AI for Net Zero

Assessing Readiness for AI

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Executive Summary

This guide seeks to inform organisations how they can use AI to transition to net zero at low cost. It provides a series of checklists to help organisations understand where they are on this journey. These checklists should be followed no matter which sector your organisation is in.

While the guide is applicable to any industry, four chosen "case study" sectors illustrate how this can be done at the end of the guide, including a summary of AI suppliers per sector:

- Electricity
- Agriculture
- Foundation industries
- Transport

To support companies in assessing their current level of AI readiness and to map out areas for further investment we provide an **AI Readiness Self-Assessment tool**. This highlights five key themes that companies can advance to become AI ready: AI opportunity identification, human capacity, data for AI, digital infrastructure and responsible AI governance. These key aspects for AI readiness were identified by industry and AI experts. We summarise the key recommendations below, however a full self assessment is recommended to identify all AI readiness requirements.

- **Opportunity identification**: Organisations should develop the capacity to assess business challenges to determine whether AI can support delivery.

- **Human capacity:** Effective management of AI requires a deep and broad understanding of the technology. Managers with business needs that AI can help address should receive training in understanding, procuring and managing AI solutions. For in house solutions, data scientists recruited to a specific sector should be given training to support a thorough understanding of the sectors. For external providers companies should ensure their contracting and procurement processes allow ongoing iteration and learning.

- **Data:** The quality of AI solutions is highly dependent on the quantity and quality of the data used. To effectively apply AI, companies will need to invest in AI-grade data collection, management and sharing systems. For any specific AI project, companies will need to identify the data required for the project, review existing internal data, identify data capture needs, and invest in data cleaning and labelling to ensure data is AI-ready.

- **Digital Infrastructure**: Powerful AI algorithms require enhanced compute and data storage infrastructure. An important choice is between hosting infrastructure through on-premises hardware or in the cloud. Companies should assess and procure the best solution for compute and data storage for initial pilot projects, and subsequently assess and procure the best solution for compute and data storage for wider organisational AI roll out.

- **AI Governance:** AI is a powerful tool with many benefits but also some risks. We recommend companies establish principles and processes to manage AI-specific risks.

Develop Projects: AI readiness can be developed concurrently with early AI projects. Effective use of AI requires problems to be clearly defined. AI project teams will need to determine what the objective or objectives are, define completely the possible actions the AI can take, and identify any system constraints that will need to be imposed to guarantee safety and security. This will require thorough consideration of factors like safety, efficiency, ethics in accordance with responsible AI governance principles, and cost.

1. Introduction

The objective of this booklet is to support companies to understand the prerequisites needed to deploy AI in support of a low cost transition to net zero.

AI can accelerate the transition to net zero. In this booklet, we refer to AI as a machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations, or decisions influencing real or virtual environments[1]. AI is becoming increasingly useful as it can help identify subtle patterns in very large amounts of data allowing it to optimise and automate complex systems. However, it also has weaknesses: its outputs can be strongly influenced by poor or biased data; it is not always clear how it arrives at its conclusions; and any answers it offers are only as good as the questions it is asked.

We are seeking to offer advice that is relevant across a wide range of countries, where systems in industries are at different stages in their digitalisation. As such we recognise some of the proposed actions in this booklet will be new for some organisations.

AI is a powerful tool. As a result it is important that it is applied in a **responsible** way. The OECD has set out a series of principles[2] regarding the responsible application of AI. Organisations considering the implementation of AI solutions should familiarise themselves with these principles. AI governance can connect to existing IT governance structures, but the complexity and power of AI means it will often require additional organisational skills, guide-rails and policies, especially in the early stages of adoption.

Some sectors' systems are critical infrastructure, so ensuring good governance of AI solutions in this sector is of the highest importance. AI governance can connect into existing IT governance structures, but the complexity and power of AI means it will often require additional organisational skills, guide-rails and policies, especially in the early stages of adoption. This booklet offers recommendations for how companies can develop Responsible AI Governance structures and processes.

A company's progress on each of the 5 AI Readiness criteria established in this booklet can be given a quantitative score based on score sheets located at the end of each section. For example, a company's progress in developing human capacity can be assigned a score between one and five based on various sub-criteria. Based on the scores for each of the five major AI readiness criteria, the company will receive a qualitative level of AI readiness, ranging from 'AI Unaware' to 'AI

[1] OECD definition
[2] OECD AI Principles (2019)

Practitioner'. The company must reach a certain score in the five criteria to achieve a qualitative level like 'AI Aware'. This reflects the fact that AI readiness requires effort across all criteria – for example strong progress to establish digital infrastructure but limited progress on opportunity identification will not be sufficient to build AI readiness. Companies must compute their score for each criterion at the bottom of its corresponding section, and can then use those to assess their readiness against the AI Readiness Assessment below:

Table 1: Summary table for AI Readiness Assessment

AI Readiness Criteria	AI Unaware	AI Aware	AI Planner	AI Ready	AI Practitioner
Opportunity Identification	1	2	3	4	5
Human Capacity: Internal and External	1	2	3	4	5
Data	1	2	3	4	5
Infrastructure	1	2	3	4	5
Responsible AI Governance	1	2	3	4	5

2. Opportunity identification

There are a range of opportunities to apply AI to help address key challenges that the sectors will experience as part of the transition to net zero. Beyond these sectoral opportunities, each individual organisation could usefully consider how AI could support their business needs as they arise.

Some organisations will seek to assess which tools and technologies, including AI, are best placed to support individual business challenges as they arise. Some organisations may seek to actively identify where data science and AI can support their business objectives. Others may use a combination of these two approaches.

For organisations that seek to assess which tools and technologies, including AI, are best placed to support individual business challenges as they arise, business challenges can be assessed against common AI problem types to determine whether an AI system may be able to support the delivery of a particular business objective. These common problem types include:

- *Classification and insight:* Based on training data, AI can classify input data as belonging to one of a set of categories supporting greater insight. For example an AI image processing algorithm might be able to identify and classify transmission lines on satellite images.

- *Prediction and forecasting*: Based on training data, an AI algorithm can estimate the next value or values in a sequence. This type of use-case can go beyond forecasting future trends in time-series data, and can be applied to a wide range of data types to support pattern recognition and sequence prediction.

- *System optimisation*: AI can support the operational optimisation of well-monitored systems by recommending a set of actions that optimise outcomes for a specific objective based on feedback from system monitoring.

- *Anomaly detection*: AI can help determine whether specific inputs are out of the ordinary when provided with historic training data.

- *Data generation*: These problems require a system to generate appropriately novel data based on training data. For instance, historic data might be used to generate new scenarios for how the system could operate.

In addition to considering whether a challenge fits one of these common problem types, there will be a need to assess whether a range of other prerequisites are in place to enable AI to be deployed as a potential solution. These include an assessment of the quantity and quality of data available, the digital controls available, the clarity of the objectives of the challenge, how quickly and easily the AI system can receive digital feedback on its performance, how clearly bounded the problem is, and whether other, perhaps simpler tools would be better placed to address the challenge if such tools exist in the market.

For organisations actively seeking to identify where AI can support net zero challenges across the company, there are a range of additional criteria to consider. These include:

- The **emission reduction potential** an AI solution could offer. This could be either a direct corporate emission reduction potential or a solution that enables a systemic reduction in emissions.
- **Connection to the company's core business and KPIs**: AI for net zero projects should be in alignment with key business objectives and should support specific company KPIs that they seek to deliver against.
- **Risk**: initial AI projects should build organisational trust for the technology by initially avoiding business or safety critical projects and demonstrating usefulness through discrete projects. AI risks should be identified and addressed as part of project and programme risk management. There are various frameworks that have been developed to assess AI related risk, including by the OECD, NIST, and EU.
- **Innovation priorities:** Companies should consider how AI for net zero projects can support wider innovation priorities required to deliver business improvement and development.
- **Availability of third-party solutions:** to help prioritise AI for net zero projects, companies should assess where there are existing AI solutions in the market that they can draw on.

Regardless of whether organisations take a business-objective led approach or a technology led approach, there is a benefit to developing a systematic method for assessing business challenges to determine whether AI can support delivery.

Table 2: AI Readiness Assessment: Opportunity identification

These numerical scores represent an organisation's stage of opportunity identification. An organisation's score corresponds to the box where they have satisfied all requirements for that score and the requirements for lower scores.	
AI Unaware (1)	• AI is not assessed as a possible tool for addressing business needs
AI Aware (2)	• The organisation has individuals who are aware of a few AI techniques but do not assess business objectives to see whether AI is a suitable tool to support delivery.
AI Planner (3)	• The organisation has individuals who can assess a small number (25% or less) of business challenges against a limited number of AI techniques to determine its potential application
AI Ready (4)	• The organisation has individuals who can assess at least 50% of business challenges against a wide range of potential AI techniques to determine its potential application
AI Practitioner (5)	• The organisation has enough individuals to assess all business challenges as they arise against a full range of potential AI techniques to determine its potential for application

3. Human capacity: internal and external

Building AI understanding of executives and managers

Different levels of knowledge and understanding exist across the sectors regarding the potential that AI offers to support the transition to net zero. As a result there is a need to support skilling-up to help executives and managers understand the potential AI offers to support the transition to net zero, to identify the opportunities for where it can be deployed, and the risk of doing so, based on an understanding of its strengths and weaknesses. Such skilling-up is essential to facilitating the integration of AI within sector planning and operation.

Priorities:

- **Offer AI training for key managers**
- **Invite AI researchers and innovators to discuss opportunities in their sector to apply AI for net zero challenges**

Developing internal data science and data engineering capacity

Many organisations have been developing their own digital teams. Companies can build the capacity of these teams to both deliver specific AI for net zero projects themselves or to work with third party AI providers to integrate their solutions into the organisations' systems. There are many companies that offer software solutions for pre-existing system infrastructure (see Annex A). Organisations may choose to develop their own data science capacity where there is a strategic imperative to develop a specific AI project internally – for example, if it could become an important business opportunity, or if there is no existing third-party solution available and the skills required are not overly specialised in nature.

When hiring data scientists, companies would ideally seek data scientists who have a combination of deep technical expertise in AI, and data, and software engineering, *and* a deep understanding of the specific sector. However, there are currently few data scientists that have this combination. As a result, organisations seeking to hire data scientists to support their net zero objectives may need to hire data scientists with limited sector-specific knowledge. Companies will then need to train these generalised data scientists in the operation of their specific digital systems and data processes, as well as the operation of the sector more broadly. For example, a data engineer hired by a wind farm to optimise their generation will need to understand how wind farms operate, the specifics of this wind farm, and the way the electricity generated is traded on electricity markets.

When developing internal AI capacity, companies should:

- **Hire technical talent (data scientists, data engineers, ML engineers, DevOps etc) to develop strategically important projects.** Assess project opportunities as to whether they are strategically important for the organisation and whether there are existing third-party providers to determine whether to build internal capacity or bring in third party solution providers.

- **Encourage newly hired data scientists to enrol on training courses that cover the wider functioning of the sector of application**, and of the digital and data environments used. This may require the development of new training courses.

- **Establish academic and research partnerships to focus university data science research** on sector specific data challenges. This may involve establishing or funding Master's, PhDs, and Professorships, to construct a talent pipeline and ensure new research is targeted and applicable.

Working with third-party AI solution providers

Companies may choose to work with third party AI service providers:

- Where there is no strategic need to develop a data science capacity internally.
- If they might struggle to hire sufficiently skilled data scientists.
- Where there is an existing AI service that they can draw on.

Performance benchmarking and due diligence is always required when procuring an IT service, however there are some issues that require specific consideration when working with third-party AI providers:

When seeking external AI capacity, companies should:

- **Conduct assessment of third-party companies' AI talent. Internal digital teams should** consider bringing in an external advisor to assess the AI technical quality of the team and solution offered.
- **Assess how easily third-party AI software can be integrated into company ICT infrastructure.** Companies should consider establishing ICT architecture standards that will allow third parties to connect their solutions quickly and easily.
- **Conduct an AI governance and risk assessment of the third party provider**. Organisations offering AI solutions should have best-practice

AI governance structures and risk management processes in place. There are a range of AI-specific risks that may need to be assessed, including functional, security, privacy and compliance risks. This may require bringing in additional technical expertise to advise as to whether the solution offered is sufficiently effective, secure and data is managed appropriately.

- **Contract and procure the solution in such a way as to allow for ongoing iteration and learning.** Successful AI projects require frequent updates to optimise performance. Structuring procurement contracts to allow for this is important to maximise the potential that AI systems can offer.
- **Assess risks and opportunities associated with the size of the company delivering the AI service**. This will range from large multinationals to small startups. There are pros and cons of working with either end of this spectrum. Working with large companies may offer security of continuity but may be more expensive and / or increase the risk of reliance if working on a number of projects. Working with SMEs may allow for better terms, and more nimble processes, but may come with continuity risks.

For more detail on AI procurement, the World Economic Forum published AI procurement guidance for the Private Sector in 2023.[3] This built on their previous work aimed at governments to use in their own public procurement initiatives, which was published in 2020.[4]

[3] WEF: Guidelines for Procurement of AI Solutions by the Private Sector (2023)
[4] WEF: AI Procurement in a Box (2020)

Table 3: AI Readiness Assessment - Human Capacity

These numerical scores represent an organisation's stage of opportunity identification. An organisation's score corresponds to the box where they have satisfied all requirements for that score and the requirements for lower scores.	
AI Unaware (1)	● No progress made towards developing internal or external human capacity for AI.
AI Aware (2)	● Organisation is aware of the need to develop AI capacity but has not determined the specific skills they require
AI Planner (3)	● Organisation has determined the specific AI / data science skills they require and initiated a hiring process; OR ● Organisation has identified a range of third party solution providers that are relevant to their organisation.
AI Ready (4)	● Organisation has hired at least one machine learning engineer or data scientist. OR ● Organisation has procured data science expertise from external company.
AI Practitioner (5)	● Organisation has sought to upskill senior management about the potential for AI to support organisational objectives. ● Organisation has sought to upskill any machine learning engineers or data scientists with energy system training.

4. Data

AI depends on large volumes of data from which it can learn about its environment, the variables that might influence performance against the project objective, and their relationship to each other. Data inputs must be determined carefully. In some instances, this data might be historic data (e.g. time series on electricity market prices or renewable generation). In others, the data might be captured by sensors during the process of the AI making changes in the action space, which can help the AI to learn and improve on a rolling basis. There are many data capture hardware solutions that provide insight into system processes and are important to implementing effective AI solutions. Companies should seek to balance primary and secondary data. For instance, using internal instead of external data on wind farm generation rates can improve AI training, but may not always be worth the extra cost of internal data capture.

Data for AI needs to be considered within a wider data governance framework that seeks to ensure that organisational data is managed responsibly to manage risks related to data quality, privacy, intellectual property, security, bias, diversity and traceability. The need for increasingly robust data governance measures increases with the potential impact an activity may have on others, including on society and economy at large.

Companies should work out data sharing arrangements or seek to join pre-existing ones, to access data that can boost the development and operation of AI solutions. For example, generation asset owners may find it useful to share data with other owners of the same type of asset, to optimise forecasts and bids into balancing markets.

Identify required data

The first step is to identify data that might be relevant for a particular project. In seeking to identify data that is relevant for a project it is worth considering the following data:

- Measure key variables in the system or process AI will be applied to.
- Measure variables that either impact or are impacted by that system or process.
- Where relevant, measure all variables that relate to ensuring that the system operates within safety and stability constraints.

- Where relevant, identify and measure all controls within the process, including the On/Off status of relevant equipment and their set points.

- Where relevant, measure conditions of equipment.

- Measure all attributes that contribute to quality of process output.

Review existing internal data

After having assessed the data requirements for a particular project the team should then assess what data exists and its quality *(resolution, robustness, fitness for purpose, specificity, representativeness, inclusiveness, diversity, traceability).* Relevant data may be held within the company or may need to be sought externally with additional constraints in terms of quality control, compliance/liability, and desired traceability, among others.

Identify data capture needs

After having assessed a projects' data needs and the relevant existing data it is probable that gaps in data availability will be identified. This may involve either procuring data externally, transferring existing data to a machine-readable format, or installing sensors to capture new data streams. When assessing existing and new data capture it is important to consider the following points:

- Is your data being trended and archived? Where and how is it trended and archived?
- Do you have the sensor data and level of quality required to compute the objective function?
- Do you have the sensor data necessary and required level of quality to verify that the actions determined by the control system are implemented?
- Do you have the sensor data necessary and level of quality to measure the impact of your actions upon the process in question?
- Do you have the sensor data and level of quality necessary to measure any external elements that influence the system?
- What is the quality of the data?
    - Is your data accurate? Sensors drift over time, and sometimes what the sensor measures does not match the description.
    - How much of the sensor data is missing? Do you track what is missing? If not, decide how you will.
- What is the cadence that you will capture data and monitor its quality? You should have a timestamp for each data point.
    - The more often you capture the state of the system or process, the easier it will be to identify the effects of changes made.

Systems are dynamic, so changes to one area may have unexpected ripple effects elsewhere in the system.

- What is the latency of the data?
    - This the delay between when something occurs in the actual system and when the data about that occurrence is actually available.
    - You don't want to make decisions based on old data!
- How much data do you have?
    - It's important to know not only how far back the data goes, but also any changes that happened to the data collection process / sensor space / action space / control policy that happened since data started being archived. For instance, if you only started calibrating your sensors at a given point in time, it is important to note that.
- Do you know what the sensors are measuring?
    - It's often necessary to understand what the data represents to troubleshoot your system.
    - Furthermore, 90% of the total data is unused due to bad quality or because the data does not add additional value for AI training. You need to be able to decide what data to include and what data to omit.

Seek to maximise data variability:

One of the issues for an optimization algorithm that learns from past experiences is lack of variability in the data and key variables. A process may have a few years of good quality data but having data without much variability in setpoints could still be an issue. This results in a learning algorithm that learns a good approach only for a limited set of scenarios. Exploration is thus necessary to increase the variability of the control setpoints.

It will be useful to establish data sharing partnerships with similar companies whose data is on similar processes but adds to the variability of the AI input data. For example, solar generators will benefit from access to generation data from different areas of the country and world, as this will increase their AI's predictive power.

- Make exploring the action space ("exploration") a priority.
    - It can be problematic if the value for the actions is mostly constant in the historical data in many systems.
- If working on critical infrastructure, identify a Controls Engineer to lead minimal **safe exploration** (once the setpoints and constraints are identified) with the objective to
    - Increase variance with respect to individual setpoints within the allowed range

    - Increase variance with respect to hard system level constraints

Conduct data cleaning and labelling:

AI may depend on data, but success depends on *good* data that is accurate, consistent, and has had any biases addressed. The process of cleaning data involves identifying and fixing bad data. It tends to require strong domain expertise and so is another area where partnership between AI experts and domain experts is vital. The process of data cleaning can involve:

- Performing sensor calibrations where relevant[5].
- Ensuring consistency within and across historical datasets.
- Identifying anomalous data (e.g. outlier data that is clearly outside of the range), missing data, and stale/stuck data, and label it appropriately.
- Note that sometimes sensor data goes stale for long periods of time.

Perform data maintenance

As the success of AI projects depends on good data, it is important to set-up routine, periodic checks to ensure ongoing data cleanliness. These require domain expertise. Data maintenance should ensure that:

- Trend names matches the sensor which it is associated with;
- Values of the trend follow the same units;
- Trend is not stuck at a static value while the sensor is properly functioning;
- Processes collecting data do not change the time range within which they capture data.
    - For example, totalisation trend does not change its periodicity from being week totalizer to daily/monthly totaliser.
- Spot checking and re-calibration of any anomalous sensor

Throughout the process of identifying and collating data required for a project, it is critical that data governance is considered to ensure data risks are responsibly managed to address data quality, privacy, intellectual property, security, bias, diversity and traceability concerns.

Data assessment process that companies should consider alongside existing data management practices:

- Identify required data
- Review existing internal data
- Identify data capture needs

[5] One of the common issues is that sensors drift out of calibration. Calibration is an expensive process as a trained technician must manually inspect sensors and replace them if there are deviations. However, manual inspection is necessary to protect from two issues: miscalibrated sensors or stuck sensors

- Seek to maximise data variability
- Conduct data cleaning and labelling:
- Perform data maintenance

Table 4: AI Readiness Assessment: Data

These numerical scores represent an organisation's stage of opportunity identification. An organisation's score corresponds to the box where they have satisfied all requirements for that score and the requirements for lower scores.	
AI Unaware (1)	• No progress made towards meeting data needs for AI use cases.
AI Aware (2)	• Organisation has an ad-hoc approach to meeting project-specific data requirements
AI Planner (3)	• Organisation has conducted an initial assessment of its existing data resources
AI Ready (4)	• Organisation has a structured approach to identifying relevant internal and external data for AI-specific projects that allows them to input data for all key variables
AI Practitioner (5)	• Organisation has a plan for increasing its internal data collection and external data access to enable greater digital optimisation

5. Infrastructure

To be trained and deployed, AI algorithms require a range of infrastructure. This includes specialised hardware such as compute, data storage and networking to enable training and deployment of advanced AI models. Companies often struggle with decisions about whether and when to develop their own hardware solutions or source them externally.

As organisations seek to expand their use of AI beyond initial pilot projects there is a need to consider the organisational infrastructure required to roll out AI more widely across the organisation.

Compute: Compute is a generic term used to reference data processing capacity required for the computational success of any program. Most AI applications are compute-intensive and thus require specific processing hardware to operate effectively and efficiently. There are a range of compute hardware options to consider for AI including CPUs, GPUs, TPUs, and ASICs. The best hardware will depend on the specific use-case.

Sensors and networking: A sensor network is a group of small, powered devices, and a wireless or wired networked infrastructure. The sensor network connects to the internet or computer networks to transfer data for analysis and use. Examples of sensors include temperature sensors, infrared detectors, proximity sensors, and motion detectors. These can be applied across the sector to produce wide-ranging data to track operations or to enable data sharing. It is crucial to provide a stable network to ensure that wireless communication is possible. Many assets and infrastructure elements are fundamentally similar, so collaboratively developing sensors or sourcing generalised equipment may be a reliable and cost-effective method of meeting this need.

Data storage: Not only do AI applications require large volumes of data to operate effectively, but access to that data must be rapid, reliable, and scalable. As a result, not only do organisations planning on deploying AI often require substantially more data storage capacity, they often find there is a need for data storage that is tailored for AI requirements. Over time, companies should consider combining a range of data storage options including data lakes - designed to store large amounts of raw data, to more purpose-specific data warehouses for cleaned, labelled data for easier querying[6]. Organisations at an early stage in their digitalisation journey should consider initially building small data stores for each project. Over time, these can be connected together to allow for easier linking of data across organisations, whilst ensuring that provisions are in place to address data security risks.

Cloud or on-premises?

Cloud computing refers to technology services and infrastructure that are provided over the internet. Data is stored and processed off-site. The traditional alternative is on-premises ('on-prem') infrastructure, involving hardware in company offices. Cloud facilities and services can include servers, storage, databases, networking, software, analytics and intelligence. Cloud infrastructure allows users to access reliable and optimised technology, only pay for the services they need, to flex their requirements of these services up or down, stay up to date with the latest technology, forecast their costs, access services from anywhere and rely on security experts to prevent security breaches.

However many companies have yet to move their infrastructure to the cloud. This is due to a combination of real and perceived risks related to security and control. As some sectors involve the use of critical infrastructure, security is a non-negotiable requirement, however cloud infrastructure is increasingly able to offer higher levels of security, and not every application of AI will have direct impacts on critical infrastructure. As a result, companies should consider a more nuanced approach to the use of cloud-based infrastructure.

For organisations piloting AI projects there is often a strong case for initially using cloud-based services, so as to avoid high upfront hardware costs and allow for a faster project development during the piloting stage. The piloting phase will allow companies to better identify what the opportunities are for them to apply AI and as a result what hardware is best suited to these applications. They can then make an informed decision as to whether it makes economic sense to continue to use cloud services or switch to "on-prem" infrastructure.

Priorities for companies to consider include

- Assess and procure best solution for compute and data storage for initial pilot projects
- Assess and procure best solution for compute and data storage for wider organisational roll out

[6] Databases, Data Warehouses and Data lakes: A database is a storage location that houses structured data. The next step up from a database is a data warehouse. Data warehouses are large storage locations for data that you accumulate from a wide range of sources. A data lake is a large storage repository that holds a huge amount of raw data in its original format until you need it. Data lakes are more flexible than data warehouses but due to the quantity of data there are greater risks if security is breached.

Table 5: AI Readiness Assessment: Infrastructure

These numerical scores represent an organisation's stage of opportunity identification. An organisation's score corresponds to the box where they have satisfied all requirements for that score and the requirements for lower scores.	
AI Unaware (1)	• No consideration of AI infrastructure needs
AI Aware (2)	• Conducted an initial assessment of the suitability of the company's existing hardware infrastructure resources for AI projects.
AI Planner (3)	• Infrastructure requirements identified for initial AI projects.
AI Ready (4)	• Procured any additional digital infrastructure required for initial pilot projects. •
AI Practitioner (5)	• Assessed and procured the optimal solution for compute and data storage to enable the application of AI to a wide range of business challenges.

6. Establish Project and Organisational Governance for Responsible AI

AI is a powerful tool, and as such may require additional organisational risk management to ensure it is used responsibly and effectively. The complexity and power of AI means it may require additional organisational guide-rails and policies. Given that some infrastructures are critical, the use of AI systems in informing decision making needs to be carefully considered. The responsible application of AI requires the consideration of the following criteria:

- **Ensure AI-specific risks are identified and mitigated.** For companies that seek to work on small-scale or pilot AI projects initially, the assessment of AI related risk should be proportionate. For organisations seeking to deploy AI more widely, organisational governance processes should actively assess and mitigate AI-related organisational risks.
- **Organisations seeking to deploy AI widely across their operations should conside**r **organisation-wide AI principles and processes.** This should include consideration of:
    - The level of human involvement required at different stages of AI development and deployment
    - How to communicate with stakeholders about the use of AI.
    - Data biases
    - The level of explainability required for AI models in different contexts.
- **Engage legal teams to ensure AI compliance where necessary.** Those overseeing the development of AI should ensure it is legally compliant. Legislation governing the use of AI is nascent but growing: for example the EU is leading the way with its AI regulation, which takes a risk-based approach to regulating AI. High-risk AI systems, including those used in critical infrastructure may be subject to obligations before they can be put on the market.

Table 6: AI Readiness Index: Governance for Responsible AI

These numerical scores represent an organisation's stage of opportunity identification. An organisation's score corresponds to the box where they have satisfied all requirements for that score and the requirements for lower scores.	
AI Unaware (1)	• No awareness of AI related risks or the need for AI governance
AI Aware (2)	• At least one team is aware of risks associated with deploying AI
AI Planner (3)	• Teams involved in developing digital projects have considered how to develop appropriate risk mitigation for AI
AI Ready (4)	• Organisation has digital and data governance processes that have AI-specific considerations
AI Practitioner (5)	• Organisation has fully developed AI risk mitigation framework capturing the principles and processes for addressing AI-specific risks and a plan to communicate their use of AI with external stakeholders

7. Develop Projects

For each individual AI project that companies seek to deploy to accelerate their transition to net zero, they will need to go through a process to determine what the objective or objectives are, define the possible actions the AI can take and identify any system constraints that will need to be imposed to guarantee safety and security.

Define the Objective Function: Whereas with some organisational projects it may be possible to have slightly fuzzy project objectives, when applying AI it is critical that the objective is clearly defined in a way that a computer can understand. For example, the objective function for owners of grid-scale storage assets is to maximise profit, by storing electricity when it is cheapest and selling it when it is more expensive. It is worth noting that some projects may have multiple objectives that need to be balanced and how these are weighted and prioritised will be important in defining project success. Some companies may have to trade-off economic objectives with social values and regulation. For example, owners of gas generators may have to balance making profits with pursuing decarbonisation. The most important objectives should be set in the project's 'objective function'. Additional objectives can be addressed when setting model parameters.[7]

Define the parameters of the project: For each AI project, there is a need to clearly and carefully delineate the parameters of the project. For example, for grid-scale battery asset projects the AI action space may be when to buy and sell on markets and controlling the maintenance of the battery when it is storing energy. When using reinforcement learning, the parameters of the project are known as the 'action space', however all projects need to clearly define the project parameters.

Define System Constraints: Within the action space it might be possible for the AI to make decisions that operators know in advance could have negative consequences, from a safety, security, ethical, social, or legal perspective. It is vital to ensure that AI software has clear boundaries that it must operate within. These constraints may need to be implemented at different levels – eg for a particular subset of the system, and for the system as a whole. For example, in the grid-scale battery example, it may be important to ensure that a certain battery temperature is not exceeded to ensure the safety of the system. It is worth noting that defining too many system constraints will limit the AI's options, and potentially reduce the scope for system improvement. Key questions to consider include:

- What are the operating boundaries necessary to ensure the safety of the system?
- What are the multiple types of constraints?
    - Component-level constraints (for example: a constraint affecting a single piece of equipment)

[7] CIOs: Here's how Google is approaching AI

    - System-level constraints (for example: constraints defined by the allowed combinations of equipment)
- What are process-level hard constraints? Hard constraints are constraints that can never be violated, including for safety and ethical reasons. It's important to determine for all constraints whether they are hard or not.
- What is the permissible operating range of each system component?
- What are the constraints on how quickly each component can ramp over time?
- When certain components are operating within a given range, what limitations should be imposed on how other components operate?
- Ensure data privacy controls are in place. Who has access to what data, trained models and inference? Are the access levels appropriate? Define who can see and who can use each type of data.

Priorities companies should consider:
- Define the Objective Function and list everything you want to optimise
- Define the Action Space
- Define the System Constraints

Scoring summary

Organisations can add their scores from each section in the table below to determine an overall score:

Table 7: Summary table for AI Electricity Readiness Assessment

AI Readiness Criteria	AI Unaware	AI Aware	AI Planner	AI Ready	AI Practitioner	SCORE
Opportunity Identification	1	2	3	4	5	
Responsible AI Governance	1	2	3	4	5	
Human Capacity: Internal and External	1	2	3	4	5	
Data	1	2	3	4	5	
Infrastructure	1	2	3	4	5	
TOTAL SCORE						

SECTORAL CASE STUDIES

A - Electricity sector

<u>Context</u>: Optimisation of electricity systems will be critical to deliver a low-cost transition to net zero. AI is an important tool that can support electricity system optimisation. The need for highly efficient balancing markets to rapidly enable more variable renewable generation will require the use of AI to ensure that every electricity asset is fully optimised to the market. AI will be important in ensuring system flexibility through radically improved forecasting of generation and demand, the optimisation of asset management and electricity trading, and to optimise dispatch markets to ensure efficient grid balancing. Increasing demands on electricity systems from heat pumps, EVs, battery storage, distributed generation, demand response assets will require AI for assets to operate most efficiently and to minimise expensive network investments. AI is already being used in a wide range of use-cases in the electricity system, and its importance will only grow as more applications emerge. However, a major roadblock is that many electricity companies are not yet ready to apply AI in their operations.

<u>Case study</u>: Electricity systems can make use of AI in the transition to net zero. The transition to net zero electricity will involve countries building, connecting, and integrating increasing shares of renewable electricity generation, with a smaller number of countries seeking to rely primarily on nuclear generation. Increased integration of renewables will require better forecasts for renewable supply, better prediction and management of electricity demand, a more intensive role for balancing services, and rapid innovation in energy storage to support constant matching of electricity supply and demand. AI and ML tools will be needed to efficiently adapt to these new requirements. At the same time as more renewables come online, electricity systems will see rapidly increasing demand as heating, transport, and various industrial processes move away from fossil fuels and towards electrification. This will intensify the need to flexibly manage the grid, increasing the role for AI. The complexity of some potential configurations for net zero electricity grids, with many thousands of interconnected two-way assets, will require advanced digital tools. AI is best suited to optimise and manage these kinds of systems.

AI offers opportunities for all aspects of electricity system planning and operation, however there are some immediate opportunities where AI can be deployed. These include:

- **Forecasting supply and demand**: To enable the integration of large amounts of renewables, and reduce the need for expensive gas backup generation, it is essential to improve forecasts of both electricity supply and demand. AI can increase the accuracy of renewable electricity supply and demand forecasting. These forecasts in turn will support improved forecasting of system inertia.[8] For example, Open Climate Fix has helped to double the accuracy of demand forecasting for the UK National Grid and increased the accuracy of solar forecasting.

- **Asset optimisation:** AI can optimise the operations of renewable electricity generating assets such as wind turbines, and solar panels, and battery storage assets. For example, Habitat Energy uses AI to optimise grid battery storage assets against the chemistry of the battery and the market in which they are operating. DeepMind also applied AI to optimise Google's wind assets and increased their value by 20%.
- **Electricity trading**: AI-enabled trading algorithms will optimise traders performance on the electricity markets, and allow trading to take place closer to real time - which will become increasingly important to allow for more variable renewable capacity on electricity grids.
- **Flexibility markets:** AI can allow for the flexible management of millions of connected devices to offer flexibility services to electricity grids. The optimised management of domestic and commercial sources of electricity demand and supply can support system balancing.
- **Accelerating energy innovation**: AI is also being used to accelerate discovery of new energy-relevant materials, such as those used in photovoltaic cells, batteries, and electrofuels. For example, Aionics uses AI to increase the pace of battery experiments.
- **Dispatch and scheduling**: AI also has the potential to improve algorithms for electricity dispatch scheduling and storage by the system operator, as well as management of microgrids in areas with decentralised systems.

To use AI to support the transition to net zero, companies in the power sector need to become AI-ready. To deploy AI for net zero challenges, companies in the power sector need to put in place the capacity, skills, governance, data infrastructure, and digital systems that are prerequisites to enable the application of AI. This booklet defines these prerequisites and proposes activities to support electricity companies to develop their AI readiness in support of net zero challenges. We are seeking to appeal to a wide range of actors within the power sector, including electricity transmission and distribution companies, system operators, electricity suppliers, renewable asset developers and operators, researchers, and innovators, who are seeking to support the digitalisation of electricity networks. Within these organisations we are looking to appeal to executives, innovation leaders, data and digital team leaders, HR leaders and product leaders. We hope this booklet can help initiate conversations between such leads that can support organisations to develop

[8] Inertia in power systems refers to the energy stored in large rotating generators and some industrial motors, which gives them the tendency to remain rotating. This stored energy can be particularly valuable when a large power plant fails, as it can temporarily make up for the power lost from the failed generator by maintaining grid frequency.

AI Readiness capacity in support of their net zero objectives. Ethical Norms for New Generation AI (2021)

Summary of AI suppliers in the electricity sector: There are an increasing number of companies seeking to offer AI services to help reduce emissions in the electricity sector. The list below is not exhaustive and inclusion in it is not an endorsement of the product of service offered, however it can act as a starting point for companies seeking to identify relevant AI service providers.

Gridbeyond	GridBeyond's focus is to build a shared energy economy that delivers sustainability, resilience, affordability and adaptability through collaboration and innovation. Their technology bridges the gap between distributed energy resources and electricity markets, allowing all connected asset tp be utilised to help balance the grid. By intelligently dispatching flexibility into the right market, at the right time, asset owners and energy consumers unlock new revenues & savings, resilience, manage price volatility, while supporting the transition to a Net Zero future.
faradai	AI-powered Digital Twin for the Energy System. Peak load prediction, Data and analytics, Local-level flexibility; Suitable for EV Charging Point and Renewable Energy Developers, Distribution Network Operators
AutoGrid Systems	Supply and demand management solutions: AutoGrid Flex™ mines the Energy Internet's rich data load to extract the highest value from all distributed energy resources.
Open Energi	Flexibility Optimisation: Dynamic Demand 2.0's core functionality is to optimise assets in response to dynamic power market signals; it works with all parts of the power market. Through algorithmic analysis of that flexibility, mapped against market trends, we can optimise transactions for any given asset to maximise revenue. Tailored or fully managed approach for grid services are available, including prequalification, contract management, bidding, dispatch and settlement.
clir	Market intelligence platform for wind and solar. Clir Portfolio empowers owners to maximize financial returns by leveraging 200 GW of wind and solar data, advanced AI, and decades of technical expertise.
BluWave ai	BluWave-ai promises to orchestrate DERs to enable virtual power plants (VPPs) for distribution utilities to manage demand, smooth PV generation and shave peaks, optimizing for multiple objectives. They include energy trading and economic dispatch of controllable units to minimize net energy cost, reduce emissions and maximize battery energy storage life.

naturailly	LV Cloud is a software solution that collects, processes and aggregates data from different types of devices, including Reclosers, TDRs, GUARDs and VisnetHubs. Based on the collected data, it is possible to trace malfunctioning or physically damaged grids and immediately decide whether it needs to be fixed by a team of engineers or if it will fix itself. LVCloud is an (IoT) application that monitors and takes care of the grid. The project combines various technologies such as machine learning and transforms them into an app that can detect and solve power network malfunctions before they escalate into major problems.
sees.ai	Uses AI enabled drones to provide several major improvements to inspection of the electricity grid. Firstly, it enables the remote capture of high-quality, close-quarter data (component by component, if required), in a way that is more efficient (multiple towers per flight) and perfectly repeatable. Secondly, it simultaneously captures 2D data (e.g. photos, video) and 3D data (digital twin) in a way that allows the 2D data to be navigated from the 3D model or vice-versa. This significantly reduces the cost of analysis by human or machine. The system also almost eliminates risk to workers and carbon emissions.
keen AI	KAI digitalises the visual assessment processes. Generating more value from expensively collected data and can help manage assets more effectively. Keen AI is using deep learning and image processing to detect corroded steelwork on National Grid towers in high resolution imagery. KAI, is being used at National Grid to support analysts to rapidly identify the objects of interest in recorded footage. Using deep learning, KAI is able to identify the key components automatically and present these to the operator for review.
Stem	Project developers and asset owners use Athena to optimize power generation and market participation revenues of both standalone energy storage and hybrid solar plus storage power plants. Services include market revenue optimization, incentive management, solar clipping, and solar self-consumption.
FLuence	Tech Stack makes it simpler for customers to deploy storage faster and more cost effectively without sacrificing quality and configurability. The Tech Stack lays the foundation for better energy storage products with fully-integrated digital intelligence, an enhanced operating system, and factory-built, highly modular building blocks. Our digital intelligence platform, Fluence IQ, enables the optimization of storage and renewables to help customers maximize the value of their assets.
Innowatts	AI data analytics for energy grid supply & demand: use AI and learnings from more than 45 million global meters to help energy retailers, utilities and grid operators unlock meter-level data, understand their customers

	and make businesses processes automated and smarter. For a more reliable grid, a more profitable position, better customer experiences and a sustainable energy future.
Open Climate Fix	Their main interest is in trying to build machine learning models to forecast solar PV (which basically boils down to trying to predict the movement and evolution of clouds); they are experimenting with new ways to predict sunlight for the next few hours. Their aim is to get early-stage prototype PV forecasts used displayed in the National Grid control room, to validate their model's effectiveness and so they can start measuring the impact on emissions and cost. They're also aiming to release a nowcasting product for general market consumption.
Kaluza (Ovo)	Demand response product. Intelligently charges millions of smart home devices to function as energy storage at times of high load.
Kraken (Octopus Energy)	Kraken uses machine learning to optimise utility customer management processes including billing, payments, meter data management, CRM, customer communications, digital self-service, contact centre telephony, industry and market connections.
Solytic	Software helps stakeholders to make smart, data-driven decisions in real time. Today, monitoring, analytics and managing assets is done manually by humans. Solytic uses AI to automate processes to optimize production and cut costs throughout the entire life cycle of assets. Automating solar PV is key for a faster and more profitable energy transition.
Sensewaves	Dynamic optimization of the electricity grid. It provides the necessary analytics and analysis tools to integrate the legacy with the new infrastructure, ensuring agility and flexibility of operations and short and long term grid sustainability. Through machine learning, Adaptix.Grid correlates existing, sparse grid information to provide Distribution System Operators (DSOs) with accurate, high resolution, end-to-end visibility into the energy flows and congestion levels at any point/asset in the grid.
Habitat	Battery optimisation and trading, using AI to identify and participate in the most profitable markets for battery assets. Also offer a 'managed AI' service managing when to sell or store energy produced from DERs.
DeepMind	DeepMind engineers partnered with UK Power Networks in 2022, which delivers electricity across London, the East and South East, to create digital versions of maps covering more than 180,000 km of electricity cables. DeepMind is using new image recognition software and artificial intelligence to digitise hand-drawn maps into a new digital format that will be easier to navigate in the future.

B - Agriculture sector

<u>Context:</u> The agriculture sector will require AI in the transition to net zero. AI can be used to monitor and enhance carbon storage in soil, optimise regenerative agriculture, limit deforestation and tilling practices, and apply on-site renewable energy. Farmers, agricultural equipment manufacturers, and fertiliser companies will need to adopt alternative manufacturing processes. AI solutions can optimise their processes and reduce inputs, thereby drastically reducing carbon emissions. AI is already being integrated in the agricultural system, and its importance will only grow as more applications emerge. However, a major roadblock is that many agricultural organisations are not yet ready to apply AI in their operations. For more information on the adoption and use of AI in agriculture, please see the GPAI project *Broad Adoption of AI by SMEs in the Agriculture and Farming Sector 2024*.[9]

<u>Case study:</u> Agricultural systems will need to use AI to enable the transition to net zero. The transition to net zero in agriculture will involve implementing and integrating AI at every level of the agricultural process. Agriculture will balance its land use to optimise farming spaces whilst protecting areas of carbon storage by limiting deforestation and optimising tilling practices. Farming processes will also introduce on-site renewable energy which allows farms to reduce their reliance on fossil fuels and promote energy independence. The numbers of livestock producing emissions will be replaced by developing plant-based meat and increasing the appeal of veganism as an alternative source of protein in human diet. . Agricultural systems will integrate hardware and software to measure and deliver real time data directly to the farmer. This will involve companies, farmers, and governments funding and implementing sensor technology, automatons, greenhouse solutions, and data processors into their networks. AI can ensure that farmers as well as other agricultural stakeholders optimise yields and the resources they use whilst being net zero.

AI offers opportunities for all aspects of agricultural system planning and operation, however there are some immediate opportunities where AI can be deployed. These include:

- **Forecasting supply and demand factors:** To enable the transition to net zero, it is important that farmers, seed and fertiliser manufacturers have accurate forecasts of both supply factors such as the conditions of the farm, and demand factors such as consumer preferences. These forecasts can help the agricultural supply chain manage waste, limit carbon emissions, and optimise yields. ML can also help in disease detection, weed detection, and soil sensing.

[9] This project will publish an updated report in November 2024. For the previous report, please see Broad Adoption of AI by SMEs in the Agriculture and Farming Sector Report, GPAI I&C Working Group, 2022

- **Input optimisation:** AI can optimise the use of inputs such as fertiliser, pesticides, and water whilst increasing yield size. This is important for farms to support local ecosystems and to reduce their carbon output. For example, in Shanghai ride production AI was applied to reduce up to 90% of water use.

- **Carbon accounting:** AI can monitor carbon emissions in agricultural supply chains. It can help to identify and measure carbon sequestration in specific locations such as peatlands and forests.

- **Autonomous robots**: Autonomous robots can carry out agricultural processes to increase resource efficiency and yield. For example, Small Robot Company provides AI-controlled robots to monitor and manage individual plants and soil plots within a field.

- **Energy access**: AI can help farmers to manage new sources of renewable energy such as solar and bio power. It can optimise the energy generated on-site and map its application across the farm.

To use AI to support the transition to net zero, companies in the agriculture sector need to become AI-ready. To deploy AI for net zero challenges, farmers, food processors, and distributors need to put in place the capacity, governance, data infrastructure, and digital systems that are prerequisites to enable the application of AI. This booklet defines these prerequisites and proposes activities to support AI readiness in agriculture to support net zero challenges. We are seeking to appeal to a wide range of agriculture stakeholders including large-scale farming interests, small-scale farmers, agricultural equipment manufacturers, and chemical companies. Each of these stakeholders has different interests and different ways in which AI solutions can be applied. Within these organisations we are looking to appeal to executives, innovation leaders, data & digital team leaders, HR leaders, and product leaders. We hope this booklet can help initiate conversations between such leads that can support organisations to develop AI Readiness capacity in support of their net zero objectives.

Summary of AI suppliers in the electricity sector: There are an increasing number of companies seeking to offer AI services to help reduce emissions in the agricultural sector. The list below is not exhaustive and inclusion in it is not an endorsement of the product of service offered, however it can act as a starting point for companies seeking to identify relevant AI service providers.

VISCA	VISCA provides climate services and a Decision Support System (DSS) that integrate climate and agricultural models with farmers' management specifications. It designs short, medium, and long-term adaptation strategies to climate change.
Small Robot Company	The Small Robot Company provides AI-controlled autonomous robots that monitor and manage individual plants and soil plots within a field. This helps farmers collect data and reduce fertiliser and agrochemical usage. This supports a net zero transition as well as greater biodiversity and resilience. Per Plant Intelligence can also be used for monitoring the development of new crops.
Trinity AgTech	Sandy made by Trinity AgTech tracks soil carbon, biodiversity, and water quality, using predictive AI to identify opportunities for carbon-cutting and cost reduction. Trinity claims it is the only carbon calculator for upland and lowland peat bogs, a crucial carbon store in the UK.
Blue River Technology	Blue River technology's See and Spray is a precision weed control solution that uses computer vision and machine learning to identify and target harmful weeds. This reduces agrochemical usage and allows for greater efficiency, making it a net zero enabling technology.
intellias	Intellias provides a range of bespoke solutions in agricultural technology, leveraging experience in AI and machine learning, IoT, remote sensing, and drone technology to enable sustainable growth and adaptation strategies.
Intelligent Growth Solutions	IGS provides vertical farming solutions to enable food producers and consumer food companies to increase resource efficiency and decrease carbon footprint, for example by reducing water consumption using hydroponic farming and by reducing transportation emissions by producing closer to market.
Climate AI	Climate AI applies AI and machine learning to climate data, producing insights to enable better forward planning for agricultural industry actors.

Blue Radix	Blue Radix's Crop Controller is an AI-powered autonomous greenhouse management solution that monitors and controls almost all functions within the greenhouse, allowing for greater resource efficiency.
Edge Impulse	Edge Impulse provides a range of machine learning solutions for agriculture. Their agriculture solutions are designed to maximise yield and also deliver greater resource efficiency, especially for water and agrochemicals such as fertiliser and pesticide.
Farmwise	FarmWise provides an autonomous weeding machine which uses computer vision and machine learning to identify harmful weeds. It has sub-inch removal precision.This machine kills weeds without using chemicals which can avoid the environmental and carbon impact of pesticides.
Prospera	Propsera's predictive agriculture solution uses advanced sensors and deep learning to optimise inputs such as water, fertiliser and pesticide. It also improves output efficiency by using deep learning algorithms to identify and monitor warning signs of crop failure, pest outbreaks, and droughts to prevent crop losses.
Gamaya	Gamaya uses machine learning and remote sensing to produce mapping and diagnostics of farmland. This technology is with the explicit aim to increase efficiency and sustainability of large industrial and small-holder farming.
PRIVA	PRIVA offers Plantonomy, a greenhouse climate management solution that uses smart algorithms to efficiently control irrigation, lighting, and ventilation of greenhouses. This approach reduces total energy usage and increases yields, supporting net zero goals by improving efficiency.
ec2ce	ec2ce provides predictive agriculture solutions using AI to optimise resources and processes such as fertilisation, irrigation, and predict crop yields.

C - Foundation industries sector

Context: Foundation Industries, such as manufacturing, construction, and mining, are some of the largest emitters of greenhouse gases. Reaching net zero in these industries will require power to be generated from clean sources, like hydrogen and solar. These 'transformational' solutions will be difficult and expensive, so AI will be essential to facilitate the transition by assisting development, installation, and management of clean technologies. AI will also be needed to optimise existing carbon-intensive processes to reduce excess emissions. AI is already being integrated into industry, and its importance will only grow as more applications emerge. However, a major roadblock is that many industrial companies are not yet ready to apply AI across their operations.

Case study: Industry will need to use AI to enable the transition to net zero. The transition to net zero will replace fossil fuel intensive processes with renewable alternatives like hydrogen and electricity. It will also involve substituting carbon intensive materials with developed new carbon-neutral materials. Industrial processes will transition to a circular economy. Material waste will need to be redistributed to manufacturers and then inputted into the industrial process. The Energy Transitions Commission estimates that moving to a circular economy for plastics, steel, aluminium, and cement would reduce carbon dioxide emissions 40 per cent globally by 2050, and by 56 percent in developed economies. As manufacturing, construction, and mining companies look to transform their operations they can reduce energy consumption, material usage, and emissions by optimising existing industrial processes. Many of these solutions will not only eliminate emissions, but reduce costs as well. AI will be integral for the successful integration of these developments into industrial systems.

AI offers opportunities for many aspects of industrial processes, however there are some immediate opportunities where AI can be deployed. These include:

- **Optimising new industrial processes:** the transition to net zero industry will require new industrial processes, however such processes require significant investment and risk. A combination of detailed industrial process simulations (sometimes known as digital twins) and AI can de-risk the transition to new industrial processes by assessing the optimal process at the design phase.

- **Alternative fuels optimisation:** In industry, renewable fuels such as hydrogen and ammonia can replace traditional carbon-intensive fuels. There are calorific prediction ML models for a variety of fuel blends for kilns. AI can implement this technology to obtain optimum efficiency from alternative fuels. This technology has already been implemented in some cement factories transitioning to renewable fuels in the next decade.

- **Accelerating manufacturing and materials innovation:** AI is being used to accelerate the discovery of new manufacturing techniques and materials. AI researchers in the MIT Department of Materials Science and Engineering are using AI to design and formulate new, more sustainable concrete mixtures, with lower costs and CO2 emissions. They reuse manufacturing byproducts by inputting them in the same processes. In another context, The European Space Agency funded a project to conduct research into developing new, more efficient alloys that also met certain sustainability principles.

- **Process efficiency:** AI is used to optimise inputs to minimise material and energy waste and increase efficiency. AI can track materials in order to re-manufacture and re-enter them into the supply chain, as well as minimising time spent running heavy machines in construction reworking or mining discovery.Machine learning, in particular visual identification systems, can be adopted to identify and sort waste.

To use AI to support the transition to net zero, companies in industry need to become AI-ready. To deploy AI for net zero challenges, industrial companies need to put in place the capacity, governance, data infrastructure, and digital systems that are prerequisites to enable the application of AI. This booklet defines these prerequisites and proposes activities to support industry companies to develop their AI readiness in support of net zero challenges. We are seeking to appeal to a wide range of industry stakeholders including foundation industry manufacturers, mining and construction companies, both carbon-intensive and carbon-neutral capital asset developers, entrepreneurs, researchers, and innovators seeking to support the decarbonisation and digitalisation of industry. Within these organisations we are looking to appeal to executives, innovation leaders, data & digital team leaders, HR leaders, and product leaders. We hope this booklet can help initiate conversations between such leads that can support organisations to develop AI Readiness capacity in support of their net zero objectives.

Summary of AI suppliers in the industry sector: There are an increasing number of companies seeking to offer AI services to help reduce emissions in industry. The list below is not exhaustive and inclusion in it is not an endorsement of the product of service offered, however it can act as a starting point for companies seeking to identify relevant AI service providers.

Carbon RE	Carbon Re apply the latest advances in artificial intelligence (AI) and machine learning to uncover energy efficiencies and reduce costs and carbon emissions in industrial processes in the cement, steel and glass sectors. Their flagship product, Delta Zero Cement, focuses on the critical pre-heater and kiln processes stages of cement manufacturing, which accounts for all thermal fuel use and emissions in order to optimise fuel use, reducing carbon emissions.

Solidia	Solidia provides two core technologies. Firstly, a sustainable cement manufacturing technology, which can be produced in traditional cement kilns using less energy, reducing greenhouse gas emissions during manufacture by 30-40% Secondly, a sustainable concrete curing technology which cures concrete with CO2 instead of water, permanently and safely consuming 240kg of CO2, and saving up to 3 trillion litres of fresh water annually. Solidia introduces AI into concrete production through its intelligent curing process - reducing waste and improving quality control and consuming CO2.
Fero Labs	Fere Labs works with the cement, chemicals, steel, oil & gas and CPG sectors to support process optimisation to increase energy efficiency.
livNSense	LivNSense is an Industrial IoT & AI Platform-led venture whose platform GreenOps™ converts continuous and discrete process industries with standard OT/Electronic systems, into a Cognitive Living Equipment, thereby significantly lowering the ost of operations, Improving Safety and Reducing the energy consumption & carbon footprint. The platform optimises the production processes.
Element AI	Element AI have created variance-analysis techniques to compare energy usage on high- and low-performing days within industrial settings. Such applications help to identify changes required and investments needed to reduce fuel consumption and emissions through industrial processes.
Yandex	Yandex Data Factory developed a machine learning-based service that recommends the optimal amount of ferroalloys—the ingredients needed to produce specific steel grades.
IoT.nxt	IoT.nxt provides IoT solutions for a variety of industries, designed to work with any existing infrastructure or process. They provide both edge- and cloud-based solutions aimed at improving operational efficiency and cutting emissions.
BCG	BCG's artificial intelligence solution, CO2 AI by BCG, enables organisations to measure, simulate, reduce, track, and report their environmental footprint at scale and to collaborate across the supply chain.
Beyond Limits	Beyond Limits' AI solution provides improved process manufacturing and robotic predictive maintenance. This maximises yields and efficiency, providing reduced emissions.
Viact AI	AI Solution for Decarbonization by viAct uses AI, IoT and Satellite Remote Sensing provides carbon accounting to companies. It uses AI detection on satellite images to measure carbon emissions and offsetting. More directly the IoT system tracks the carbon footprints of each piece of equipment.
Plan A	Berlin-based Plan A has developed an AI- and digital-driven SaaS platform for automated carbon accounting, decarbonization, ESG management, and reporting. Their technology allows companies to manage their carbon accounting while also reducing their negative environmental impact. Plan A empowers firms to play a vital role in the effort to attain Net Zero.

Aeromon	Aeromon provides emission monitoring as a service. They offer a platform which comprises the BH-12 measuring device and an analytics system - the Aeromon Cloud Service (ACS). The platform delivers actionable emission results to their customers. They specialise in servicing oil & gas, pulp & paper, mining and chemical production companies.
Earth AI	The Earth AI technology and lean processes are designed to reduce greenfield drilling costs and emissions.Their equipment does not require tracks or in-ground sumps, making mobilisation of earthworks equipment unnecessary, significantly lowering downtime and environmental disturbance of mineral exploration. Their mission is to provide the building materials for the sustainable energy transition.
Algo8 ai	Algo8's AI-powered solutions enable intelligent operations for cement industry operations, with better asset and process management; thus, reducing the risk of unexpected shutdowns, and optimising preventive maintenance operations. Increased efficiency will reduce emissions.
Uptime AI	Uptime AI solutions improve the efficiency of metal production, reducing net emissions from this process. Some of their artificial intelligence systems and learning algorithms work in real-time and some use data analytics behind the scenes to chart better courses for business processes.

D - Transport sector

Context: Transport systems will need to make use of AI in the transition to net zero to shift to zero emission energy sources and to optimise transport systems and processes. This will involve the construction of smart networks of electric charging infrastructure that will require the application of AI to optimise changing against the electricity networks and other energy assets. Cities will become increasingly integrated and smart, with intelligent traffic management systems and connected forms of public transport. As major operators transform their operations, they can reduce emissions by optimising existing logistics and fleet management. AI is already being used in a wide range of use-cases in the transport system, and its importance will only grow as more applications emerge. However, a major roadblock is that many transport companies are not yet ready to apply AI in their operations.

Case study: Transport systems will need to use AI to enable the transition to net zero. The transition to net-zero transport will involve land transport, the maritime industry, and aviation all shifting to zero emission energy sources and increased automation. Fleets of electric buses will help to decarbonise public transport, while autonomous fuel cell cargo ships will drastically reduce emissions from major shipping lanes. These green alternatives will require constructing smart networks of electric charging and hydrogen fueling infrastructure. Only a small amount of the infrastructure needed exists today. As major transport companies look to transform their operations, they can reduce emissions by optimising their existing logistics and fleet management models. Many of these solutions will not only eliminate emissions from the transport sector, but reduce costs in the process. The increasing complexity and integration of decarbonised transport networks will require advanced digital tools to optimise many different systems, including the use of AI.

AI offers opportunities for decarbonising each part of the global transport network. However, there are some immediate opportunities where AI can be deployed. These include:

- **EV Fleet Management:** AI can optimise EV fleet management, whether that be for fleets of taxis constantly moving in and out or a fleet of freight trucks that all require charging overnight. Smart EV fleet management solutions can charge when electricity prices are low, optimise electricity use, stagger the time vehicles are 'taking the charge', and offer a number of other advantages. There are also many AI companies currently offering EV fleet management.
- **Route & Navigation Optimisation:** AI can optimise the routing and navigation of different vehicles in land transport, maritime shipping, and aviation, reducing fuel consumption. For example, Alaska Airlines are now using Airspace Intelligence's AI platform Flyway to improve the routing of their flights, reducing fuel consumption.

- **Operations electrification:** To transition to net zero, it is essential to first identify what parts of a fleet should first be electrified. AI can determine what vehicles should be replaced with EVs in an efficient and cost-effective way.
- **Shared 'last mile' delivery:** AI can allow for the route optimisation of last mile delivery, whether that be for mailed packages or a customer's weekly grocery order from a supermarket. Cruise recently launched a pilot program of a 'last mile' delivery autonomous EV fleet for Walmart in Arizona, so 'last mile' delivery is likely to be fully autonomous in the future.
- **Micro-mobility solutions:** AI can optimise the operations of micro-mobility companies that offer e-scooters and bikes by improving pre-positioning, data sharing for local multimodality solutions, and efficient recharging. FLO Mobility is developing autonomous e-scooters that will be offered to micro-mobility companies. Improving micro-mobility fleet efficiency and convenience will encourage consumers to transition from high emission alternatives.
- **Generative Design:** Aircraft and maritime vessel manufacturers are experimenting with generative design, where AI software optimises the design of parts like an engine component or wing spar. These designs can slash the costs and weight of parts, reducing energy requirements. An aircraft part Airbus designed last year using AI was 45 percent lighter than that designed by a team of engineers.

To use AI to support the transition to net zero, companies in the transport sector need to become AI-ready. To deploy AI for net zero challenges, transport companies need to put in place the capacity, governance, data infrastructure, and digital systems that are prerequisites to enable the application of AI. This booklet defines these prerequisites and proposes activities to support transport companies to develop their AI readiness in support of net zero challenges. We are seeking to appeal to a wide range of transport companies including freight transport operators, municipal, institutional & commercial fleet operators, airports, short sea & deep sea shipping companies, and innovators seeking to support the digitalisation of transport systems. Within these organisations we are looking to appeal to executives, innovation leaders, data & digital team leaders, HR leaders and product leaders. We hope this booklet can help initiate conversations between such leads that can support organisations to develop AI Readiness capacity in support of their net-zero objectives.

Summary of AI suppliers in the transport sector: There are an increasing number of companies seeking to offer AI services to help reduce emissions in the transport sector. The list below is not exhaustive and inclusion in it is not an endorsement of the product or service offered, however it can act as a starting point for companies seeking to identify relevant AI service providers.

BluWave ai	The BluWave ai EV Fleet Orchestrator is a solution for fleet management of freight transport operators like postal, retail, and grocery chains; municipal, commercial, and institutional transit fleet operators; and ground service vehicle fleet operators at airports. The Fleet Orchestrator uses AI to optimise EV fleet charging, maximise the use of renewable energy, reduce carbon emissions, and reduce peak demand at depots and warehouses to mitigate the need for expensive electric power distribution infrastructure upgrades.
CEREBRUMX	CEREBRUMX provides a range of AI solutions to improve EV fleet operations. They implement AI and data analytics to find the nearest charging stations, charge planning for managing range anxiety, monitoring EV battery health, creating cost savings, and optimising energy consumption. CEREBRUMX also offers a range of smart city solutions like intelligent traffic management and AI powered urban policy development.
Moixa	Moixa's GridShare AI software can show fleet operators how they can integrate smart charging, onsite storage and renewables to manage EV transition in a cost-effective way. Moixa's GridShare software can manage onsite energy assets like solar PV and energy storage, including second-life batteries from retired EVs that can unlock new value for fleets.
ACEINNA	ACEINNA offer a number of sensors and modules that are useful for AI applications. Their Integrated GNSS / RTK Inertial Navigation Module, for example, is a surface mount module for developers creating guidance and navigation systems for autonomous vehicles, robots, drones, and machinery.
Windward	Windward's Data for Decarbonization program brings stakeholders in the shipping industry together in compiling useful data that can maximise the efficiency of maritime transport.
Vorza	Vorza offers a range of solutions and services to help integrate electric or fuel cell fleets. They also offer consulting services to help trucking companies reach net zero. Not all of the solutions and services they offer use AI.
Massterly	Massterly aims to provide autonomous, battery operated shipping as an alternative to high emissions transport. Their focus is currently on short-sea shipping.
Cruise	Cruise is creating an all-electric, self-driving ride service starting in San Francisco. They have also partnered with Walmart to deliver groceries in the Phoenix metro area.
Uber Freight	Uber Freight offers logistics AI solutions for trucking which improve efficiency, minimising emissions. Their app for truckers allows truckers to find backhauls, reducing the harmful practice of empty return trips.
Convoy	Convoy's AI solutions include an online platform that provides accurate load tracking and a response system to the frequent problem of empty

	trucking return trips. Through this platform freight transport can find backhauls to minimise the transport of empty loads.
Electra	EVE-Ai Fleet Analytics uses vehicle-specific and fleet-wide battery pack data to generate accurate State of Health (SOH) trends and predictive models, detect future battery faults and failures, and maximise fleet efficiency and performance. Onboard data backlogs with Electra's experts to get immediate business insights for informed fleet management decisions.
Otonomo	Otonomo has large sources of real-time and historical transport data that is cleansed, normalised and aggregated. Their datasets could be useful for a variety of AI projects. Their datasets include, but are not limited to, EV data, commercial fleet, traffic, OEMs fleet, and mobility intelligence data.
Envision Digital	By creating a smart connected energy network with the EnOS™ AIoT platform, EV charging solutions can be integrated with Solar Photovoltaic (PV) and Energy Storage System (ESS) to expand grid capacity by more than 10 times without grid connection expansion, avoiding hefty CAPEX. Energy generation, consumption and storage can also be dynamically optimised to balance demand and supply at the lowest cost. In addition, EV batteries connected via a Vehicle-to-Grid (V2G) network can turn batteries into mobile & green power stations for grid stabilisation.
ATS Worldwide	ATS seeks to improve safety and fuel efficiency for carriers and airports while reducing the environmental impact of ground processes. Their AI software can control an electric-powered dolly that automatically pulls aircraft from the runway to a gate.
Gemini Motor	Gemini Motor is developing fleets of autonomous hydrogen fuel cell vehicles. Integrating these fleets will increase the efficiency and reduce the costs of trucking operations.
MOEV	MOEV'S artificial intelligence based machine learning system uses continuous and real-time prediction and optimisation to perform smart management of EV charging infrastructure for transit fleets, school bus fleets and delivery truck fleets to save cost, streamline EV operations, reduce operator stress, and maximise EV battery life.
Synop.AI	The Synop platform works across all commercial EV types. From helping with the transition to electrification, to tracking sustainability, to maximising productivity, to enabling Vehicle-to-Grid functionality with utilities, their tools and services are designed to ease EV fleet operations.
Rapid Flow Technologies	Rapid Flow Technologies is trying to use AI to ease congestion in cities. The company employs a system known as Surtrac to bring more intelligence to traffic lights. Radar sensors and cameras monitor car flow and wait times at intersections. The AI then adjusts the timing of the lights to move vehicles through as efficiently as possible. A test pilot in Pittsburgh reduced average travel times by one-fourth and average wait times by 40%.

MarshallAI	MarshallAI's computer vision and AI solution helps cities get closer to carbon neutrality by making traffic management more efficient. They apply deep-learning-based artificial intelligence to video sensors to understand roadway usage, and inform and optimise traffic planning. When a city's traffic light management system is able to adjust to real-time situations and optimise traffic flow, its increased efficiency can reduce emission-causing activities, such as frequent idling of vehicles.