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Energy Security and the Road to Net Zero: the Role of the Derivatives Market

CONTENTS

EXECUTIVE SUMMARY

Climate change may be humanity's greatest threat. Rapidly increasing greenhouse gas emissions have led to rising sea levels, recurring heatwaves and melting glaciers, all of which have contributed to an increasingly dismal economic and environmental outlook[1]. Between 2030 and 2050, the World Health Organization forecasts there will be an additional 250,000 deaths per year as a direct consequence of climate change[2]. Between 2016 and 2018, climate-related disasters were reported to have cost the global economy $650 billion[3].

In an effort to mitigate and ultimately offset these effects, governments and organizations across the globe have committed to implementing solutions to halve greenhouse gas emissions within the next decade, and eliminate net emissions by 2050[4]. Specifically, the EU and US have committed to reaching carbon neutrality – or net-zero emissions – by 2050; China has committed to become carbon neutral before 2060, and other countries participating in the 2015 Paris Agreement have made similar commitments[5]. More recently, decisions made at the 2022 United Nations Climate Conference reiterated the commitment to achieving carbon neutrality within previously proposed timeframes[6]. As a result of these initiatives, a number of new solutions to reduce or eliminate carbon emissions have developed, in addition to new markets to finance these solutions[7].

One particular area of focus has been the intersection between the net-zero transition and global energy security. The energy sector produces around three quarters of global greenhouse gas emissions[8], making it a primary contributor to the climate crisis. In order to ensure long-term energy security while achieving global net-zero targets, public and private investments in renewable energy and green technology must triple by 2050[9]. However, recent volatility in energy markets, exacerbated by geopolitical conflict, has negatively impacted green investment. Innovation in financial and risk management solutions will be vital to safeguarding energy security and facilitating the transition to a net-zero economy.

This paper aims to build on existing literature on the topic of decarbonization and provide insight into how the derivatives market can protect energy security while facilitating the transition to net zero.

Insights and recommendations include:

- **Current state of the market:** Insight into the current state of the market and the challenges resulting from extreme price volatility in energy markets, most notably for corporates in the energy sector participating in cleared derivatives markets;

- **Medium-term recommendations:** Scale existing voluntary carbon credit markets, further standardize emissions products and create the necessary legal framework to establish a unified global market;

[1] The Effects of Climate Change, NASA, March 2023, climate.nasa.gov/effects

[2] Climate change and health, World Health Organization, October 2021, www.who.int/news-room/fact-sheets/detail/climate-change-and-health

[3] Five Sectors That Cannot Escape Climate Change, Morgan Stanley, February 2020, www.morganstanley.com/im/publication/insights/articles/articles_fivesectorsthatcannotescapeclimatechange_us.pdf

[4] Paris Agreement, United Nations, December 2015, unfccc.int/sites/default/files/english_paris_agreement.pdf

[5] Emissions Gap Report 2022, Table 3.4, United Nations, October 2022, www.unep.org/resources/emissions-gap-report-2022

[6] Decisions taken at the Sharm El-Sheikh Climate Change Conference, United Nations, unfccc.int/cop27

[7] The Paris Agreement, United Nations, unfccc.int/process-and-meetings/the-paris-agreement

[8] Climate change puts energy security at risk, World Meteorological Organization, October 2022, public.wmo.int/en/media/press-release/climate-change-puts-energy-security-risk

[9] 2022 State of Climate Services: Energy, World Meteorological Organization, library.wmo.int/index.php?lvl=notice_display&id=22136#.Y0ZyI8xBwyp

- **Long-term recommendations:** Update derivatives products to reflect rapidly evolving needs as renewable energy grows in adoption and importance to global energy security.

As the world faces the reality of the climate crisis, it is clear the transition to a net-zero economy is vital to ensure the long-term sustainability of the planet. The commitment of governments and multilateral organizations across the globe to reduce greenhouse gas emissions is encouraging, but the private sector will also play a central role.

The ISDA Future Leaders in Derivatives (IFLD) program invited emerging leaders across a diverse range of functions, business lines and geographies within the derivatives market to collaborate on the important topic of energy security and the transition to net zero. Participants in the 2022-2023 IFLD cohort have expertise in environmental, social, and governance (ESG), energy (renewables and non-renewables) and the related financial markets from leading multinational financial institutions, market infrastructure platforms, and legal and compliance firms.

Engaging expertise across jurisdictions, the IFLD has identified ways in which strategic use of derivatives can be used as a fundamental risk management tool and can support innovative financing solutions that will encourage greater investment in green technologies and the global economy's transition from carbon. If implemented in collaboration with industry, regulators, governments, multilateral organizations and other key stakeholders, these recommendations can help to safeguard energy security and create a sustainable future for generations to come.

INTRODUCTION

Energy security has long been at the forefront of government policies and public debate. In the wake of the COVID-19 pandemic, policymakers' focus shifted away from forward-looking concerns related to emissions reductions towards more imminent challenges resulting from the pandemic. Lockdowns impacted energy supply chains worldwide, resulting in the delayed deployment of renewable energy production. Post-pandemic, rebounding economies triggered a surge in energy demand and related consumer prices on a regional level, while Russia's war in Ukraine has exacerbated price volatility on a global scale. European markets experienced drastic energy supply disruption, with energy prices soaring 18 times higher in 2022 when compared to 2021[10], and the US markets experienced the largest increase in the electricity index since 1981[11].

Policymakers worldwide are taking steps to address price volatility and ensure reliable access to energy resources. In the short term, they have focused on mitigating extreme market moves and increasing the capacity of the energy grid to regulate and respond to sudden changes in supply and demand. Measures such as price controls and the substitution of renewable energy for non-renewable energy sources provided temporary relief, but do not fully address the fundamental issue of energy security in the medium and long term[12]. More permanent solutions must focus on investing in a diverse mix of renewable energy sources that satisfies the needs of economies as they migrate away from non-renewable energy. Developing the financing structures and technologies for more permanent solutions in the long term will require significant investment from the private sector to further develop decarbonization technologies and increase adoption of renewable energy sources.

Intensified by geopolitical instability and extreme energy price volatility, the climate crisis requires a comprehensive solution. Balancing energy security in the short term, increasing green investment in the medium term, and easing the transition to net zero in the long term, is a complex task. Not all regulatory policies and market initiatives will be successful. However, continued support from the public and private sectors to develop new financial structures and technologies is critical to achieving energy security and related sustainability goals. Strategic use of derivatives will help to achieve these goals by providing innovative, bespoke solutions to support the necessary capital allocation to green technologies and manage the risks associated with the transition to net zero.

[10] Financial stability risks from energy derivatives markets, European Central Bank, November 2022, www.ecb.europa.eu/pub/financial-stability/fsr/special/html/ecb.fsrart202211_01~173476301a.en.html

[11] Consumer Price Index News Release, US Bureau of Labor Statistics, September 13, 2022, www.bls.gov/news.release/archives/cpi_09132022.htm

[12] Not too late – Confronting the growing odds of a late and disorderly transition, Network for Greening the Financial System, September 2022, www.ngfs.net/sites/default/files/media/2022/09/07/not_too_late_-_confronting_the_growing_odds_of_a_late_and_disorderly_transition.pdf

CURRENT STATE OF THE MARKET

A. Price Volatility and Collateral Challenges

Extreme volatility in energy prices has eased over the past year, primarily due to a combination of unseasonably warm winter weather, significantly reduced energy demand[13] and increased reliance on emergency energy reserves. However, there are still fundamental concerns regarding continued reliance on fossil fuels and supply chain concentration. Recent geopolitical events, such as the war in Ukraine and its impact on European energy markets, highlight these vulnerabilities and the need for immediate action to strengthen market resilience against further disruption.

Policymakers' efforts to address these and related energy security concerns have traditionally focused on the underlying causes of energy market volatility by ensuring the availability of conventional energy resources and improving existing power generation infrastructure. However, recent spikes in volatility have instead been met with direct intervention in secondary markets – including emergency trading closures and price caps – with unintended adverse consequences[14].

Rather than implementing ad hoc trading suspensions and other market interventions, policymakers should instead focus on putting in place transparent and consistent volatility controls to promote orderly market functioning. Many securities and derivatives exchanges have already implemented high-frequency market monitoring functions (often referred to as circuit breakers) that temporarily halt trading in the event of extreme price moves to prevent errant trades and irrational price moves[15]. Research indicates circuit breakers have been effective in reducing volatility during times of market stress[16].

In addition, the extreme market volatility due to recent global events led to significant challenges for corporates in the energy sector that participate in cleared derivatives markets. In volatile markets, these corporates face greater difficulties in securing favorable future energy prices (required for their core business activities) and they incur higher margin requirements as a result. To address some of these challenges, the European Securities and Markets Authority recently introduced target measures to ease liquidity pressures, including the temporary expansion of the scope of eligible collateral to uncollateralized guarantees for corporates participating as clearing members, and to public guarantees for all participating members.

Although these and other market monitoring and control functions could be adjusted to operate over longer periods to allow market participants sufficient time to assess risks during periods of high volatility, such measures are not sufficient to address market disruption in the medium and long term.

[13] Council adopts regulation on reducing gas demand by 15% this winter, Council of the EU, August 5, 2022, www.consilium.europa.eu/en/press/press-releases/2022/08/05/council-adopts-regulation-on-reducing-gas-demand-by-15-this-winter

[14] ISDA, AFME and FIA Paper on the European Commission Market Correction Mechanism Proposal, December 7, 2022, www.isda.org/2022/12/07/isda-afme-and-fia-paper-on-ec-market-correction-mechanism-proposal

[15] Interval Price Limit Functionality, ICE, January 2023, www.theice.com/publicdocs/futures_us/Futures_US_IPL_Levels.pdf; Circuit breakers and other market safeguards, World Federation of Exchanges, March 2021, www.world-exchanges.org/storage/app/media/Circuit%20breakers%20taxonomy%20paper%20March%202021.pdf

[16] Circuit breakers and market quality, World Federation of Exchanges, September 2022, www.world-exchanges.org/storage/app/media/US_Circuit_Breakers_V20220914%20w_Cover2.pdf

B. The Need for Medium-term and Long-term Solutions

Energy shortages resulting from the COVID-19 pandemic and recent geopolitical conflict led to an increased reliance on coal, among other non-renewable energy sources. As a primary source of greenhouse gas emissions, coal is a particularly damaging form of non-renewable energy. Increased reliance on climate-harming energy resources directly contradicts net-zero targets. It is critical for policymakers and market participants to ensure that energy security is preserved in a manner that aligns with net-zero objectives. The measures taken so far to respond to volatility and collateral challenges are a helpful starting point but, in order to be sustainable, they must be complemented by investment in green technology and a transition to renewable energy sources.

Investment from the public sector is expected to have the greatest impact on the development of green technologies and the transition away from fossil fuels in the medium and long term. In the US, the 2022 Inflation Reduction Act will invest approximately $369 billion in energy security and climate change programs over the next 10 years[17]. The 2022 Inflation Reduction Act aims to lower energy costs, increase cleaner energy production and reduce carbon emissions by roughly 40% by 2030. The EU is looking to implement similar measures through its Green Deal Industrial Plan, in which it will relax the EU's state aid rules for investment in green technology.

However, large-scale investment from the private sector is also necessary to fund the transition to net zero. The voluntary carbon credit market has the potential to generate significant private investment in green projects in the medium term, and the derivatives market can facilitate the scaling of that market. The next section of this paper will consider recommendations to scale the voluntary carbon credit (VCC) market to encourage green investment as part of the transition to net zero.

[17] Summary: The Inflation Reduction Act of 2022, US Senate, 2022, www.democrats.senate.gov/imo/media/doc/inflation_reduction_act_one_page_summary.pdf

MEDIUM-TERM MEASURES

A. Standardizing Carbon Markets

Valued at more than $2 billion in 2021, the VCC market is expected to exceed $17 billion by 2027[18]. The global voluntary carbon market consists of voluntarily generated and traded credits, usually corresponding to one metric ton of carbon, or other powerful greenhouse gases avoided or removed from the atmosphere.

In contrast to the well-established compliance carbon markets, which are driven by regulation, and in which in-scope participants obtain credits or 'allowances' to surrender to the relevant regulatory authority, the voluntary carbon market is relatively nascent and fragmented. Investors use VCCs purchased from carbon-reducing projects to offset their own emissions and can obtain VCCs on an exchange-traded or over-the-counter (OTC) basis. Continued growth suggests VCCs will play an important role in mitigating carbon emissions by directing private investment into carbon reduction and neutralization projects, and derivatives will be central to facilitating their sale and purchase.

Initiatives are underway in various financial markets to scale the voluntary carbon markets and realize their full potential as a medium-term measure to address climate change. These initiatives include, among others, CME Group's carbon credit futures contracts[19], the London Stock Exchange's voluntary carbon market designation for its Main Market and AIM entities, and the $45 million investment by nine global banks in a voluntary carbon credit platform, expected to launch in 2023[20].

Notwithstanding these initiatives, it is challenging for market participants to assess the risks relating to investments in VCCs. Fundamental questions regarding the quality and legal status of VCCs remain unanswered, and a recent high-profile investigation suggested the vast majority of VCCs certified by one of the world's leading VCC program providers may in fact be contributing to, as opposed to mitigating, the effects of global warming[21]. Without quality and legal standardization across VCCs and related products, these types of issues will persist, giving rise to fears over greenwashing, and VCC markets will fail to provide a viable solution in the transition to net zero.

B. Quality Standardization

A lack of quality standardization is a significant obstacle to scaling the voluntary carbon market. Different VCC program providers and registries certify project-backed credits using different criteria, which results in VCCs trading at a wide range of prices. This price discrepancy creates concerns about transparency and product integrity, making it difficult for investors to draw meaningful comparisons between VCC product offerings.

[18] Global Voluntary Carbon Market: Analysis By Value, By Traded Volume, By Credit Retirements, By Credit Issuance, By Project Category, By Type of Project, By Region Size and Trends with Impact of COVID-19 and Forecast up to 2027, Daedal Research, December 2022, www.researchandmarkets.com/reports/5697812/global-voluntary-carbon-market-analysis-by?utm_source=BW&utm_medium=PressRelease&utm_code=4htqq8&utm_campaign=1799626+-+Global+Voluntary+Carbon+Market+Report+2022%3a+Increasing+Corporate+Efforts+in+Carbon+Offsetting+Boost+Sector&utm_exec=como322prd#product–toc

[19] Voluntary Carbon Emissions Offset futures, CME Group, www.cmegroup.com/markets/energy/emissions/voluntary-carbon-emissions-offset-futures-product-group.html

[20] Nine global banks invest $45 mln in carbon credit platform, Reuters, February 2023, www.reuters.com/business/sustainable-business/nine-global-banks-invest-45-mln-carbon-credit-platform-2023-02-08/

[21] Revealed: more than 90% of rainforest carbon offsets by biggest certifier are worthless, analysis shows, The Guardian, January 2023, www.theguardian.com/environment/2023/jan/18/revealed-forest-carbon-offsets-biggest-provider-worthless-verra-aoe

In response to these concerns, market participants are developing guidelines to address VCC quality standardization, with the goal of creating a 'meta-governance' framework applicable across all registries. The Core Carbon Principles, published by the Integrity Council for the Voluntary Carbon Market in March 2023, aim to provide a credible, rigorous, and readily accessible means of identifying high-quality VCCs that have a verifiable climate impact with high environmental and social integrity[22].

Independent carbon credit rating agencies have also been established to assess the quality of carbon programs on a project-by-project basis. These agencies provide quality assessments in a manner similar to those provided by credit rating agencies in debt capital markets. Market participants should be unequivocally in favor of these top-down governance frameworks, together with carbon-credit ratings programs, which work in tandem to facilitate comparability and standardization across registries and project types.

C. Legal Standardization

Another obstacle to scaling the VCC market is the lack of legal certainty around the creation, transfer and taking security over VCCs, particularly for insolvency and netting analysis purposes. Establishing a cross-jurisdictional consensus on the legal treatment of VCCs would provide market participants with greater certainty around the legal risks relating to trading of these products, which in turn would encourage the standardization of trading terms and deepen liquidity in the voluntary carbon markets.

Trade organizations have taken important steps to facilitate trading in the voluntary carbon markets. For example, ISDA recently published the 2022 ISDA Verified Carbon Credit Transaction Definitions, which provide a standardized set of terms for derivatives transactions in verified VCCs and are compatible with governing laws in multiple jurisdictions[23]. While this is a step in the right direction for legal standardization, reaching a cross-jurisdictional consensus on outstanding legal issues will take time. To encourage and potentially expedite this process, policymakers and market participants should lobby for the creation of a globally accessible 'meta-registry' for the recording of holdings and transfers in VCCs.

As the use of VCCs is not governed or required by any strict regulatory or legal mandate, there has been significant divergence across platforms and registries. A meta-registry should impose a top-down set of rules on individual registries, requiring adherence to a minimum set of VCC quality criteria and transfer terms.

To reduce the legal uncertainty surrounding VCCs, a meta-registry should be:

(i) accompanied by a statement on the legal nature of VCCs by global legal standard setters, such as the United Nations Commission on International Trade Law or the International Institute for the Unification of Private Law; and

(ii) established in a jurisdiction where there is currently greater certainty as to the legal classification of VCCs.

A meta-registry would also need to be supplemented by a single verification and validation arm imposing minimum quality criteria for VCCs (as discussed in the Quality Standardization section).

[22] The Core Carbon Principles, Integrity Council for the Voluntary Carbon Market, March 2023, icvcm.org/the-core-carbon-principles/

[23] ISDA Launches Standard Definitions for the Voluntary Carbon Market, ISDA, December 2022, www.isda.org/2022/12/13/isda-launches-standard-definitions-for-the-voluntary-carbon-market

The success of a meta-registry will depend upon consistent and comparable rules and processes across member registries. The Common Domain Model (CDM) has been used to enhance interoperability between historically incompatible IT systems in the derivatives market. Technological innovations such as the CDM could facilitate the development of a meta-registry by providing a standard operational framework for financial products (including derivatives) referencing VCCs, or otherwise serve as a model for resolving the lack of legal standardization in the voluntary carbon markets.

D. Transitioning From Medium-term to Long-term Solutions

In the medium term, VCCs can play a key role in raising the private finance necessary to develop renewable energy infrastructure and green technology, provided that the primary market is strong, transparent and auditable. Derivatives are uniquely positioned to support the scaling of the secondary market in VCCs by providing liquidity, and derivatives market participants should continue to be vocal supporters of the need for standardization. However, it is widely accepted that VCCs and the practice of carbon offsetting is not the only, or the primary, solution to the climate crisis.

To safeguard long-term energy security and facilitate the transition to net zero, it is important for the derivatives market to develop new financial products and hedging strategies to support the development of renewable energy sources and green technologies. These products and strategies will be considered in the next section of this paper.

LONG-TERM MEASURES

The development of renewable energy sources, such as bioenergy, hydrogen, geothermal energy, hydroelectricity, marine energy, solar and wind energy, is the only viable long-term solution to achieving energy security and facilitating the transition to net zero. Over the past decade, renewable energy sources have become an increasingly important part of the global energy mix. They are expected to become the main source of electricity generation by 2030, and are forecast to supply nearly half of US electricity by 2050[24].

However, these forecasts must be exceeded in order to meet the global commitment to net zero. Increased investment in renewable energy sources may be generated by the development of derivatives products that provide risk management solutions tailored to the unique challenges faced by renewable energy projects. Further investment in analytical and technology frameworks, in addition to the development of new derivatives products, is necessary to sustain these efforts. The financing of renewable energy sources also has great potential to increase profits for market participants as new technologies, analytics and products are developed to address market challenges.

A. Managing Risks Related to Renewable Energy Financing

The ability to develop clean energy requires the construction of renewable energy facilities (eg, wind farms, solar panels, hydroelectricity facilities) and storage facilities (eg, battery farms, storage centers) capable of storing renewable energy produced on an intermittent basis. The ability to obtain financing for these projects requires effective management of the risks associated with energy production given energy price fluctuations, as well as the risks associated with the related financing given currency and interest rate fluctuations. Derivatives and other structured transactions enable developers to hedge future production, predict revenue streams and mitigate financing risks.

1. Mitigating Renewable Energy Facility Production and Price Risks

Certain types of structured transactions can mitigate risks related to renewable energy projects, including by providing a predictable stream of income to the project and transferring related price risk away from the developers of renewable energy facilities. By mitigating these risks, structured transactions facilitate the construction and development of renewable energy facilities. The following structured transactions are particularly well-suited to the task of mitigating production and price risks.

Structured Transaction	Mitigation of Energy Production and Price Risk
Power Purchase Agreements	A power purchase agreement (PPA) is a long-term (typically 10+ years) contract in which a purchaser (either a corporate or a financial institution) agrees to purchase electricity directly from a renewable energy project at a pre-agreed price. Due to the pre-agreed price being lower than prices available in the spot market, PPAs enable the purchaser to hedge the financial risk associated with reliance on conventional energy sources, while also providing the seller (typically a renewable energy project developer) with long-term revenue security for a renewable energy project. PPAs provide green credentials where power is purchased from renewable sources, encouraging diversification of energy sources and the development of renewable energy projects, as well as facilitating decarbonization. PPAs also allow energy trading firms to provide energy marketing services, as such firms can purchase energy through PPAs and sell it in the spot market.

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[24] EIA projects that renewable generation will supply 44% of US by 2050, US Energy Information Association, March 2022, www.eia.gov/todayinenergy/detail.php?id=51698#

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Structured Transaction	Mitigation of Energy Production and Price Risk
Renewable Energy Put Options and Call Options	An option is a contractual right to buy (call) or sell (put) a specified amount of energy at a fixed (strike) price in the future. Developers of renewable energy projects may purchase put options to ensure a steady revenue stream in the event revenue from the renewable energy facility falls below a given amount. For example, a renewable energy project may exercise a put option when energy prices fall below the pre-agreed strike price in order to guarantee revenues when prices are depressed. Developers of renewable energy projects may purchase call options to ensure a steady output stream in the event energy produced by the renewable energy facility falls below a given amount. For example, a renewable energy project may exercise a call option at the strike price when output is low in order to avoid a default on its contractual obligations (including those under PPAs). Due to the value of a renewable energy facility being tied to the market price of energy and the quantity of energy available at the time of delivery, options provide an effective tool to hedge against price risk.
Energy Storage Tolling Agreements	An energy storage tolling agreement is a contractual agreement between a renewable energy facility that develops, owns and operates an energy storage facility and a utility or other entity acting as 'offtaker' for the energy stored at the energy storage facility. Energy storage tolling agreements provide the renewable energy facility developer with a steady stream of revenue from the offtaker, while providing the offtaker with a steady (and adjustable) stream of stored energy. The demand for reliable baseload renewable energy by utilities and industrial offtakers has fueled the development of renewable energy storage systems. Energy from renewable sources can be stored in battery storage systems, and in accordance with energy storage tolling agreements a utility would pay for energy used to charge the storage system when prices are low and have the right to discharge energy from the system into the spot market when prices are high.

2. Mitigating Renewable Energy Financing Risks

Financing renewable energy projects requires implementation of a successful risk management framework to mitigate the risks related to financing structures, including price and volatility risk, interest rate risk and currency risk. Derivatives products can be customized to mitigate these risks in several ways, including by transferring the risks away from the financing structure. By mitigating these risks, derivatives products can facilitate the financing of renewable energy facilities. The following derivatives products are particularly well-suited to mitigating these risks.

Derivatives Product	Mitigation of Energy Production and Price Risk
Exchange-traded Power Futures	Structured transactions are sensitive to fluctuations in power prices when energy is produced. For example, a PPA purchaser risks purchasing energy at a strike price that is sold into the spot market for a lower price, resulting in a loss for the purchaser. Power futures, which are exchange-traded futures transactions based on the spot market price of electricity for future delivery in specific markets, are liquid instruments that can be used to hedge energy generated by renewable energy facilities. Intercontinental Exchange (ICE) and European Energy Exchange (EEX) offer exchange-traded power futures contracts to hedge directional risk associated with structured transactions, and EEX offers exchange-traded long-dated power futures contracts (up to nine or 10 years)[25] providing liquidity for long term PPAs. ICE and EEX also offer exchange-traded options to hedge volatility on products with embedded optionality (eg, energy storage or revenues). The main drawback of structured transactions is the inability to capture hourly risk with exchange-traded derivatives products. Renewable energy is produced on an hourly basis with a corresponding hourly spot price. However, futures contracts are traded on a fixed monthly volume basis with a corresponding monthly price. Options contracts have a similar monthly feature. These derivatives products are not perfect hedges because they do not capture the risk resulting from misalignment of hedging instruments (traded monthly) and energy production (calculated hourly). Structured transactions therefore present an inherent risk that is not covered by available derivatives instruments. However, that misalignment can instead be captured using modeling techniques. The ability to forecast the distribution of hourly energy prices through analytical methods (see Part B) will be essential to understanding inherent risks at the outset of these financing structures, potentially creating profitable markets for sophisticated traders.

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[25] Renewable Energy Price Risk Management at the Exchange, Viviana Ciancibello, European Energy Exchange, February 2020, www.eex.com/fileadmin/EEX/Markets/Power_Derivates_Market/190612-eex-price-risk-management-data_01.pdf

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Derivatives Product	Mitigation of Energy Production and Price Risk
OTC Interest Rate and FX Derivatives	The high interest rate environment makes it impossible to hedge price risk without hedging interest rate (IR) and foreign exchange rate (FX) risk. The ability to manage IR and FX risk concurrently with energy price risk is essential for the successful financing of renewable energy projects. In a high interest rate environment, interest rate risks may profoundly impact the mark-to-market value of related structured transactions. Moreover, renewable energy facilities in foreign markets are exposed to FX rates. Commodity traders may have limited (if any) experience of managing fixed income and currencies portfolios; however, IR/FX risks could be managed by commodity trading desks implementing a sweep process that decouples commodity and IR/FX risks. Specifically, IR/FX exposures can be calculated daily across a commodities portfolio and transferred to a standalone IR/FX portfolio that is separately managed by the IR/FX trading desks. This would allow the IR/FX risks to be managed independently of related commodity risk. Standard IR/FX derivatives instruments can then be used for hedging, as described in Part C.

B. Updating Existing Derivatives Structures

Developments in modeling and analytics will strengthen market infrastructure, allowing for further diversification of derivatives products to help facilitate the transition to net zero. Existing derivatives products present several challenges for renewable energy financing. However, these challenges also present opportunities for market participants that are successful in updating these products to better support green portfolios.

The IFLD makes the following recommendations for market participants and policymakers to help update existing derivatives products and address current challenges.

Derivatives Product	Description	Challenges and Recommendations
Sustainability-Linked Derivatives (SLDs)	SLDs are conventional derivatives transactions with an embedded ESG target. Market participants benefit from financial incentives (eg, reduced interest rate payment) when pre-agreed sustainability performance goals are met. SLDs are highly customizable transactions and can use various performance indicators to determine sustainability goals.	SLDs are difficult to use in the hedging context, as market participants are unable to effectively hedge the sustainability component. To increase adoption, market participants should consider developing a hedging product aligned with quality controls and standardization, where appropriate, which could be exchange-traded or OTC.
Renewable Energy Certificate (REC) Futures	REC futures are futures contracts based on RECs. One REC is allocated for each MWh produced and can then be sold on the REC spot or futures market, so that any purchaser can 'green' its carbon emissions by purchasing the RECs.	REC futures are subject to regional price differentials. To increase adoption, market participants and policymakers should encourage harmonization between jurisdictions to help make national standards more effective in measuring and adequately pricing pollution prevention.
Wind Index Futures	Wind index futures hedge risks associated with fluctuations in wind energy.	Wind index futures are limited to a specific renewable energy source in specific regions. To increase adoption, market participants should consider developing similar derivatives transactions for alternative sources of renewable energy such as geothermal, tidal and solar energy across different regions, with affiliated index futures for regions that contain an abundant source of a renewable energy type.

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Low-carbon Fuel Standard (LCFS) Futures	LCFS is a greenhouse gas reduction program focusing on the transportation sector in certain US states that incentivizes low-carbon fuels and other alternative transportation methods. Different fuel types are given carbon intensity (CI) scores, and producers that are below their annual CI benchmark are awarded credits, while producers that are above their annual benchmark must procure LCFS credits to remain in compliance.	LCFS are limited to specific regions. To increase adoption, market participants and policymakers could consider developing similar regimes in regions where low-carbon fuels are available alongside traditional fuels. Even where low-carbon fuels are not available, similar regimes could generate substantial growth and diversification in alternative transportation fuels, such as electricity.
Emissions Trading Derivatives	Emissions trading sets a cap on pollution through tradable instruments that authorize holders to emit a specific quantity of the respective greenhouse gas. Derivatives based on emissions allowances are tradable on exchanges or in the OTC markets as spots, forwards, futures and options contracts. Currently, the three major compliance emissions trading systems are in the EU, US and China.	Emissions trading derivatives are subject to specific government policies in specific jurisdictions. To increase adoption, market participants should continue to develop the voluntary carbon market alongside compliance markets, as the voluntary carbon market has the potential for global reach.
Exchange-traded ESG Indices	ESG index derivatives reference indices that embed certain ESG components into index selection criteria. Various ESG methodologies have been jointly developed by providers of ESG index products with clients and ESG research firms, in order to reflect investors' ESG exposure preferences.	ESG indices are not subject to standardized criteria. However, to increase adoption, market participants should consider using these products to align hedging strategies with sustainability and ESG-linked mandates. Passive funds could also consider using these products as a tool to implement beta benchmarking strategies and cash management strategies embedding an ESG methodology.
Hydrogen Derivatives	Hydrogen may play an important role in the long-term transition to net zero, but this is at an early stage. Hydrogen as an energy source facilitates the decarbonization of a range of sectors for which meaningful reduction of carbon emissions has proven inherently difficult, including long-haul transport, chemicals manufacturing, and iron and steel production. Current technologies enable hydrogen to be produced from existing sources, including renewables, nuclear, natural gas, coal and oil. A fuel-based hydrogen plant could burn fuel to produce hydrogen and as such would be sensitive to hydrogen and fuel prices. Financial institutions could help to finance hydrogen facilities by issuing insurance products such as put options to guarantee income when hydrogen and fuel prices make the facility economically unviable (eg, fuel cost too high compared to hydrogen price).	A hydrogen trading market is yet to develop and would be required to facilitate the development of derivatives products. As this market develops, trade associations such as ISDA could consider developing standardized documentation to promote greater liquidity and encourage the development of effective risk management products

C. Enhancing Analytics and Technology

The complex nature of renewable energy financing and related structured transactions and derivatives products requires advanced quantitative techniques for fundamental modeling of physical assets, derivatives pricing and trading. This is particularly true for financing structures with typical pricing and risk management inherent in structured transactions (as discussed on page 12 in the section on power futures). Certain analytics and technologies could enable firms to successfully manage structured transactions portfolios in the renewable energy financing space.

1. Enhancements Create Opportunities

Expanding product offerings to include structured transactions and related derivatives products in renewable energy financing incentivizes the development of renewable energy products by stabilizing revenue while transferring away energy marketing services and price risks to trading firms. Successful marketing and risk management for these structured transactions could create profitable opportunities for trading firms. Trading firms quick to invest in cutting-edge systems that are able to house complex analytics, while providing trade capture and downstream services, will be able to take advantage of these opportunities.

Renewable energy financing requires a strong risk management framework. Financial institutions should leverage liquid hedging products available on exchange platforms while concurrently developing advanced analytics for valuation and risk management of structured transactions, particularly those with misaligned risk. To do so requires both fundamental modeling of power prices used to value renewable facilities (and physical assets in general) and derivatives pricing analytics for hedging risk. This combination of modeling and analytics is currently lacking in many institutions. Specifically, risk management at the point of energy delivery requires quantitative trading capabilities enabling trading firms to anticipate short-term price movements and better manage their portfolios as energy is produced. Enhanced analytics and technology should be attractive to financial institutions and energy companies sourcing market opportunities, as well as corporates diversifying energy resources.

2. Modelling and Pricing Enhancements

Spot price dynamics are a primary driver of revenue for a renewable energy facility. Energy prices are modeled using a combination of economic dispatch and uniform clearing price[26]. In the first part of the equation, energy prices are determined based on the cost of the marginal generator that helps meet the electricity demand. Energy generation resources are used in full, going from least to most expensive, with the last accessed resource setting the final energy price. Because of low variable costs, renewable energy generation sources are used first, which means that renewable energy sources have a significant impact on observed energy prices.

Large sets of alternative data are needed to determine pricing, including historical weather data, electricity consumption data, wind and solar data, and the data from all available electricity generation sources. Advanced statistical methods, when combined with machine learning techniques (enabling machines to learn from experience) can be used to predict relevant variables over the lifespan of derivatives products and structured transactions in the renewable energy space, while also providing valuation metrics for simulations. Derivatives pricing engines also allow for continuous management of derivatives hedges to provide a quantitative assessment of the hedging strategies.

Although increased renewable energy financing and related trading activity has contributed to an increasingly volatile short-term energy spot market, pricing models are being enhanced with key data, such as bid-ask spreads, volatility measures, volume measures and other market forecast data, which improves back-tests and modeling costs[27]. The use of advanced analytics may also significantly reduce costs and improve bidding on renewables in both the day-ahead and the intraday trading markets[28].

[26] Economic dispatch of generation units determines power prices. See, How Resources Are Selected And Prices Are Set in the Wholesale Energy Markets, ISO New England, www.iso-ne.com/about/what-we-do/in-depth/how-resources-are-selected-and-prices-are-set

[27] Due to high volatile markets and availability of fundamental data like weather, the deployment of quantitative trading strategies is useful for risk management in the energy trading space. Quant Strategies to Weather Volatile Energy Markets, Sigtech, www.sigtech.com/insights/quant-strategies-to-weather-volatile-energy-markets

[28] Large numbers of data sets can be used for bidding in the day-ahead and intraday markets. A new age for energy and commodity trading, McKinsey, June 2021, www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/the-power-and-gas-blog/a-new-age-for-energy-and-commodity-trading

3. Technology Enhancements

In order to sustain enhanced analytics and promote trading opportunities in renewable energy transactions, best-in-class technology and infrastructure must be adopted.

Master front-office analytics, together with a modeling library, can be used to value derivatives products and define a framework for risk management that includes physical asset modeling (such as a Monte Carlo simulation engine forecasting weather variables, demand and price scenarios and values for complex energy deals using distributional analysis), as well as risk and profit-and-loss attribution calculations.

Such platforms must be able to handle large data sets, large-scale calculations and portfolio simulations, and could leverage cloud computing and parallel simulation infrastructure. In addition, an Energy Trading and Risk Management System (ETRM) interface for booking and trade execution, and risk and position reporting, would provide a platform through which traders can holistically view their positions. Downstream back-office systems, including scheduling, settlement and accounting platforms, as well as platforms for documentation and electronic trade matching should be employed and, if available, connected to the ETRM interface to relay information necessary for the day-to-day operations of the trading desk.

D. Developing New Derivatives Markets and Products

The derivatives market plays an important role in the green energy transition by proposing instruments for hedging a range of risks associated with green energy. While the derivatives market has taken initial steps to help manage the risk associated with these structures, expanding to a new set of derivatives can enhance the green energy transition.

The IFLD makes the following recommendations for developing new derivatives markets and structures to mitigate the risks in the transition to net zero.

Challenge	Recommendation
User Base	Trading platforms (including exchanges) and dealers must identify a user base for new derivatives products and understand and map potential use cases. This identification exercise is essential to ensure that new derivatives products have the support of market participants and to encourage dealers' market-making activities.
Market Makers	Trading platforms (including exchanges) and dealers must identify dealers that are best positioned to act as market makers. Few dealers will be first movers, and they will start making a market only if an established user base exists. Internally, a dealer will need to decide which trading desk is best suited to value and price new derivatives products, and may rely on those desks with access to underlying spot or cash markets.
Trading and Clearing Infrastructure	Alongside users and market makers, the infrastructure of trading platforms, including exchanges and clearing houses, must be ready to support the introduction of new derivatives products. Vendors must also establish appropriate infrastructure and policies to provide access for market participants and their customers to trading platforms housing new derivatives products, in order to increase distribution of new derivatives products across a wide range of market participants. For complex products, significant changes to current infrastructure may be necessary, which would lengthen the preparation time for the product to launch.
Brokers	Brokers act as intermediaries between an investor and an exchange, specializing in facilitating trades. Specifically, dealer-to-client brokers help to distribute a new product to clients that is generally out of reach for exchanges and market makers, while interdealer brokers help distribute the new product to dealers.
Availability of Trading Platforms	Trading platforms (such as request-for quote multilateral trading facilities) represent alternative pools of liquidity for a product, as these platforms function in a similar way to OTC markets and are therefore able to reach participants that are not accessible to exchanges.

CONCLUSION AND RECOMMENDATIONS

To mitigate the impact of the climate crisis, public and private sector participants are collaborating on solutions to achieve carbon neutrality while safeguarding energy security. This paper makes recommendations for derivatives market participants to support the transition to net zero.

Policymakers and various exchanges have implemented measures to reduce market volatility caused by geopolitical conflict and regional energy shortages. These include transparent market controls known as circuit breakers to mitigate extreme volatility without undue market disruption, and the expansion of eligible collateral available to corporates participating in exchange-traded energy markets.

However, these measures are not permanent fixes. With increasing levels of government investment and legislative support, the market is seeing a transition to renewable energy sources. In the medium term, market participants and policymakers are encouraged to continue their efforts to scale the VCC market to support green investment. The lack of quality and legal standardization are key obstacles in the scaling of the VCC market. Establishing a meta-governance framework and a meta-registry are recommended to achieve standardization.

In the long term, derivatives will play a vital role in supporting the financing of renewable energy sources and related risk management structures. Derivatives with renewable energy products as underliers provide consistent revenue streams and offtake arrangements in volatile markets. Advanced quantitative modeling and technologies are needed to strengthen the market infrastructure for further diversification of derivatives products. Updates are needed to existing derivatives products to better support renewable energy financing. New derivatives products should also be developed to facilitate the green energy transition.

The recommendations presented by the IFLD in this whitepaper provide a starting point for market participants. Further collaboration is needed between the public and private sectors to achieve the ultimate goal of supporting global energy security and facilitating the transition to net zero.

APPENDIX

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ABOUT THE IFLD

The ISDA Future Leaders in Derivatives (IFLD) program aims to make a positive impact on the future of the derivatives industry by identifying a diverse group of emerging leaders across the industry. The program has four core objectives: to create an active forum for networking and discussion of industry topics and future industry trends; to increase the demographic, cultural and professional diversity of senior leaders within the financial services sector; to support emerging leaders in developing soft skills and technical expertise; and to develop and produce content on issues of strategic importance to ISDA and its members. For more information on the IFLD program, please contact IFLD@isda.org.

ABOUT ISDA

Since 1985, ISDA has worked to make the global derivatives markets safer and more efficient. Today, ISDA has over 1,000 member institutions from 79 countries. These members comprise a broad range of derivatives market participants, including corporations, investment managers, government and supranational entities, insurance companies, energy and commodities firms, and international and regional banks. In addition to market participants, members also include key components of the derivatives market infrastructure, such as exchanges, intermediaries, clearing houses and repositories, as well as law firms, accounting firms and other service providers. Information about ISDA and its activities is available on the Association's website: www.isda.org. Follow us on Twitter, LinkedIn, Facebook and YouTube.