OFGEM SIF – ROUND 4 DISCOVERY

Digital Decommissioning of Large-Scale Equipment

Genesis Early Advisory

May 20th 2025

OUTLINE





Executive Summary & Overview

Work Package 1: Digital Tool Identification for Decommissioning

Work Package 2: Machine Learning, Automation and Integration in National Gas IT

Work Package 3: Cost Benefit Analysis & Circular Economy Study

Work Package 4: Digital vs Traditional Analysis

T.EN TECHNIP ENERGIES GENESIS

Executive Summary

- National Grid Transmission (NGT) is committed to enabling the UK's net-zero carbon goal by 2050, aligning with the Paris Agreement to limit global warming below 2°C. As part of its RIIO-GT3 priorities, NGT aims to decarbonize its network and reduce environmental impacts, focusing on responsible asset management. This includes decommissioning redundant natural gas infrastructure, such as pipelines and compressor stations, to support the transition to sustainable energy systems.
- Currently, detailed studies on how machine learning (ML) and artificial intelligence (AI) can streamline decommissioning workflows are not available. Existing tools are fragmented and lack integration, limiting efficiency and effectiveness. NGT recognizes the need for a digitalized, unified platform to enhance decommissioning processes, ensuring they are safer, cost-effective, and environmentally responsible.
- Decommissioning requires careful planning, decision-making, and monitoring. Digital tools and AI/ML technologies can enhance this process by analyzing large datasets to predict risks, asset failures, and optimal workflows. Key data sources include asset specifications, operational history, maintenance records, and real-time field data. Current software solutions lack end-to-end capabilities, necessitating a bespoke digital platform.
- This proposed platform will integrate a robust data foundation (e.g., CAD models, logs, spatial data) with an application layer to provide a comprehensive view of assets and enable data-driven decision-making. AI will act as an enabler, automating repetitive tasks and delivering actionable insights, but it is not a standalone solution.

The results of this analysis indicate the following:

- **Work Package 1** - There is no one tool in the market currently that can support an end-to-end decommissioning process. The proposed tool is a Multi layered architecture with a "tailor-made" Application Layer to support decommissioning functions.
- **Work Package 3** - A digital tool could offer several decommissioning solutions, one of which is enabling larger tendering opportunities which has the potential to reduce costs by as much as 21% and reduce CO2 emissions by as much as 80%. The use of a digital tool can also facilitate emissions reduction to 0.12 KgCO2e per £ spent in decommissioning.
- **Work Package 4 -** Overall, digital decommissioning using tailored solutions (such as one Decommissioning Tool) can streamline operations, enhance traceability and promote greener practices for a more efficient and responsible decommissioning process.

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Executive Summary

Recommended Next Steps for Developing a Bespoke Digital Platform:

- **Develop a bespoke digital decommissioning platform-** As current software solutions in the market lack end-to-end capabilities.
- **Further Fine Tune Core Features and Functionalities of the Platform-** Develop a deeper understanding of NGT's pain points by engaging with key stakeholders to document specific challenges and inefficiencies. Use this information to create detailed use cases that will guide platform design and functionality. This will prioritise the development of certain features based on business impact, feasibility and alignment with NGT's strategic decommissioning goals.
- **Engage Stakeholders and Identify Key Partners-** This includes mapping out internal stakeholders at NGT as well as external partners who will be involved in the platform's development, ensuring their requirements and expectations are clearly documented
- **Define Integration and Interoperability Requirements-** This includes conducting a thorough review of NGT's current software ecosystem to identify systems that can be leveraged or integrated into the new platform. It also includes planning for seamless integration by determining which external systems, services or tools the platform needs to integrate with such as third-party software or legacy systems.

Context

NGT response to a changing energy system

NGT, in response to a changing energy system which includes the transition to net zero as well as changes in the supply and demand for gas, is required to decommission its large site-based assets across certain locations.

This project aims to implement an AI tool (digital solution) that could help NGT manage its decommissioning process to yield certain benefits. Such a tool could bring about certain advantages such as efficiency improvements in time, cost estimation, carbon emissions reduction as well as the identification of the re-use potential of assets.

The discovery phase will assess commercially available tools for several key areas of the decommissioning process, determining whether they can be integrated into a unified platform, or a new digital solution developed. As part of the study, a cost benefit analysis with a focus on circular economy principles will be carried out.

Current Phase

Discovery Phase	Alpha Phase	Beta Phase
•Market Intelligence •Cost Benefit Analysis •Circular Economy	•Integrated Single Platform or New Tool Design Flow	•Developing & Testing of Tool

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Project Overview

Work Package objectives

WP 1: Digital Tool Identification for Decomissioning

- Identify and assess commercially available digital tools against a pre-agreed set of decommissioning value drivers.
- Determine the optimal path forward: integration of these tools into a single reporting platform, or the development of a new, customised digital tool.

WP 2: Machine Learning, Automation and Integration in National Gas IT

- Assess how AI/ML and other automation capabilities can be embedded to improve the overall decommissioning process.
- Understand how the final tool can be implemented and integrated into the National Gas IT infrastructure

WP 3 & 4: CBA, Circular Economy and Digital vs Traditional Analysis

- Conduct comprehensive cost benefit analysis comparing traditional and digital decommissioning methods, with a focus on circular economy benefits.
- High-level quantification of advantages and disadvantages of digital decommissioning, including cost savings, impact on efficiency and environment.

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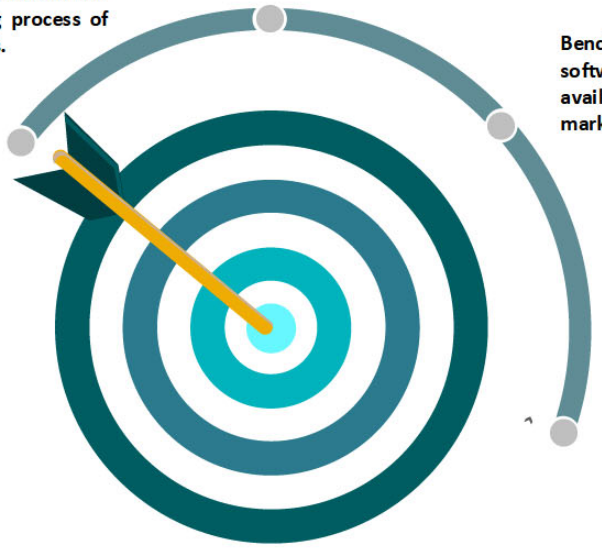
Objectives and Methodology

Work Package 1

Key Objectives of the Study

Pinpointing the key features of the identified software that provide significant value during the decommissioning process.

Identification of available software that assists in the decommissioning process of oil and gas assets.



Benchmarking the identified software to highlight the best available solutions in the market.

Discovering the whitespace in the market where an "ideal software" could offer comprehensive solutions compared to the best available options.

Research Methodology

Identification of Decommissioning Software

Thorough primary and secondary research identifies software solutions for oil and gas decommissioning.

Categorization of Value Drivers

The evaluation framework is based on two value driver categories: primary (core) and secondary (supporting) drivers, each assessed by the availability of relevant features.

Raw Feature Summation Approach

The methodology counts features within each value driver category, then plots the aggregated totals on a two-dimensional chart to provide a clear, objective measure of each software platform's capabilities.

This approach offers a comprehensive view of the competitive landscape, showing that no current software excels in both core and peripheral functions. It also reveals whitespace opportunities for creating an ideal, industry-defining solution.

Benchmarking Analysis | Key Features Driving Digital Decomm.

IBM Maximo, DEMplus, MODS, BIM Model, and VIRCORE are very close to meeting digital decommissioning needs

Overall Performance of Decommissioning Software

Primary Drivers

Cost Optimization	Optimizing Productivity	Environmental Sustainability
Preventive Maintenance	Preventive Maintenance	Compliance Management
Real Time Data Monitoring	Real Time Data Monitoring	Real Time Tracking Capabilities
Real Time Tracking Capabilities	Workflow Automation/ Management	
Workflow Automation/ Management	Lifecycle Management/ Optimization	
Cost Estimation and Optimization	Digital Documentation/ Document Management	
Plan Generation and Optimization	Data Visualization, Integration and Tagging	
Lifecycle Management/ Optimization	Plan Generation and Optimization	

Secondary Drivers

Empowering Informed Decisions	Risk Reduction	Reduction of Human Intervention
Real Time Data Monitoring	Preventive Maintenance	Workflow Automation/ Management
Preventive Maintenance	Risk Management	Digital Documentation/ Document Management
Digital Documentation/ Document Management	Real Time Tracking Capabilities	
Workflow Automation/ Management	Plan Generation and Optimization	
Data Visualization, Integration and Tagging		
Plan Generation and Optimization		

- Benchmarking is based on the presence of individual features, with each available feature earning a point in its respective primary or secondary driver category.
- Each feature contributes to enabling primary and secondary drivers. Plan Generation and Optimization, along with Preventive Maintenance, are the most impactful, supporting multiple drivers. Other key features include Data Visualization, Integration and Tagging, Digital Documentation, Real-Time Monitoring, and Tracking.

- **Software with 16+ features show strong support across core and peripheral drivers, making them best suited for comprehensive decommissioning.**
- **Software with 10–15 features offers partial support for primary and secondary drivers, limiting their effectiveness in full digital decommissioning.**
- **Software with fewer than 10 features lacks sufficient support for primary and secondary drivers in digital decommissioning**

In-Scope Digital Software in Benchmarking
IBM Maximo
DEMplus Simulation Software
MODS Connect Completions
Building Information Modeling (BIM) Model
VIRCORE
AFRY Real Digital Twin
FLYT
rahd·AI's AI Platform
Oracle's Primavera Unifier Facilities and Asset Management
SIMULIA Solutions
Industrial Work Surface
Smart Digital Reality
Delfi Digital Platform
SAP S/4HANA Enterprise Asset Management (EAM)
VAIL Plant Module - Structural Integrity Management System (SIMS)
IFS Cloud Enterprise Asset Management (EAM)
Integral (ix3)
Azure Digital Twins
FieldTwin
Lumi Data and AI Platform
VEERUM DigitalTWIN
Actenum DSO Scheduling Software
Asset Integrity Management System | VAIL-Plant Software
AS-TEG Module
Veristar AIM3D (VAIM3D)
Asset Lifecycle Management (ALM)
WD Apollo Software
Virtualplant
CIRCA Real-Time (RT) Simulation and Analysis Software
Platform Abandonment Estimating System (PAES)

Features Benchmarking | Top Identified Software

Top identified software are not fully optimized to drive NGT digital decommissioning

Comparison of Features in Top Available Software vs. Ideal Software

Drivers	Ideal Software*	IBM Maximo by IBM	MODS Connect Completions by MODS	VIRCORE by Ingecid	Building Information Modeling (BIM) Model by Assystem
Cost Optimization	● ● ● ● ● ● ●	● ● ● ●	● ● ● ● ●	● ● ● ●	● ● ● ● ●
Optimizing Productivity	● ● ● ● ● ● ●	● ● ● ● ●	● ● ● ●	● ● ● ●	● ● ●
Environmental Sustainability	● ●	● ●	● ●	●	●
Empowering Informed Decisions	● ● ● ● ● ●	● ● ● ●	● ● ●	● ● ● ●	● ● ● ● ●
Risk Reduction	● ● ● ●	● ●	● ●	● ● ●	● ●
Reduction of Human Intervention	● ●	● ●	● ●	●	●

Legend

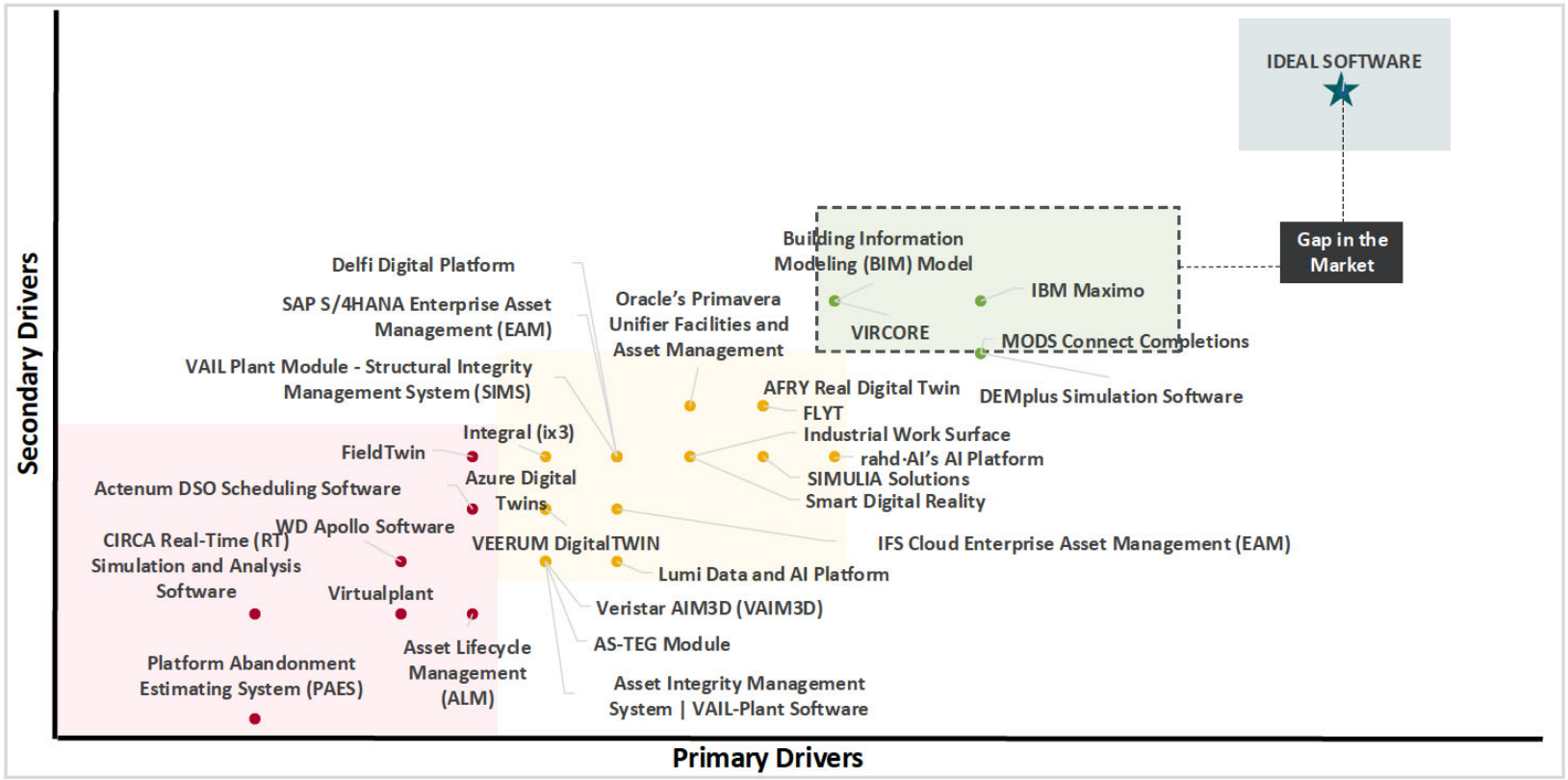
- Preventive Maintenance
- Real Time Data Monitoring
- Real Time Tracking Capabilities
- Workflow Automation/ Management
- Cost Estimation and Optimization
- Plan Generation and Optimization
- Lifecycle Management/ Optimization
- Risk Management
- Digital Documentation/ Document Management
- Data Visualization, Integration and Tagging
- Compliance Management

- The well-rounded, top available solutions, offer several features that contribute to the execution of primary and secondary drivers, however, there are several features available in the market that can be incorporated into an ideal software to offer better and more effective digital solutions for decommissioning.
- IBM Maximo exhibits the highest number of points accumulated based on feature availability across primary and secondary drivers. Whereas the benchmarking analysis (in the following slide) showcases a market gap which can be fulfilled by an ideal software.

***Note:** An Ideal Software meets the "North Star" metric in the digital decommissioning software industry based on feature availability and the ability to execute primary and secondary drivers. An Ideal Software exhibits maximum available points attained by the availability of all relevant features across the market spectrum.

Software Positioning | Primary vis-à-vis Secondary Drivers

Significant Gap Between Leading Solution and the Ideal 'North Star' Vision



★ An Ideal Software achieves the "North Star" benchmark by offering all relevant features needed to fully support both primary and secondary drivers, attaining the highest possible score in digital decommissioning.

● These leading software platforms offer the highest number of features, to enable partial execution of primary and secondary drivers.

● These platforms offer limited features, providing only limited execution of primary and secondary drivers.

● These platforms lack sufficient features to effectively execute primary and secondary drives.

The Digital Advantage | Optimizing Decommissioning Process

Case studies analyses in the Oil & Gas and Nuclear Industries

The Adoption of Software for Optimizing Oil and Gas Decommissioning is at a Nascent Stage

Advanced technologies such as AI, ML, and autonomous systems are being explored for decommissioning but remain largely in the experimental phase.

Software Innovations are described as "unique" and "innovative," emphasizing their novelty in a market where manual processes still dominate.

Key standards such as Capital Facilities Information Handover Specification for process industries (CFIHOS) and ISO 15926 are vital for data management but face slow adoption due to complexity and fragmentation.

Software use in decommissioning is often early-stage, making impact hard to gauge. MODS Connect aided the Hewett Gas Field by enhancing digital tracking; decommissioning concludes in 2025.

Notes:

- **SOGIN** is Italy's state-owned company managing nuclear plant decommissioning and radioactive waste.
- **JAVYS**, a Slovakian state-owned firm, focuses on nuclear decommissioning and waste management.
- **VISIPLAN**, developed by SCK CEN, supports ALARA analysts with dose assessment and communication in pre-job studies.

Digital Decommissioning In the Nuclear Industry

Due to higher radiation risks and safety concerns in the nuclear industry, automation and software assistance have been adopted earlier to minimize human exposure and enhance decommissioning efficiency and control.

SOGIN (Italy)
SOGIN's decommissioning of Italian plants is ongoing, with progress noted as of November 2024. The company employs 3D models and simulations throughout its operations.

JAVYS (Slovakia)
JAVYS is using digital tools and simulations in the ongoing decommissioning of the Bohunice V1 plant, set for completion by 2027. Virtual modeling was highlighted in the April 2023 IAEA Bulletin.

VISIPLAN (Belgium)
VISIPLAN, a 3D ALARA planning tool, was used at the BR-3 reactor to simulate decommissioning scenarios, assess radiation risks, and optimize workflows for safer, more efficient dismantling.

The Digital Advantage | Optimizing Offshore Decommissioning

Digital Involvement in Offshore Oil and Gas Decommissioning Process

Plugging and Abandonment of Wells		
Company Name	**Software Name**	**Involvement in Decommissioning Process**
Actenum Corp.	Actenum DSO Scheduling Software	Scheduling well abandonment
WellDecommissioned	WD Apollo Software	Cost optimization for well decommissioning
IBM	IBM Maximo	Well decommissioning for managing asset lifecycle and maintenance

Facilities and Structural Decommissioning		
Company Name	**Software Name**	**Involvement in Decommissioning Process**
eserv	AS-TEG Module	Integrates data from multiple sources to generate precise and detailed 3D models of as-built offshore platforms.
MODS	MODS Connect Completions	Efficient and cost-effective digital completions & documentation
Bureau Veritas	Veristar AIM3D	It enables the construction of an intelligent 3D digital twin.
VELOSI	VAIL Plant Module - Structural Integrity Management System	SIMS software ensures compliance, maintaining structural integrity until decommissioning or removal.
RemSense	Virtualplant	Virtualplant leverages VR, AI, and digital twin technology to create digital representations, enhancing asset management integration.

Scheduling, Project Planning and Workflow Optimization		
Company Name	**Software Name**	**Involvement in Decommissioning Process**
Actenum Corp.	Actenum DSO Scheduling Software	Actenum DSO software uses advanced analytics to optimize schedules, helping achieve business goals efficiently.
Well Decommissioned	WD Apollo Software	WD Apollo software reduces well decommissioning costs and risks, enabling quick generation and review of plans.
SAP SE	SAP S/4HANA Enterprise Asset Management (EAM)	Digital automation of key activities from commissioning to decommissioning enhances efficiency and reduces errors.
Hexagon AB	Smart Digital Reality	Hexagon's Smart Digital Reality enables automated workflow processes, enhancing enterprise asset management and operational efficiency.
Konsberg Digital	Industrial Work Surface	Plan, manage, and collaborate seamlessly on end-to-end workflows for improved efficiency and outcomes.

The Digital Advantage | Optimizing Offshore Decommissioning

Digital Involvement in Offshore Oil and Gas Decommissioning Process

Asset Integrity, Regulatory Compliance and Cost Estimation		
Company Name	**Software Name**	**Involvement in Decommissioning Process**
TSB Offshore	Platform Abandonment Estimating System (PAES)	It offers accurate cost estimation for oil and gas decommissioning process.
IBM	IBM Maximo	With IBM Maximo, organizations can generate reports on asset performance, maintenance costs, and other critical metrics.
IFS	IFS Cloud Enterprise Asset Management (EAM)	IFS Cloud EAM helps oil and gas companies manage asset lifecycles, ensuring safety, environmental considerations and minimizing disruptions.
Microsoft	Azure Digital Twins	Digital twins optimize asset performance, predicting repairs and minimizing downtime to extend asset lifespan efficiently.
SAP SE	SAP S/4HANA Enterprise Asset Management (EAM)	SAP Enterprise Asset Management streamlines asset lifecycles with proactive maintenance, mobile solutions, and intelligent geographical views.
VELOSI	VAIL Plant Module - Structural Integrity Management System (SIMS)	Ensures offshore asset owners stay informed throughout the asset lifecycle by providing timely, accurate information to operators.
Konsberg Digital	Industrial Work Surface	It covers all asset management lifecycle stages, fully digitalizing assets like platforms, pipelines, plants, and new energy assets.
Hexagon AB	Smart Digital Reality	Smart Digital Reality optimizes asset lifecycles, transforming facilities into efficient, safe operations for sustainable growth.

- Software automates data collection and decision-making, enhancing accuracy and reducing manual effort during the decommissioning process.
- Optimized scheduling and automated workflows reduce delays, ensure resource efficiency, and streamline operations.
- Real-time monitoring and predictive maintenance software extend asset life and reduce costly downtime by identifying potential failures early.
- Software ensures compliance with regulations and provides accurate, real-time cost estimations, reducing overspending and mitigating risks.

The Digital Advantage | Optimizing Offshore Decommissioning

Digital Involvement in Offshore Oil and Gas Decommissioning Process

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Microsoft	Azure Digital Twins	Digital twins optimize asset performance, predicting repairs and minimizing downtime to extend asset lifespan efficiently.
SAP SE	SAP S/4HANA Enterprise Asset Management (EAM)	SAP Enterprise Asset Management streamlines asset lifecycles with proactive maintenance, mobile solutions, and intelligent geographical views.
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Market Analysis Summary

No standalone E2E digital decommissioning tool exists necessitating the development of 1DT

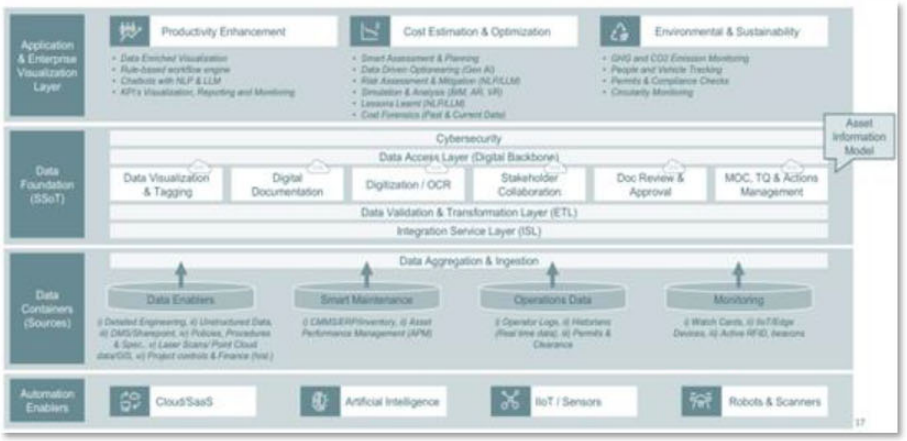
Key Findings

- No one tool to support end-to-end decommissioning process. Traditional decommissioning software lack advanced features e.g. AI-driven analytics, 3D asset visualization, GIS integration, regulatory compliance tracking, and detailed cost-risk assessment.
- The industry lacks a single complete tool that offers all necessary features required to enable optimized decommissioning process.
- With more than 2 million energy assets slated for permanent closure in the next decade, an integrated decommissioning solution can deliver up to 30% cost savings, boost workforce productivity by as much as 70%, and ensure uncompromised worker safety throughout the process.

Our Recommendation

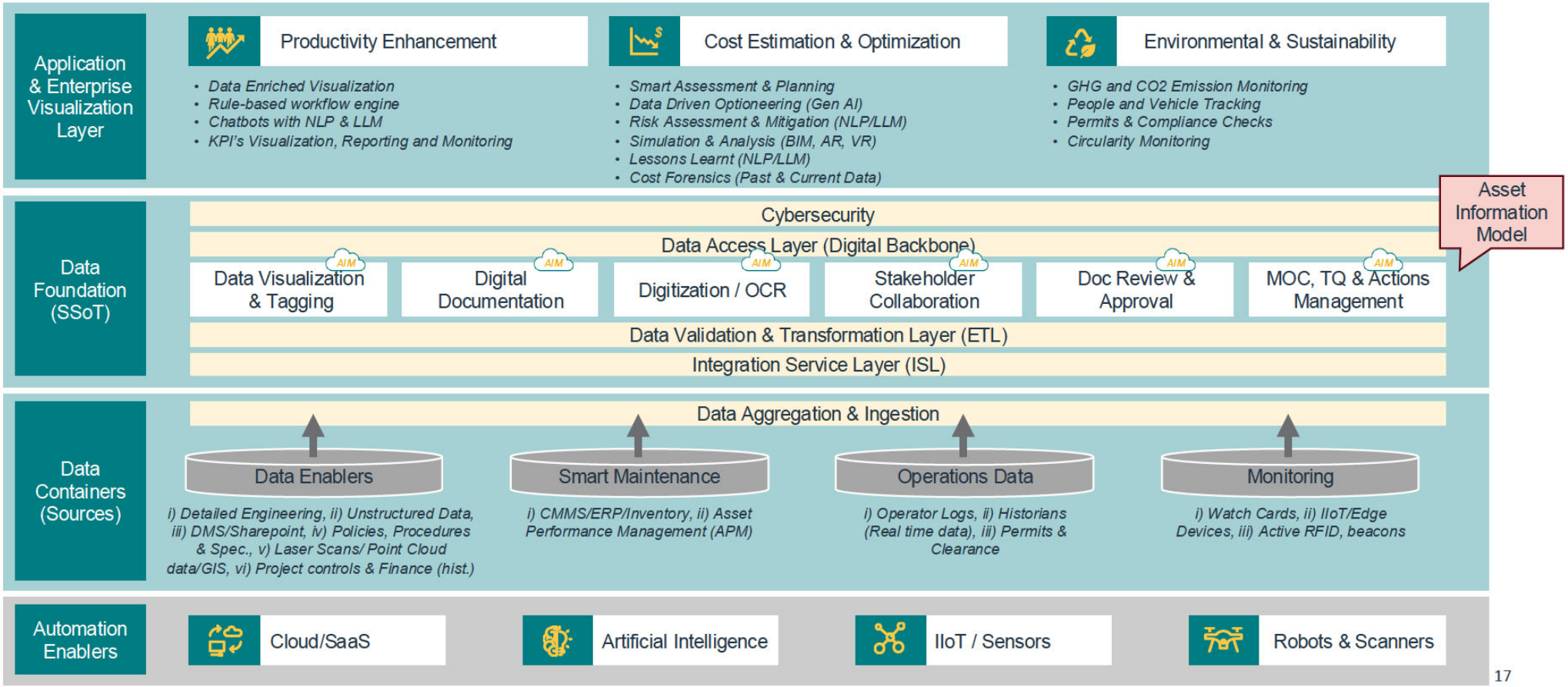
- Build bespoke digital one decommissioning tool.
- 1DT development should be done in phases, with set priorities and milestones.
- Data and its readiness is an essential element. Along with plans for continuous user feedback and iteration process to ensure adoption in NGT.

Proposed One Decommissioning Tool (1DT)



Proposed One Decommissioning Tool

E2E digital decommissioning platform enhanced with real-time data analytics and AI



Proposed One Decommissioning Tool

Application Layer Features/Functions

	Application / Feature	Functionality
Productivity Enhancement	Data enriched visualization	Ability to quickly find the right data at the right time with proper contextualization.
	Rule-based workflow engine	Automate a process with a list of steps, predecessor & successor for each step, step assignee(s), defined duration for each step coupled with email server for notifications.
	Chatbots with NLP & LLM, Gen AI	Data gathering and processed response from historical and real-time information.
	KPI's Visualization (Dashboarding)	Ability to present information in the form of charts (bar charts, PI charts, etc..,) with complex filters and queries. Ability to design a dynamic dashboard, its layout, widgets and dependency between the widgets.
Cost Estimation & Optimization	Smart Assesment & Planning	Ability to determine asset redundancy based on data driven responses. Generation of optimized planning portfolios based on past and current data. Ability to produce various planning portfolios for the type of job in hand with pros and cons.
	BIM - Simulation & Analysis	Walk through the 3D models to understand spatial associations which will help in decision making based on simulation to plan & optimize a decommissioning job.
	Data driven Optioneering	Helps in selecting the proper approach based on the nature of the job, lessons learnt in the past, associated costs, risks, etc.
	Lookback Analysis / Lessons Learnt (NLP & LLM)	A self learning module that present insights, opportunities & incidents based on historical data and past projects.
	Risk Assesment & Mitigation (NLP & LLM)	A self learning module that present risks and mitigation measures based on present data & historical data from past projects.
	Cost Forensics	Helps in estimating direct and indirect costs, contingency costs (risks) and measures to mitigate cost overruns.
Environmental & Sustainability	GHG and CO2 Monitoring	Monitor emissions through the data points, sensors, and other devices in the field.
	People & Vehicle tracking	Monitor the movement of the vehicles and persons through out the decommissioning job. Isolated and confined space monitoring.
	Permits & Compliance Checks	Compliance checks with respect to CO2 emmisssions.
	Circularity Monitoring	An inventory or a marketplace for dismantled assets.

One Decommissioning Tool Integration Overview

Assess compatibility of identified software packages against Lead Partner existing systems, narrowing options against the requirements – to be provided by Kynan

+ other requirements (e.g. data, taxonomy etc) as per NGT/IBM

One Decommissioning Tool Development Roadmap

Non-Exhaustive

Developing and integrating the digital tool is a journey that typically extends over 3 maturity steps

Note: Detailed 1DT development activities and timelines to be investigated and finalized in the ALPHA phase. Indicative timelnes of development between 1-3 years depending on NGT digital readiness

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WP 2 Summary/Overview – to be provided by NGT/IBM

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Purpose of the Cost Benefit Analysis

An Overview

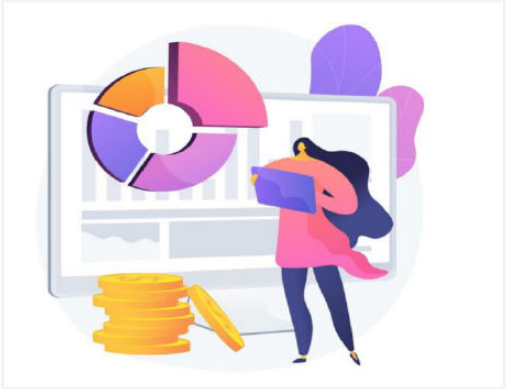
Methodology

In this report, Genesis provides a summary of a Cost Benefit Analysis performed on several scenarios for the decommissioning of NGT assets. These scenarios aim to examine ways in which digital solutions can optimise the decommissioning of block valves, by reducing the cost as well as the carbon footprint to do so.

A representative business case was built using the economic model. The economic competitiveness of the base case was compared against Scenario 2 as seen below;

Scenario 1 – Traditional Decommissioning of block valves (business as usual)
Scenario 2 – Digital Decommissioning of block valves

The cost and benefit profiles in these scenarios were used to create discounted cash flows for each of the scenarios. A comparison of these two sets of discounted cash flows then determined whether there was a net benefit or cost to NGT when incorporating a digital tool into its decommissioning process. To calculate these discounted cash flows, several key assumptions were made, and these will be discussed in the following section.



Main Assumptions

Valuation Assumptions

Variable	Description	Value
Discount rate	Percentage to which all cash flows are discounted	3.5%
Lifetime	Period over which costs and benefits are included	3
Base Year	Year to which everything is discounted	2025
Start Year	Year at which decommissioning will start	2026
End Year	Year at which decommissioning will finish	2028
Price of Carbon Steel	The current market price per tonne of carbon steel	£550

Methodology

- In the Cost Benefit Analysis, the costs and benefits of the two scenarios are calculated based on technical and economic assumptions as well as industry cost data.
- This data comes from a combination of literature, expert judgement, data used by Genesis in previous projects as well as data provided to Genesis by NGT.
- Costs and benefits over the project life across the 2 scenarios are then discounted back to the present year (2025) using the societal discount rate of 3.5% recommended by HMT Treasury Greenbook.
- NPV is then calculated as the sum of these discounted cash flows.

Source: RoyMech Metal Costs

Scenarios Modelled

Scenario 1- Business As Usual (Traditional Decommissioning of a Block Valve)

Description
The BAU is the model's expected case; this is the scenario we see either most likely to happen or which is already partly implemented. In the BAU, NGT is decommissioning a block valve.

Methodology

Block Valve Outline
Block valves are main isolation valves that are strategically located and installed on NGT's cross country pipelines to facilitate maintenance, flow direction, testing and commissioning and limit inventory loss in an emergency.

Valve Body
The valve body serves as the predominant part of a valve assembly as it is the framework that holds all of the other parts together. This includes the seat rings and stem seal.

Valve Stem Extension
The valve extension is the primary way of extending the valve stem from below the ground when buried to above ground to allow routine valve operations to occur. This includes the vent and sealant lines.

Valve Actuator/Gearbox
The actuator is used to fully open or close the valve; it produces motion (both linear and rotary) utilising a power source under the action of a source of control (Actuator Control Cabinet).

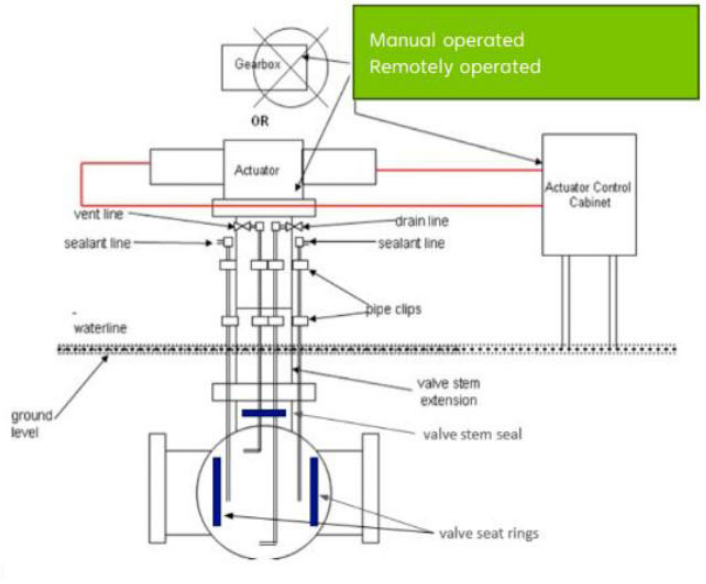


Diagram of a Block Valve

Scenarios Modelled

Scenario 1- Business As Usual Workflow

The Stages to Block Valve Decommissioning

1. **Planning an outage**, to enable the isolation of the pipeline feeder, i.e. closing other strategic valves upstream and downstream of the block valve being removed or replaced.

2. **Recompression of gas inventory** 'locked' in between the points of isolation, venting the remainder at around 7bar, then purging the pipeline feeder to air to allow safe access into the system.

3. **Breaking containment** (i.e. cutting into the pipeline) to remove the block valve assembly, ready for either pipe through with a new piece of pipe or replacement with a new block valve assembly.

Limitations of the Cost Benefit Analysis Model

- The cost to implement a digital tool has not been modelled into this Cost Benefit Analysis. There are several reasons for this key of which centers on data readiness limitations at NGT and the proposed tool assumes data readiness.
- Costing will require a phased approach, involving input from multiple departments and stakeholders to estimate development costs accurately. As a result, implementation costs are out of scope for this phase.
- Only a few features of the digital tool have been modelled, though additional features could impact decommissioning costs and emissions.

Cost Benefit Analysis

Scenario 1- Business As Usual (Traditional Decommissioning of a Block Valve)

Costs

NGT estimates that the entire block valve decommissioning process would take approximately [redacted]

This has been split out into Asset Management Planning which involves pre screening, identifying, planning and approval around asset and takes approximately [redacted] The project implementation phase of decommissioning which would involve block valve removal of pipe through, is estimated to take around [redacted] and would cost approximately £[redacted]

For the purposes of this exercise, it is assumed that [redacted] valves will be decommissioned within the next RIIO-T3 period (2026-2031).

Emissions

For a typical 36" 30km pipeline there would be approximately [redacted] m3 of natural gas vented. For a typical 36" 60km pipeline there would be approximately [redacted] m3 of natural gas vented.

For the purposes of this project, an average of the two volumes was used to calculate [redacted] m3 of gas vented during block valve decommissioning.

In the year of physical decommissioning (2028), [redacted] tonnes CO2eq are emitted per block valve site. Given the cost of CO2 emissions (using DESNZ carbon appraisal values central estimate) is £[redacted] per tonne CO2 in 2028, the carbon cost of emissions is £[redacted] per block valve site.

Decommissioning Costs Profile

[redacted]

Decommissioning Emissions Profile

[redacted]

Total Costs from BAU Scenario (£)

[redacted]

Source: Department for Energy Security and Net Zero (DESNZ)

Cost Benefit Analysis WIP

Scenario 2- Digital Technology Enabling More Efficient Decommissioning Planning and Execution

Assumptions

In this scenario, a digital platform with certain features could enable more efficient decommissioning planning and execution. A digital dashboard for decommissioning activities for instance could enhance transparency, collaboration and efficiency by providing contractors with detailed project insights, enabling better planning ,resource allocation and cost saving activities.

Block Valves Planned for RIIO 3 Decommissioning

If the below features are assumed to be incorporated into a digital platform, there can be both cost and emissions savings.

Digital data availability and **automated workflows** could improve planning. It is estimated that this could reduce costs by 33%.

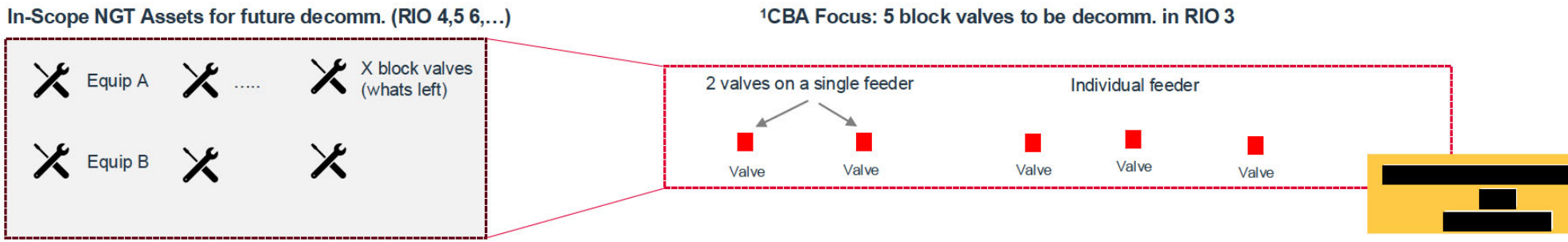
Cloud scans of sites and **asset level data** enable large number of decommissioning scopes to tender together with less risk getting better value for larger jobs e.g. Longer equipment rental, correct fittings etc. It is estimated that this could result in 10% cost savings

Larger number of jobs being performed by the same contractor with real data (weight, dimensions) enables **learning curve** in execution across multiple projects. This has been estimated to reduce costs by 10%

The below digital tool features or combination of features have been applied to each of the main stages of block valve decommissioning

Stage of Block Valve Decommissioning	Relevant Digital Tool Applications	Cost Reduction Applied	Time Savings Applied Due To Learnings
Asset Management Planning	• **Rule Based Automated Workflows** to improve planning	33%	4 months
Block valve removal of pipe through	• **Data Enriched Visualisation** – Cloudscan and asset level data of sites • Learning curve benefits	20%	1 month

FSM CONCEPT



Notes: Add something on 'based on available data during discovery to demonstrate benefits'. Upside cost and emission reduction benefits to be asssed in detail during Alpha phase

Cost Benefit Analysis WIP

Scenario 2- Digital Technology Enabling More Efficient Decommissioning Planning and Execution

Description
Scenario 2 or the alternative scenario is the scenario being tested. Can digital technology enable Imore efficient decommissioning planning and execution opportunities for contractors and in so doing can it reduce both the cost and emissions profile for block valve decommissioning. To capture the value from incorporating a digital tool to enhance block valve decommissioning, several assumptions were made about the features of a potential tool.

COSTS

Digital Tool Assumed Features	Cost Reduction
Rule Based Automated Workflows to improve planning	33%
Data Enriched Visualisation – Cloudscan and asset level data of sites	10%
Learning curve benefits	10%

EMISSIONS

Emissions Assumptions	Emissions Reduction
Rule Based Automated Workflows to improve planning	20%
Data Enriched Visualisation- Cloudscan and asset level data of sites	15%
Given the DESNZ projected price of CO2 emissions is £306 per tonne in the year of decommissioning (2028), and [redacted] tonnes CO2e is emitted, the overall cost of emissions is £[redacted]	

Decommissioning Costs Profile

	Decommissioning Costs (£)	Decommissioning Period (months)
[redacted]		

Decommissioning Emissions Profile

[redacted]

Total Costs from Digital Solutions Scenario (£)

[redacted]

Source: Genesis Internal Research

Summary of Results

Impact of Incorporating Digital Solutions to Block Valve Decommissioning

Costs

The results of this analysis show that incorporating a digital tool could potentially generate cost savings. Total decommissioning costs have been reduced by £[redacted] which represents a [redacted] cost reduction

Reduction to Decommissioning Costs	
	Decommissioning Costs Reduction (£)
[redacted]	

Emissions

Incorporating a digital tool could also reduce total GHG emissions. Total emissions have been reduced by [redacted] tonnes CO2e which represents an [redacted] emissions reduction

Reduction in GHG Emissions			
	Gas Vented (m3)	Tonnes CO2 eq	Emissions Cost Reduction (£)
[redacted]			

Net Present Value

The results of this analysis show that incorporating a digital tool generates an NPV of £[redacted] M. The difference between the Total BAU costs from Scenario 1 (£[redacted] and the total costs from Scenario 2 (£[redacted] is £[redacted] When discounted to present day using the [redacted] discount rate, the NPV is £[redacted]

Net Present Value of Implementing a Digital Solution (£)	
Total NPV	£[redacted]

Conclusion

- Scenario 2 delivers an NPV of £136,833 per block valve demonstrating the economic viability of adopting a digital solution.
- On the basis of [redacted] of the [redacted] block valves at NGT being decommissioned over the next [redacted] years then up to £[redacted] of savings could be unlocked.
- This also includes emissions reduction by 35%, equating to a monetary saving of £[redacted] per block valve site. Applied across [redacted] sites, carbon savings worth £[redacted] could be unlocked.
- **If all [redacted] valves were decommissioned with the current NPV value of £[redacted] then £[redacted] M worth of savings could be unlocked.**
- **This would also include emissions reduction of £[redacted] M worth of savings since [redacted] valves are decommissioned with a current NPV of £[redacted] of carbon savings.**

The Circular Economy

Applying Circular Economy Principles to Block Valve Decommissioning

An Overview of Circular Economy

The UK government, as part of its net zero ambition, is committed to transitioning the UK to a circular economy. Such attainment would require major changes throughout the economy. Given that we live in a world with finite resources and environmental challenges, the traditional model of linearity (take-make-dispose) is no longer viable.

The circular economy is a model of production and consumption whereby products and materials are continually reused, refurbished and recycled. As these materials and products are kept in circulation for as long as possible, the life cycle of these products and materials is extended.

Extending the lifecycle of products and materials is beneficial because it means

- waste is kept to a minimum. These goods and materials can be productively used repeatedly, creating additional value
- limited resources are conserved
- Because the use of natural resources is slowed down, the transition to circularity helps to reduce greenhouse gas emissions which makes it key in the fight against climate change.

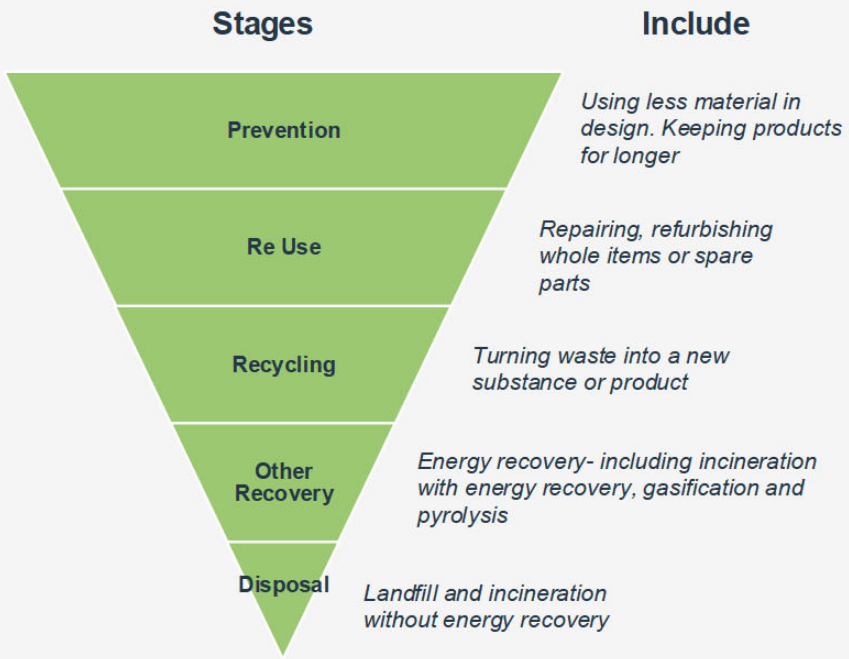
To date, the approach for most of the assets at NGT to be decommissioned has mainly followed a linear model.

The Circular Economy

Applying Circular Economy Principles to Block Valve Decommissioning

- NGT has identified value losses associated with the traditional linear approach to decommissioning large-scale assets.
- This value can be captured by incorporating circular economy principles such as reusing and recycling functional equipment and parts into the assets.
- These methods are highlighted in the Waste Hierarchy in Article 4 of The Waste Framework Directive (2008/98/CE)- top priority is given to prevention of waste. If and when waste is created, it gives priority to preparing it for re-use, recycling, recovery and lastly for disposal.
- At NGT, block valve removal has been identified as a key area for circular integration. The current valve removal process already includes recycling:
  - Valves are dismantled
  - Carbon steel components (e.g. shell, seat pockets, stem extensions and gear boxes) are smelted and recycled
- Reuse of valves is currently limited due to functional failures (e.g. faulty seals or operations) in removed valves.

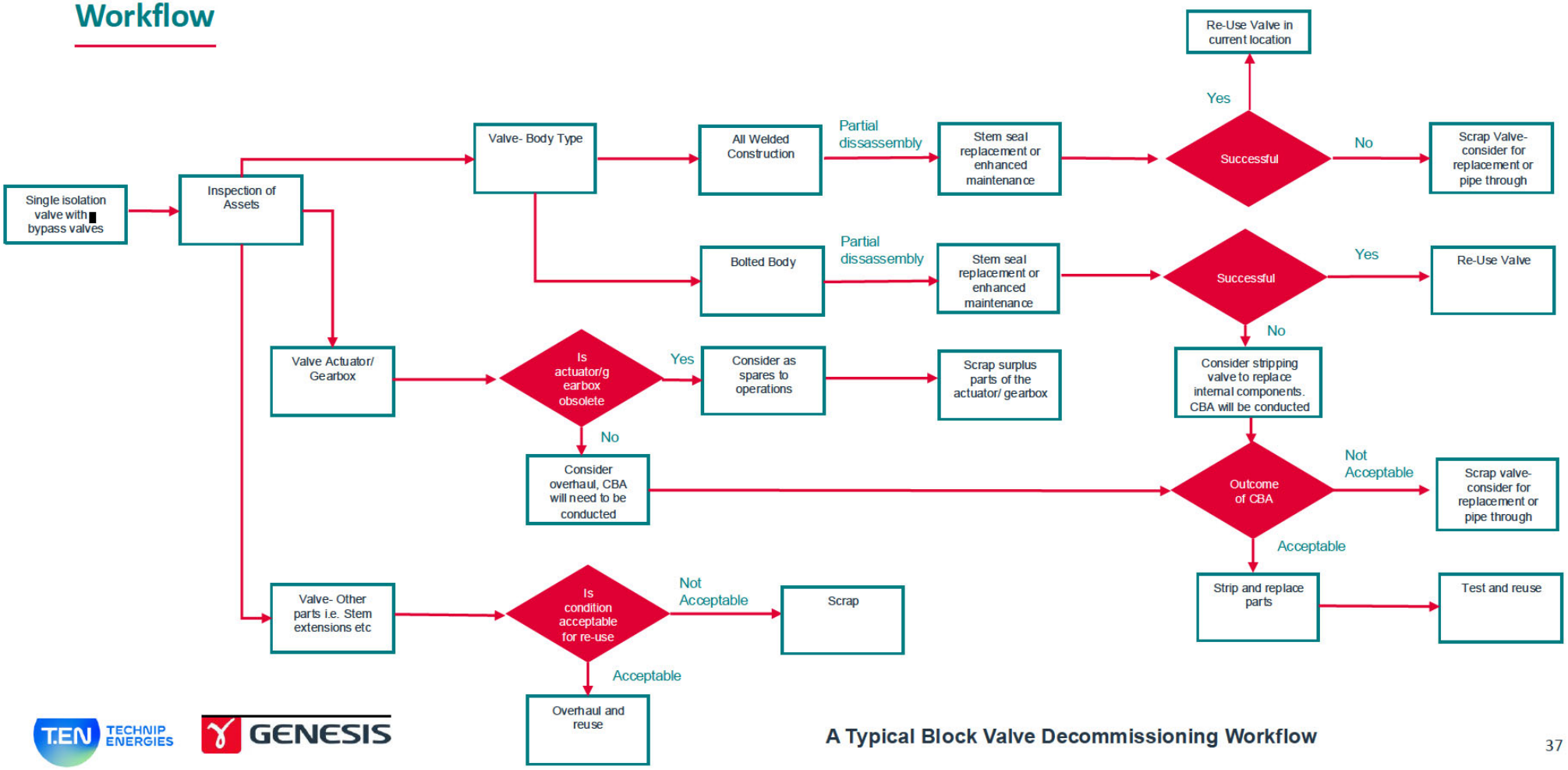
The Waste Hierarchy



Source- Department for Energy Food and Rural Affairs (DEFRA)

Block Valve Decommissioning

Workflow



A Typical Block Valve Decommissioning Workflow

Circular Decommissioning

Impact of Recycling and Reuse of Block Valves

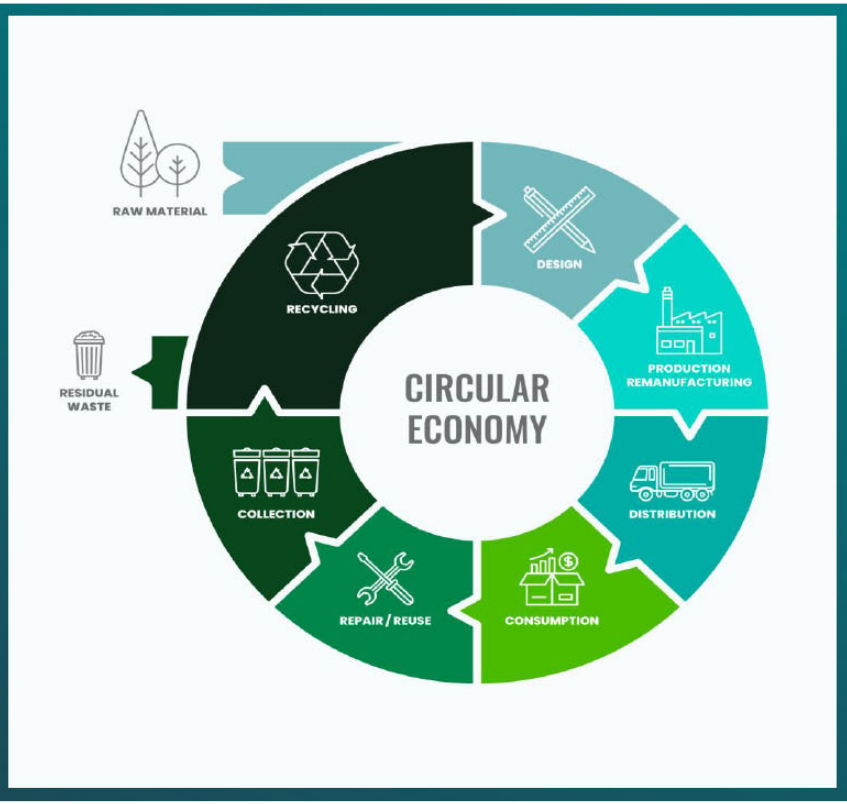
Monetary Value from Recycling

In addition to extending the lifecycle of the valves and reducing waste to a minimum, there is a monetary value add to recycling of the block valves. For a typical valve, 9.8 tonnes of carbon steel is smelted at a cost of £550 per tonne of carbon steel which **generates revenue for NGT of £5,390 per block valve that is recycled.**

Emissions Savings from Recycling and Reuse

Even though NGT does not currently reuse any of its valves, reuse of valves/ valve components, could be beneficial to the environment; if valves/valve components are reintegrated into the NGT system or retained as strategic spares, less new assets would need to be purchased.

The GHG emissions associated with the production of new valves can be avoided and the resources used to produce the valve i.e. the carbon steel can be conserved.



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Circular Decommissioning

Impact of Recycling and Reuse of Block Valves

The IEA estimates that direct CO2 emissions created when one tonne of steel is produced is 1.4 tonnes CO2. Given that a typical valve is approximately 9.8 tonnes of carbon steel, the emissions profile of a block valve is approximately 13.72 tonnes CO2. **Reuse or recycling of this weight of steel could mean carbon savings of up to 13.72 tonnes CO2.**

Currently the block valve decommissioning process recycles 100% of the decommissioning waste, therefore no waste is sent to landfill.

Carbon Intensity Analysis

Carbon intensity is a measure of the carbon emissions generated per unit of economic expenditure (CO2e per £ spent). Measuring carbon intensity is important because it will allow NGT to measure its environmental impact with regards to its economic activities in the context of transitioning to a circular economy. Given that the cost benefit analysis indicates that 341,000 Kg CO2e are vented during traditional block valve decommissioning and the total spend on block valve decommissioning is £0.56M, for every £1 spent on decommissioning 0.61 Kg CO2e are emitted

As seen in the cost benefit analysis, a digital platform can enable lower emissions. Features such as digital twin technology and automation of workflow processes can reduce emissions by as much as 35% to 221,200 Kg CO2e. This would mean for every £1 spent on decommissioning, 0.39 Kg CO2e are emitted, which represents an improvement in carbon intensity of 0.22 Kg CO2e per £ spent.

Circular Business Model Metrics	
	Cost Savings/ Revenue per Block Valve Decommissioned (£)
Current Recycling	5,390
Future Potential Reuse	Under consideration by NGT
Environmental Impact	
	Emissions Savings per Block Valve Decommissioned (tonnes CO2eq)
Current Recycling	13.72
Future Potential Reuse	13.72
Waste and Resource Efficiency	
Recycling Rate (% of waste recycled)	100%
Waste Diversion Rate (% of waste not sent to landfill)	100%

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Circular Decommissioning

Impact of Recycling and Reuse of Block Valves

Resource Efficiency to Optimize Asset Life

Product Longevity measures how long block valves are used for. The product lifetime is a measure of the actual lifespan of block valves compared to their designed or expected lifetime. An increase in longevity would reduce the need for premature decommissioning and any associated emissions as the lifespan of assets is extended with strategies like refurbishment and repair. At NGT block valves generally last for 25 years and have a designed lifetime of 30 years giving a product lifetime metric of 83%.

A digital tool can improve product lifetime and resource efficiency by several means.

- IoT sensors can be used to facilitate predictive maintenance. They can help to identify potential issues that could lead to asset failure; this could be used to facilitate repairs that can be used to extend the asset lifetime.

- It is estimated that predictive maintenance could increase asset life by 20 to 40%. Given the current life of block valve assets is 25 years, an increase in asset life of just 20% to 30 years could increase the product lifetime metric from 83% to 100%.

Carbon Intensity		
	Traditional Decommissioning	Digitalised Decommissioning
Carbon Intensity (kg CO2e per £ spent)	0.61	0.39
Resource Efficiency		
	Traditional Decommissioning	Digitalised Decommissioning
Product Lifetime	83%	100%

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Source: McKinsey

Summary of WP3

Cost Benefit Analysis and Circularity Analysis

CBA

- A digital tool enables data-driven decision-making by providing accurate, real-time information, significantly reducing the time to access insights and make decisions. The cost-benefit analysis demonstrates that adopting a digital solution for decommissioning is economically viable, with an NPV of £136,833 per block valve site. If we assume that [redacted] block valve sites at NGT could be decommissioned in the next 5 years, this could represent cost savings of £[redacted]

- Additionally, the analysis shows that a digital platform could cut CO2e emissions by 35%, reducing emissions by 120 tonnes CO2e per block valve site and delivering cost savings of £36,720 per decommissioned valve. If we assume that [redacted] block valve sites at NGT could be decommissioned in the next [redacted] years, this represents emissions savings of [redacted] tonnes CO2e worth £[redacted]

CIRCULARITY

- The circularity analysis highlights that recycling a typical block valve (9.8 tonnes of carbon steel) generates £5,390 in revenue, with carbon savings of up to 13.72 tonnes CO2 if future reuse or recycling is implemented.

- Carbon intensity calculations reveal an improvement: emissions drop from 0.61 Kg CO2e to 0.39 Kg CO2e per £ spent on decommissioning, a reduction of 0.22 kg CO2e. Furthermore, resource efficiency improves, extending the product lifetime of block valves from 83% to 100% with the adoption of a digital tool.

OUTLINE





Executive Summary & Overview

Work Package 1: Digital Tool Identification for Decommissioning

Work Package 2: Machine Learning, Automation and Integration in National Gas IT

Work Package 3: Cost Benefit Analysis & Circular Economy Study

Work Package 4: Digital vs Traditional Analysis

NGT Traditional Decommissioning

An Overview

- NGT defines a **decommissioned asset** as one that is no longer in use containing or not containing inventories. This asset will be categorised as such pending a decision to demolish or if there is no set decision to re-commission the asset, it is mothballed until required.
- The decommissioning workflow at NGT covers two main phases:
    - **I. Asset Management Planning (typically led by investment manager)**
        - Determination of asset reduncancy
        - Feasibility assessment of decommissioning options
        - Work planning and risk assesment
    - **II. Project Implementation (led by ops team)**
        - Isolation of asset (disconnecting from gas / power networks)
        - Dismantling and removal
        - Waste management
- Following the above, any close out documentation and reporting will be submitted to regulatory authorities to confirm compliance and site restoration outcomes.

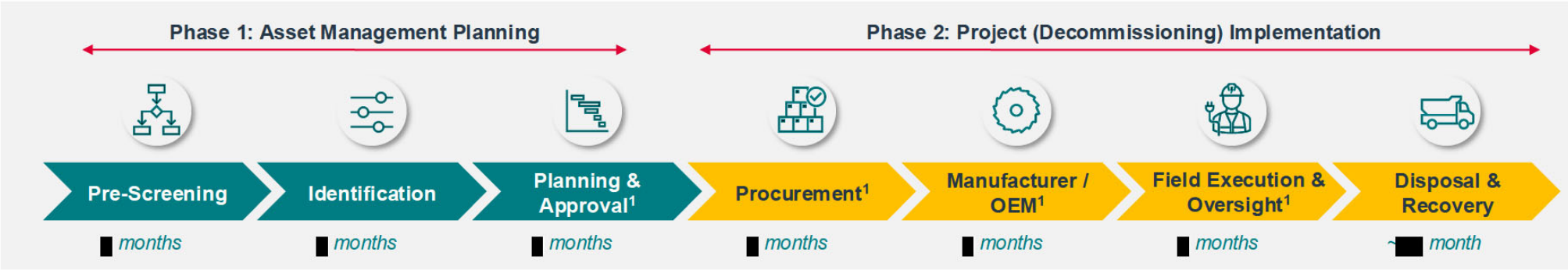
NGT Traditional Waste Management Approach

1. Project Contractors fill in waste reporting form
2. National Gas Project Manager ensures quarterly submissions are timely
3. Waste Data collected and added to internal system
4. Data is displayed in Power BI and refreshed monthly

Role of Construction Environmental Advisors	
Review and accept site waste management plans produced by the main works contractor	
Complete site inspections ensuring correct waste management procedures are followed and that the waste onsite is checked	
First Advisory point of contact for waste management onsite. Responsible for disseminating info / alerts on waste management	
Relevant point of contact for when a construction environmental and/or HSE incident occurs onsite.	

Traditional Decommissioning

NGT Current Decommissioning Workflow (Business-as-usual)



Key Activities

- Determination of asset redundancy
- Declaration of Asset Redundancy Status
- Potential redundant assets identified
- Confirmation of Asset Redundancy Status

- Optioneering (management options identification)
- Optioneering (selection of preferred options)
- Project Development (planning to isolate the asset from gas/electric suppy system, ensuring safety).

- Asset Use Study and establishment of Decom Plan
- Risk Assessment

- Contracting and supply chain. Identify options in the market to define contracting strategy.

- Build/ buy whole units/new parts to replace decommissioned assets if needed to keep facilities running

- De power and de install- disconnect ion and depressurisation
- Dismantling/ demolition
- Remediation
- New/refurbished equipment test and Future Grid- if being sold to others need to show transfer of ownership

- Duty of care in tracking of the waste to final disposal points
- Close out report
- Ongoing care and maintenance

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Note: 1) Regulatory approval required from planning & approval through to field execution & oversight

NGT Traditional Decommissioning

Risks and Inefficiencies in the Decommissioning Workflow

nefficiencies in the current decommissioning workflow…

Limited application of Circularity
- No current circularity tracker
- Reluctance to reuse assets in some instances
- Survey costs and operational assessments required for some assets have made application of circular economy principles uneconomic

Lack of Onsite Storage
- No physical space to store decommissioned material onsite
- Demolition and disposal have to go hand in hand

Data Management
- There is no single source of truth
- Records are sometime inaccurate due to being out of date (e.g., drawings w/ outdated valve locations) leading to higher decommissioning costs

Stakeholder Management
- Multiple approval processes with across different stakeholders with each element of work requiring discussions with an SME
- Difficult to speak to SME's as they are a limited resource

…exposing NGT to added risk

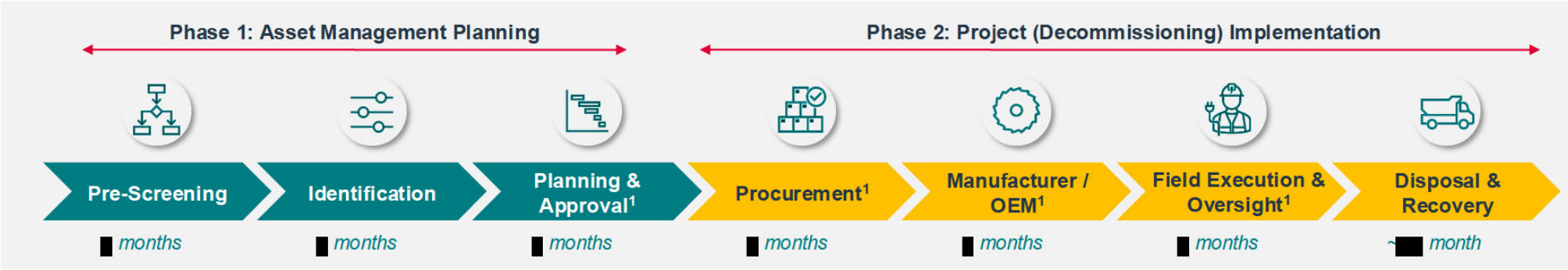
01 Insufficient Decommissioning Funding
Financial allowance may not be sufficient to deliver a successful decommissioning outcome

02 Operational Inefficiencies
Changes to current processes need additional time and resource to review e.g. HSE requirement to halt pipe throughs requires NGT to review process and manage deviation

03 Regulatory and Compliance Violations
Decommissioning may result in non compliance with legal obligations (e.g. data retention requirements and non compliance with env. regulations)

Digital Decommissioning

Digitalisation To Enhance The Decommissioning Workflow



Key Digital Enablers

- Work process automation (Electronic Workflow Engines)
- Smart Assessment & Planning
  - Chatbots, Lessons Learnt (LLM)
  - Data Driven Optioneering (Gen AI)
  - Risk Assessment & Mitigation (LLM)
  - Cost Forensics
  - Simulation Analysis (BIM, AR, VR)
- ERP
- People & Vehicle Tracking
  - KPI Visualization & Reporting
  - GHG & CO2 Emission Monitoring
  - Circularity Monitoring
  - Permits & Compliance Check
  - Lessons Learnt (LLM)

T.EN TECHNIP ENERGIES GENESIS

Note: 1) Regulatory approval required from planning & approval through to field execution & oversight

Digital Decommissioning

Digitalisation to Improve Asset Decommissioning

Benefits of Digitalisation	Key Digital Enablers	Description of Benefit
Lower Decommissioning Costs 	**Smart Assessment and Planning**	**Enhanced Cost Benefit Analysis- Providing Insights during pre screening and planning phases.** - Digital enablers such as IoT sensors and 3D scanners can be used to gather comprehensive asset data (including its condition, structural integrity etc) which will feed into a CBA. This data from various sources can be integrated into a centralised platform to ensure that all relevant information is included in the CBA. - Digital Twin technology can be used to enable more accurate cost estimation- as a virtual replica of the asset, a digital twin can simulate the decommissioning process to estimate costs (including labour and equipment) more accurately. This can enable a more optimised planning portfolio outcome that can be based on both past and current data. **Timely Identification of Risks** - Potential risks such as structural instability, environmental hazards or regulatory non-compliance can be identified early. This can reduce the likelihood of costly fines, delays or accidents.
	Automation of work processes by rule-based workflow engine	**Improved Project Planning and Scheduling** - Workflow automation tools can be used to create and manage decommissioning schedules more efficiently. This can ensure tasks are completed in the correct sequence and on time. Estimates from the cost benefit analysis done in WP3 show that having a rules based automated work process could lower planning costs by approximately 33%.
	Simulation & Analysis (BIM, AR, VR)	**Enhances What If Analysis** - Simulations can help in "what-if" analysis, arriving at different viable options to execute a job. This can play an important role in planning, scheduling and execution of a job.
	KPIs Visualisation, Reporting and Ad hoc Dashboards	**Real Time Visibility** - This can provide real time updates on the status of any tasks and resources across different work fronts which could enhance productivity. Such visibility is important for simultaneous operations where multiple activities occur at the same time. - As seen in the case of the MODS Connect Software identified in the benchmarking analysis in WP1- the MODS connect feature enables visible SIMOPS for integrated work front management which could enhance productivity by up to 70%.

Digital Decommissioning

Digitalisation to Improve Asset Decommissioning

Benefits of Digitalisation	Key Digital Enablers	Description of Benefit
Faster Decommissioning Time 	Easier and quicker access to information (Data Enriched Visualization).	**Enhanced Planning** - Digital Twin technology streamlines decommissioning by simulating scenarios to identify the most efficient approach, reducing trial and error. - In the Okarshamn Nuclear Decommissioning, it cut commissioning time by 80% and project development time by 30%. Accurate documentation further boosts efficiency by ensuring quick access to critical data throughout all phases. - Having access to correct documentation is vital not only for enhanced planning but throughout all the decommissioning phases. This helps reduce the time that the workforce spends daily to access the right data at the right time. **Enhancing Stakeholder Collaboration** - Because they can provide a visual representation of the decommissioning process, simulations can facilitate an improved flow of information between teams and contractors reducing any potential misalignment and potential reworks. - Estimates from the cost benefit analysis done in WP3 show that Digital documentation could enable like for like procurement which could lead to cost savings of 10%. In addition, Data Enriched Visualisation (cloudscan and asset level data of sites) could lead to an additional 10% cost savings.
Enhance traceability of assets 	People and Vehicle Tracking	**Real Time Tracking Location** - GPS technology and RFID technology can be installed in vehicles to provide real time location data which would enable accurate tracking of their movements. This can lead to improved decision making because it can be used to recommend the most efficient route for vehicles, reducing fuel consumption and travelling time. - Workers can also use wearable devices such as edge devices (smart badges) which have GPS technology to track their location. Construction industry case studies indicate that asset tracking systems can free up to 40% of a company's time otherwise spent looking for a missing asset and can also reduce safety risks by 30%.
Reduced Environmental Footprint 	GHG and CO_2 Emission Monitoring	**Real Time Emission Tracking** - Continuous monitoring via IoT sensors and monitoring sensors can provide real time data on GHG and CO_2 emissions during the decommissioning workflow. This monitoring can help to identify emission "hotspots" and any necessary corrective actions can be taken. Real time tracking can also ensure emissions data is readily available for stakeholders and regulators which can help to facilitate compliance.
	Circularity Monitoring	**Material Inventory and Tracking** - Digital Twin Technology can be used to provide a detailed inventory of all materials, components and equipment which could include information about their condition and potential for reuse or recycling **Waste Minimization** - Predictive analytics can be used to predict the amount and type of waste generated during decommissioning which would enable proactive planning for recycling, reuse or repurposing

Source: Company Websites, Company Annual Report, Company Press Release

Summary of WP4

Advantages of Digital Asset Decommissioning over Traditional Asset Decommissioning

Traditional Decommissioning Issues
Decommissioning is a complex multi-tiered process with interdependent sub-processes where delays in one area can cascade into others, impacting overall time and budget. Key challenges include

i. **Interdependency of Processes**: Delays in one sub process can disrupt subsequent tasks, leading to increased costs and extended project timelines
ii. **Legislative Compliance**: Monitoring and adhering to all legal requirements is critical, as any oversight could result in severe financial, legal or reputational consequences
iii. **Environmental and Waste Management**: Managing environmental risks, waste disposal and recycling remains logistically challenging, especially when these activities are carried out in isolation
iv. **Circular Economy Opportunities**: Embracing circular economy principles, such as reusing assets as strategic spares could unlock significant value and sustainability benefits.

A Digital Solution
Using a digital platform such as the proposed **One Decommissioning Tool** can address some of these challenges ensuring the necessary cost effectiveness, efficiency and enhanced traceability of assets while supporting sustainability goals.

i. The proposed One Decommissioning Tool combines smart assessment and planning, automated workflows, advanced simulations and intuitive KPI visualization to streamline processes and **drive down decommissioning costs efficiently.**
ii. The platform also has the ability to provide **seamless and instant access to critical information**, empowering faster decision making and **significantly accelerating the decommissioning process.**
iii. The platform can **enhance asset traceability** with advanced real time tracking of people and vehicles, ensuring complete visibility and control at every step of the process
iv. Lastly, the proposed One Decommissioning Tool can **drive sustainability forward and reduce environmental footprint** through advanced GHG and CO2 emissions monitoring, paired with circularity tracking for a greener future.