation also applies when speaking of project participants, where claims can be managed between the owner and the contractor within the "four corners" of the contract, as opposed to other parties (third parties) that are not parties to the contract and, thus, not constrained by the rights and remedies contained within the contract. The impact of a nuclear accident on these third parties may result in very large consequences and claims for damages. Third party consequences may be seen in multiple countries, being more likely when a country is small and surrounded by other countries or when a nuclear power plant is close to a national border.

One advantage of siting this Project in South Australia is the remoteness of the location vis-à-vis other countries that could be implicated in claims in the event of a nuclear incident. Of course, how transit risk is allocated could expose the Project to third-party liability during transit. A scenario under which the client country holds title at least until delivery to South Australia would eliminate transport risk exposure for the Project.

The potential for third party claims (and the damages, whether for personal injury or property damage) has led to the development of third party liability (TPL) treaties and conventions. These TPL regimes establish a system for managing the third party liabilities arising from nuclear accidents. This system includes limits on liability assigned to operators of nuclear power plants and other nuclear facilities and a streamlined process for compensating third party claimants.

Third party liability regimes, limitations, and insurance requirements are separate from the potential property and casualty losses at the Project facilities and the specialized insurance for these types of losses.

A. Background on Third Party Liability Issues

TPL issues can arise from any accident where there is a release of radioactive materials that exposes (or potentially exposes) areas outside a nuclear power plant or facility (i.e., population and businesses) to radiation and/or radioactive contamination. This may occur because of a severe nuclear power accident where the reactor core is damaged and radioactive fission products are released to the environment. Other nuclear facilities (e.g., nuclear fuel enrichment and fabrication facilities, nuclear fuel re-processing facilities, and spent nuclear fuel storage facilities) may also have accidents that result in off-site radioactive contamination and third party liability. Accordingly, TPL regimes cover a range of nuclear facilities, including nuclear power plants.

In the event of a severe nuclear accident with significant off-site radioactive releases and contamination, the total amount of damages might be very large. Such accidents are only expected to occur very infrequently, but to have very large consequences (i.e. a low-probability, high-consequence event). This presents a challenge from a risk allocation perspective, where a very remote event could have an almost unquantifiable risk. Moreover, the tendency to lump accidents on the scale of Chernobyl and Fukushima with accidents that have no third party liability presents difficulties in the case of spent fuel transportation and management, where one could argue that the downside risk is lower, as the subject is not in the "criticality" space. Thus, thinking must be adjusted to the specific case and not to the nuclear industry writ large.

The potential negative financial consequences of such a low-probability, high-consequence event would expose the owner or operator of a nuclear power plant or facility to almost unlimited liability and lead to a significant hurdle to commercial ownership or operation of nuclear power plants or other nuclear facilities. Without some limits on third-party liability in these low-probability events, nuclear power might not be developed.[56]

It is also important to recognize, too, that if a catastrophic nuclear event were to occur, any parties associated with a nuclear industry project – especially those with deep pockets – would be exposed to potential lawsuits. If each of these project participants had to account for (and, thus, put a price on – either through contingency pricing or the purchase of insurance) such risk separately, the cost would be significant and would likely make any nuclear industry project uneconomic. Moreover, insurance is of limited availability and of very significant expense. By ordering all claims and channeling them to the licensed operator, an economic rationality is created that makes nuclear industry projects feasible.

The international treaties, conventions, protocols and national laws related to TPL issues were put in place to limit the potential liability faced by a nuclear facility operator to help facilitate the nuclear power industry and, importantly, to facilitate claims and reparation of third parties claiming damages.

A central feature of TPL regimes is limiting the liability of a nuclear power plant or facility operator. If the total amount of third party claims from a nuclear accident exceeds the limits put in place by the TPL regime, the remaining (or excess) liability is assumed by the host government as the insurer of last resort (at least in theory).

The role of the government as the insurer of last resort for nuclear accidents is like the role of the government as the ultimate insurer for other types of large disasters (e.g., floods or earthquakes). Government as the insurer of last resort spreads the cost of bearing these very large but infrequent risks across the entire population. The ability of the host government to accept this excess liability is important.

TPL regimes, in addition to limiting the liability of nuclear facility operators, establishes a streamlined process for compensating third party claims and requires these operators of nuclear facilities to maintain a significant level of insurance or other surety. Such minimum coverage requirements (to include the requirement to collateralize or insure the obligation) ensure that a significant money is available to address third party claims.

[56] An exception is government-owned nuclear power plants or facilities, where the government bears all liability. Even a government-owned nuclear power plant or facility would benefit from some features of the TPL regime such as strict liability provisions that remove liability from private suppliers of goods or services to government-owned nuclear power plants or facilities.

NECG notes that international treaties are less specific than the national laws that implement these treaties. Therefore, ultimately the Australian national laws and regulations will determine the impact of third party liability arrangements for a nuclear waste facility in Australia.

It is important to note that Australia has not acceded to any of the international nuclear liability conventions, nor does its national law establish an overall limit of liability for a licenses operator for a facility of this nature. There are several approaches to international treaties that Australia could entertain (Vienna Convention; Amended Vienna Convention; Convention on Supplementary Compensation, to which Australia is already a signatory but has not yet acceded; Joint Protocol), as well as approaches to national law in the implementation of such treaties or a stand-alone law absent accession to any of the treaties that would cover legal channeling with or without a limit of liability for the licensee and specified government obligation to cover excess liability, etc.

The international nuclear industry (both companies and countries) would expect Australia to take significant action to address shortcomings in treaties and national laws before these parties would consider involvement in the Project. Australia would need to put treaties and national laws in place that cover these issues:

- All liability should be channeled to the licensed Project company (i.e., the party that holds the operating license for the facility or facilities);
- Liability should not transfer until delivery to the site (i.e., rather than when waste leaves client country);
- Liability for the Project company should be capped;
- The State and Commonwealth need to be aligned on all of this, and some government entity is going to have to be the insurer of last resort;
- Project will need to insure up to the capped amount;
- If insurance is not available in the market, or not available at a commercially reasonable price, the State or Commonwealth Government could act as the insurer, charging the Project a commercially reasonable fee;
- Insurance costs will need to be included in Project financial analysis; and
- Third party liability issues should be focused on waste issues that are likely to be different from nuclear power plant issues.

There is also the reality that the actions of the host government in the event of a nuclear accident may have the effect of significantly increasing third party damage claims. A government decision to evacuate a large area that is well beyond any contamination threat may be needed to respond to public concerns, but such a wide evacuation will lead to a significant increase in legitimate third party claims by the evacuees, recall of potentially contaminated goods, and other issues.

B. Nuclear Facility Insurance Requirements

A TPL regime will typically establish a ceiling on third party liability for a nuclear facility. If damages are above that ceiling, the national government will typically take responsibility for the damages. We note that this is somewhat theoretical until tested by a real incident/accident and note that none of the international treaty conventions has ever been tested in a court of law.

A nuclear facility will be required to obtain insurance coverage for third party liability up to the ceiling and will also want a range of property and liability insurance for the facility to cover typical industrial (i.e., inside the fence) losses (to include damage to facility assets because of a nuclear accident).

The national laws that establish a TPL limit will also set out the requirements for nuclear facilities to obtain suitable insurance coverage for TPL damages up to the TPL limit. However, nuclear insurance is a specialized market, and such insurance is generally quite expensive (in the case of NPPs). For a project of this scale, a nuclear insurance pool would need to be formed. That is no small task, and it takes time to form a nuclear insurance pool. Moreover, until the pool is established, it is unclear what the insurance will cost. Because of the first-of-a-kind (FOAK) nature of the Project, there could be uncertainties from the insurance market. The State and/or Commonwealth Government might need to consider interim solutions until the market is formed.

The key point here is that any Project participants will want to see that nuclear liability is channeled and capped, with a clear understanding of how specialized nuclear insurances are to be maintained. If not, the likelihood of participation from investors and contractors could be severely limited. At a minimum, absent such channeling and limitations, Project participants must build risk contingencies into their participating / pricing, which will increase Project costs. Thus, to create efficiencies at the Project level and to increase participation (and, thus, competition), it is essential that the State and/or Commonwealth Government establish a nuclear liability strategy that is risk-informed and commercially sensitive, and then implement that strategy within a time frame that supports Project development.

An additional consideration from a Project structuring perspective is the possibility of splitting ownership and operation of the facility. If third party owners are desired, separating the ownership vehicle from the operational vehicle (the latter being the entity to which all liability is channeled) might also enhance the value of the asset, from an investor's perspective. If such a structure were to be desired, significant coordination with the nuclear regulatory authority would need to be done in advance of implementation, to ensure that the regulator would not object to such a structure after the fact (i.e., at the time it is issuing key licenses for the Project).

Appendix G International Treaties related to transport of nuclear materials

The treaties that govern international transportation of nuclear material are listed in the chart below. The treaties speak to the following principles regarding transport of nuclear materials: safety (protect people and environment); security (protection material from malicious acts) and physical protection. The World Nuclear Transport institute (WNTI) identifies nine good practices to support packaging, transport and treatment of nuclear material, as follows: training, accuracy and review, auditability, assurance (nuclear site reviews), fit for purpose data, dedicated resources, dynamic waste inventory data, clarity and alignment.

Table 3 – International Treaties related to the transport of nuclear materials[57]

Treaties/ Conventions	Key Provisions from Convention	Comments re Relevance
UN Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. Entered into force on 18 June 2001; Australia is a party to it	Key provisions include: • Establishing and maintaining a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management and protect the public (Articles 4, 19) • (If a destination country), consenting to transboundary movement only if a country has administrative, technical and regulatory capacity needed to manage the spent fuel or radioactive waste consistent with the convention (Article 27) • Taking appropriate steps to ensure transboundary movement is authorized and takes place only with prior notification and consent (Article 27)	This Convention is based on the concepts contained in the IAEA Code of Practice on the International Transboundary Movement of Radioactive Waste. It applies to spent fuel and radioactive wastes from civilian nuclear reactors and applications and to spent fuel and radioactive waste from military or defence programs. Its provisions suggest that Australia will have to evaluate its import and export protocols, as well as its administrative, technical and regulatory capacity (including waste acceptance criteria) to be sure that all are adequate to handle the spent fuel or radioactive waste appropriately. Note: In respect of this convention, regular review meetings are held. In the most recent (fifth) review meeting report, it is noted that "many contracting parties are very skeptical whether [a regional or multinational disposal facility] is implementable". Nonetheless, subject to available funds, a

[57] The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes, which came into force in 1992, does not apply by virtue of Article 1(3) which states, "Wastes which, as a result of begin radioactive, are subject to other international control systems, including international instruments, applying specifically to radioactive materials, are excluded from the scope of this convention.".

Treaties/ Conventions	Key Provisions from Convention	Comments re Relevance
		working group recommended a Topical Meeting on "safety challenges and responsibility issues in the framework of the Joint Convention, related to the disposal of spent fuel or radioactive waste in another country than the one in which they were generated". (p.16)
Code of Practice on the International Transboundary Movement of Radioactive Waste Adopted by IAEA in Sept 1990; has advisory status	Obligations include: • States shall take appropriate steps to ensure international movement is undertaken in a manner consistent with international safety standards (Section III, Basic Principles, cl. 4) • States have appropriate regulatory authorities in place and have adopted appropriate regulatory procedures for the regulation of international transport (Section III, cl. 6) • States should introduce into national law and regulation relevant provision for liability, compensation or other remedies for damage that could arise from the international transboundary movement of radioactive waste (Section III, cl. 8)	Australia will likely have to address issues of liability and compensation for damage in new national legislation.
Convention on the Physical Protection of Nuclear Material Signed at Vienna and New York on 3 March 1980; ratified by Australia in 1987	Parties' obligations include: • Taking appropriate steps to ensure that during international nuclear transport, nuclear material within its territory or on board a ship or aircraft under its jurisdiction, insofar as such ship or aircraft is engaged in the transport to or from that State, is protected. (Article 3) • Refraining from import, export, authorization to import or export, or transit of nuclear	This binding international undertaking applies in the area of physical protection of nuclear material for peaceful purposes during international transport. Nuclear materials are those which carry a risk of being used in a nuclear explosive device. It obligates parties to take steps to protect nuclear material within their territories and to implement protocols for the import and export of nuclear material. Existing import and export protocols would have to be evaluated to determine whether

Treaties/ Conventions	Key Provisions from Convention	Comments re Relevance
	material unless the State Party has received assurances that such material will be protected during the international nuclear transport. (Article 4) • Cooperating and consulting with other states parties on the design, maintenance and improvement of systems of physical protection of nuclear material in international transport (Article 5) • Making the intentional commission of certain acts (e.g., theft of nuclear material) a punishable offence (Article 7)	they are sufficient to meet the requirements of the Convention. See row below for IAEA guidance on the kinds of measures that constitute "physical protection". Australia would also likely be required to come to agreements with the waste exporting countries, in accordance with this convention.
Amendment to the Convention on the Physical Protection of Nuclear Material Ratified by Australia in 2008	Parties' obligations include: • Requirement to establish, implement and maintain an appropriate physical protection regime applicable to nuclear material and nuclear facilities under their jurisdiction to guard against theft, sabotage and other misuse, which shall include a legislative and regulatory framework to govern physical protection and establishing a competent authority to implement said framework (Article 2A)	The amendment clarifies that the Convention applies to nuclear material in use, storage AND transport (with certain exceptions) (Article 1A). The convention requires parties to develop legislation and regulatory competence to provide for physical protection of nuclear material in transport and storage. IAEA guidance documents clarify that computer systems used for physical protection should be protected against compromise. Further, physical protection should encompass minimizing the total time during which nuclear material remains in transport, minimizing the number of nuclear material transfers, avoiding the use of predictable movement schedules, etc. Existing legislation, as well as technical and regulatory capacity will have to be evaluated to assess whether provisions are adequate to meet the Convention's requirements.

Treaties/ Conventions	Key Provisions from Convention	Comments re Relevance
Nuclear Non-Proliferation Treaty Ratified by Australia]	Parties' obligations include: • Each non-nuclear weapon state party undertakes to accept IAEA safeguards on all source or special fissionable material in all peaceful nuclear activities within the territory of that state or otherwise under its jurisdiction or control (Article III)	Many IAEA safeguards agreements contain reporting requirements, among other things, which Australia would be required to adhere to under this Treaty. Commentators have noted that there is an unresolved issue relating to coverage of IAEA safeguards if a multi-national repository is shared by weapon states and non-weapon states.

Most of these Treaties do not have amendments that explicitly cover cyber risks across the transport, storage, disposal continuum, which is an issue that should be considered for the Project

In addition to the treaties reviewed above, governmental organizations, some states and several transportation agencies have been active in developing regulations and codes that pertain to the safe transport of radioactive material. The IAEA's Waste and Environmental Safety Section works to develop internationally agreed standards. Their first set of (non-binding) regulations was put out in 1961. They form the basis for many other agencies' safety programs, including air and sea transport regulators. The requirements laid down in the Regulations must ensure the containment of the radioactive contents, the control of the external radiation level, the prevention of a chain reaction and the prevention of damage caused by heat.

Appendix H Other Legal Issues

The World Nuclear Association notes that, "at present there is clear and unequivocal understanding that each country is ethically and legally responsible for its own wastes, therefore the default position is that all nuclear wastes will be disposed of in each of the 50 or so countries concerned".

Yet, it is important to note that this is a general understanding, not a matter of international treaty. However, certain countries prohibit the export and/or import of nuclear waste and spent fuel.

A. Australian Law

Section 13 of the *Nuclear Waste Storage Facility (Prohibition) Act of 2000* reads as follows:

> **13—No public money to be used to encourage or finance construction or operation of nuclear waste storage facility**
> (1) Despite any other Act or law to the contrary, no public money may be appropriated, expended or advanced to any person for the purpose of encouraging or financing any activity associated with the construction or operation of a nuclear waste storage facility in this State.
> (2) Subsection (1) does not prohibit the appropriation, expenditure or advancement to a person of public money for the purpose of encouraging or financing community consultation or debate on the desirability or otherwise of constructing or operating a nuclear waste storage facility in this State.

- Section 13 contains a broadly worded prohibition on the expending of public money "for the purposes of encouraging or financing any activity associated with the construction or operation of a nuclear waste storage facility" in South Australia.

- Subsection 2 is a recent amendment, which, in theory, allows the use of public money for the purpose of encouraging or financing community consultation or debate on the desirability of constructing or operating a nuclear waste storage facility in South Australia. It is activated when the Commission makes a recommendation to conduct public consultation.

- The main concern of Section 13 is associated with the burden of the government having to answer a legal question of whether its activity is 'for the purpose of community consultation or debate', or whether it otherwise falls outside of section 13, while in the process of trying to foster effective and informed community consultation and debt. The argument is that this section precludes an orderly, detailed and thorough analysis and discussion of the opportunity to establish such facilities in South Australia.

- The Jacobs MCM Report states, "It would be preferable for the immediate steps to be undertaken free from any debate about whether expenditure of public money is lawful, through the repeal of section 13".[58]

- The Jacobs MCM Report states that, during the repeal of Section 13, Section 8 and 9 would remain in force. This means that construction or operation of a nuclear waste

[58] *Nuclear Fuel Cycle Royal Commission Report*, May 2016, at p. 171.

storage facility would be prohibited, as well as the importation or transportation of nuclear waste for the delivery to a nuclear waste storage facility.

- Sections 8 and 9 of the Act provide penalties for violating the prohibitions against constructing or operating a nuclear waste facility.

NECG recommends that significant attention be given to the necessary adjustments to State and Commonwealth laws that will be required to consider and develop the Project.

B. Legal Responsibility for wastes

To the extent that any country is legally responsible for its own wastes, this appears to be a matter of national legislation, and not international law. Indeed, the international conventions reviewed above contemplate that countries can export wastes under the appropriate conditions, and the IAEA has been encouraging research on international disposal options for some time.

Nonetheless, most nuclear waste is managed within the country in which it is generated. From an ethical or policy perspective, many nations adhere to the "polluter pays" concept, whereby the waste producers and owners are responsible for the funding, organization, management, operation and disposal of their own wastes. Laws that reflect this principle include:

- Host country laws that that prohibit importation of waste from other countries; and
- Client country laws that prohibit exportation of waste to other countries.

Such laws do not constitute a legal impediment that would require amendments to any of the applicable international treaties before a multi-national waste repository could be established. Australia, however, may wish to research the number of counties with export prohibitions, as that may impact the size of its target market.

Some countries already permit the export of nuclear waste under appropriate conditions; for example, the European Union, the Directive 2011/70 regarding safe management of nuclear waste. This EU Directive requires that radioactive waste must be disposed of in the country where it was generated, unless there are agreements with other countries. If waste is shipped to a country outside the EU, responsibility for safety still rests with the EU country that generated the waste and the EU country must ensure that the country receiving the waste (e.g., the Project):

- has an agreement with the EU on how to properly handle radioactive waste/SNF;
- has waste management and disposal programmes that comply with the EU directive's safety standards, and
- has authorized facilities in operation before the material is shipped.

Appendix I Other Comments on Jacobs MCM Report

A. Concept not well defined

The potential commercial arrangements for a multinational repository may include approaches that are different from those anticipated in this report, including multinational ownership of the Project.

The Project, under the scenarios in the Jacobs MCM Report, faces a real risk that the ISF could become a de facto permanent solution since radioactive waste would be received prior to the permanent repository development and commencement of operation.

The differences between a permanent repository approach and long-term interim storage approaches are significant. The emergence of new reactor designs that use spent nuclear fuel from light water reactors as fuel and the potential value of remaining fissile and fertile materials in spent nuclear fuel may mean that long-term interim storage (e.g., in dry casks) will be an attractive option compared to a permanent deep underground repository approach. Interim storage using dry casks will facilitate monitoring, retrieval, and relocation of spent nuclear fuel.

The Jacobs MCM Report might have considered a scenario with a near-permanent ISF located inland. This scenario would include the potential for client countries to retrieve HLW in the future or even the obligation to retrieve this waste. This would have lower cost and lower risk than the current scenarios that all require the development of a permanent repository.

On the other hand, the reliance on an ISF in the Project baseline scenario may present public acceptance issues that will be greater than those with the actual repositories. Some countries have concluded that interim storage of SNF is an acceptable, safe, and even preferable approach for SNF that is already stored in spent fuel pools or dry casks at nuclear power plants. Nevertheless, even in the US or Germany, where dry storage is a standard SNF storage solution at nuclear power plant sites, transportation of this SNF to central storage sites has been difficult:

- In the U.S., the Nuclear Regulatory Commission (NRC) has approved the interim storage of SNF at the reactor site for up to 60 years, but public consent issues for a centralized ISF are large. As an example, the Private Fuel Storage project in Utah received a license from the NRC, but was never placed into operation. The primary issues were related to transfer of SNF across US state borders and related issues that seem to apply in an even larger sense to the Project.

- In Germany, all nuclear power plants have dry interim storage sites for SNF and there are two central ISF facilities, but transport is not possible and the two central ISF sites will not be used.

It will be important for the Committee to define clear positions on these issues in defining the program baseline for the next steps in line with the Royal Commission recommendation.

B. PTC

Section 3.7 (page 122 of the Jacobs MCM Report) suggests that some client countries may be willing to pay even higher prices due to a range of factors. This implies that the negotiations and pricing for each client country (maybe each utility in a client country) might be different. This implies a significant investment in time, analysis, and negotiations with client countries that may not be realistic and that may not be included in schedules or cost estimates.

PTC is defined as a payment for a transfer of liability cost. The transfer of ownership of radioactive waste is not described in detail. A transfer of radioactive waste that left the original client country owner with any residual liability or financial risk to the client country would have a lower value than a transfer of all ownership and liability related to the radioactive waste to the Project. Amore detailed description of what the transfer of liability entails would resolve this issue. This will be a very important issue for the Project.

C. Transport and Storage of Waste

The Jacobs MCM Report simplifies various issues related to transportation and storage. This is acceptable for an Opportunity Assessment but will need substantial refinement in an Actionable Business Plan. It should be noted that relevant questions concern not only costs but that there may be various opportunities for South Australian to derive economic benefits from these activities.

- In Section 3.10 (pages 76-77 of the Jacobs MCM Report), a range of options are discussed for storage and transportation casks that will have large implications for Project activities and costs.

  "…In a national waste management programme, unlike the transportation casks which will remain the property of the originating power plant (and will be returned to them once they are emptied at the ISF) storage casks will form part of the operating costs of the ISF. They will be directly borne by the ISF operator or will be passed on to the owners of the waste being stored…"

  "…Another option is for the ISF operator to send his own casks to collect the SF at the client nuclear power plants. One advantage of would be that the ISFS representative can inspect the fuel before it is shipped. If the fuel already in casks, it is easier for the owner to ship, but the casks have to be opened at some point to repack for disposal and the ISF operator is then reliant on the quality assurance processes of the original utility. The optimum procedure depends on the range of the clients…"

  Although the Jacobs MCM Report acknowledges the impact on costs of certain "technical" aspects of the transportation of SNF to the site, it seems to avoid certain critical issues, such as the overall feasibility of the concepts, or the various challenges and costs associated with the transport of high level nuclear waste across the globe.

- With respect to Section 2.2.1 (pages 157-158 of the Jacobs MCM Report), there are some issues with the implicit assumptions about waste transport.

Overall, there are less than a dozen specialized ships to transport nuclear waste / SNF. It is likely that this fleet would need to be increased to support the Project. It is unclear who would bear the cost for this, but this cost appears to be one that client countries would bear. It is also unclear how long it would take to develop, build, and commission a fleet of a minimum satisfactory size once the Project is implemented (i.e., a real commercial need to transport waste to South Australia is created).

- Similar to considerations pertaining to ships and international transfer of radioactive waste, there is a need to address port, rail, and road fleet requirements, infrastructure investments, and operating and maintenance costs.

- Although the Jacobs MCM Report discusses various SNF storage and transport systems, the commercial model is based exclusively on Holtec products and U.S. parameters. These may not be acceptable and/or competitive in all circumstances, e.g. when considering optimal waste logistics from reactor to repository, national regulatory requirements, and localization strategies.

Appendix J Glossary

The following is a list of acronyms and other terms used in this NECG Report:

Table 4 – Glossary

Acronym or term	Meaning
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
CAPM	Capital Asset Pricing Model
CPI	Consumer Price Index
CSC	Convention on Supplementary Compensation for Nuclear Damage
DCF	Discounted Cash Flow
DOE	U.S. Department of Energy
EU	European Union
FID	Financial Investment Decision
FOAK	First of a Kind
GDF	Geologic Disposal Facility; a deep underground and permanent repository for HLW. In the Project, the GDF also includes on-site facilities to repackage SNF into permanent disposal canisters
HAW	High Activity Waste; a term that is similar to HLW
HLW	High Level Waste
HLW	High Level Waste
IAEA	International Atomic Energy Agency
IDR	Intermediate Depth Repository; a facility for long-lived ILW
IEA	International Energy Agency
IFNEC	International Framework for Nuclear Energy Cooperation
ILW	Intermediate Level Waste
ISF	Interim Storage Facility; a surface storage facility for HLW, SNF, and other radioactive waste
LCOE	Levelized Cost of Electricity

Acronym or term	**Meaning**
LLW	Low Level Waste
LLWR	Low Level Waste Repository
MTHM	Metric Tonnes of Heavy Metal (same as tHM)
NEA	Nuclear Energy Agency, a part of the OECD
NECG	Nuclear Economics Consulting Group
NPV	Net Present Value
NRC	U.S. Nuclear Regulatory Commission
OECD	Organization of
PRIS	Power Reactor Information System; a nuclear database maintained by the IAEA
PTC	Price to Charge
RNFSWG	Reliable Nuclear Fuel Services Working Group, part of IFNEC
SNF	Spent Nuclear Fuel
SOE	State-Owned Enterprise
TAD canister	A multi-purpose Transportation, Aging and Disposal (TAD) canister developed by U.S. DOE
tHM	Tonnes of Heavy Metal (same as MTHM)
TPL	Third Party Liability
TSLCC	Total System Life Cycle Cost; as applied to the U.S. Civilian Radioactive Waste Management Program and the Yucca Mountain Project
WACC	Weighted Average Cost of Capital
WNA	World Nuclear Association
WTP	Willingness to Pay
YMP	Yucca Mountain Project, a proposed U.S. geologic repository

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