ARTIFICIAL INTELLIGENCE IN ENERGY TRADING

A benchmark on how Artificial Intelligence is used among European Energy Traders

A study by Capgemini Invent, March 2024
We observe a 22% increase of perceived disruptiveness of AI in Energy Trading since 2021: Study participants categorize AI as highly disruptive. That score increased significantly since our last survey conducted in 2021.

87% of participants are engaged in AI, up from 72% in 2021: The majority of the surveyed energy trading companies is actively participating in AI. Nevertheless, participation differs significantly between municipalities (72%) and pure energy trading companies (100%).

Only 30% of participants show strong AI governance structure: More than 50% of participants show significant AI capabilities according to our AI maturity matrix assessment, while only around 30% show strong AI governance.

More than 60% of 102 actually implemented use cases of our participants are Front Office related: Across the different maturity clusters Trade Execution, Trade Capturing and Physical Operations represent more than 60% of all implemented use cases of the participants, whereas Middle Office and Back Office represent only ~17% of all implemented use cases.

Mature AI traders use “make” or “hybrid” systems for more than 90% of their use cases: Beginners are highly reliant on buy solutions for AI applications with a 44% buy rate, while masters are much more reliant on self-built or hybrid solutions (90%).
Agenda

01 Understanding AI’s role in Energy Trading (pages 4-7)

02 Study methodology and participant insights (pages 8-10)

03 Maturity assessment of Energy Trading companies (pages 11-14)

04 Use case landscape in Energy Trading (pages 15-17)

05 In-depth evaluation of use cases and their methodologies (pages 18-20)

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Trends on the energy market make trading more complex and faster and are the foundation of enhanced AI considerations.

**GREENIFICATION**
The transition to cleaner and more sustainable energy sources lead to new structured products and increased spot market relevance paired with increased short-term deal-counts.

**CHANGING DEMAND BEHAVIOR**
Smart meters, integrated decentralized renewable assets, dynamic pricing and flexibility requirements and values lead to shifts and increased volatilities of demand behaviors of different customer segments.

**REGULATORY CHANGES AND POLICY SHIFTS**
Regulatory changes to secure the integrity of energy markets and control and restrict market abuses impact the necessity of End-to-End data and decision oversight.

**DIGITALIZATION**
Digitalization of the overall energy value chain leads to increased automation and machine-to-machine interactions.

**ELECTRIFICATION AND E-MOBILITY**
Increased adoption of EVs and electricity-driven heating increases volatilities and requires rapid data-driven decision making in trading and energy procurement.

**DECENTRALIZATION & DEMOCRATIZATION**
The integration of scaled energy storage solutions and changing balancing revenues allow for new business models like aggregators and virtual power plants (VPPs) and lead to complex orchestration requirements.
Participants view AI as more disruptive than in 2021 but still have not reached “Plateau of productivity”

Study participants seem to value AI as highly disruptive and significantly higher than in our last survey conducted in 2021; from 5.4 to 6.6.

In general we observe that the peak of inflated expectations towards AI in Trading is left behind and focus is put on implementing scalable and practical structures, processes and governance models.

GenAI only represents a subelement of this study and can be individually considered to be on a different part of the hype cycle currently.
AI requires a nuanced definition and can be largely categorized in two overarching methodologies:

**Artificial Intelligence (AI)**

**Machine Learning**
- Empowering systems to automatically learn & improve from experience without being explicitly programmed
- Employing algorithms to analyze data, identify patterns & make informed predictions

**Deep Learning**
- Transforming representation at one level into a representation at a higher & more abstract level
- Advantage in ability to process vast amounts of big data

**Supervised Learning**
- Trained on labeled datasets with known outcomes
- Learns patterns and relationships between inputs and outputs
- **Methods:** Linear regression & classification

**Unsupervised Learning**
- Processes unlabeled data to identify patterns or relationships
- Does not rely on predefined outcomes
- **Methods:** Clustering & user segmentation

**Reinforcement Learning**
- Decision-making through trial and error
- It learns by receiving rewards or penalties based on its actions
- **Methods:** Automated agents

**Examples in Energy Trading:**
- Uses historical data with labeled energy prices & relevant features to predict future prices
- Analyzes unlabeled data like market behavior & consumption patterns to gain insights
- Executes trades of energy assets based on market conditions, refining strategies over time through continuous feedback

AI provides powerful tools that can be strategically deployed in energy trading, unlocking lucrative opportunities.
Machine Learning and Deep Learning methods offer a wide tool set for AI use cases in Energy Trading

<table>
<thead>
<tr>
<th>Tool</th>
<th>Description</th>
<th>👍</th>
<th>👎</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random Forests for Price Prediction</td>
<td>Ensemble learning method used for predicting energy prices by combining multiple decision trees</td>
<td>Capturing nonlinear relationships</td>
<td>Struggling with overfitting on small datasets</td>
</tr>
<tr>
<td>Ensemble Learning with XGBoost</td>
<td>Efficient ensemble learning algorithm often applied to optimize energy market predictions by combining multiple models</td>
<td>Handling missing data &amp; offering high predictive accuracy</td>
<td>Challenging interpretability of model</td>
</tr>
<tr>
<td>Markov Decision Processes (MDP)</td>
<td>Modeling decision-making processes over time, making them suitable for optimizing energy trading portfolios</td>
<td>Comprehensive management portfolio approach</td>
<td>Accurate modeling of transition probability required</td>
</tr>
<tr>
<td>Long Short-Term Memory (LSTM) Networks</td>
<td>Part of Recurrent Neural Networks, effective in capturing sequential dependencies for time series forecasting in energy markets</td>
<td>Modeling complex patterns in energy market trends</td>
<td>Struggling with abrupt changes in market conditions</td>
</tr>
<tr>
<td>Transformer Models for Time Series Forecasting</td>
<td>Analyzing historical energy market data to predict future trends and price movements</td>
<td>Capturing &amp; handling global, long-range dependencies in data</td>
<td>Requiring large amount of data for effective training</td>
</tr>
<tr>
<td>GenAI</td>
<td>Employing generative algorithms to simulate and propose diverse trading strategies based on historical market data</td>
<td>Enhancing adaptability to dynamic markets</td>
<td>Requiring careful scrutiny and testing before implementing</td>
</tr>
</tbody>
</table>

The AI toolset is vast and proves highly beneficial for numerous use cases within the realm of energy trading, addressing a wide range of potential challenges.
Our 2024 survey analyzed 22 Energy Trading companies in Europe to identify trends and patterns in AI approaches.

The goal of this study is to **identify the trends of AI adoption within the energy trading industry** enriched by a trend analysis based on our last AI in Energy Trading Survey in 2021.

Capgemini Invent surveyed **22 energy traders** in Europe with a focus on Central Europe.

Our guiding question is: What is the **current and changed** picture of **AI-maturity**, relevant **use case maturity**, and **technology adoption strategy** in the Central European energy trading industry?

![Bar chart showing company type by survey year](chart.png)
Throughout all company types AI participation in the Energy Trading industry is high and increased from 73% to 87%

AI Participation Rate in Energy Trading
AI participation rate (current and planned implementation), group averages, %

<table>
<thead>
<tr>
<th>Category</th>
<th>2021</th>
<th>2024</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Respondents</td>
<td>73</td>
<td>87</td>
</tr>
<tr>
<td>Fully integrated energy</td>
<td>70</td>
<td>88</td>
</tr>
<tr>
<td>Municipal utility</td>
<td>50</td>
<td>72</td>
</tr>
<tr>
<td>Pure energy trading companies</td>
<td>90</td>
<td>100</td>
</tr>
</tbody>
</table>

87% of energy trading organizations participate in AI

PURE ENERGY TRADING COMPANIES: With a 100% adoption rate in this year’s survey pure energy trading companies stand out in the AI adoption degree.

FULLY INTEGRATED ENERGY COMPANIES: 9 out of 10 fully integrated energy companies use AI in their trading operations. 3 years after our first survey fully integrated energy companies have the same adoption rate as pure energy traders in 2021.

MUNICIPAL UTILITY COMPANIES: Municipal utility companies continue to represent the lowest degree of AI adoption. With an almost 50% increase municipal utilities witnessed the relatively spoken biggest increase of AI adoption across all segments.
Perceiving AI as a competitive advantage is highly correlated with the AI understanding in the surveyed companies.

Unlocking AI competitiveness through understanding

In our survey, a compelling correlation emerges: Perceiving AI as a competitive advantage is highly correlated with the AI understanding in the surveyed companies. This relationship underscores the pivotal role of AI Literacy in bolstering market advantage.

To gain a competitive advantage, enhancing AI understanding or AI Literacy is vital. This often stems from hands-on experience with AI use cases. Notably, companies excelling in perceived AI understanding have already capitalized on these practical applications.
More than 50% of participants have built up significant AI capabilities, while less than 30% show strong AI governance
Based on the AI governance and AI capabilities 4 different maturity groups can be differentiated

**BEGINNER – What’s in it for me?**
“Beginners” are just getting a taste of things, hardly using any form of AI. They have a relatively low level of governance structures, organize AI in a largely decentralized manner, mostly do not employ AI experts, and are implementing their first AI projects, which are usually intended to prove the viability of AI. With their first projects, they gain initial experience and prepare the organization for further steps.

**EXPLORER – Trial and error.**
“Explorers” are feeling their way forward. They have a relatively low level of governance structures, organize AI in a largely decentralized manner, employ only a few AI experts, and have initial scaled AI projects that represent isolated organizational solutions. With their projects, they continue to expand their know-how in specific domains and thus increase personal skills and organizational learning.

**MANAGER – Rules before action.**
“Managers” rely on an organizational framework. They show a high degree of governance structures, usually organize AI in a central unit, and may already have hired AI experts. On this basis, they plan and develop the first AI projects. With each additional project, structures grow first, before experience and know-how come into play.

**MASTER – AI is in my DNA.**
“AI Masters” know what they are doing. They show a high degree of governance structures, organize AI in a central unit, employ experts, and engage in very mature AI projects that require a high level of organizational embedding. With their numerous and diversified use cases, they have perfected their experience and built reliable programming skills.

**NO ACTIVITY – AI is nothing for me.**
These companies have no AI initiatives. Organizational structures remain unaffected by AI so far and the companies are not building up experience in this area.
In comparison to 2021, Explorers & Masters double while a structural trend towards more governance can be observed.

**Maturity Cluster Evolution**

**Trend: 2024 vs. 2021 results**

1. **BEGINNERS**
   - Experienced a substantial decline, as many companies have begun to actively involve themselves with AI.

2. **EXPLORERS**
   - There has been a stronger focus on governance, as many companies have already built a solid knowledge base.

3. **MANAGERS**
   - Experienced a decline as they successfully advanced to master level, driven by the establishment of essential capabilities.

4. **MASTERS**
   - Substantial increase as maturity advances within the industry, leading to initial master-level entities.

5. **NO ACTIVITY**
   - Drastic decrease, since many companies have started dealing with AI. The remaining are mostly municipal utilities.

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Learn how Capgemini recommends to become an AI master on the next slides.
To ensure a capability-driven development we recommend a “Use Case First” approach on the road to AI mastery

Capgemini recommends an N-shaped path to AI mastery, to ensure a capability-driven development.

What does this mean?

In the pursuit of AI mastery, prioritize developing AI capabilities before establishing governance. This acknowledges that creating governance structures often incurs higher costs and setting them up without clear needs can result in unfitting frameworks.

For Beginners, skill enhancement begins by experimenting with use cases. Prioritizing personal AI capabilities before institutionalizing governance, facilitates swift evaluation of potential cases and clearer identification of high-value opportunities.

Explorers with advanced AI skills should concentrate on establishing AI governance for their capabilities to yield desired impacts. However, this process might temporarily slow down use case development.

Managers equipped with robust AI governance should prioritize high-impact use cases, scaling them up to maximize their value.
Use case application differs widely between maturity clusters, while Front Office represents the most active application area.

### Established Use Case Categories Popularity

<table>
<thead>
<tr>
<th>Trading Area</th>
<th>Use Cases</th>
<th>Maturity Cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trade Execution</strong></td>
<td></td>
<td>Beginner</td>
</tr>
<tr>
<td>Automated Trading</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Decision supporting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade timing optimization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Algorithmic trading in financial markets (derivatives)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Algorithmic trading in short-term physical markets</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Financial Forecasting</strong></td>
<td>Price forecasting</td>
<td></td>
</tr>
<tr>
<td>Cash flow forecasting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenue and cost forecasting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generation of custom-made financial plans and investment strategies</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Trade Capturing</strong></td>
<td>Information Extraction</td>
<td>5</td>
</tr>
<tr>
<td>Automated trade capturing via voice-to-text recognition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automated trade capturing via text-to-text recognition</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Physical Operations</strong></td>
<td>Predictive load forecasting</td>
<td>3</td>
</tr>
<tr>
<td>Scheduling and balancing optimization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automated nomination on a continuous real-time basis</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Risk Management</strong></td>
<td>Anomaly detection</td>
<td></td>
</tr>
<tr>
<td>Fraud detection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquidity risk forecasting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predictive credit scoring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predicting risk assessment (market, price, operational, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Compliance</strong></td>
<td>Supply chain monitoring</td>
<td></td>
</tr>
<tr>
<td>Trade Surveillance</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Billing &amp; Settlement</strong></td>
<td>Automated Report Generation</td>
<td></td>
</tr>
<tr>
<td>Intelligent and automated reconciliation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intelligent invoice processing via Optical Character Recognition</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. **Trade execution** remains the most actively pursued use case across different maturity clusters.
2. Only **Masters & Explorers** venture into the Middle- & Backoffice use cases.
3. **Explorers** are heavily active in physical operations, which can be partially explained by the fact that the majority are integrated energy companies.
4. **Managers** have the most concentrated/limited range of use cases, focusing on trade execution, trade capturing & physical operations.
5. **Beginners** experiment in all application areas and lack a common focus area.

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All maturity clusters tend to focus and expand on known use case areas in Front Office before extending into new areas.

<table>
<thead>
<tr>
<th>Maturity Cluster &amp; Trading Area</th>
<th>Beginner</th>
<th>Explorer</th>
<th>Manager</th>
<th>Master</th>
<th>% of overall use cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade Execution</td>
<td></td>
<td></td>
<td>4</td>
<td>11</td>
<td>30,4%</td>
</tr>
<tr>
<td>Financial Forecasting</td>
<td>3</td>
<td>13</td>
<td>0</td>
<td>6</td>
<td>20,6%</td>
</tr>
<tr>
<td>Trade Capturing</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>15,7%</td>
</tr>
<tr>
<td>Physical Operations</td>
<td>5</td>
<td>9</td>
<td>3</td>
<td>0</td>
<td>16,7%</td>
</tr>
<tr>
<td>Risk Management</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td></td>
<td>9,8%</td>
</tr>
<tr>
<td>Compliance</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3,9%</td>
</tr>
<tr>
<td>Billing &amp; Settlement</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td></td>
<td>2,9%</td>
</tr>
</tbody>
</table>

It is a self-propelling situation: Trading areas in which use cases are established are being further expanded!
Only beginners are strongly reliant on exclusive buy solutions, whereas more mature participants use make or hybrid systems.

We have not only assessed the use cases but also considered the decision between making or buying the use case:

**BEGINNERS**
Beginners exhibit disproportionately high buy activities in all trading areas.

**EXPLORERS**
Explorers are planning use cases in nearly every trading area; the make/buy decision is driven by use cases.

**MANAGERS**
Managers focus on a few specific trading areas and use cases due to a higher emphasis on governance; the make/buy decision is driven by use cases.

**MASTERS**
Masters tackle challenging Middle- & Backoffice use cases and seek assistance when needed.
The study shows that every maturity cluster has a different recommended next use case

<table>
<thead>
<tr>
<th>Maturity cluster</th>
<th>Next Use Case</th>
<th>Top Benefit</th>
<th>Top Cost Reduction</th>
<th>Interpretation</th>
</tr>
</thead>
</table>
| No Activity      | Price forecasting | • Enhanced decision-making  
• Risk mitigation | • Resource optimization  
• Operational efficiency | In AI adoption, novices explore proven price forecasting for its widespread use and simple implementation with external expertise. |
| Beginner         | Trade Execution | • Optimized liquidity management | • Process efficiency and error reduction | No Beginner has dealt with automated trading → Close gap to explorer, easy to implement. |
| Explorer         | No use case recommendation, main goal: Focus on Governance | | | Explorers prioritize building governance, ensuring scalable deployment of diverse use cases. |
| Manager          | Financial forecasting & Trade Execution | • Enhanced decision-making  
• Risk mitigation | • Resource optimization  
• Operational efficiency | Managers enhance governance to fill the gap in financial forecasting, crafting resilient strategies. |
| Master           | Trade Surveillance | • Early risk detection  
• Improved compliance | • Automated monitoring  
• Labor cost savings | Masters innovate in Middle- and Backoffice edge cases and gain a distinctive market advantage. |
## Capgemini’s expertise: Understanding top use cases and offering qualified implementation recommendations

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Assumption</th>
<th>Methodical Implementation</th>
<th>Effort Score</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Price Forecasting</strong></td>
<td>• Historical data available&lt;br&gt;• Adequate computing resources&lt;br&gt;...</td>
<td>• Linear regression&lt;br&gt;• Neural networks with ensemble learning</td>
<td>★★★★★</td>
<td>• Precise predictions to enhance trading decisions&lt;br&gt;...</td>
</tr>
<tr>
<td><strong>Cash flow forecasting</strong></td>
<td>• Detailed financial records&lt;br&gt;• Adequate computing resources&lt;br&gt;...</td>
<td>• Time series analysis&lt;br&gt;• Neural networks with ensemble learning</td>
<td>★★★★★</td>
<td>• Accurate insights for optimized financial planning (liquidity etc.)&lt;br&gt;...</td>
</tr>
<tr>
<td><strong>Algorithmic trading in financial markets</strong></td>
<td>• Real-time market data&lt;br&gt;• High-speed trading systems&lt;br&gt;...</td>
<td>• Moving averages&lt;br&gt;• Reinforcement learning</td>
<td>★★★★★</td>
<td>• Automated trading for structured and faster trading activities&lt;br&gt;...</td>
</tr>
<tr>
<td><strong>Information Extraction</strong></td>
<td>• Structured data sources&lt;br&gt;• Adequate data processing tools&lt;br&gt;...</td>
<td>• Natural language processing&lt;br&gt;• Transformer networks</td>
<td>★★★★★</td>
<td>• Extracting valuable insights from textual data&lt;br&gt;...</td>
</tr>
<tr>
<td><strong>Risk Prediction</strong></td>
<td>• Comprehensive risk factors&lt;br&gt;• Statistical modeling skills&lt;br&gt;...</td>
<td>• Decision trees&lt;br&gt;• Random forests</td>
<td>★★★★★</td>
<td>• Improved risk assessment for informed decisions&lt;br&gt;...</td>
</tr>
</tbody>
</table>
Shaping the future: Each trader’s current AI maturity status sets the stage for next focus areas

**What’s next?**

1. **Use Cases First - Governance second**
   - The N-shape approach shows that exploring use cases first and governance second is the most efficient way towards AI mastery. AI applications seem to be self-propelling, hence active measures to spread applications are required to create cross department value.

2. **Diversifying Beyond Front Office Use Cases**
   - Beyond the market-centric applications, companies poised for progress should explore promising Middle- & Backoffice use cases. Despite being seemingly distant from direct revenue generation, these initiatives play an essential role regarding efficiency and insights. The challenge lies in aligning Back Office operations with the accelerated pace of Front Office activities.

3. **Anticipating the Future: A Vision for Traders in the Next 3 Years?**
   - In the face of reduced human involvement, the main challenge for energy trading will be to enable and upskill professionals – a "Trader 2.0" - a hybrid of a traditional Front-/Middle-/Backoffice employee and a data scientist. This convergence aims to blend the strengths of the data and energy trading worlds for a more adaptive and proficient future.
Empower your Energy Trading Skills: Connect with us to master AI!

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Lennard Knorrr
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