Magazine of EU-China Energy Cooperation Platform

EU-China Energy Magazine

2022 April 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.

Disclaimer:

The views and opinions expressed in the articles of this magazine are the authors' own, and do not represent the views of ECECP.

Graph vectors created by macrovector, rawpixel.com, brgfx, pch.vector- www.freepik.com
Free poster templates from pikbest.com

EU-China Energy Magazine

2022

CONTENTS

02 / **Consumer participation in energy markets – P2P electricity markets in China and the EU**

How consumers participate in energy markets via P2P electricity markets in China and the EU?

11 / **Energy efficiency solutions from EU that could help meet China's 'Dual Carbon' Goals**

Danfoss shares its experience in two high profile innovative energy efficiency projects: how Facebook's data centre provided heat to 12,000 homes, and how Marselisborg wastewater treatment plant became a net energy producer.

19 / **The Renaissance of Aquifer Thermal Energy Storage in China**

How are the prospects for ATES - a sustainable heating and cooling technology that originated in China and is now florishing in the Netherlands?

27 / **Using electrostatic repulsion to clean Solar panels, avoiding up to 30% power loss**

How to clean solar panels without water. A new cleaning method could remove dust on solar installations in water-limited regions, improving overall efficiency.

30 / **Accelerating transitions to zero carbon**

Better collaboration across governments, communities, businesses and philanthropy can help keep the 1.5℃ goal in sights.

34 / **Hydrogen Industry reaches a crossroads**

ECECP summarises key findings from the International Energy Agency's report 'Global Hydrogen Review 2021'.

38 / **News in Brief**

46 / **Reports Recommendation**

Dear All,

Welcome to the April 2022 issue of the EU China Energy Magazine.

On 31 March 2022, EU Commissioner for Energy Kadri SIMSON and Administrator ZHANG Jianhua of the China National Energy Administration (NEA) held the 10th EU-China Energy Dialogue online to exchange views on current issues and discuss the status of the implementation of the 'Joint Statement on the Implementation of EU-China Energy Cooperation'.

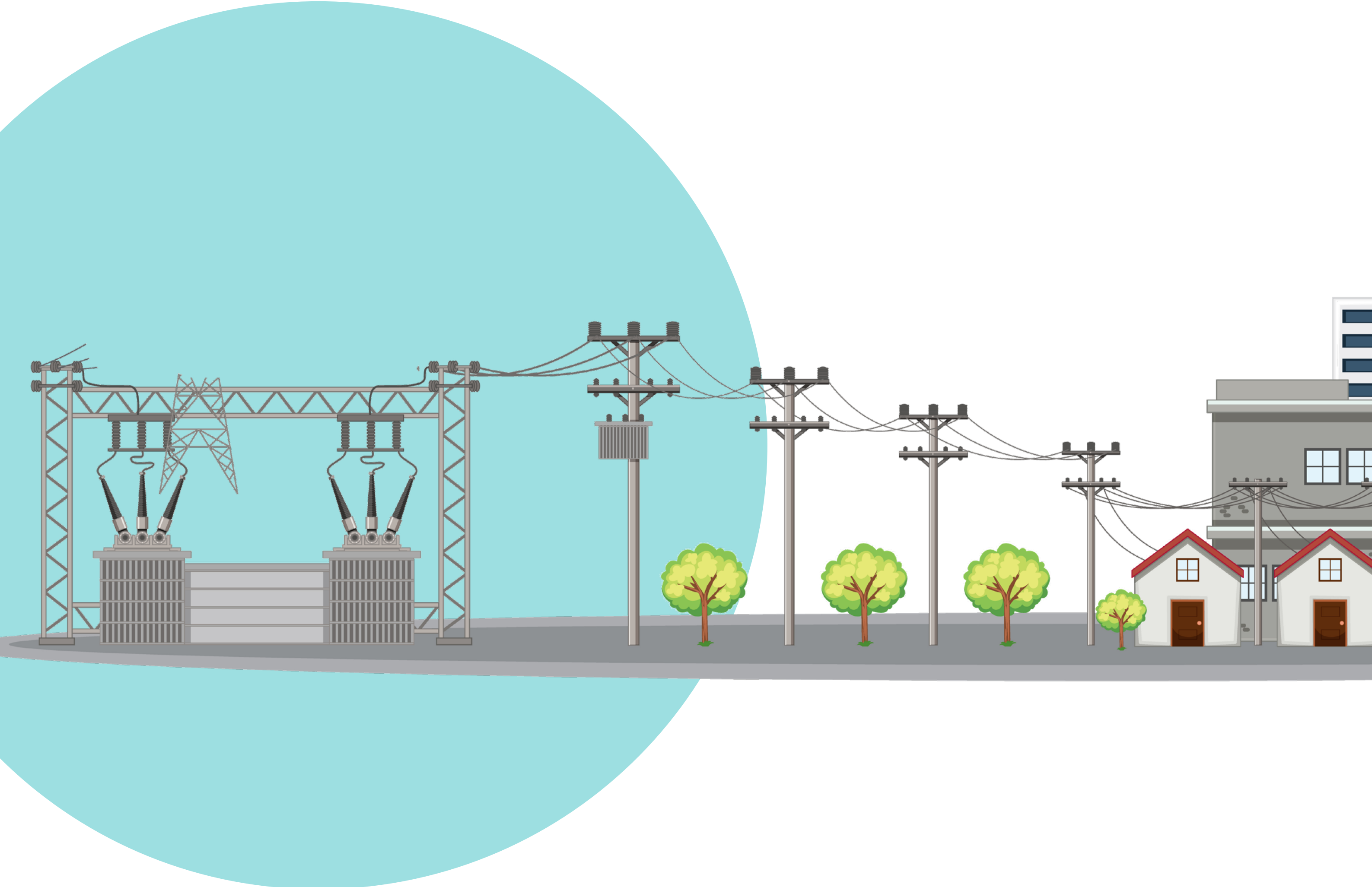
In this issue, we focus on how EU-China energy cooperation can contribute to the global energy transition. We look at how consumers participate in energy markets via P2P electricity markets in China and the EU; how energy efficiency solutions from the EU are standing ready to contribute more to China's 'Dual Carbon' Goals, and finally, we look at the prospects for aquifer thermal energy storage (ATES) technology, a sustainable heating and cooling technology that originated in China and has been commercialised in the Netherlands.

We hope you will find them interesting and look forward to hearing your feedback!

Best regards,

Flora Kan

ECECP Team Leader



Consumer participation in energy markets –

P2P electricity markets in China and the EU

System flexibility is the key to overcoming challenges in the energy system by integrating more variable renewable energy resources, maintains the EU-China Joint Statement Report 'Integration of variable renewables in the energy system of the EU and China'. The authors urge more discussion about the evolving role of distribution networks and local energy markets.[1] ECECP Junior Postgraduate Fellow Helena Uhde, who is conducting research on peer-to-peer (P2P) electricity markets, gives an insight into status, regulation and implementation of the concept in China and the EU.

1.Davies et al. (2020). Integration of Variable Renewables in the Energy System of EU and China – Policy Considerations. http://www.ececp.eu/en/integration-of-variable-renewables-in-the-energy-system-of-eu-and-china-policy-considerationsnew/

With the EU's announcement that it is to become a climate-neutral continent by 2050, as well as President Xi Jinping's aim for China to be carbon neutral by 2060, both economies have set ambitious climate targets that can only be achieved with a radical energy transition. According to scenario analyses by the IEA, China needs to increase the share of renewable energy sources in the total electricity generation mix from about 25% in 2020 to 40% in 2030 and 80% in 2060 if it is to achieve its carbon neutrality target.[2] Photovoltaics alone are expected to cover almost 45% of the electricity generation mix in 2060, compared to 4% in 2020. The EU is even more ambitious, announcing that it will raise its current renewables target from 32% to at least 40% of the EU's total energy mix by 2030.[3] Integration of these renewables will require fundamental changes to the current energy paradigms.

The timeline and socio-technical structure of the power systems in China and the EU may differ, but common challenges are becoming apparent as the proportion of renewable energy resources rises. A fundamental challenge is the need for close to real-time, local signals on supply and demand to balance the system and maintain system reliability. A more active demand side is also needed to enable the necessary flexibility, for example in the form of ancillary

2.IEA (2021). An energy sector road map to carbon neutrality in China. https://www.iea.org/reports/an-energy-sector-roadmap-to-carbon-neutrality-in-china

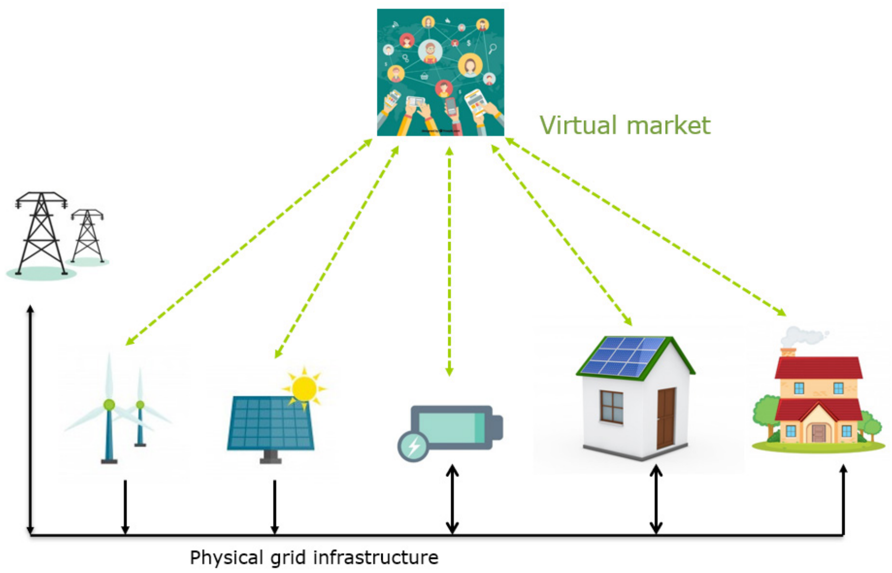
3.European Commission (2021). Renewable energy target. https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-targets_en markets and demand-response mechanisms.

One instrument for increasing flexibility is to expose the demand side of the electricity system to changing market prices, e.g., through so-called 'peer-to-peer electricity markets'. In these, often locally constrained markets, consumers and small-scale generators can trade electricity with each other as equal 'peers'. Other energy commodities, such as heat, cooling, and flexibility, can also be traded in P2P markets. These electricity markets enable consumers to participate actively in the market while creating new business models for small-scale electricity generators. P2P electricity markets are often designed with two layers: a physical layer for transmission and a virtual layer for electricity trading, as depicted in Figure 1.

Energy Communities as the starting point for P2P markets in the EU

Unlike wholesale electricity markets, an important aspect of P2P markets is that consumers become market participants. With its 2019 Clean Energy Package for All Europeans, the EU introduced the legislative concept of 'energy communities', which defines the rights of consumers to participate in energy markets individually or as a community through generation, consumption, transfer or sale.[4] Two documents in the package are of particular importance: the revised Renewable Energy Directive [(EU) 2018/2001] and the revised Internal Electricity Market Directive [(EU) 2019/944]. The Renewable Energy Directive defines the role of renewable energy self-consumers and renewable energy communities and focuses on renewable energy. It further specifies that this role can be fulfilled by means of 'renewables power purchase agreements, electricity suppliers and peer-to-peer trading arrangements', among others. The document stresses that renewable energy self-consumers and communities must not be placed

Figure 1: Simplified depiction of a P2P electricity market.



Vectors designed by Freepik.

4.European Commission: Energy communities. https://energy.ec.europa.eu/topics/markets-and-consumers/energy-communities_en

Table 1: Key policies for P2P electricity markets in the EU. Based on: Uhde (2022).

Year	Regulatory body	Title	Relevance for P2P electricity markets
2018	EU Parliament and Council	Renewable Energy Directive [(EU) 2018/2001]	Market participation of renewables self-consumers and renewable energy communities, either by generating, consuming, sharing or selling renewable energy; equal footing with large participants.
2019	EU Parliament and Council	Electricity Market Directive [(EU) 2019/944]	Market participation of active consumers, individually or through citizen energy communities, either by generating, consuming, sharing or selling electricity, or by providing flexibility services through demand-response and storage.

at a disadvantage compared to large market players. The Internal Electricity Market Directive puts the emphasis on electricity, encouraging market participation either by individuals or citizen energy communities. These can provide flexibility services through demand response and storage. Now that the directives have been jointly adopted by the EU Parliament and Council, the EU Member States are obliged to incorporate the directives into their national legislation.

Implementation in the EU

There are many research and pilot projects relating to P2P electricity markets in the EU, although the exact number is difficult to establish, as they include not only EU-funded pilot projects, but also private initiatives. Under the European Commission initiative BRIDGE, Horizon 2020 funded projects in the area of smart grid, energy storage, energy islands and digitalisation are documented to foster an exchange of information between projects and develop best practice. A total of 90 projects (58 ongoing) are included in this initiative, only some of which are P2P electricity market projects. The BRIDGE 2021 brochure, which provides a comprehensive overview of the projects, deserves special mention.[5]

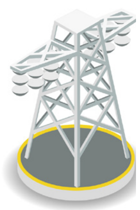
On 20 April 2022, the Energy Communities Repository was launched.[6] The project will support energy communities in the EU for 24 months and gather best practices. The repository will be implemented by a consortium consisting of Energy Cities, REScoop and FEDARENE. The Horizon 2020 project COME RES, for example, is supporting the development and testing of new business models for renewable energy cooperatives in nine EU Member States. As can be seen, the EU's focus is on promoting citizens' initiatives, of which P2P electricity markets are only one of many possibilities for community energy management. Different business models and market mechanisms are being tested in local communities.

5.Publications Office of the EU (2021). BRIDGE, Cooperation between Horizon 2020 projects in the fields of smart grid, energy storage, islands, and digitalisation. https://op.europa.eu/en/publication-detail/-/publication/abf32809-143e-11ec-b4fe-01aa75ed71a1/language-en

6.European Commission (2022). Launch of the Energy Communities Repository. https://ec.europa.eu/info/events/launch-european-commissions-energy-communities-repository-2022-apr-20_en

Case study 1: The Landau Microgrid Project in Germany

One of the first implementations of a local P2P electricity market in Germany is the Landau Microgrid Project (LAMP), implemented by the Karlsruhe Institute of Technology (KIT) in cooperation with Energie Südwest AG, a local energy supplier, and software developer Selfbits GmbH.[7] In the pilot project, 20 households located in the Lazarettgarten in Landau, a city in south-west Germany, are enabled to trade locally generated renewable electricity among themselves. Trading on the platform takes place via automated software agents, in line with the participants' price preferences. Participants gain insight into their electricity consumption and generation data, collected through blockchain-enabled smart meters and transmitted via mobile app. Market participants are provided with a smart meter and a mobile device so that they can use the app free of charge. If P2P market prices fall below the actual electricity tariff, market participants receive a credit on their electricity costs reflecting the savings made. If the P2P market prices rises higher than their actual electricity tariff, the energy supplier Energie Südwest AG covers the additional costs.[8] The pilot project is an experiment that replicates the free market but builds in financial safeguards. However, it is worth noting that if exposed to the risk of actually losing money, the behaviour of market participants may well deviate from that observed in the pilot.



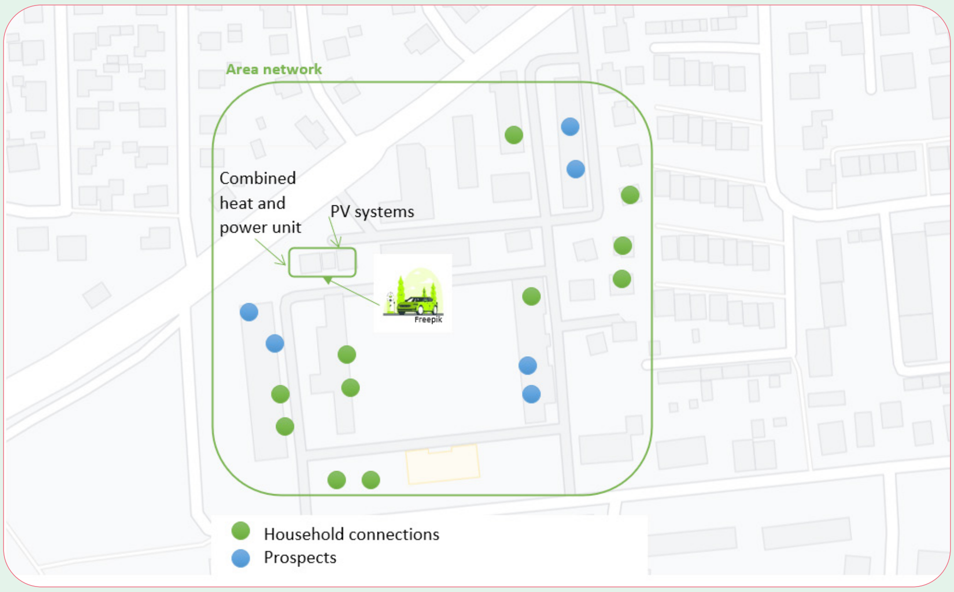


Figure 2: Landau Microgrid Project. Based on Mengelkamp (2019).

7.Mengelkamp (2019). Energiewende unter Nachbarn. Das Landau Microgird Project. http://www.csells.net/downloads/CSells_LAMPvortrag_EME.pdf
8.Energie Südwest. Wollen Sie selbst entscheiden wo Ihr Strom herkommt? https://energie-suedwest.de/unternehmen/projekte-dienstleistungen/lamp/

Market-based trading of distributed energy in China

While the term 'P2P electricity markets' is not used explicitly in Chinese regulations, policies issued by the National Energy Agency (NEA) and the National Development and Reform Commission (NDRC) between 2016 and 2019 reflect the concept.[9] An overview of the policies is given in Table 2. The first phase of policies (2016-2017) focused on market-based trading under the concept of the 'energy internet', i.e., the interconnection of the energy sector with the Internet, and the second phase of policies (2017-2019) focused on market-based integration of distributed energy resources. In the 'Outline of the pilot program for distributed electricity generation market trading', issued by NEA in 2017, three mechanisms for the exchange of distributed energy were announced: direct trading, entrusted sales, and sales to grid. While the second option leaves it up to the grid operator to trade the electricity on behalf of the distributed energy generator and the third option basically represents selling electricity into the grid at a fixed tariff, the first 'direct trading' option leaves room for the design of different P2P market mechanisms. Distributed multi-bilateral trading is thus an option, in addition to a centrally controlled auction.

Table 2: Key policies for P2P electricity markets in China.

Year	Regulatory body	Title	Relevance for P2P electricity markets
2016	NDRC	'Energy Supply and Consumption Revolution Strategy (2016-2030)'	Enabling consumer participation in micro-balancing and energy markets.
2016	NDRC	'Guiding Opinions on Promoting the Development of "Internet +" Smart Energy'	Strategic outline for the implementation of the 'energy Internet', promotion of market trading for individual users and distributed energy resources.
2017	NEA	Announcement of the first batch of 'Energy Internet' demonstration projects.	List of 55 energy Internet pilot projects, including market pilots in microgrids.
2017	NEA	'Outline of the pilot program for distributed electricity generation market trading'	Presentation of pilot-program on distributed energy trading: 1) direct trading, 2) entrusted sales, 3) sales to grid.
2018	NEA	'Distributed Generation Management Measures (Draft for Consultation)'	Policy draft to introduce local markets for distributed energy (for discussion).
2019	NDRC	List of the market-oriented trading pilots for distributed power generation 2019	List of 26 chosen pilot sides for distributed energy trading.

Based on: Uhde & Malima (2020) and Uhde (2022).

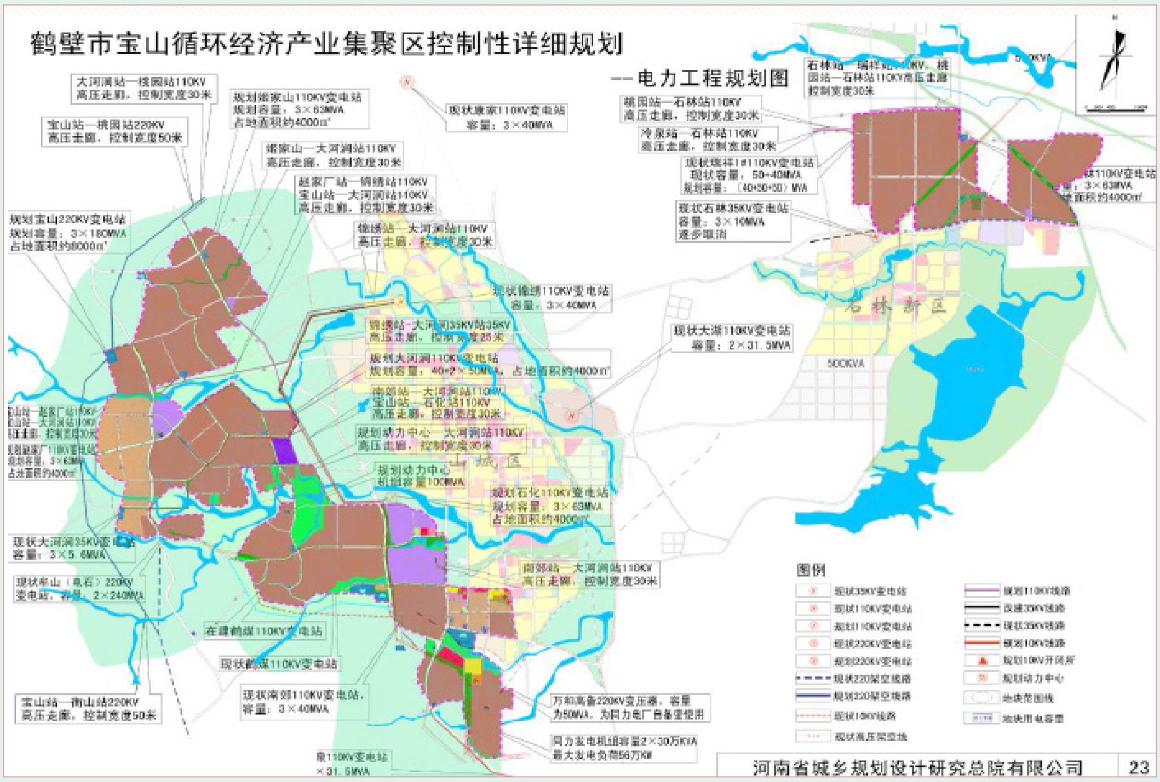
9.Uhde H. Peer-to-peer electricity trading in China and the EU – A comparative evaluation of key policy documents[J]. Research in Globalization, Elsevier, 2021: 100078.

Implementation in China

In 2019, NDRC announced a list of 26 market pilots for distributed energy. The pilot projects are mainly located in provinces with a large share of distributed energy capacity, and about half of the pilot projects are located in 'economic and technological development zones' or industrial parks.[10] Apart from the breakdown of the energy mix in the market, not much information is available on the pilot projects.

Case study 2: Hebi Distributed Trading Pilot

One of the 26 selected pilot projects is the Hebi Distributed Trading Project in the Baoshan Industrial Park in Hebi, Henan Province.[11] The pilot project for market-based trading of distributed generation has been implemented by Beikong Clean Energy Group. By 2020, a total capacity of 220 MW of distributed energy capacity was planned, including 70 MW of distributed photovoltaic power plants, 150 MW of distributed wind farms and 30 MWh of supporting energy storage. Trading on the platform was to be carried out using the 'direct trading' method. Transaction settlement was to take place via the provincial electricity trading platform.



10.Uhde & Malima. Experimenting with local electricity markets in China – multilevel drivers and barriers in the sociotechnical regime, Energy Res. Soc. Sci. 69 (2020). https://doi.org/10.1016/j.erss.2020.101577.

11. 河南 220MW 分布式发电市场化交易试点实施方案细节解密！ https://new.qq.com/omn/20190802/20190802A070C000.html?pc

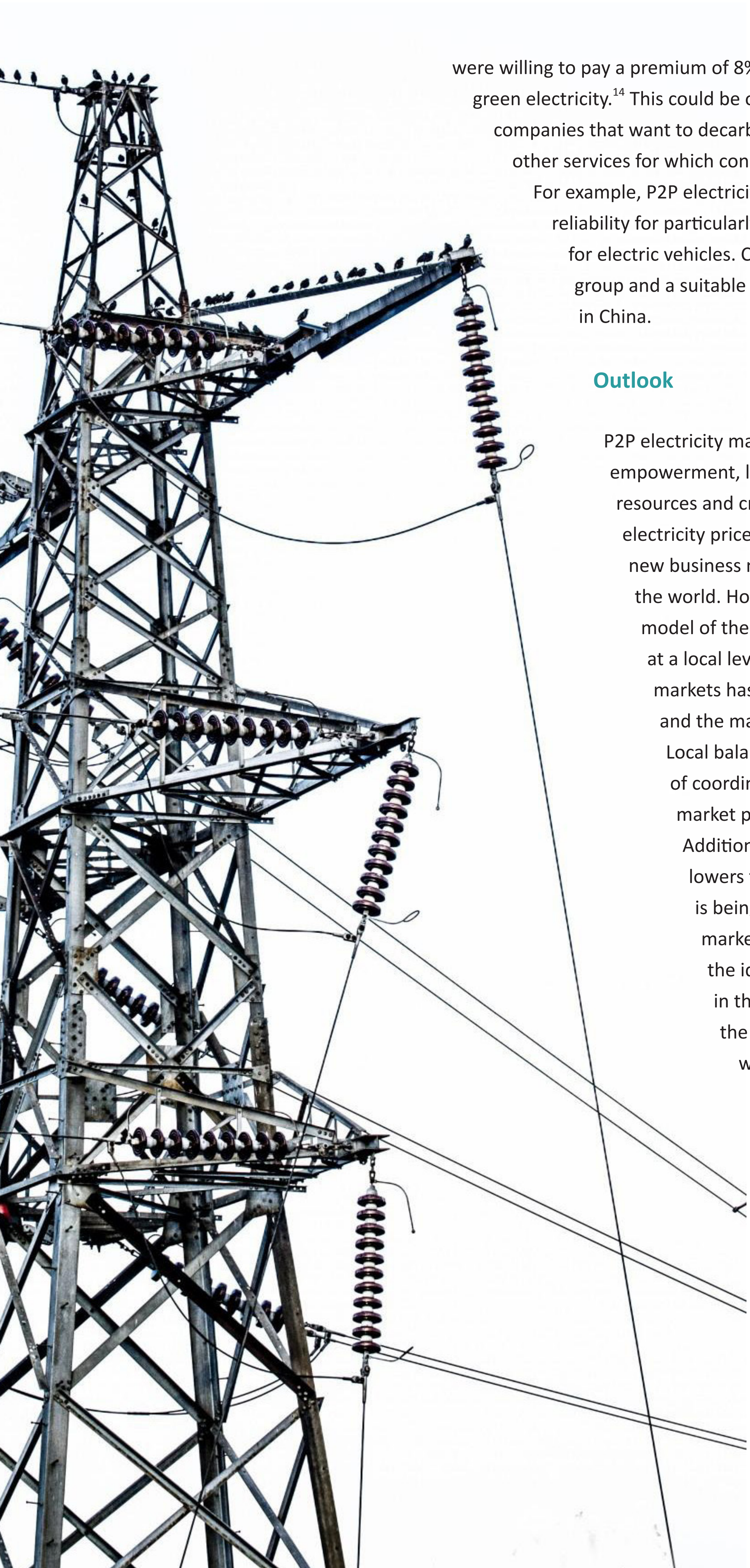
In this project, the market participants are distributed energy generators (sellers), and nearby electricity consumers (buyers). The solar and wind energy systems are distributed over a relatively large geographical area, on 15 pieces of previously unused land. The grid company controls the power flow and receives a wheeling fee for distributing the electricity generated. Unlike the European P2P electricity markets, which are centred around residential consumers, the consumers here are chemical and cement companies located in the industrial park.[12] *One could argue that this project should be called a business-to-business (B2B) market rather than a P2P market. Against this, however, it is worth bearing in mind that electricity trading is not the core business of the industrial consumers taking part.*

Barriers to implementation in China

Apart from the 26 pilot projects that have been announced, start-ups are struggling to implement the concept in practice. One Chinese company with a lot of potential was Energo Labs, a Shanghai-based startup largely focused on south-east Asia that built blockchain-based platforms for P2P, machine-to-machine, and vehicle-to-microgrid trading. One of the company's projects was the De La Salle University campus microgrid project in Manila, Philippines.[13] In this blockchain-based P2P electricity market project, electricity was traded between university buildings. However, due to the small number of market participants (two buildings), trading was not particularly effective. Today, the Energo Labs website is no longer accessible, social media accounts have not been updated since 2018 and there are no reports on new projects. A former employee tells us that projects in China only reached the planning stages, but did not get as far as implementation. 'First, there is a lack of regulations for new models. Current regulations cannot keep up with and may even hinder the use of new technologies such as AI, blockchain, behind-the-meter energy balancing, etc. Secondly, the regulatory environment is extremely complex. In order to get approvals for pilot projects or the introduction of new technologies and business models, many hurdles have to be overcome.'

Besides regulatory barriers, finding an economically feasible business model for P2P electricity markets in China is also difficult. Electricity is heavily subsidised, resulting in very low tariffs for private consumers. Moreover, the density of high-rise buildings in cities leaves hardly any space for renewable installations. One feasible application area could be the trading of renewable energy between commercial and industrial consumers in industrial parks. As reports of the initial phase of China's green power trading pilot have shown, companies

12. 北控清洁能源集团（2019）. 河南省鹤壁市宝山循环经济产业集聚区分布式发电市场化交易试点实施方案 .
13. PV-Magazine (2018). *Energo boosts clean energy production through Qtum Blockchain implementation in Philippines. https://www.pv-magazine.com/press-releases/energo-boosts-clean-energy-production-through-qtum-blockchain-implementation-in-philippines/*



were willing to pay a premium of 8%-13% over the price of coal power for green electricity.[14] This could be of interest, for example, to multinational companies that want to decarbonise their supply chain. There may be other services for which consumers would be willing to pay more. For example, P2P electricity markets may be able to ensure energy reliability for particularly critical processes or priority charging for electric vehicles. Creativity is needed to find the right target group and a suitable business model for P2P electricity markets in China.

Outlook

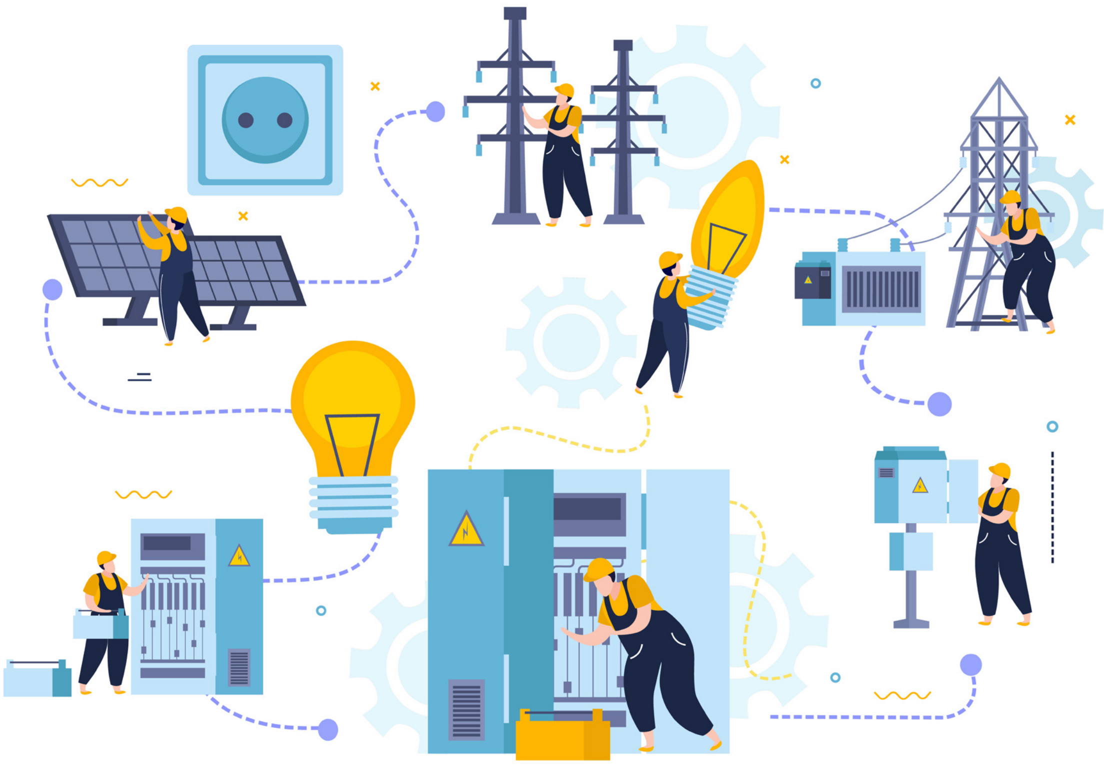
P2P electricity markets are a means of consumer empowerment, local integration of distributed energy resources and creation of flexibility via time-varying electricity prices. These concepts are being tested and new business models developed in pilot projects around the world. However, are P2P electricity markets the model of the future for organising electricity distribution at a local level? So far, the scale-up of P2P electricity markets has been difficult due to regulatory barriers and the market power of utilities and grid operators. Local balancing still poses difficulties, and questions of coordination between network operators and P2P market project developers also need to be clarified. Additionally, although decentralised organisation lowers the risk in many areas, if new infrastructure is being built, the risk for investors increases: market participants need to see the merits of the idea in the first place, and then stick with it in the long term. The future will show whether the P2P electricity markets model will prevail when the pilot projects are over.

*By **Helena Uhde***

Junior Postgraduate Fellow at ECECP

PhD Candidate at Beijing Institute of Technology

14.Hove & Li (2021). China Kicks off its Green Electricity Trading. https://www.energypartnership.cn/home/china-kicks-off-its-green-electricity-trading/



Energy efficiency solutions from EU that could help meet China's 'Dual Carbon' Goals

Danfoss shares its experience in two high profile innovative energy efficiency projects: how Facebook's data centre provided heat to 12 000 homes, and how Marselisborg wastewater treatment plant became a net energy producer. These projects show that there is scope for a significant impact on global emissions when the EU and Chinese economies collaborate, argues ***Alfred Che****, vice president of Danfoss China.*

In recent years, China has focused more and more on the benefits that efficiency solutions could deliver in order to achieve the country's carbon peak and neutrality goals. In practice, there are some quick wins with readily available energy efficiency solutions from the EU that China could leverage in such areas as data centre energy management, wastewater facility energy management, and district energy.

Facebook's hyperscale data centre warms Odense

Facebook's Odense data center campus opened in September 2019 and covers an area of 50 000 sq m. The site at Odense was selected because of the possibility of waste heat recovery. Odense district heating system is operated by Fjernvarme Fyn A/S, who helped Facebook design and build the system.

The system circulates water from the district heating system into the Meta campus, where it is routed to the roof and passed through the data centre cooling units. The water picks up low-temperature heat and is channelled back to the local heat pump facility, which then uses heat pumps to warm the water further, making it hot enough for use in the district heating system.

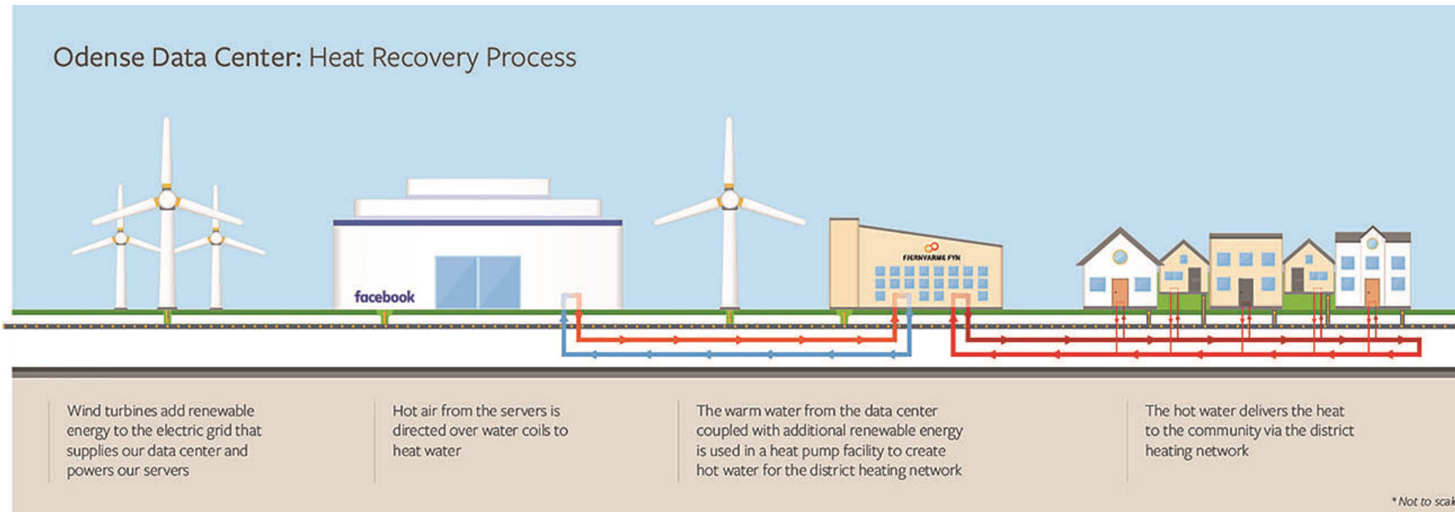
Source: Tech at Meta

Facebook Odense Data Centre

The Odense data centre campus recovers and distributes 100 000 MWh of energy annually from its servers — enough to heat to 12 000 homes. This heat is funnelled to a local hospital and thousands of other buildings in the surrounding community.

This technology saves 80 000 MWh (2.88*10^14J, 9 827 tonnes standard coal) each year, cutting CO_2 emissions by 24 500 tonnes annually. It is a major factor in the city's plans to phase out coal-fired heating by 2025, five years ahead of Denmark's national target.

The innovative solution developed by Danfoss recovers heat from the data sector using sector coupling. 'Heat pumps are not new — they are a very big part of the Danish heating strategy to phase out coal and natural gas — and neither are coils to recover heat. It's the pairing of these two at hyperscale



Source: Tech at Meta

that is innovative,' says Lauren Edelman, an official blogger for 'Tech at Meta' that covers all tech innovation at Meta, Facebook's parent company.

'The International Energy Agency estimates that 1% of all global electricity is used by data centres and that by 2025, data centres will consume one fifth of the world's power supply. The majority of the energy demand comes from powering the servers, but they in turn produce heat and need to be cooled. This cooling again requires a lot of energy and generates a lot of excess heat – most of which is currently being let out into the surrounding environment,' explains the Danfoss website.

What would be the impact of this technology in China? In the 2021 - 2022 heating season, Chinese residential users were paying 160 RMB/MWh for heating, while non-residential users were paying 360 RMB/MWh. If this project were to be implemented in China, this translates to between 16 million RMB (EUR 2.29 million) and 36 million RMB (EUR 5.14 million) additional income for the district heating company. Together with Chinese partners, Danfoss has already started to implement similar solutions in cities like Tianjin and Shanghai.

Lessons learnt – recommendation from Danfoss

How can policies make data centers greener?

There are several steps policy makers can take to help implement green solutions for data centers. For example, they could:

- *Design a regulatory framework which encourages systems integration and the use of waste heat, heat pumps, smart heating and cooling systems, and energy storage. It should focus not only on greening energy sources but encourage reduced use and reuse of energy.*
- *Improve energy planning to better integrate the different sectors to the energy system and leverage synergies, such as utilizing the waste heat from a nearby data center to heat buildings instead of investing in additional heat supply.*
- *Allow urban regulatory free test zones to innovate and develop new energy efficient technology, through removing technical, regulatory and financial barriers for reusing energy between sectors.*
- *Encourage thermal networks by introducing a facilitating framework. Elements include allowing flexible energy prices and not taxing waste heat.*

Marselisborg waste water treatment plant. *Source: aarhusvand.dk*

The Marselisborg story: Treat wastewater and become an energy provider at the same time

Executives and engineers travel from all over the world to visit Marselisborg wastewater treatment plant (WWTP), which processes 12 mcm of wastewater per year for the 220 000 inhabitants of the Danish town Aarhus.

There are good reasons for the interest in Marselisborg. While in the rest of Denmark, and in the wastewater treatment industry in general, WWTP power self-sufficiency is typically around 80%, Marselisborg achieves 153%, that is 53% higher than the electricity it consumes. That means it is effectively a net energy producer. On top of this, it also contributes heat to the local district heating system. When heat and power are combined in the calculation, Marselisborg produces 168% of the energy it consumes.

No wonder Marselisborg is cited by IEA as an example of how energy consumers can be transformed into 'prosumers', capable of producing energy while consuming efficiently. The Marselisborg Wastewater Treatment Plant was referenced in the IEA World Energy Outlook 2016 and is widely seen as a best practice model.

So how did Marselisborg achieve this feat?

Energy efficiency program. In 2011, the plant embarked on a 10 year development program that has just concluded, aiming to reduce energy consumption and optimise energy efficiency at each step of the water treatment process.

Increased energy production. Marselisborg produces biogas from three biodigesters, each of which can hold 2 000 m^3 of sludge. The biogas is used to generate heat and power. The previous gas-fired engines have been replaced with combined heat and power units. In total, two 250 kW CHP units and one 355 kW CHP unit have been installed, at a cost of EUR 1.2 million. The three units produced 4.8 million kWh in 2016 and the surplus electricity was sold to the grid at a subsidised rate similar to that given to wind power producers:

<table>
<tr><th>Measures – in order of implementation</th><th>Saving</th></tr>
<tr><td>Optimisation with SCADA (Supervisory control and data acquisition) control system (EUR 400 000 euro)</td><td rowspan="2">700 000 kWh, corresponding to an annual saving of EUR 61 000.
These measures offer the largest savings in terms of power consumption.
Payback time is calculated to be achieved within 2 - 3 years.</td></tr>
<tr><td>Online control of ammonium and phosphorus, and frequency controllers on some equipment.</td></tr>
<tr><td>Replacement of blowers for the aeration system: Replaced HV turbo blowers with ABS HST compressors</td><td>Reduction in power consumption of 300 000 kWh per year and annual savings of some EUR 26 000.
Reduction of 153 tons of CO_2 emissions.</td></tr>
<tr><td>A side-stream Anammox (anaerobic ammonium oxidation) sludge liquor treatment process. (EUR 400 000 euro) installed in 2014.</td><td>This requires less aeration and consequently less electricity.
A yearly saving in the wastewater tax payment, equivalent to EUR 80 000 per year.
50 000 kWh saved per year.</td></tr>
<tr><td>Decanter centrifuge. The unit dewaters waste sludge from digesters, creating dry matter, in preparation for transport from Marselisborg for delivery as fertiliser.</td><td>50 000 kWh saved per year.</td></tr>
<tr><td>Frequency converters are installed on almost all rotating equipment at Marselisborg WWTP: blowers, pumps, mixers and dewatering pumps. The frequency converters allow the plant to adapt to load variations with maximum flexibility. Over 100 motors are controlled by VLT® frequency converters.</td><td>*Savings data unavailable at the time of writing.</td></tr>
<tr><td colspan="2">Overall reduction in power consumption ~ 1 GWh per year (25% saving)</td></tr>
</table>

Source: City of Aarhus

'In total we invested approximately EUR 3 million in energy optimisation projects. But when taking into account the sale of surplus heat and power - which amounts to a little over EUR 326 000 annually – alongside all the savings made, reduction in consumption of EUR 206 000, reduced wastewater taxes of EUR 80 000 and so on, we're looking at an overall saving of EUR 612 000, and payback time for all investments of approximately five years,' said Per Overgaard Pedersen, chief engineer at the company operating the plant, Aarhus Water , in a 2017 article 'Self Sufficient Wastewater Treatment - Sharing Denmark's Sustainability Blueprint' published by WaterWorld in 2017.

VLT® AQUA Drive installed at Marselisborg WWTP.

Source: Danfoss China.

According to the latest figures published by the city of Aarhus , in 2019, total energy production stood at 8 461 MWh/yr and total energy consumption was 5 848 MWh/yr, equivalent to a net energy production of 145%. New technologies have resulted in a reduction in power consumption of approximately 1 GWh/year, a drop of 25%, directly contributing to the city's carbon neutrality goal by 2030.

At least nine similar water treatment plans in Denmark are now producing more energy than they consume. The Danish wastewater treatment industry as a whole has a double neutrality goal, to become both carbon neutral and energy neutral by 2030.

Cities across China could benefit from this technology

Beijing's Gaobeidian Wastewater Treatment Plant deals with 1 mcm wastewater per day, equal to 40% of the total wastewater discharge in Beijing. Gaobeidian WWTP is 30 times the scale of Marselisborg WWTP.

If the outcomes at Marselisborg were achieved in Gaobeidian, the plant would be able to supply 49.5 Gh green electricity to the grid and 78 000 MWh heat to the district heating system. Income from heat supply would be between RMB 12.48 million RMB (EUR 1.78 million) and RMB 28.08 million (EUR 4.01 million euro) per annum.

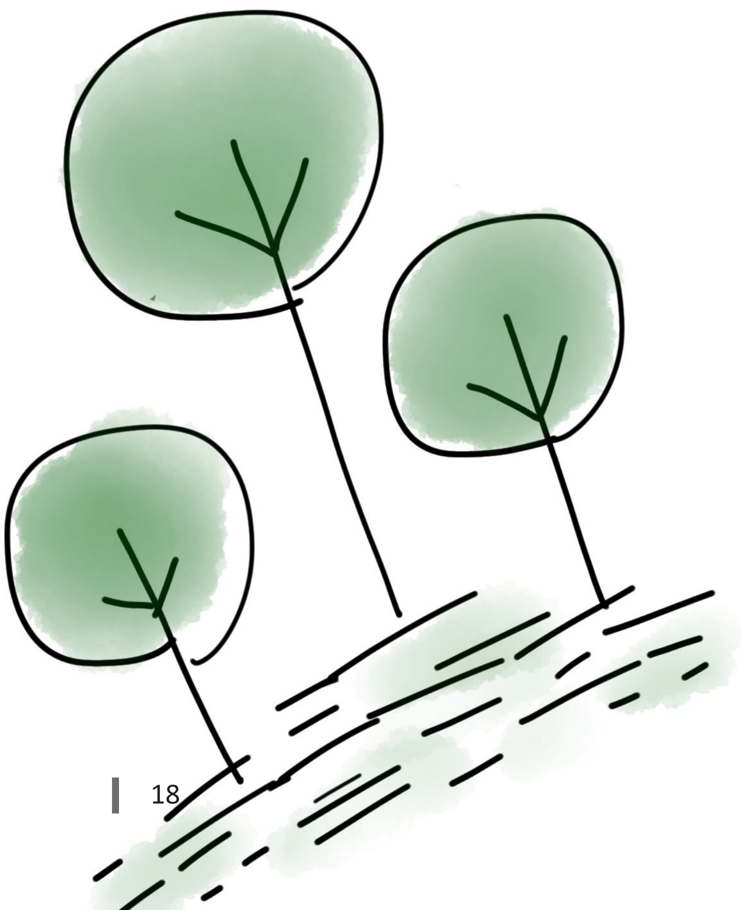
Beijing Drainage Group, the operator of Gaobeidian WWTP, has already started on an optimisation program, and has installed 38 Danfoss Aqua drives (variable frequency motor controllers) with a total capacity of 6.4 MW. The aim is to increase energy efficiency by between 25% and 40%.

Towards further EU China cooperation in energy efficiency

The cases cited in this article clearly demonstrate that 'the greenest energy is the energy we do not use!' - a Danfoss catchphrase. In the current challenging geopolitical environment, a green partnership between EU and China is perhaps one of the most practical bilateral collaborations in the world, which will also help both sides build a stable economic relationship. Therefore, closer cooperation between EU and China in the field of energy efficiency is likely to be mutually beneficial as the world battles global climate change, and will contribute to the achievement of China's 'dual carbon' goals - for the nation to reach peak carbon emissions before 2030 and become carbon neutral by 2060.

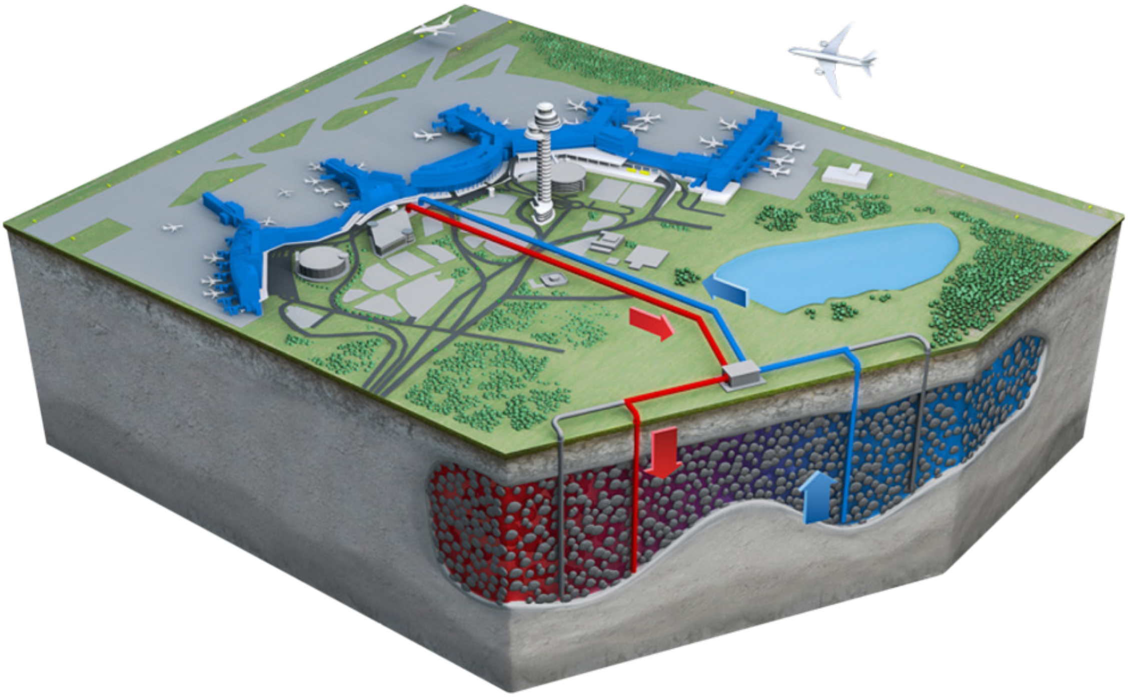
*By **Alfred Che**, Vice President, Danfoss China*
***Ken Xiao**, PR Manager, Danfoss China.*

Danfoss is one of the largest Danish industrial groups and a world-leading global supplier of energy efficiency solutions for a wide range of industries, covering buildings, district energy, refrigeration and air conditioning, and water and waste water among others.



Sources

1. *https://tech.fb.com/engineering/2020/07/odense-data-center-2/*
2. *https://www.datacenterdynamics.com/en/news/facebook-begins-installing-district-heating-system-odense-data-center-denmark/*
3. *https://www.danfoss.com/en/about-danfoss/insights-for-tomorrow/integrated-energy-systems/data-center-power-consumption/*
4. *http://bj.bendibao.com/news/2019117/265861.shtm*
5. *https://www.waterworld.com/international/utilities/article/16201138/self-sufficient-wastewater-treatment-sharing-denmarks-sustainability-blueprint*
6. *https://www.aarhusvand.dk/en/international/our-solutions/energy-optimization/marselisborg-wwtp-turning-wastewater-into-green-energy/*
7. *https://www.aarhusvand.dk/globalassets/filer/subsites/aarhus-water/english.pdf*
8. *https://gogreenwithaarhus.dk/media/41251/marselisborg-wastewater-treatment-plant.pdf*
9. *https://www.un.org/sites/un2.un.org/files/energy_efficiency_and_environmental_protection_in_wastewater_treatment_at_the_marselisborg_wastewater_treatment_plant.pdf*



The Renaissance of Aquifer Thermal Energy Storage in China

The ground beneath our feet is repository of hidden treasures. It provides 95% of our food and all our minerals and precious metals alongside many other resources. It also has huge potential for the storage and recovery of thermal energy. In this article, ECECP looks at the development of aquifer thermal energy storage (ATES) technology, a thermal storage solution that originated in China and is now flourishing in Europe, most notably in the Netherlands. It is a great example of successful EU-China energy cooperation. Is ATES set to play a bigger role in China's energy system?

The latest IPCC report signals a 'now or never' tipping point for implementing low-carbon strategies to limit average global temperature rises to 1.5°C above pre-industrial levels. While the deployment of renewables in the power sector is in full swing across the world, the decarbonisation of the heating and cooling sector is trailing other sectors.

According to IRENA[1], heating and cooling (H&C) accounts for half of the world's total energy consumption. Given that more than 77% of that demand is met with fossil fuels and non-renewable electricity, the H&C sector is responsible for 40% of energy related greenhouse gas emissions. Recent spikes in gas and power prices have exposed billions of people to heat supply risks, especially in Europe, in a sharp reminder of how vulnerable our fossil fuel-dominant economies can be.

Various renewable heating and cooling solutions are now being proactively explored, including a ramping up of solar heating and heat pumps powered by green electricity. Most of these alternative sources, however, are intermittent in nature, relying on wind or sun for power. With the rising penetration of variable renewables in decarbonisation of the H&C sector, energy storage technologies are now taking centre stage, providing a variety of flexibility solutions.

A neglected piece in the H&C decarbonisation puzzle

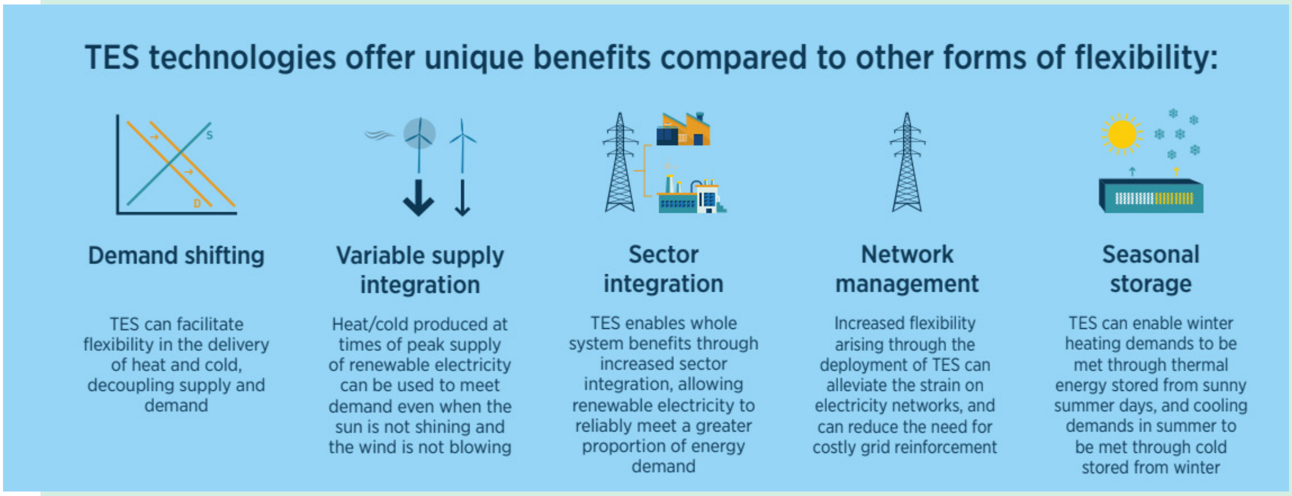
While electricity storage technologies such as lithium batteries have emerged as one of the hottest markets in the modern energy landscape, thermal energy storage (TES) technologies have not yet been able to make many waves. However, TES technologies offer unique benefits to the energy system: a sizeable quantity of energy can be stored on a seasonal basis, either in the form of heat or cold, and that is hard to replicate using electrical energy storage.

This particular characteristic of TES is particularly relevant to the H&C sector, as demand is led by the seasons. According to IRENA, of 234 GWh of TES systems installed globally at the end of 2019, almost 99% are used for heating and space cooling.[2]

ATES, an enabler for sustainable heating and cooling under your feet

It is a little known fact that at depths of around 200 metres, the temperature remains constant throughout the year and roughly equal to the average annual air temperature at the earth's surface. In fact, connecting a building's climate to a constant and mild

TES benefit to the energy system.



Source: Innovation Outlook: Thermal Energy Storage, IRENA.

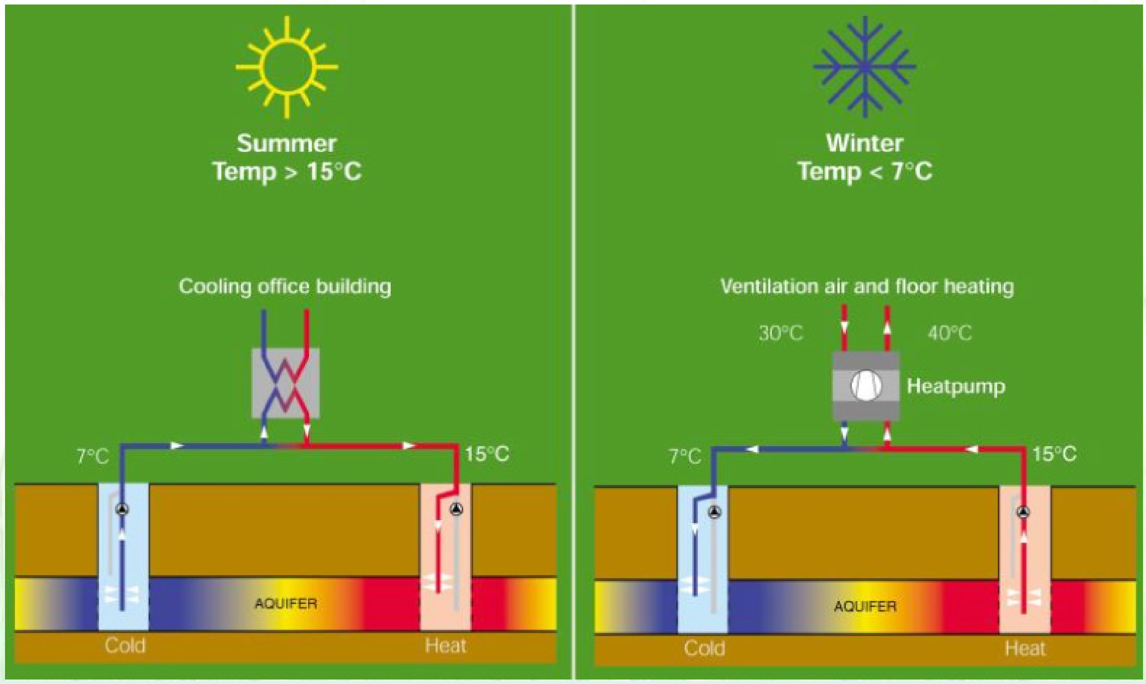
1.IRENA, IEA, REN21: Renewable Energy Policies in a Time of Transition: Heating and Cooling (2020)
2.IRENA (2020), Innovation Outlook: Thermal Energy Storage

temperature in the subsurface makes more sense than connecting it to above-surface temperatures, which can vary widely during winter and summer. The subsurface aquifer is characterised by the high specific heat capacity of water, while the natural subterranean water flow makes it an excellent medium to store and recover heat. This brings enormous potential for delivering sustainable heating and cooling.

This is where the Aquifer Thermal Energy Storage (ATES) comes in to its own. By means of injection and withdrawal of water from the aquifer using groundwater wells, ATES is a proven underground TES solution that maximises the use of the earth's natural capacity to store heat and cold, thus minimising the use of external energy sources for climate control. With a fairly large storage capacity, ATES is particularly suited to provide a seasonal heating and cooling solution for large scale ventures such as public and commercial buildings, district heating or for industrial purposes.

'To put it simply, ATES has made it possible to store winter cold to cool the summer and to store summer heat to warm the winter, simply by circulating the groundwater through the building that carries natural thermal energy,' explains Wu Xiaobo, chief technology officer of the Geothermal Company of China Energy Engineering Cooperation (CEEC) in an interview with ECECP. Wu Xiaobo has worked in the ATES field for more than two decades, and believes firmly in the technology's potential. 'It is much more efficient and eco-friendly to move thermal energy around, rather than burning fuels or using fossil-based electricity to generate heat or cold when it is needed.'

How does the ATES system work?



ATES concept and configuration. Source: IF Technology[3]

Aquifer storage uses a natural underground water-permeable layer as a storage medium. The transfer of thermal energy is achieved by mass transfer of groundwater by extracting/re-injecting water from/into the underground layer. While conventional geothermal systems only store warm/cold water in the drilled wells, ATES systems store heat/cold in the entire aquifer (water and soil). A major prerequisite for this technology is the availability of suitable geological formations such as the existence of the aquifer.

The ATES system typically consists of a hot well and a cold well. During cold winter weather, ground water can be pumped through a simple heat exchanger where it is chilled and stored in a designated 'cold store' portion of an aquifer. Cold groundwater is recovered from the cold store during summer months and used for cooling. The water that has been used for cooling becomes warmer, and is injected into the designated 'warm store' portion of the aquifer. The cycle is repeated seasonally. Some ATES systems use heat pumps to boost the temperature depending on the outlet temperature from the aquifer storage.

3.IF Technology, 2012: An Introduction to Aquifer Thermal Energy Storage (ATES), https://icax.co.uk/pdf/ATES_Presentation_Rehau_31May2012.pdf

The rise and fall of ATES in China

It is perhaps not widely known that the idea of storing heat and cold in aquifers originated in China, and can be traced back to the mid-1960s. 'ATES is truly a Chinese born concept that has inspired the world!' says Dr Wu. The technology emerged in Shanghai when Chinese engineers were working to reduce subsidence as a consequence of long-term groundwater over-pumping. They decided to recharge the aquifer artificially and soon discovered that the injected surface water could maintain its temperature over several months. Subsequently, Shanghai's textile industry became aware of the potential of artificial water recharging for industrial cooling purposes that can be applied to store winter cold for summer cooling[4]. Given the high demand for industrial cooling, construction of these early generation of ATES systems was rolled out rapidly across 20 cities in China.

However, by the 1980s such systems were gradually being phased out of the market: many of the wells clogged up due to the hydrochemical properties of the aquifer fluid and inappropriate well construction methods. Additionally, groundwater could not be effectively recharged back into the clogged up wells, resulting in a severe reduction in system efficiency and operation. In some instances, it even led to groundwater pollution by surface water, fluctuations in the seasonal groundwater level, and waste of water resources.[5] These unresolved technical barriers and related environmental concerns, among other reasons, meant that ATES deployment ground to a standstill. 'The premise to ensure an ATES solution can fully deliver its value is effective groundwater re-injection that helps keep the balance of the natural aquifer while minimising the man-made influence on the underground environment,' notes Dr Wu. 'Without further improvement to well quality and a better solution to the clogging issue, ATES is not sustainable'.

The Netherlands: a frontrunner in the commercialisation of ATES

European technology has helped to remove some of the blocks on the use of ATES technology. While China has put a hold on ATES projects for years, in Europe ATES has attracted more and more attention and is now showing its unique qualities to a wider audience. The best example of ATES commercialisation is in the Netherlands. According to the latest country report by IEA Technology Collaboration Program on Energy Storage[6], of roughly 3 500 currently operational ATES systems across the world, 3 000 are based in the Netherlands!

What makes the Netherlands a frontrunner in ATES commercialisation? According to Dr Wu, the Netherlands has a superior aquifer resource and a high density of buildings which are suitable for large scale ATES deployment. However, the core factors that contribute to the Dutch success are their advanced drilling technology know-how, and the solid expertise and rich knowledge of hydrogeology and geological science gleaned from the country's long track record of traditional oil and gas extraction. This wealth of experience has successfully resolved the re-injection clogging issue, one of the key blocks to ATES technology in China.

The Dutch government has also played its part, introducing various facilitating policies and measures to help realise the great potential of ATES. At a national level, a minimum energy performance coefficient value requirement in

4.Paul Fleuchaus, et al. Worldwide application of aquifer thermal energy storage – A review. Renewable and Sustainable Energy Reviews, 2018.
5.Xiaobo Wu and Xinnan Ouyang, 2019 IOP Conf. Ser.: Earth Environ. Sci. 249 012023. Successful Application of ATES/Groundwater Source Heat Pump in China.

the Dutch Building Decree was introduced to create a market for energy efficiency technologies including ATES. The Geo Energy Systems Amendment was adopted in order to improve the planning and the reliability of ATES systems by unified and simplified application procedures.

All these factors have helped to deliver a fully-functioning ATES industry in the Netherlands, and have facilitated the construction of more demonstration and commercial projects. 'It is in fact the close cooperation between industry, government, and knowledge institutions that has facilitated this expansion,' noted Dr Wu. ATES is now a standard H&C design option for large public commercial buildings and residential blocks in the Netherlands, although awareness of the technology is still absent in many other countries.

Dr Wu is convinced that this clean technology is set to attract the interest of more countries. 'For one thing, ATES is an architecture-friendly technology; it has a very small footprint on the building because it doesn't require chillers/condensers on the roof. It is so unobtrusive that when you walk into climate-controlled buildings equipped with ATES systems, you can hardly feel their existence as they mainly operate quietly underground all the year round. For another thing, ATES is environmentally friendly, as the system simply borrows the groundwater for its energy capacity without disrupting the balance of the aquifer or introducing chemical alterations.'

Even though the market share of ATES remains limited in the Netherlands - only around 2% of the country's H&C demand (127 TWh) was supplied by ATES systems by 2020[7] - the country envisages a bright future for the technology in its energy landscape. 'Think of it, this gas-rich country is now firmly dashing away from gas[8]. The successful commercialisation of ATES has already proved its value in decarbonising the country's cooling and heating sector, and will see a rapid takeoff in the next decade', said Dr Wu.

The proven gains

Will the showcasing of ATES in the Netherlands encourage uptake of the technology elsewhere? Thirty years of proven Dutch ATES experience have already revealed some valuable energy saving and economic benefits that ATES offers compared to traditional heating and cooling solutions such as central heating with chillers or ground-source heat pumps (GSHP). These benefits include 40% lower heating energy consumption, and 65% lower cooling energy consumption[9].

As for system efficiency, the coefficient of performance (COP) of an ATES system in cooling mode can reach as high as 10-20, compared to only 4 for a GSHP system. while in heating mode the COP is 5, also much higher than that of GSHP. In particular, using ATES for cooling can achieve storage efficiencies of up to 90%: the stored cold can be used for passive cooling, without using a heat pump, thus significantly reducing peak power demand.

In addition, ATES can deliver up to 60% carbon emissions reduction compared to traditional solutions[10]. Case studies of more than 74 Dutch ATES projects show an average CO_2 saving of 0.46 kg per m^3 of pumped groundwater. This corresponds to an estimated annual reduction in CO_2 emissions of 150 t/yr for a small-scale system (100-300 KW) and of up to 1 500

6.IEA ES, https://iea-es.org/wp-content/uploads/public/Netherlands_Country_Report_2021.pdf
7.Aquifer Thermal Energy Storage (ATES) systems - current global practical experience.
8.The Netherlands used to be the biggest gas producer in EU, with gas meeting 90% of building and 40%-50% of heating energy needs. In 2016, the government revealed an ambitious plan to stop major domestic gas production activities by 2022, and to phase out gas in heating and cooking in all residential buildings to reduce the sector's CO_2 emissions by 80% before 2050. Seven million existing homes will gradually be disconnected from the gas grid. Source: https://energypost.eu/netherlands-gas-phase-out-transition-must-tackle-the-geopolitical-implications-of-importing-from-russia/ http://energypost.eu/a-revolution-the-netherlands-kisses-gas-goodbye-but-will-it-help-the-climate/

t/yr for a large-scale system (5-30 MW). By comparison, the average CO_2 savings for a GSHP unit ranges between 1.8 and 4 t/yr, depending on the heating system it replaces and the electricity mix.[11]

Due to the hydrogeological and engineering knowledge required to design an ATES system, the upfront design and construction costs are relatively high compared to a conventional Heating, Ventilation and Air Conditioning (HVAC) system. Nevertheless, the lifetime cost remains competitive due to the reasonably low operating and maintenance cost. Typically, the initial costs of an ATES project can be recouped within 2-10 years[12].

EU-China cooperation revives ATES in China

Can the upgraded technology revive ATES in China, giving it a greater role in the country's journey towards its dual-carbon targets?

According to Dr Wu, the Chinese market for ATES systems is already beginning to take shape. Shanghai Chongming Island National Facility Agriculture Center, which began operations in 2013, is the first new-generation ATES system in China, consisting of two cold wells and two hot wells serving a 20 000 m2 greenhouse. The system was almost fully imported under a Sino-Dutch cooperation framework (financed by the Dutch government's Package for Growth (P4G) program and China's Ministry of Science and Technology). The introduction of the Dutch advanced well design and drilling technique has overcome the well clogging barrier that had kept China from deploying ATES for years, and the extracted groundwater is fully re-injected.[13] Monitoring data shows that the annual heating cost of this pilot project is 62% less than traditional gas heating, and nearly 75% less than electric heating, which remains highly coal-dependent. Overall, the pilot achieves roughly 75% CO_2 reductions compared to traditional heating systems.[14]

Following this successful pilot and China-Dutch cooperation, ATES are now seeing increasing penetration into the Chinese market. According to Dr Wu, four large scale ATES projects have been built in Hubei, Shanxi and Jiangsu provinces in China, with several more in the pipeline.

'By continuing close cooperation with the Dutch, we have further developed this technology to cater for the diverse geological and climate conditions of China, and even successfully applied our collaborative outcome into a third-party demonstration project in Japan. The success of these projects indicates that sustainability of ATES could be reached through technology innovation. EU-China cooperation could further facilitate technology development, which is beneficial to both sides and contributes to the battle against world climate change.'

Looking forward, Dr Wu anticipates particular relevance for ATES in eastern China. 'ATES has promising prospects in shallow groundwater-rich areas, especially in the middle and lower reaches of the Yangtze River. These areas are heavily populated regions which enjoy high economic activity, and therefore higher energy consumption needs. Most importantly, these regions share seasonal temperature differences, with typical cold and heat demand peaks. However, they are normally out of reach to existing district heating networks, while H&C often relies on gas and electricity. This is just where ATES could better realise its potential as an optimal energy conservation and flexibility solution.'

9.Dutch ATES, Dutch Policy on ATES systems. https://dutch-ates.com/wp-content/uploads/2016/09/DutchPolicyOnATESSystems092016.pdf
10.See footnote 3.
11.See footnote 4.
12.ibid.
13.See footnote 5.
14.Monitoring data provided by Dr Wu in a project report.

What is needed to unlock the potential of ATES in China?

Perhaps a key lesson learned from the successful energy market penetration of ATES witnessed in the Netherlands is how effective incentive policies and light-touch legislative barriers could help to increase the attractiveness of the technology.

As China steadily moves towards meeting its carbon neutrality targets, a series of favourable policies have been introduced recently that place an increased emphasis on improving building energy efficiency. These include the 14th Five-Year Plan on Building Energy Efficiency and Green Buildings and the national General Code for Building Energy Efficiency and Renewable Energy Utilization (GB 55015-2021) which came into effect on 1 April 2022. The latter introduces mandatory renewable utilisation and carbon emissions assessments at the feasibility study stage for building projects. As in the Netherlands, these measures are set to create market space for energy conservation solutions such as ATES.

At the same time, energy storage is now top of the agenda in China's push to shift towards a greener energy system. On 21 March 2022, China NDRC and NEA jointly issued a road map for the country's energy storage sector in the 14th Five-Year Plan period, which advocates a boost to commercialisation of new energy storage systems and to large scale developments by 2025. Durable thermal storage solutions, including ATES, are described as key breakthrough technologies for ensuring system flexibility.

Research and development on energy storage technologies is also set to get more support. On 2 April 2022, in China's newly released 14th Five-Year Plan on Energy Technology Innovation, ATES technology was singled out for mention when emphasising the crucial need to promote the utilisation of seasonal energy storage in the next five years. Moreover, the plan calls for efforts to achieve major technological breakthroughs on higher temperature ATES which have the potential for storing waste heat from the industrial sector.

More detailed plans and ATES demonstration projects are likely to be unveiled in the near future.

In addition to encouraging policies, Dr Wu believes that better communication and more demonstration projects will be vital in raising the visibility of the technology, and so boosting uptake of ATES. 'Various demonstration projects on different ATES application scenarios in the energy system will be crucial to improve stakeholders' awareness of the benefits that it can deliver to different parts of the energy system.'

As sector coupling increases in the transition towards a zero carbon economy, a technology neutral, whole-system approach in national and local policy making will be crucial to overcome the conflicting rules and regulations that arise from siloed thinking across heat, power and end-use sectors. That approach will help unlock the potential of ATES in China's energy system.

*By **Daisy Chi***

About CEEC Geothermal:

CEEC Geothermal is a subsidiary company of China Energy Engineering Corporation, one of the major construction groups in China and the first state-owned enterprise to develop geothermal energy. The company is now leading on the country's shallow geothermal development featured in renewable centred geothermal + smart energy regional integrated solutions with specialties in ATES and BTES.
This article is based on exclusive interview with Mr Wu Xiaobo, CTO of CEEC Geothermal.

Using electrostatic repulsion to clean Solar panels, avoiding up to 30% power loss

Dust build-up on solar panels can reduce the power output by as much as 30% in just one month. Even a 1% reduction in power for a 150MW solar installation could result in a USD 200,000 (€180,000) loss in annual revenue. Cleaning normally requires purified water, but that needs to be trucked in to prime locations like deserts where solar potential is highest. Cleaning with brushes is labour intensive and can damage surfaces irreparably. David Chandler at MIT describes research there into using simple electrostatic repulsion to clean the panels. The dust particles are first charged, then the panels. The dust literally leaps off the panels. At scale, the process can be automated and controlled remotely. Solar's potential is an essential contributor to the world's clean energy transition, so any obstacle to efficiency like dirty panels will have to be addressed wherever solar farms exist. Many of the largest solar installations in the world, including ones in China, India, the U.A.E., and the U.S., are already located in desert regions. Could this be the solution they are looking for?

How to clean solar panels without water. A new cleaning method could remove dust on solar installations in water-limited regions, improving overall efficiency. By David Chandler, MIT News

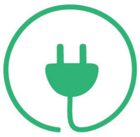
Solar power is expected to reach 10 percent of global power generation by the year 2030, and much of that is likely to be located in desert areas, where sunlight is abundant. But the accumulation of dust on solar panels or mirrors is already a significant issue — it can reduce the output of photovoltaic panels by as much as 30 percent in just one month — so regular cleaning is essential for such installations.

Cleaning with water or brushes

But cleaning solar panels currently is estimated to use about 10 billion gallons of water per year — enough to supply drinking water for up to 2 million people. Attempts at waterless cleaning are labour intensive and tend to cause irreversible scratching of the surfaces, which also reduces efficiency. Now, a team of researchers at MIT has devised a way of automatically cleaning solar panels, or the mirrors of solar thermal plants, in a waterless, no-contact system that could significantly reduce the dust problem, they say.

Electrostatic repulsion

The new system uses electrostatic repulsion to cause dust particles to detach and virtually leap off the panel's surface, without the need for water or brushes. To activate the system, a simple electrode passes just above the solar panel's surface, imparting an electrical charge to the dust particles, which are then repelled by a charge applied to the panel itself.



The system can be operated automatically using a simple electric motor and guide rails along the side of the panel. The research is described in the journal Science Advances, in a paper by MIT graduate student Sreedath Panat and professor of mechanical engineering Kripa Varanasi.

Rapid power loss

Despite concerted efforts worldwide to develop ever more efficient solar panels, Varanasi says, ‘a mundane problem like dust can actually put a serious dent in the whole thing.’ Lab tests conducted by Panat and Varanasi showed that the dropoff of energy output from the panels happens steeply at the very beginning of the process of dust accumulation and can easily reach 30 percent reduction after just one month without cleaning.

Every percentage point matters

Even a 1 percent reduction in power, for a 150-megawatt solar installation, they calculated, could result in a USD 200 000 loss in annual revenue. The researchers say that globally, a 3 to 4 percent reduction in power output from solar plants would amount to a loss of between USD 3.3 billion and USD 5.5 billion.

‘There is so much work going on in solar materials,’ Varanasi says. ‘They’re pushing the boundaries, trying to gain a few percent here and there in improving the efficiency, and here you have something that can obliterate all of that right away.’

Many of the largest solar power installations in the world, including ones in China, India, the U.A.E., and the U.S., are located in desert regions. The water used for cleaning these solar panels using pressurised water jets has to be trucked in from a distance, and it has to be very pure to avoid leaving behind deposits on the surfaces. Dry scrubbing is sometimes used but is less effective at cleaning the surfaces and can cause permanent scratching that also reduces light transmission.

Water cleaning makes up about 10 percent of the operating costs of solar installations. The new system could potentially reduce these costs while improving the overall power output by allowing for more frequent automated cleanings, the researchers say.

‘The water footprint of the solar industry is mind boggling,’ Varanasi says, and it will be increasing as these installations continue to expand worldwide. ‘So, the industry has to be very careful and thoughtful about how to make this a sustainable solution.’

Better than the electrodynamic alternatives

Other groups have tried to develop electrostatic based solutions, but these have relied on a layer called an electrodynamic screen, using interdigitated electrodes. These screens can have defects that allow moisture in and cause them to fail, Varanasi says. While they might be useful on a place like Mars, he says, where moisture is not an issue, even in desert environments on Earth this can be a serious problem.

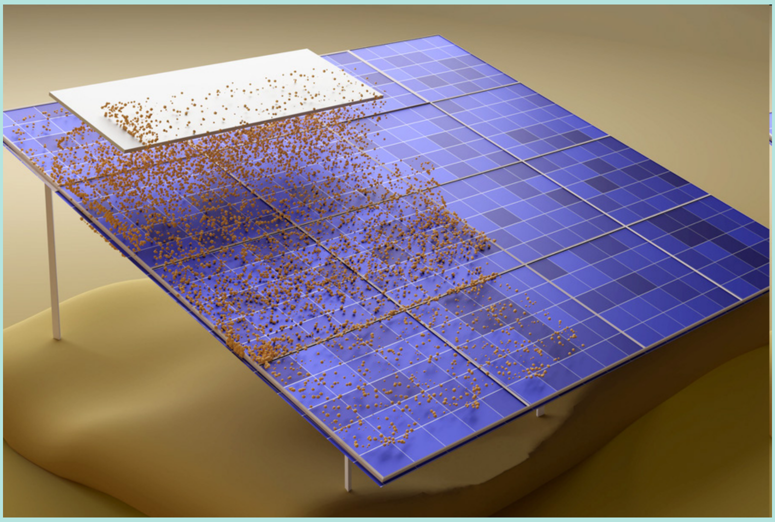
The new system they developed only requires an electrode, which can be a simple metal bar, to pass over the panel, producing an electric field that imparts a charge to the dust particles as it goes. An opposite charge applied to a transparent conductive layer just a few nanometers thick deposited on the glass covering of the solar panel then repels the particles, and by calculating the right voltage to apply, the researchers were able to find a voltage range sufficient to overcome the pull of gravity and adhesion forces, and cause the dust to lift away.

Humidity matters

Using specially prepared laboratory samples of dust with a range of particle sizes, experiments proved that the process works effectively on a laboratory-scale test installation, Panat says. The tests showed that humidity in the air provided a thin coating of water on the particles, which turned out to be crucial to making the effect work. 'We performed experiments at varying humidities from 5 percent to 95 percent,' Panat says. 'As long as the ambient humidity is greater than 30 percent, you can remove almost all of the particles from the surface, but as humidity decreases, it becomes harder.'

Varanasi says that 'the good news is that when you get to 30 percent humidity, most deserts actually fall in this regime.' And even those that are typically drier than that tend to have higher humidity in the early morning hours, leading to dew formation, so the cleaning could be timed accordingly.

Dust that accumulates on solar panels is a major problem, but washing the panels uses huge amounts of water. MIT engineers have now developed a waterless cleaning method to remove dust on solar installations in water-limited regions, improving overall efficiency / IMAGE: Courtesy of the researchers



'Moreover, unlike some of the prior work on electrodynamic screens, which actually do not work at high or even moderate humidity, our system can work at humidity even as high as 95 percent, indefinitely,' Panat says.

In practice, at scale, each solar panel could be fitted with railings on each side, with an electrode spanning across the panel. A small electric motor, perhaps using a tiny portion of the output from the panel itself, would drive a belt system to move the electrode from one end of the panel to the other, causing all the dust to fall away. The whole process could be automated or controlled remotely. Alternatively, thin strips of conductive transparent material could be permanently arranged above the panel, eliminating the need for moving parts.

By eliminating the dependency on trucked-in water, by eliminating the buildup of dust that can contain corrosive compounds, and by lowering the overall operational costs, such systems have the potential to significantly improve the overall efficiency and reliability of solar installations, Varanasi says.

The research was supported by Italian energy firm Eni. S.p.A. through the MIT Energy Initiative.

*By **David Chandler***

Republished with permission of MIT News and Energy Post

Accelerating transitions to **zero carbon**

The Intergovernmental Panel on Climate Change (IPCC) has released the latest installment in its Sixth Assessment Report. The Working Group III (WGIII) report focuses on climate change mitigation and the policy, technological, and social levers we must urgently mobilize to keep the world below 1.5C of warming by the end of the century. It adds to the body of science the IPCC has released in this cycle – the latest science behind climate change (Working Group I report) released in August 2021 and the impacts of climate change, including limits of natural ecosystems and society to adapt

to disastrous climate change impacts, (Working Group II report) released in February this year. The WGIII report lays out very starkly that if we miss the window to act on climate change over the next few years, we will no longer be able to stabilize the climate at under 1.5C of warming. As the WGI and WGII Reports bleakly highlighted, climate impacts are already affecting people on every continent of the world at just 1.1C of warming, so every fraction of a degree matters.

One of the main messages of the latest IPCC Report is that we need to urgently use all our tools to tackle the climate crisis, not just a few, and we must do so at scale. If we do, we can together shift onto a better path for the climate this decade before it is too late.

One of the main messages of the latest IPCC Report is that we need to urgently use all our tools to tackle the climate crisis, not just a few, and we must do so at scale.

To meet the Paris Agreement goals, governments and businesses need to halve greenhouse gas emissions by 2030. The IPCC report shows that sustained emissions reductions are possible with supportive policies. At least 18 countries have sustained GHG emissions reductions in annual CO_2 and GHG emissions for well over a decade. Many achieved these emissions reductions alongside sustained economic growth. This trend, both for consumption and production-based emissions, needs to be amplified and expanded to many more countries. A range of strategies enacted through policies can limit warming, including:

Electrify the global energy system with carbon-free energy and phase-out fossil fuel infrastructure.

The cost of renewables has fallen so precipitously that they have become the default economic choice for new power generation capacity. Scaling all forms of zero-carbon power generation can also benefit other sectors. Some of these technologies already exist, and some, like green hydrogen, need to be scaled rapidly.

Electrify all modes of transportation to slash emissions.

Powered by abundant renewable energy, electric transportation can eliminate over 90% of transport-related climate pollution and nearly all oil demand from road transport. It is an important part of a broader package, including a focus on compact urban design, public transport, and non-motorized transport.

Slash short-term super pollutants by 34% by 2030 instead of 2050.

Eight years ago, the IPCC targeted reducing methane by 34% by 2050. The latest report significantly moves up that deadline to 2030. The immediate reduction in methane, hydrofluorocarbons (F-gases), black carbon, and ground-level ozone can dramatically slow the rate of warming in the near term and offers a chance to meet net-zero emissions targets by 2050.

Address the climate finance gap immediately.

Rich countries are overdue in delivering on their promise of giving $100 billion per year in climate finance to less wealthy nations to help them mitigate and adapt to climate change. Without financing options, people living in the most vulnerable nations cannot adapt and will suffer the most.

Removing excess carbon from the atmosphere is essential to restoring the climate.

The IPCC report makes clear there are no pathways to 1.5C that don't include carbon removal. Natural sinks as well as technologies that mimic nature will be needed and scaled to meet the challenge of removing legacy CO_2 emissions. Natural sinks alone cannot solve the problem. For more on the IPCC's findings on carbon removal, read here.

Embed sustainable development in transitions.

Inequitable decisions lead to resistance, and we cannot expect to scale low carbon transition solutions without embedding principles of equity and a just transition into decisions. If done well, bold climate action can boost jobs and income, lead to significant health benefits and more inclusive, sustained growth. But we also need to understand and manage any trade-offs.

Apply holistic approaches to reduce carbon in buildings.

Smarter building design and construction choices made today can reduce emissions for decades to come. The IPCC report offers a range of interventions to decarbonize the built environment across the building lifecycle, including retrofitting existing building stock, repurposing existing buildings, and using low-emission construction materials.

Build a circular economy.

We can strengthen policies and innovation around using materials more efficiently to reduce waste and emissions. This includes more materials recycling, especially in the industrial sector.

Gain large-scale emissions reductions from sustainable shifts in agriculture, forestry, and other land use.

The IPCC report underscores the untapped mitigation potential in this space. Measures such as sustainable forest management, reforestation, soil carbon management, sustainable crop and livestock management, and healthier diets can provide as much as 20%-30% of the emissions reductions needed to meet climate goals.

A rapid but orderly low-carbon transition can reduce risk globally. Government decisions about when and how to implement a national clean energy transition matter. It influences energy security and how nations react in times of calamity. Russia's invasion of Ukraine has underscored the massive dangers of continuing our addiction to oil and gas. By pursuing orderly, planned transitions to reaching net-zero targets by 2050, including immediate near-term action, countries can help avoid worst-case scenarios, enhance energy and food security, and reduce geopolitical and economic risks. There is a limit to how many times society can adapt to shocks, be it financial or energy, food, or extreme climate event related.

To help nations decarbonize their economies, central banks, governments, businesses, and civil society groups need robust economic analysis to better integrate the opportunities and costs of climate action and an understanding of the risks of inaction in their climate action frameworks. An integrated framework to assess the physical and transition risks stemming from the impacts of a warming world can help show the advantages of shifting to a low-carbon economy and how to avoid costly lock-in of fossil assets. We need to identify, categorize, calculate, and balance the associated societal, economic, and financial impacts of climate action and inaction and reflect that in country budgets, and economic and investment planning.

For the first time, the IPCC report recognizes that a rapid transition to a low-carbon economy will not be a drag on the economy, with the underlying models used for the assessment having reflected some of the latest rapidly falling costs of clean energy and other solutions which have increasingly made them cost-competitive with fossil fuel based power. Once the much larger costs of inaction are considered as well, and the dynamic opportunities of new innovations through a net-zero economy, many other analyses suggest the opportunity for a significant net benefit from bold climate action instead. The new IPCC report reflects an important first step in the economic modeling frameworks catching up with reality, but there is still more to be done.

Philanthropy is vital to increasing the pace and scale of climate action.

The IPCC's recommendations for climate change mitigation represent a huge step-change in how the community needs to work together to raise and deploy the resources and supportive policies and technologies needed to tackle the climate crisis. This is where philanthropy has been and must continue to play a critical role in catalyzing action at the scale and speed the world needs. Below are areas where philanthropy can substantially help to avoid a code red future.

- **Cross-sectoral approach to integration of solutions —** Achieving full mitigation means all stages—from production to consumption to transportation and disposal—have to be considered in addressing emissions, utilizing both supply and demand side measures in various sectors, as noted in the report. An example being food systems where philanthropy can support multi-disciplinary approaches to how one integrates innovative technology, energy use, biodiversity, human and ecosystem health and livelihood protection while solving for tradeoffs and synergies to achieve both climate and societal goals.

- **Equitable and a just transition** — The world can only win on climate if we ensure the major system-wide transformations needed actually work for people – as individuals, communities, and economies. Philanthropy is well positioned to support a diversified set of solutions that reflect social and economic justice by supporting people-led movements and ensuring the voices of the most vulnerable and underrepresented groups are heard.

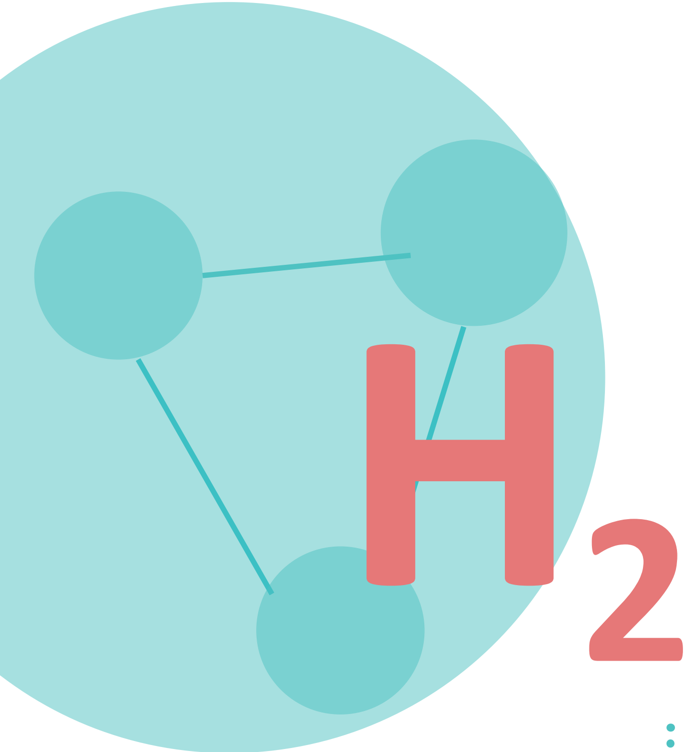
- **Transparency and accountability** are essential building blocks for effective climate action, increasing ambition, and building international credibility. Philanthropic-led initiatives can drive accountability by helping stakeholders clearly understand where action is on track and where more effort is needed.

- **International multi-stakeholder cooperation** — Philanthropy is adept at bringing together relevant actors from governments, NGOs, businesses, people-led movements, and other civil society groups to foster radical collaborations and elevate new approaches that deliver results. The recent COP26 in Glasgow showcased a number of breakthroughs and new pledges, and we now have to deliver on them and hold ourselves accountable.

The best pathway to tackle the climate crisis is to accelerate an orderly transition to zero emissions, deploying all the levers we have available. We have the tools and solutions to cut emissions in half by 2030 and achieve net-zero emissions by mid-century. The IPCC report is clear: the primary barriers we face are not technical or economic, they are political. But with financing and better collaboration across governments, communities, businesses and philanthropy, we can keep the 1.5C goal in our sights.

*By **Surabi Menon** and **Helen Mountford***

Republished with permission from Climteworks Foundation



Hydrogen Industry reaches a crossroads

ECECP summarises key findings from the International Energy Agency's report 'Global Hydrogen Review 2021'.

In 2020, hydrogen demand was focused on industrial and refining applications and totalled 90 Mt. Because most of the hydrogen produced was a byproduct of fossil fuels, it released almost 900 Mt of CO_2 into the atmosphere. Greenhouse gas emissions resulting from hydrogen production totaled 2.5% of global CO_2 emissions in the energy and industry sectors. This is equivalent to the combined total emissions of the UK and Indonesia. Thus, even not considering the enormous potential for hydrogen to decarbonise the land-based transportation sector, decarbonisation of the currently existing hydrogen industry would be a significant benefit in itself. The hydrogen economy is arguably set to be one of the key pillars of the green energy transition.

Hydrogen Demand

- In 2020, global hydrogen demand, which is centred on the needs of the chemical and refining industry, stood at 90 mt H_2 t, 50% higher than in the year 2000. Total hydrogen demand is expected to increase from 90 Mt H_2 to between 250 and 500 Mt H_2 in 2050.

- Demand for hydrogen for transportation was 0.02% of total demand in 2021. This very low level of demand is set to increase dramatically as hydrogen starts being adopted in heavy-duty road transport, shipping and aviation.

- Hydrogen will also be used in power plants and stationary fuel cells, where its deployment will be tied to stabilising grid production at times when renewables cannot provide the required power.
- Demand for ammonia, which can be produced from hydrogen and nitrogen, is also expected to soar as it starts being used as fuel in the global shipping industry.
- It is expected that by 2050 synthetic fuels, produced from hydrogen and CO_2, will cover one third of global aviation fuel demand.
- Hydrogen usage for refining applications will decline, as the overall usage of fossil fuels is set to drop significantly by 2050.

Hydrogen Supply

- It is possible to produce hydrogen while limiting CO_2 emissions by means of (a) electrolysis powered by renewable energy sources, (b) using fossil fuels with carbon capture, utilisation, and storage (CCUS) and (c) via biomass gasification. However, all of these methods of production today account for less than 1% of total hydrogen output.
- Based on projects that have already been announced, it is projected that the global hydrogen production from electrolysis could reach 8 Mt in 2030, still far short of the 80 mt that is required by 2030, according to the IEA roadmap for the global energy sector. However, more projects are likely to be announced over the next few years, thus bringing the industry closer to IEA goals.
- The cost of producing hydrogen from natural gas is in the range of USD 0.50-1.70/kg H_2, depending on the cost of gas in the region. Production using renewable energy costs USD 3.00-8.00/kg H_2, with 50%-90% of the price tag coming from the cost of the electricity itself.
- The cost gap between fossil fuel-based and renewables-based production is expected to narrow significantly because of (a) a reduction in the cost of renewable energy and electrolysers and (b) the introduction of and increases in carbon prices/tax (a price of USD 100/t CO_2 would lead to an increase of USD 0.90/kg H_2 for natural gas-based production, or USD 2.00/kg H_2 for coal gasification).
- Electricity costs in particularly favourable areas for solar energy production are already at a level that would theoretically allow for economical production of hydrogen via electrolysis (below 20 USD/MWh). Developments in production technologies and economies of scale will be crucial to the transformation of this prospect into a practical reality.

Options for hydrogen pipeline infrastructure

- Hydrogen can be transported, like natural gas, by pipeline or in liquefied form in cryogenic tanks. For distances above 1 500 km, pipeline transport is more economical. While hydrogen pipeline technology is mature, uncertainty about demand and regulatory frameworks could slow down the planning and construction process of this critical, but expensive, infrastructure.

- Blending hydrogen into natural gas (with hydrogen comprising 10%-20% of volume) has the potential to offer a short- to medium-term alternative for transportation, using the existing gas pipeline infrastructure. However, regulatory and technological barriers still need to be overcome.

- Repurposing gas infrastructure can offer a medium- and long-term cheaper solution for hydrogen infrastructure. The cost of repurposing would depend on the required percentage volume of hydrogen. For example, compression stations, which are expensive, can be repurposed without significant investment if hydrogen comprises 10% of the volume, but they would need to be replaced if hydrogen were to make up 40% of the piped energy.

- The first full pipeline conversion to hydrogen was completed in the Netherlands in 2018, with the entire process taking about six months.

- The European Hydrogen Backbone (EHB) initiative, made up of 31 European gas infrastructure companies, estimates that repurposing of existing pipelines would cost 21%-33% of the price tag of building a new pipeline.

- More than 90% of the hydrogen pipeline infrastructure in Germany in 2030 is expected to come from repurposed gas pipelines.

Hydrogen Trade

Given the already uneven levelised cost of electricity globally, whether from renewable energy or nuclear energy, the cost of producing hydrogen will vary significantly across regions. This difference is likely to spur a lively hydrogen trade over the coming decades.

Various storage and transport technologies for hydrogen are currently being developed. Two of these are:

- Transport of hydrogen in a liquefied state, which is significantly more dense than the widely used liquefied natural gas. Turning hydrogen into a liquid requires cooling to extremely low temperatures (-253°C) and is thus very energy-intensive. Current liquefaction processes require one third of the energy contained in the hydrogen itself. It is expected that more efficient processes may reduce this fraction to around one-fifth, which is still a substantial portion of the energy potential.

- Transformation of hydrogen into ammonia or liquid organic hydrogen carriers (LOHCs). Global trade in ammonia already exists, but the product is toxic and thus requires special care when handling it. However, ammonia does not require the same very low temperatures as hydrogen (it liquefies at -33°C), and thus significantly less energy is required in the process. LOHCs are similar to oil products and can be transported easily in a liquid state. However, turning hydrogen into LOHCs is expensive and thus further technological developments will be required to make this technology cost-competitive.

A vast infrastructure network will be necessary to underpin the global hydrogen trade.

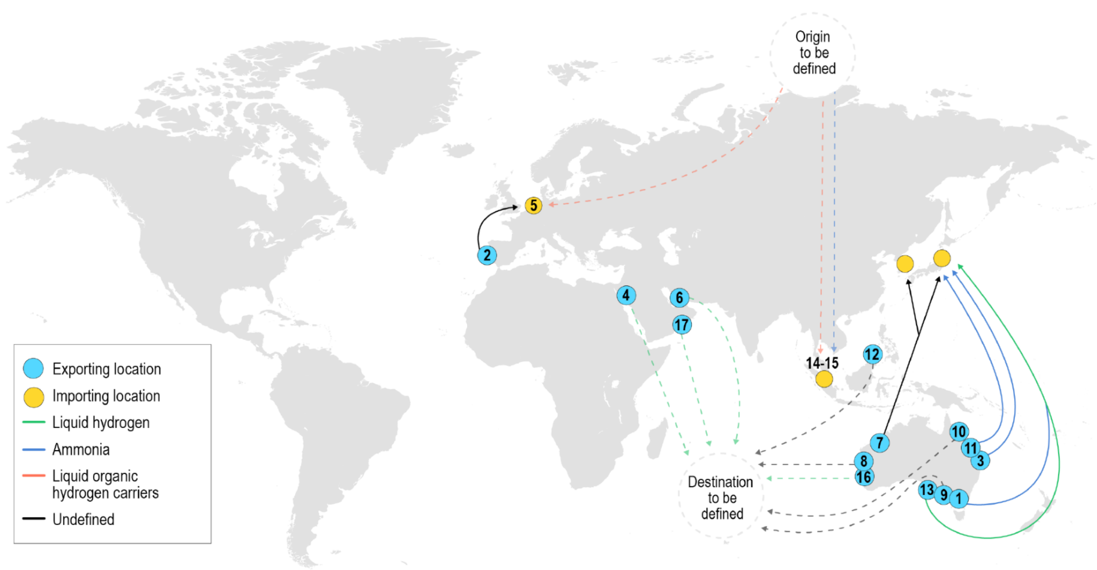
Several projects are currently under construction, with a geographic focus on Asia-Pacific. A pilot program has started to produce and trade hydrogen from Brunei to Japan using LOHCs.

In 2020 Saudi Aramco led a project that exported 40 tonnes of blue ammonia from Saudi Arabia to Japan, which is also the destination of planned exports of liquefied hydrogen from Australia.

By **Lucio Milanese**

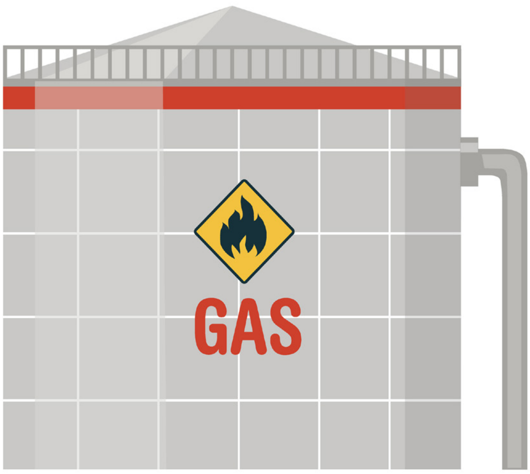
ECECP Junior Postgraduate Fellow

Map of import/export facilities under development. Most of the projects are currently in Asia-Pacific.



NEWS IN BRIEF

Gas storage centre stage as EU strengthens energy security



In a bid to boost energy security, the European Commission released a new legislative proposal on 23 March calling for at least 80% of gas storage to be filled by 1 November 2022 to underpin winter gas supplies. For subsequent years, the figure rises to 90%

In addition, the EU plans to introduce a new mandatory certification of all storage system operators in order to avoid potential external risks on critical storage infrastructure. Non-certified operators will have to cede ownership or control of EU gas storage facilities. In addition, closure of a gas storage facility will require authorisation from the national regulator.

In order to encourage the refilling of EU gas storage facilities, the European Commission is proposing a 100% discount on capacity-based transmission tariffs at entry and exit points of storage facilities.

On 8 April 2022, the EU launched a joint procurement platform for Member States to purchase non-Russian gas, LNG and hydrogen, in a bid to achieve stable prices and create a buffer against potential gas supply disruptions. More detailed plans are expected in the coming months, on the heels of the EU's announcement that it is to move away from Russian oil and gas by 2027.

+ more

EU supports low-carbon development with EUR 1.1 billion grant

On 1 April, the European Commission signed off EUR 1.1 billion in grants for seven large-scale projects supporting the EU's climate transition through the EU Innovation Fund. Money for the Fund is raised from revenues generated by the EU's Emissions Trading System (ETS), which is the world's largest carbon pricing system.

These projects are intended to deploy innovative low-carbon technologies at industrial scale, and cover key sectors such as hydrogen, steel, chemicals, cement, solar energy, biofuels, carbon capture and storage. Together, the projects are intended to reduce emissions by over 76 million tonnes of CO_2 equivalent during the first ten years of operation, paving the way for others to follow.

Revenues for the Innovation Fund are generated by the auctioning of 450 million allowances from the existing ETS between 2020 and 2030. Under the Commission's Fit for 55 proposals, it is set to be topped up with 50 million allowances from the revised ETS and 150 million allowances from the new system covering emissions from road transport and buildings.

+ more

UK unveils new strategy to boost energy security

The UK released its British Energy Security Strategy on 7 April 2022, which aims to improve the country's long-term energy independence and security by promoting domestic oil and gas production, reducing reliance on imports, and supporting the development of low-carbon energies including wind, solar, hydrogen and nuclear to supply 95% of its electricity output by 2030.

A new licensing round for North Sea gas extraction projects will be lunched this summer to ramp up North Sea output. The government is now aiming for 24 GW of nuclear power by 2050, which would meet around 25% of the country's power demand. Nuclear currently supplies around 20% of the UK's electricity. The offshore wind target will be raised to 50 GW by 2030, including up to 5 GW of floating wind, facilitated by a streamlined approval process. In addition, 10 GW of low carbon hydrogen production capacity could be in place by 2030 – a doubling of the government's previous target announced in August 2021 - with at least half coming from green, wind-powered hydrogen. Other planned measures including boosting solar capacity to 70 GW by 2035, and promotion of heat pumps.

A new independent public body, the Future System Operator (FSO), is to be established to oversee the UK's transition to net zero emissions. It will assume the functions of the National Grid's Electricity System Operator (ESO) and some of the National Grid's gas activities. The FSO is likely to accelerate the integration of more renewable electricity into the energy system as the UK races to meet its net zero targets.

+ more

Portugal raises renewable generation targets to 80% by 2026

Portugal this month unveiled a new energy plan that aims to raise the share of renewables in power generation to 80% by 2026, four years earlier than previously planned. The country wants to speed up the switch to renewables in the face of the current world energy crisis.

Unlike central European countries that depend on Russian natural gas, Portugal mainly imports LNG from Nigeria and the US, and has not imported Russian crude oil since 2020.

In the past decade, Portugal's renewable power has increased rapidly, and currently accounts for 83% of its overall capacity, with generation mainly from hydropower and onshore wind. The country now aims to more than double its renewable installed capacity over the next decade and to raise the share of renewables in final energy consumption to 47% by 2030. Portugal is looking to solar to make up the difference, and in a bid to accelerate solar development, the government plans to end environmental impact assessments for projects with capacity lower than 50MW.

According to the new energy plan, over EUR 25 billion is to be invested in energy in the next 10 years in various forms, such as public and private investment, incentives and financing.

+ more

Spain to boost grid development in 2021-26

Spain has approved a five-year electricity sector plan (2021-26) that focuses on strengthening power transmission to promote power consumption from renewables and to maximise the use of the existing grid to meet the rising electricity demand. Renewables are projected to account for 67% of Spain's power mix by the end of 2026.

According to the plan, a total of EUR 6.96 billion will be invested in power grid projects over the five-year period. Of this, nearly EUR 1.9 billion will be used to promote the integration of renewables while mitigating associated technical restrictions; EUR 1.5 billion is to be invested in underwater cables that interconnect Spain's non-mainland territories; the remaining EUR 1.26 billion will fund grid connections with France, Morocco, Portugal and Andorra. These investments will help to deliver 2 700 km new power lines and 700 km of underwater interconnections as well as the modernisation of 8 000 kilometres of existing infrastructure.

+ more

China releases its 14th FYP plan for energy development

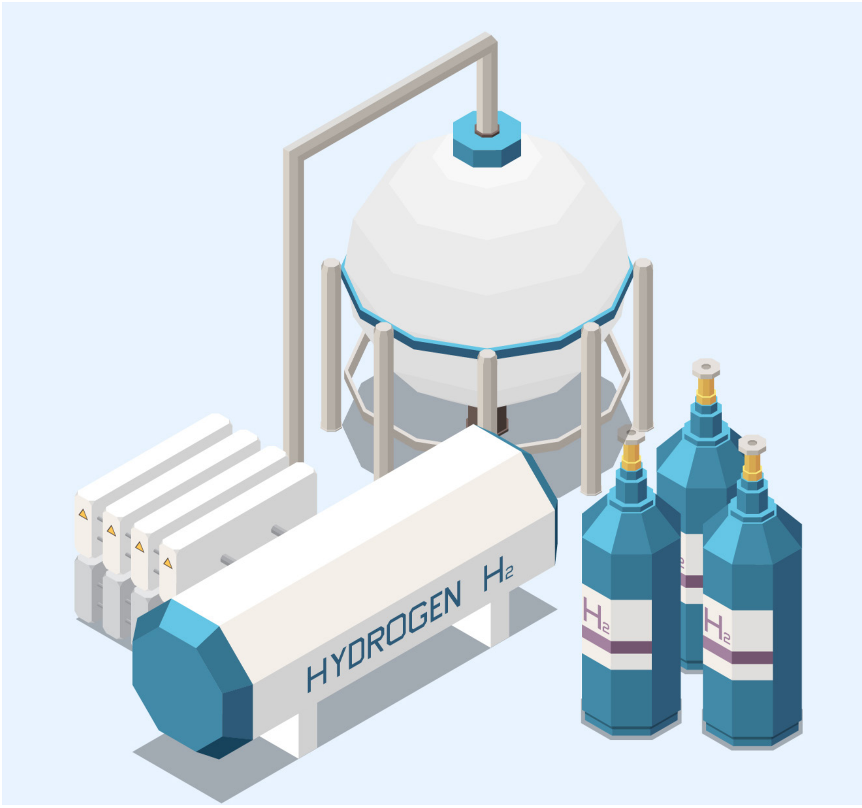
On 22 March 2022, China's central government published its long-awaited 14th Five Year Plan for the energy sector, which provides a general overview as well as specific tasks and goals for the next five years. The overarching objective is to accelerate the development of a 'modern energy system' that is clean, low-carbon, secure and highly efficient.

The document doubles down on recent government instructions requiring enhanced energy efficiency, setting quantitative targets on energy production and confirming the continuing role of coal and coal power. It also highlights the urgency for a low-carbon transition to allow more renewable energy to enter the energy system.

These are among the key objectives announced:

- Reduce CO_2 intensity by 18%;
- Cut energy consumption per unit of GDP by 13.5%;
- Increase the share of non-fossil energy in total energy consumption to 20%;
- Build energy production capacity to 4.6 billion tce per year;
- Increase the share of non-fossil power in the total power generation to 39%;
- Raise the share of electric power in final energy consumption to 30%;
- Installed capacity for power generation to reach about 3 000 GW;
- Electric vehicles to account for 20% of new car purchases.

+ more



China maps out its first national plan for hydrogen industry

China's hydrogen industry plan for the next 15 years was released on 23 March 2022, by China NDRC and NEA.

Hydrogen is set to play a strategic role in the energy landscape, and the plan sets out a five-year-phased development of a domestic hydrogen industry. China aims to put around 50 000 hydrogen fuel cell vehicles on road and produce between 100 000 and 200,000 tons of green hydrogen from renewable sources by 2025. This will achieve an annual CO_2 emissions reduction of between 1 and 2 million tonnes. The document also calls for deeper integration of hydrogen into the electricity and thermal energy systems.

Even though China is currently the largest hydrogen producer in the world with an annual output of about 33 million tonnes, its hydrogen industry is still in its infancy and mainly fossil fuels based. Lack of technology innovations, low level technical equipment, insufficient infrastructure and inadequate policy support are some of the barriers currently confronting the industry.

+ more

New energy innovation plan to accelerate clean transition

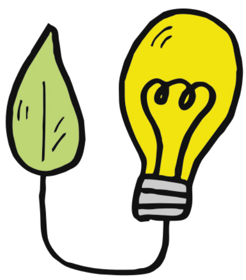
China's NEA and the Ministry of Science and Technology unveiled their Five-Year Plan on Energy Technology Innovation on 2 April 2022, to propel green growth and the digital transformation of the energy sector through innovative technologies.

The plan sets out major tasks and technological breakthroughs for key identified areas, placing a special focus on fostering new technologies that could help deliver a more efficient, cost-effective, reliable and flexible energy system.

Five key identified areas and tasks include:

- Advanced renewable generation and integration: technologies that will facilitate high-level renewable utilisation, hydrogen production, storage, transportation, and fuel cell technology;
- New technologies that support renewables in the electricity system: and distributed energy;
- Safe and efficient nuclear power: advanced nuclear technologies including small modular reactors (SMR), ultra high-temperature gas-cooled reactors (HTGR), and molten salt reactors (MSR);
- Green fossil fuel exploration and utilisation: more efficient, flexible and low-carbon coal-based generation technologies.
- Deep digitalisation in the conventional energy sectors such as coal mining, oil and gas, power plants, and the power grid.

+ more



China backs cross-sector electricity substitution

In March, China's ten national ministries jointly issued a cross-sector guiding policy on promoting electricity substitution. China wants electricity to account for 30% of final energy use by 2025, with deep electrification across all economic sectors.

Key measures include accelerating the construction of industrial green micro grids and speeding up the development of distributed energy systems such as factory PV, distributed wind power, hybrid energy storage, heat pumps, waste heat and pressure utilisation, as well as smart energy management systems.

The policy document prioritises green and low-carbon transition of energy end-use sectors by encouraging the consumption of renewable energy, especially in carbon intensive sectors such as iron and steel, building materials, nonferrous metals and petrochemical industries. Detailed electrification measures and tasks are specified for the petrochemical sector.

The policy paper attaches great significance to the deep integration of electrification, as well as smart technologies. It encourages the participation of electric vehicle V2G, big data centres, 5G data communication base stations, etc. in system interactions through virtual power plants, among other means.

In addition, it calls for increasing financial support for electric energy substitution projects and further development of financing tools such as green bonds and green credit.

In its 2022 Guiding Opinions on the Energy Sector released at the same month, China's NEA announced 2022 will see 180 TWh of electricity substitution, in an effort to accelerate the country's energy transition.

+ more

China to build unified energy markets

On 10 April 2022, the Central Committee of the Communist Party of China (CCCPC) and the State Council jointly released the Opinions on Accelerating the Construction of the National Unified Market. This document outlines the creation of a national unified market to improve standardisation and consistency in the implementation of regulations across a wide range of industries. The aim is to break down long standing barriers such as local protectionism and market segmentation by implementing standards and regulations that can be consistently applied across the country, while integrating infrastructure across regions to increase market efficiency and promote fair competition.

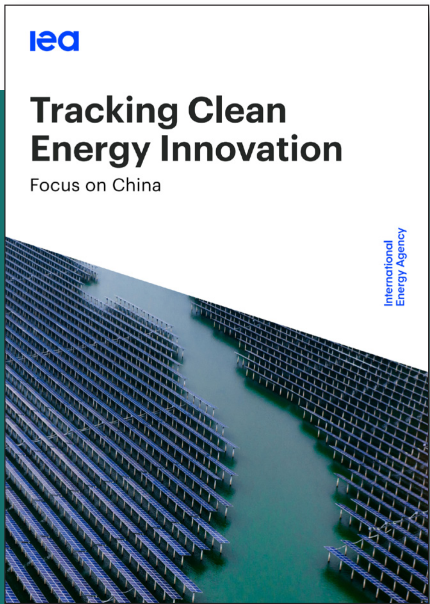
In its section on the energy sector, the opinion paper proposes the phased development of a series of national unified energy markets, including markets for oil and gas, coal, and electricity.

Specifically, it calls for an improvement to trading infrastructure in the oil and gas market, while improving inter-connections to ensure non-discriminatory third-party open access to transmission pipelines. The establishment of a unified energy content calculation scheme for natural gas pricing will be accelerated under the plan.

In addition, the opinion paper states that a national power trading centre will be established in due course to improve unified electricity market trading at multiple levels.

+ more

Reports Recommendation



Tracking Clean Energy Innovation: Focus on China

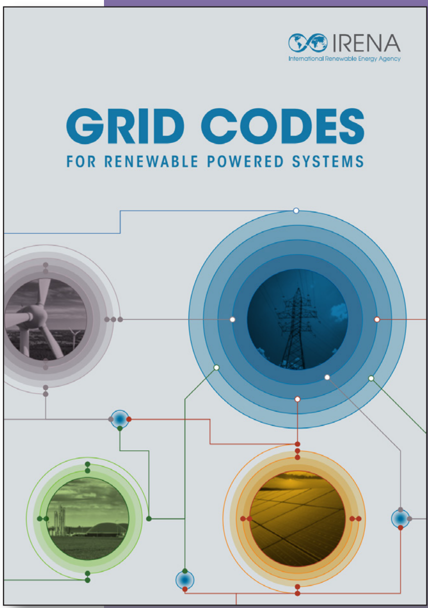
This IEA report maps the institutional and policy landscape of clean energy innovation in China including key actors, priorities, policies and programmes, as well as the country's approach to knowledge management and networks.

China has strengthened its position as a global energy innovator in fields like solar power and electric mobility by increasing its policy focus on technology innovation, which underpins China's ambitions to become a producer of knowledge and foster innovation-driven socioeconomic development. Looking forward, clean energy innovation will play a crucial role to achieve China's dual carbon objectives.

By tracking selected metrics such as R&D spending and energy patents etc., the IEA report examines the progress of technology development and improvements in output from China's innovation system. In addition, key insights are given on the role of market-oriented policies in China's energy innovation.

The report concludes that China's focus on technology innovation and development is set to strengthen, notably to deliver on long-term carbon neutrality objectives and position the country in global value chains for clean energy technologies.

→ Read More



Grid Codes for Renewable Powered Systems

While the power system is becoming more decentralized and digitalized, and as it delivers increased electrification in end-use sectors, the high penetration of variable renewable energy is posing challenges for grid system operators, who have to ensure the stability of the system at all times.

This IRENA report highlights the critical role of grid codes in building trust between the system operators and stakeholders and in ensuring the safe and efficient operation of the power system. Grid connection codes not only define technical requirements, regulations, and behaviour for all active participants in the power system, including power generators, adjustable loads, storage, and other units; they are also evolving to enable innovative technologies to be connected to the network safely, without compromising the reliability of supply.

This report elaborates on the latest developments and good practices related to technical requirements for connecting growing amounts of variable renewables into the energy system, and the enabling technologies such as storage, electric vehicles and flexible demand.

→ Read More

Building Europe's Net-Zero Future:

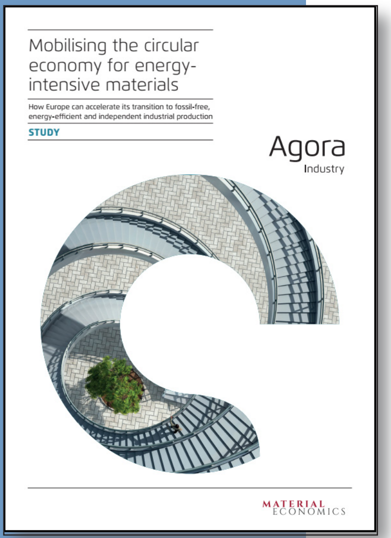
Why the transition to energy-efficient and electrified buildings strengthens Europe's economy

Europe will need to change the way it heats and cools homes to avert a climate crisis and reduce its dependence on fossil fuels. At the moment, energy-inefficient buildings are not being renovated fast enough and Europe meets the majority of its heating demand with fossil fuels, with gas boilers being the most prevalent heating technology.

Electrifying and renovating Europe's residential buildings has the potential to help reduce gas imports and generate massive benefits for the economy, according to this summary report by the European Climate Foundation and the European Alliance to Save Energy (EU-ASE), based on a study by Cambridge Econometrics.

The research focuses on the environmental, social and economic benefits of different scenarios for reducing fossil fuel consumption in residential buildings in the EU and the UK. It concludes that by renovating and electrifying the residential sector, the EU could cut annual spending on gas imports by EUR 15 billion within a decade.

→ *Read More*



Mobilising the Circular Economy for Energy-Intensive Materials

Industrial production of a few key carbon-intensive materials including iron and steel, aluminium, cement and lime, and plastics accounts for a large and growing share of EU energy consumption, including fossil fuels.

This new study from Germany's Agora Industrie, compiled with support from Swedish consultancy firm Material Economics, finds that increasing and improving closed-loop recycling and developing more material-efficient value chains is essential to ensure a more economically-efficient transition. There is enormous untapped potential in enhanced recycling and greater material efficiency. Such measures could help the EU to reduce its annual industry greenhouse gas emissions by up to 10% (70 mt of CO_2) by 2030 and up to 34% (239 mt of CO_2) by 2050 compared to 2018 levels. The study notes that the EU's new Circular Economy legislation will be crucial to spur demand for high quality recycling while boosting collection and supply of high quality recyclables.

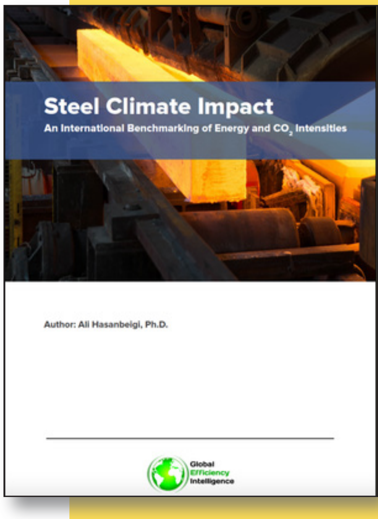
→ [Read More]

Steel Climate Impact

An International Benchmarking of Energy and CO_2 Intensities

The iron and steel industry accounts for around 7% of global greenhouse gas emissions and 11% of global carbon dioxide emissions. With current policies and technologies in place, energy use and GHG emissions within the steel industry are likely to keep rising in line with demand for steel.

This recent benchmarking analysis report prepared, by US-based Global Efficiency Intelligence ,provides a comparison of energy and CO_2 emissions intensities in the steel industry among the largest steel-producing countries. It ranks Italy, the US and Turkey the lowest and Ukraine, India and China the highest for emissions. Italy, the US and Turkey have achieved lower emissions by introducing electric arc furnace technology. The report also discusses other key factors that contribute to the varying data from different countries.



The benchmarking can be used to assess the energy and emissions improvement potential of energy efficiency or CO_2 reduction measures. At a national level, policy makers can use the report to prioritise energy saving and decarbonisation options and to design policies to reduce energy and GHG emissions.

→ [Read More]

86-10 6587 6175

info@ececp.eu

Unit 3123 & 3125, Level 31, Yintai Office Tower C,
2 Jianguomenwai Avenue, Chaoyang District,
Beijing 100022, People's Republic of China

www.ececp.eu

Editor-in-chief: Jieqiao Chi
English editor: Helen Farrell

Feedbacks and Contributions: magazine@ececp.eu

EU-China Energy Cooperation Platform Project (ECECP) is funded by the European Union.