*Magazine of EU-China Energy Cooperation Platform*

# *EU-China Energy Magazine*

**2022 November Issue**

# About ECECP

EU-China Energy Cooperation Platform was launched on 15 May 2019, to support the implementation of activities announced in the 'Joint Statement on the Implementation of EU-China Energy Cooperation'.

The Joint Statement was signed during the 8th EU-China Energy Dialogue that was held in Brussels on 9th April between Commissioner for Climate Action and Energy Miguel Arias Cañete and the Administrator of the National Energy Administration of China Mr ZHANG Jianhua, back-to-back with the 21st EU-China Leaders' Summit on 9 April 2019 and was witnessed by Jean-Claude Juncker, President of the European Commission; Donald Tusk, President of the Council of Europe and Dr Li Keqiang, Premier of China.

The start of the implementation of the EU-China Energy Cooperation Platform (ECECP) was included in the EU-China Leaders Summit Joint Communique.

> The overall objective of ECECP is to
>
> *'enhance EU-China cooperation on energy. In line with the EU's Energy Union, the Clean Energy for All European initiative, the Paris Agreement on Climate Change and the EU's Global Strategy, this enhanced cooperation will help increase mutual trust and understanding between EU and China and contribute to a global transition towards clean energy on the basis of a common vision of a sustainable, reliable and secure energy system.'*

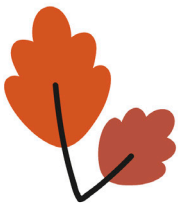
Phase II of ECECP is implemented by a consortium led by ICF, and National Development and Reform Commission - Energy Research Institute.

# EU-China Energy Magazine

2022

# CONTENTS





*Dear All,*

*Welcome to the November 2022 issue of the EU-China Energy Magazine!*

*During EU-China Climate Diplomacy Week earlier this month, ECECP organised a three-day virtual Expo: 15 European companies showcased their innovative clean energy solutions in renewable energy, energy efficiency, buildings, electricity grids and storage. At the time of writing, there were 1 300 visits and nearly 20 000 page views from China, the EU, the US, the UK, Japan and Russia. It is still possible to visit the virtual booths, while interested parties can contact the companies directly.*

*The Digest of the Handbook on Electricity Markets, in both Chinese and English, was launched at the Expo's opening ceremony. The original Handbook on Electricity Markets - a 650-page encyclopaedia of the global electricity market, -was written by some of the most brilliant thinkers in the field. ECECP commissioned the Digest so that the Handbook's key points are accessible to busy decision-makers. The Digest, in English and Chinese, is available for free download on the ECECP website.*

*A Chinese translation of the original Handbook on Electricity Markets is now under way and will be available in the spring of 2023.*

*Interviews with exhibitors, political representatives and other energy experts are available on our website.*

*The ECECP magazine includes an article that offers a brief overview of the key points raised in the Handbook and in discussions held at the Expo.*

*Other articles in the issue include a focus on the energy supply challenges looming in the winter of 2023-24; Leonardo Mees of the Florence School of Regulation looks forward to a time when power consumption can be managed without recourse to emergency measures; a summer drought in China has highlighted the need for power market reform in the country; and the World Economic Forum looks into ways to accelerate investment into hydrogen power.*

*This month, our designer has been laid low by Covid and we were not able to publish as scheduled. We wish her a speedy recovery. As always, I would like to thank our hard-working editors, Daisy Chi and Helen Farrell.*

*I hope you enjoy reading this issue.*

*Flora Kan*
*ECECP Team Leader*

# Never too early to prepare for next winter

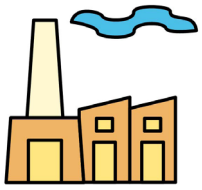
As winter approaches, a combination of favourable LNG market dynamics, robust pipeline deliveries from non-Russian suppliers, lower demand, and policy actions has given Europe a chance to sidestep some of the worst immediate impacts of Russia's steep cuts to natural gas deliveries.

Russia's pipeline gas deliveries to the European Union halved in the first ten months of 2022 compared with last year's levels. The decline in absolute terms was 60 bcm, the equivalent of over 10% of the global LNG trade. The steep decline in Russian gas supplies coincided with multi-year lows in European hydro and nuclear power output (down by 20% and 16% year-on-year, respectively), putting huge pressure on European gas markets.

Gas prices on the Dutch Title Transfer Facility (TTF) – a leading European gas hub – averaged over EUR 130/MWh (USD 40/MMBtu) year-to-date, almost eight times the 5-year average between 2016 and 2020. The all-time high prices attracted record LNG inflows to the European Union and the United Kingdom, rising by 65% or over 50 bcm year-on-year in the first ten months of 2022.

Gas demand in the European Union and the United Kingdom in the first 10 months of 2022 was down by an estimated 10%, or over 40 bcm, compared with the same period a year earlier. This was mainly the result of lower consumption across the residential, commercial and industrial sectors, but it also includes some efficiency gains and behavioural responses to higher prices. It also reflects demand destruction, particularly in gas-intensive industries.

Non-Russian pipeline supplies to Europe increased substantially. Pipeline deliveries from Norway rose by 5% (5 bcm) and flows from Azerbaijan via the Trans Adriatic Pipeline surged by close to 50% (3 bcm) year-on-year in the first ten months of 2022. In both cases, export infrastructure is running close to nameplate capacity. Algeria increased its pipeline supplies to Europe by over 10% (or 3 bcm) on available export routes in the first ten months of the year, and has some limited upside.



Strong European demand for LNG led to a reconfiguration of global LNG flows as increases in LNG supply (23 bcm) were not sufficient to meet Europe's rapidly rising LNG imports. Higher LNG flows towards Europe were enabled in part by China's LNG imports falling by 20% (or 19 bcm) year-to-date as it drastically reduced spot procurements. Europe's thirst for LNG also disrupted gas and electricity supply in more price-sensitive markets, including in South Asia.

**Year-on-year changes in global LNG exports and imports by key regions, January – October 2022**

Mild weather, healthy storage levels and strong LNG supply have led to a significant fall in some natural gas price markers.

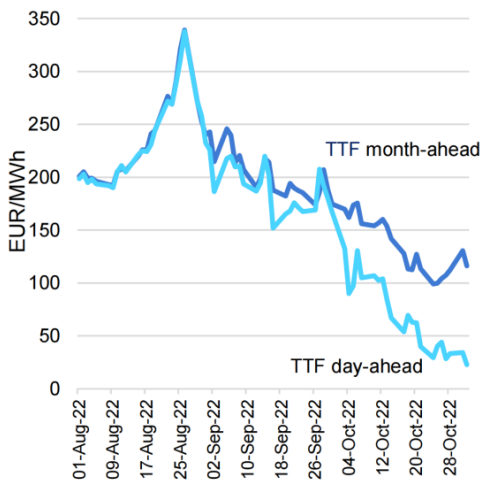
The combination of higher non-Russian gas imports and lower demand was instrumental for Europe to offset Russia's gas supply cuts and enable a near-record build-up of storage levels. Storage injections were 22%, or 13 bcm, above their 5-year average in 2022. At the beginning of November, EU storage sites were close to 95% full – well above the European Union's 80% target and well-aligned with the IEA's 10-Point Plan to Reduce the European Union's Reliance on Russian Natural Gas.

Unseasonably mild weather in October reduced gas demand from distribution networks (concentrated in the commercial and residential sectors) by over 30% year-on-year and effectively delayed the start of the heating season in most European markets. This steep decline in demand coincided with a persistently strong influx of LNG cargoes, which have limited immediate flexibility to change destination, as deliveries are typically scheduled several weeks in advance.

Lower-than-expected demand, together with high LNG inflow and healthy storage levels, pushed down European gas prices. Month-ahead prices on TTF fell to just below EUR 100/MWh (USD 30/MMBtu) by the end of October. This was less than one-third of the all-time high at the end of August but still more than five times the 5-year average during the 2016-20 period. Day-ahead prices – which are more reflective of short-term supply-demand factors – fell below USD 10/MMBtu at the end of October, while next-hour prices dropped into negative territory for a short period on 24 October amid infrastructure constraints in the TTF market zone.

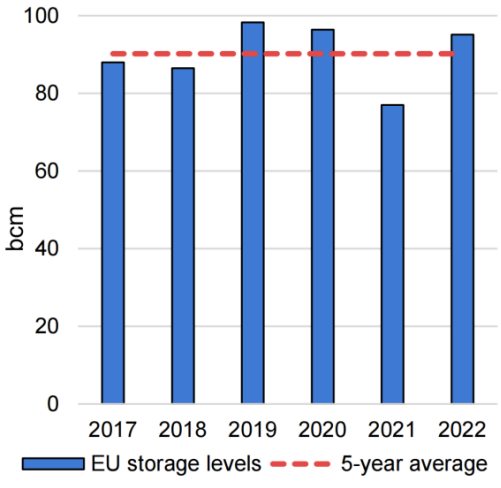
**Day-ahead and month-ahead TTF prices**

*(August – October 2022)*




**EU gas storage levels**

*(1 November 2022)*



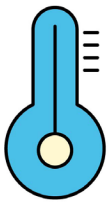
The temporary comfort provided by today's market conditions should not lead to overly optimistic conclusions about the future: a cold spell could quickly change sentiment and Europe's gas balance faces even tougher tests in 2023.

While EU gas inventories are standing 5%, or 5 bcm, above their 5-year average, this additional storage cushion could be quickly erased: 5 bcm is just two days of EU gas demand during a cold spell.

There is a wide range of possible outcomes for EU gas storage at the end of this winter heating season. Assuming no or very low Russian gas deliveries to the European Union this winter, and average levels of LNG imports (around 13 bcm per month), then gas storage levels could be anywhere between 5% and 35% by the end of the heating season, depending on demand trajectories over the coming months.

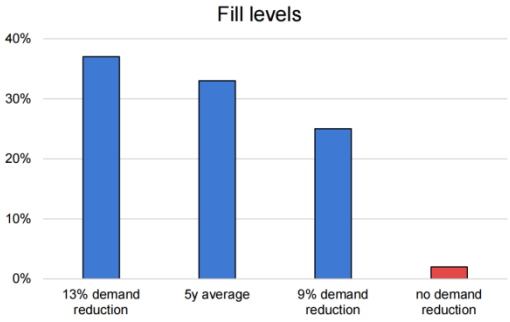
Variable demand trajectories, which can be influenced by policies as well as prices and weather, translate into a variety of future scenarios for gas injection needs during the summer of 2023. These vary between 60 bcm and 90 bcm in order to reach 95% storage levels by the beginning of the 2023-2024 heating season.

Considering current market trends, our assessment today is that the storage injection needs of the European Union and the United Kingdom will be 68 bcm (including 1.68 bcm of injections to the Rough storage in the United Kingdom). This is based on the assumption that European gas demand during this November-March period is 11% below its 5-year average. A colder-than-average winter could deplete European storage levels faster, resulting in injection needs in the range of 80-90 bcm.

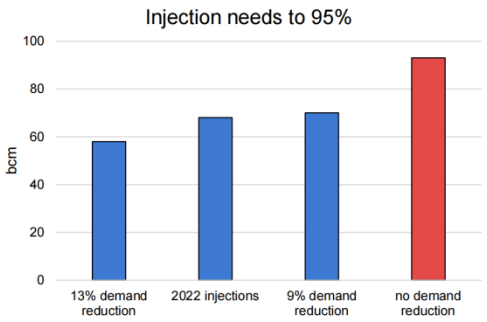


Measures to limit short-term demand and storage depletion, alongside more structural measures to bring down gas demand, are absolutely essential to position Europe for next year. The drive to refill Europe's gas storages for the 2023-24 winter heating season has to begin now.

**Potential EU and UK storage levels by end March 2023**




**Resulting injection needs in summer 2023 to reach 95% fill level**






Note: assuming no Russian piped gas to the European Union from 1st of January and average (13 bcm/month) LNG imports into the European Union and the United Kingdom.

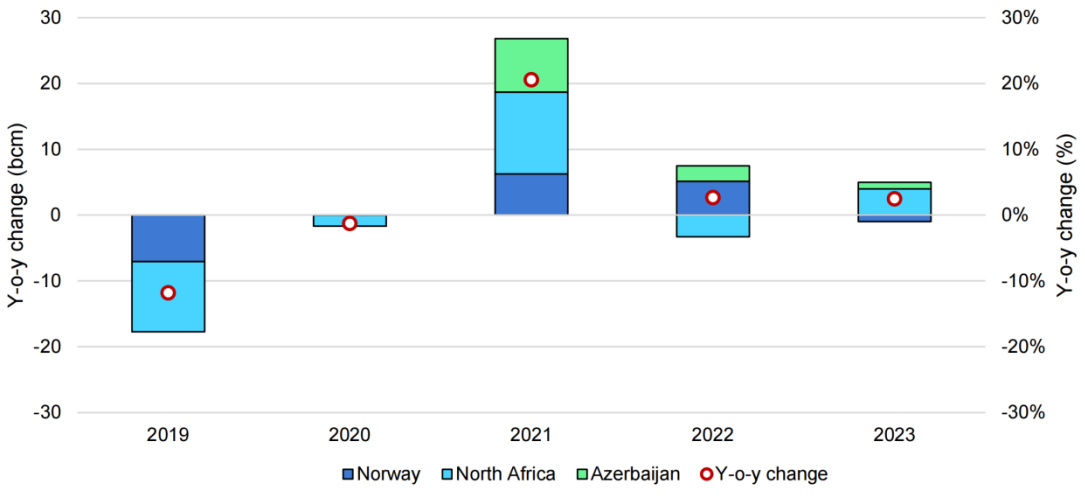
Some of the factors that helped Europe in 2022 are unlikely to be as favourable in 2023: in particular, Russian deliveries are likely to be considerably lower and competition from China for available LNG cargoes considerably higher.

Although Russian gas deliveries to Europe were cut sharply during 2022, they were close to 'normal' levels for much of the first half of the year. Total pipeline supply from Russia in 2022 is likely to amount to around 60 bcm. It is highly unlikely that Russia will deliver another 60 bcm of piped gas in 2023. If supply remains at current levels, then Russian pipeline supply would be around 25 bcm in 2023. It is also entirely possible that Russian deliveries could fall further – or cease entirely.

Non-Russian pipeline suppliers have limited upside potential, with both Azerbaijan and Norway supplying close to their nameplate capacity in 2022. In the case of Algeria, some limited upside is expected with the development of gas fields in the Berkine South basin.

Global LNG supply is expected to increase by 20 bcm in 2023, supported mainly by the ramp-up of the Calcasieu Pass LNG facility in the United States and the Coral South LNG facility in Mozambique, as well as the return of the Freeport LNG facility in the United States. However, this increased LNG supply will not be not sufficient to offset the likely decline in Russia's pipeline deliveries to the European Union.

**Change in non-Russian pipeline gas deliveries to Europe**



Domestic gas production in the European Union is set to decline in 2023. In the Netherlands, production at the Groningen field was capped at 2.8 bcm for the 2022-23 Gas Year1, down from 4.5 bcm in the 2021-22 Gas Year. Production from small fields in the Netherlands also continues to decline. In Denmark, the restart of the Tyra field was postponed to the 2023-24 winter –meaning that it will not contribute to the refilling of gas storages during summer 2023. In the United Kingdom, gas production recovered strongly in 2022 and the potential for further short-term growth is limited.

Even more significantly, China's LNG imports could rebound next year. China's lower LNG imports in the first ten months of 2022 were a key enabler of higher LNG availability to Europe. A return to stronger Chinese economic growth and some easing of lockdowns could bring 2023 LNG imports back to their 2021 levels (108 bcm), which would capture over 85% of next year's expected increase in global LNG supply and limit the amount of LNG available to the European market.

China has pursued a strong LNG contracting strategy in recent years. As a result, China's reliance on destination-fixed LNG contracts is set to increase from 88 bcm per year in 2022 to 100 bcm per year in 2023. This effectively means that China will have the right-of-first-refusal on an additional 12 bcm of LNG – well over half of the expected increase in global LNG supply in 2023.

In mid-October, it was widely reported that China's National Development and Reform Commission had asked state-owned gas importers to stop reselling LNG to buyers in Europe and Asia to ensure stable gas supply ahead of winter.

EU gas exports to Ukraine are set to rise. Ukraine started the 2022-2023 heating season with storage levels at just 14 bcm – well below their historic average. Even assuming a 25% reduction in the country's winter gas consumption, storage sites are expected to be severely depleted by the end of March 2023. Our analysis indicates that Ukraine would require at least 5 bcm of gas imports from the European Union during the summer of 2023 to replenish its storage levels to 14 bcm by the start of the 2023-2024 heating season.

Europe could face a 30 bcm shortfall in the gas it needs to fuel its economy and sufficiently refill storage sites during the summer of 2023, jeopardising its preparations for the winter of 2023-2024.

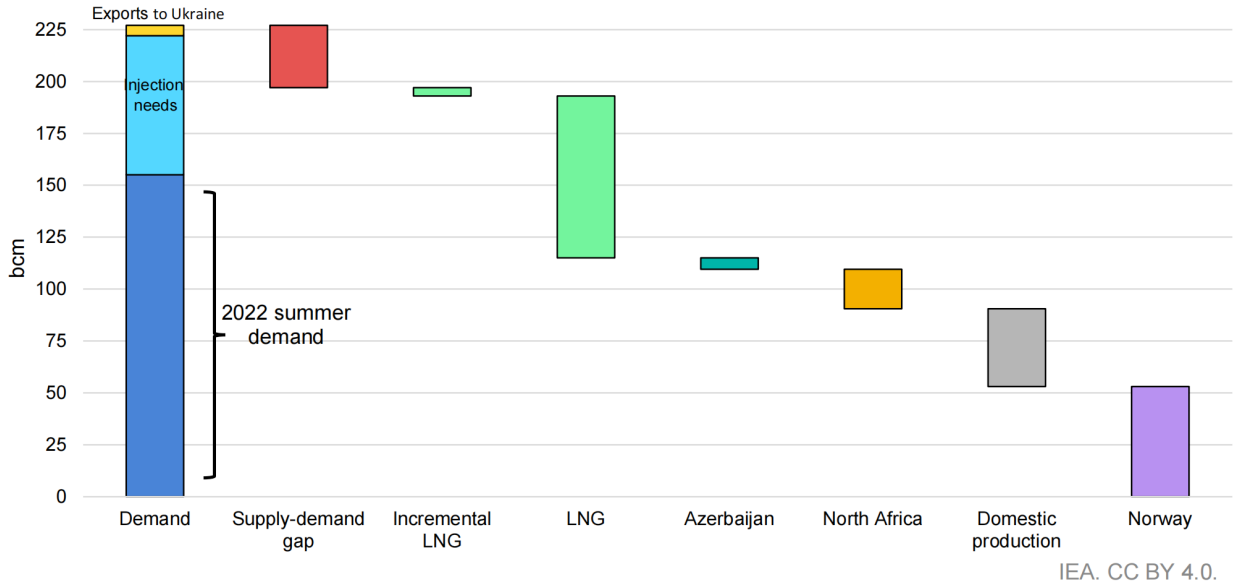
A full cessation of Russian pipeline gas supplies to the European Union combined with a return of Chinese LNG imports to their 2021 levels would lead to a shortfall of 30 bcm of gas in Europe during the summer of 2023, the period when gas storage sites need to be refilled.

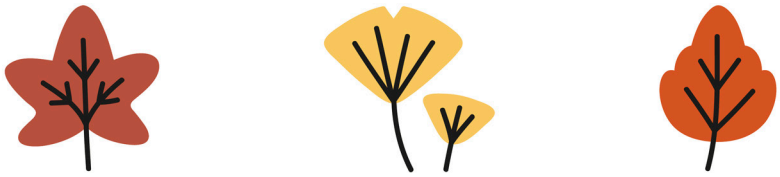
This equates to almost half of the injections required to fill storage sites to 95% of capacity by the start of the 2023-24 heating season. This is based on the assumption that natural gas demand in the European Union and the United Kingdom will decline by 11% compared to its 5-year average during the November 2022 – March 2023 period and that Europe's gas storage sites will be around 30% full at the end of this winter.

A recovery in European hydropower generation to its 5-year average and higher nuclear power output in France (aligned with the mid-range of EDF's latest guidance) could reduce the shortfall to 22 bcm, but it would not eliminate it.

This puts the spotlight back on natural gas demand. Shortfalls in available supply would put immense pressure on prices again, but this could be relieved by accelerated structural changes in European gas demand.

**Breakdown of the summer 2023 natural gas balance of the European Union and the United Kingdom in case of full cessation of Russian flows and limited LNG availability, April – September 2023**





An even faster deployment of renewables, heat pumps and energy efficiency measures can mitigate the risks of a worsening energy and gas crisis.

While healthy storage levels and unseasonably mild weather at the beginning of the 2022-2023 winter season provide some temporary relief to gas and related energy markets in Europe, our analysis indicates that supply-demand fundamentals are set to tighten in 2023.

A more rapid deployment of renewables, heat pumps and energy efficiency measures can mitigate the risk of a worsening energy and gas crisis. However, this would require immediate action from governments.

The IEA will present a roadmap for securing Europe's gas balance for next winter showing what is needed to ensure storage sites are filled to 95% capacity by the beginning of the 2023-2024 heating season and to structurally reduce gas consumption during the winter. Key measures include:

- Speeding up investments in energy efficiency improvements.
- Faster deployment of renewables.
- Accelerated installation of heat pumps.
- Identifying remaining fuel-switching options in industry and the power sector.
- Behavioural changes.

A further push to accelerate structural changes and reduce gas consumption is essential not only for Europe's clean energy transitions but also for its energy security and the wellbeing of its citizens and industries.

The current market context requires greater attention to instruments and measures that could facilitate investment in methane abatement options.

# The 5th EU electricity market reform: a renewable jackpot for all Europeans package?

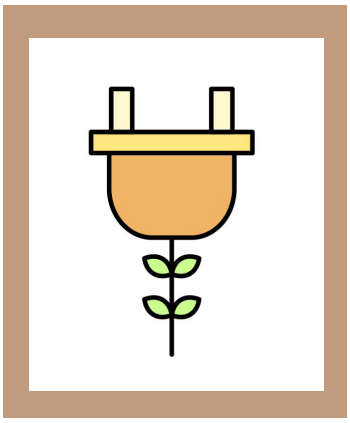
Electricity prices are extremely high. We are short of gas in Europe, and gas power plants are pushing up the prices of electricity. It is also unfortunate that an unprecedented number of nuclear power plants are under forced maintenance in France, which increases electricity prices even further. Consumers are suffering, and some producers of electricity are making unexpected profits.

Many emergency measures have been taken to protect consumers and to claw back windfall profits. Beyond these short-term measures, the process towards an electricity market reform for the medium to long term has also started. This could become the fifth EU electricity market reform. Working title: Renewable jackpot for all Europeans package[1].

In the ongoing debate, some have argued that electricity markets are broken and that we should suspend or radically change them[2]. The objectives of this revolution are to decouple gas and electricity prices, eliminate windfall profits, and give consumers access to cheap renewables. Many revolutionary proposals have been made, like splitting the market into groups of technologies according to their characteristics and to price or regulate them separately. With these proposals, we risk going backwards in the European electricity market integration process by introducing new obstacles for cross-border trade. This would be unfortunate because the market integration benefits are increasing with the ongoing transition to renewables.

The good news is that going backwards is not necessary. The Renewable jackpot for all Europeans can be organised with the electricity markets we have jointly developed over the past two decades[3]. We 'only' have to complete these markets, and we have to combine them with a few instruments that have already proven their usefulness during the current crisis. These instruments could be at the centre of the market reform. It could become a revolutionary reform, but one that goes forward instead of backwards.

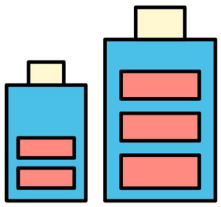
To illustrate this point, I will discuss electricity markets and the following instruments: Contracts for Difference (CfD), Power Purchase Agreements (PPA), Capacity Remuneration Mechanisms (CRM), Energy Communities, and Demand-side Flexibility. The discussion is organised in three steps: 1/ introduction; 2/ performance during the crisis; 3/ lessons learned for the reform. I do not claim that this is an exhaustive scope for possible reform, but it is at least a start.



Note, to conclude this introduction, that the fourth electricity market reform took several years to develop with studies, impact assessments and public consultations. The European Commission's work plan foresees a reform proposal in 2023, which would be much faster than usual, and the European Council in October 2022 asked the Commission to speed up even more[4]. Speed is important, the crisis requires us to move, but are we not confusing reforms with emergency measures?

1. *Title inspired by an article in Les Echos (July 18, 2022): 'Eolien, solaire: vers un jackpot d'au moins 8,6 milliards d'euros pour l'Etat'. Available here.*
2. *President von der Leyen, in her State of the Union address (September 14, 2022) 'This is why we will do a deep and comprehensive reform of the electricity market'. Available here.*
3. *Have a look at our open access book: Leonardo Meeus, 2020. The Evolution of Electricity Markets in Europe. Edward Elgar. Available here.*
4. *European Council conclusions from 20-21 October. Available here.*
5. *The savings are documented and explained in the ACER/CEER annual market monitoring reports. Available here.*

# Electricity Markets



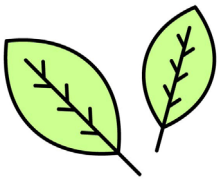
**Introduction.** In Europe, we have a sequence of electricity markets from forward to day-ahead, intra-day, and balancing markets. These markets allow us to exchange electricity across country borders with standardised contracts from a few years ahead of delivery all the way to real-time. We have discovered that this is very beneficial because we are saving billions of euros every year[5]. This achievement is unique in the world, and it is an important asset in the transition towards a more sustainable energy system.

**Performance during a crisis.** When market integration started, Belgians feared transits would increase between France (exporter of nuclear power) and the Netherlands (importer of power) with limited benefits for Belgium. A few years later, Belgium faced power shortages in winter, and the country was saved by imports. Today France is short of power, so the market is helping to save France. Electricity markets in Europe are a stabilising factor in times of crisis, and also organise solidarity among countries. If we were to suspend electricity markets, it would be up to governments to organise that solidarity. We risk short-sighted and expensive blame games with limited solidarity. In the current debate, the market is seen as the problem, but the problem would be much worse if it were not for energy markets that organise the flow of energy to where it is most needed. Sharing our resources across borders via markets (and cross-border network infrastructure) will be even more important in a future with renewable energy. The alternative is that each country invests in their own backup systems and flexibility, which would be way too expensive, and also unnecessary as long as we do not close our borders within Europe.

**Lessons learned for reform.** The crisis has been a wake-up call for the importance of hedging and the regulatory framework for long-term investments. We all wished we had entered into a fixed-price retail contract or another insurance against high prices, and some retailers have gone bust during the crisis because they were not sufficiently hedged. Academics have long talked about completing the EU electricity markets with better functioning forward markets. There are many ideas to do that, like introducing regulated incentives for consumers and retailers to hedge, or coupling forward markets across borders. Each of these ideas deserves to be looked at in more detail.

6. *See also the FSR policy briefs by Pototschnig et al. (2022): 'Recent energy price dynamics and market enhancements for the future energy transition' (available here) & 'Consumer*

# Contracts for Difference (CfD) and Power Purchase Agreements (PPA)



**Introduction.** As renewable energy has matured, subsidy schemes have also evolved. We gradually integrated renewables into electricity markets. Many countries started with fixed 'feed-in' tariffs and no exposure to market prices for renewable developers and then evolved towards 'premium' schemes with the support that comes on top of market prices. More recently, countries started to introduce Contracts for Difference (CfDs) to support renewable energy. The developers compete via tenders for the price they need to cover their investment costs. If market prices turn out to be lower than the awarded price, governments cover the difference; if market prices are higher, developers pay back the difference. These contracts have to be two-sided (or symmetric), and they can also be tweaked to make them compatible with short-term markets, to preserve the incentives for the developers to respond to prices, while still capping their revenues.

**Performance during the crisis.** Renewables have been blamed for making windfall profits during this crisis. Retroactively taxing them or capping their revenues is difficult and creates a lot of distortions. Meanwhile, government entities that entered into CfDs with renewable developers have already experienced a renewable jackpot, which is for example the case in Denmark, France and the UK. When entering into these contracts, governments probably did not anticipate earning so much money. In the current crisis, the public money that governments hand out to compensate for high prices is much larger than the money they collected with CfDs, but this could change in the future if these contracts become the standard, and if we improve our consumer support schemes.

**Lessons learned for reform.** The more we invest in renewables, the more we decouple the price of electricity from the price of gas. If we want to guarantee that consumers have access to cheap renewables, governments could further develop CfDs on their behalf. We then need to think about how the money that these contracts raise during a crisis can be used to support consumers in periods of high prices. The support should target those most in need, and it is also important that we preserve the incentive to save energy during a crisis[6]. Another option would be to have an entity mandated by member states to act as an intermediary so that consumers can buy these contracts as insurance against high prices. Note that some large consumers and suppliers already entered into Power Purchase Agreements (PPA) with renewable developers, but these agreements can be indexed to spot prices, which does not help in times of crisis (and in retrospect also does not benefit developers who now face measures against their windfall profits).

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*protection mechanisms during the current and future periods of high and volatile energy prices' (available here).*

# Capacity Remuneration Mechanisms (CRM)

**Introduction.** Utilities have long argued that electricity markets need to be supplemented with capacity remuneration mechanisms to make sure that there are adequate investments. Even if we complete our shorter-term electricity markets with better-functioning forward markets, these markets do not necessarily guarantee that we have enough investments. However, before the crisis, the common concern was that these mechanisms would be abused to favour certain technologies, or to provide state aid to utilities that are not able to recover the investment costs of outdated and dirty technologies.

**Performance during the crisis.** The costs of being short of energy are so high, that I think we are all willing to pay a bit more to avoid another supply shortage with extreme prices. As we expect demand to go up due to the electrification of transport, heating and industry, we seem to be more worried about under-investments than over-investments. If we use CfDs to accelerate the investments in renewables, we can use capacity remuneration mechanisms to ensure that we have enough investments in backup power and flexibility, which can be a combination of low-carbon dispatchable generation, energy storage solutions and demand response.

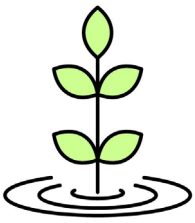
**Lessons learned for reform.** The EU Clean Energy Package paradigm was to avoid the abuse of capacity mechanisms. The package also made sure that these mechanisms are designed in a way that minimises the possible negative impact on short-term electricity market signals. If we change the paradigm and consider these mechanisms part of the electricity market target model, we can go a step further in harmonising and integrating them. This could be achieved through network codes and guidelines, which is a process that has also been successfully used for other aspects of electricity markets.

# Energy Communities

**Introduction.** The EU Clean Energy Package introduced a regulatory framework for individual and collective action by citizens to take ownership of the energy transition. Energy cooperatives have been around for a while. Several of them were initiated by activists that wanted a greener and more local supply of energy, and took matters into their own hands. Their purpose is primarily driven towards social and environmental benefits rather than financial profitability. Members of such communities are often willing to pay a premium for greener energy.

**Performance during the crisis.** Most energy communities co-invest in renewable energy, some also source their energy with long-term power purchase agreements from local renewable energy producers. This business model was not designed to be a hedge against extreme prices during a crisis, but it turned out to be cheaper than market prices in recent times. Co-investing in renewables is also cheaper and more efficient than doing it alone. Of course, the hedge against market prices is not perfect, communities still have to source some of their energy from the market, but it can contribute to protecting consumers from high market prices. Energy communities can help consumers to take ownership of the transition.

**Lessons learned for reform.** If more citizens want to join a community, and if we want to make sure that they have access to renewable projects, we need to strengthen the regulatory framework for renewable production, energy sharing and supply. Some countries have enabled communities' participation in tenders for large renewable energy projects; maybe they could also be given access to CfDs and receive a role in public-private partnerships. Local authorities could give energy communities access to public buildings to invest in PV panels, and they could make sure that vulnerable consumers are integrated in these communities. Energy communities can be involved in social housing projects, and many other best practices that are emerging across Europe. To upscale these initiatives, further technical assistance, capacity building and awareness-raising activities for communities and citizens should be developed.



# Demand-side Flexibility

**Introduction.** The EU Clean Energy Package represented a big step forward to engaging consumers and modernising networks and system operations. Consumers are for instance entitled to a smart meter in combination with a dynamic retail price contract. TSOs are increasingly welcoming aggregated flexibility in balancing markets. DSOs are increasingly engaging with flexibility service providers at the local level to manage congestion in their grids.

**Performance during the crisis.** For the moment, extreme prices have solved our shortages. In countries that did not cap retail prices, domestic and industrial consumers did respond by saving energy, we only wished that demand would be more flexible and respond at lower prices. However, we are also reminded that we are not yet well-organised to deal with emergencies. If everything is voluntary, and people are not responding enough to the price signals, we would need to ration energy. We have load-shedding plans to organise rationing in case of emergencies. We always hope that we will never need to implement these plans. For instance, in the winter of 2021, Texas did have to activate their load shedding plans, which led to a lot of chaos and public outrage. People did not understand why they were cut off from the electricity system, while others could continue to consume unlimited volumes. The rotation of the power cuts was unclear, and some grid users also discovered they were never cut because they happened to be connected via the same feeder of a hospital or another protected consumer.

**Lessons learned for the reform.** The EU Clean Energy Package's paradigm was to focus on voluntary flexibility, which is incentivised via cost-reflective network tariffs, dynamic retail prices and market-based procurement of flexibility services by the system operators. For emergency situations, it would be useful to get a step further. We should be able to reduce everyone to basic energy consumption, which would be less painful and more acceptable than rotating power cuts. Grid users could also volunteer to be cut in case of emergencies in exchange for compensation. We could ask all retailers to offer subscriptions with different levels of guaranteed supply. Hedging can then be about volume as well as price. We could ask all TSOs and DSOs to offer firm and non-firm connection agreements, or different levels of discounted non-firm connection agreements. It would imply that we evolve from voluntary flexibility towards a combination of voluntary and smart mandatory (backup) schemes. This will be necessary to deal with (temporary) bottlenecks in electricity networks, and could also save us from chaotic rolling blackouts in case of emergencies.

By **Leonardo Meeus**

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# What can China's electricity markets draw from international experience?

*The electricity market is set to play a key role in China's construction of a new energy based power system. Although China has made substantial initial progress, its electricity market still faces an uphill struggle in promoting the consumption of renewables, resource allocation across provinces and regions, and unlocking demand side potential. What can the world's mature electricity markets show China? Daisy Chi offers some insights from the Handbook on Electricity Markets, as well as part of the discussion at an event launching a Digest of the Handbook in November 2022.*

# Power market reform in China: achievements so far

Over the past two decades, China has been steadily developing its own unique power market system. The journey started with a massive reorganisation of the electricity sector in 2002, when power generation and the grid sector were unbundled. A new round of power system reform in 2015 heralded an acceleration in China's power market development: the sector moved away from an administrative allocation system and towards a market-based system, characterised by mid- and long-term contracts between electricity producer and consumers, and the emergence of competitive retailers. Wholesale and spot power market structures have been taking shape since then. More recently, with the power tariff reform in October 2021 that allows for market-formed and more fluctuation in power prices, and the announcement of a new national power market system in January 2022, China's power market development has moved into a whole new phase.

Although the Chinese power market is still in its infancy, some noticeable progress have been achieved so far. The country is increasingly emphasising market-based means to build towards a renewable-based new power system. The mid- and long-term power market, which covers a large percentage of total demand in individual provinces, has been gradually expanding. Additionally, spot market pilots have got under way. There are new requirements for all coal-fired generation as well as industrial and commercial power users to participate in power market trading. All these reforms are helping to unlock a booming electricity market. As a result, China is seeing rapidly expanding power transaction sales and a growing number of market participants. According to the statistics of China Electricity Council (CEC)[1], a total of 3,700TWh of electricity was traded in the country's power markets in 2021, nearly five times higher than in 2015, and accounting for 44.6% of the overall electricity consumption. By the end of 2021, 467,000 registered entities were taking part in various power trading centres across the nation, up 76% in just one year[2].

1. http://www.cnenergynews.cn/dianli/2022/04/13/detail_20220413121518.html
2. http://www.xinhuanet.com/power/2022-07/07/c_1211664934.htm

# Obstacles and new challenges

Although these numbers seem encouraging, there is a long way to go before China will be able to boast of a unified national electricity market system. As noted by Yang Kun, President of China Electricity Council, the power market rules in the country's regions have yet to be aligned by reforming policies and market mechanisms. In addition, the green value of renewable power is not fully reflected in the current power market, and this is hindering market participation. Meanwhile, the connections between the electricity market and the green certificate trading / the carbon market, between the mid- and long-term wholesale market and the spot market, and between the inter- and intra-provincial power market, all need to be strengthened[3].

China's power market reform is an essential part of the country's efforts to achieve its carbon peaking and carbon neutrality targets. This national strategy, which requires decarbonisation within just 30 years, is posing unprecedented challenges to the existing power system, which is built primarily on fossil fuels.

In the context of constructing a new power system, the growing proportion of variable and intermittent renewable energy in the system is making it more difficult to balance supply and demand, given the vulnerability of these energy resources to weather conditions. Market mechanisms are crucial if the flexibility potential in the system is to be unlocked.

At the same time, the rapid development of renewable energy is set to add significantly to the overall system costs, given the associated need for storage and flexibility resources as well as power network expansion and reinforcement, warns Ma Li, Vice Chief Engineer of State Grid Energy Research Institute. It is crucial for the power market design to take account of the higher operational costs by introducing an appropriate price mechanism on both supply and demand sides to guarantee a fair return on investment for all parties.

An even more complex challenge is looming: how to encourage renewable energy companies to participate in the power market. Recent research conducted by CEC found that on average only 30% of renewable energy companies are participating in power market trading. The only regions to exceed that percentage tend to be in the central and western regions of China[4]. The settlement price of renewable power in the spot market is generally lower than its fossil fuel equivalent and does not fully reflect the green attributes of renewables, and this price discrepancy is hampering market participation. The current market arrangements were originally designed for conventional power supplies, and are not appropriate for the output characteristics of renewables. The result is a lack of competitiveness when renewables join the spot power market. All of these challenges inevitably require systemic adjustment in policy support and a complete transformation of existing market mechanisms.

3. *See note 1.*
4. *https://cec.org.cn/detail/index.html?3-315657*

# Handbook on Electricity Markets: a classic reference tool

Given that China is still developing its national electricity market, this is a good time for its specialists to observe and draw on international experiences and deepen their understanding of the various market mechanisms in the global energy market in order to better design a market that takes into account the particular characteristics of the situation in China. The publication of the Handbook on Electricity Markets in November 2021 could not have come at a better moment. Edited by Jean-Michel Glachant, Director of the Florence School of Regulation, Paul L. Joskow, Massachusetts Institute of Technology, and Michael G. Pollitt, University of Cambridge, the 600+ page Handbook brings together insights from some of the most brilliant thinkers and experts in the field of electricity markets.

The book is composed of two sections with 22 chapters. The first section offers an overview of the current legacy state of power markets around the world. It not only covers the fundamental theories of traditional arrangements for electricity supply, wholesale and retail electricity markets and price design, but also provides detailed analysis and key lessons learned in major electricity markets in Europe, the UK, Australia and the USA. The second section focuses on the future, discussing how the electricity market is evolving to adapt to the current new situations that are being shaped by higher renewable penetration and new market drivers, such as the emergence of new technologies on the supply and demand side, tools and policy priorities for decarbonising power systems, future electricity market design, new characteristics in balancing supply and demand, as well as emerging business models.

EU-China Energy Cooperation Platform (ECECP) has commissioned a Digest of the Handbook with funding from the EU. Co-authored by Jean-Michel Glachant and Nicolò Rossetto, the Digest presents the Handbook's wealth of information in a highly condensed form in both English and Chinese, so that the key points are more available to busy decision-makers. What's more, the edition of the Digest available for distribution in China features an extra chapter 'Takeaways from the Handbook on Electricity Markets in China,' written by Michael G. Pollitt, which draws key insights from each chapter and highlights how they relate to the issues and challenges faced by China. A complete Chinese translation of the Handbook is also under preparation by ECECP. Publication will be in 2023, offering a more detailed reference for Chinese readers.

# Some key insights for China

Will this Handbook help to solve some of the profound puzzles for China in optimising its own power market? According to Mrs Ma Li, the Handbook is informative and very valuable to Chinese electricity market researchers and practitioners, particularly in view of its in-depth analysis of mature market models across the world. Many key issues currently encountered in China's electricity market, including provincial and regional market connections, market mechanisms that allow for variable renewables and encourage their consumption, as well as strategies to unlock the demand side flexibility potential, are addressed in detail in the Handbook.

- Market models to achieve a unified national market

In China, there is an unbalanced geographic distribution of renewable energy supply and demand as well as curtailment issues in the renewable rich regions. This means that green power output need to be allocated and distributed on a wider scale, which is exactly the point of building a national power market.

There has been a wide-ranging discussion about which mature power market model China should adopt in order to build a fully functioning national market by 2030. The US PJM model, as well as the standard market design of the European system, both covering large geographic areas of different states, are two typical and often cited models that have particular relevance for China[5].

However, as Dr Michael G. Pollitt argued at the launch event of the Digest, the PJM market, famously including a day-ahead spot market and nodal prices, might not be the ideal option for China: its efficacy depends on the particular conditions of the US market, such as the difficulty in expanding the transmission system, which does not seem to be a pressing issue in China. In addition, to expose everybody to time and space varying prices could be even more problematic in the Chinese context at present.

The European single market, on the other hand, represents a textbook example of the long-running integration of different sub-regional and national markets. This bears similarities to China's current efforts to bring the Chinese provincial system into a single market. According to Dr Pollitt, the

5. *For detailed analysis of PJM and the European power market, see Chapter 7 and Chapter 11 respectively of the Handbook.*

European single market case makes it clear that there is a substantial role for the European Commission and a need for very significant interventions to reduce gaming in inter-jurisdictional trading and so to reduce the power of incumbent companies and their national regulators. 'A key lesson for China is that strong regulatory leadership from central government is needed in supporting the provinces in order to develop a genuine national market, and that simply concentrating on developing markets at provincial level may miss a huge benefit,' noted Pollitt.

- Market mechanisms to accommodate high-share of renewables

Even as China moves towards a new power system, the rise of intermittent renewables poses on-going challenges to system security, because the availability of renewables does not necessarily correlate with demand. 'Whenever we're thinking about matching supply and demand in the power market, we can either do it through price mechanisms or we can do it through some sort of quantity control. So, if we have a shortage of electricity generation from renewables, we can ration electricity demand through some sort of rationing algorithm which people have agreed to in advance. This offers an alternative to simply exposing people with higher prices in real time market,' notes Pollitt. In terms of future electricity market design[6], Pollitt stresses that long-term contracting coupled with short-time quantity control will allow China to cater for the characteristics of a new power system based on renewables, as this long-term model emphasises flexible qualities rather than flexible price.

All around the world, many mechanisms have been explored that offer reliable operation of a power system that can incorporate a growing share of renewables, such as new auxiliary service mechanisms to encourage flexibility, capacity compensation for power sources that supporting system reliability, establishment of a capacity market to supplement energy markets and to ensure resource adequacy, as well as scarcity pricing mechanisms. All of these mechanisms, discussed in

6. *See Chapter 16 of the Handbook.*

detail in the Handbook with actual examples and lessons learned, are worth further exploration in the Chinese context.

In addition to the need to secure system reliability, there is another factor: decarbonisation. The design of the market mechamism should reflect the green value of renewable energies. This is vital to encourage renewable energy producers to participate in the market. There are many existing market-based tools such as green certificates, green power trading and the carbon market, which complement each other and all work towards the same goal of promoting the participation and consumption of renewables. Although building blocks are in place for China, such as the newly established national carbon market, Pollitt suggests that such tools need to become more integrated, and that renewable subsidy schemes need to be developed alongside. 'More importantly, prices and ambition need to rise to a certain high level where it's actually making a difference in the power sector,' said Pollitt.

- Unlocking the potential of demand side flexibility

Unlocking the potential of the demand side is key to being able to manage intermittency, and constitutes one of the main reasons for development of an electricity market, said Pollitt in the launch event. It is not only about accelerating the development of various demand side technologies, such as energy storage and EVs, but also about who should manage them, and in what way. As most end users are not currently able to participate directly in the power market, the question of how they should be included in the power market – initially through retailers or suppliers- is absolutely crucial.

China's introduction of large numbers of competitive electricity retailers since 2015 shows that it recognises the importance of the demand side, notes Pollitt. However, he remarks on an apparent lack of understanding about the potential role for competitive retailers: a truly competitive retail market is yet to be established.

'Full retail competition is about

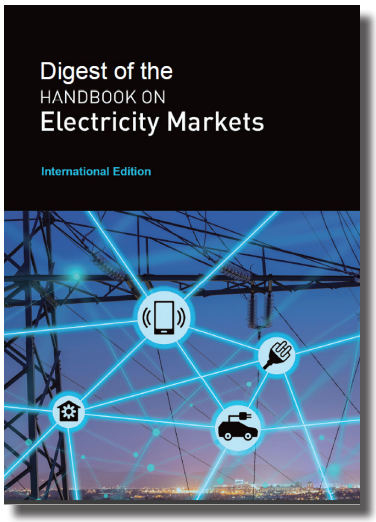
competition in who bundles wholesale contracts, meters, invoices and manages the customer relationship. Successful retailers should have been innovative with respect to the customer relationship and have experimented with different degrees of integration with generation. However, China is not moving towards this sort of retail competition.' writes Pollitt in the Digest. He further stresses that 'a key argument for China is that without wholesale market pricing and retail competition, the potential on the demand side in China cannot be fully unlocked.'

Looking into the future, the transformation of passive consumers into active market participants enabled by new demand-side technologies offers enormous potential for system flexibility, which could be unlocked by new business models that offer new options for reactions to market signals and grid incentives[7]. Pollitt suggests that more experimentation is needed in China to find out what payment regimes will encourage power users to be more flexible and elicit the biggest demand response, whilst also being politically acceptable. In this context, it is worth studying some of the experiments that have already been trialed in other parts of the world with respect to consumer behaviour.

## More to be explored

In conclusion, there is a great deal of relevant information for a Chinese audience in the 600+ pages of the Handbook. ECECP is hoping anticipates that the Digest will help China to avoid some of the pitfalls encountered in other countries, and that market players will choose to take the opportunity to find out about some of the successful – and not so successful – market developments throughout the world.

By **Daisy Chi**




*The condensed version - Digest of the Handbook on Electricity Market - is now available with open access on the websites of both ECECP and FSR. Click the underlined links to download.*

7. *See Chapter 17 of the Handbook.*

# China's power system needs to modernise

*The Sichuan drought shows the need to better balance supply and demand, not simply build new coal power plants.*

*The Baihetan hydropower station, which straddles the provinces of Yunnan and Sichuan in southwest China (Image: Cao Mengyao / Alamy)*

Sichuan, the most densely populated and industrialised province in south-west China, relies heavily on hydropower. This summer it was hit by extreme heatwaves and drought, causing reservoirs to dry up and the power system to suffer.

To keep power flowing to homes, the local government pulled the plug on factories for two weeks. But as the drought dragged on, household supplies were affected too.

Experts say the crisis highlights thorny and longstanding problems for China's electricity reforms: inflexible markets, insufficient demand-side response, and a failure to tune and balance the power system. Together, these mean a drought can quickly cause electricity shortages. And the growing threat of climate change impacts may be more than the ageing system can handle.

China must decide: should it shore up the existing system with more coal and gas power or speed up its reforms?

## Crisis

Sichuan is known as the province of a thousand rivers, counting 1,419 of them, large and small, within its borders. It also boasts diverse terrain, stretching from the heights of the Qinghai-Tibetan Plateau and the Hengduan Mountains down to the Sichuan Basin, with a fall of almost 7,000 metres between its highest and lowest points. That makes Sichuan ideally suited for hydropower, which now accounts for the lion's share of its energy mix.

Hydropower accounted for 77.39% of the province's total generating capacity of 114 gigawatts (GW) in late 2021.

In normal years, summer is the rainy season. Rivers rush east off the plateau and are channelled through turbines as they go, generating huge quantities of electricity. This isn't just for Sichuan's own needs. There is a surplus for export to Shanghai, Zhejiang and the other industrialised provinces in eastern China.

*A small hydropower station on the Zhou River, Dazhou City, Sichuan, which has stopped working due to lack of flow, August 2022 (Image: Tom Wang / Alamy)*

But climate change transformed this year's rainy season into a drought, with rivers in the Yangtze Basin running dry when least expected.

In July and August, rainfall in the Sichuan Basin was half or more below usual levels. Meanwhile, temperatures were 2.3C higher than average between June and the end of August, the highest since full records started in 1961, according to the Sichuan Climate Centre.

Those historic highs meant new lows for hydropower generation. According to the Sichuan Daily, by 16 August, water in a number of important reservoirs had reached the 'dead level', meaning there was no longer enough to run the turbines. Hydropower generation was 50% lower than in the same period the previous year. Meanwhile, the hot weather had locals reaching for their air conditioning: the demand for electricity province-wide shot up 25% year-on-year.

The electricity system was overdrawn and at risk of collapse. If the load stays too high for too long, the grid can fail and cause widespread blackouts. Sichuan had no choice but to pull the plug on its factories. That continued until the end of August, when cooler air blew in from the north, pushing out the subtropical high pressure. Rain fell at last and the crisis drew to an end.

## Coal power raises its head again

Some said the crisis could be blamed on an over-reliance on hydropower and that more thermal power plants were needed to ensure stable supplies.

Sure enough, after the shortages, the provincial government put policy incentives in place for new gas-fired power plants. In October, it issued a document saying it would make capacity payments to gas-fired plants that can regulate power at peak times, the first such statement in China. That would mean payments could be collected by a power plant even when it is on standby.

Since mid-July, Caixin reports that provinces including Guangdong, Anhui, Xinjiang and Guizhou have put building new coal power plants on their agenda. Total generating capacity when built, according to Caixin, would come to almost 17 GW. It looks like China may see a wave of coal power construction in the coming three years.

That trend can be traced back to September last year when several provinces were hit by electricity shortages. In the final quarter, approvals for coal power plants suddenly increased compared to the same period in 2020. Almost 20 GW of coal power plant construction was approved in the six months from October 2021 to March 2022, according to a Greenpeace briefing, which judged that the need to ensure supplies and energy security was now driving the electricity sector.

Yuan Jiahai, a professor at North China Electric Power University's School of Economics and Management, told China Dialogue: 'We have seen a lot of electricity supply issues these two years. What to do? If we build more coal power then it'll be there when we need it, but utilisation rates will usually be very low. It'd be an ongoing waste in order to ensure we don't see shortages in a crisis. For policymakers, security and stability come first.'

Yet, more coal power won't necessarily make the system more secure. An unexpected jump in coal prices could also trigger a crisis.

That was what caused last year's shortages: a disconnect between coal prices and power prices meant many coal power plants were losing money with every single kilowatt-hour of power they produced, so they shut down.

Moreover, coal power is no less vulnerable to extreme weather than hydropower. In July 2021, a downpour in Zhengzhou left the local electricity system reeling. A Yuneng Power plant to the west of the city flooded and was at risk of being unable to continue generating. The same downpour damaged the electricity infrastructure in Zhengzhou, Luoyang, Jiaozuo and elsewhere.

Any single piece of infrastructure can fall foul of unpredictable risks: a dry summer, a sudden downpour, or high coal prices. The question is, how do we ensure the system as a whole can stay safe and stable?

## An inflexible system

Electricity systems have three connected stages: generation, transmission and distribution. This year's problems in Sichuan were mainly caused by a large and sudden drop in generation. A simple solution would be to add more generating capacity to cover any fall. But the underlying problem is more complex.

*The Baihetan to Jiangsu ultra high voltage transmission line is a key part of China's 'west–east power transmission' strategy*

*(Image: Alamy)*

Sichuan is China's biggest exporter of hydropower, with one-third of its generation sent to places like Jiangsu, Zhejiang and Shanghai in the east, rather than meeting local demand. If it hadn't been for those existing commitments, Sichuan could have kept the factory lights on.

Of the province's 114 GW total generating capacity, 88.87 GW is hydropower, 18.25 GW is thermal power, and 7.23 GW is new energy. Even operating at half of the total capacity, Sichuan's hydropower plants can generate 40 GW.

Yuan Jiahai and others have calculated that with thermal power running at full capacity, as well as 3 GW of generation from new energy sources and 4 GW in electricity imports from elsewhere, Sichuan had a total of 65 GW of power. That is equal to the province's peak demand, meaning balance could have been maintained.

However, cross-provincial electricity transfer agreaements (both under government instruction and as deals between grid operators) mean that a significant part of Sichuan's generated power is sent east. At the worst point of the drought, only 23–25 GW of hydropower was available for local use, leaving a peak-time shortage of around 15 GW.

As well as the cross-provincial agreements, this situation is also due to the physical design of the grid and how the system works.

'The cross-regional energy market is planned at the national level and designed and operated based on direct current, high volume and unidirectional transmission of power,' said Yuan Jiahai.

He added: 'Such a grid design does not allow Sichuan to keep more power for itself. And the system as it stands doesn't give Sichuan the authority to change planned transfers. When the crisis started, Sichuan declared a 'Class I power supply emergency' after approval from national energy supply and security authorities. Only after allocation of supply and demand at the national level was Sichuan able to keep more power for itself.'

Indeed, in China, investment and cross-provincial electricity dispatch is planned at the national level, with provincial authorities mainly in charge of implementing those plans, according to a 2019 report by the China Electric Power Planning and Engineering Institute. When things go off the rails, existing systems do not allow those in immediate control to respond quickly.

'It's inflexible and lacks market mechanisms,' said Yuan Jiahai. 'Long-term cross-provincial deals and trading schemes determined at the national level are set in stone, so there's very little scope to make use of cross-provincial spot markets to improve the situation at the margin.'

## Away from the supply side

In 2015, the State Council published a document on further reforms to the electricity system known as Document No. 9. It referred to a lack of market mechanisms and problems coordinating national- and provincial-level planning.

Yuan Jiahai said electricity trading should 'send electricity wherever demand is highest', similar to the bilateral and bidirectional agreements common in Europe but entirely absent in China. 'In other words, our regional markets are lagging far behind.'

'The situation this summer showed how much room there is for more coordination in the existing system,' he said. If there were a regional market, he added, higher prices could have been used to encourage other provinces to fire up reserve capacity and allow Sichuan to retain more of its own electricity. That would have eased problems for the province and been much less damaging than the factory shutdowns. But the costs of doing this would need to be spread fairly. Under market mechanisms, Sichuan would have to be willing to pay more for power originally destined for export, prompting eastern provinces to use reserve generating capacity to meet their own needs.

'I think there's a lesson here for government and market actors: electricity security and guarantees come at a cost, and low prices can't necessarily be maintained under all circumstances.' But, he warned, the reforms cannot happen overnight. There will need to be a managed process.

Another problem is that the demand side is failing to respond to supply-side problems. Fixed electricity prices meant household demand remained high throughout that scorching August, with some homes running their air conditioning all day and night. In the end, industrial usage was sacrificed to maintain supplies for households.

'In a situation like that, how much reserve generating capacity would we need to ensure supplies if we don't think about the demand side?' asked Yuan. Based on his calculations, adding 15

GW of reserve capacity – the amount needed to close the gap this summer – would require a huge investment and would only be used a few days a year. But if electricity users were persuaded to reduce demand, the gap could be shrunk by 7 or 8 GW. Regional markets could supply 4 or 5 GW of the remainder, requiring an investment on the supply side of only 2 or 3 GW.

Document No. 9 also calls for demand-side management to be used to balance supply and demand. The government is to use market reforms on both the demand and the supply side to maintain that balance.

And while the 14th Five Year Plan sets a target for demand-side management – demand-side response mechanisms should be able to shift 3–5% of peak load – market incentives to encourage investment in such mechanisms are lacking. Yuan Jiahai thinks the role of the National Energy Administration (NEA) is a major factor.

He explains that the NEA acts as a 'power supply management agency', rather than improving the overall system. There is no NEA department responsible for managing the demand side, which means that after two power shortages, China is still working to increase supply, rather than balance supply and demand.

So China should focus investment on electricity system reforms, build regional electricity markets, and develop demand-side response.

As Huang Hui, manager of NRDC China's Climate and Energy Project, and Dr Yang Fuqiang, a research fellow at Peking University's Institute of Energy, have written: 'Whether it is to combat climate change, to achieve the dual carbon targets, or to make a return on investment, new coal power should always be the last choice.'

By **Xia Zhijian**

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# 3 ways clean hydrogen projects can boost their chances of securing final investment decisions

There are many barriers preventing clean hydrogen projects from reaching final investment decision (FID). Here, we take a closer look at the importance of securing clean hydrogen offtake customers and share practical solutions to overcoming this challenge.

Clean hydrogen is set to play a critical role in the energy transition, yet, despite a growing pipeline of projects, only 4% have reached FID. To discover what is driving this dynamic and to identify ways to remove barriers, the World Economic Forum launched the Clean Hydrogen Project Accelerator to understand how the pathway from announcement to FID may be expedited. Somewhat counterintuitively, given demand forecasts, Accelerator projects highlight that finding and securing offtake agreements is a challenge. This is critical as it enables these capital-intensive projects to demonstrate long-term bankability and return on investment.

So, why is it difficult to secure offtake agreements and how can this challenge be overcome? Through the Accelerator engagements, three key avenues were identified:

## Closing the price gap between buyers and sellers

There is a sizable gap between the price expectations of clean hydrogen buyers and sellers. Most buyers are constrained by the price of their existing energy and a switch from grey to clean hydrogen could be multiple times more expensive. Despite the soaring natural gas prices driven by the war in Ukraine and increasing public and regulatory pressure, the cost gap still prevents many companies from taking meaningful action towards net-zero. This is a particular challenge in sectors with low-profit margins, such as fertiliser production, where hydrogen is a critical component.

In the short to medium term, government intervention and subsidies will play an important role in helping to bridge the price gap between buyers and sellers, making offtake contract negotiations more attractive for both parties. In Europe, under RePowerEU, the European Commission will roll out carbon contracts for difference (a financial mechanism to cover the switching cost) to support the uptake of green hydrogen by industry. In the US, the Department of Energy has announced an USD8 billion program to develop regional clean hydrogen hubs under the Infrastructure, Investment and Jobs Act and USD270 billion for clean energy tax credits under the historic Inflation Reduction Act, allowing green hydrogen to have a USD3/kg subsidy advantage over grey.

At the project level, Yara Clean Ammonia, the world's second-largest ammonia producer, received a USD33.2 million grant from the Norwegian government for the development phase of its Skrei Project, a new electrolysis plant that will tie into the existing plant for ammonia production.

A similar approach has been adopted by JERA, the largest power generation company in Japan. It is undertaking an ammonia procurement and co-firing demonstration project at its Hekinan Thermal Power Station and has leveraged government grants to reduce ammonia production costs and to cover R&D costs until FY2024.

**Clean Hydrogen Project Accelerator**

The initiative is working with the four hydrogen projects across the value chain:

**Green Ammonia Production, Norway**

Building a 24 MW green hydrogen demonstration plant to produce ammonia for fertiliser and shipping by 2023

**Green Hydrogen Production, Denmark**

Building a 1 GW green hydrogen plant to provide hydrogen for on-road mobility, a large-scale green methanol plant, green ammonia production and maritime applications

**LOHC Hydrogen Import Technology, Netherlands**

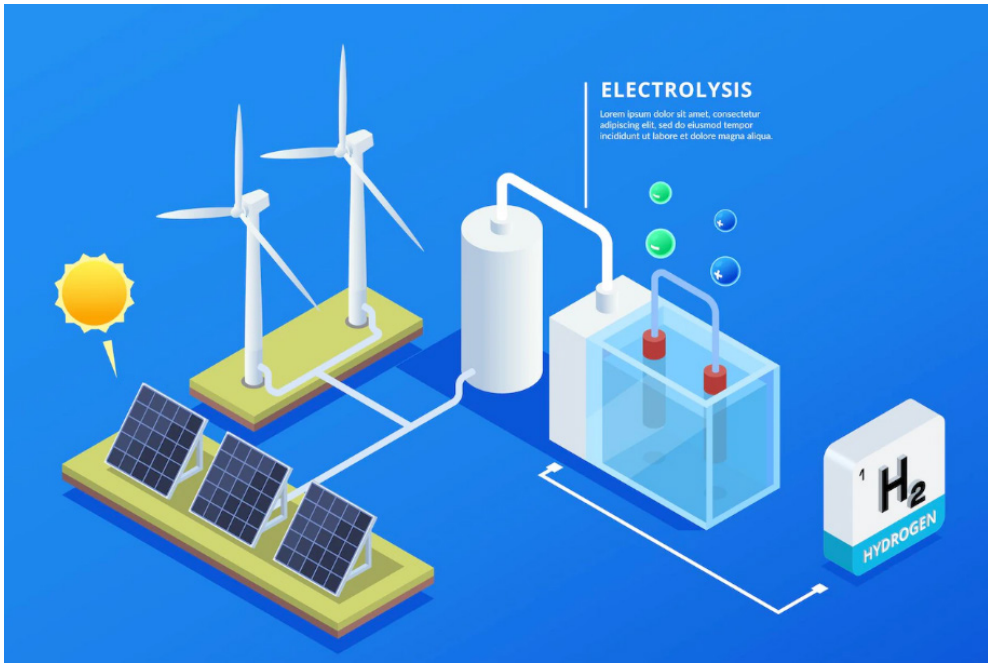
Developing global hydrogen supply chains by utilising their SPERA hydrogen transport technology

**Ammonia Procurement and Co-firing, Japan**

Demonstrating 20% ammonia co-firing ahead of commercial scale up in late 2020s. This is supported by international competitive biding for the procurement of ammonia

# Dealing with supply-side risk

While over 45 giga-scale clean hydrogen projects proposals (over 1 GW of electrolysis) have been announced, production at this scale is not yet proven, creating significant supply-side risk. This will improve over time, but it creates a real risk for early-moving offtakers and is particularly unpalatable for buyers, such as public utility companies, for whom reliability and security of supply is a matter of national interest.




To overcome this issue, two key strategies have been adopted:

One strategy is to create industrial clusters, where supply and demand are co-located. These industrial clusters are epicentres for hydrogen activity, coalescing stakeholders across the entire hydrogen value chain and aligning them around common goals. This enables cluster members to source hydrogen from multiple sources and for suppliers to take advantage of a readily available pool of potential offtakers. The HyNet North West cluster in the UK is a visible success story in this regard having facilitated over 24 Memorandums of Understanding for offtake. Another example is how Mitsubishi and Chiyoda have engaged the Port of Rotterdam industrial cluster to support their efforts in sourcing offtakers for hydrogen delivered through their 'SPERA' technology. They are now in the early stages of securing offtake within the steel, sustainable aviation fuel, chemicals and power sectors.

The second strategy is vertical integration. A growing number of companies are taking on multiple roles across the hydrogen value chain and others are exploring options to become equity partners in aspects of the value chain that are not typically core to their business. This has allowed them to act as their own offtaker, increase control and awareness of the price premium challenge and utilise trusted relationships. H2 Energy Europe (a joint venture between H2 Energy and Trafigura), for example, is developing green hydrogen in Denmark's two key landing sites. Its approach has been to prioritise large-scale production so that economies of scale will enable future demand. In order to create an end-to-end hydrogen value chain, it established a joint venture with Phillips 66 to create a European network of hydrogen refuelling stations, combining retail and hydrogen experience to boost hydrogen development in Europe.

## Navigating uncertainty in standards and certification

In addition to the policy clarity needed from governments, market-wide standards and certification frameworks and tradeable guarantees of origin are essential to alleviate uncertainty, garner investor and market confidence and enable global trade. In other words, beyond the debates around the colour of hydrogen (blue versus green), investors and offtakers need to understand and compare the carbon content of hydrogen products from a lifecycle analysis perspective. Without this security, many developers are hesitant to invest in projects that may not comply with future regulatory requirements and prevent them from achieving offtake.

The Enabling Measures Roadmaps for Green Hydrogen, published last year at COP26, highlighted the need to ensure clear technical standards for projects across the hydrogen value chain, including a common approach to certification for carbon intensity. Through the G7, IRENA is working on a gap analysis of hydrogen certification schemes that will provide much-needed clarity for the industry.

There are a few instances of organizations innovating to overcome this barrier. Yara Clean Ammonia, for example, has created its own certification scheme that it expects will align with future standards as they are rolled out. Although not yet internationally recognized, its introduction has been key to providing certainty and reassurance to offtakers paying a price premium.

## Where to from here?

Securing offtake contracts will play a vital role in progressing projects to FID, but this is not the only challenge. It is critical that supply, demand and infrastructure for clean hydrogen are scaled up jointly, and that the underlying supply chain and required skills are developed at pace.

At the time of writing, governments from across the globe are gathered at COP27. We need them to work together and with industry to solve bottlenecks, establish policy frameworks and enable measures that will build the confidence needed to unlock the market for clean hydrogen and help fulfil its role in achieving a net-zero future.

By **Jorgen Sandstrom, Noam Boussidan, and Catherine O'Brien**

# Monthly News Round-Up

ECECP highlights the key energy news headlines from the past month in the EU and China

**COP27 closes with no breakthroughs on emissions cuts**

COP27 closed on 19 November with agreement on a dedicated loss and damage fund to help vulnerable nations hit by climate disasters, but failed to step up efforts to tackle the damaging emissions that cause them. Highlights from COP27 include a first high-level report on the Net-Zero Emissions Commitments of Non-State Entities, which slams greenwashing, a new tool offering an independent inventory of greenhouse gas emissions, as well as a so called master plan to accelerate the decarbonisation of five major sectors – power, road transport, steel, hydrogen, and agriculture.

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**EU tables emergency permitting rules for renewables**

The European Commission has tabled temporary emergency rules to accelerate the deployment of renewable energies like wind and solar, saying the ongoing energy crisis fueled by Russia's war in Ukraine calls for exceptional measures. Solar rooftop projects, for instance, and small solar installations below 50 kW of capacity will be exempt from a dedicated environmental impact assessment. Appraisals for replacing ageing wind turbines with new, often larger, units will have to be concluded within six months.

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**EU strikes deal on climate 'effort sharing' regulation**

European Union negotiators reached an agreement in November on a regulation mandating 40% emission cuts compared to 2005 levels across sectors such as buildings, road transport, agriculture and waste. Member States can bank up to 25% unused annual allocation to subsequent years or borrow allocations from the following year, and can trade emission quotas with each other.

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**EU and Egypt step up cooperation on the clean energy transition**

The European Commission has signed a bilateral Memorandum of Understanding (MoU) with Egypt on a strategic partnership on renewable hydrogen. The MoU will serve as a framework to support long-term conditions for the development of a renewable hydrogen industry and trade between the EU and Egypt, including infrastructure and financing. The European Bank for Reconstruction and Development (EBRD) will also contribute up to EUR 35 million to Egypt's Energy Wealth Initiative, which aims to phase out gas-based power generation in the country.

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**European countries join international alliance to boost offshore wind power**

Nine countries have joined an international alliance to scale up offshore wind energy, according to Euronews. Belgium, Colombia, Germany, Ireland, Japan, the Netherlands, Norway, the UK, and the US signed up to the Global Offshore Wind Alliance at COP27 in Egypt.

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**UK joins countries to commit to slashing emissions from oil and gas**

The UK has joined the US, EU, Japan, Canada, Norway and Singapore at COP27 to commit to taking rapid action to reduce greenhouse gas emissions from the oil and gas industry. The nations are calling on fossil energy importers to reduce the methane emissions associated with their energy consumption, as well as requiring fossil fuel producers to implement projects and support policies and measures that lead to emissions reductions.

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**UK government sets out carbon capture framework**

The UK government has announced its long-awaited regulatory framework to support the development of carbon capture and storage (CCS) projects in the country. The new Dispatchable Power Agreement sets out the official business model and contract structures that will shape the country's nascent CCS sector.

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**UK unveils Europe's largest energy storage system**

The UK has brought online Europe's largest battery energy storage system, marking a new era in power diversification in the UK. The Pillswood project, developed by Harmony Energy Limited and managed by Tesla, employs Tesla 2-hour Megapack technology systems and has the capacity to store up to 196 MWh of electricity in a single cycle – enough to power around 300,000 UK homes for two hours.

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**France unveils decarbonisation strategy for industrial sector**

French President Emmanuel Macron has presented a plan to curb carbon emissions in the industrial sector, aiming over the next ten years to halve the emissions from 50 industrial sites that are among the 120 biggest carbon emitters in France. If implemented, the proposal would reduce France's carbon emissions by 5%. A total of EUR 5 billion has been secured to finance high quality decarbonisation projects and to support SME low-carbon technology development and deployment.

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**Germany to leave Energy Charter Treaty in effort to better tackle climate change**

Parliamentarians from Germany's ruling parties have announced an agreement that the country will be the latest to leave the controversial 1994 Energy Charter Treaty (ECT), a multilateral framework for cross-border cooperation in the energy industry that protects investments in certain sectors, in particular nuclear and fossil fuel energy sources. Instead, the country intends tosupport new EU free trade agreements with the US, Canada and South America.

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**Heat pumps installed in over half of all new buildings in Germany in 2021**

Heat pumps are starting to play a significant role in Germany's heat supply and were installed as the primary heating system in more than half of all new buildings in 2021, the country's national energy agency dena announced in its latest report. More than 170,000 heat pumps were sold in the country last year, half of which went into existing buildings rather than new-builds.

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**Norway raises its emissions reduction target for 2030**

Norway has submitted an updated nationally determined contribution (NDC) under the Paris agreement, which increases the country's 2030 emissions reduction target from 50% to at least 55% from a 1990 baseline. The target does not include land use, land-use change and forestry.

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**France and Spain pledge halt to gasoline-driven vehicle sales**

France and Spain are among the new signatories to join the Zero Emissions Vehicles Declaration, a group launched at COP26 that pledges to stop sales of gasoline-driven vehicles by 2035, five years earlier than previously planned.

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**Spain's Iberdrola to build 12 GW of renewables by 2025**

Spanish utility Iberdrola has announced it will invest EUR 17 billion in renewable energy by 2025 in order to reach around 52 GW of total installed renewable capacity by the end of 2025. This investment is part of a EUR 47 billion spending package that includes a EUR 27 billion investment in grids and electricity networks.

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**Romania partially regulates energy markets until 2025**

Romania government has amended its energy support scheme for households, small businesses and industry, partially regulating its power market until March 2025 to ensure security of supply. The new move introduces a centralised energy acquisition mechanism via emergency decree, requiring power producers to sell available output at a regulated price from January 2023.

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**New policy to promote green power consumption**

Annual incremental consumption of renewable energy, including wind, solar, hydro, biomass and geothermal power, from the 2020 base level, as well as energy consumption for the production of raw materials, will be deducted from total energy consumption calculation in China, according to a statement jointly released by China NDRC, NBS and NEA in November. The new policy proposes use of the green certificate as a proof of consumption of green electricity, and promotion of the green certificate trading system as a way of encouraging renewable power consumption.

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**China to step up energy performance management of major energy consuming products**

Five departments of China have jointly released a new notice that aims to raise energy performance levels and the overall management of major energy consuming products covering 20 types of industrial and residential appliance. The document also calls for the accelerated introduction of a unified green product certification scheme and more widespread public procurement of green and low-carbon products.

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**China issues carbon peaking plan for building materials sector**

China's Ministry of Industry and Information Technology and three other top regulators have issued a plan for the building materials sector, targeting an industry wide carbon emissions peak by 2030. According to the plan, energy consumption in cement clinker production units should drop by over 3% during the 14$^{th}$ Five-Year Plan period. The plan also calls for establishment of a green and circular industrial sector by 2030 and an improvement in the utilisation rate of clean fuels.

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**China to support relocation of energy intensive industries to its western regions**

China is to roll out measures to maintain the post-Covid recovery of the industrial economy, according to a circular released in November. Measures include further improvement of the business environment in the western region, and support for the relocation of energy intensive industries that meet ecological and energy efficiency requirements to the clean-energy-rich regions in the west of the country.

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**CEC proposes restructuring the electricity price scheme**

A recent report by China Electricity Council (CEC) proposes a restructuring of the power price scheme to reflect more green and system-balancing values, as the country moves towards a renewable energy-based new power system. The report also proposes raising the benchmark coal-fired power price to CNY 0.4335/kWh.

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**Further steps to boost foreign investment as China targets carbon neutrality**

Six ministries, including the NDRC, have recently issued a policy notice aiming to boost foreign investment in the manufacturing sector, especially in high-end equipment, basic components and key parts for advanced manufacturing, as well as high-tech industries. China wants to encourage foreign investors to take part in activities and projects that contribute to China's carbon peaking and neutrality strategy.

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**China to strengthen supervision of lithium battery supply chain**

The impact of material shortages on EV profits is to be tackled with stronger supervision of the lithium battery supply chain, China's Ministry of Industry and Information Technology said in November. The sector faces explosive demand growth for electric cars and a complex Covid-19 situation. The ministry said it would curb hoarding, price gouging and unfair competition in the supply chain, and would overcome barriers currently standing in the way of a unified lithium battery market.

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**China ramps up energy production, imports for winter use**

China continued to shore up energy supplies in October to ensure stable supplies for winter heating, according to the latest data from the National Bureau of Statistics (NBS). The output of coal, crude oil and natural gas increased year-on-year by 1.2%, 1.5% and 12.3% respectively in October 2022. Imports of coal and crude oil rose sharply by 8.3% and 14.1%, respectively, while natural gas imports plunged 18.9%.

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**Russia-China energy trade continues to grow**

Russia's energy exports to China increased in value by 64% in 2022, and by 10% in volume, thanks to a jump in oil and gas prices and a rerouting of energy flows away from Europe and towards Asia said Russia's Deputy Prime Minister Alexander Novak in November. China pays for Russian gas delivered through the Power of Siberia gas pipeline in Chinese yuan and Russian roubles.

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**Shell and Sinopec to study feasibility of large CCUS project in China**

British oil and gas company Shell has signed a memorandum of understanding (MoU) with the Chinese state-owned refiner Sinopec, as well as with Chinese steel company Baowu and Germany's BASF, to explore the feasibility of developing an open-source CCUS project in eastern China. If successful, it will be China's first large-scale open-source CCUS project, with a potential capacity of tens of million tonnes of CO2 per year.

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**China and Qatar seal 27-year gas supply deal**

State-owned QatarEnergy has announced a 27-year natural gas supply deal with China. The company will send 4 million tonnes of liquefied natural gas annually from its new North Field East project to China Petroleum and Chemical Corporation (Sinopec) till 2050. The deal marks the longest gas supply agreement in the history of the LNG industry.

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**Energy companies issue more special bonds to ensure supply security**

Chinese central energy companies are issuing more special-purpose bonds, in a move to help companies to ease investment and financing pressures amid a volatile global energy market and ensure sufficient domestic energy supplies during the upcoming winter season. In total, major Chinese energy companies have so far issued bonds valued at more than CNY 100 billion .

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**Government to push for NEV and battery shipments to Europe**

The Ministry of Industry and Information Technology (MIIT) has joined with two other ministries to issue a notice that aims to consolidate industrial production, with a raft of new supportive measures. The circular also calls for more support to shore up transportation of new-energy vehicles and electric batteries using the China-Europe Railway Express freight route.

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**China produces world's largest offshore wind turbine**

The world's largest offshore wind turbine rolled off the production line in East China's Fujian province in November, setting a new benchmark for global offshore wind power equipment. Co-developed by China Three Gorges Corporation and Xinjiang Goldwind, a single 16 MW unit can generate 34.2 kWh per revolution, with an average annual output of more than 66 million kWh of clean electricity- sufficient for the annual consumption needs of 36,000 Chinese households.

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# Featured Publication


## Coal in Net Zero Transitions

This IEA special report, part of the World Energy Outlook series, presents pragmatic, real-world guidance on how policymakers can achieve a reduction in carbon dioxide emissions from coal without harming economies or energy security. The authors outline measures to finance energy transitions and address their social impact. The report explores the options for the power sector and other parts of the economy where coal plays a notable role, examining a range of policy and technology areas, including the potential for carbon capture, utilisation and storage. It also addresses investment and financing needs, taking into account the importance of ensuring reliable and affordable energy supplies and of tackling the social consequences of change.

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## PolyGrid 2050: Integrating Hydrogen into the European Energy Transfer Infrastructure Landscape

Development of a hydrogen economy is dependent on adequate transport infrastructure. Developers are faced with the task of avoiding inefficiency and redundancy in the future hydrogen transport infrastructure, which is even more challenging thanks to technological uncertainty, the unpredictability of future supply and demand for hydrogen, network externality effects, and irreversibility of grid-based infrastructure investment. Meeting these challenges entails coordinating investments in all modes of hydrogen transportation infrastructure in order to establish a cross-sectoral hydrogen polygrid. This paper, by the Oxford Institute for Energy Studies (OIES), analyses the strengths and shortcomings of three possible approaches—centrally coordinated, market-based, and regulatory. The paper concludes with policy recommendations for establishement of a coherent institutional framework governing investment in the future hydrogen polygrid.

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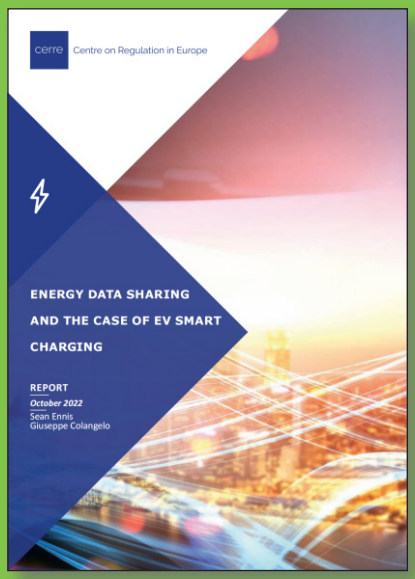


## Energy Data Sharing and the Case of EV Smart Charging

Data-sharing frameworks are key to development of smart charging initiatives: they provide guidelines and protocols to ensure that stakeholders can share data securely and seamlessly. Bi-directional charging has huge potential to reduce greenhouse gas emissions relating both to transport and electricity production. This report, by the Center on Regulation in Europe (CEERE), examines the economic features of bi-directional charging technology and examines the broad regulatory framework relating to data sharing in the EU, showing how this framework is supplemented by energy-specific data requirements. The authors explore the potential impact of data sharing in the context of electric vehicle battery charging and electricity provision.

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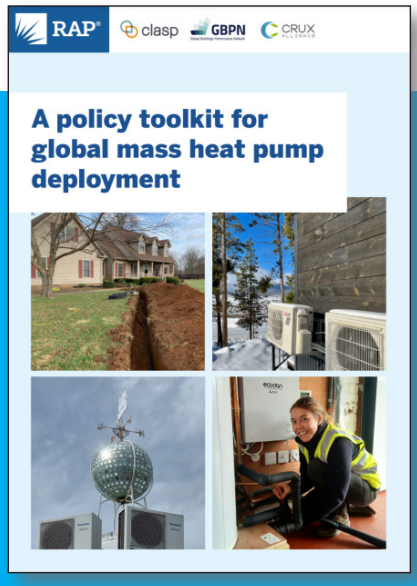


## A Policy Toolkit for Global Mass Heat Pump Deployment

Heat pumps, a critical technology for clean energy systems, are poised to become the most widely used technology for decarbonisation of heating. The Regulatory Assistance Project (RAP), CLASP and the Global Buildings Performance Network have developed a heat pump policy toolkit that provides a suite of tools and advice on how to use them. The toolkit is intended for policymakers interested in promoting this critical technology. It offers a synthesis of policy approaches to heat pump deployment and a guide to designing the best packages of policies. The interactive toolkit also features a complementary series of short videos that provide an overview of each element of the toolkit.

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## ▲ Market Structures Global Energy Transformation Guide: Electricity

The design and rules of wholesale, retail, and local electricity markets impact which, when, and how resources are purchased, sold, and utilised by system operators. Market parameters are evolving to support electricity reliability and affordability as systems accommodate higher levels of variable and distributed energy resources. Through research and interviews with experts around the globe, RMI provides examples and data to describe how power sector leaders are leveraging market structures to make progress on energy transition priorities. Specifically, this report describes how market structures can advance seven key outcomes for successful global energy transformation. It also provides case studies to illustrate what is being attempted across the industry and to share the experiences of practitioners.

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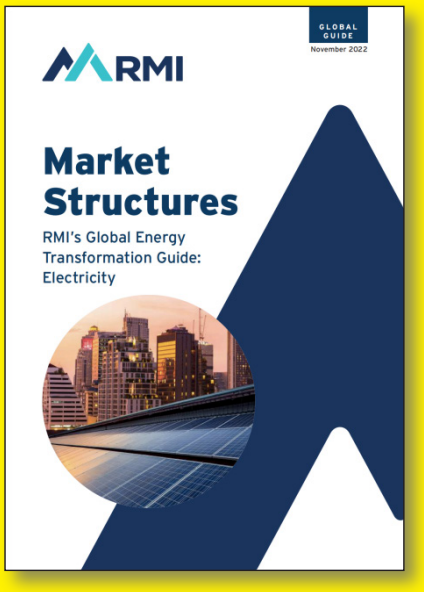


## ▲ Opportunities for Hydrogen Production with CCUS in China

This IEA report, produced in collaboration with the Administrative Centre for China's Agenda 21 (ACCA21), explores the current status of hydrogen and CCUS in China, and the potential evolution of hydrogen demand in various sectors of the Chinese economy through to 2060, in light of scenarios developed independently by the IEA and the China Hydrogen Alliance. The report also provides a comparative assessment of the economic performance and life cycle emissions of different hydrogen production routes and discusses potential synergies and regional opportunities for the deployment of CCUS and hydrogen. The report goes on to identify the financing mechanisms and supporting policies required to enable the deployment of hydrogen production with CCUS in China.

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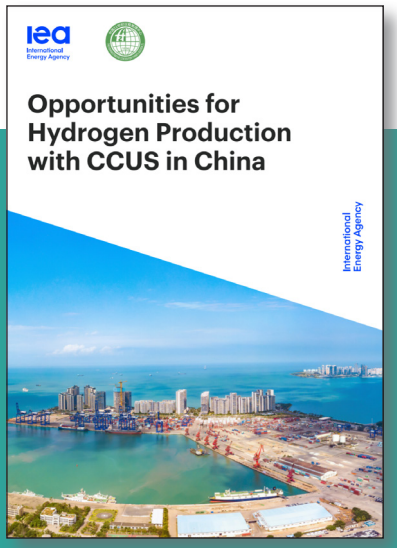

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