# AI Strategy for Sellafield Ltd

*"NDA Operating Company experiences on the road to digital nirvana"*
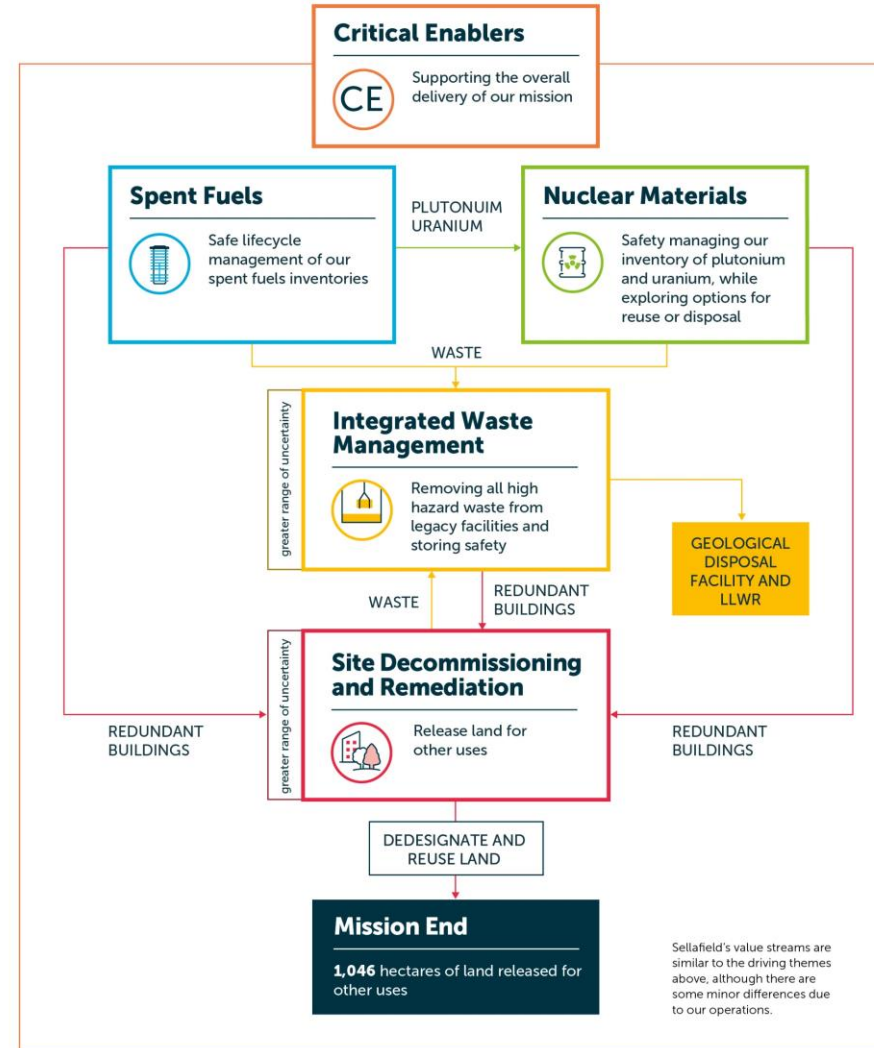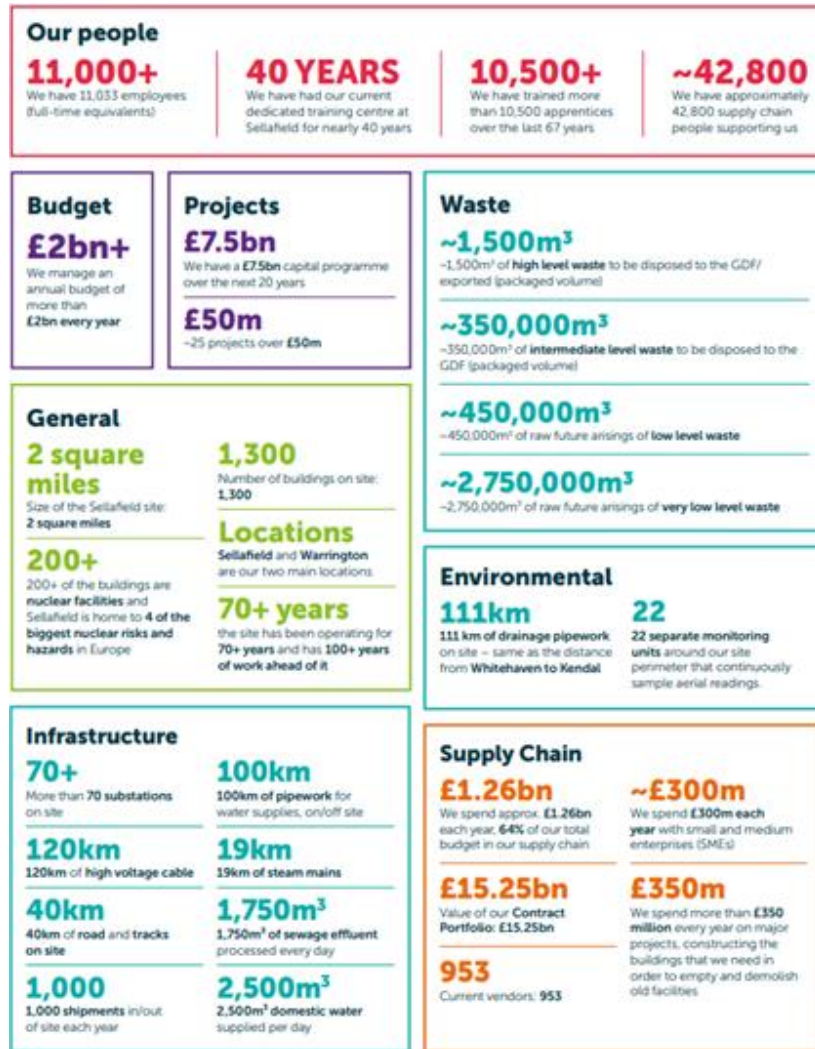
**Cross Industry Learning, Aberdeen**

**11th October 2022**

Dr Melissa Willis
melissa.willis@sellafieldsites.com
robotics@sellafieldsites.com

**Sellafield Ltd**

ROBOTICS & ARTIFICIAL INTELLIGENCE INTEGRATED RESEARCH TEAM
Delivering Change Through the Use of Robotic Solutions
#RoBAUtics – Making Robots Business as Usual

Sellafield Ltd

ROBOTICS & ARTIFICIAL INTELLIGENCE INTEGRATED RESEARCH TEAM
Delivering Change Through the Use of Robotic Solutions
#RoBAUtics – Making Robots Business as Usual

# The Sellafield Ltd Enterprise Strategy

## Our people

**11,000+**
We have 11,033 employees (full-time equivalents)

**40 YEARS**
We have had our current dedicated training centre at Sellafield for nearly 40 years

**10,500+**
We have trained more than 10,500 apprentices over the last 67 years

**~42,800**
We have approximately 42,800 supply chain people supporting us

## Budget

**£2bn+**
We manage an annual budget of more than £2bn every year

## Projects

**£7.5bn**
We have a £7.5bn capital programme over the next 20 years

**£50m**
~25 projects over £50m

## Waste

**~1,500m³**
~1,500m³ of high level waste to be disposed to the GDF/exported (packaged volume)

**~350,000m³**
~350,000m³ of intermediate level waste to be disposed to the GDF (packaged volume)

**~450,000m³**
~450,000m³ of raw future arisings of low level waste

**~2,750,000m³**
~2,750,000m³ of raw future arisings of very low level waste

## General

**2 square miles**
Size of the Sellafield site: 2 square miles

**200+**
200+ of the buildings are nuclear facilities and Sellafield is home to 4 of the biggest nuclear risks and hazards in Europe

**1,300**
Number of buildings on site: 1,300

**Locations**
Sellafield and Warrington are our two main locations.

**70+ years**
the site has been operating for 70+ years and has 100+ years of work ahead of it

## Environmental

**111km**
111 km of drainage pipework on site – same as the distance from Whitehaven to Kendal

**22**
22 separate monitoring units around our site perimeter that continuously sample aerial readings.

## Infrastructure

**70+**
More than 70 substations on site

**100km**
100km of pipework for water supplies, on/off site

**120km**
120km of high voltage cable

**19km**
19km of steam mains

**40km**
40km of road and tracks on site

**1,750m³**
1,750m³ of sewage effluent processed every day

**1,000**
1,000 shipments in/out of site each year

**2,500m³**
2,500m³ domestic water supplied per day

## Supply Chain

**£1.26bn**
We spend approx. £1.26bn each year, 64% of our total budget in our supply chain

**~£300m**
We spend £300m each year with small and medium enterprises (SMEs)

**£15.25bn**
Value of our Contract Portfolio: £15.25bn

**£350m**
We spend more than £350 million every year on major projects, constructing the buildings that we need in order to empty and demolish old facilities

**953**
Current vendors: 953

## Critical Enablers

**CE**
Supporting the overall delivery of our mission

## Spent Fuels
Safe lifecycle management of our spent fuels inventories

PLUTONIUM URANIUM →

## Nuclear Materials
Safety managing our inventory of plutonium and uranium, while exploring options for reuse or disposal

WASTE

## Integrated Waste Management
Removing all high hazard waste from legacy facilities and storing safety

*greater range of uncertainty*

GEOLOGICAL DISPOSAL FACILITY AND LLWR

WASTE    REDUNDANT BUILDINGS

## Site Decommissioning and Remediation
Release land for other uses

*greater range of uncertainty*

REDUNDANT BUILDINGS    REDUNDANT BUILDINGS

DEDESIGNATE AND REUSE LAND

## Mission End
**1,046** hectares of land released for other uses

Sellafield's value streams are similar to the driving themes above, although there are some minor differences due to our operations.

### Sellafield Ltd

ROBOTICS & ARTIFICIAL INTELLIGENCE INTEGRATED RESEARCH TEAM
Delivering Change Through the Use of Robotic Solutions
#RoBAUtics – Making Robots Business as Usual

## Spent Fuels

Safe lifecycle management of our spent fuels inventories

- Thermal Oxide reprocessing is complete

- Magnox fuel reprocessing is complete

- From this point forward Sellafield will receive and store the UK's spent nuclear fuel for storage

- As commercial reprocessing comes to an end our focus is shifting to the accelerated clean-up of the site –working with our supply chain partners, academia and research institutes
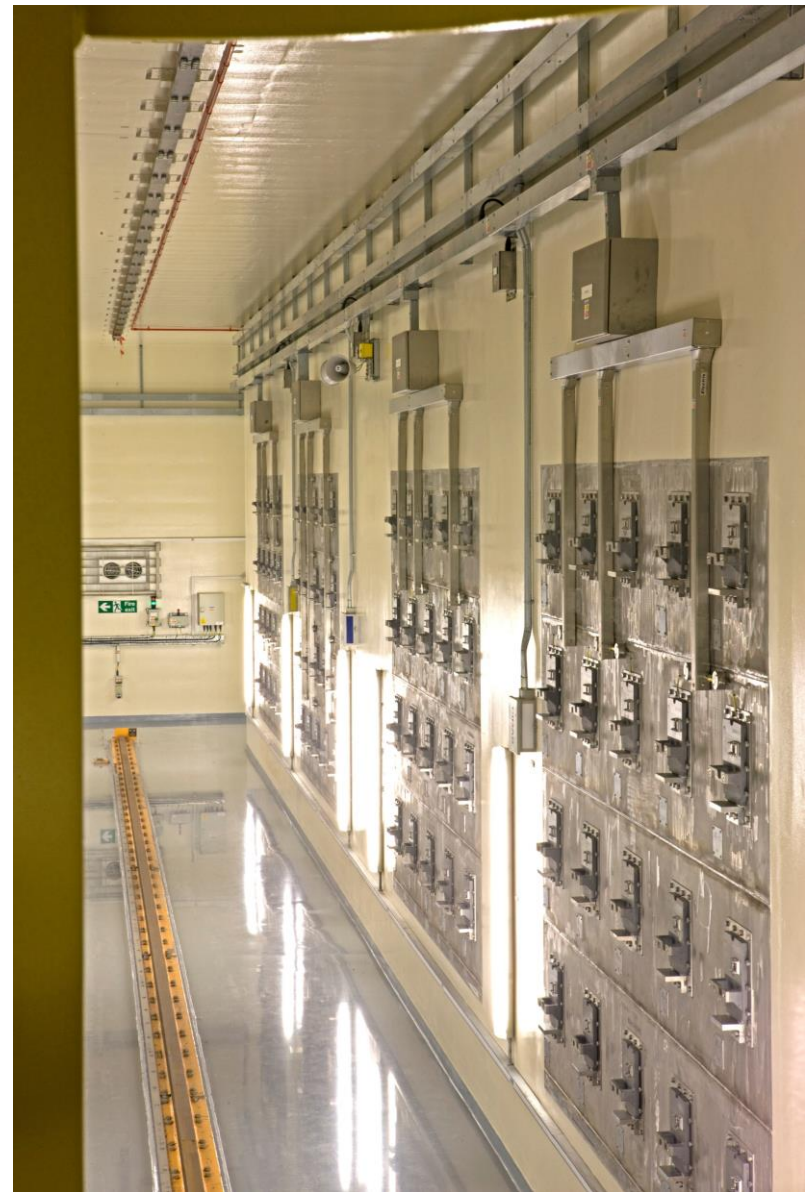
Sellafield Ltd

ROBOTICS & ARTIFICIAL INTELLIGENCE INTEGRATED RESEARCH TEAM
Delivering Change Through the Use of Robotic Solutions
#RoBAUtics – Making Robots Business as Usual

## Nuclear Materials

Safety managing our inventory of plutonium and uranium, while exploring options for reuse or disposal

- Reprocessing at Sellafield has produced many tonnes of uranium and plutonium

Key priorities:

- Manage the product safely for many decades

- Explore reuse or disposal options

Sellafield Ltd

ROBOTICS & ARTIFICIAL INTELLIGENCE INTEGRATED RESEARCH TEAM
Delivering Change Through the Use of Robotic Solutions
#RoBAUtics – Making Robots Business as Usual

# Integrated Waste Management

Removing all high hazard waste from legacy facilities and storing safety

During the 1950s through to 1980s we stored spent fuel and spent fuel cladding in ponds and silos. These facilities do not meet modern standards.

### Pile Fuel Storage Pond
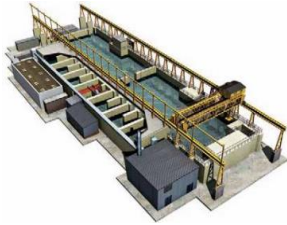


- Constructed 1948-1952 to store Windscale fuel for reprocessing. Waste consists of sludge, fuel, intermediate and low level waste.

### First Generation Magnox Storage Pond
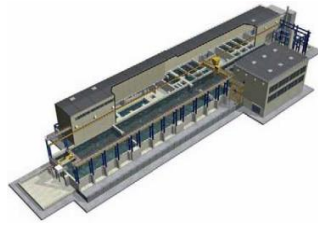


- Constructed in 1950s and 1960s to store Magnox fuel for reprocessing. Waste consists of sludge, fuel, intermediate and low level waste.

### Magnox Swarf Storage Silos
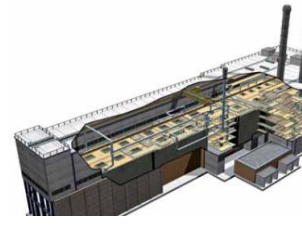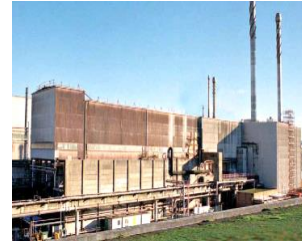


- Constructed 1960s-1980s to hold irradiated fuel canning waste. Received waste until 2000.

### Pile Fuel Cladding Silo
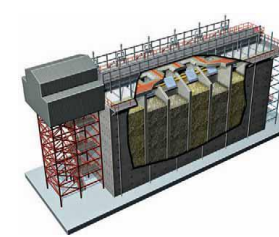


- Commissioned in 1952, 1st storage facility for intermediate level waste constructed at Sellafield. The silo was filled by 1964.

Sellafield Ltd

ROBOTICS & ARTIFICIAL INTELLIGENCE INTEGRATED RESEARCH TEAM
Delivering Change Through the Use of Robotic Solutions
#RoBAUtics – Making Robots Business as Usual

## Site Decommissioning and Remediation

Release land for other uses

*greater range of uncertainty*

Decommissioning is broken down to 2 elements: alpha and beta/gamma (based on the primary hazard)

### Current beta\gamma scope includes:

- Calder reactor complex (x4)
- Pile reactor complex (x2)
- Windscale Advanced Gas-cooled reactor complex
- First generation reprocessing and support facilities
- Active handling facilities
- Thorp is currently in the Post Operational Clean Out phase

**Future scope is much larger than today's scope**

Sellafield Ltd

ROBOTICS & ARTIFICIAL INTELLIGENCE INTEGRATED RESEARCH TEAM
Delivering Change Through the Use of Robotic Solutions
#RoBAUtics – Making Robots Business as Usual

# NDA Grand Challenges

| Challenge Theme | Interim innovation aims by 2025 | Grand challenges for technical innovation (our 2030 aspirations) |
|---|---|---|
| Reducing our waste and reshaping the waste hierarchy | 70% of all initial characterisation will be undertaken in situ, with results available within 24 hours, by 2025. | 50% of waste, produced from de-commissioning and clean-up, being recycled. |
| Intelligent Infrastructure | All external monitoring of buildings should be carried out remotely by 2025. | All new buildings to be self-monitoring and energy neutral by 2030 - with a 50% lifetime cost reduction. |
| Moving humans away from harm | Remote decommissioning of glove-boxes by 2025. | A 50% reduction in decommissioning activities carried out by humans in hazardous environments. |
| Digital delivery - enabling data driven decisions | Accurate and up to date 3D virtual models (such as digital twins) exist for all key NDA sites by 2025. | All data captured at source which is then used to drive decisions, planning and training. |

The NDA's 'Grand Challenges' for technical innovation - Cleaning up our nuclear past: faster, safer and sooner (blog.gov.uk)

Sellafield Ltd

ROBOTICS & ARTIFICIAL INTELLIGENCE INTEGRATED RESEARCH TEAM
Delivering Change Through the Use of Robotic Solutions
#RoBAUtics – Making Robots Business as Usual

# AI strategy

- Builds on previous work

- Development of an AI Strategy for SL

- In collaboration with Ada Mode

- 3 phases; discover, develop and deliver

- Strategy due in June and Roadmap in September

# Discover Phase

Discover

Understand value stream objectives, current technical maturity, existing AI and digital work, levels of AI engagement form people and ONR objectives
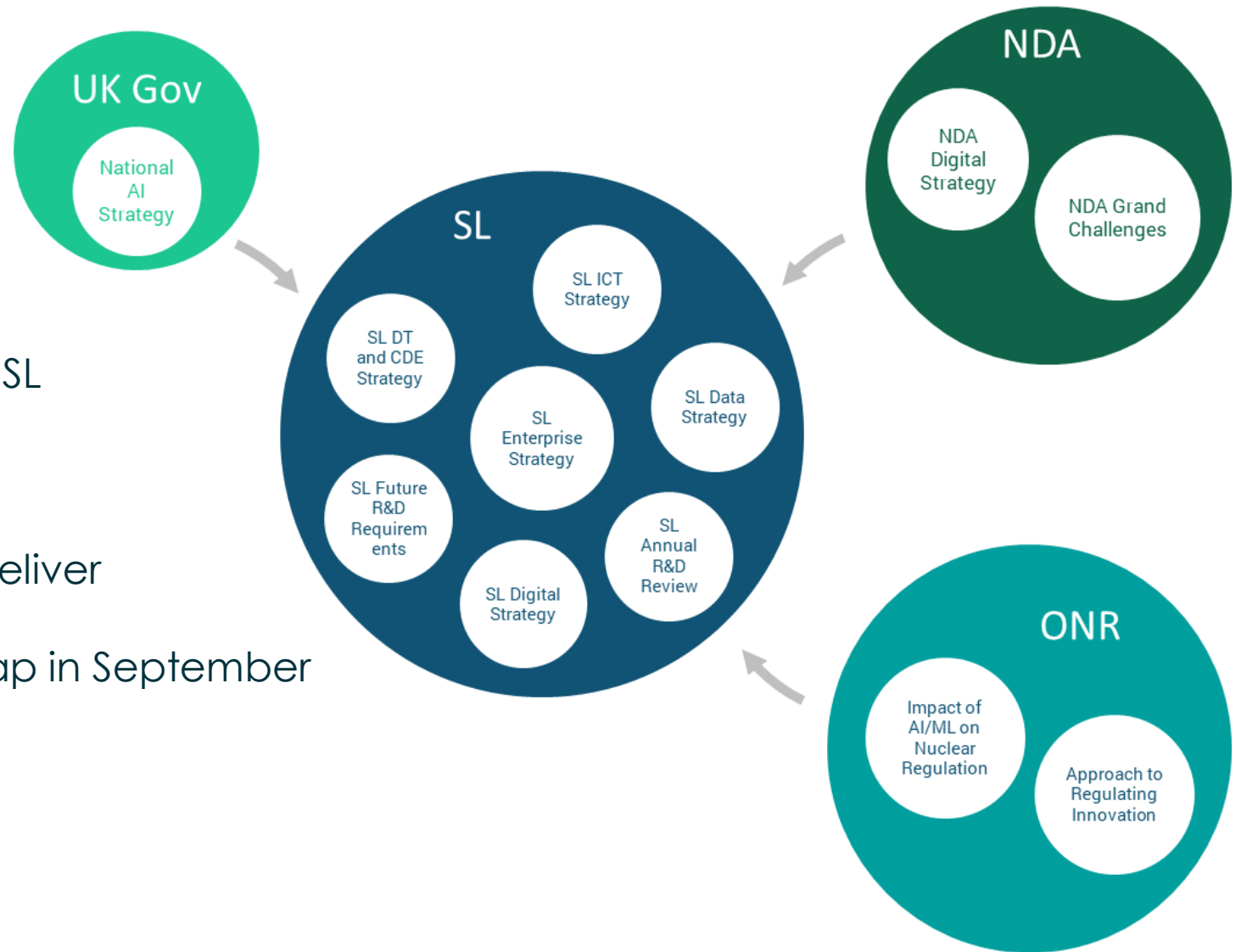
- Over 50 Stakeholder 1:1s conducted including SL, NDA and ONR

- Identification of at least 15 Spark and Excite Projects

- SL Site-Wide AI Survey

- Discover Phase Report Issued June 2022

**"** Reg & gov
There is clearly substantial benefit to be gained from AI/ML and that maintaining the status quo is not an option. However, bringing the ONR into this is key.

**"** Reg & gov
Circa 10 years ago there was a period of less general reliance on more innovative techniques. Lately the focus has shifted back toward 'tried and tested'. This needs to change to one of open collaboration.
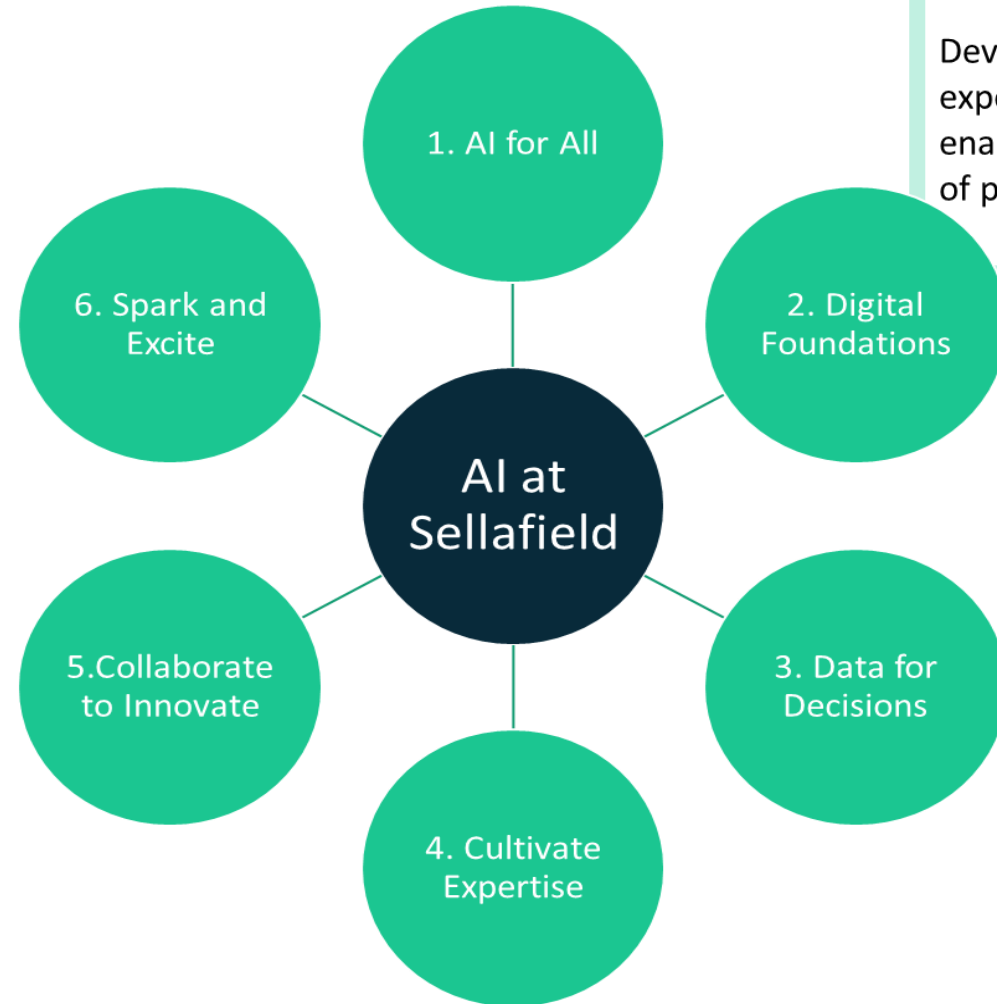
**"** Reg & gov
ONR are engaged from the start of a PMP, if sensitive. They are involved in all Cat As, some Cat Bs and get all PMPs sent to them every month. Level 4 provides foresight of upcoming projects with ONR.

Sellafield Ltd

ROBOTICS & ARTIFICIAL INTELLIGENCE INTEGRATED RESEARCH TEAM
Delivering Change Through the Use of Robotic Solutions
#RoBAUtics – Making Robots Business as Usual

# Develop Phase

- Draft Strategy Issued June 2022

- Centres around 6 key pillars

- Focuses on key enablers

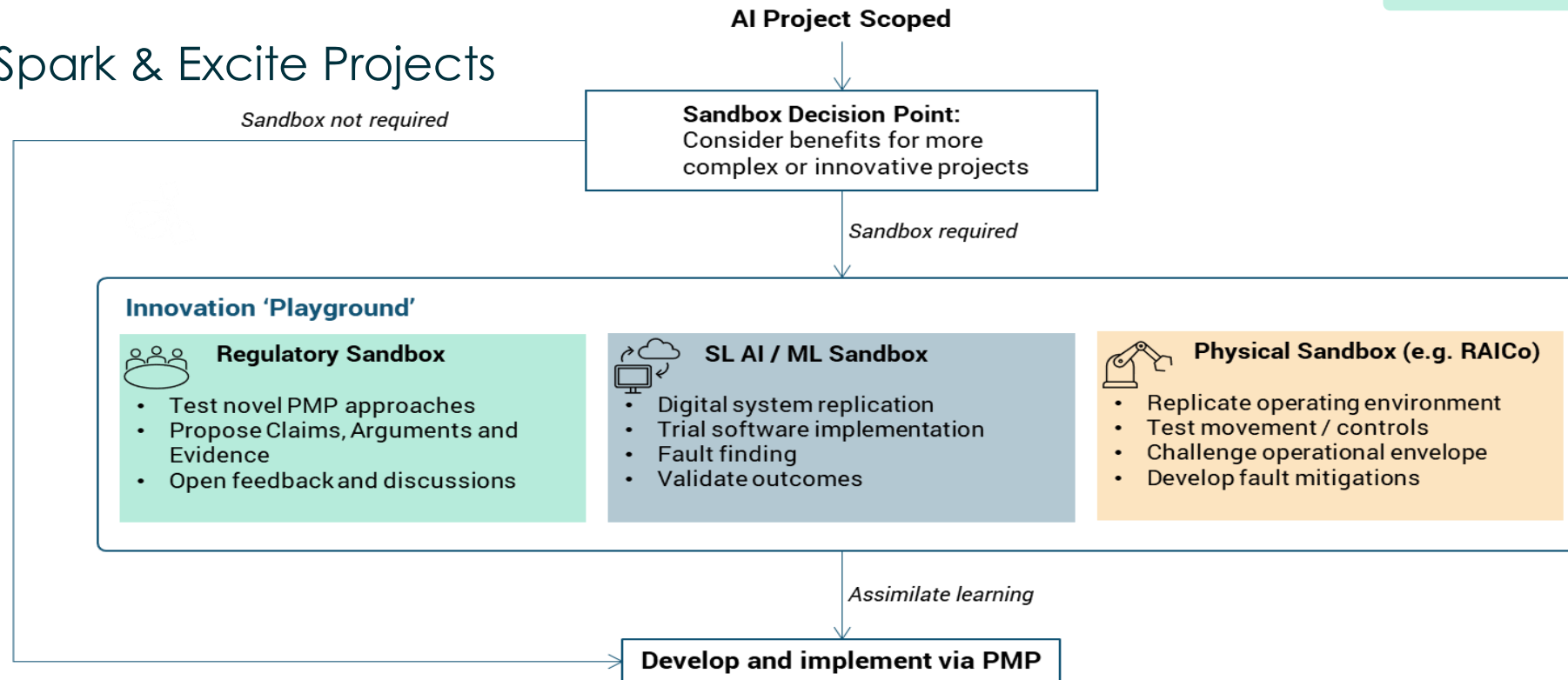- Makes recommendations for the future of AI at Sellafield

## Sellafield Ltd

ROBOTICS & ARTIFICIAL INTELLIGENCE INTEGRATED RESEARCH TEAM
Delivering Change Through the Use of Robotic Solutions
#RoBAUtics – Making Robots Business as Usual

# Deliver Phase

- Roadmap due in November

- Identify Spark & Excite Projects

**AI Project Scoped**

*Sandbox not required*

**Sandbox Decision Point:**
Consider benefits for more complex or innovative projects

*Sandbox required*

**Innovation 'Playground'**

| **Regulatory Sandbox** | **SL AI / ML Sandbox** | **Physical Sandbox (e.g. RAICo)** |
|---|---|---|
| • Test novel PMP approaches<br>• Propose Claims, Arguments and Evidence<br>• Open feedback and discussions | • Digital system replication<br>• Trial software implementation<br>• Fault finding<br>• Validate outcomes | • Replicate operating environment<br>• Test movement / controls<br>• Challenge operational envelope<br>• Develop fault mitigations |

*Assimilate learning*

**Develop and implement via PMP**

Sellafield Ltd

ROBOTICS & ARTIFICIAL INTELLIGENCE INTEGRATED RESEARCH TEAM
Delivering Change Through the Use of Robotic Solutions
#RoBAUtics – Making Robots Business as Usual

# Implementation

From our work so far the areas where AI can deliver the most benefit can be largely categorised into 3 areas:

- Computer Vision

- Natural Language Processessing (NLP)

- Time-Series Analysis

Technologies for AI are readily available but more research is required into:

- Implementation

- Assurance

- Explainability

- Ethics

Sellafield Ltd

ROBOTICS & ARTIFICIAL INTELLIGENCE INTEGRATED RESEARCH TEAM
Delivering Change Through the Use of Robotic Solutions
#RoBAUtics – Making Robots Business as Usual

# Thank You

**Sellafield Ltd**

ROBOTICS & ARTIFICIAL INTELLIGENCE INTEGRATED RESEARCH TEAM
Delivering Change Through the Use of Robotic Solutions
#RoBAUtics – Making Robots Business as Usual