01 Feb 2025

# FORRSight

## Market Trends & Voices from the Market

FORRS's view on market trends and insights from market experts

## Algo Trading & Algo Architectures

The FORRS maturity model and architectural components for algo trading

## Rethinking ETRM Landscapes

The ongoing evolution and its impact on the industry

# A New Era in Energy Trading

**Geopolitical developments and the expansion of renewables are shaping energy trading more than ever**

FORRS

# Content

# Dear readers,

Every challenge comes with an opportunity, and this applies to the energy industry more than ever. Looking back, 2024 was an exciting, yet challenging, year, not only for the energy industry, but for energy trading in particular. It's hard to think of another industry in Europe that must face and adapt to changes so fast, driven by geopolitical developments and the rapid expansion of renewables . We strongly believe that 2025 will see similar trends.

We are delighted to publish this first edition of our FORRSight Magazine during such a challenging period. Nurtured by our project experience and expertise, we want to share our views on the major topics which are driving today's energy trading industry. Along with market trends and voices from the industry, this edition provides insights into automation along the trading value chain, plus risk management and ETRM setups, to name a few topics.

We are also making a long-term investment in the development of our GRYT platform, which is tailored for energy trading. The FORRSight Magazine will dive deeper into our underlying GRYT implementation story and its key applications and benefits.

We strongly believe that academia can provide answers to challenges and facilitate solutions for practitioners in the energy industry. To support this process, we have initiated and engaged in interdisciplinary projects between universities and our industry. This edition of FORRSight Magazine will offer more information on our ongoing engagement.

As a trusted consulting company with a long-term, proven track record, we are very much looking forward to shaping the energy trading landscape together with our clients and partners.

Don't forget to stay tuned for upcoming editions of our FORRSight Magazine!

***Martin Hiller***
Partner at FORRS

# Dear readers,

Today, global energy markets are undergoing tectonic shifts, driven by urgent climate imperatives, clean energy innovations, demand- and supply-modifying AI technologies, and geopolitical tensions. Europe stands at a critical juncture, grappling with energy security issues and ambitious net-zero goals. Given the evolving framework of international relations and environmental regulations, the European economy, long reliant on fossil fuel imports, faces new challenges. These have been brought on by transitioning to clean solutions, which is affected by variability in renewable resource quality and seasonal availability, exposure to climate risks, and raw material needs.

To build a reliable energy system and uplift value chains, Europe must prioritize interregional infrastructure connectivity, develop global markets for clean energy solutions – such as hydrogen – and invest in advanced technologies, including energy storage, to address vulnerabilities. The European Union made commendable strides in diversifying energy sources, expanding renewable capacity, and reducing dependency on Russian gas, but they come with prohibitive costs, threatening economic resilience and competitiveness of industrial production. To ensure affordability and accelerate the transition, investments in clean energy systems must be scaled up.

Even more critical than financial support and technological advancements is human capital. A new generation of skilled professionals, agile and equipped with expertise in energy technologies and artificial intelligence, is needed to navigate the evolving energy markets, policy frameworks, and technology adoption. Only through a dual investment strategy – focusing on human capital and technological innovations – will Europe lead the global net-zero transition and boost its economic competitiveness.

***Prof. Dr. Svetlana Ikonnikova***
Technical University of Munich

# Market Trends

*Every challenge comes with an opportunity. And utilizing opportunities requires the ability to change. Nearly all participants in energy markets are facing changes, often resulting in larger-scale transformation projects. The right technology and architecture as a foundation for energy trading are key enablers for changes.*

## The challenge

The global push for a net zero economy is the core driver for rapid changes all over the planet and throughout all energy companies. The massive expansion of decentralized and inflexible generation from renewables is a huge opportunity, but at the same time creates high complexity, for example, due to a large resulting lack of generation flexibility impacting entire power systems. All this requires a pressing need for fast changes. Automation, resilience, and speed are all paramount for energy trading organizations to cope with these challenges.
Geopolitical instabilities drive insecurity and complexity further, especially on the supply side, such that governments globally put security of energy supply on their national security agendas. The resulting price spikes and massively increasing volatility has placed significant pressure on trading organizations globally.

Along with the transition to a net zero economy and geopolitical instabilities, ongoing power market liberalizations and market integration through market coupling across Europe increase the complexity for energy trading organizations. At the same time, those developments also provide new opportunities. Screening and forerunning the market together with innovation are crucial ingredients to identify and leverage those opportunities.

On the one hand, energy trading organizations must heavily increase their sophistication levels in existing fields of business, but must also establish new business models to generate new profits. The journey towards 2030 and beyond is a pathway driven by organizational, operational, and especially technological changes for all companies and their associated businesses. How we generate, manage, and consume energy is undergoing a significant transformation.

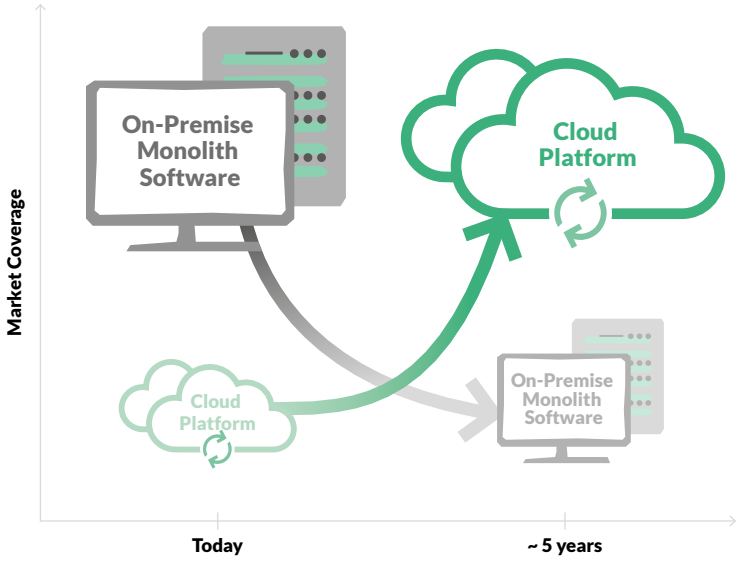
Energy companies are facing massive transformation journeys already today. Moreover, the demand for even faster changes towards a future proven infrastructure is heating up. Not every organization starts at the same level and with the same business models, resources, and skills. There is no “one-size-fits-all” approach for shifting trading organizations towards their future targets.

## The shift

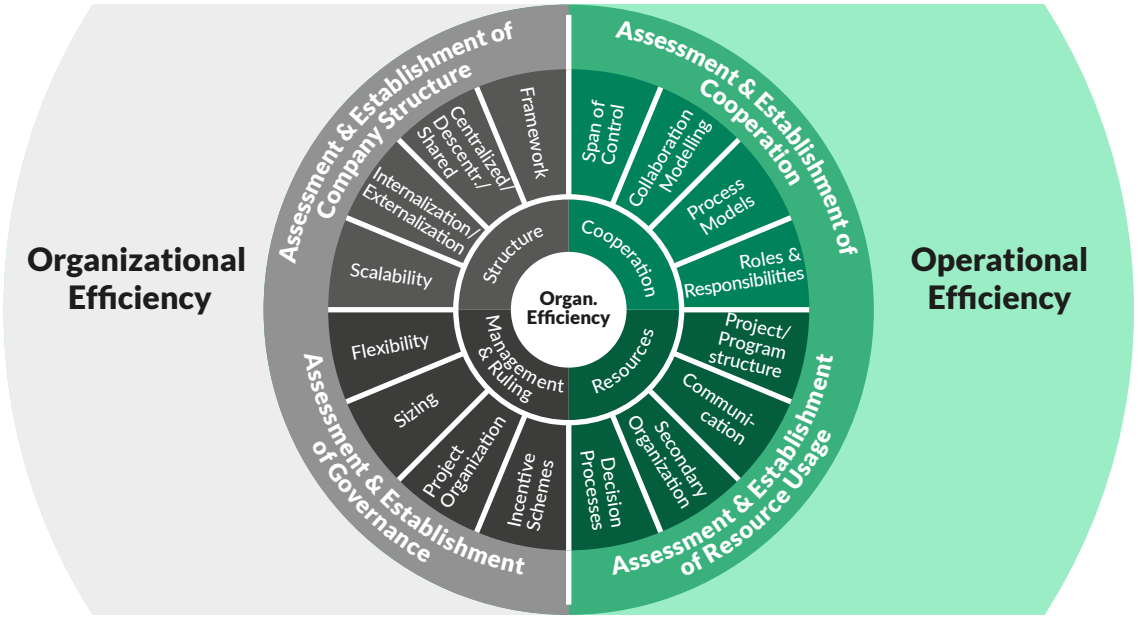
Energy companies are exposed to manifold challenges, driven and enabled by current and future technologies. The selection and integration of the right technologies has become a core strategic matter and is no longer optional. Choosing the right technology stack will become even more important in the future, given the foreseeable challenges.

In past years organizations learned to build technology within projects and to operate applications daily. Now, the main shift is to transform towards an assembly organization, where adoptions to data, models, and processes are continuously integrated without losing consistency, correctness, timeliness, or other measurable key performance indicators (KPIs).

Quants are building better models every day, improved generation forecasts are provided constantly, and new assets, deals or counterparties are onboarded continuously. Given the high volatility,




Trading organizations are moving from on-premise monolithic ETRM setups to a microservice-based ETRM strategy




The right technology choices and a flexible architecture are the backbone of organizational and operational efficiency

risks must be evaluated, not at only end-of-day, but at intraday/near-real time, to ensure staying within given risk policies and to have sufficient liquidity.

At this time, the industry is moving from a **price taker to a risk taker trading approach**. The same development was seen in the banking world years ago. For example, real-time position and risk views are required to avoid losses and imbalance fees in physical short-term markets. This development towards a real-time and event-driven architecture can only be achieved with the right technology choice as a foundation.

## The competitive edge

For a long time, technology has been a decisive factor. Better technology forms better energy organizations. This competitive edge is shifting. Choosing the right technology and adopting it **fast** is more a survival factor than a "best of breed" factor. Technology is the backbone of automation and fast decision making. And faster time-to-market typically creates more revenue and profits.

## Implementing the shift

Future energy organizations will be much more resilient and constructed from an operations perspective. The core questions will be *"can we safely operate it? If not, when will we be able to?"* or *"if our software infrastructure has an outage, what do we do, and when are we back online?"*

Organizations and their technology architectures become more of an integrated platform than an application landscape consisting of monolithic applications. Speed and the ability to integrate new data, models, or processes are the leading factors, rather than having the one and only required feature. The clear trend in the market is to move away from monolithic systems architectures toward adoptable and flexible cloud-based platforms solutions.

Business continuity and resilience are the core KPIs and guide the roadmaps of organizations.

## A new solutions era

Designing a future technology and software landscape for an energy trading company always comes back to the fundamental question – "brown field or green field?" This means "shall we start from nothing and build everything new ('green field'), or should we rebuild the existing environment efficiently ('brown field') to deliver all capabilities for a future proven trading landscape?" Again, the right technology choice is the backbone for organizational and operational efficiency.

### Conclusion

Major paramount capabilities of a future trading landscape in energy trading are outlined in this FORRSight magazine, to guide you through your decision processes and solutions design initiatives.

## Market Development & Evolution

| From Grid to Smart Grid | Renewables Energy Growth | Increase in Storage Capacity | Hydrogen as an Energy Carrier | eMobility | Geopolitical Developments | Convergence of European Energy Markets | Policy & Trading Regulatory | Climate Finance & Investment |
|---|---|---|---|---|---|---|---|---|
| Evolution towards optimized energy distribution through smart grids | Increasing share of renewable energy sources | Advancements in storage technologies, including batteries and Power-to-X, leading to enhanced grid reliability | Rising prominence of hydrogen as an e-fuel for storing and transporting (green) energy | Rapid growth in electric mobility, reshaping energy demand patterns | Disruption and reconfiguration of energy supply chains due to geopolitical shifts | Integration and interconnection of energy markets through market coupling | Emphasis on clean energy, grid harmonization, digitalization, and consumer-centric approaches | Shift towards more sustainable and responsible investment practices in energy markets |
| Emergence of decentralized energy resources and real-time dynamics in the smart grid landscape | Challenges in production forecasting and short-term / day-ahead management of renewables | Altered dynamics in storage costs and performance, and new business model opportunities | Deal with market immaturity and complexity associated with new hydrogen products | Shifts in demand patterns require a dynamic approach to energy supply management | Extreme price volatility and liquidity / cashflow shortcomings as major threats to business stability | Complex regulatory landscape, real-time dynamics in cross-border intraday trading, and increased liquidity | Navigating evolving regulatory landscapes and adapting to changing standards | Growing importance of ESG considerations in trading strategies |

## Energy Trading Landscape

**Energy trading must constantly transform to stay successful and profitable within steadily evolving energy market landscapes**

**Collaboration**
Facilitating collaboration between IT and Trading

**Market Data Management**
Ensuring centralized and consistent data

**Cloudification**
Providing scalability and performance

### Portfolio Management and Asset Optimization

Adoption and integration of new technologies, such as renewables (PPAs, certificates, etc.) and improvement of forecasting accuracy and speed

### Quant- and Analytics

Integration of real-time market data feeds and advanced analytics to support decision-making processes

### Pricing and Advanced Risk Management

Implementation of advanced risk models and platforms to accurately measure and manage relevant risks in real-time

### ETRM

POSITION & PNL ↑ POSITION & PNL ↑ TRADE ←

- **Managing of increasing** trading volumes and trades
- **Storage** of comprehensive data (including all quotes)
- **Renewables integration**
- **Ensuring flexibility, real-time capabilities, and seamless integration** with analytics platforms and other enterprise systems

### Algorithmic Trading and Automation

Development and maintenance of effective algorithms capable of navigating dynamic market conditions and ensuring algorithms compliance with regulatory requirements

### MARKET PLACE

| Bilateral Trading & OTC Markets | Energy Exchanges | Ancillary Services |
|---|---|---|

- Coping with a significant **increase in market volatilities**
- Navigating through the **increasing liquidity** in spot and forward markets
- **Adapting to the introduction** of new products and emerging markets
- Addressing market fragmentation by **efficiently navigating and integrating** diverse markets
- **Managing regulatory complexity and staying abreast** of regulatory changes to ensure compliance and operational effectiveness

**From Price Taker to Risk Taker:** requires a shift from EoD to intraday risk & PnL monitoring

## Production

| Importance of adaptability and responsiveness in trading practices and processes | Requires flexible and new trading strategies to navigate uncertainty and unpredictable generation patterns | Manage higher variety of assets, requiring advanced trading processes, e.g. for forecasting & optimization | Higher efforts for integrating regulatory compliance into trading processes | Requires automated trading process and new optimization trading strategies |
|---|---|---|---|---|
| **Shift to Renewables** | **Flexible Power Plants** | **Diversification of Production Technology** | **Regulations for Grid Stability** | **Battery Storage Facilities** |
| Moving away from traditional fossil-fuelled plants toward renewable sources | Increasing flexibility of power plants to adapt quickly to fluctuations in energy generation | Expanding variety in energy production technologies | Evolving regulatory frameworks, ensuring grid stability | Highly flexible battery storage facilities incorporate a huge future potential for covering renewables overproduction |

## Retail Market

| Requires optimized energy procurement strategies for energy industries | Implies risks from new product types and requires advanced real-time forecasting | Requires more sophisticated risk & pricing models for managing complex risks | Innovation towards digital solutions, shaping efficient and technologically-advanced trading practices |
|---|---|---|---|
| **Retail Products Complexity** | **Increasing Demand in Green Energy** | **Evolving Risk Landscape** | **Digitalization & Efficiency** |
| Growing intricacy in retail energy products | Growing demand for green energy and carbon neutrality, introducing new product types like PPAs | Transfer and offloading risks to energy producer | Growing demand for digitalization and efficiency in energy retail |

# The New Energy Trading Landscape: Innovations and Challenges

As the energy landscape evolves, fast adaptability is becoming even more essential for success. Three major forces are currently shaping the energy trading landscape: **Market Evolution, Retail Transformation**, and **Production Progression**. These collectively redefine trading practices, requiring organizations to adapt quickly to new challenges and seize emerging opportunities.

**Energy Trading Landscape** at the heart of the infographic is advancing beyond traditional methods under the influence of these dynamic forces. Traders must now address complex challenges; from managing decentralized energy generation and smart grids to optimizing battery storage systems to integrating green energy solutions. Success in this competitive landscape requires building agile and data-driven strategies alongside advanced analytics, automation, and flexible approaches.

FORRS's infographic delves into the rapidly evolving energy trading landscape, exploring how advancements, such as real-time forecasting, sophisticated risk models, and innovative ETRM systems are reshaping the industry. It highlights key trends, such as the rise of inflexible renewables, the impact of geopolitics, and the surge in green energy products.

Discover how energy professionals like you can turn volatility into opportunity by adopting innovative approaches and embracing digital transformation. This shift is vital for thriving in a market defined by rapid change, complexity, and unprecedented opportunities.

FORRS

# Voices from the Market: Perspectives that Matter

*This is where the energy market comes together. Industry experts and insiders share their view on the biggest challenges, opportunities, and shifts shaping energy trading today. From navigating market turbulence to driving innovation, these voices offer sharp insights and fresh perspectives on the forces transforming the industry. Dive in and hear directly from those leading the change.*

**OLA LOME**
VP Strategy & Business Development
VOLUE

Intermittency and shorter gate closures demand tighter integration between forecasting, optimization, and trading. To succeed with the green transition, we need everyone to participate in the market. It's clear that the current toolset employed by asset-backed traders needs to be automated and made available for all new entrants, since optimal energy planning and trading is now a make-or-break task for all.

**AVIV HANDLER**
Managing Director | ETR Advisory

The regulatory burden on trading market participants continues to evolve and grow more complex. The coming year will see the impact of REMIT II, both for monitoring for abuse and algorithmic trading and for REMIT reporting. What's more, we'll see movement in other areas, such as CBAM and MIFID II. As always, it's important to remain ahead of the regulatory curve, so that no one is adversely affected by an unexpected impact.

**DR. JENS HAUCH**
Chairman of the Board of ENERGIEregion Nürnberg e.V. and Head of Research Unit at the Helmholtz Institute Erlangen-Nuremberg for Renewable Energies

Electrification of the heating and mobility sectors are the next key steps in the energy transition. This creates the basis for systemically integrating renewable energies and drastically reducing $CO_2$ emissions. It's crucial that companies and local authorities have the courage to make strategic investments in green technologies and infrastructure, to mitigate the consequences of the climate crisis and prevent long-term damage to our society and economy.

**ANDREAS POINTVOGL**
Managing Partner | OMNIA

Interconnector development in Europe is like planning a grand feast but forgetting the forks – crucial yet neglected. Without opening the market to new Interconnector TSOs, abandoning monopolies, investing congestion income EU-wide, and standardizing regulation, energy transitions risk failure. At OMNIA, we're paving the way for a new era of Interconnector TSOs.

**IRINA REITGRUBER**
Affiliate Analyst | Commodity Technology Advisory

The transition to renewable energy is only feasible if the energy system has sufficient aggregated flexibility. Encompassing production, consumption, and BESS, this flexibility is commonly called a Virtual Power Plant (VPP). It must be sourced from distributed assets, evaluated, and traded across various markets. A wide range of software tools support companies in bringing this flexibility to market, enabling real-time trading and risk, revenue settlement and more.

**MARIA DE KLEIJN**
Partner | Kearney

Price levels are significantly down from 2 years ago, with a stable-to-negative outlook range. Capture rates continue to drop. Weather-driven volatility is up. As a result, pay-as-produced, single-asset PPAs are dropping in value. Capturing superior value by creating a portfolio with enough flexibility, retaining and monetizing market risk – requires state-of-the-art trading and risk management. Many of our clients are building up this capability, while sorting out the interface between their asset and trading businesses.

**HANS-ARILD BREDESEN**
CEO | Bredesen Consulting

The global trend of electricity market reform is gaining traction in emerging economies. The lessons learned from the European experience, both good and bad, are supporting these reforms, especially in Africa. Continued support for reforms will be crucial to attract much-needed investments in new infrastructure, both in generation and transmission, to secure the electrification of these countries and continued growth in their economies.

**DR. MARTIN FENGLER**
CEO | Meteomatics

The expansion of renewable energies makes accurate weather information indispensable. From production and demand forecasts, energy trading and infrastructure management, next-generation high-resolution weather models make all the difference every day. Tomorrow's winners are already relying on the best possible weather data today.

# Battery Energy Storage Systems (BESS) as a Key Flexibility Provider

*Europe's urgent need for flexibility – will BESS be a major technology in the future for providing flexibility?*

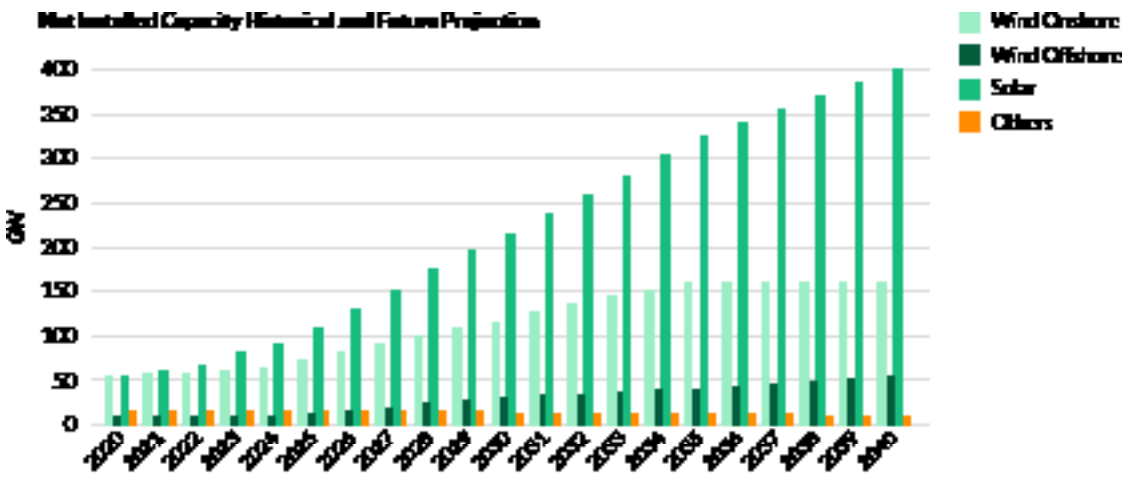
The transition to renewable energy is crucial for addressing climate change and enhancing energy independence. The EU's 2023 Renewable Energy Directive targets a share of 42,5% of energy comsumption in the EU from renewable energy sources by 2030 and climate neutrality by 2050. The EU has significantly increased the share of energy produced from renewables over the last decades, which currently stands at 37% for power generation. Germany mirrors this trend, with wind and solar capacity growing as coal and nuclear decline. As depicted below, Germany aims to triple wind and quadruple solar capacity by 2040.

However, renewable energy generation is challenging, due to its dependence on weather conditions, while fossil fuel plants remain more controllable. The rise of renewables increases volatility in power generation and demands flexible options to balance supply and demand. A theoretical undersupply currently requires backup from costlier sources like gas. In addition, theoretical oversupply from renewable generators leads to curtailment and frequent negative electricity prices.

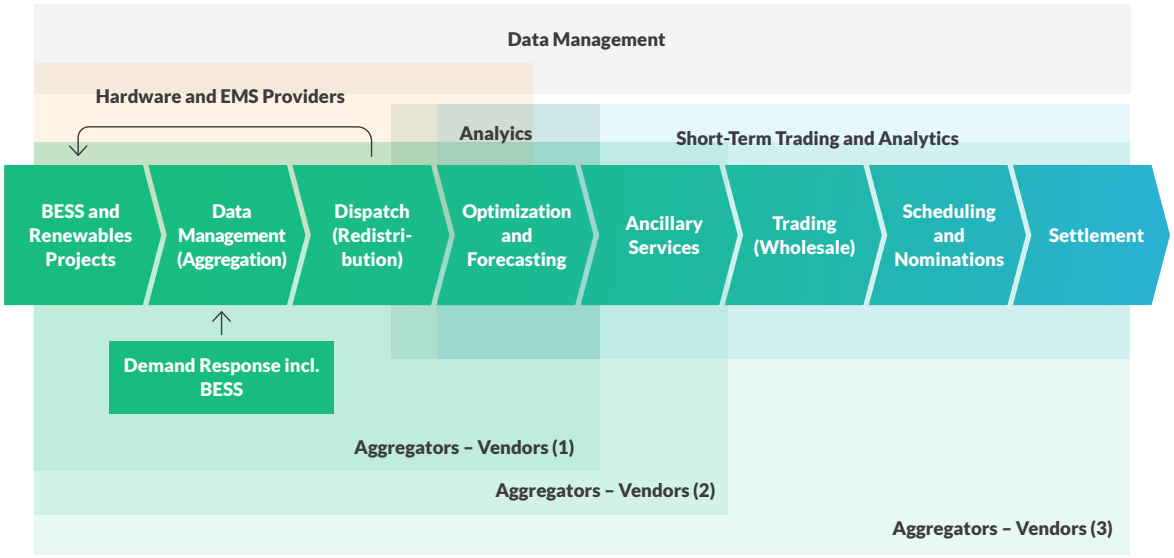
Greater flexibility in the entire power system is required to accommodate high fluctuations from renewable generation. A 2023 EU report[2] projects short-term flexibility needs to grow sharply, as shown in the table below.

Various technologies are under consideration to provide this flexibility, including demand side management, Battery Energy Storage Systems (BESS), EV batteries, and hydrogen. Demand side management faces challenges, including the need for aggregation, complex market access rules, and insufficient consumer engagement due to missing incentives and lacking expertise. Although hydrogen is promising, it offers limited efficiency and is costly for building electrolysers and converting the existing gas network. For EV batteries to play a crucial role, conflicting objectives with grid needs must be addressed first, such as restricted availability of EVs due to vehicle operation, limited battery capacity, and the necessity to maintain a minimum charge level for vehicle use.

In contrast, BESS currently represent the best option to provide badly needed flexibility from all options discussed in this article. This is due to cost efficiency, fast technological improvements for BESS, and regulatory changes. Greater battery efficiency with improved storage duration and lower investment




Forecast for yearly net installed capacity for renewables in Germany[1]




Software solutions along the BESS value chain

costs have made BESS a profitable business case without governmental subsidiaries. Regarding the regulatory framework, it is expected that European countries will further ease the development and connection of BESS to the power grid.

Major use cases for BESS in the energy market include:

- **Stand-alone, front-of-the-meter BESS**: These storage capabilities ensure grid stability by engaging in short-term power trading and arbitrage across different energy markets, with the potential to generate significant profits.
- **Co-located BESS with renewable energy**: This involves smoothing renewable energy production volatility; for example, compensating for production fluctuations from wind or solar plants.
- **Behind-the-meter BESS**: These batteries are usually installed at prosumer sites for purposes, such as peak shaving, or as part of aggregated flexibility brought to the market.

When optimizing BESS profitability, it is essential to consider technical factors, such as cycle limits, warranties, and battery lifespan. There is an important trade-off between maximizing profits and ensuring battery longevity. Another obstacle for BESS optimization is the profitability due to reduction of price volatility. If there is a high degree of participation of other storages and specific subsidies and fees, such as EEG in Germany, BESS as an investment case can become less attractive due to increasing BESS competition.

European markets vary in terms of market access rules. For front-of-the-meter installations, whether stand-alone or co-located with renewable energy, participation in wholesale and ancillary services markets is possible. However, demand-side flexibility and behind-the-meter aggregation vary significantly across countries. For example, in France and the UK, demand-side flexibility aggregators can participate in multiple markets, while in Germany, the situation is more complex.

The BESS value chain is comprehensive and spans from technical BESS component management and BESS optimization to market participation. Typically, multiple companies are involved in a single battery project; from investment to operations and market access. These players all require software solutions and a robust architecture to manage their parts of the process. The integration of those software components is challenging on a technical basis, requiring a holistic architecture design across systems and interfaces.

A wide variety of software vendors exist along the battery value chain. Currently, no single solution covers all stages. Instead, there are specialized vendors offering solutions for different steps in the process (summarized in the figure above).

For more detailed insights into this topic, we recommend the white paper, "Battery Energy Storage Systems (BESS) as a Key Flexibility Provider", a collaboration between FORRS and Comtech Advisory. It can be downloaded from our website.

[1] Source: Historical Installed Capacity - Fraunhofer Institute, Installed Power | Energy-Charts; Projected Installed Capacity up to 2035 – BMWK, Overview of the Eastern Package | BMWK; Projected Installed Capacity beyond 2035 – BMWK and Netzentwicklungsplan Strom, Scenario Framework for NDP 2037/2045 | Netzentwicklungsplan Strom

[2] Source: Joint Research Centre, Flexibility Requirements and the Role of Storage in Future European Power Systems | JRC Publications Repository

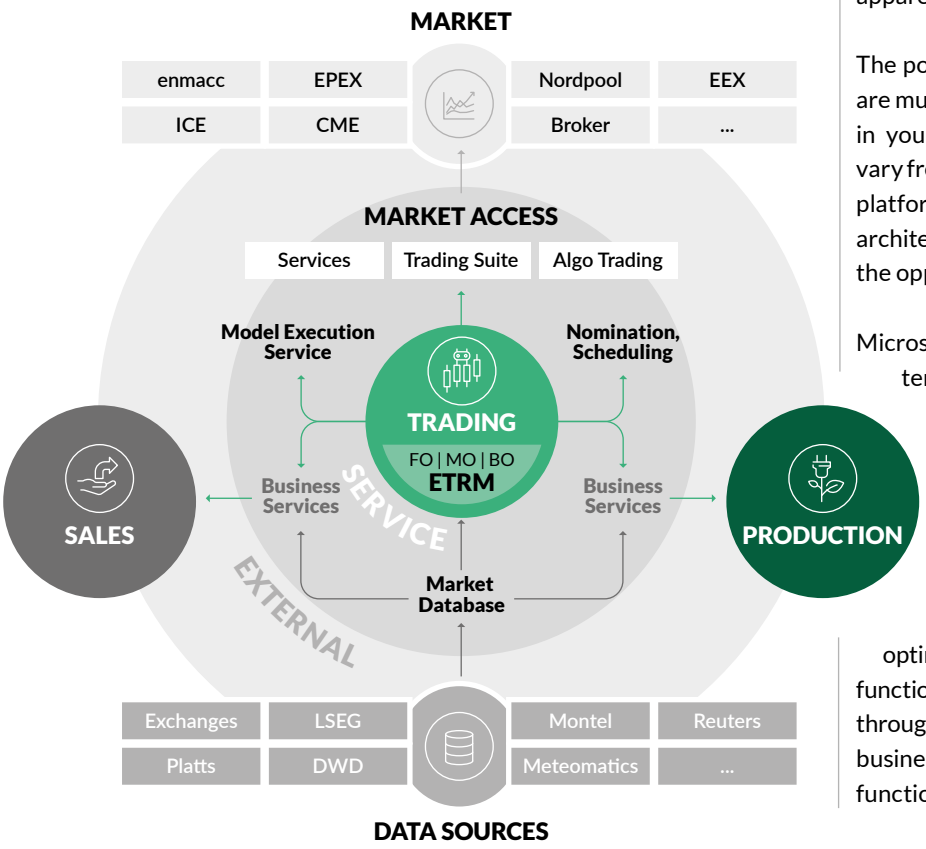
# Rethinking ETRM Landscapes to Master the Challenges of Tomorrow

*The rapidly evolving energy and commodity industry requires organizations to reevaluate their **Energy Trading and Risk Management (ETRM)** strategy. Here are some essential success factors and effective approaches for handling related architectural questions, ETRM system selections, and implementations.*

## Rethinking ETRM landscapes

The current energy and commodity trading industry is strongly characterized by continuous change, with incredibly fast-paced dynamics in its technological surroundings. These circumstances have led to a widespread need to fundamentally rethink trading landscapes. Among all systems of a trading landscape, the ETRM clearly stands out as the most central system of all. Today, most organizations, from global players to regional energy suppliers, are reconsidering their ETRM strategy to ensure their long-term competitiveness and to improve of cost-effectiveness, time-to-market, and efficiency.

**Schematic ETRM System Landscape:** The trading organization and its ETRM system interacts with numerous services, data, and the market




Unfortunately, the right course of action for energy and commodity organizations is not easy to determine. The market of ETRM systems and vendors is diverse, and offers many options for any setting along the dimensions of capability coverage and required flexibility.

## Technology and architecture

Before considering any aspect of a future ETRM, key questions about technology and architecture must be answered. An adequate architectural design sets the foundation for a growing and capable landscape, with an ETRM as a central building block. Since technological choices cannot be changed frequently, the importance of the selected path becomes apparent.

The possible approaches an organization could take are multidimensional. Which role will the ETRM take in your future environment? The prominence can vary from being the major system in an ETRM-centric platform to establishing an extensive microservices architecture. The demands arising from each are on the opposite ends of the spectrum.

Microservice platform architectures are characterized by satellite-like systems and services around the ETRM, so changes can be implemented incrementally and according to immediate business priorities.

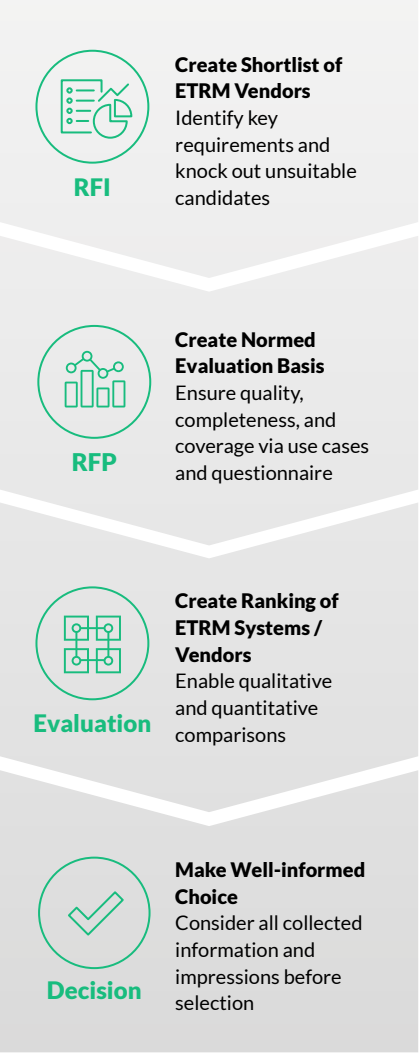
Opposingly, in an ETRM-centric approach, powerful ETRMs cluster the core capabilities across trading departments and utilize the optimized interoperability between the system's functionalities. Flexibility is ensured by a thought-through interfacing concept for integrating new business cases, providing scalability throughout all functions.

Further, single- or multi-ETRM setups, cloud, on-premise, or SaaS, are considerations which have major implications on a sustainable and lasting system like an ETRM.

## System selection

In recent years, the ETRM market has changed drastically. From monolithic to modular systems; from commodity specific to more general solutions, the variety is almost endless. More than ever, an efficient selection approach is key to finding the right fit.

Besides matching the functional and non-functional requirements of the current operations, you must consider ever-evolving business cases, especially given the rapid development of the industry. To match these criteria and select a system that perfectly integrates with the previously defined architecture and technology, it is important to follow these success factors:




**ETRM System Selection Approach:** A comprehensive selection approach is indispensable for well-informed decision-making

- A clear pre-selection of systems, based on knockout criteria
- Thoroughly described use cases, reflecting the current and future business activities
- Clearly defined functional and non-functional requirements for each use case, covering all organizational departments
- Prioritization that reflects actual business needs
- Planning and clear communication, to orchestrate vendors equally through a tight evaluation process
- Knowledge about the capabilities and common shortcomings of ETRM systems
- A qualitative and quantitative approach, to allow an objective view on requirement coverage and integrate qualified preferences

Following a comprehensive selection approach, a well-informed decision can be taken in a short amount of time, while considering all relevant aspects.

## Implementation

The journey towards a fully operational ETRM is determined by its implementation. While these projects are mostly associated with long durations and excessive costs, they hold many opportunities for your organization to distinguish itself from other market participants and gain a competitive edge.

**Success factors include:**

- Involving business throughout the whole design phase, to ensure a fit-for-purpose system for all use cases.
- Agreeing on core elements early, for a stable implementation basis (deal life cycle, deal templates, and more).
- Covering more than just functional tests. Build a regression set. Ensure performance with growing functionality and load.
- Defining a comprehensive, but efficient, migration plan early on, as the complexity of deal, market, and static data migration is often underestimated.
- Planning the cutover ahead and thoroughly. The impact on business operations must be minimized.
- Involving your operational team during the implementation, to avoid a huge handover volume right before your go-live.

# Algo Trading and Algo Architectures

*Algorithmic energy trading is rapidly evolving. The energy transition boosts renewables and flexible assets, such as Battery Energy Storage Systems (BESS), while its increased volatility attracts diverse traders. Discover what is essential to stay competitive in the face of these challenges.*

The presence of algorithms in both short- and long-term markets is increasing year by year, with more and more electronic orders being placed in order books. The growing penetration of renewables has further shaped the market dynamics that make algo trading indispensable. The pan-European market coupling for cross-border trading further increases opportunities for algo trading by increasing liquidity.

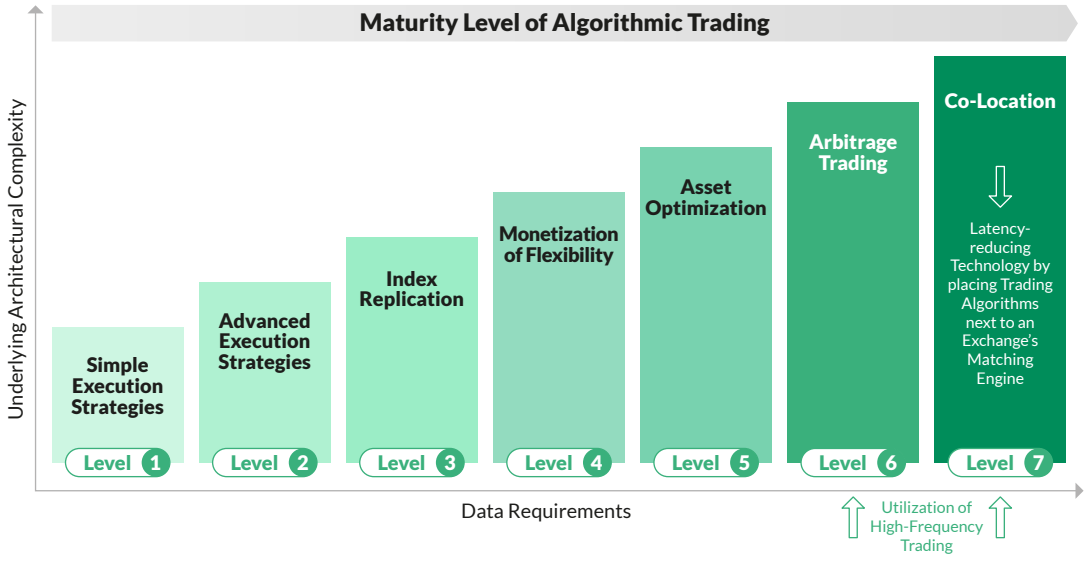
Beyond the management of renewables in physical short-term markets, more utilities and trading firms are establishing rule-based algos for speculative trading strategies in short-term and also liquid long-term/forward markets ("trading the curve"). Though yet less developed, the application of machine learning and artificial intelligence is another clear trend, and is typically used to identify trading signals in short-term markets, based on the most recent price and power generation forecasts.

However, the primary focus for algo trading continues to be on short-term markets, where algorithms are crucial in continuous trading for managing flexible and inflexible assets, such as renewables. No matter the underlying purpose, a sophisticated and resilient algo framework is crucial for building up a scalable and profitable algo trading.

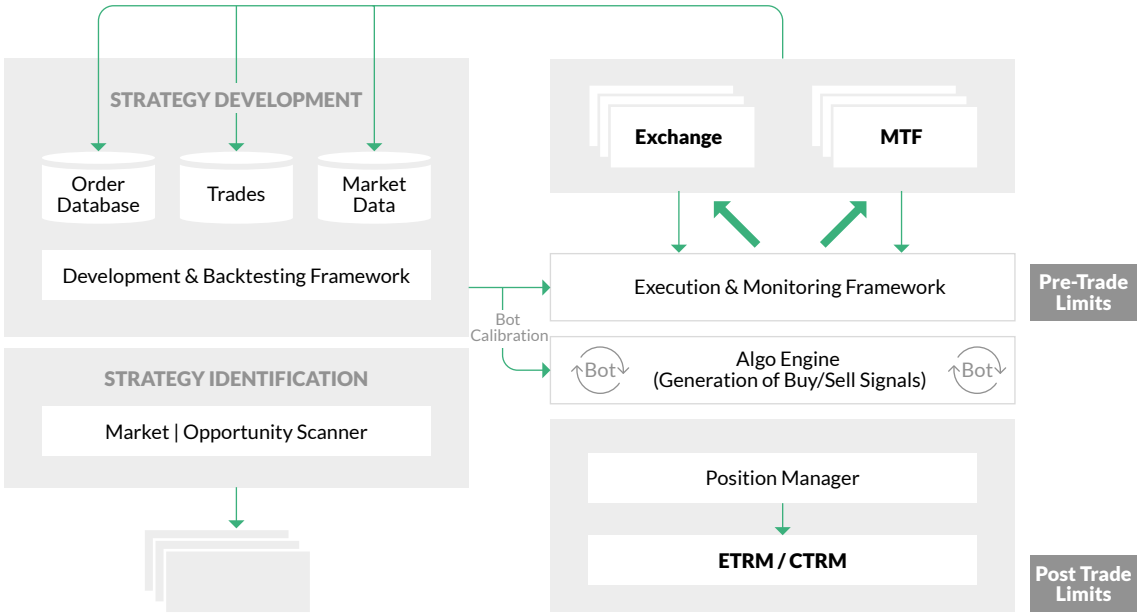
## The FORRS maturity model: target use cases define the starting point for algo trading

The algo framework and underlying architecture must support the intended use case for algo trading. For example, closing open intraday positions from inflexible renewables in continuous power markets requires a different underlying architecture than optimizing BESS or flexible generators across several markets, such as long-term, short-term, and reserve markets.

Therefore, it is important to first define the use case and related functional requirements. From there, the technical requirements for the architecture can be derived, including the technology stack, systems, or interfaces. Our experience shows that building algo strategies without designing a fit-for-purpose algo




The FORRS maturity model for algo trading is a structured approach towards establishing a resilient and scalable framework for algo strategy development




Developing algo strategies requires an integrated framework based on a robust state-of-the-art architecture and technology components

framework and architecture as a scalable technical foundation first will create huge complexity and costs later, to correct the technical components that have been built out.

At FORRS, we have developed a Maturity Model for algo trading (see below) to make identifying the target use case easier than ever. Depending on the target use cases, we are deriving the underlying functional requirements, along with the technical requirements towards the architecture. For example, a "smart iceberg" strategy for position closing implies fewer complex requirements than developing a front-to-end algo strategy for asset optimization, such as a gas-fired power plant or a gas storage facility

## Algo trading requires an integrated framework for short time-to-market

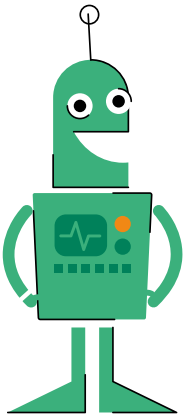
Once the target use cases for algo trading have been defined, a fit-for-purpose architecture, including technology selection, should be derived, to build up a robust and extendible algo framework. We will dive into the most important framework components in the following.

To ensure that algo strategies can be implemented on a common and maintainable code base, a **robust and scalable development framework**, based on continuous integration and continuous development (CI/CD) principles, is required. This ensures that developing and maintaining strategies can be scaled simultaneously across several persons and teams. In addition, it allows for continuous integration of new strategies into production quickly, to speed up time-to-market.

A **backtesting framework** ensures that strategies can be thoroughly tested before deploying them into production, ideally based on historical order book data. This requires a sophisticated **data management framework** as a backbone, granting access to historical data in a normalized and fast way. The developed, tested, and calibrated algo must then be integrated into the algo engine to generate buy and sell signals. To act on these signals, a comprehensive **execution and monitoring framework** is essential to translate them into orders on exchanges and multilateral trading facilities (MTFs).

### Conclusion

Developing algos in a sustainable and scalable manner does not start with coding. We can clearly see that utilities and energy trading companies think about algo trading in a holistic way, where designing a robust and extendable algo framework and underlying architecture is a key component, and often the first step before coding algos.



# The Challenge of PPA Integration

*Power Purchase Agreements (PPAs) are transforming renewable energy markets but integrating them into the deal lifecycle demands strategic planning, robust systems, and seamless execution. Discover how organizations can master the complexities of PPAs and turn challenges into opportunities.*

## PPAs: key to the renewable energy market

Power Purchase Agreements (PPAs) are non-standard, long-term contracts between energy producers and consumers or intermediaries. These contracts are aimed at providing a framework for purchasing electricity, typically from renewable sources, such as wind or solar. In Europe, PPAs have recently gained significant traction due to climate goals and rising demand for renewable energy, alongside a reduction in subsidies for renewables.

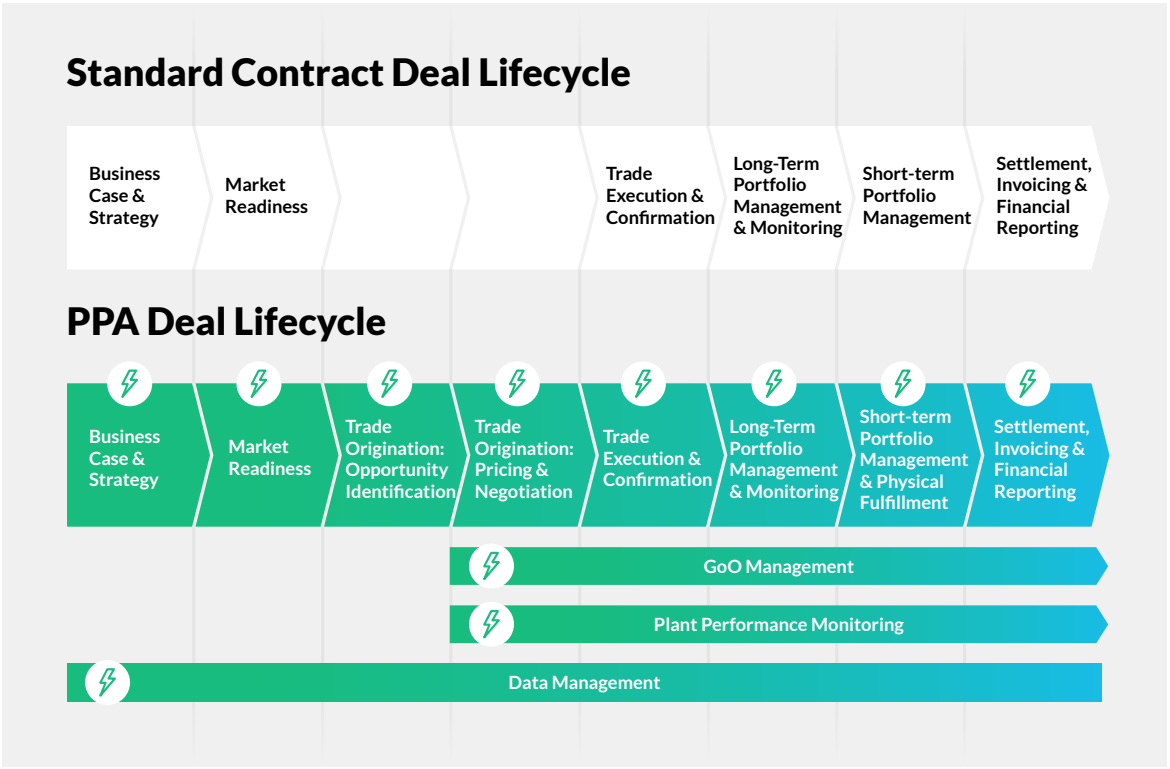
PPAs address a number of key market needs. They offer energy producers financial certainty to invest in new renewable projects, while offering consumers – particularly corporations – stable and often low-cost energy prices, to help meet sustainability targets. The growth of PPAs is further driven by the increasing volatility of wholesale energy markets and the EU's push for decarbonization, making PPAs a crucial tool in the energy transition. In this context, PPAs also allow easier access to wholesale energy markets for especially smaller-sized developers of renewable generation.

## What makes PPAs unique?

Mastering the full trade lifecycle is key for every energy trading organization. Most players handle this with ease, but PPAs often diverge from standard products, demanding adjustments within the existing trading landscape.

Let us navigate through the PPA deal lifecycle, focusing on its uniqueness and challenges.

The first step is to define a **PPA strategy and an underlying business case**. This can involve making an existing power portfolio greener, providing indus-




**The PPA deal lifecycle:** The complexity of PPA contracts requires extending standard deal lifecycles across the entire trading landscape

trial customers with green electricity, or generating profits by being a PPA risk taker.

The next step is **to specify a PPA product structure** – whether solar or wind, physical or financial, indexed or fixed price, or fixed vs. floating volume. Each variation comes with distinct downstream process challenges.

Once the strategy is clear, **market readiness** must be assessed. Key considerations include legal and regulatory obligations, access to wholesale energy markets, and creating an account in the guarantees of origin register. Standardized term sheets and contracts are critical to swiftly secure PPA deals, as market volatility often results in short binding periods.

Once potential deals are identified, **the pricing and negotiation** phase begins, including a thorough risk analysis. A PPA pricing and risk model or platform must be flexible to cope with different risks implied in PPA structures and with diverse data sources and qualities.

If the negotiations succeed and a contract is signed, **long-term PPA portfolio management** follows. The PPA portfolio management cycle includes valuation and risk management, position management, hedging strategies execution, End-of-Day reporting, and more.

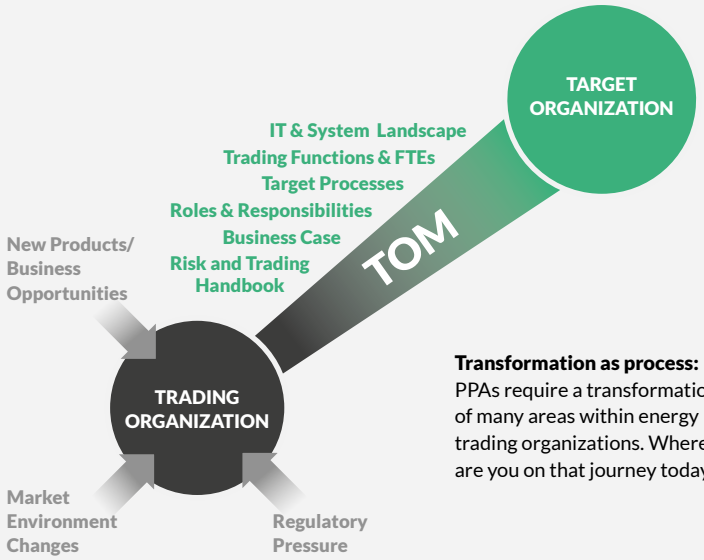
Throughout this cycle, accurately measuring the risks of PPAs and hedges is crucial for making optimal use of risk capital and sound hedging decisions.

As physical delivery approaches, organizations must establish a fast and resilient **short-term portfolio management** for PPAs with physical delivery. Unlike earlier stages, this step requires 24/7 monitoring and trading systems to address immediate operational needs.

The final step – **settlement and invoicing** – requires robust processes. Common pitfalls include data gaps, contract specificity, or evolving regulations like Redispatch 2.0 in Germany. Errors here can harm profitability and customer satisfaction. Since PPAs fall under REMIT reporting obligations, required systems and processes must be available.

In conclusion, PPAs demand significant adaptations across an organization's systems and processes. See our approach to develop a Target Operating Model (TOM) on the right to learn how we at FORRS can make your trading organization ready for PPAs.

# FORRS's Experience After the First Implementation Waves/ Target Operating Model (TOM)




**Transformation as process:** PPAs require a transformation of many areas within energy trading organizations. Where are you on that journey today?

Integrating PPAs affects the entire trading organization. While all departments are involved, their interests and profit contributions often vary, leading to unclear profit-sharing arrangements and lengthy disputes.

Moreover, effective PPA data management is critical for PPA success. Many organizations struggle with complexities of PPA data, requiring adjustments to their IT and organizational structures. But how can organizations transform to handle PPAs efficiently?

At FORRS, we have established an approach for developing a TOM, which has proven invaluable on different projects throughout Europe and Africa, ranging from market model changes to seizing new business opportunities, such as PPAs.

## What is a TOM for PPAs?

Managing PPAs requires a robust organizational and operational foundation, and a TOM provides a solid approach to reach that goal. On an organizational level, the TOM defines structures across the front-, middle-, and back-offices to support PPA management. On an operational level, it outlines detailed processes to ensure daily efficiency.

**The TOM is a proven way to manage and integrate PPAs.** Starting from industry best practices, a TOM identifies those organizational and operational components needed for PPA integration. The result is a tailored model for efficient PPA management that is aligned with the organization's unique strategy and processes.

# Transformation of Risk Management – From Price Taker to Risk Taker

*The energy industry is undergoing a transformative phase, where effective risk management (RM) is essential for navigating challenges and achieving success. This article explores the dynamic landscape of RM, emphasizing its vital role and the necessity for continuous enhancement.*

In energy trading companies, risk management (RM) is increasingly under scrutiny, particularly following events like the German energy crisis and "Dunkelflaute" periods. These incidents have driven management to reevaluate their RM strategies' readiness for future challenges. To succeed, energy trading companies must align their RM practices with their business objectives.

## Status of risk management

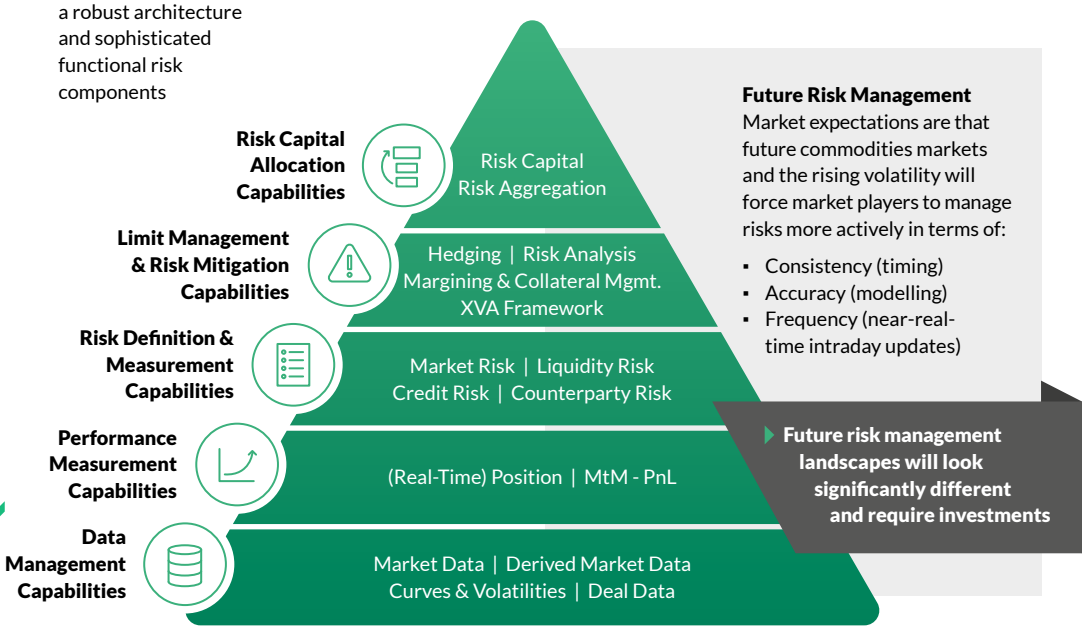
Today, RM practices in energy markets vary significantly, from basic approaches to those on par with financial institutions' standards. At the fundamental level, RM involves simple metrics like Value at Risk (VaR) for assessing market risk, often using manual Excel reporting. This approach typically uses historical data, at best from the previous day's end. More advanced firms utilize databases to enhance metric calculations and improve reporting timeliness, yet they often lack capabilities for real-time intraday risk decisions. To bridge this gap, some companies adopt dynamic strategies with near-real-time and event-driven reporting, leveraging semi-automated software or coding languages like Python. At the advanced end, a wide array of risk metrics, including credit, liquidity, and operational risks, undergo rigorous evaluation and audits. Here, RM is an integral part of business strategy, focusing on risk-adjusted returns and suitable risk capital allocation, elevating energy trading companies' RM to that of financial institutions.

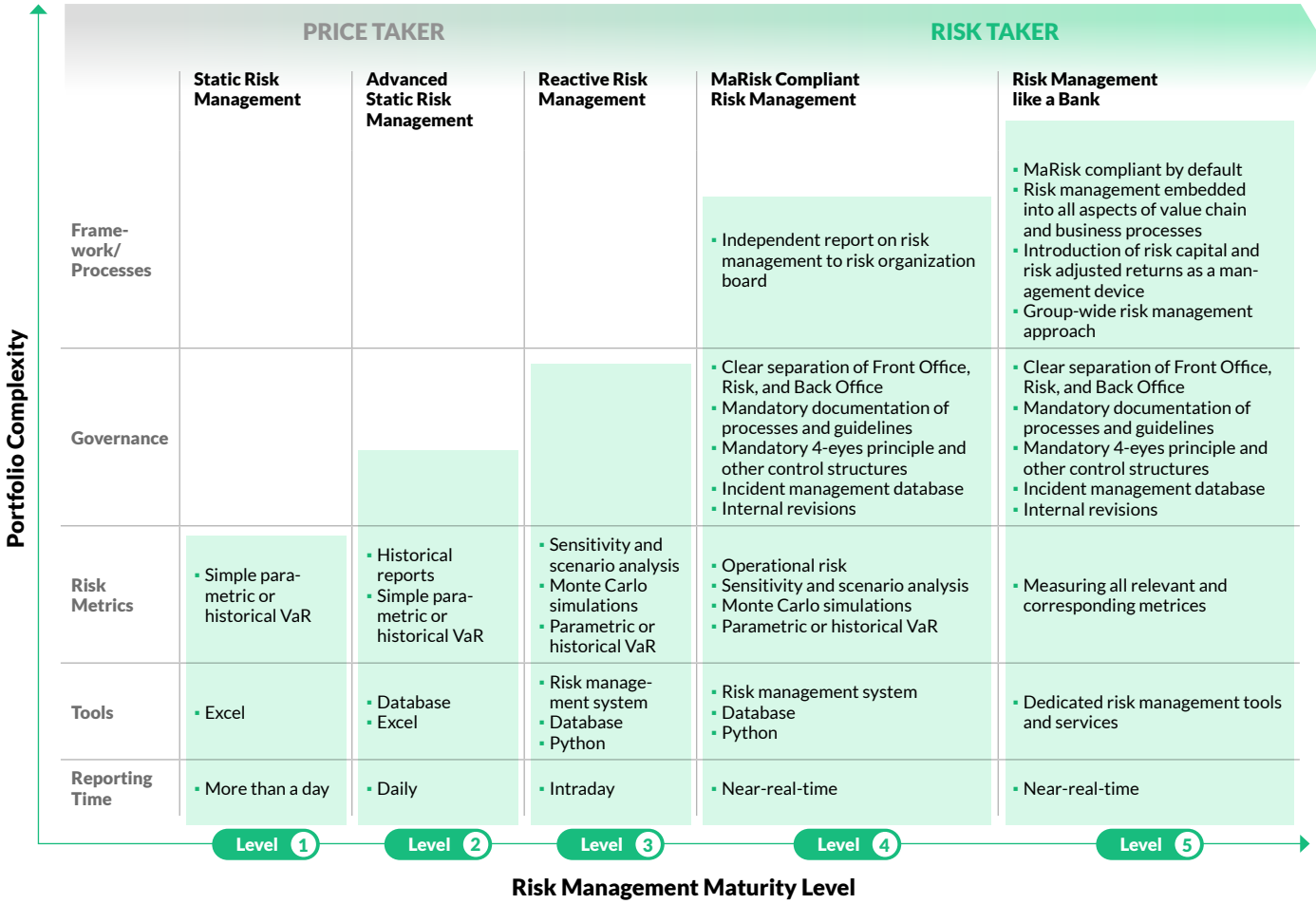
## Tackling energy market challenges

An effective RM framework should identify, measure, monitor, and mitigate risks to prevent financial losses and existential threats. Trading organizations face numerous external and internal risks from both anticipated and unforeseen events. Unpredictable shocks like global pandemics or geopolitical conflicts heighten price volatility, disrupting supply-demand equilibrium and intensifying market, margin, and liquidity risks. Foreseen external factors cover energy production shifts, market dynamics, and growing competition, requiring shorter time-to-market cycles.

As renewable energy expands – constituting more than half of Germany's power generation – and the demand for green Power Purchase Agreements (PPAs) grows, RM must integrate green products into existing systems to manage risks, including weather forecast accuracy. Weather variability affects multiple producers

Building a cross-commodity and cross-currency risk management framework requires a robust architecture and sophisticated functional risk components






Building a comprehensive risk management framework requires trading organizations to know their starting point and to define their target of risk capabilities

simultaneously, exposing them to more significant price and volume risks compared to conventional sources. Effective short-term renewable trading necessitates rapid reactions achievable only through timely data input, analysis, and monitoring. This drives companies to adopt advanced tools that offer advantages in terms of time and flexibility.

Open markets attract diverse participants, from renewable producers to financial institutions seeking risk premiums via sophisticated RM systems. The increasing number of participants and the quality of their frameworks decrease profits for inefficient traders. Internally, expanding business strategy significantly contributes to risks. Trading organizations frequently aim to broaden their strategies, market reach, and portfolios to boost profits. However, this growth introduces greater risks if RM infrastructure and policies are inadequate.

## Find the right maturity level

Considering the fast-paced business climate described above, understanding your organization's RM maturity is crucial for success. We provide a framework with five maturity levels, each marking increased sophistication and effectiveness.

- **Level 1**: Static Risk Management is basic and reactive, addressing risks as they arise without proactive mitigation.
- **Level 2**: Advanced Static Risk Management offers a more structured approach but remains responsive.
- **Level 3**: Reactive Risk Management, organizations actively deal with risks when they occur, moving towards a dynamic response system.
- **Level 4**: MaRisk Compliant Risk Management aligns with established standards, promoting a comprehensive approach that preempts risks before they affect the business.
- **Level 5**: Risk Management embodies proactive practices, similar to those of a bank, embedding RM into culture and strategy, optimizing processes to preemptively tackle risks.

Assessing your RM maturity level is the first step towards improvement. By knowing your starting point, you can target your efforts to reach a higher level, enhancing decision-making, resilience, and competitive edge. Advancing RM maturity transforms it from an obligation to a strategic advantage, allowing organizations to anticipate and mitigate potential threats. Let us help you understand your current status and craft a path to improved security and opportunity.

# Voices from the Market: Technology Leaders Speak

*Systems and technology are the enablers of efficiency and innovation. In energy trading, many sophisticated software vendors and service providers are driving business. They not only shape today's energy trading from within, but will do the same through innovation in the future. We are delighted to present important views and insights from major vendors in the industry.*

**JENS HARTMANN**
CEO | enmacc

Traditional OTC trading has declined sharply since 2021. Amid the energy crisis, traders have accommodated onerous margin requirements set by exchanges. Now, OTC is back in focus – but in a different way: pre-trade transparency enables pricing of individual counterparty risk, while front-to-end digitization and automation address rising efficiency needs. Modern OTC trading offers complementary liquidity to exchanges and draws new players to fuel its growth.

**DR. ROLAND PEETZ**
SVP Energy Software | VOLUE

Flexibility is the new gold of the intermittent power market. To some this is news. But many large and small customers already monetize the value of their flexible assets systematically, at scale, end-to-end, and across multiple markets and regions with the help of Volue's data, software, and scalable automated processes. Relevant data flow and its management, portfolio optimization, and automated trading need to be thought and solved together.

**FRANZISKA DANZ**
VP of Product Management | ION Group

Oversupply in GoO markets requires traders to focus on the unique characteristics of certificates to capitalize on niche opportunities or leverage Power Purchase Agreements (PPAs) to a bundled offering. To succeed, it is essential to break down certificates by individual characteristics and understand profitability drivers of PPAs and renewable assets, such as batteries. As a result, optimizing the combined portfolio and managing these value drivers is crucial.

**MARTIN BECHTOLD**
VP Sales DACH & CEE | Corporates and International Banking | FIS

Facing highly volatile and tightly regulated markets, energy companies must adopt flexible, cloud-native trading, and risk management solutions. These systems must be capable of handling high trading volumes, enabling real-time calculation of mark-to-market positions, managing physical and financial instruments across various commodities, and analyzing both historical and interval market data from diverse sources. Such capabilities are key to establishing robust risk controls and ensuring regulatory compliance.

**ASBJØRN HANSEN**
Managing Director Previse Systems | Previse

The energy trading market is evolving rapidly. With growth in renewables and with alternative fuels increasing in importance, scaling businesses through advanced automation and technology is key. Success in short-term trading depends on handling high data volumes with performance. Technology is reshaping the market globally, fostering scalability and versatility, while creating immense opportunities for businesses to adapt, innovate, and lead in a dynamic energy landscape.

**ROMAIN THUAUDET**
Energy Product Manager | Orchestrade

Rapid shifts in gas supply into and across Europe underscore the need for systems to accurately capture changes in market conditions and facilitate quick decision-making. Platforms need to capture and correctly value optionality rapidly, across the full range of physical gas assets, including swing contracts, storage, or transport capacities. Ever-expanding data requirements of short-term power markets and long-term power purchase agreements are further shaping today's system landscape.

**DR. JENS BARTENSCHLAGER**
CEO | Fidectus

Since the energy market crisis, we've observed OTC markets rebound with recovering volumes and an influx of new entrants. From our perspective, traditional post-trade methods no longer meet market demands, as seen in the shift from electronic to PDF and email confirmations. To address these needs, we believe it's crucial to rethink post-trading to lower entry barriers, boost working capital, and drive market participation, preparing traders for growth in emerging markets.

**LUCA PEDRETTI**
COO & Co-Founder | Pexapark

As the PPA market matures, we're witnessing a shift from simple volume-based deals to intelligent, tailored solutions. The future lies in delivering green, firm profiles that combine multiple sources to meet the evolving needs of the market.

# Managing Model and Data – from Prototyping to Operations

*As energy trading undergoes rapid changes, managing data and models is more challenging than ever. Using automation for model execution and data handling is crucial for reducing operational risks and integrating new business models.*

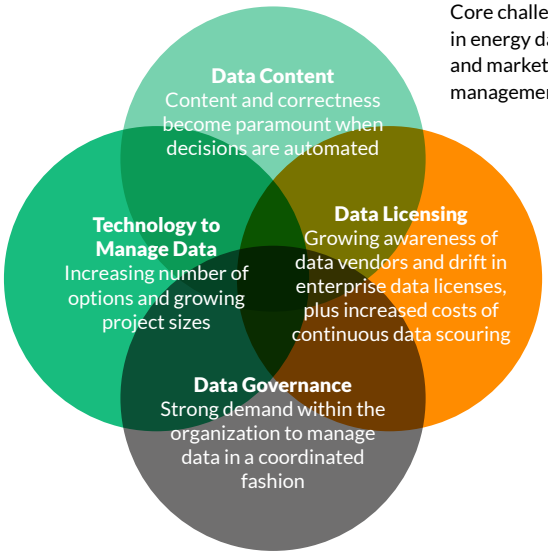
## Rising challenges in energy markets

Energy markets are becoming more dynamic imposing challenges to all market participants, particularly for data and model management. While current technological developments dominate both areas, selecting suitable solutions is more complex than ever. The management of renewables and their technical requirements for the integration into the trading value chain further highlight this complexity, especially when the platforms in use are not fit-for-purpose. Decision-taking processes are becoming more automated, to adapt to fast-changing market conditions. However, this requires integrated and calculated data to remain consistent and reliably available at any time.

## Increasing complexity in data and model management

Simultaneously, the number of onboarded data sources is growing, driven by expanding business and market activities, as well as by the availability of more data sources in the market. Therefore, data ingestion has become a significant ongoing effort in every professional trading environment.

Core challenges in energy data and market data management

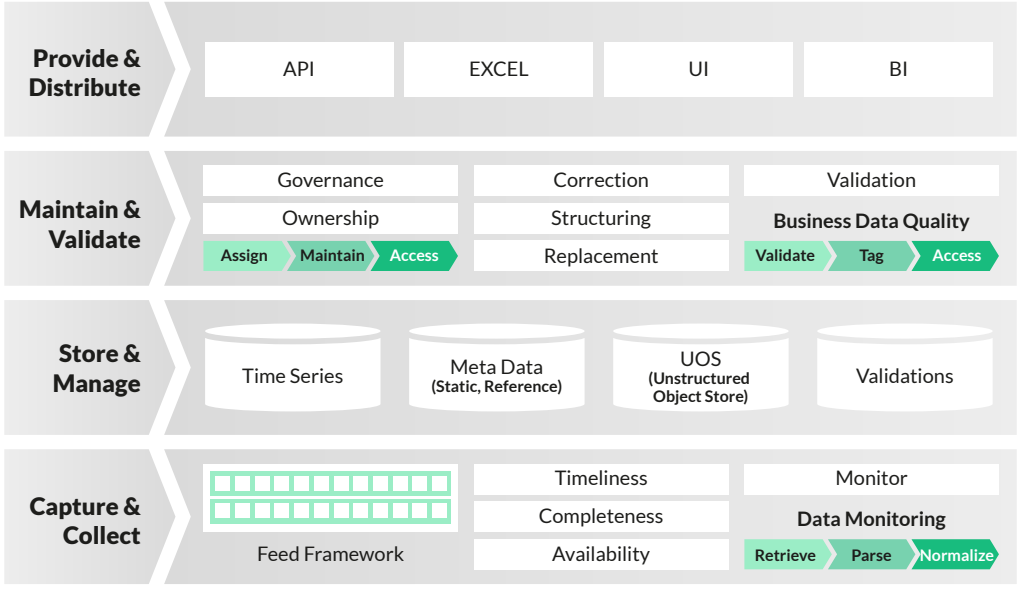


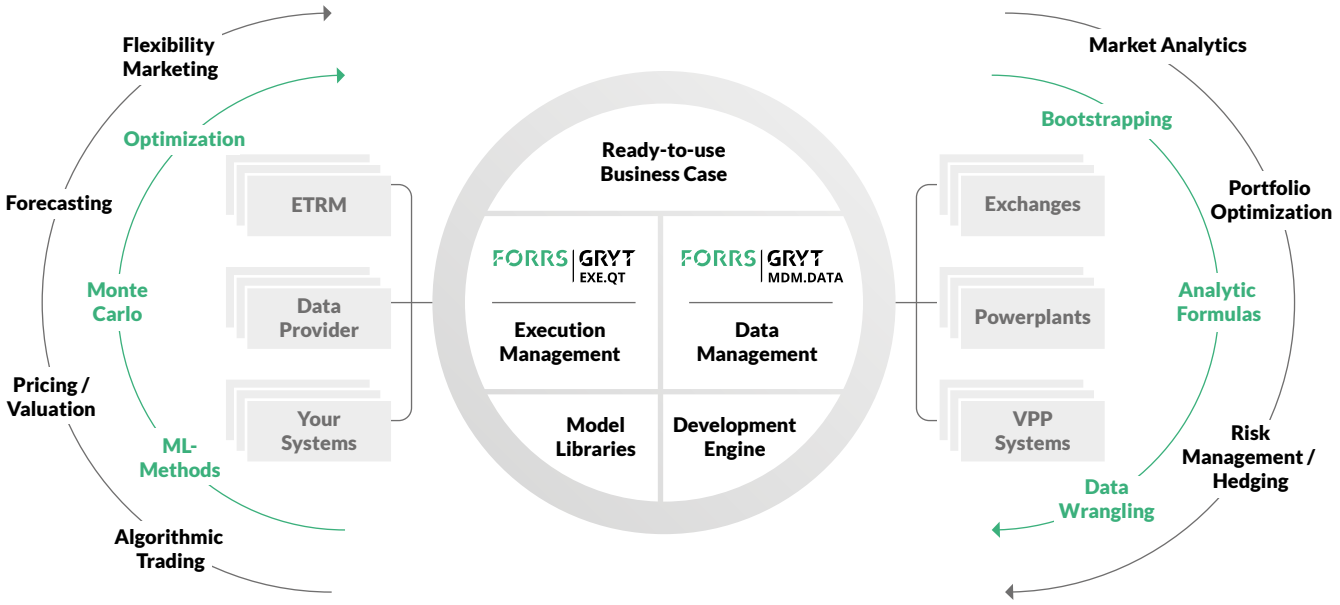

As these challenges within data management environments become more apparent, they must be efficiently addressed for organizations to remain competitive.

## Core challenges in energy data and market data management

Choosing the right technology solutions or platforms to manage data, especially market data of an energy trading organization, is a complex task. Many interfering aspects must be considered, and the demands of all departments within an organization need to be covered. Solution discussions often focus narrowly on specific technologies or database products, but the overall solution must support the targeted business processes, workflows, and should stay within planned budgets.

FORRS's market data management capability architecture






**The GYRT Ecosystem** specifically designed for individual modeling in energy trading and risk management

Technology choice questions and data content challenges are typically accompanied by additional complexity, particularly arising from data governance and data licensing issues. A lack of effective data governance is an internal cost driver, while poor data licensing practices represent an external operational risk, often leading to significant costs or even fines.

## Capability architecture for effective solutions

One of the most effective methodologies used by successful organizations is to design solutions based on a capability architecture. This methodology allows business-related discussions to be separated from technological-focused decisions, ensuring that the solution correctly aligns with organizational needs and goals.

At FORRS, we developed this capability architecture and use it as a leading principle when planning both small or large data architectures and platforms.

## Automating decisions and managing models

Due to the increasing demand for the integration of renewables into the deal lifecycle, continuous and automated decision-making has become essential. This automation is performed by models and even chains of models for energy trading companies. As the number of decisions to be automated grows, the need for test automation, and the operation of numerous models and workflows, grows similarly. Even smaller organizations can find themselves managing an unexpectedly high volume of productive models or scripts that often exceed 100 or more operative decision models.

To professionally manage data and models in such a magnitude across the complete organization, we have developed a comprehensive software suite called GRYT. By using GRYT, market participants can establish an efficient internal ecosystem and utilize a professional data and model platform. Operational stability is ensured through encapsulated prototyping environments and a clearly defined deployment pipeline that seamlessly transitions into production.

## Conclusion

Effectively managing data and models is crucial, but choosing the right technology solutions requires careful consideration of numerous factors. Data governance and licensing issues add further complexity, impacting both internal costs and external operational risks. By adopting a capability architecture and focusing on automating decision-making through models, companies can create efficient ecosystems that support growth, operational stability, and resilience.

# FORRS Research

*The fast-changing energy market demands constant adaptation and innovation. By combining the expertise of academia and industry, we are analyzing the latest trends and developments, which lead to innovative approaches and solutions.*

**DR. FABIAN PFAFFENBERGER**
Managing Director Hydrogen Center Bavaria (H2B)

## The Need for Innovation-Friendly Regulations and Investment Security

Germany aims to create a competitive hydrogen market by 2030. This requires a clear political course to ensure planning security and improve the investment climate. To ensure global competitiveness, a coherent funding policy, streamlined approval procedures, and incentive mechanisms, such as binding quotas, are required. The regulatory framework must promote innovation instead of slowing it down.

**PROF. DR. ANDREAS WAGNER**
Karlsruhe University of Applied Sciences

## Collaborative Research: Renewables Forecasting with Federated Learning

The successful implementation of renewable energy relies heavily on precise short-term forecasts of weather-dependent electricity generation. However, market participants often have only small and local databases, limiting the precision of the models developed. Federated learning (FL) holds promise, allowing market participants to collaboratively utilize data from their respective systems for precise model development without exchanging sensitive information. As part of this project, Karlsruhe University of Applied Sciences is researching the use of FL models, together with FORRS and four other partners from the energy industry.

**PROF. BERNARD BEKKER**
Stellenbosch University

## Supporting Renewable Energy Research in South Africa

The Centre for Renewable and Sustainable Energy Studies (CRSES) at Stellenbosch University focuses on renewable and sustainable energy research in Africa. In particular, South Africa has an abundance of renewable energy resources which are essential to addressing the current energy crisis and energy transition. However, successfully integrating renewables into the electricity network requires unique solutions. This project between CRSES and FORRS aims to develop technological solutions that can be implemented in South Africa, while promoting skill development, knowledge exchange, and interdisciplinary collaboration across international borders.

**PROF. DR. GÖRAN KAUERMANN**
Ludwig Maximilian University of Munich

# Machine Learning with Uncertainty Quantification for Wind Power Forecasting

In this joint cooperative project between FORRS and Ludwig Maximilian University of Munich, we undertook several research initiatives to leverage machine learning for forecasting wind production in Day-Ahead power markets. Utilizing production data from the industry, we have developed models that enhance the accuracy of power generation predictions, thereby reducing risk when energy companies market their renewable portfolios. By integrating machine learning with parametric techniques, forecasts are being produced that incorporate uncertainty quantification, to facilitate more informed decisions. This endeavor highlights the mutual benefits of aligning academic research with industry requirements, advancing both fields in the process.

**PROF. DR. SVETLANA IKONNIKOVA**
Technical University of Munich

# Techno-Economic Assessment on Intercontinental Green Hydrogen Transport

The Center for Energy Markets (CEM) at Technical University of Munich advances energy market understanding and supports global decarbonization through research, education, and industry collaboration. Partnering with FORRS, CEM examined the cost components of intercontinental green hydrogen and ammonia transportation, emphasizing the collaboration between Chile and Germany. This research assessed the costs of transporting green hydrogen from Chile to Germany in liquid hydrogen and ammonia forms, considering storage, conversion, and regasification. Sensitivity analyses explored scenarios involving fuel types and carbon taxes. This study combined industry expertise with academic excellence to address the challenges of hydrogen transportation.

**PROF. DR. RÜDIGER KIESEL**
University of Duisburg-Essen

# Unique Climate Risks Require New Approaches

The risks arising from climate change are uniquely global, uniquely long-term, uniquely irreversible, and uniquely uncertain. Because their structure is complex and their consequences go beyond financial losses, climate risks are difficult to price. Clearly, risk that is not adequately quantified is difficult to manage effectively.

Thus, we are developing approaches to improve the analysis of climate risks within the usual risk categories (credit, market, etc.). Acknowledging the special character of climate risks, we are investigating measures to increase the resilience of companies and propose ways to implement risk-oriented dialogues on transition plans. In addition, new financial products and structures to help smooth the decarbonization path are being designed and evaluated.

**PROF. DR. ALEXANDER SZIMAYER**
University of Hamburg

# Integrating Renewable Power – International Summer School 2025

Renewable power production is becoming a crucial component of the global sustainable transformation, yet it presents complex challenges requiring interdisciplinary approaches across academia and industry. To address these challenges, Hamburg University, along with Stellenbosch University, Ludwig Maximilian University of Munich, and FORRS, is hosting the “Integrating Renewable Power - International Summer School 2025.” This event will explore key topics and their interplay, including power network stability in electrical engineering, power markets in business, weather, and climate in meteorology, and forecasting via econometrics that include machine learning. FORRS will provide invaluable expertise on power markets and meteorology for energy forecasting.

FORRS

# Problem Focused – Solution Driven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