ARTIFICIAL INTELLIGENCE IN ENERGY TRADING

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

A study by Capgemini Invent, March 2024

Management Summary and Key Facts

1   **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.

2   **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%).

3   **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.**

4   **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.

5   **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)

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

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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.**

European energy trends make trading more complex than ever before

DIGITALIZATION

Digitalization of the overall energy value chain leads to increased automation and **machine-to-machine interactions.**
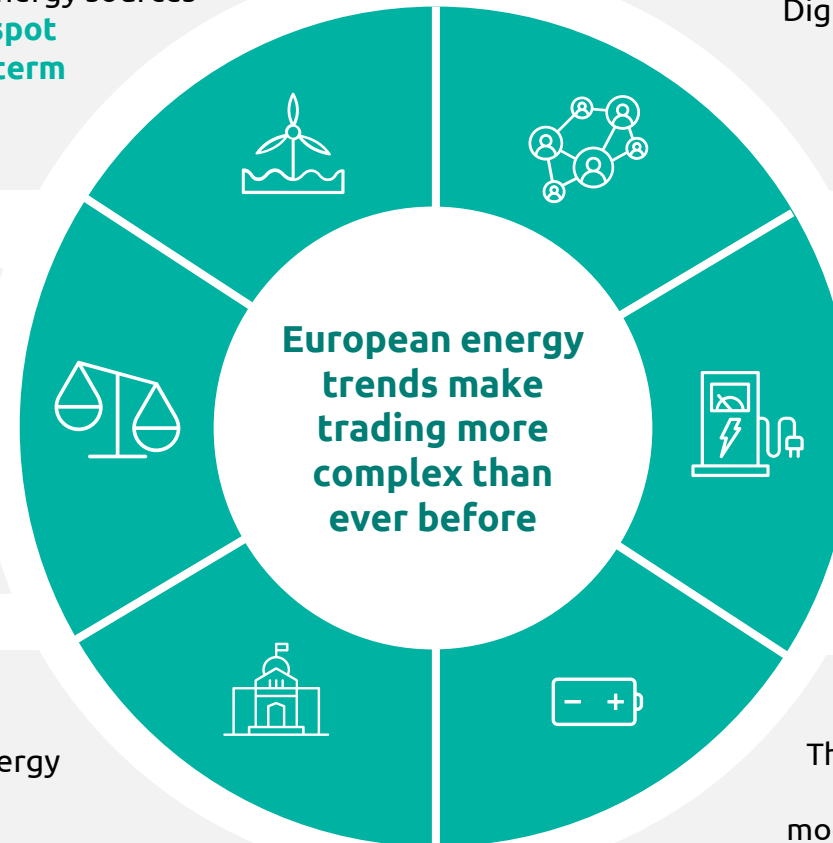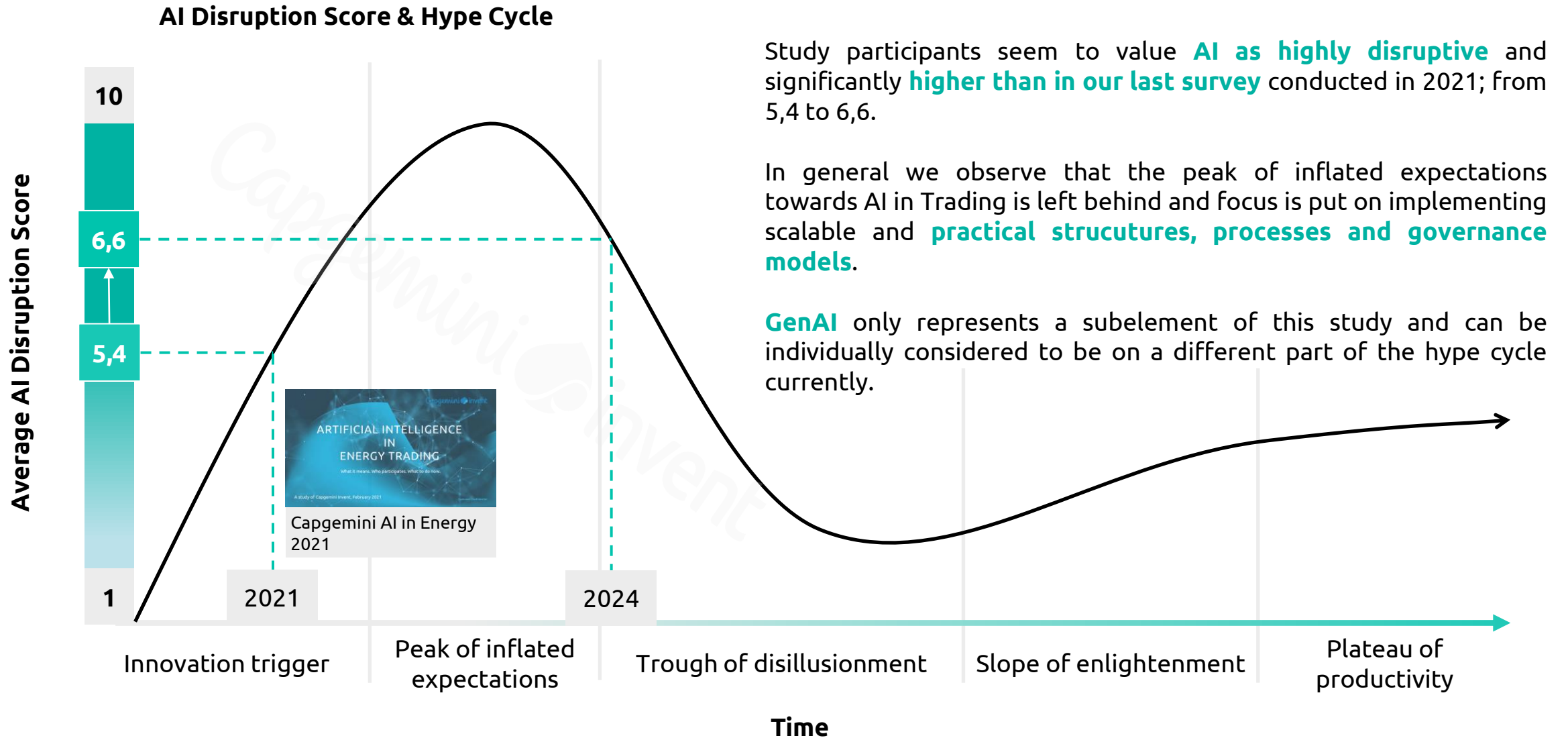
ELECTRIFICATION AND E-MOBILITY

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"

AI Disruption Score & Hype Cycle

Average AI Disruption Score

10

6,6

5,4

1

Capgemini AI in Energy 2021

2021

2024

Time

Innovation trigger

Peak of inflated expectations

Trough of disillusionment

Slope of enlightenment

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 strucutures, 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

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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

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

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.

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Our 2024 survey analyzed 22 Energy Trading companies in Europe to identify trends and patterns in AI approaches
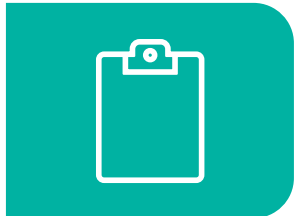
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The goal of this study is to **identify the trends of AI adoption within the energy trading industry** enriched by a trend analysis based on our last AI in Energy Trading Survey in 2021.

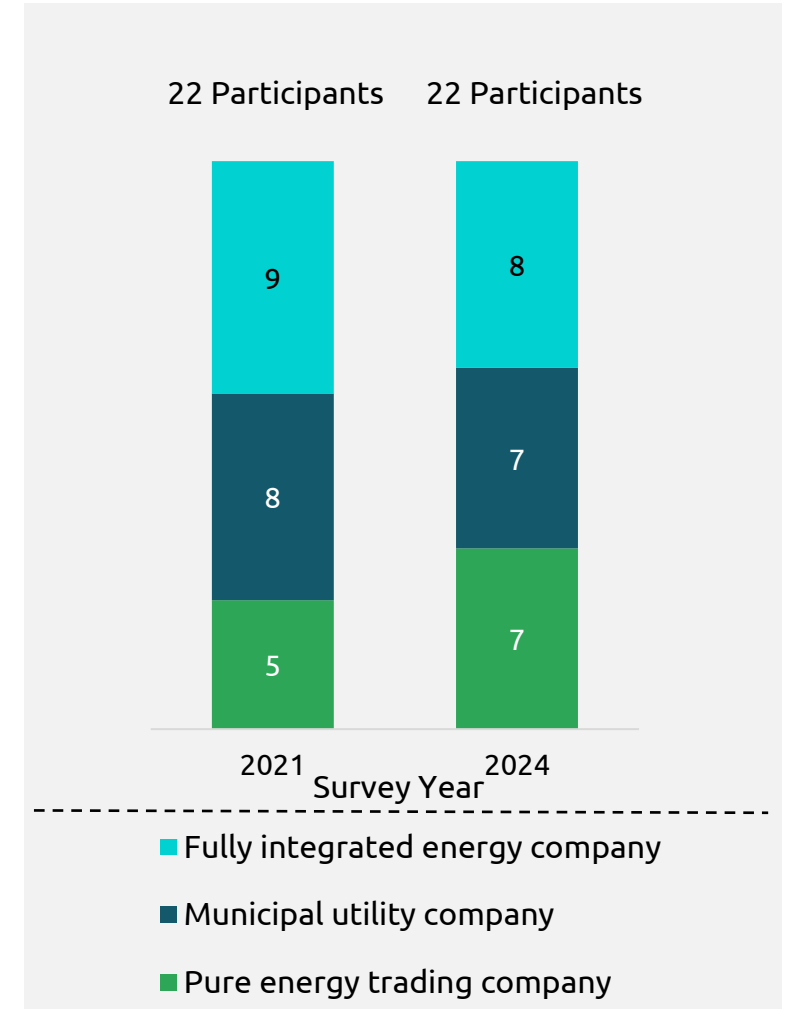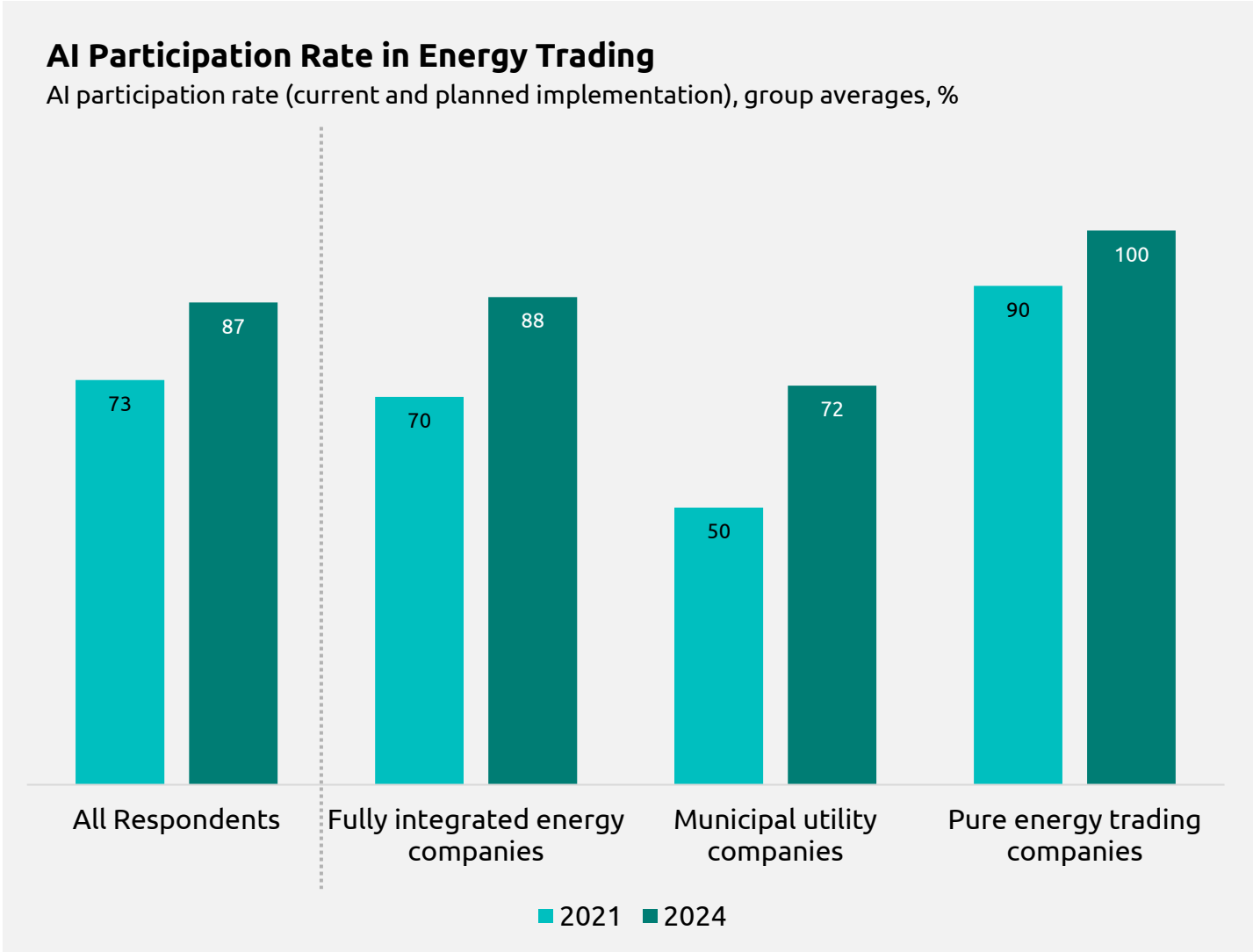Capgemini Invent surveyed **22 energy traders** in Europe with a **focus on Central Europe**.

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?

Company Type by Survey Year

22 Participants   22 Participants

- 2021 — 9, 8, 5
- 2024 — 8, 7, 7

Survey Year

■ Fully integrated energy company

■ Municipal utility company

■ Pure energy trading company

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, %

All Respondents: 73 (2021), 87 (2024)
Fully integrated energy companies: 70 (2021), 88 (2024)
Municipal utility companies: 50 (2021), 72 (2024)
Pure energy trading companies: 90 (2021), 100 (2024)

■ 2021 ■ 2024

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
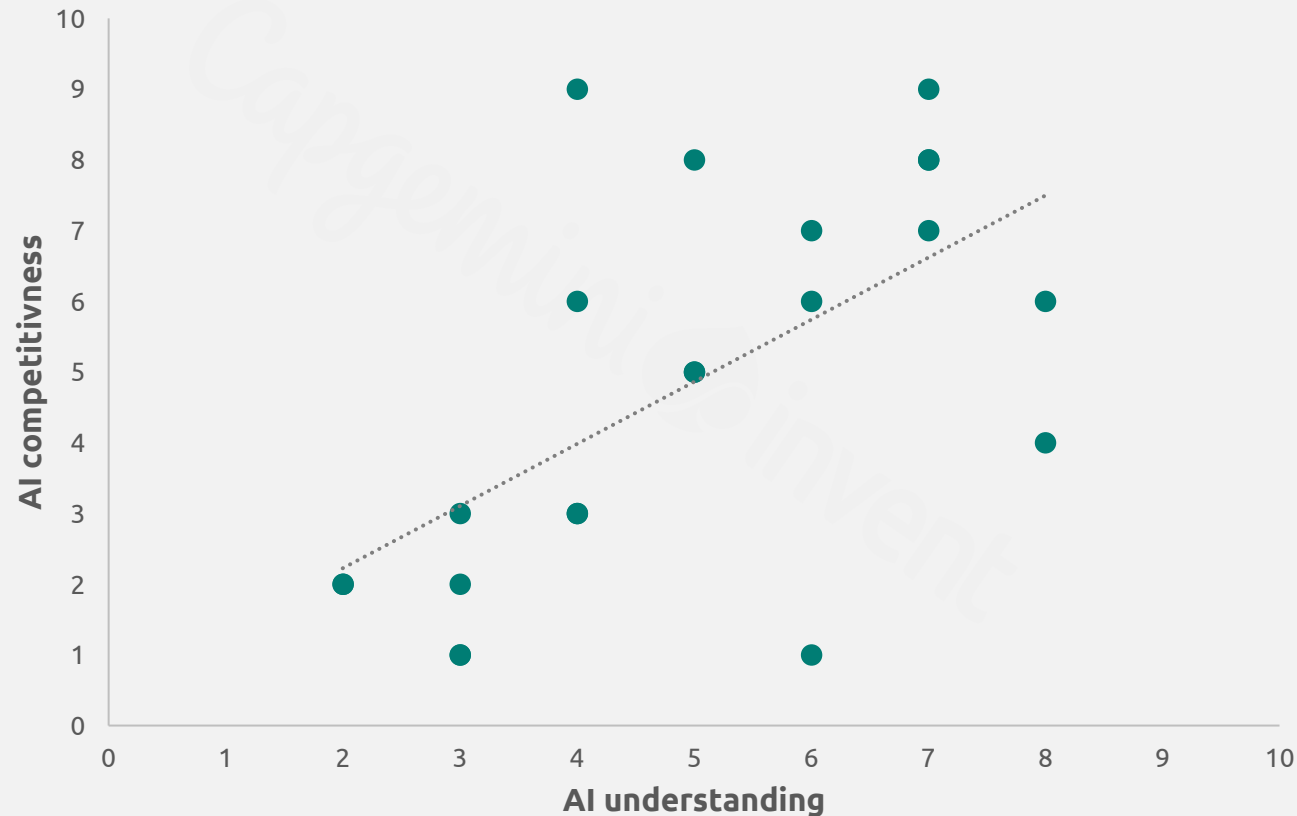
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Organization's Self-Rated AI Understanding vs. AI Competitiveness

X-axis: AI understanding (0–10)
Y-axis: AI competitivness (0–10)

High perceived AI understanding significantly influences the energy trader's competitive edge.

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.
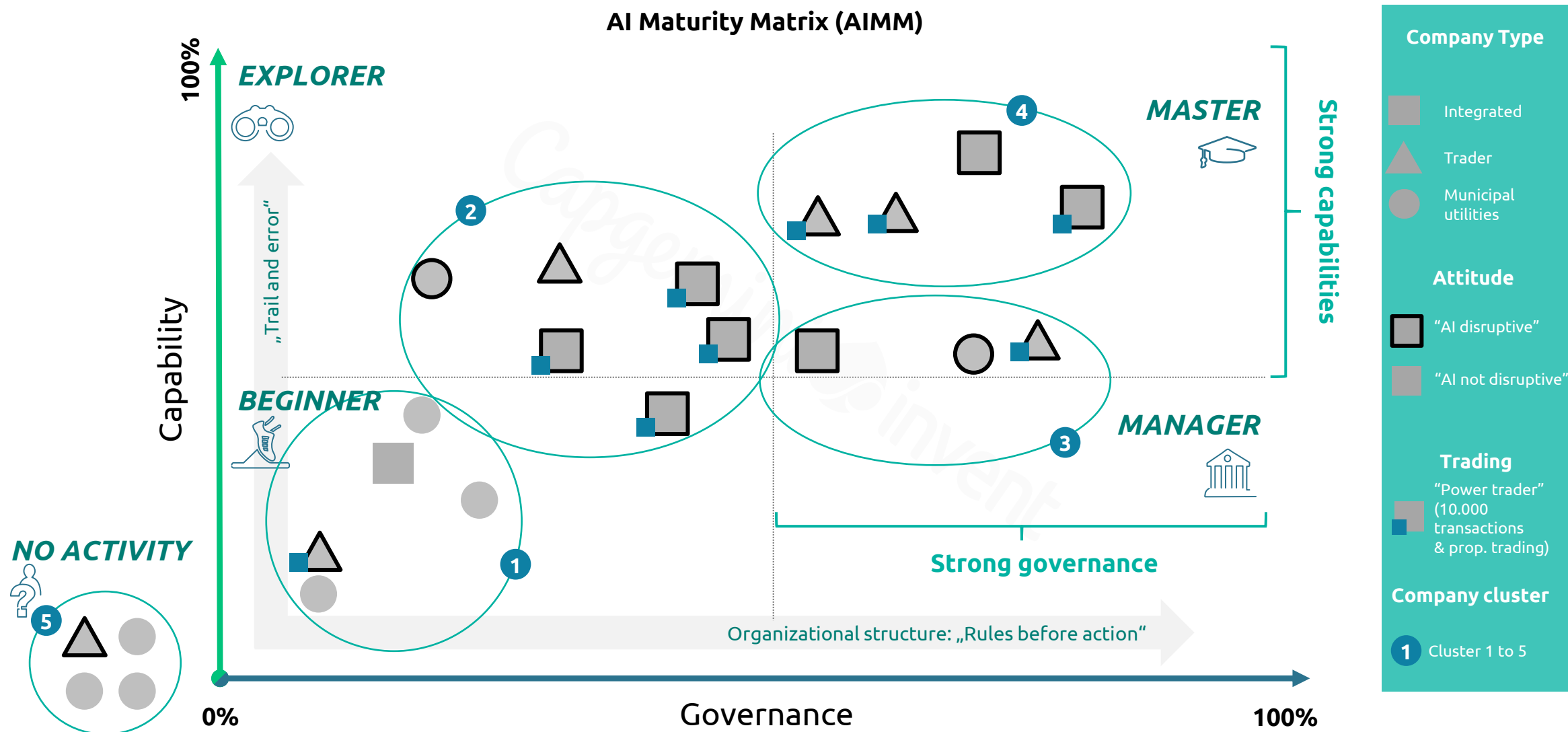
More than 50% of participants have built up significant AI capabilities, while less than 30% show strong AI governance

AI Maturity Matrix (AIMM)
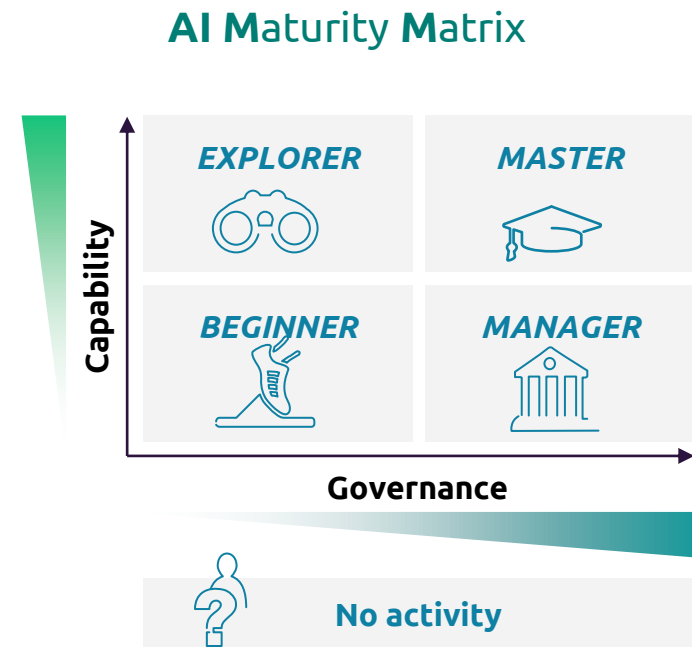
Based on the AI governance and AI capabilities 4 different maturity groups can be differentiated

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AI Maturity Matrix

EXPLORER MASTER

BEGINNER MANAGER

Capability

Governance

No activity

Capability

How skilled are employees and how developed is the AI pipeline infrastructure?

Governance

How well is AI structured into the organization and progressing with a clear strategy?

Intermediary Stages

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 from 2021 to 2024
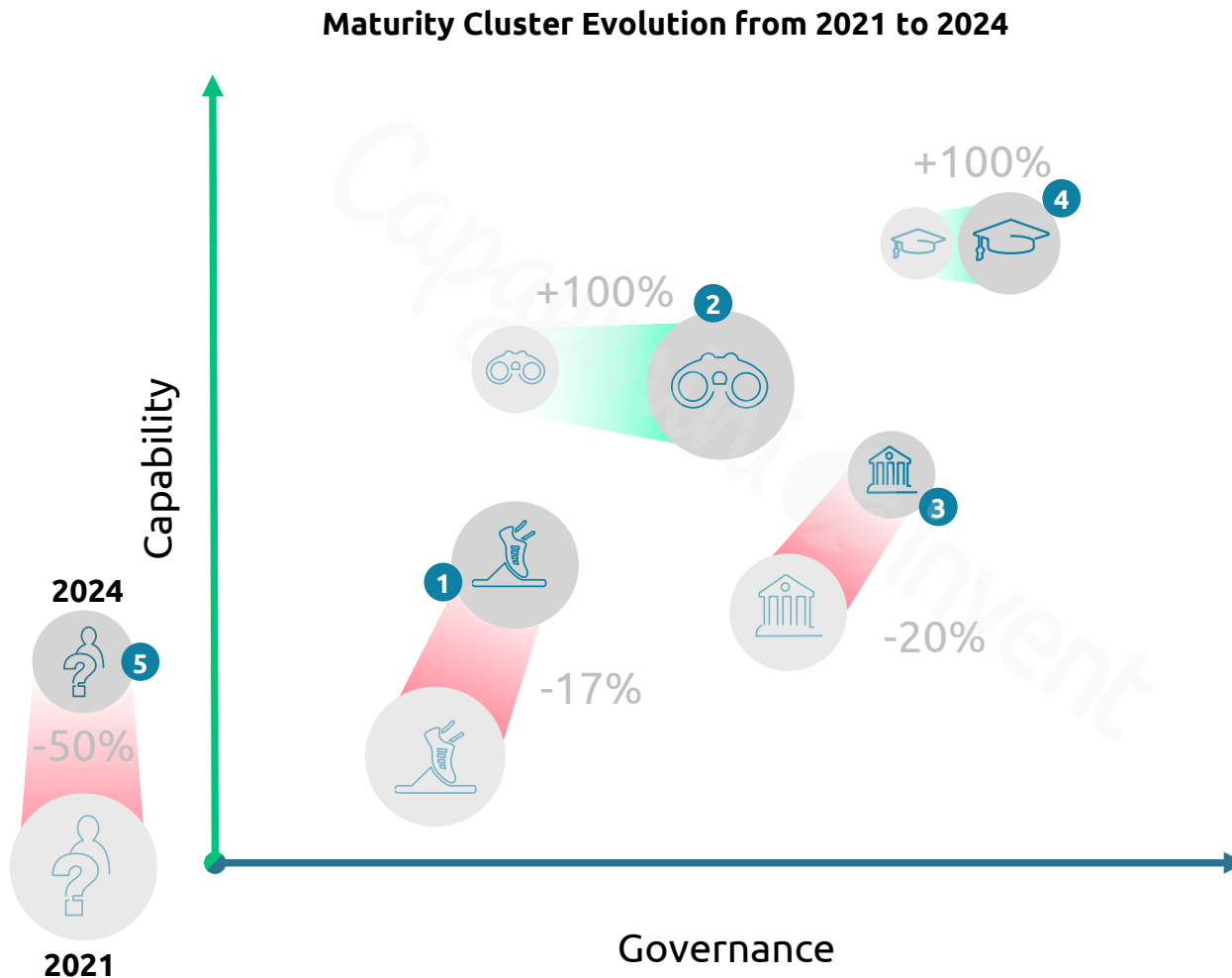
Maturity Cluster Evolution

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.

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

Road to AI Master

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

Capability
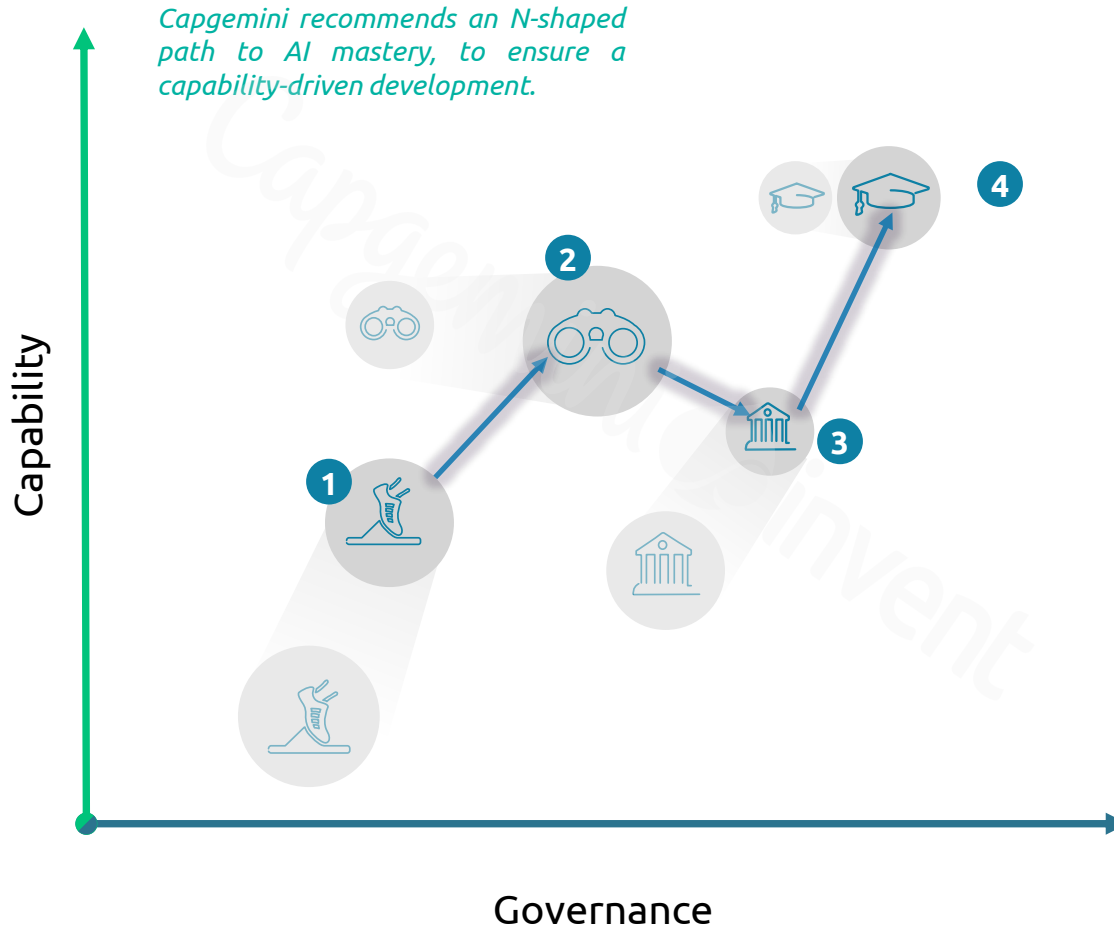
Governance

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

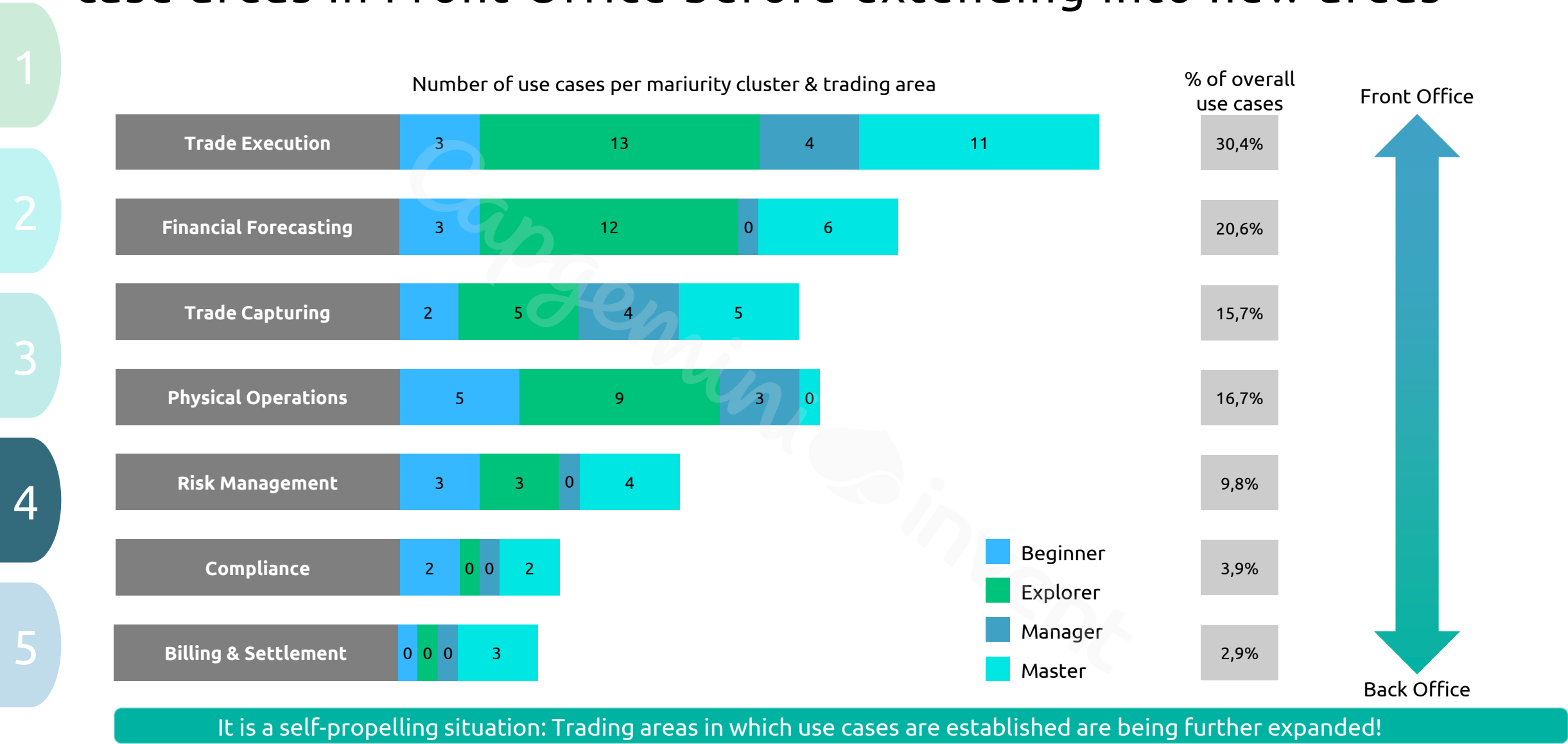**Established Use Case Categories Popularity**

Trading Area	Use Cases	Maturity Cluster			
		Beginner	Explorer	Manager	Master
Trade Execution	Automated Trading				
	Decision supporting				
	Trade timing optimization ①				
	Algorithmic trading in financial markets (derivatives)				
	Algorithmic trading in short-term physical markets				
Financial Forecasting	Price forecasting				
	Cash flow forecasting				
	Revenue and cost forecasting				
	Generation of custom-made financial plans and investment strategies				
Trade Capturing	Information Extraction				
	Automated trade capturing via voice-to-text recognition ⑤ ④				
	Automated trade capturing via text-to-text recognition				
Physical Operations	Predictive load forecasting				
	Scheduling and balancing optimization ③				
	Automated nomination on a continuous real-time basis				
Risk Management	Anomaly detection				
	Fraud detection				
	Liquidity risk forecasting				
	Predictive credit scoring				
	Predicting risk assessment (market, price, operational, etc.) ②				
Compliance	Supply chain monitoring				
	Trade Surveillance				
Billing & Settlement	Automated Report Generation				
	Intelligent and automated reconciliation				
	Intelligent invoice processing via Optical Character Recognition				

Capgemini Interpretation

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.

% of companies within maturity-cluster   0% — 100%
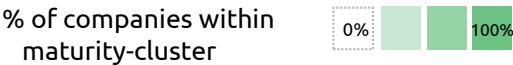
All maturity clusters tend to focus and expand on known use case areas in Front Office before extending into new areas

Number of use cases per mariurity cluster & trading area

	Beginner	Explorer	Manager	Master	% of overall use cases
Trade Execution	3	13	4	11	30,4%
Financial Forecasting	3	12	0	6	20,6%
Trade Capturing	2	5	4	5	15,7%
Physical Operations	5	9	3	0	16,7%
Risk Management	3	3	0	4	9,8%
Compliance	2	0	0	2	3,9%
Billing & Settlement	0	0	0	3	2,9%

Legend:
- Beginner
- Explorer
- Manager
- Master

Front Office ↑
Back Office ↓

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

EXPLORER
- 42,9%
- 45,2%
- 11,9%

MASTER
- 35,5%
- 58,1%
- 6,5%

BEGINNER
- 22,2%
- 33,3%
- 44,4%

MANAGER
- 36,4%
- 45,5%
- 18,2%

Capability

Governance

Legend:
- Exclusively Make
- Exclusively Buy
- Make and Buy
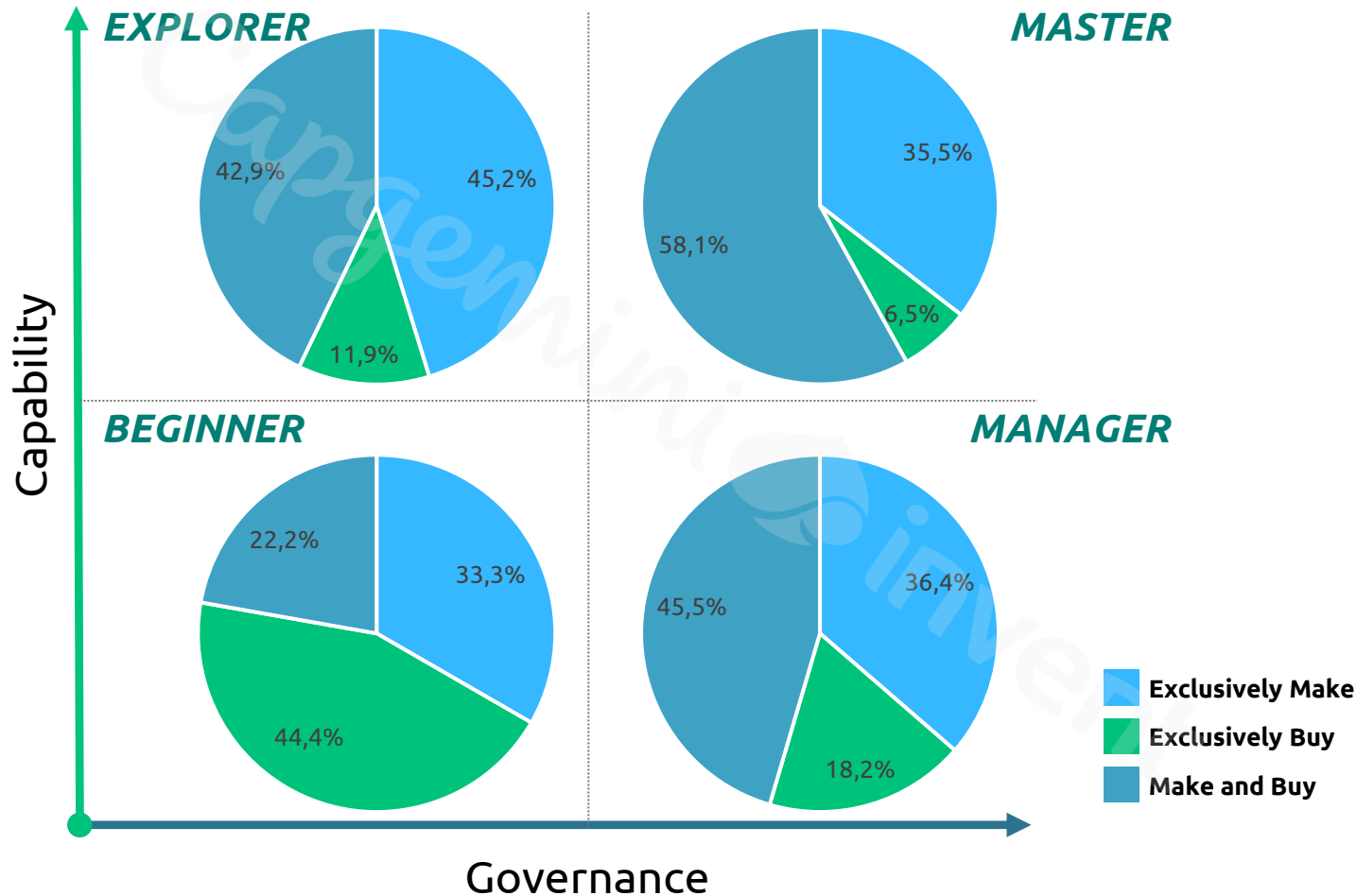
We have not only assessed the use cases but also considered the decision between making or buying the use case:

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

Maturity cluster	Next Use Case	Value Add when Implemented		Interpretation
		Top Benefit	**Top Cost Reduction**	
Top recommended use case for each maturity cluster		*Top benefits and cost reduction based on responses concerning existing use cases*		*These recommendations, rooted in the survey insights, guide toward strategic success*
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.

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Capgemini's expertise: Understanding top use cases and offering qualified implementation recommendations

Use Case	Assumption	Methodical Implementation	Effort Score	Interpretation
Price Forecasting	• Historical data available • Adequate computing resources • …	• Linear regression • Neural networks with ensemble learning	★★★☆☆ ★★★★☆	• Precise predictions to enhance trading decisions • …
Cash flow forecasting	• Detailed financial records • Adequate computing resources • …	• Time series analysis • Neural networks with ensemble learning	★★★★☆ ★★★★★	• Accurate insights for optimized financial planning (liquidity etc.) • …
Algorithmic trading in financial markets	• Real-time market data • High-speed trading systems • …	• Moving averages • Reinforcement learning	★★★☆☆ ★★★★☆	• Automated trading for structured and faster trading activities • …
Information Extraction	• Structured data sources • Adequate data processing tools • …	• Natural language processing • Transformer networks	★★★☆☆ ★★★★☆	• Extracting valuable insights from textual data • …
Risk Prediction	• Comprehensive risk factors • Statistical modeling skills • …	• Decision trees • Random forests	★★★☆☆ ★★★☆☆	• Improved risk assessment for informed decisions • …

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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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