

August 2025

# Artificial intelligence

Identifying leadership and solutions

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# “AI is likely to be either the best or worst thing to ever happen to humanity.”

Stephen Hawking<sup>1</sup>

Developments in artificial intelligence (AI) offer expansive potential benefits and also extensive risks. Therefore, reporting on the field tends to take on a tone of either techno-optimism or techno-doom. As fundamental investors, we are focused on developing a more nuanced understanding, with a goal of recognizing the links between these new technological capabilities, business models, and long-term outcomes. In this report, we explore the relevance of AI for fundamental investors. We offer analytical frameworks for assessing opportunities for corporate leadership and for the development of new solutions that support thriving individuals, effective institutions, and planetary health.

AI has existed in different forms for decades, and its development has recently accelerated, due to advances in computing techniques, components, and infrastructure. Generative AI, a form that typically uses large language models (LLMs) to create new data like text, images, and content, became more familiar to the general public with the release of ChatGPT in November 2022. Some observers believe that the goal of Artificial General Intelligence is close to being reached. Though there is debate about how to best assess this form of AI, it refers to models that can self-teach and solve problems they were not explicitly trained to address, a capability that will expand the range of opportunities and risks even further.

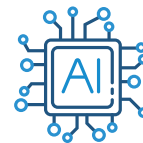
Two distinguishing characteristics of AI development are especially notable:

- **AI represents a foundational set of new capabilities, with very far-ranging use cases.**
- **The field and its related tools and products are developing extremely quickly.**

These attributes make analysis of the field unusually interesting and challenging, and they imply a dynamic and potentially very large opportunity set for investors.

## Early benefits, emerging questions, and potential risks

The economic impact of AI acceleration is already notable. Spending on AI worldwide is expected to reach \$600 billion by 2028<sup>2</sup>, and capital spending for major technology companies (hyperscalers) has already increased from roughly 10% of total S&P 500 spending to 25%, largely driven by growth in AI-related infrastructure.<sup>3</sup>



## \$600 billion

Expected spending on artificial intelligence worldwide by 2028

Deployment of AI-driven tools is already creating impacts far beyond these spending numbers. Growth in innovation within information technology and life sciences is already notable, and advances in economic development and global governance offer tangible opportunities for beneficial outcomes.<sup>4</sup>

**FOR EXAMPLE:** *The 2024 Nobel Prize in chemistry was awarded to scientists who used AI-enabled models to predict the structures of proteins, which could dramatically accelerate understanding and development of therapeutics. This group included two scientists from Google's DeepMind team, indicating the importance of corporate involvement in this form of foundational scientific research. Additionally, the 2024 Nobel Prize in physics was awarded to researchers who developed approaches that inform the structures of current large machine learning and AI models.*<sup>5</sup>

Because of advances like these, we can already see improvements in access to specialized knowledge and expertise, with far ranging impacts. Many observers agree with the prediction of venture capitalist Vinod Khosla: Very soon, most expertise will be near free, from structural engineering to oncology to coding, with potential to eliminate many barriers that have historically impeded access and slowed positive development.<sup>6</sup>

In terms of business operations, numerous companies are beginning to see improvements in productivity, effectiveness, and accuracy as their business processes benefit from AI. In many cases these technological advances improve speed, quality, or safety outcomes, as detailed later in this report.

Any innovation that offers such dramatic potential for positive impact also involves significant questions, challenges, and potential risks.

**FOR EXAMPLE:** *The compute intensity of new AI-focused data centers has already influenced the growth of overall energy demand in the United States. Department of Energy projections indicate that data center-related energy use will rise from about 2% of total US demand to as much as 12% by the end of this decade.*<sup>7</sup>

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The productivity offered by AI deployments also can have significant implications on employment patterns.

**FOR EXAMPLE:** *The World Economic Forum estimates that 22% of jobs will be transformed between 2025 and 2030, with increased digital access as the greatest contributing factor. Though the study is quick to highlight expectations for overall job growth (not declines), it also notes that 40% of employers are planning to reduce staff as skills become less relevant and efficiency improves due to technological advances.<sup>8</sup> Recent layoff announcements from a range of companies like Meta, Google, IBM, Alphabet, and Salesforce indicate some confirmation of this trend, with Salesforce CEO Marc Benioff recently reporting that AI is already handling 30% to 50% of the company's internal workloads.<sup>9</sup>*

Additionally, data is being used in new ways for training large language models, including development of new protocols for data acquisition, scope, use, and permissions. Deploying these technologies requires similar frameworks to guide decision making in many areas, and only a portion of these are well served by existing rules and regulations.

Acceleration of AI-enabled tools also has potential to create new security risks, exacerbate structural inequities, and disrupt current economic and social systems. As scientist Melanie Mitchell summarizes:

**“We should be afraid. Not of intelligent machines. But of machines making decisions they do not have the intelligence to make.”**<sup>10</sup>

Philosopher and cognitive scientist Dan Dennett offered similar cautions:

**“The real danger is not that machines more intelligent than us will usurp us as captains of our destinies, but that we will overestimate the comprehension of our latest thinking tools, prematurely ceding authority to them far beyond their competence.”<sup>11</sup>**

The scale and speed of AI development raises important questions for citizens, policy makers, business leaders, and investors. Many organizations, analytical frameworks, and policy approaches are underway to address high-level opportunities and concerns related to AI.

**FOR EXAMPLE:** *A major international review chaired by Turing Award winner Professor Yoshua Bengio describes three categories of risks:<sup>12</sup>*

**Malicious use,** *including creation of fake content, cyberattacks, and facilitation of biological or chemical attacks.*

**Malfunctions,** *including reliability issues for use in medical or legal settings, bias that can lead to discriminatory outcomes, and loss-of-control scenarios where AI systems operate autonomously.*

**Systemic risks,** *including shifts in the labor market, creation of an “AI divide,” and potential for market concentration and single points of failure if a small number of general purpose systems sit at the heart of financial or health care sectors. Other systemic risks include environmental risks due to energy, water, and materials intensity, privacy risks for users or with respect to training data, and copyright infringements or other data collection risks.*

Professor Bengio also has candidly commented on the lack of current regulation—both formal and informal—that might mitigate these risks.

**“A sandwich has more regulation than AI.”<sup>13</sup>**

In summary, though AI-related headlines currently seem omnipresent and animated, this is for good reason: both the promises and risks of this arc of development are tremendous.

## Relevance for investors

The sweeping potential highlighted above is important for all investors, and there are also more particular opportunities for research-driven, long-term fundamental investors like Putnam. We see potential benefit in complementing the vital top-down considerations noted above with a more granular, roots-up, functionally-based framework for analysis. Specifically, we see an opportunity to define AI-related leadership and solutions across all sectors and business types, with a goal of identifying characteristics that could contribute to long-term success, positive impact, and business value.

## Identifying leadership

### Financial materiality as a focus for investor analysis

Putnam’s sustainable investment approach is centered on two key criteria for value-added analysis:

- **Focus on what matters**
- **Focus on the future**

We invest in public equities, buying ownership stakes in businesses where the security value reflects the present value of all future cash flows. Therefore, these two analytical priorities are obvious drivers of potential investment returns.

Businesses that are leading in the sustainability issues most relevant for their own operational settings have the chance to generate superior growth, operating effectiveness, and returns over time. Step one of assessing leadership is to analyze what matters—issues that are financially material to long-term business outcomes. When a new set of issues is developing quickly, as with AI, investors can benefit from understanding how the emerging questions connect to this concept of materiality.

For a longstanding business or market sector, the sustainability topics that are considered to be financially material are also typically well established.<sup>14</sup> For example: For a manufacturing company, a material issue could be secure access to raw materials supply. For a retailer, the business might be more dependent on employee engagement, productivity, and development.

## AI materiality map

The map below summarizes Putnam's tailored approach to considering financially material issues, illustrating that key issues vary across different sectors. Beyond this distinction, relevance varies by business model, company, and time horizon. As active managers, we can incorporate analysis of financially material issues in a dynamic and context-specific way.

### Putnam materiality map

|               |                                                              | Consumer | Health Care | Financials | Tech<br>(hardware) | Comm<br>and Tech<br>(software) | Industrials | Materials<br>and Energy | Utilities | Real Estate |
|---------------|--------------------------------------------------------------|----------|-------------|------------|--------------------|--------------------------------|-------------|-------------------------|-----------|-------------|
| GOVERNANCE    | Board structure and composition                              |          |             |            |                    |                                |             |                         |           |             |
|               | Management incentives, ownership, and compensation alignment |          |             |            |                    |                                |             |                         |           |             |
|               | Risk management and leadership                               |          |             |            |                    |                                |             |                         |           |             |
|               | Corporate purpose, culture, and mission alignment            |          |             |            |                    |                                |             |                         |           |             |
|               | Workforce engagement, diversity and inclusion                |          |             |            |                    |                                |             |                         |           |             |
| SOCIAL        | Employee well-being, development and opportunity             |          |             |            |                    |                                |             |                         |           |             |
|               | Product impact and customer well-being                       |          |             |            |                    |                                |             |                         |           |             |
|               | Supply and distribution network management                   |          |             |            |                    |                                |             |                         |           |             |
|               | Data procurement, privacy, security, and use                 |          |             |            |                    |                                |             |                         |           |             |
|               | Marketing and selling practices                              |          |             |            |                    |                                |             |                         |           |             |
| ENVIRONMENTAL | Pricing philosophy and access                                |          |             |            |                    |                                |             |                         |           |             |
|               | Climate change mitigation and adaptation                     |          |             |            |                    |                                |             |                         |           |             |
|               | Physical climate change risk                                 |          |             |            |                    |                                |             |                         |           |             |
|               | Greenhouse gas (GHG) emissions                               |          |             |            |                    |                                |             |                         |           |             |
|               | Energy sourcing and intensity                                |          |             |            |                    |                                |             |                         |           |             |
|               | Materials sourcing, intensity, and lifecycle management      |          |             |            |                    |                                |             |                         |           |             |
|               | Water sourcing, intensity, and lifecycle management          |          |             |            |                    |                                |             |                         |           |             |
|               | Biodiversity and ecosystems risk                             |          |             |            |                    |                                |             |                         |           |             |

Source: Putnam Investments, adapted from SASB Materiality Map, as of December 31, 2024.

■ Most relevant ■ Often relevant ■ Less relevant

The above is the opinion of the investment manager and is for illustrative purposes only.

Once an understanding of material sustainability issues has been established, we can extend the analysis to identify leadership that goes beyond basic business requirements. Sustainability leadership does not always contribute to enhanced financial prospects. Therefore, in evaluating the potential for leadership to be additive to the investment case for a company, Putnam's approach analyzes the links between a company's strengths and its potential for growth, profitability and free cash flow generation; we then compare these prospects to the current valuation of the company. To understand the nature of the company's leadership more completely, we assess these four characteristics:

### Sustainable leadership markers identify business-enhancing opportunity



#### Material

Focused on strategic, business-relevant issues



#### Proactive

Actions that go beyond basic requirements to create potential business benefit



#### Transparent

Reporting that is relevant, timely, and candid



#### Effective

Creating benefits both within the firm and beyond its corporate borders

### Financial materiality for AI-related businesses

AI is rapidly developing, and so are the material issues and related analytics. Moreover, the span of activity is wide, involving everything from data access to model development to operational deployment.

With this varied and evolving landscape in mind, we have developed a materiality-based framework for assessing AI-related business issues. As with all analysis, we believe a tailored focus on subsectors of AI development and deployment can identify the most relevant questions. The existing well-established frameworks for analyzing financial materiality adapt well to this specialized use case.

Specifically, we have extended traditional sector-based considerations to define five major functional areas that can be considered as AI subsectors:

**Components:** This group includes semiconductor and hardware producers like Nvidia, Taiwan Semiconductor, and Cisco

**Infrastructure:** Data center operators like Microsoft, Alphabet, Amazon, Meta, and X (private)

**Foundational model development:** Companies like OpenAI (private), Anthropic (private), DeepSeek (private), and Meta, along with their major partners

**Application and agentic development:** This group includes a wide range of organizations and activity. Examples include software services, content creation, and customer service.

**Implementation and operations:** This group also involves a broad span of activity. As AI-supported tools are more widely deployed, almost all areas of operations can be affected, including activity like product design, risk management, manufacturing production, marketing, and logistics.

It is important to note that these sectors generally decrease in concentration as we move from more centralized activities like data centers and foundational models to the more far-ranging application, agentic, and operational arenas. While only a handful of companies operate major data centers, thousands of companies are already involved in applying AI to specific use cases and managing the related operational activity.

## AI materiality map

When we consider the issues that are financially material for these AI subsectors, we see some areas that are comparable with existing considerations, and others where new questions are emerging. The map below extends Putnam's existing materiality framework to the newly defined AI subsectors.

### Putnam equity research materiality map for AI

CREATION —————> DEPLOYMENT

|               |                                                                 | Components<br>(semis and<br>hardware) | Infrastructure<br>(Data centers<br>and compute) | Foundational<br>models | Application layer<br>(software<br>and agents) | Implementation<br>and operations |
|---------------|-----------------------------------------------------------------|---------------------------------------|-------------------------------------------------|------------------------|-----------------------------------------------|----------------------------------|
| GOVERNANCE    | Board structure and composition                                 |                                       |                                                 |                        |                                               |                                  |
|               | Management incentives, ownership,<br>and compensation alignment |                                       |                                                 |                        |                                               |                                  |
|               | Systemic risk management and leadership                         |                                       |                                                 |                        |                                               |                                  |
|               | Corporate purpose, culture,<br>and mission alignment            |                                       |                                                 |                        |                                               |                                  |
|               | Workforce engagement, diversity<br>and inclusion                |                                       |                                                 |                        |                                               |                                  |
|               | Employee well-being, development<br>and opportunity             |                                       |                                                 |                        |                                               |                                  |
| SOCIAL        | Product impact and customer well-being                          |                                       |                                                 |                        |                                               |                                  |
|               | Supply and distribution network management                      |                                       |                                                 |                        |                                               |                                  |
|               | Data procurement, privacy, security, and use                    |                                       |                                                 |                        |                                               |                                  |
|               | Marketing and selling practices                                 |                                       |                                                 |                        |                                               |                                  |
|               | Pricing philosophy and access                                   |                                       |                                                 |                        |                                               |                                  |
| ENVIRONMENTAL | Climate change mitigation and adaptation                        |                                       |                                                 |                        |                                               |                                  |
|               | Physical climate change risk                                    |                                       |                                                 |                        |                                               |                                  |
|               | Greenhouse gas (GHG) emissions                                  |                                       |                                                 |                        |                                               |                                  |
|               | Energy sourcing and intensity                                   |                                       |                                                 |                        |                                               |                                  |
|               | Materials sourcing, intensity, and<br>lifecycle management      |                                       |                                                 |                        |                                               |                                  |
|               | Water sourcing, intensity,<br>and lifecycle management          |                                       |                                                 |                        |                                               |                                  |
|               | Biodiversity and ecosystems risk                                |                                       |                                                 |                        |                                               |                                  |

Source: Putnam Investments, as of June 2025.

■ Relevant in new ways ■ Most relevant ■ Often relevant ■ Less relevant

The above is the opinion of the investment manager and is for illustrative purposes only.

## Using the AI materiality map

As we review the graphic on the previous page, a few clear conclusions stand out:

- **A tailored approach is essential.** Just as with more traditional business sectors, financially material governance, social, and environmental issues vary across different parts of the AI landscape.
- **Some areas are already analyzable**, with metrics that are fairly well established. For example: Business considerations like management incentives, supply network management, or employee development are already important for most technology companies (and in fact most types of businesses). The details might evolve as AI continues to develop, but the nature of the questions is consistent. This set of more established issues is well served by existing research and analytical toolsets.
- **Other areas are worthy of further inquiry.** Beyond the well-understood categories noted above, there exists a set of issues that are clearly important, with analytics that are still emerging (these are reflected in orange in the above graphic). In these areas, entirely new questions are arising, and/or the range of outcomes from management decisions is dramatically widening. Rather than skipping ahead to fine-grained analytics, the issues in this category lend themselves to deeper exploration and iterative, ongoing inquiry.

## Putnam's analysis indicates six major areas in this category

### 1. Systemic risk management and leadership

How can we assess the roles of individual companies in establishing high-integrity operating principles and systemic risk mitigation? How could partnership, collaboration, or policy work enhance opportunity and mitigate risk? Specific focus on transparency and decision-making around auditability, scaling and deployment could be helpful.

### 2. Workforce engagement, diversity, and inclusion

What new skills and functions need to be developed? Who has input for design, testing and deployment decisions? What perspectives are needed but not reflected in current teams?

### 3. Product impact and customer well-being

What is the best way to assess impact across varied settings and constituents? What processes are in place for ongoing monitoring and analysis? What types of impacts can be assessed or anticipated a priori? What frameworks are used to determine higher versus lower risk deployments? How do the protocols for higher versus lower risk settings vary? Where is the circle of responsibility drawn, and how does this differ from legal or economic liability?

### 4. Data procurement, privacy, security, and use

What aspects of data procurement and use require new forms of consent or permissioning? How are ongoing data issues monitored and managed? How do these details differ depending on the type of information and its use case?

### 5. Pricing philosophy and access

Who pays for what? Which services are bundled into existing offerings versus standalone? Who gets access to the most advanced tools, and why? Where does value creation accrue, and how does this relate to up-front capital investments?

### 6. Energy, materials, and water sourcing, intensity, and lifecycle management

For companies focused on AI infrastructure buildout, a range of environmental topics is increasing in complexity due to the massive scale of new and planned facilities. How will power, energy, and material needs be met while maintaining grid and systemic stability and ensuring access and affordability? What extra provisions are in place for operations that sit in resource-scarce areas? How to consider extended lifecycle needs for AI-related infrastructure over a multi-decade timespan?

## Examples of potential opportunities for AI leadership

We believe a wide range of companies are exhibiting certain markers of leadership on material AI issues as defined above. For many organizations, strategy and leadership are evolving along with the technology and the broader field of practice, creating new opportunities and challenges along the way. Here we offer examples from multiple sectors to illustrate the scope of current activity.

Companies that provide essential components and infrastructure, like **Nvidia** and **NextEra Energy**, are advancing their own product offerings as well as sharing more complex systemic analysis, to inform better decision-making across the entire field.

Hyperscalers that operate large data centers are taking bold and creative steps to address their need for additional power supply, while also actively considering environmental, community, and systemic implications. For example, **Microsoft** and **Meta** have signed long-term agreements with **Constellation Energy** for zero-carbon nuclear power supply, and **Amazon** has signed three agreements to support the development of small modular reactors that will create additional zero-carbon power supply.

Foundational model companies like **Anthropic**, **OpenAI**, and **Meta** are developing business models that advance access through both direct offerings and partnerships. They also are informing broader development by sharing their differing views on risks and opportunities.

Companies working in content-intensive environments like **Adobe** are helping to craft appropriate systems for crediting creators and ensuring intellectual property rights.

Organizations that focus on improving operational effectiveness like **Salesforce** and **ServiceNow** are finding ways to proactively tailor AI capabilities to specific customer needs.

Leadership in these and other areas described above can contribute to long-term business success and mitigate both company-specific and systemic risks.

Conversely, lack of leadership could impede growth prospects and/or lead to increased business or systemic risks. Investors can benefit from assessing the leadership attributes of companies involved in AI as the field continues to develop.

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## Identifying solutions

### **Innovation and improvement as a focus for investors**

We believe companies that solve pressing needs also have the chance to create successful businesses. Therefore, our second major investment focus is on identifying AI-driven solutions.

Only a subset of inventions become deployed innovations, and only a subset of innovations become profitable and effective solutions. Many clever inventions do not ultimately serve a valuable purpose, or cannot support a viable business model. Therefore, for investors it is helpful to constantly ask, toward what end? What is the best and highest use of new technologies? Sometimes these answers vary dramatically in the short term versus the long term.

For example, considering the power and potential that the generative AI toolset brings, it is hard to believe that the ultimate pinnacle of success will be better chatbots for customer service centers. However, these might indeed be compelling early case studies of improvements in productivity through the use of AI-driven tools. More dramatic AI-powered advances in areas like human health, education, materials science, or energy systems are also possible over time.

## Framework for identifying solutions

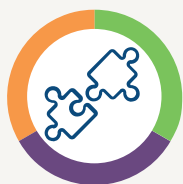
Putnam's map of sustainability solutions starts with the essential question, **"What is needed for a thriving world?"** It describes products, services, and ideas that can contribute to thriving individuals, thriving public (society and organizations), and a thriving planet.





In evaluating the potential for an idea to become an investible solution, Putnam's approach analyzes the business model and its potential for growth, profitability, and free cash flow generation; we then compare these prospects to the current valuation of the company. To understand the nature of the solution more completely, we assess these four characteristics:

### Markers of effective solutions identify investible opportunities



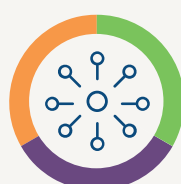
#### Relevant

Meeting an identified need and contributing to a thriving world



#### Advancing

Solutions that offer tangible improvement versus prior options



#### Expanding

Benefits that increase over time through added scope, scale or performance



#### Effective

Creating benefits both within the firm and beyond its corporate borders

### Identifying AI-driven solutions

Many innovations in the world fall within a narrow scope of application, such as new energy storage technologies or treatments for previously untreatable diseases. In contrast, AI-driven tools have extremely broad-based potential use. In Putnam's solutions map, almost every area could benefit from appropriately crafted and employed advanced computing tools. For example: early stages of drug development could be streamlined. Management of existing energy, production, or transportation systems could be more efficient. Monitoring the health of natural ecosystems could be more robust and effective.

Given this breadth, and similar to the approach to materiality noted above, it is helpful to consider AI solutions in a functionally focused way. Here we describe three categories of activity that are found in all sorts of solutions-based offerings and we explore how advanced computing could contribute to each.

### We define three major functional areas where AI-supported technologies can be additive

#### 1. Design

AI-driven tools can dramatically accelerate product design and testing, which is often time- and labor-intensive.

Design tools, such as those that can support multi-dimensional analysis for qualities like energy efficiency and protein structure, or provide enhancements to content creation, are examples. For individual users of AI, design solutions can include activities like personal content creation.

#### 2. Operations

AI can improve efficiency and effectiveness in a wide range of operational settings as well. Personalized marketing and customer service systems, digital twins that can improve monitoring and management of manufacturing lines, and advances in automation and robotics are examples. Similar improvements can extend to individual users of AI as well, with solutions like AI-driven personal assistants

#### 3. Analytics and feedback loops

AI-supported analytics can enhance precision, response rates, and overall effectiveness of many processes. Security threat detection and response, methane detection via satellite imagery, and medical diagnostics algorithms are examples. This set of functions can also apply to individual end users of AI as well, with offerings like personally tailored tutoring or health monitoring.

## AI driven solutions: Deployment across different business functions

The matrix below defines offers a sketch of potential benefits, metrics, and examples of use cases for AI in these functional areas.



|                                                        | DESIGN                                                                                                                                        | OPERATIONS                                                                                                                                                                             | ANALYTICS                                                                                                                                                        |
|--------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Potential benefits                                     | Acceleration of product design and testing, which is currently often time and labor intensive.                                                | Improved efficiency and effectiveness in a wide range of operational settings.                                                                                                         | Enhanced response rates and ongoing improvements to business processes.                                                                                          |
| Metrics of success                                     | <ul style="list-style-type: none"> <li>• Improved time to market</li> <li>• Higher success ratios</li> <li>• Greater revenue</li> </ul>       | <ul style="list-style-type: none"> <li>• Higher output</li> <li>• Improved quality</li> <li>• Lower costs</li> </ul>                                                                   | <ul style="list-style-type: none"> <li>• Greater understanding</li> <li>• Faster response times</li> <li>• Improved customer experience</li> </ul>               |
| EXAMPLES:                                              |                                                                                                                                               |                                                                                                                                                                                        |                                                                                                                                                                  |
| <b>THRIVING PEOPLE</b><br>Human health                 | <ul style="list-style-type: none"> <li>• Modeling for initial drug and trial designs</li> </ul>                                               | <ul style="list-style-type: none"> <li>• Enhanced manufacturing processes</li> </ul>                                                                                                   | <ul style="list-style-type: none"> <li>• Surgical robotics with analytics that improve patient outcomes</li> </ul>                                               |
| <b>THRIVING PUBLIC</b><br>Organizational effectiveness | <ul style="list-style-type: none"> <li>• Development of training or product content</li> <li>• Code writing</li> </ul>                        | <ul style="list-style-type: none"> <li>• Tailored customer communications</li> <li>• Improved ad placements</li> <li>• Streamlined finance, sales, and management processes</li> </ul> | <ul style="list-style-type: none"> <li>• Security monitoring, threat detection and response</li> <li>• Production analysis and preventive maintenance</li> </ul> |
| <b>THRIVING PLANET</b><br>Environmental health         | <ul style="list-style-type: none"> <li>• Equipment design for lower energy use</li> <li>• Packaging design for reuse and recycling</li> </ul> | <ul style="list-style-type: none"> <li>• Digital twins for manufacturing efficiency</li> <li>• Automation of recycling technologies</li> </ul>                                         | <ul style="list-style-type: none"> <li>• Responsive demand tools for power grids</li> <li>• Methane detection and leak abatement</li> </ul>                      |

## Examples of companies developing AI-driven solutions

A wide range of companies are experimenting and embracing the capabilities of AI to enhance their operations and offerings. In some cases AI is improving existing processes and services, and in others it is leading to entirely new product possibilities. Here we offer examples from multiple sectors to illustrate the broad scope of current activity.

### Design

Acceleration of product design and testing processes can dramatically improve time to market for new developments across multiple sectors. For example, within the semiconductor industry, AI-supported design approaches that involve partnership between companies like **Nvidia**, **Taiwan Semiconductor**, **Cadence**, and **Applied Materials** can more quickly and accurately optimize for qualities like compute power, energy efficiency, and production complexity. Within digital learning, **Duolingo** is using AI to enhance its human-powered curriculum development, enabling a greater range of product offerings for customers. In health care, **Novo Nordisk** sees potential to decrease drug development time by two-thirds via AI-driven discovery tools. Energy company **Shell** is using AI-supported analysis in partnership with **Microsoft** to dramatically improve time to discovery for new materials for power storage and carbon capture.

### Operations

Advances within business operations can improve the efficiency of production and service offerings in a wide range of corporate settings. For example, **Gitlab** is integrating AI-driven coding tools to dramatically improve speed and effectiveness of software code writing and management, as are AI-native startups **Cursor** and **Windsurf**. Within the insurance industry,

**AIG** is using AI-powered analytics with partners like **Anthropic** and **Palantir** to improve the efficiency of labor-intensive underwriting processes. **AppLovin** is using AI models to inform more effective ad placements and customer connections for their clients.

### Analytics and feedback loops

Improvements in business analytics and feedback loops can enhance response rates and effectiveness across a variety of business settings. For example, cybersecurity company **CrowdStrike** is using AI to improve security monitoring, detection, and response. Within health care, **Intuitive Surgical** is using AI to enhance analytics and improve surgical outcomes. In the field of planetary health, Earth imaging company **Planet Labs** is partnering to provide real-time information on methane leaks, enabling quicker remediation.

Opportunities for AI-driven sustainable solutions will continue to develop rapidly as the technology advances. Companies that build effective solutions have the chance to create attractive businesses, and investors can benefit from assessing the effectiveness of these solutions as the field continues to progress.

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## Conclusion

The development of AI involves unusually broad scope, speed, and power, and therefore the related opportunities and risks are similarly amplified. Given the far-ranging impact of these new technologies, citizens and policy makers have a vital role to play in shaping their deployment. Business leaders also hold significant influence, as they consider how to effectively make use of AI-enabled tools and technologies within their operational settings. As explored in this report, investors can benefit from understanding characteristics of AI leadership and development of effective solutions and analyzing how these translate to specific investment opportunities.

Scientist E.O. Wilson famously observed,

**“We have created a Star Wars civilization, with Stone Age emotions, medieval institutions, and godlike technology.”<sup>15</sup>**

As active, human investors during this unique period in history, we can proactively and seriously consider new questions, even when they do not yet have tidy answers. We can carefully analyze emerging opportunities and risks. We can identify characteristics of leadership and solutions that are not just clever, but potentially wise. We can align our investment decision-making with the world it is intended to serve.

## Members of our Sustainable Equity team and Equity Research team contributed to this report

### LEAD AUTHOR



**Katherine Collins, CFA, MTS**

Head of Sustainable  
Investing and Portfolio  
Manager

### CONTRIBUTORS



**Stephanie Dobson**

Portfolio Manager



**Rob Forker**

Portfolio Manager



**Andrew O'Brien**

Portfolio Manager,  
Analyst



**Di Yao**

Portfolio Manager,  
Analyst



**Robert Gray**

Portfolio Manager,  
Analyst



**Will Rives**

Portfolio Manager,  
Analyst



**Devin Ahearn**

Equity Analyst



**Carly Schultz**

Equity Analyst



**Chris Orski**

Equity Analyst



**Matthew Mu**

Equity Associate

## Endnotes

- 1 Stephen Hawking, speech at University of Cambridge, October 2016.
- 2 IDC, Worldwide AI and Generative AI Spending Guide, August 2024.
- 3 Putnam analysis, using data from company disclosures, market data, and NYU Stern. Publicly disclosed capital spending plans for major hyperscalers total approximately \$250b in 2025 and 300 billion in 2026. Estimates for total S&P500 capital spending for 2025 are approximately \$1 trillion (for the total of all U.S. public companies, this figure is approximately \$1.2 trillion). Based on these estimates, public company hyperscaler capex alone currently accounts for about 25% of S&P500 capital spending in 2025.
- 4 Dario Amodei, Machines of Loving Grace, October 2024.
- 5 The Royal Swedish Academy of Sciences, The Nobel Committee for Chemistry, Computational protein design and protein structure prediction, October 2024. The Nobel Committee for Physics, For foundational discoveries and inventions that enable machine learning with artificial neural networks, October 2024.
- 6 Vinod Khosla, speech at TED conference, April 2024.
- 7 Arman Shehabi et al. Lawrence Berkeley National Laboratory, United States Department of Energy. 2024 United States Data Center Energy Usage Report, December 2024.
- 8 World Economic Forum. Future of Jobs Report, January 2025
- 9 Marc Benioff, CNBC interview, June 26, 2025.
- 10 Melanie Mitchell, Artificial Intelligence: A Guide for Thinking Humans. Farrar, Strauss, and Giroux/Macmillan, October 2019.
- 11 Daniel Dennett, From Bacteria to Bach and Back: The Evolution of Minds. W.W. Norton & Co, February 2017.
- 12 Yoshua Bengio, Chair. International AI Safety Report, January 2025. This report was authored by a panel nominated by the governments of 30 countries, the UN, EU, and OECD.
- 13 Yoshua Bengio, speech at TED conference, April 2025.
- 14 Financial materiality in the context of investment analysis refers to information that is reasonably likely to be important to investors in making investment decisions. Related tools called materiality maps aim to identify governance, social, and environmental issues that are reasonably likely to impact the enterprise value of a company or investment value of a security and, thereby, are most important to investors. General considerations that help to characterize financial materiality for any given issue include prevalence of the issue, intensity or level of impact, and time horizon. The most well-recognized materiality maps have been developed by the Sustainability Accounting Standards Board (SASB) and are now incorporated into the International Sustainability Standards Board (ISSB) framework, which informs the overarching work of the IFRS (International Financial Reporting Standards) Foundation in this area. (IFRS, International applicability of the SASB Standards and Seven key takeaways from the IFRS Sustainability Symposium, March 2023.)
- 15 E.O. Wilson, The Social Conquest of Earth. W.W. Norton & Company, 2013.

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