Thought Leadership

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ENUIT
A PASSION FOR COMMODITIES

Evolution, Volatility, Change

The impact of renewables on energy market structure

Chartis
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About Chartis

Chartis Research is the leading provider of research and analysis on the global market for risk technology. It is part of Infopro Digital, which owns market-leading brands such as Risk and WatersTechnology. Chartis' goal is to support enterprises as they drive business performance through improved risk management, corporate governance and compliance, and to help clients make informed technology and business decisions by providing in-depth analysis and actionable advice on virtually all aspects of risk technology. Areas of expertise include:

- Credit risk.
- Operational risk and governance, risk management and compliance (GRC).
- Market risk.
- Asset and liability management (ALM) and liquidity risk.
- Energy and commodity trading risk.
- Financial crime, including trader surveillance, anti-fraud and anti-money laundering.
- Cyber risk management.
- Insurance risk.
- Regulatory requirements.
- Wealth advisory.
- Asset management.

Chartis focuses on risk and compliance technology, giving it a significant advantage over generic market analysts.

The firm has brought together a leading team of analysts and advisors from the risk management and financial services industries. This team has hands-on experience of developing and implementing risk management systems and programs for Fortune 500 companies and leading consulting firms.

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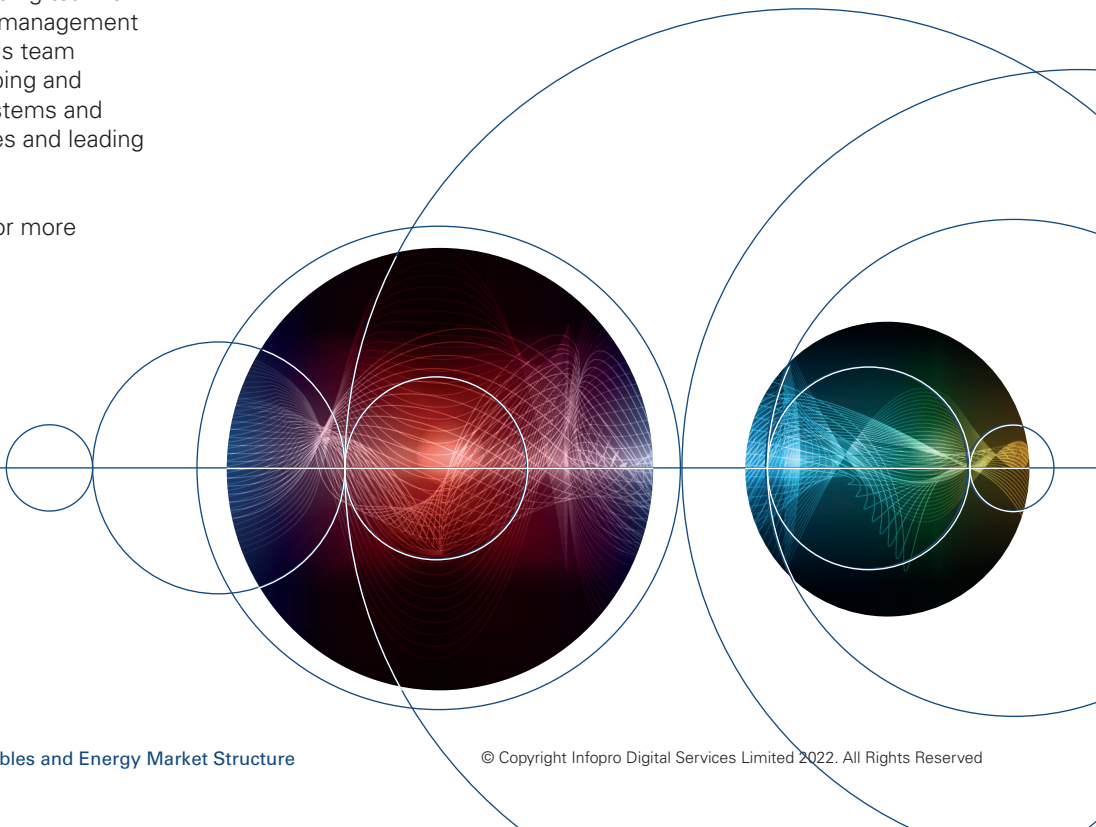
Join our global online community at **www.risktech-forum.com**.



About Enuit

Enuit[1] was founded in 2008 with a single goal in mind: to bring to the market an affordable and fully functional trading and risk management solution.

Enuit's ETRM solution, Entrade, helps clients to have uncensored visibility over their transactions through the entire deal lifecycle, from done-deal through to sent-bill.

Entrade is a flexible, robust, open-data risk management solution that supports every commodity, feature and end user in one place, ensuring users can trade what they want when they want without limitations.

With Entrade firms have all the functions they need to run their commodity trading business, including:

- Deal capture and risk reporting.
- Valuation and attribution.
- Scheduling physical commodity movements.
- Tracking primary and secondary costs.
- Monitoring inventory levels and costs.
- Actualizing volumes and settling deals.
- Tracking credit exposure.
- Generating accounting entries.
- Monitoring operational and market-related risks.
- Providing useful reports and a data warehouse.

In 2021, Enuit decided to bring in renowned expertise to grow its product suite for environmental and global power markets. **Seenu Kaliamurthy** joined as Managing Director of Power Solutions. With Seenu's advice, Enuit has further developed Entrade's capabilities to:

- Model complex power transactions.
- Capture, track and value environmental instruments accurately.
- Capture renewables bundled to physical transactions and provide clear and concise analytics for users.
- Manage the integration of physical processes and operations with trading and risk.
- Capture pertinent data that traders can use to improve efficiency and generate accurate prices and risk estimates.
- Integrate more effectively with other systems that are emerging as the market diversifies.
- Provide full support for all renewable energy sources, including all carbon-related trading activities.

For more information about Enuit visit:
www.enuit.com

[1] *Text provided by Enuit.*

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1. Renewables: impacts and disruption

Renewable power has been one of the most significant topics of the past 30 years. Implementations have grown rapidly, in many geographies, as a way to combat climate change and generate electricity with lower ongoing costs. But this growth raises several issues for those involved in energy markets: the impact on trading, new investment decisions for both renewables and conventional power components, and how to integrate renewable technologies into current systems without excessive disruption or volatility.

These have stimulated much discussion around renewables, but an exact, standardized definition of 'renewables' is still lacking; few discussions clearly state what they consider the term to mean.

This report in part attempts to address this (see, for example, the taxonomy on pages 8 and 9), and considers the profound impact that renewable energy and sources will have on the structure of energy markets and the software technology employed by their key players.

Market disruptors and impacts

The capacity conundrum

Integrating renewable technologies into existing energy systems is a challenge. How much so depends on the nuances of the current system, plus the characteristics of the renewable technology in question. Stable renewable power sources – those with predictable, stable outputs – are generally more straightforward to integrate with power grids, as they do not introduce much variability into power networks. Intermittent renewable energy sources, on the other hand, can raise the complexity of load balancing significantly: the power outputs of these technologies are highly variable, so additional mechanisms are needed to compensate for this.

One way to tackle this is to use capacity mechanisms – power network components that can either:

- Increase or decrease their power output (usually using 'fast' power stations, such as those that use natural gas), or
- Increase/decrease power requirements ('demand resources') as necessary to ensure system load is well-balanced.

These mechanisms take the form of either 'capacity markets' or 'strategic reserves'. Capacity markets consist of components that are already integrated into power markets, which then bid in an auction for contracts that require them to balance markets a certain number of times in a set period. Strategic reserves, by contrast, are solely for the purpose of capacity management, and are formed of resources that are otherwise not engaged in power networks.

Better storage

Since much of the increase in renewables focuses on intermittent power sources, the generally high renewables growth we have seen is increasing the need to manage capacity. In the slightly longer term, battery energy storage systems (BESS) offer an alternative to traditional capacity mechanisms, storing electrical power for use when demand is higher than expected. Although current implementations are limited, as battery technology becomes more economically scalable it is likely that use of BESS implementations will increase.

Many regions will use a blend of approaches, and as technology develops, this mix may also shift toward a more battery-focused approach. It is unclear where the mix of market structure components will settle in future, but there are several likely options.

Of course, the way renewables-driven intermittency is handled by either conventional capacity mechanisms or battery storage will vary depending on geographic and policy factors. Understanding how intermittency is handled is critical to understanding the overall functioning of markets.

Data-intensive

The rapid increase in renewables is also driving demand for supporting data and data capabilities. Energy systems have become more data-intensive, particularly those that handle intermittent sources, creating a need to forecast power outputs as accurately as possible (forecasting power demand on a large scale has a much more established history).

Stable energy outputs can either be directly controlled, or at least comprise a known value. Forecasting power outputs from intermittent power sources creates challenges around the data,

as it relies largely on high-volume, granular time-series datasets, particularly weather forecasts. Incorporating these datasets into analytics is computationally intensive and can require specific software and hardware.

Renewables-linked data and analytics are also growing in other areas. New infrastructure and hardware are key elements of the renewables expansion – greater renewables penetration (which occurs regardless of how broad the renewables taxonomy is) is made possible by investment in physical infrastructure. The analysis behind these investment decisions has substantial data and computational requirements, and includes data on physical geography, as potential sites for renewables generation, processing or transmission infrastructure must be evaluated carefully. For power-generation infrastructure, the viability of investment decisions will be affected not just by connectivity to existing power networks but also by the geography and climate of the site in question, so data on these factors can be extremely valuable.

Similarly, technological improvements to sensors and monitoring devices have improved the data ecosystem for renewables, providing operational data that operators and traders can use to improve efficiency or generate accurate prices or risk estimates. For both investment decisions and operations, planning requires analytics that are increasingly linked with trading and risk. This can cause additional challenges for software solutions under pressure to integrate effectively with other systems.

Pricing issues

Pricing is a key challenge for renewable fuels, which are relatively illiquid, with much lower trade volumes than for conventional energy commodities. Pricing is further complicated by the existence of multiple viable methods for producing biofuels, with differing efficiency and carbon characteristics. Pricing depends heavily on the different underlying feedstocks and processes used to produce the fuel, with a premium to compensate for the inefficiencies involved in producing it. So grey hydrogen is priced lower than blue hydrogen, for example, because blue hydrogen production incurs additional costs for carbon capture and storage. Similarly, green hydrogen uses more costly production methods, which are reflected in price assessments. However, pricing is uncertain for renewable fuels, as it remains to be seen how widely they will be accepted into existing energy markets, how well their adoption will scale and what their role will ultimately be. Until these details are known, operational characteristics (which have a significant impact on pricing) are similarly uncertain.

Currently, renewable fuels and power are more costly than conventional power (although costs continue to fall as technologies improve and scale). As low-carbon technologies, however, they have advantages over conventional power sources in markets that use carbon trading schemes. So when firms evaluate the cost of conventional power versus renewable technologies, they must have a firm understanding of the dynamics of carbon trading schemes to make well-informed decisions.

Software systems: more adaptation, more integration

As the shift toward renewables – and decarbonization in general – causes significant disruption in the energy sector, market participants are responding by changing how they trade and operate, and this influences their software use and requirements.

Mirroring the trend in conventional energy markets, the integration of physical processes and operations with trading and risk management is crucial – even more so for renewable power and fuels, with their complex operational chains and multiple dependencies. To operate in the renewable energy space, market participants will increasingly require systems that can manage and integrate multiple processes. The extent to which this enterprise resource planning (ERP)-like functionality is required will depend on who is using it, and their portfolio. Pure financial commodity traders, for instance, will have less need for operational data integration than those trading physical commodities. Even so, when considering the renewables space, the prevailing trend will be toward integrated systems.

Under pressure

More specifically, systems are also under pressure to adapt to the challenges posed by intermittent renewable power sources. Wind and solar power are growing especially quickly, and the variance in their output will have major consequences for short-term power pricing. Firms trading short-term power have a growing need for data and analytics to incorporate the weather data necessary for accurate instrument assessments. Data analytics in general are in higher demand, as data becomes more widely available and datasets

more complex and granular. Growth in renewables is creating additional data ecosystems for specific fuels, and market participants who want to trade renewables will require suitable systems. Because of the scope of the renewables market, the data landscape is very broad, and firms will have to rely on a range of data providers.

Commodities and carbon are crucial

Systems that can handle multiple commodity types effectively are especially relevant to renewable energy, which is inherently a multi-commodity space. Renewables sit squarely within the wider energy space, in terms of physical infrastructure and power grids (where they function alongside and in concert with conventional energy), and trading and pricing (as renewable energy prices are strongly linked to conventional energy and electrical power prices). Indeed, power markets have very close links between conventional electrical power and renewable electricity, as these are both components of the same power grids and differ in trading terms only in their carbon attributes.

Carbon trading is also an area closely linked with renewables – carbon prices directly affect how viable renewable electricity is, just as they influence the overall economy of different power-generation types. These links are reflected in the changing software needs of energy market participants, who increasingly require multi-commodity software systems.

Conclusion: a need for flexibility

Overall, growth in renewables is causing a rapid shift in energy markets, although this varies depending on the renewable technology in question (solar and wind power, for instance, are far more mature than hydrogen fuel). Indeed, some nascent technology approaches, such as those around hydrogen, face considerable uncertainty, in terms of how widely they will be applied and in what context.

To an extent, even the most mature renewable technologies share some of this uncertainty. With this in mind, there is a growing need for flexibility in software systems for the energy sector. Flexible software enables firms to respond more rapidly to unforeseen changes in energy markets, with fewer compromises. Given the current state of energy markets, this agility is critical.

2. A taxonomy of renewables (the ecosystem and enabling environment)

At a basic level, 'renewables' include technologies that generate electricity from a source that is naturally replenished on human timescales. This includes many technologies that rely on varied power sources and generation approaches:

- **Intermittent-generation approaches**. Unpredictability is inherent to the output of these sources, usually because of the weather. Incorporating them into existing systems requires careful planning.
  - *Solar*. Sunlight is used to generate electricity, whether directly through photovoltaics or indirectly by concentrating solar energy to heat another medium, which is then used to generate electricity. Cloud coverage and daylight hours determine output.
  - *Wind*. Wind turbines can be placed on land or offshore. Wind strength determines power output.
  - *Wave*. Less common than solar or wind, wave energy converters generate electricity from wave movement in bodies of water. Wave magnitude largely varies with wind.
- **Consistent-generation approaches**. These approaches have less day-to-day variability in terms of their output, although there can be regular variation during a day, in addition to longer-term variability throughout the year.
  - *Hydroelectric*. At present, hydroelectric power accounts for a larger proportion of total electricity generation than any other renewable energy source. It provides stable outputs that can be modulated and used as a form of energy storage. While energy production is generally stable, times of drought can limit output seasonally. Suitable locations for hydropower are limited compared to other technologies.
  - *Tidal*. Unlike wave energy, tidal energy relies on the regular rising and falling of tides, making it more reliable than wave power. Implementation of tidal power technologies is limited, but growing.
  - *Geothermal*. Geothermal power accounts for a small fraction of total renewable energy generation, in part because of high initial costs relative to other technologies. It provides very stable power output.

Beyond these power-generation technologies, renewable fuels are also becoming more significant in the energy sector, as viable replacements for conventional fuels with potentially lower carbon costs. These fuels split broadly into two categories: biofuels and hydrogen (see Figure 1). Biofuels are themselves a broad category, ranging from simple biomass to refined fuel products derived from biomass, and different biofuels vary extensively in their complexity and carbon costs. The two most economically significant biofuels are bioethanol and biodiesel, commonly used in transport fuels.

Finally, some technologies that historically have been considered conventional are now being labeled as 'green' or 'sustainable'. While these terms are not strictly the same as 'renewable', they are often discussed in much the same way. In February 2022, the European Commission announced[1] that under certain conditions, nuclear and natural gas power generation can be considered necessary in reducing greenhouse gas emissions, helping in the move away from conventional power sources. This is a controversial view, however, and climate-focused pressure groups have criticized the initiative.

When discussing 'renewables', technologies vary (see Figure 2). The core set of renewable technologies are those with no fuel input, but technologies outside this may or may not be considered part of the same taxonomy. Ultimately, the full spectrum of renewable technologies is far wider than most people think, so will have wider impacts and consequences. Each renewable technology has its own trajectory and will differ in terms of uptake, position/role in energy markets and trading characteristics. These trajectories in turn will depend heavily on the policies and strategies implemented by different geographies.

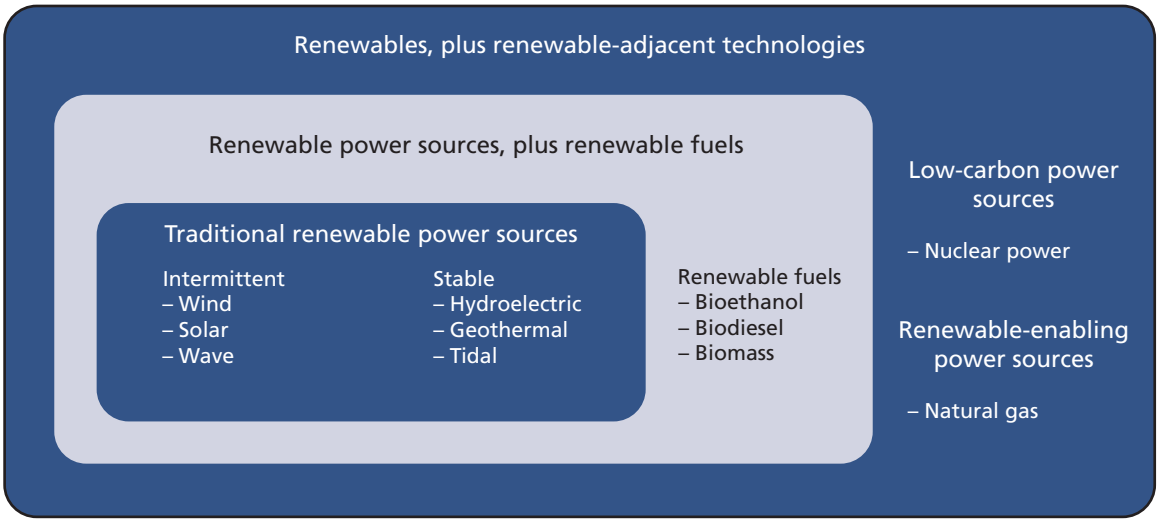
[1] *https://ec.europa.eu/finance/docs/level-2-measures/taxonomy-regulation-delegated-act-2022-631_en.pdf*

Figure 1: A comparison of common renewable fuels

	Hydrogen	Bioethanol	Biodiesel
Generation/ refining methods	Hydrogen can be generated using a range of techniques. These include thermal processes involving hydrocarbon reformation, electrolytic processes, and solar- and biologically driven methods.	A wide range of biological feedstocks can be used to produce bioethanol. Commonly these include high-sugar crops or fast-growing grasses. Production stages include fermentation and distillation, followed by final removal of water.	Biodiesel relies on the transesterification and esterification of fats and oils. These are commonly sourced from recycled vegetable oil, although other sources are also available.
Usage	Hydrogen releases energy when combusted with oxygen, producing water. This can occur in specially designed combustion engines, or in fuel cells. Much of the research into hydrogen fuel is focused on powering vehicles.	As with hydrogen fuel, bioethanol is most commonly used as a transportation fuel. Unlike hydrogen, however, it is often blended with conventional fuels as an additive. Some engine types can accept a wide range of bioethanol percentages up to 100% ethanol.	Biodiesel is commonly blended with conventional petroleum diesel for use as a transportation, heating or electrical power-generating fuel.

Source: Chartis Research

Figure 2: A taxonomy of renewables



Source: Chartis Research

3. How to use research and services from Chartis

In addition to our industry reports, Chartis offers customized information and consulting services. Our in-depth knowledge of the risk technology market and best practices allows us to provide high-quality and cost-effective advice to our clients. If you found this report informative and useful, you may be interested in the following services from Chartis.

Advisory services

Advisory services and tailored research provide a powerful way for Chartis clients to leverage our independent thinking to create and enhance their market positioning in critical areas.

Our offering is grounded in our market-leading research, which focuses on the industry and regulatory issues and drivers, critical risk technologies and leading market practices impacting our sector. We use our deep insight and expertise to provide our clients with targeted market and industry analysis, tailoring content to assess the impact and potential of relevant regulatory and business issues, and highlighting potential solutions and approaches.

Chartis' advisory services include:

Market dynamics

The markets that our clients – vendors, institutions and consultants – address are changing at an ever-increasing pace. Understanding the market dynamics is a critical component of success, and Chartis uses its deep industry and technical knowledge to provide customized analysis of the specific issues and concerns our clients are facing.

Market positioning

In today's highly competitive market, it is no longer enough simply to have a leading product or solution. Buyers must be able to appreciate the differentiating capabilities of your brand and solutions, and understand your ability to help them solve their issues.

Working with our clients, we generate compelling, independent co-branded research, targeting critical business issues. This helps our clients to position their solutions effectively, 'own' key issues and stand out from the crowd.

Collaborating closely with our clients, we develop pragmatic, resonant thought-leadership papers with immediate industry relevance and impact.

Our offerings include:

- **Co-branded research** on key market topics to provide a unique and compelling point of view that addresses a key industry driver and highlights the relevant issues. Reports can be tailored to varying levels of depth and can be powered by quantitative survey fieldwork, qualitative industry interviews, our deep domain expertise or a blend of all three.
- **Chairing roundtables and/or facilitating events and workshops** to support clients in hosting compelling events that put them at the heart of the discussion.
- **Targeted marketing through our sister brands**, leveraging the power of our parent group – Infopro Digital – to reach across leading brands such as Risk.net, WatersTechnology, FX Week and Central Banking.

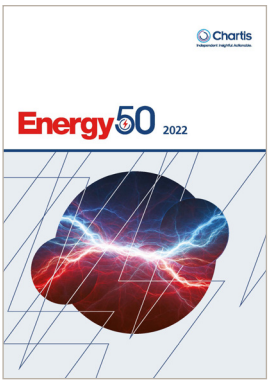
Competitor analysis

Our unique focus on risk technology gives us unrivalled knowledge of the institutions and vendors in the sector, as well as those looking to enter it. Through our industry experts, Chartis clients can tap our insights to gain a much deeper understanding of their competitors and the strategies they should pursue to better position themselves for success.

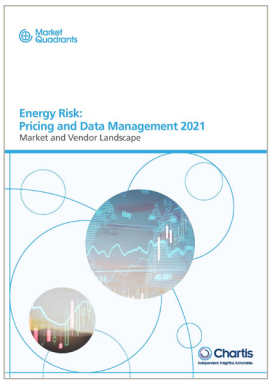
Regulatory impact analysis

The analysis and assessment of regulatory change and implementation is one of Chartis' core strengths. We can apply our insights to assess the impact of change on the market – either as it applies to vendors and the institutions they serve, or on a client's specific product and customer base. We can also provide insights to guide product strategy and associated go-to-market activities, which we can execute for internal use to drive our clients' strategy or as a co-branded positioning paper to raise market awareness and 'buzz' around a particular issue.

4. Further reading



Energy50 2022



Energy Risk: Pricing and Data Management 2021; Market and Vendor Landscape

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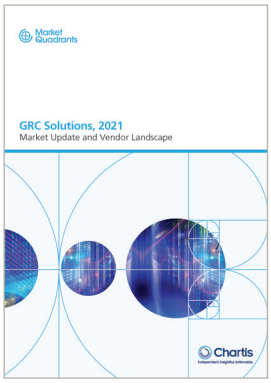
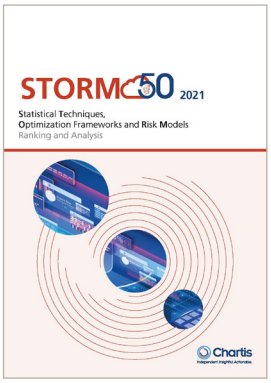


GRC Solutions, 2021: Market Update and Vendor Landscape



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