PROSPECTS 5.0

PROSPECTS 5.0 Industry 5.0 Wiki March 2026 Patent Analysis

Artificial Intelligence in Manufacturing, Production & Industrial Maintenance

Date	: 25.03.2026
Responsible Partner	: INTRACT
Dissemination Level	: PU
Authors	: Nilay Yalcinkaya Yoruk, Kübra Yurduseven

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948

TABLE OF CONTENTS

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948

LIST OF TABLES

LIST OF FIGURES

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948

EXECUTIVE SUMMARY

This report presents a comprehensive patent landscape analysis of Artificial Intelligence (AI) applications in manufacturing, production, and industrial maintenance. The analysis is based on 32,481 patent families retrieved from the European Patent Office's Espacenet database, covering patents classified under CPC code G06Q10 (Administration/Management) intersected with G06N (Computing Arrangements Based on Specific Computational Models) and containing keywords related to manufacturing, production, industry, and maintenance.

The patent landscape reveals an extraordinary growth trajectory, with annual filings increasing from just 22 families in 2007 to 9,459 in 2025, representing a compound annual growth rate (CAGR) of approximately 40% over the last decade. China dominates the filing landscape with 26,448 families (81.4% of all filings), followed by the United States (5,628), WIPO (2,498), South Korea (1,658), and the European Patent Office (1,569). The technology domain is primarily focused on scheduling and resource planning (G06Q10/04), neural networks (G06N3), and sector-specific applications in energy (G06Q50/06) and manufacturing (G06Q50/04).

Europe demonstrates a strong strategic position in this landscape, with the European Patent Office serving as the second-largest CPC assigning office globally (13,840 classifications). European applicants from Germany, the United Kingdom, France, Switzerland, the Netherlands, and other EU member states collectively represent a significant innovation force. Europe's strength lies in high-quality, internationally oriented patent portfolios rather than volume-based strategies, supported by a robust regulatory framework and deep domain expertise in industrial applications.

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948

1. INTRODUCTION

1.1. Background

The convergence of Artificial Intelligence and industrial manufacturing represents one of the most transformative technological shifts of the 21st century. As Industry 4.0 continues to reshape global production systems, AI-driven solutions for manufacturing optimization, predictive maintenance, supply chain management, and quality control have become critical areas of innovation and intellectual property development.

Patent landscape analysis provides a powerful lens through which to examine the evolution, geographic distribution, and competitive dynamics of this rapidly growing technology domain. By systematically analysing patent filings, stakeholders can identify emerging trends, key players, technology focus areas, and strategic opportunities.

1.2. Scope and Methodology

This analysis is based on data exported from the European Patent Office's Espacenet database. The search query combined CPC classification G06Q10 (Administration; Management) with G06N (Computing Arrangements Based on Specific Computational Models), filtered for content related to manufacturing, production, industry, and maintenance. The complete search query was:

```
cpc = "G06Q10/00/low" AND (ctxt = "manufact" OR ctxt = "produc*" OR ctxt =
        "industry" OR ctxt = "maintenance") AND cpc = "G06N/low"
```

This query yielded 32,481 patent family results. The analysis covers multiple dimensions including geographic distribution, temporal trends, technology classifications (IPC and CPC), competitive landscape (top applicants and inventors), language distribution, and applicant/inventor country analysis.

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948

2. TEMPORAL ANALYSIS

2.1. Publication Trend

The publication trend reveals a dramatic acceleration in patent activity, particularly from 2017 onwards. The earliest patents in the dataset date back to 1987, but meaningful filing activity only began in the early 2000s. The period from 2000 to 2015 saw gradual growth, with annual publications rising from 1 to 158 families. The real inflection point occurred around 2016-2017, coinciding with breakthroughs in deep learning and the widespread adoption of AI in industrial applications.

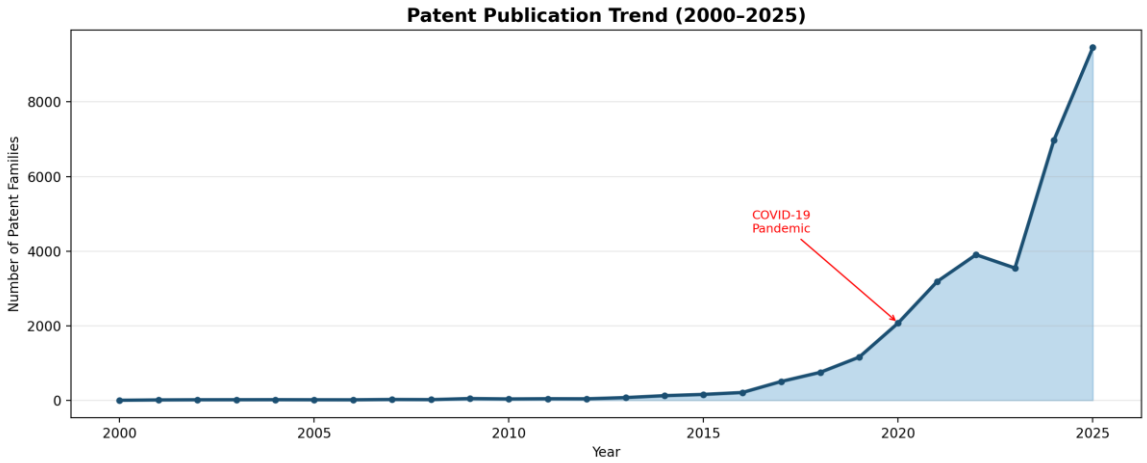

Figure 1 Patent Family Publication Trend (2000-2025)

Key observations from the publication trend:

- 2017-2019: Rapid acceleration phase with year-over-year growth rates of 48.2%, 54.4%, and 79.1% respectively, driven by breakthroughs in deep learning and the Industry 4.0 agenda.
- 2020-2021: Continued strong growth despite the COVID-19 pandemic. The pandemic actually accelerated AI adoption in manufacturing as companies sought automation solutions to address labour shortages, remote monitoring needs, and supply chain disruptions. Publications grew from 2,073 (2020) to 3,183 (2021), a 53.5% increase.
- 2022-2023: A temporary plateau was observed, with 2023 showing a slight decline to 3,547 from 3,904 in 2022 (-9.1%). This may reflect post-pandemic normalization and processing backlogs at patent offices.
- 2024-2025: Explosive resurgence with 6,974 publications in 2024 (96.6% growth) and 9,459 in 2025, likely driven by the generative AI wave and increased integration of large language models into manufacturing systems. The 2025 figure may still increase as more patents are published.

2.2. Year-over-Year Growth Analysis

The year-over-year growth rate analysis provides further insight into the dynamism of this technology domain. Growth rates have been consistently positive with the exception of 2023, which saw a brief contraction.

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948

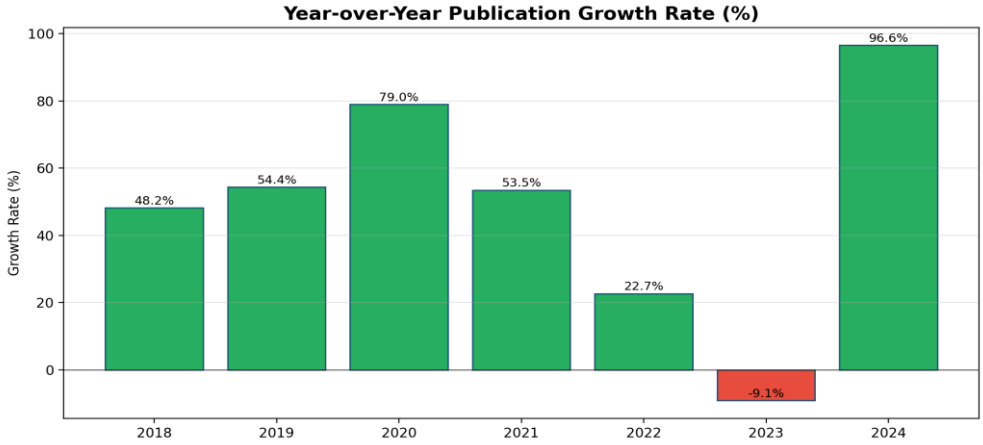

Figure 2 Year-over-Year Publication Growth Rate (%)

2.3. Priority Date Analysis

The earliest priority date distribution provides insight into the actual timing of inventive activity, as priority dates precede publication dates. The data confirms that the bulk of inventive activity in AI for manufacturing has occurred since 2016, with a particularly steep climb from 2019 onwards. The priority date distribution shows 7,412 families with a 2024 priority date and 6,541 with a 2025 priority date. The lower 2025 figure reflects the typical 18-month publication lag rather than declining activity.

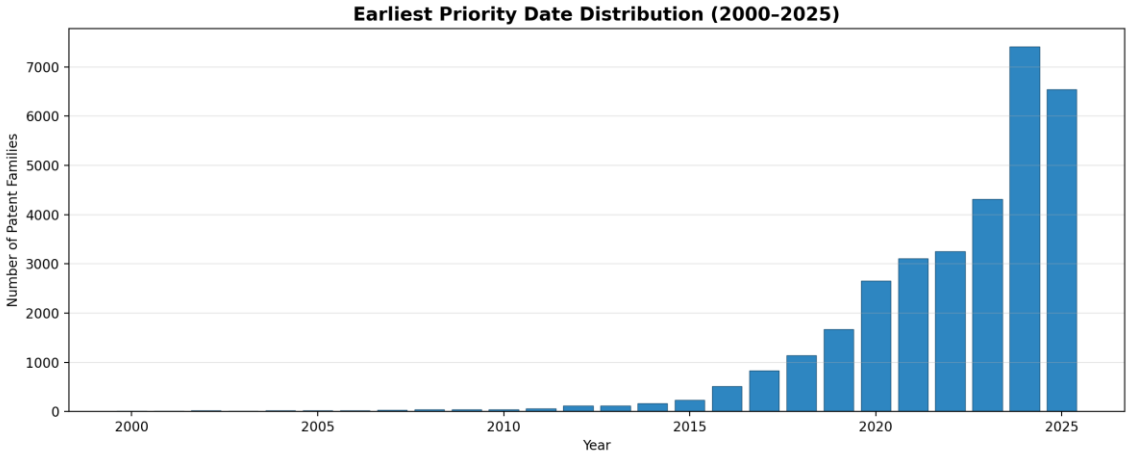

Figure 3 Earliest Priority Date Distribution (2000-2025)

2.4. Impact of COVID-19

The COVID-19 pandemic (2020-2021) had a notable catalytic effect on AI-related patent activity in manufacturing. Rather than suppressing innovation, the pandemic drove a 79.1% increase in filings between 2019 and 2020 (from 1,158 to 2,073 families). Several factors contributed to this acceleration:

- Urgency to automate manufacturing processes to reduce dependence on physical labour presence.
- Increased demand for predictive maintenance and remote monitoring solutions.
- Supply chain disruptions that prompted AI-driven optimization and resilience planning.
- Government stimulus programs and digital transformation initiatives across major economies.

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948

3. GEOGRAPHIC ANALYSIS

3.1. Filing Countries / Offices

The geographic distribution of patent filings reveals a highly concentrated landscape, with China dominating the field by a substantial margin.

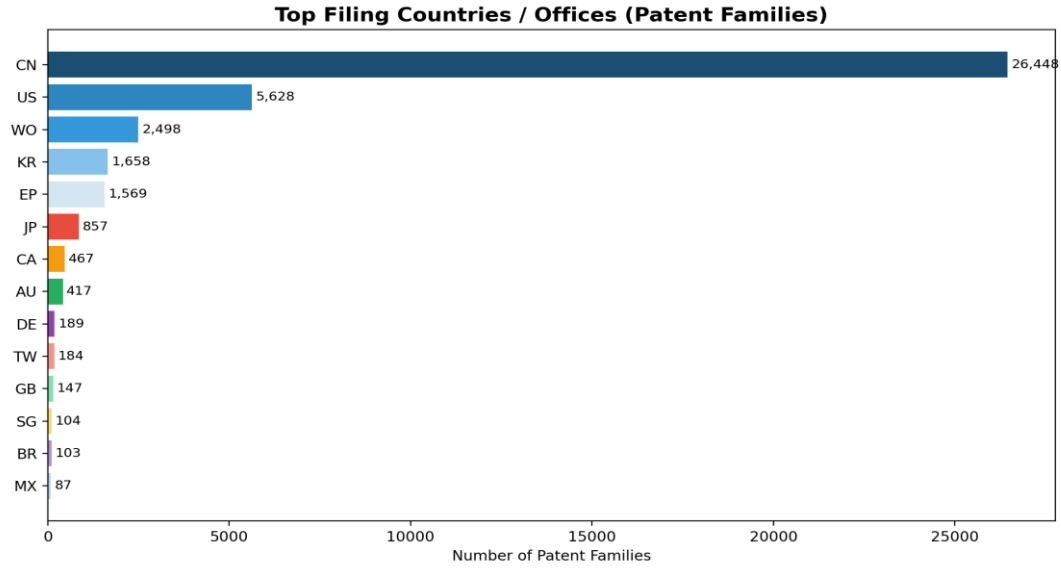

Figure 4 Top Filing Countries / Offices (Patent Families)

China's dominant position (81.4%) reflects its massive investment in AI research and its strategic emphasis on patent filings as a measure of technological progress. The United States holds the second position with 5,628 families, maintaining its role as a key innovation hub. The high number of WIPO filings (2,498) indicates significant international patent protection strategies. The European Patent Office with 1,569 filings demonstrates Europe's active engagement in this technology space.

Table 1 Top Filing Countries / Offices (Patent Families)

Rank	Country/Office	Families	Share (%)
1	China (CN)	26,448	81.4%
2	United States (US)	5,628	17.3%
3	WIPO (WO)	2,498	7.7%
4	South Korea (KR)	1,658	5.1%
5	European Patent Office (EP)	1,569	4.8%
6	Japan (JP)	857	2.6%
7	Canada (CA)	467	1.4%
8	Australia (AU)	417	1.3%

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948

3.2. Applicant Country Analysis

Applicant country analysis identifies where patent-owning entities are headquartered, providing a different perspective from filing office data. In this view, the United States leads with 10,357 patent families, as many US-based companies file extensively through the Chinese (CN) and WIPO (WO) systems.

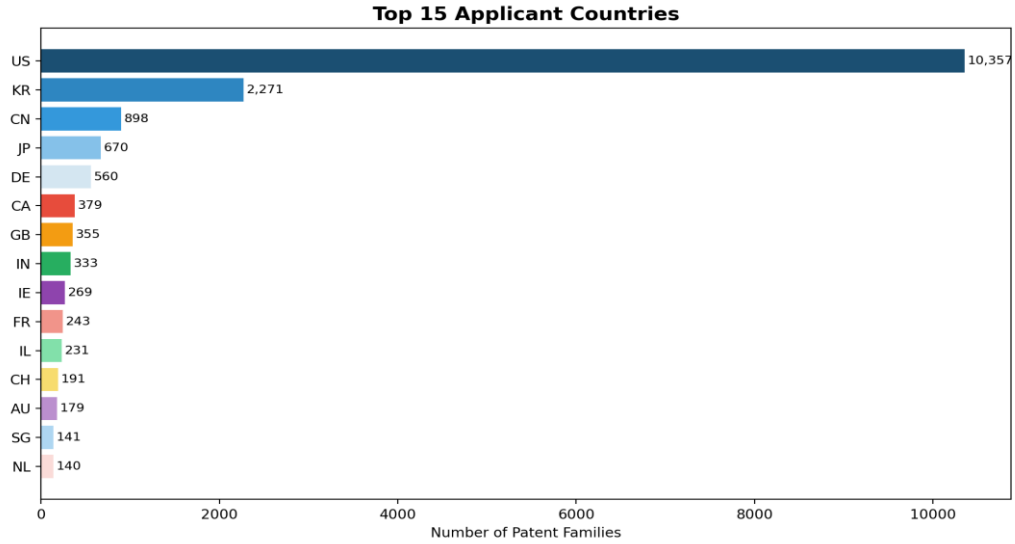

Figure 5 Top 15 Applicant Countries

This distribution reveals that US-headquartered entities are the most prolific applicants globally, despite China having the most filings at its national office. South Korea (2,271), driven by major conglomerates and electronics firms, ranks second. Chinese applicants with identified country codes account for 898 families in this view, though many Chinese university applicants may not have country identifiers in the international dataset.

3.3. Inventor Country Analysis

The inventor country analysis shows where the actual inventive talent is located. The United States leads with 9,358 inventor-linked families, followed by India (1,368), reflecting the significant R&D workforce at US technology companies with India-based development centers. China (1,049), South Korea (953), the United Kingdom (630), Japan (598), and Germany (581) follow as major sources of inventive talent.

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948

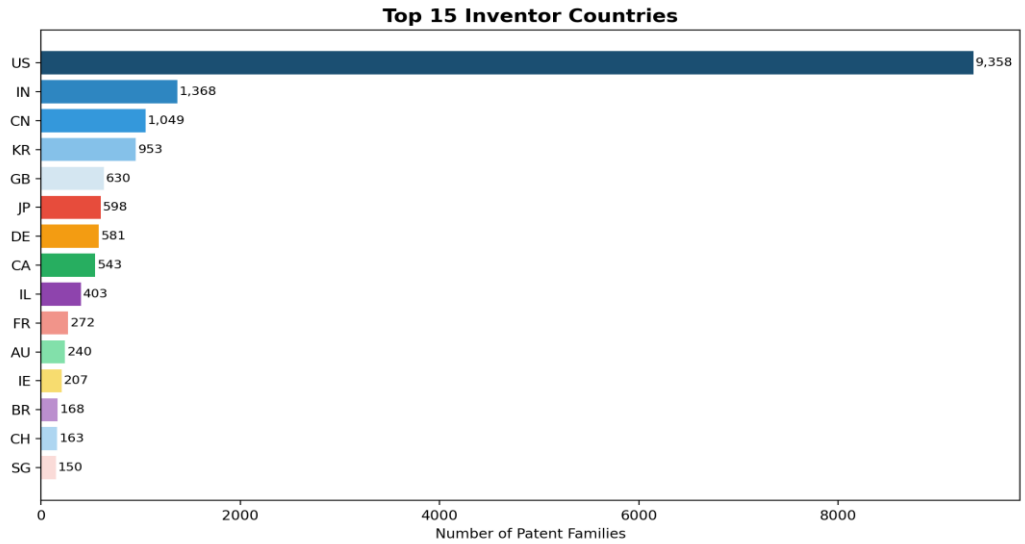

Figure 6 Top 15 Inventor Countries

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948

4. EUROPE: A STRATEGIC INNOVATION HUB

4.1. European Patent Landscape Overview

Europe occupies a strategically significant position in the global AI-for-manufacturing patent landscape. While the filing volume at the European Patent Office (1,569 families) is lower than China and the US in absolute terms, Europe's innovation ecosystem demonstrates remarkable depth, quality, and diversity across multiple nations.

The European Patent Office serves as the second-largest CPC assigning office globally with 13,840 classifications, indicating that a substantial proportion of global patents in this domain are being examined and classified under European standards. This underscores Europe's role as a key gatekeeper and quality benchmark for international patent protection.

4.2. European Applicant Strength

European applicants span a broad geographic base, demonstrating the continent's distributed innovation model:

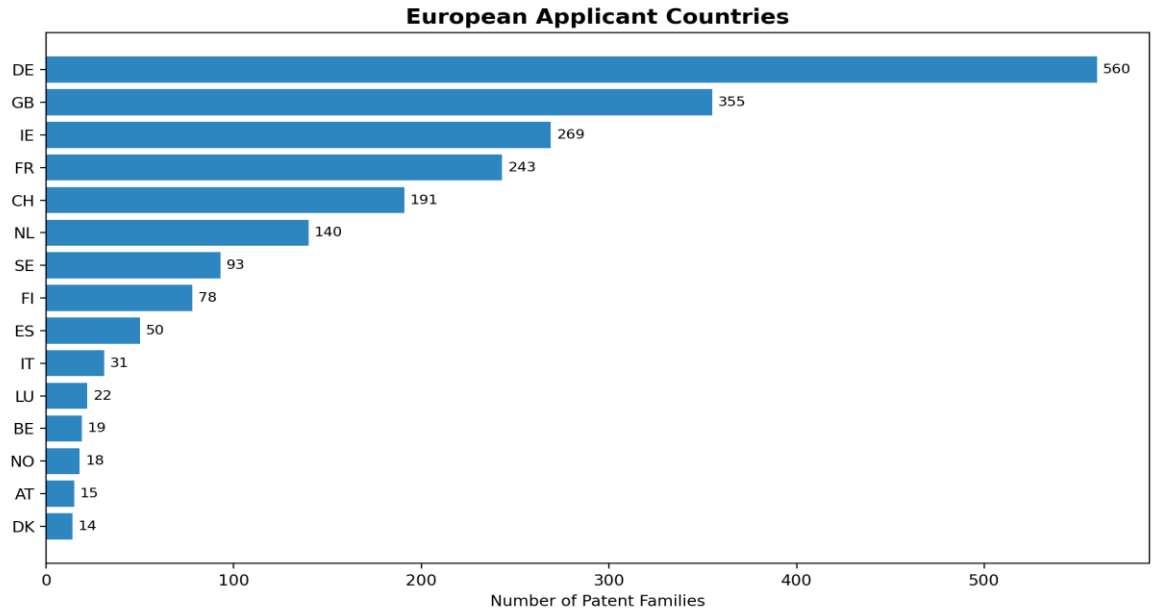

Figure 7 European Applicant Countries

Collectively, European applicants account for over 2,000 patent families, representing a diverse and robust innovation ecosystem. Germany stands out as Europe's leading contributor with 560 families, leveraging its world-renowned industrial base and strong tradition of engineering excellence. The United Kingdom (355 families) and Ireland (269 families) benefit from the presence of major technology company European headquarters and vibrant AI research communities.

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948

Table 2 Applicant Countries – Patent Families and Key Strengths

Country	Applicant Families	Key Strengths
Germany (DE)	560	Industrial automation, Industry 4.0, automotive manufacturing
United Kingdom (GB)	355	AI research, financial technology, energy management
Ireland (IE)	269	Tech multinationals European HQs, enterprise AI
France (FR)	243	Aerospace, energy, industrial engineering
Switzerland (CH)	191	Precision manufacturing, pharmaceuticals, engineering
Netherlands (NL)	140	Semiconductor equipment, logistics, agritech
Sweden (SE)	93	Telecommunications, automotive, industrial robotics
Finland (FI)	78	Telecommunications, energy, environmental tech
Spain (ES)	50	Renewable energy, construction, smart grids

4.3. European Inventor Talent

The inventor country data reveals that Europe possesses a deep and geographically distributed pool of AI talent in manufacturing applications. The United Kingdom (630), Germany (581), France (272), Switzerland (163), the Netherlands (100), Finland (102), Spain (116), and Sweden (82) together represent over 2,000 inventor-linked patent families. This highlights Europe's strength in translating research into patentable innovations.

Notably, European inventor counts often exceed their respective applicant counts (e.g., GB: 630 inventors vs. 355 applicants), suggesting that European researchers are also contributing inventions to globally headquartered companies, particularly US-based multinationals with European R&D centres.

4.4. Europe's Strategic Advantages

- Quality over Quantity: European patents undergo rigorous examination at the EPO, ensuring high patent quality and enforceability. The 1,569 EP filings represent carefully selected, high-value inventions.
- International Orientation: European applicants actively pursue international protection through the WIPO PCT system, indicating confidence in the global commercial value of their innovations.
- Regulatory Leadership: The EU AI Act and related regulatory frameworks position Europe as a global leader in responsible AI deployment, creating a favourable environment for high-quality, ethically grounded innovation.
- Industrial Heritage: Europe's deep expertise in precision manufacturing, automotive engineering, aerospace, and energy systems provides a strong foundation for AI-driven industrial innovation.
- Collaborative Ecosystem: Strong university-industry partnerships and pan-European research programs (e.g., Horizon Europe) foster innovation across borders.

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948

5. TECHNOLOGY CLASSIFICATION ANALYSIS

5.1. IPC Main Groups

The IPC (International Patent Classification) main group analysis reveals the core technology areas covered by patents in this landscape:

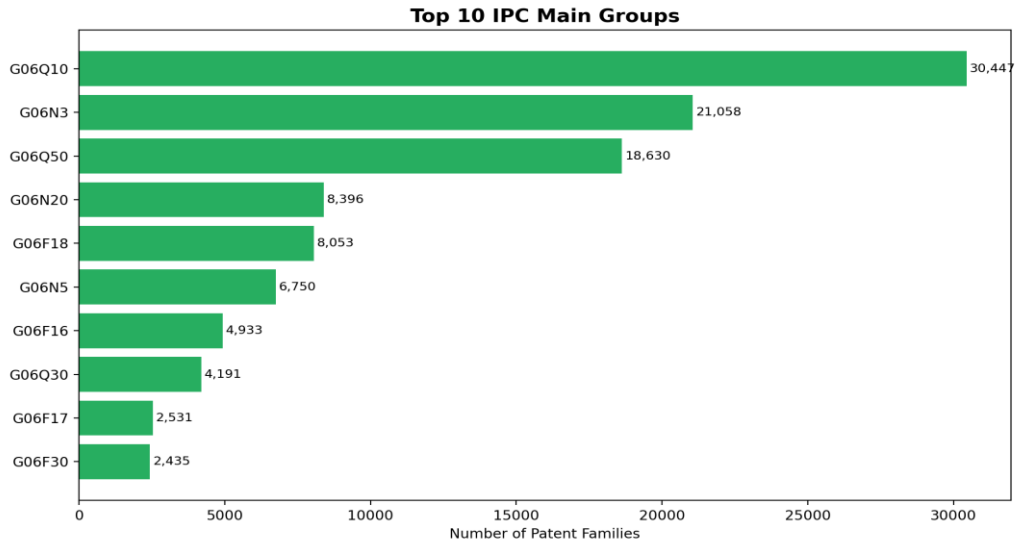

Figure 8 Top 10 IPC Main Groups

The dominance of G06Q10 (Administration/Management, 30,447) confirms the strong focus on operational optimization. G06N3 (Neural Networks, 21,058) indicates that deep learning is the primary AI methodology employed. G06Q50 (Sector-Specific Applications, 18,630) reflects the practical, industry-oriented nature of these innovations.

Table 3 Top IPC Main Groups and Their Patent Families

IPC Code	Description	Families
G06Q10	Administration; Management	30,447
G06N3	Computing arrangements based on biological models (neural networks)	21,058
G06Q50	Information and communication technology for sector-specific applications	18,630
G06N20	Machine learning	8,396
G06F18	Pattern recognition	8,053
G06N5	Computing arrangements using knowledge-based models	6,750
G06F16	Information retrieval; Database structures	4,933
G06Q30	Commerce (e.g., marketing, shopping, e-commerce)	4,191
G06F17	Digital computing or data processing	2,531
G06F30	Computer-aided design	2,435

Funded by the European Union
This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948

5.2. IPC Subgroups

Table 4 The top IPC subgroups provide further granularity

IPC Subgroup	Description	Families
G06Q10/04	Forecasting or optimisation	11,496
G06Q50/06	Electricity, gas, or water supply	7,460
G06N3/08	Learning methods for neural networks	7,412
G06N20/00	Machine learning	6,926
G06Q10/06	Resources, workflows, personnel scheduling	6,460
G06Q10/0631	Resource planning or scheduling for enterprises	5,939
G06N3/04	Architecture of neural networks	4,319
G06Q50/04	Manufacturing	3,811
G06Q10/20	Supply chain management or logistics	3,595
G06Q10/10	Office automation	3,114

Forecasting and optimization (G06Q10/04) lead with 11,496 families, reflecting the core value proposition of AI in manufacturing: predicting demand, optimizing schedules, and improving resource allocation. The energy sector (G06Q50/06, 7,460) emerges as a particularly active application domain, while manufacturing-specific applications (G06Q50/04, 3,811) and supply chain management (G06Q10/20, 3,595) represent focused areas of innovation.

5.3. CPC Classification Analysis

The CPC (Cooperative Patent Classification) analysis largely mirrors the IPC distribution but provides additional insights through its Y-section codes, which identify cross-cutting technologies:

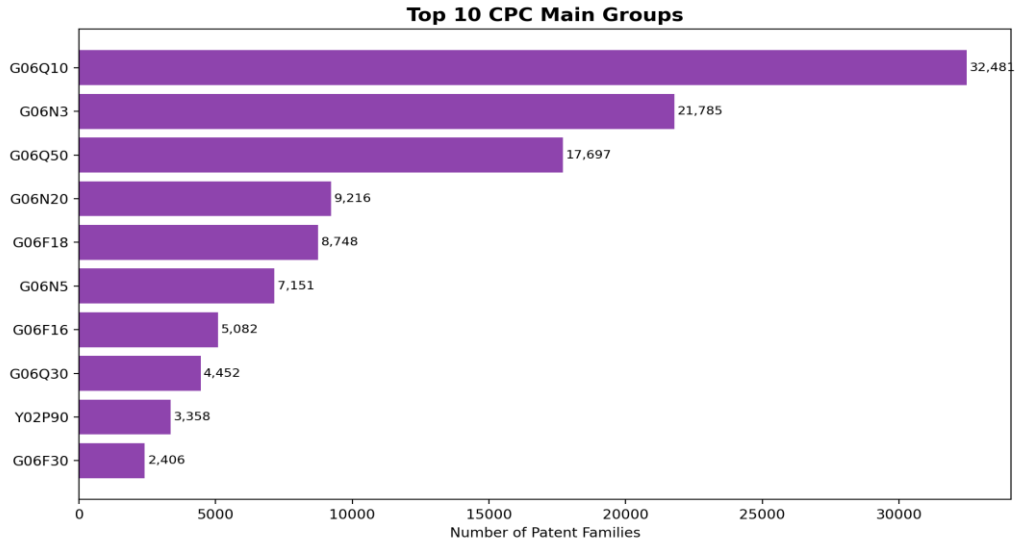

Figure 9 Top 10 CPC Main Groups

Funded by the European Union
This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948

Notably, Y02P90 (Climate change mitigation in production/processing, 3,358 families) and Y04S10 (Smart grids, 2,308 families) appear in the CPC analysis, highlighting the significant intersection between AI-driven manufacturing innovation and sustainability objectives. This aligns with Europe's strong policy emphasis on green industrial transformation.

5.4. CPC Assigning Offices

The CPC assigning office distribution reveals which patent offices are actively classifying patents in this domain:

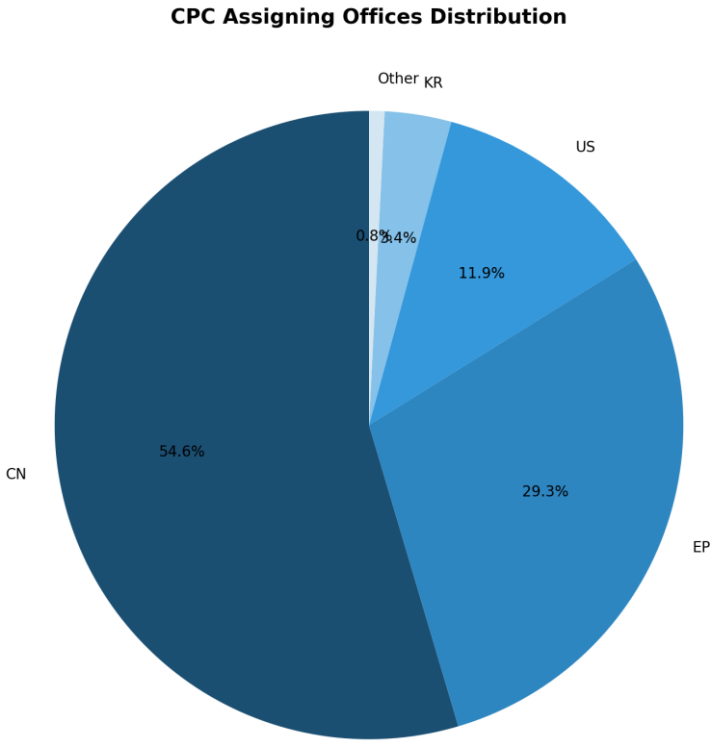

Figure 10 CPC Assigning Offices Distribution

China leads with 25,815 classifications (54.7%), followed by the European Patent Office with 13,840 (29.3%), and the United States with 5,644 (12.0%). The EPO's strong second position as a CPC assigning office demonstrates Europe's significant role in shaping the classification and examination standards for this technology domain, far exceeding its share of national filings.

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948

6. COMPETITIVE LANDSCAPE

6.1. Top Applicants

The applicant landscape is diverse, featuring global technology corporations, major Chinese state-owned enterprises, and leading universities:

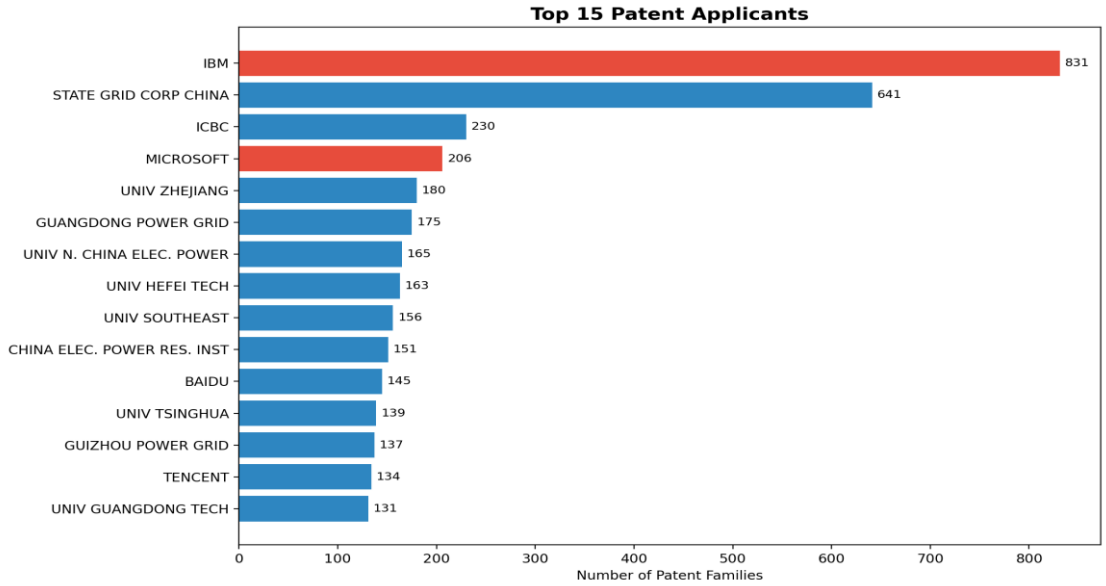

Figure 11 Top 15 Patent Applicants

IBM leads the global ranking with 831 patent families, reflecting its long-standing commitment to AI research and enterprise applications. State Grid Corporation of China follows with 641 families, underscoring the strong focus on energy grid optimization in the Chinese innovation ecosystem. Microsoft (206 families) represents the second major US technology company in the top rankings.

A notable feature of the competitive landscape is the prominence of Chinese universities, including Zhejiang University (180), North China Electric Power University (165), Hefei University of Technology (163), and Tsinghua University (139). This reflects China's academic-driven patent filing culture and the strong university-industry nexus in the Chinese innovation system.

Chinese power grid companies (State Grid Corp, Guangdong Power Grid, Guizhou Power Grid) feature prominently, confirming the strong energy-sector focus within the AI-manufacturing intersection.

6.2. Inventor Analysis

The inventor analysis shows a high degree of Chinese inventor representation in the top rankings. The most frequent inventor names (Wang Wei, Wang Lei, Zhang Wei, Li Wei) are common Chinese names, and the high counts (154-197 per name) likely reflect aggregation of multiple distinct inventors sharing the same name, which is typical in large Chinese patent datasets. This pattern confirms the dominance of Chinese institutional filings in the overall landscape.

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948

7. LANGUAGE ANALYSIS

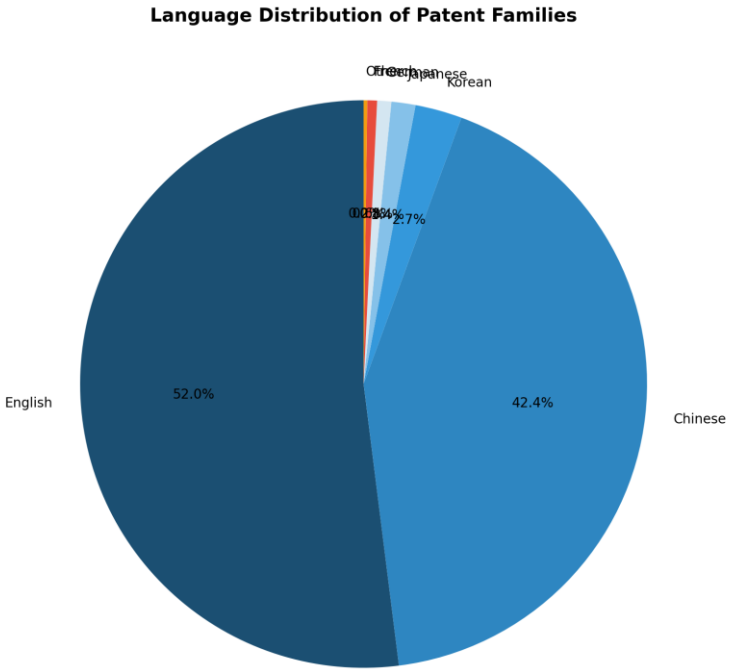

Figure 12 Language Distribution of Patent Families

The language distribution closely mirrors the geographic filing patterns. English (32,457 families) is the most common language, appearing in patents from virtually all filing offices. Chinese (26,468) reflects the massive volume of Chinese filings. Korean (1,669), Japanese (856), German (503), and French (345) round out the top languages. The presence of German (503) and French (345) documents further confirms the active European participation in this technology domain.

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948

8. CONCLUSIONS AND KEY TAKEAWAYS

This patent landscape analysis of 32,481 families in AI applications for manufacturing, production, and industrial maintenance reveals several important conclusions:

- Explosive Growth Trajectory: The field has experienced extraordinary growth, with annual publications increasing from fewer than 50 families in 2009 to over 9,400 in 2025. The recent surge (2024-2025) suggests that the integration of generative AI and large language models into manufacturing systems is opening new waves of innovation.
- COVID-19 as an Accelerator: The pandemic served as a catalyst rather than an impediment, driving increased automation, remote monitoring, and AI-powered supply chain resilience, resulting in sustained growth through 2020-2021.
- China's Volume Leadership: China leads in absolute patent volume (81.4%), driven by state-owned enterprises, power grid operators, and a prolific university system. The United States maintains leadership in applicant-level innovation, with IBM and Microsoft among the top filers.
- Europe's Strategic Strength: Europe demonstrates significant competitive advantages in this landscape. The EPO's position as the second-largest CPC assigning office (29.3% of classifications), the breadth of European applicant countries (led by Germany, UK, Ireland, France, and Switzerland), and the deep pool of European inventor talent position the continent as a quality-driven innovation leader. Europe's regulatory frameworks, industrial heritage, and collaborative research ecosystem provide a strong foundation for continued growth in AI-driven manufacturing innovation.
- Energy and Sustainability Focus: The prominence of energy-related classifications (G06Q50/06, Y02P90, Y04S10) and power grid companies among top applicants highlights the strong convergence between AI-manufacturing innovation and clean energy/sustainability objectives.
- Technology Convergence: The landscape confirms the deep integration of neural networks (G06N3), machine learning (G06N20), and knowledge-based models (G06N5) with operational management and optimization (G06Q10), reflecting the maturation of AI from research curiosity to industrial necessity.

The AI-in-manufacturing patent landscape is poised for continued rapid expansion, driven by advances in generative AI, digital twins, autonomous systems, and the ongoing global push toward sustainable industrial transformation.

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948

9. APPENDIX: METHODOLOGY

Data Source: European Patent Office Espacenet database.

Search Query: cpc = "G06Q10/00/low" AND (ctxt = "manufact" OR ctxt = "produc*" OR ctxt = "industry" OR ctxt = "maintenance") AND cpc = "G06N/low"

Query Languages: English, German, French.

Total Results: 32,481 patent families.

Data Export Date: March 15, 2026.

Analysis Dimensions: Geographic distribution (filing countries, applicant countries, inventor countries), temporal trends (publication dates, priority dates), technology classifications (IPC and CPC codes), competitive landscape (applicants, inventors), and language analysis.

Note: Patent family counts may exceed the total number of unique families as individual patents can be filed in multiple countries and classified under multiple technology codes.

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948

PROSPECTS 5.0

PROSPECTS5-0

PROSPECTS5-0

PROSPECTS5_0

PROSPECTS5-0.EU

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101135948