EUROPEAN
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Issue 57 | **Spring 2025**

Baltic spring
New connections for a changing Europe

Reactor corps: how SMRs must change the way we think about policing

It could help decarbonise shipping – **but who will make our marine methanol?**

Plus: five Horizon Europe projects on the front line of energy research

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European Commission

10-12 JUNE 2025

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CLAIM YOUR SEAT AT EUSEW 2025

Organised by the European Commission, the European Sustainable Energy Week (EUSEW) is the biggest annual event dedicated to renewables and efficient energy use in Europe. This hybrid, interactive event will take place both in Brussels on 10-12 June and online, offering an excellent opportunity for energy experts working in policy, industry, academia and other energy-related sectors to share expertise and create synergies. Registrations open in April 2025 via ec.europa.eu/eusew.

HOST A SUSTAINABLE ENERGY DAY

Apply to earn the title of Sustainable Energy Day for your next clean energy event or initiative. As the events are published on an ongoing basis, regularly check out the new community, research, policy, and industry initiatives that have received this title. This year, selected Sustainable Energy Days are taking place across Europe and beyond, between March and June 2025.

HELP DETERMINE WHO WINS

In May, an online public vote will help select this year's EUSEW Awards winners in the Innovation, Local Energy Action, and Woman in Energy categories. The three finalists for each award category will be invited to the Awards ceremony on 10 June 2025 in Brussels.

MEET THE KEY POLICY MAKERS

Dan Jørgensen, EU Commissioner for Energy and Housing: "*Energy policy is at the core of almost all the important challenges we face today: it is critical for Europe's competitiveness, security and jobs, but also to accelerate the green transition and the fight against climate change. For this, we need to step up investments, in particular in clean energy and technologies, which will be a key factor to bring down energy prices and fully end Russian fossil fuel imports, while engaging on a just transition path.*

This is vital for our businesses, facing competition from outside the EU, and for households, facing problems with the cost of living. This is why, already within the first 100 days in office, this Commission will present the Clean Industrial Deal, including an Action Plan for affordable energy, which we are currently preparing. I am looking forward to discussing these initiatives with the European clean energy community at the EU Sustainable Energy Week in June!"

CONNECT WITH THE COMMUNITY

Whether you will be attending in person or online, you will have multiple ways to meaningfully join this vibrant community. EUSEW is a co-created event: do not miss this year's high-level Policy Conference, the EUSEW Awards, getting to know the new Young Energy Ambassadors and participating in the sixth European Youth Energy Day, and for those of you who have a chance to join in Brussels, the opportunities to build connections at the Energy Fair. For updates on the agenda and event location, please refer to ec.europa.eu/eusew and #EUSEW2025 on social media.

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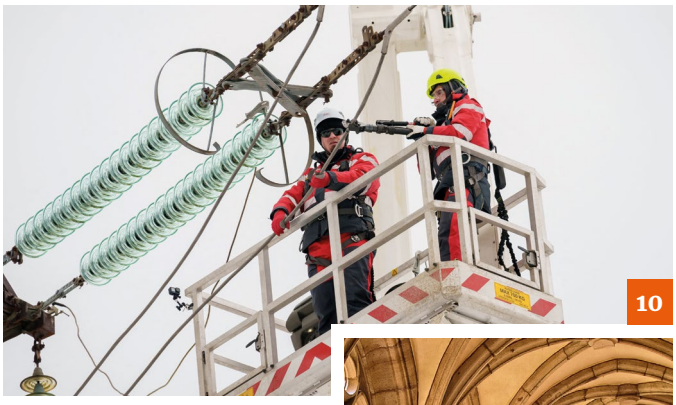

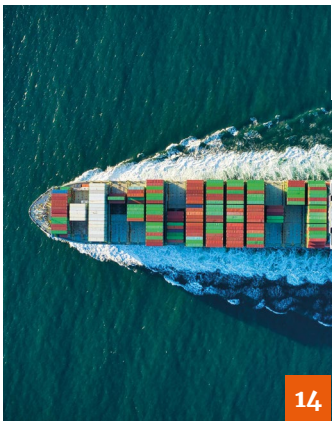

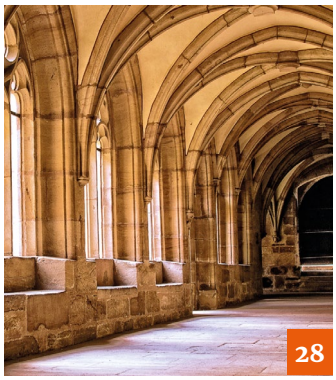

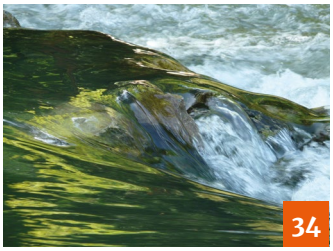

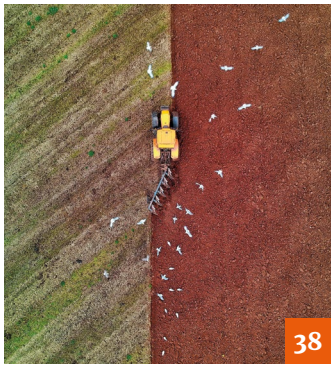

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Foreword

By **Ed Wiseman**, EEI magazine

"Emissions regulations and environmental leadership can consolidate Europe's competitiveness and encourage innovation"

Not long after 2025 began, French diplomats were mulling sending troops to Greenland as a gesture of solidarity against President Donald Trump's "Red-White-and-Blue-Land" rhetoric. Against the backdrop of America's weaponised daftness, European politics this year has been an oasis of propriety so far.

The Clean Industrial Deal – which the Commission is announcing just as *European Energy Innovation* goes to press – seems set to answer some of our questions about the main concern of our time: how the environment fits in with our quest for industrial competitiveness amid rising energy prices and geopolitical instability. It's a very different sort of politics to the kind that reaches the front pages, but it deserves far more of our attention. And while the Deal is unlikely to be perfect, and for many interested parties will fall quite far short of expectations, it is inherently rooted in the politics of collaboration and cooperation, rather than the shouty sabre-rattling we have all grown used to in the post-pandemic era.

One piece of news from across the Atlantic that has not been widely reported is the mounting corporate resistance to anti-equality measures. After the Trump administration called for an end to so-called "DEI" initiatives (standing for "diversity, equity and inclusion") shareholders and executives at companies including Apple, Costco, Procter & Gamble and Delta Air Lines have reaffirmed their commitment to equality measures, and resisted increasingly firm requirements to scrap the progressive initiatives. P&G CEO Jon Moeller explained: "It's critical to who we are and what we do, to our principles, values and purpose – and most importantly to winning."

European environmental leaders can learn a lot from these quiet acts of resistance. Quite aside from the deep belief that diversity and inclusion are worth doing in their own right, shareholders know that DEI hiring practices are advantageous, even business-critical. It's difficult to tell Apple to stop doing what has propelled it to a $3.6tn market cap. But the same can be argued for our green measures – rather than being a hindrance to be scrapped at the earliest opportunity, emissions regulations and environmental leadership can consolidate Europe's competitiveness and encourage innovation. That sentiment is likely to play a large role in the media in the year ahead.

Much of this year's news has been aggravating, or simply downbeat. But behind the stupidity of the headlines are some promising stories, optimistic signs, and evidence of truly results-focused cooperation. The fact that you have to try so hard to find it is a failure of journalism as much as anything else. ■

European Energy Innovation is written *by and for* the leaders of Europe's green transition. Senior politicians, policymakers, researchers and heads of industry contribute to this unique magazine, which will always be free to read.

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I would also like to take this opportunity to wish a full recovery to Ray Heath, our longstanding lead designer, who was taken ill in December. Ray has worked on many thousands of pages for EEI over the past fifteen years, and his patience, creativity and technical skill have contributed enormously to this magazine's success. We hope you get well soon.

Reactor corps

SMRs pose a challenge to conventional security practices – and could change the way we think about policing

By **Fraser Sampson,** former police officer and Professor in Governance and National Security at the Centre of Excellence in Terrorism, Resilience, Intelligence and Organised Crime Research at Sheffield Hallam University

Moving fast and breaking things is a hubristic engineering approach from Silicon Valley. Shattering moulds and conventions – especially cherished assumptions – seems to be the political as well as the technological mood.

Many governments (31 and climbing) are moving unusually fast towards a nuclear energy renaissance, towards a world where towns are powered by their own local reactors. Deadlocks and dams that add huge cost and delay to nuclear builds will be broken by a new planning and regulatory regime, accelerating design, production and proliferation.

In this fast and fragmented future, data centres, mines and even commercial ships will be running on micro-reactors, and there are even some distant noises about nuclear batteries.

From the perspective of climate targets and secure energy supplies, a global tilt to a dynamic scenario – where low cost, quick build, emission-free reactors are the preferred solution – makes sense. Improvements in design, safety, manufacturability and affordability make "the nuclear option" more attractive to build, operate and maintain than in previous eras.

However, if they are to succeed, these fast-bred community-based solutions must bring with them a comprehensive, integrated multi-disciplinary response to the rapidly evolving policing realities.

Global solutions

Smaller nuclear reactors are attracting excitement and investment. With few viable alternatives to meet climate targets, at least 80 Small Modular Reactors (SMR) are already being developed in 19 countries according to the International Atomic Energy Agency. Encouraged by reduced red tape and increased financial incentives, energy companies with nuclear credentials are talking to European governments revisiting their nuclear strategies, while novice nations with no history of nuclear power are preparing to exploit the next iteration of a once-controversial solution. This activity is well documented – a rudimentary browser search of "SMR" will reveal both the enthusiasm that these proposed power plants have generated and the alacrity with which they are being pursued.

Local realities

Support from the community in which it will be built and operated will be critical to the life cycle success of any new nuclear facility in a range of ways including workforce supply, educational and scientific research, communication and engagement. As argued in paper (Sampson/McNeill 13/1/25), to be introduced successfully into a UK neighbourhood an SMR will need to be supported by local policing and resilience partnerships. In other words, policing and resilience partners will need to move fast and break things too.

The acid test for whether an SMR can be safely and securely introduced into UK communities will not be a matter of nuclear engineering or design innovation. It will be the extent to which local police chiefs can assure their communities that they can confidently accommodate such reactors. Before giving that assurance, local policing leaders – including directly-elected mayors and police and crime commissioners – will need to consider many factors, some of which will require fundamental reconstruction of the policing arrangements for which they are accountable.

Policing design

The design of policing in England and Wales does not have much synergy: national response capability is essentially the sum of its parts. And some of those parts are missing, as HM Chief Inspector of Constabulary (HMIC) noted nearly 20 years ago.

HMIC recommended breaking with conventions and shattering old geographical structures to close the gaps in critical national capabilities but they were never actioned. Since 2012 directly-elected local policing bodies set the budgets and priorities for their 43 police areas. Those locally-elected leaders have been chosen by their communities through the democratic process to ensure that the views of local people are reflected in policing activity. Community reaction to proposed sites, the national expectations and expense will therefore be of existential importance to them.

Community fallout from proposed energy solutions is not new for policing (as anyone visiting villages affected by the 1984 miners' strike will discover to this day). For a more recent example, look at Kirkby Misperton, North Yorkshire (population 370). In October 2016, the government's announcement that the village was to be a fracking site to assess the viability of shale oil reserves required an immediate police presence. A year later the police were still there at an additional local cost to North Yorkshire communities of £101,476, not including the impact of the site on 'routine' community policing.

In neighbouring Lancashire, the additional cost of policing for fracking opposition was an estimated £11.5m which the UK government had to underwrite. In addition to the financial cost, the fracking experience brought other demands for local police resources including the need for specialist officers to deal with protestors in trees and a steep increase in complaints against officers, each of which had to be properly investigated. Policing leaders will be acutely aware of these effects, from far less ambitious energy policies, on their communities. However, before they can assure their communities that they can confidently accommodate nuclear

"The risk architecture and attack vectors for the next generation of nuclear reactors will be very different"

reactors, police chiefs will need to stress test the realities of the UK's policing model, moving fast and, if necessary, breaking with tradition.

Policing expectations

The internationally recognised principles for nuclear site security are "deter, detect, delay and respond". The first two are common to policing but the third and fourth will not fit with current local and national capabilities in the UK if the proliferation of small nuclear sites goes ahead.

Taking the 'delay' principle, it is questionable whether time will always be on the side of the local police and their communities managing a site-based incursion. A protracted standoff with attendant international news coverage (there is no such thing as a local nuclear policing incident) and speculation, along with disinformation driving fears of environmental contamination will have a seismic impact on communities. Delay may also give occupiers space to work out a way of converting material into a dirty bomb, or malignant posts claiming to have done so; for serious public disorder and for copycat incidents to spread virally.

In relation to the fourth principle, 'respond', international experts have explained that this means "more SWAT team type people who, if a threat is detected, come charging out". In UK policing, first responders will be local, invariably unarmed, police. Under current nuclear policing arrangements, the specific burden of mitigating site-based threats rests with the Civil Nuclear Constabulary (CNC), a small body of around 1,060 permanently armed police officers, funded by the nuclear operating companies.

The CNC model was configured in 2005 for immediate defence of ten large licensed nuclear sites across the UK. If the international response expectation is further armed 'SWAT team type people' it is unclear who these people might be, where they would be coming from, how and when they will get there and what they were being paid to do when not charging out to local nuclear sites. Equally unclear is the community impact of seeing such a display of brigaded lethal force hurtling to a site they were assured was safely covered.

For UK policing, these are not hypothetical or speculative questions; they are the same questions that were asked (and never properly answered) when the National Police Air Service (NPAS) was established in 2012. The national model for policing the UK depends on calling up local support on a 'mutual aid' basis. Ministers have the power to mandate collaborative contribution to the national effort but NPAS is the first and only time it has been used. Directing police chiefs to share and pay for air support encountered significant resistance, with the national strategic board being locked in an almost perpetual review of costing and deployment models struggling to balance fairness, effectiveness and affordability across differing demand profiles. Compared to the demand challenges of SMRs, managing a small fleet of airframes should be a walk on the beat.

UK Counter-Terrorism policing has a sub-division dedicated to Chemical, Biological, Radiological and Nuclear (CBRN) threats, but this too relies on local policing contribution for training, equipment and secondment of staff and was built for an entirely different threat, risk and harm landscape than that which SMR would bring. In distinction to policing models such as the Gendarmerie in France, UK policing has not been designed for these national challenges and, to adopt a sporting metaphor, will need to break the 'club versus country' dilemma at the very earliest point of SMR planning.

And of course, there are many risks that cannot be swatted away. No affordable national reserve capability would be effective against insider threats, cyber attacks, aerial assault and the risk of simultaneous multiple attacks.

One expert assessment has questioned whether the previous 'habits of nuclear appraisal optimism' were a thing of the past, pointing out that 'the smaller scale of SMRs means that associated risks are more widely distributed and more difficult to defend against.' A proliferation of small nuclear plants across semi-urban communities facing attack vectors unknown in the last era would quickly overwhelm both specialist and general policing resources under our current structure for one obvious reason: it is the solution to a different problem.

New risk architecture

In many ways, the new nuclear world is not really a renaissance; some key features are very different from our first foray into nuclear energy. We have not moved at this speed before, we have not had multi-site proliferation before and we have not had the technological capability for disruption, disinformation and cyber attacks before. The risk architecture and attack vectors for the next generation of nuclear reactors will be very different from the ones we faced in the last era of civil nuclear power. For example, social media has turbocharged the citizen's ability to create substantial disruption from anywhere on Earth, a capability unimagined by the Magnox generation and their military equivalents at Greenham Common.

Unmanned aerial vehicles (UAV) are an interesting example of a new risk that we are struggling to address in a non-nuclear setting. While little was said or done about risks from drones to large, geographically remote nuclear facilities (an ongoing concern at Zaporizhzhia and Chornobyl), there is abundant evidence

of the problems countering UAV activity around sensitive installations. If we cannot stop drones from delivering drugs and laptops to local prisons with perimeter defences, strict access controls and a mature intelligence infrastructure, why would we believe we will be any more successful with small nuclear sites without a substantially different approach?

Additional new site risks include sabotage during the planning and construction life cycle and continuing insider threats against the challenge of providing effective vetting and security clearance for an exponentially enlarged workforce operating at speed. Non-site-specific risks include deepfakes and cyber-enabled crime, deliberate and concerted disruption of communications, supply chains, transport of materials, dis/misinformation and, perhaps most of all, technological complacency.

New costing model

While lower project costs of SMRs are one of their attractions, life cycle disruption will still have enormous commercial consequences. Although smaller, construction sites will have fixed daily costs based on thousands of people working and the utilisation of specialist equipment. At the same time, every year of construction delay jeopardises inbound cash flow for the project owner taking all the investment risk. That will impact on the policing costs which, under current rules, must be agreed in advance within a 'police services agreement' between the operator and the local police force. With the litigation still ringing in the ears of police chiefs that have football stadiums to police, and the experience of providing cover to local airports under the National Aviation Security Plan, the funding mechanism underpinning additional policing expectations is the very opposite of moving fast and the traditional impasse it creates will need to be broken.

Re-engineering policing

If we are to move fast and break the things impeding progress, then policing needs to be part of the re-engineering. The threat, risk and harm profile for SMRs, together with operational policing imperatives, reach far beyond the UK and, irrespective of jurisdictional differences, affect every country that identifies SMR as a solution to its climate change obligations.

To accommodate the global energy ambitions, policing needs to be re-designed for functionality, reliability and sustainability; it needs finite element analysis (FEA) of the whole and optimisation of its component parts including who pays and how; and it needs computer aided design (CAD) in the form of augmented reality tools, design visualisation, dynamic risk matrices and prototype testing.

In the new nuclear world, effective and affordable policing needs to be supported by, and delivered through systems specifically designed for the environment in which it is expected to function. Within those systems, the sharing and addressing of risks and potential solutions within applicable constraints will be critical. The timely provision of information – public and confidential – may be as important as physical infrastructure, requiring international communication and learning systems using multi-disciplinary design analysis and optimization to support interactive public engagement. And there is an immediate need for formal research and development partnerships between established research bodies such as CENTRIC with the relevant experience and expertise in infrastructure policing and national security.

Conclusion

Moving fast, the UK Government will shortly announce the two approved contractors for the first tranche of SMRs: the local infrastructure issues they present will be as different as from the large nuclear plants we grew up with as the buildings and sites themselves. Meanwhile, local blue light services are already stretched in matching resources to calls for service and, as they currently stand, the local and national policing arrangements will not be able to keep up.

Global nuclear safety and security arrangements are mature, comprehensive and so far have proved reassuringly resilient. International bodies like the OECD Nuclear Energy Agency help countries develop their security arrangements through international co-operation, while national regulators like the UK Office for Nuclear Regulation have a strong record in protecting communities by securing safe nuclear operations.

A new nuclear world of 'smaller and many' must move fast and must be supported by a new approach to local threat, risk and harm assessment. Facing a range of new risks, from attacks by hostile states and their proxies, the weaponizing of nuclear energy infrastructure to concerted attacks by a complex mix of motivations; from political interference to ransomware plots to 'hot headed coders', local and national policing must be sighted on, and adequately prepared for a new risk matrix. An unrefined response framework designed decades ago for a rare and isolated incident occurring on a large and remote site will be hopelessly unsuited to the world of local nuclear multiples. If unchanged, it will become a casualty of this dynamism and that should perhaps be the primary risks in the strategic energy assessment for introducing SMRs in the UK.

In the new nuclear future, the sooner the contribution expected from policing is brought into the international security framework, the better the prospects of ensuring 'a safe, environmentally sound and economical use of nuclear energy for peaceful purposes'. ■

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In from the cold: how the Baltic states (finally) decoupled their grids from Moscow

After decades of wrangling, Estonia, Latvia and Lithuania have synchronised their grids with the EU. Here's how it happened and what it means for the region.

By **Lizzie Meager**

In a momentous shift that has been decades in the making, Estonia, Latvia, and Lithuania have succeeded in decoupling their electricity grids from Russia, synchronising them with the EU's power network. This milestone, which has been in the works for nearly two decades but was not finalised until February 8, marks a significant geopolitical and economic achievement for the Baltic states, which have long sought to sever the energy ties that bound them to Moscow.

For the region, decoupling from a grid controlled by Russia is more than just a technical or infrastructural feat. It is a statement of sovereignty, an embrace of European integration in an era of heightened tensions with Russia – and a signal that these nations are now looking west instead of east.

While the process itself was highly technical, the moment was emotionally charged for many. Workers reportedly used a crane to cut wires in Latvian town Viļaka, near the Russian border, and handed out cuttings as souvenirs to a cheering crowd of onlookers.

"We've reached the goal we strived for, for so long. We are now in control," the Lithuanian energy minister, Žygimantas Vaičiūnas, told a press conference. "We will never use it again. We are moving on," added Latvia's energy minister Kaspars Melnis.

Recognising the importance of energy security in the face of Russian aggression, the EU was a strong advocate of the synchronisation project. In total the project cost around €1.6bn, with more than €1.23bn of that made up of grants from the EU. The remainder of the financing was provided under the Recovery and Resilience Facility in Latvia and Lithuania.

The Soviet legacy

The Baltic states' electricity grids were developed in the 1950s and were designed to integrate seamlessly with the broader Soviet energy infrastructure as part of the USSR.

Following their independence in 1991, Estonia, Latvia, and Lithuania inherited electrical grids that were synchronised with Moscow's system; specifically, the unified power system (UPS) of Russia and its neighbouring republics. In 2001 the BRELL energy ring synchronised the power systems of Belarus, Russia, Estonia, Latvia and Lithuania under Moscow's centralised dispatch.

This meant that for nearly three decades following independence from the Soviet Union, the Baltic states remained dependent on Russia for much of their electricity. This was in spite of their growing desire to integrate more fully with the west, and long after they joined both NATO and the EU in 2004.

Rokas Masiulis, CEO of Lithuanian

electricity operator Litgrid, tells EEI that the idea of disconnecting from the Russian system and synchronising with Europe had been "floating in the minds of energy professionals here as soon as Lithuania regained its independence in 1990", but both politics and economics prevented it from becoming a strategic goal until 2007.

As well as being highly symbolic, interconnection with Russia presented a considerable security risk to the three countries. The Baltic states realised that reliance on Russia for their energy needs made them vulnerable to potential political leverage, which became increasingly evident as the Kremlin's approach to foreign policy became actively aggressive. The annexation of Crimea in 2014 in particular was a key moment for the region. The issue of energy security became a pressing concern.

"The synchronisation of the Baltic states with the continental European networks is one of the most urgent priorities for EU energy infrastructure," says Masiulis. "It is the most ambitious energy independence project in the Baltics – the entire EU – and will allow for independent, stable, and reliable frequency control of the Baltic states' electricity grids."

A question of security

Tõnis Vare, managing director of the Union of Electricity Industries of Estonia, says that the project is purely about energy security. From a technical point of view, "disconnecting from the larger system and connecting to the smaller system does not seem to be reasonable", he says.

"But desynchronisation from BRELL is not only a technical exercise," he adds. "It's about having control over your own devices and not being controlled by a party which you cannot trust."

The first significant step came in 2007 when the Baltic states began to push for greater energy integration with the EU – not long after Russia launched a major cyber-attack on Estonian organisations, including parliament, banks, ministries, newspapers and broadcasters following a dispute over the relocation of a Soviet-era statue.

But it wasn't until 2014, with tension growing between the EU and Russia over Ukraine, that the urgency of energy independence became more apparent.

Russia has a history of weaponising energy specifically, particularly against Ukraine, says Jason Moyer, research director at Washington DC-headquartered think-tank the Wilson Center. "The government recognises that it's a lever it can hold over countries in the region," he says. "Having control of your electricity grid located in Moscow is just not a good idea for a NATO member – you need electricity independence."

Then in February 2022, Russia launched a full-scale invasion of Ukraine – and things reached a fever pitch. The Baltic states have not bought electricity from Russia since 2022, but their connection to BRELL left them dependent on Moscow for the management of energy.

It is not just the Baltic states that remained vulnerable to Russia long after its invasion of Ukraine. Despite the hundreds of sanctions meted out against Russian companies, individuals and entities, the whole of Europe has struggled to wean itself off Russian gas. Between early 2022 and the end of 2023, EU countries slashed their imports of Russian fossil fuels by 94 percent, from $16bn per month to around $1bn. Despite this, EU imports of Russian liquefied natural gas increased in 2024 to 16.5m metric tonnes – up from 15.2m in 2023.

"In total it took more than 40 individual projects across Estonia, Latvia, Lithuania and Poland to complete the process"

The long road to decoupling

The desynchronisation project had initially been planned for completion by early 2025, but a further escalation from Russia forced the timeline to be accelerated. In the past 18 months, damage has been reported to at least 11 subsea cables running under the Baltic Sea, leading Nato to increase its presence in the area in late 2024.

While European leaders were initially reluctant to play the blame game, they eventually admitted that a pattern had begun to emerge, which European Commission president Ursula von der Leyen also acknowledged during a ceremony to mark the grid synchronisation occasion on February 9.

The decoupling process was not straightforward. The challenge of disconnecting from Russia's power grid and connecting to the EU's electrical network required years of technical, regulatory, and financial coordination.

In 2017, the European Commission and the Baltic states jointly unveiled a roadmap to Baltic-EU grid interconnection, outlining the technical steps necessary. The plan also included the construction of new interconnectors, including an overland high-voltage direct current (HVDC) link between Lithuania and Poland, known as "Harmony Link", as well as plans for the "LitPol

Workers physically sever connections with Russia near Viļaka in the east of Latvia

"One of the primary technical challenges of decoupling the Baltic grids from Russia was ensuring that the process would not compromise the stability of electricity supply in the region."

Link" and the "EstLink" to connect the Baltic countries with neighbouring EU grids. While the latter two are already operational, the Harmony Link is not scheduled for completion until 2030.

One of the primary technical challenges of decoupling the Baltic grids from Russia was ensuring that the process would not compromise the stability of electricity supply in the region.

"It's been a huge effort between the public and private sector, including various energy entities within the Baltic states, the EU, and the Russian and Belarusian governments," says the Wilson Center's Moyer. "There were all kinds of backup measures in place in the event of a failure or breakdown – not that anyone was expecting anything to go wrong."

As well as ensuring that the Baltic region's energy needs could be met in times of high demand, synchronising with the EU means that electricity generated in the Baltics can be reliably exported into western Europe. This two-way possibility integrates the Baltic systems as full partners in the European system.

The Baltic states also had to modernise their energy infrastructure to meet EU standards, including upgrading transmission networks, building new interconnectors, and ensuring a stable flow of electricity. "To de-couple from the Russia-controlled IPS/UPS system, the electricity transmission system operators of Lithuania, Latvia, Estonia, and Poland – Litgrid, AST, Elering, and PSE – had to strengthen electrical grids, investing in new lines and substations, and new equipment such as synchronous condensers, battery storage, and system control tools," explains Litgrid's Masiulis.

In total it took more than 40 individual projects across Estonia, Latvia, Lithuania and Poland to complete the process.

Looking ahead – and west

The successful decoupling of the Baltic energy grids from Russia has far-reaching implications for the region, both in terms of energy security and broader geopolitical considerations.

First and foremost, the decoupling ensures that the Baltic states are no longer vulnerable to Russian control over their electricity supply, greatly reducing the risk of supply disruptions due to political tensions. This enhances the region's overall energy security and resilience, particularly in light of the ongoing war in Ukraine and the threat of further Russian aggression in Europe.

Integration with the European grid also allows the Baltic states to tap into a larger, more diverse energy market, increasing their access to renewable energy sources and reducing their dependence on fossil fuels. This is a key step towards achieving the EU's broader energy transition goals and carbon neutrality targets.

The Baltic states are moving fast in their transition to renewables: in 2018, around 60 percent of their electricity came from fossil fuels. As of today, more than 72 percent of their power comes from renewables instead, with wind generating 28 percent of all consumed energy across the three nations.

EU interconnection will "foster the development of renewable energy in the Baltic states and Poland, as newly installed power lines, substations, and synchronous condensers will increase the ability of transmission grids to support a higher share of renewable sources in overall electricity generation", Litgrid's Masiulis explains.

However overall, it does not change that much in practical terms, explains the Union of Electricity Industries of Estonia's Vare. "Cross-border trade is already conducted with northern and western neighbours, and it has stopped with eastern neighbours, including Russia and Belarus," he says. "All the Baltic countries should continue developing renewable power generation and storage, and keeping sufficient levels of dispatchable capacity in the system – but these tasks are common for the entire region."

For the EU, the successful synchronisation of the Baltic grids is a testament to the power of solidarity and cooperation in achieving energy independence. It also strengthens Europe's energy security by integrating the Baltic states into its wider electricity market, ensuring that energy resources are distributed more efficiently across the region. ■

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Methanol ships depend on China

China acounts for more than half of the project pipeline for renewable methanol globally. What does this mean for the EU's maritime future?

By **Xiaoying You**

Just as you are reading this sentence, some 50,000 ships are crisscrossing the oceans around the world, carrying everything from toothbrushes to electric vehicles for tens of thousands of miles.

The vast majority of them are powered by fossil fuel, but a tiny — albeit growing — portion have taken up renewable methanol, a clean fuel that can significantly reduce the carbon dioxide (CO2) and air pollutants emitted by those vessels.

"Renewable methanol will play a key role in the immediate term as a scalable zero-emission fuel," Michael Petroni, an analyst tracking the shipping industry at the Berlin-based NGo Climate Analytics, tells EEI.

But the conversion isn't without challenges. For one, there is a chicken-and-egg situation in establishing supply chains for renewable methanol due to the absence of a real market. China is also ahead of the rest of the world in building factories for the fuel.

But the vulnerability of the European Union (EU) may lie in the manufacturing of ships, not the fuel. Petroni expects Europe to be "heavily reliant on China" in building methanol-enabled vessels as its maritime industry sails towards its net-zero goal.

Uncharted waters

In the EU, the shipping industry's CO2 emissions have increased year-on-year since 2015, according to this year's European Maritime Transport Environmental Report. The only exception was 2020 when the pandemic held up global logistics, it says.

The emissions rise was not only driven by the growing volume of cargo, but also the longer journeys ships had to make to avoid "maritime choking points" created by conflicts, geopolitical tensions and other factors, said Maja Markovčić Kostelac, executive director of the European Maritime Safety Agency, at the report's launch in Lisbon in early February.

Renewable methanol has emerged as an attractive alternative for shipping companies as they look to decarbonise container ships, which contribute the greatest portion of CO2 emissions out of all types of vessels.

The fuel is more ready to be adopted than other renewable options, such as ammonia and hydrogen, because it is immediately available, easy to handle and compliant with current safety requirements, Petroni says. Plus, existing engines can be adapted to use it, he adds.

In 2021, Danish major Maersk ordered the world's first dual-fuel container ship capable of running on methanol and conventional fuel. Since then, its global competitors have followed suit.

Today, the number of methanol-enabled vessels in operation or on order worldwide has reached 410, according to estimates by Gena Solutions Oy, a Finland-based company that analyses low-carbon technologies and projects.

The figure includes new builds and retrofitted ones.

"By 2030, we project that there could be more than 600 to 650 methanol-fuelled vessels based on the current trend," Vitalii Protasov, chief executive and co-founder of Gena Solutions Oy, tells EEI. Maersk alone has deployed nine dual-fuel methanol vessels, including seven delivered in 2024. Another 50-60 are expected to enter service between 2026 and 2030, according to the company's annual report for 2024.

It's not just container ships. Methanol adoption is spreading across the entire maritime sector, from ocean-going chemical tankers to super yachts, according to Gregory Dolan, chief executive of the Methanol Institute, a global trade association. Last May, the world's first methanol-powered tugboat, the Methatug, was unveiled at the Port of Antwerp-Bruges in Belgium.

Inland vessels are making similar moves. Stolt Ijssel, a chemical tanker, has become the first inland vessel in Europe to be certified to run on methanol. However, compared to ocean-going vessels, inland ships have the additional option of switching to batteries because of their shorter ranges, Petroni notes.

Chicken-and-egg dilemma

A key driver for methanol's rising popularity are the tightening policies. The International Maritime Organization (IMO), a United Nations agency that regulates maritime transport, has pledged to cut the industry's CO2 emissions by "at least 40%" by 2030 and make "at least 5%" of its total fuel and energy consumption "zero or net-zero" by the same year.

In the EU, any large ships above 5,000 gross tonnage must slash the greenhouse gas intensity of their fuels if they call at the bloc's ports — or face penalties, according to the FuelEU Maritime Regulation. They must also pay for their CO2 emissions partly or fully under the EU's emissions trading scheme.

As interest grows, the supply of renewable methanol has emerged as a challenge. At present, virtually all of the methanol produced globally is derived from fossil fuels, while only around 0.2% is considered renewable.

They are two types of renewable methanol. One is bio-methanol, which is made from sustainable biomass, such as agricultural waste. The other is e-methanol, which is produced by combining renewably sourced CO2 with hydrogen that has been separated from water using electrolysis powered by renewable energy.

In Protasov's view, the problem isn't that there won't be enough supply in the future. Rather, it is hard to move planned projects into construction and operation.

According to his company's assessment, there are more than 200 renewable methanol projects in the global pipeline, whose combined capacity is expected to exceed 34 million tons a year. "That's a lot more than the needs of shipping companies," Protasov says. He predicts the annual demand of renewable methanol by the maritime industry to range from four to eight million tons by 2030.

However, the lion's share won't be built unless they ink long-term offtake contracts with shipping companies in advance so as to reach final investment decisions. Only about 3% of the current pipeline has secured such agreements, according to Protasov. This is "a major issue" for the industry, he notes.

"There is a chicken-and-egg situation in establishing supply chains for renewable methanol due to the absence of a real market"

The cost challenge

Cost is viewed as another obstacle. Renewable methanol, especially e-methanol, is currently much more expensive than conventional marine fuels.

According to Maritime Strategies International, the average cost for e-methanol in 2024 was $2,348 per ton of low sulphur fuel oil equivalent, nearly four times the price of low sulphur fuel oil.

Mariam Tzannatos, a decarbonisation analyst at the London-based consultancy, tells EEI: "Pricing is currently a significant barrier to the widespread adoption of renewable methanol in the shipping industry."

But changes are looming. Tzannatos expects regulatory frameworks and the development of the global hydrogen market to bring down the price gap. Plus, penalties will increase for those companies that fail to meet the emissions-reduction targets, and the development for relevant infrastructure will scale up. Both are due to improve renewable methanol's cost-competitiveness, she notes.

From 2040, renewable methanol may even become cheaper than conventional marine fuels, particularly on routes heavily impacted by EU regulations, according to analysis by Tzannatos and her colleagues.

Some industry insiders are even more positive about the fuel's future. One of them is Frank Obrist, founder of the German-Austrian Obrist Group, which has invented a technology to capture CO2 directly from air.

Obrist argues that the key to slashing costs lie in harnessing solar energy, which is "almost free". Using his company's technology plus renewable hydrogen produced with solar power could yield renewable methanol that is cheaper than

Photo: Port of Antwerp-Bruges

"As in other clean energy sectors, China is the global leader in making renewable methanol"

fossil fuels and can achieve negative emissions in its lifecycle, he tells EEI.

His group projects the production cost of the renewable methanol produced in this way to be $0.43 per liter, less than half of the cost of fuel oil in the US at the end of last year.

China leads the show

As in other clean energy sectors, China is the global leader in making renewable methanol. But compared to the solar and battery sectors, where it has virtually achieved a monopoly, China's advantage in the budding industry is smaller. It accounts for 52% of the current project pipeline in terms of capacity, followed by Europe and North America, Protasov says.

But 87% of all projects that are under construction right now are based in China, he notes. "This means that most of the new supply in the next two to three years will come from China to the global market." His company projects China to be the world's largest exporter of renewable methanol from 2026.

Over the past two years, European shipping companies have closed a few landmark deals with Chinese renewable energy providers. Maersk has signed long-term contracts to source renewable methanol from Xinjiang-based wind-turbine maker Goldwind and Shaanxi-based solar giant LONGi. German carrier Hapag-Lloyd has also reached an agreement with Goldwind.

But there is little comparison between the EU's ties with China on methanol and the bloc's previous dependence on Russia for fossil fuels, according to Protasov.

As most vessels can run on two types of fuels, they will always have the option to switch to the other if the supply of methanol becomes problematic, Protasov says. He adds that unlike gas from Russia, the EU doesn't rely on physical pipelines to receive renewable methanol only from China. "It could be delivered from North America, which will likely also be a big supplier to the European Union."

The best option, however, would be for European shipping companies to invest in green technologies, such as direct air capture and the production of renewable methanol, themselves, as Obrist puts it. "At the moment, far too little is being done in this direction," he says.

EU's reliance on China

But apart from the manufacturing of renewable methanol, the building of vessels is critical for the EU's shipping transition, and that's where "China will play a much bigger role", says Petroni of Climate Analytics.

China is the world's largest shipbuilding country followed by South Korea and Japan. Last year, Chinese shipyards bagged a whopping 70% of the global shipbuilding orders when calculated in compensated gross tonnage, crushing their competitors, according to a report by Clarksons Research, which provides data and intelligence about shipping and trade.

The report attributes China's dominance to its flexibility in shedding or increasing shipbuilding capacity according to needs, continuous industrial expansion and competitive prices. It notes that 76% of the orders currently held by Chinese shipyards are from overseas shipowners.

European shipowners place about 85% of their orders with Chinese and South Korean shipyards, and the trend is unlikely to change since Europe lost its shipbuilding competitiveness to Asia decades ago, Petroni says.

"In this regard, Europe is and will be heavily reliant on China for its shipping transition," he says. ■

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News in Brief

Belgium tweaks nuclear energy approach

One of the reactors at Belgium's Doel power station, near Antwerp, was shut down in February, leaving the country with just four in opperation. Doel-1, which has been producing energy for fifty years, had been granted a ten-year extension in 2015; this year, it joins Doel-3 and one of the three reactors at Tihange in being decommissioned.

However, the new Belgian government has expressed renewed interest in extending the use of its existing reactors as well as adding new nuclear capacity. Extending the use of the remaining reactors is understood to be essential to the country's energy security from next year. Doel 4 and Thiange 3 could now be supported until 2034.

Energy minister Mathieu Bihet has indicated that SMR and conventional nuclear power stations could be part of the country's strategy – a departure from phase-out laws passed in 2023.

"Which technology we will use, we still have to evaluate. But it is clear that it will not only be SMRs. Only small reactors will not suffice," he said, according to *Tjid*.

Nuclear provides around one quarter of Europe's energy.

Seabed survey for floating renewables

A new geophysical and geotechnical survey carried out offshore of Viana do Castelo has provided key data on the seabed's characteristics and offered support to the development of floating offshore renewable energy projects in the area.

The survey was commissioned by WavEC Offshore Renewables and conducted by the Instituto Hidrográfico – Marinha Portuguesa within the Technological Free Zone as part of the EU-SCORES initiative. This scheme focuses on developing energy multi-use parks uniting offshore wind, wave energy, and solar technologies in one location.

Renewable energy use is growing in Portugal, but with few fossil fuel reserves of its own, the country is still heavily reliant on other countries to meet their energy needs. A substantial portion of Portugal's power demand is met by electricity imports from its Iberian neighbour, Spain.

The first phase focused on the geomorphology of the seabed, sedimentary layer composition, and overall seafloor characteristics and revealed a predominantly stable seabed.

The findings will inform engineering and deployment strategies for EU-SCORES' proposed floating energy multi-use parks, which aim to use offshore space more efficiently and balance the electricity grid to achieve a resilient and cost-effective 100% renewable energy system.

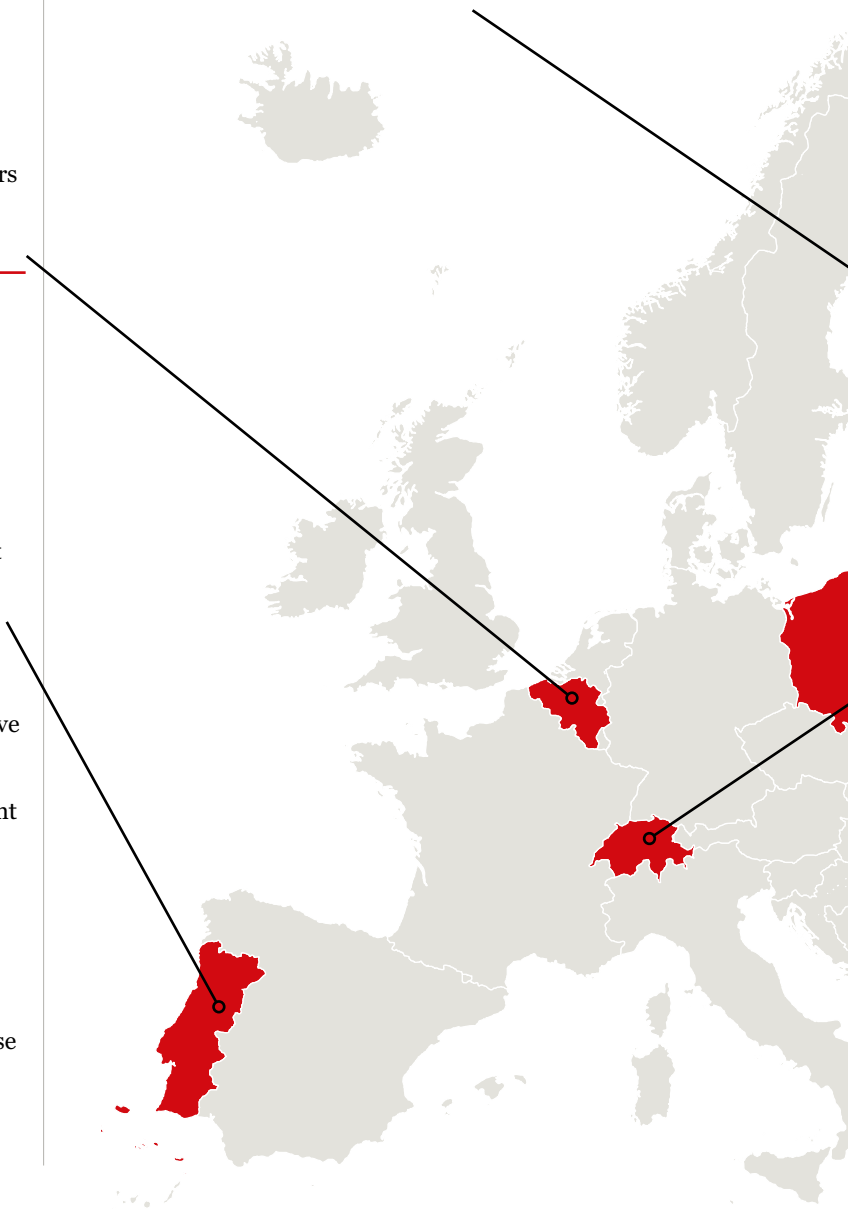
Green hydrogen powers up in Finland

Finland's first industrial plant for the commercial production of green hydrogen has opened in Harjavalta. The facility uses renewable energy to produce green hydrogen through electrolysis.

P2X Solutions has installed 20MW of pressurised alkaline electrolysers from electrolysis company Sunfire at the plant.

"The electrolysis plant in Harjavalta is a flagship project in Europe," said Nils Aldag, CEO of Sunfire. "With the commercial operation of Sunfire's electrolyser underway, P2X Solutions has achieved a major milestone in accelerating Finland's green hydrogen market."

P2X plans to develop two more facilities with 40MW and 100MW capacities. Finnish project developer Ren-Gas has chosen Sunfire's technology for its 50 MW plant in Tampere.



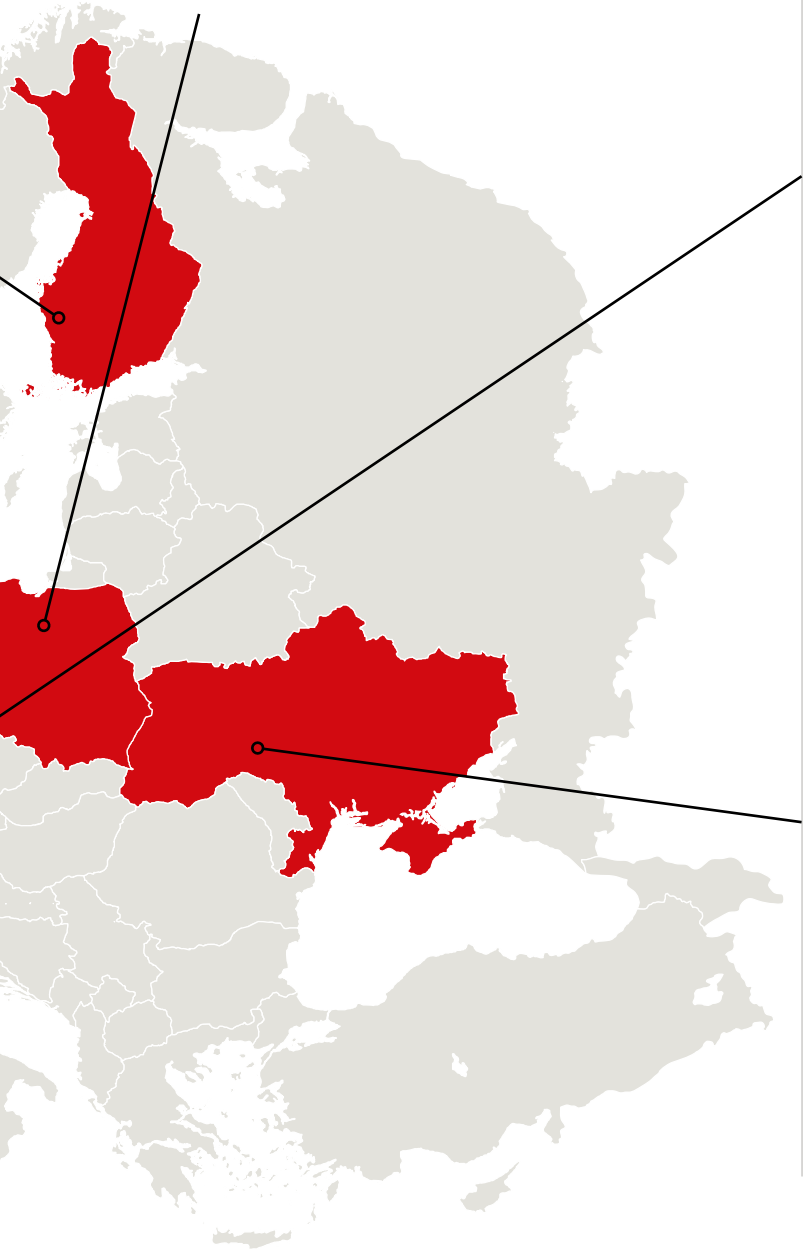
$1.8bn for Poland's power grid


Photo by Janusz Walczak on Unsplash

Northern and central Poland's power grid will be upgraded after Energa-Operator, an Orlen Group company, secured $1.8bn to modernise and digitalise the grid.

This initiative includes constructing 18,000km of new lines and modernising 10,000km of existing lines. Around 350,000 new electricity consumers and 1,600 public vehicle charging stations will be connected to the grid, together with 200,000 new prosumers. When finished, the works will connect 9GW of renewable energy sources and energy storage facilities to the network, and install 1,000 advanced transformers and voltage control elements.

The programme aims to enhance the country's energy security, stabilise energy generation and reduce dependency on fossil fuels, and reduce weather-related dependencies.



Swiss nukes to run on Kazakh uranium

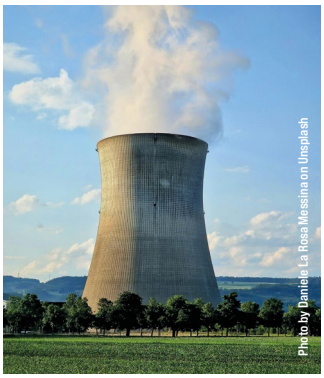


Photo by Daniele La Rosa Messina on Unsplash

Swiss nuclear operator Axpo has signed uranium supply contracts for its Beoznau and Leibstadt power stations with Kazakhstan's national Kazatomprom, the first of its kind between the countries.

Axpo say the contracts are an effort to diversify its fuel supply chain away from Russia, and that contracts have also been signed with Canada.

The first deliveries will take place from 2026, with the uranium being further processed into reactor fuel in France, Germany, the Netherlands, the UK and the US.

Bruno Zimmermann, head of nuclear fuel at Axpo, said the contract "is of strategic importance for Axpo as we continue to diversify and secure our fuel supplies."

Around 32% of Switzerland's electricity generation is provided by four reactors including two at Beznau and one at Leibstadt.

Axpo will invest €382m in Beznau to ensure operation until 2033. Leibsadt will be operational until 2045, with a fourth reactor, at Gösgen, operational until 2039. Although the Swiss parliament agreed to phase out nuclear gradually by not replacing any reactors, all operational reactors have unlimited-duration licences providing they can prove their safety to the regulator.

Ukrainian women now mining coal

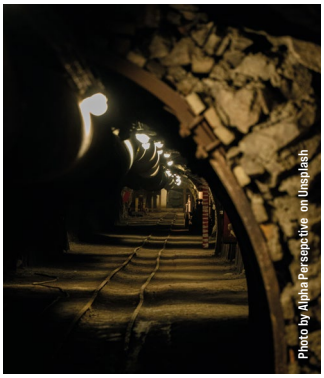


Photo by Alpha Perspective on Unsplash

Ukrainian women are holding the country's energy front line by entering the coal mines in Ternivka, western Donbas.

The mines produce around 80% of the country's coal and are a potential target for Russian forces; their capture or destruction would mean serious power cuts throughout the country.

But the oldest coal mine in the area is still in operation thanks to an increasing number of women joining the workforce. Many of these women have been displaced by war, losing their former jobs, and their homes; the job at the mine ensures their livelihood.

Women were forbidden from working in Ukrainian mines before the war under a law dating back to Soviet times. They now make up around 5% of the underground workforce in this particular mine. The change came following the Russian invasion in February 2022; many miners joined the military, leading to significant worker shortages in the male-dominated industry.

"This country needs women to rebuild it," Valentina Riabova, a 50-year-old welder at the repair shop at the Ternivka mine, told NPR.

"We are all doing what we can to survive this terrible war. This is my part," added Tetiana Medvedenko, a former housewife who now works underground.

News in Brief


Photo by MacCare on Unsplash

USB-C mandate begins

New phones, headphones, e-readers and other gadgets must now be capable of being charged via USB-C, after the Common Charger Directive came into force in December.

The new rules, which were approved in October 2022, could prevent 980 tonnes of e-waste being discarded annually. For context, EU consumers throw out an estimated 11,000 tonnes of chargers each year. In addition to reducing waste, the rules are designed to improve convenience for users, while reducing the need for manufacturers to ship devices with a whole new charger, theoretically saving consumers 250m euro a year.

Currently, the common charger rules apply to phones, e-readers, tablets, headphones, mobile gaming systems, headsets, certain computer peripherals, satellite navigation systems, and in-ear audio buds. From next April, the rules will be extended to cover laptops.

A consultation is underway in the UK about whether to follow the EU's lead, while India – the world's second-largest market for smartphones – will implement a similar rule this June. Apple (reluctantly) agreed to ditch its proprietary charger in Europe and will likely do the same around the world as USB-C becomes the de facto global standard.


Image by Konstantin Kolosov from Pixabay

UK back on Horizon

It's been a year since the UK formally rejoined Horizon Europe, the EU's flagship research funding programme, and its Earth observation programme, Copernicus.

Since 1 January 2024, UK researchers have participated in Horizon Europe on the same terms as those from EU Member States, allowing them to lead consortia and directly access funding.

This January, the EU's delegation to the UK said the UK's participation in Horizon Europe "is on a good track". It's too early to gauge how successful researchers have been with their applications as many funding calls remain open, but data shows a positive trend towards UK-based researchers and organisations.

UK researchers topped the most recent round of European Research Council (ERC) proof of concept grants, receiving 15% of the total grants given. They were also among the most successful in winning the ERC's consolidator grants and starting grants for early-career researchers; they also submitted the highest number of proposals from any country for Marie Skłodowska-Curie Actions postdoctoral fellowships in 2024.

UK involvement in Horizon Europe was delayed due to Brexit, but an agreement was reached in 2020 following a researcher-led campaign.

Boost to cross-border energy infrastructure

The Commission will award almost €1.25 billion in grants from the Connecting Europe Facility (CEF) to 41 cross-border energy infrastructure projects designed to build the continent's Energy Union, secure Europe's competitiveness and aid the EU's goals of integrating energy markets and decarbonising the energy system. Almost €750 million is assigned to eight electricity grid projects across Europe, including offshore and smart electricity grids, whilst hydrogen infrastructure will benefit from grants for 21 development studies to help decarbonise EU industry.

A further €250 million is earmarked to support the construction of three projects and the financing of nine preparatory studies for CO2 infrastructure, including projects on carbon capture and storage.

"Once completed, the successful projects will boost our efforts to decarbonise our economies and societies, integrating our energy markets and safeguarding our industry's competitiveness," said Dan Jørgensen, Commissioner for Energy and Housing.

The allocations follow the 2024 call for CEF funding, the first under the revised Trans-European Networks for Energy (TEN-E) Regulation which includes hydrogen and offshore electricity grid projects. The formal adoption of the award decision will follow in the coming weeks, with next CEF Energy call for proposals for energy infrastructure planned for 2025.

Graphene from methane

British climate technology firm Levidian recently launched their second-generation LOOP technology, making it possible to produce industrial levels of high-quality graphene for the first time.

The company hopes a network of LOOP devices will enable them to reach an annual production rate of more than 50,000 tonnes of graphene by 2030 whilst reducing emissions of around three million tonnes of CO2 equivalent per year.

The LOOP system uses a patented 'nozzle' to apply microwave energy to crack methane into its component parts, creating clean hydrogen and capturing carbon as high purity graphene.

It is estimated that one nozzle can produce fifteen tonnes of high-quality graphene annually, enough to provide thousands of electric vehicles with graphene-enhanced batteries and tyres. The graphene could also be used to improve the quality of products like thermoplastics, batteries and solar panels.

Low temperature and low pressure mean the LOOP process is efficient, does not require a catalyst or water, nor does it produce any extra CO2.

The system could allow heavy emitters and hard-to-abate industries, like landfill and aluminium producers, to decarbonise their processes and open new revenue streams from the graphene and hydrogen created. This unlocks decarbonisation projects that might otherwise be too costly.

ENTSO-E launches ten-year plan

The European Network of Transmission System Operators for Electricity (ENTSO-E)'s long-term vision for pan-European electricity infrastructure development, the Ten-Year Network Development Plan (TYNDP) 2024, was published on 31 January 2025, with it's key findings and methodologies presented in a public webinar on 28 February 2025.

The latest TYNDP identifies critical infrastructure investments that would enhance Europe's energy security and competitiveness. The plan identifies that by 2040, 108 GW of additional cross-border capacity will be needed. By 2050, 224 GW of additional cross-border capacity and 540 GW of storage would be economically efficient, delivering cost savings of over two euros for every euro invested.

The public consultation on the draft TYNDP 2024 is open until 14 March 2025, with a stakeholder workshop in Brussels on 27 March to discuss TYNDP 2024 and future cycles.

The TYNDP 2026 process for collection of submissions for electricity transmission, energy storage facility, radial or hybrid projects will take place in two windows, in Spring and Autumn 2025 respectively. ENTSO-E have released a draft Guidance document and have invited projects promoters and interested stakeholders to comment and raise questions.

Trump halts climate research

The Trump administration has withdrawn grants and support for any research in the US or overseas that references the climate crisis as the President continues his war on environmental regulations and clean-energy development.

Donald Trump has previously said the climate crisis is a "giant hoax" and has already purged government websites of the terms 'climate change' and 'global heating'. Other references to climate are being erased elsewhere too, with the administration's hostility towards climate research spreading overseas via the US's Fulbright exchange program, which offers around 8,000 grants a year to American and foreign teachers and scholars.

The administration has also imposed a freeze for federally backed scientific work, targeting any work mentioning climate on the grounds of health and public safety, and is preventing US government scientists working on next instalment of the Intergovernmental Panel on Climate Change report, due in 2029.

The suspension of grants has plunged the US scientific community into chaos and disrupted scientific research across federal agencies, hospitals, and universities, casting uncertainty over the future of research worth hundreds of millions of dollars.

The administration is also targeting other topics they consider 'woke', including racial equity, gender identity and anything including the phrase 'diversity, equality and inclusion'.

Fossil fuel power usage at historic low

The continued growth of solar and wind power in the EU has pushed fossil fuel power to its lowest level in 40 years according to Carbon Brief analysis of new figures from energy analysts Ember.

Coal power use has fallen by 61% in the last decade, while wind generation more than doubled between 2014 and 2024. Solar power output tripled from 120GW to 338GW during the same period and in 2024, overtook coal generation for the first time.

This growth of renewables over the past decade has also helped the EU avoid €59bn in fossil-fuel imports over the past five years, Ember says – without it, the EU would have imported an extra 92bn cubic metres of gas and 55m tonnes of hard coal, representing cumulative emissions of some 460m tonnes of carbon dioxide.

Since 2019 and the passing of the European Green Deal, the EU's electricity sector has undergone a significant transformation, according to the latest findings, with the palpable surge in renewables driving down the use of fossil fuels and related CO2 emissions.

In 2019, fossil fuels provided 39% of the EU's electricity, compared to 29% in 2024. In comparison, renewables provided 34% in 2019, and 47% in 2024. Nevertheless, groups including the Centre for Research on Energy and Clean Air (CREA) have criticised the EU's ongoing use of Russian fossil fuels in particular.

2024 warmest year on record

2024 was the warmest year on record and the first ever to exceed 1.5°C above pre-industrial levels for the annual global average temperature, according to the Copernicus Global Climate Report 2024.

It was also the warmest year for all continental regions, including Europe, except for Antarctica and Australasia. Europe is the fastest-warming continent, warming twice as fast as the global average, a trend that has been observed since the 1980s.

European land in the Arctic continues to be the fastest-warming region, with changes in atmospheric circulation favouring more frequent summer heatwaves, glacier melting and changes in the pattern of precipitation.

The overall incidence and severity of extreme weather events are increasing, the report found. Sea surface temperatures also remained extremely high, with July to December 2024, being the second warmest on record for the time of year.

Increasing concentrations of greenhouse gases (GHG) are a major contributor to rising temperatures, and the European Commission has already recommended a 90% net GHG emissions reduction target for 2040 in addition to EU legislation to reduce GHG emissions by at least 55% by 2030.

The UK Met Office predicts that 2025 will be another record-breaking year, with global temperatures reaching around 1.41°C above the average for the pre-industrial period.

CarboDoH2: Exploration of functional and affordable electrodes for hydrogen generation

By **Stefanos Chaitoglou, Roger Amade** and **Enric Bertran-Serra,** Department of Applied Physics and IN2UB, University of Barcelona, Spain and **Panagiotis Loukakos** and **Argyro Klini,** Institute of Electronic Structure and Laser, Foundation for Research and Technology - Hellas, Greece

CarboDoH2 is a Horizon Europe project focused on developing novel composite electrodes to accelerate hydrogen production in water electrolysis cells. The project explores the potential of innovative low-dimensional nanomaterials, such as graphene and its derivatives, as efficient and cost-effective solutions for sustainable hydrogen generation. Coordinated by the University of Barcelona (Spain), the project also involves the Foundation for Research and Technology – Hellas (FORTH) in Greece. Running from September 2023 to August 2025, the project will span 24 months.

Background and conceptualization: In the fight against climate change, the development of environmentally sustainable energy generation and storage technologies is essential for ensuring both environmental and economic security. As fossil fuels are finite, there is a growing need for alternative and renewable energy carriers. Hydrogen has gained considerable attention as a promising solution because it is the most abundant element in the universe and offers the highest specific energy density of any known fuel (~120-142 MJ/kg, corresponding values for petroleum and natural gas are ~45 and ~55 MJ/Kg, respectively). Additionally, hydrogen is a clean fuel: when used in a fuel cell, it produces only water, electricity, and heat. As such, hydrogen fuel cells are central to the transition towards sustainable energy systems and circular economies (see Figure 1).

Currently, hydrogen (H_2) is primarily produced through two methods: i) natural gas steam reforming and ii) methanol reforming. However, the first method relies on a non-renewable energy source, while methane reforming results in CO_2 emissions, contributing to the greenhouse effect. As such, these conventional routes are insufficient for meeting the energy demands of a post-fossil-fuel society, while preventing global warming. An environmentally responsible, carbon-free alternative is water splitting through electrolysis, a technique for hydrogen production that does not rely on fossil fuels. Water splitting occurs in an electrolysis cell and requires a minimum potential difference of 1.23 volts to drive the reaction. In practice, however, higher potential values are required to initiate these reactions due to sluggish reaction kinetics and other inefficiencies. The hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) take place at the cathode and anode of the cell, respectively, producing gaseous hydrogen and oxygen. Heterogeneous electrocatalysis plays a critical role in accelerating the electrochemical reactions on the surface of catalyst materials, enabling them to initiate at lower potentials and higher rates. Therefore, the design and development of highly efficient catalysts is fundamental for improving the overall performance and cost-effectiveness of water electrolysis for hydrogen production.

To date, noble metals from the platinum group (e.g., Rh, Pt, Ru) are the most efficient electrocatalysts for hydrogen generation. However, the high cost and scarcity of these materials limit their widespread use. In contrast, earth-abundant transition metals (TMs) have also shown significant potential for HER. Among them, transition metal carbides (TMCs) are particularly promising due to their excellent performance and availability. To enhance hydrogen production per electrode surface area, it is critical to engineer catalysts with a high active surface area, thereby increasing the number of active sites. This principle lies at the heart of the CarboDoH2 project, which aims to design novel nanostructured TMCs capable of accelerating the hydrogen evolution reaction. To achieve this, we propose a new synthetic approach that enables the fabrication of nano-engineered TMC films supported by graphene-based conductive templates. These templates not only provide excellent electrical conductivity but also significantly increase the active surface area of the catalysts.

Main results: The project focuses on developing new technological concepts for the preparation of nanocomposites and their validation in a laboratory environment. To achieve this, vapor deposition techniques, such as magnetron sputtering and chemical vapor deposition (CVD), are employed. These techniques are widely used across various industries, from semiconductors and electronics to coatings and solar cells, offering significant scalability potential. This scalability is essential for advancing the technology readiness

level (TRL) of our system and bringing it closer to meeting real-world operational demands. Additionally, complementary studies explore the use of laser irradiation as an efficient method for controlling and fine-tuning the electrical conductivity and surface properties of the materials.

Main outcome 1: Deposition of vertically aligned graphene nanowalls compound with a high surface-to-volume ratio. The graphene film is deposited in both semiconducting and metallic substrates. The film exhibits very good adhesion, as well as mechanical and chemical stability. It can be an ideal coating applied in current collectors to enhance the total surface area.

Main outcome 2: Transition metal carbides are deposited on graphene-based electrodes to form hybrid composite materials with a large number of active sites. Molybdenum and tungsten carbides have been proven to be very efficient electrocatalysts for hydrogen evolution. By careful tailoring of their morphology in the nanometre scale, these hybrid systems can offer performance levels comparable to platinum, even under harsh operation conditions.

Main outcome 3: Pulsed laser irradiation is employed for the rapid functionalization of the nanocomposites, effectively controlling both the density of defects in the graphene crystal matrix and the size of the transition metal nanoparticles deposited on it. These two parameters have proven to be crucial for optimizing the performance of the composites towards hydrogen generation. This outcome brings forward the application of laser-based methods for the enhancement of the efficiency of metal catalysts in the hydrogen evolution reaction.

Main outcome 4: The excellent performance of the composites is manifested by the following performance metrics:

- Capacity to generate a current density up to 1 A cm-2.
- Low required overpotentials, e.g. generation of 10 mA cm -2 at 80 mV.
- Stable performance during tenths of hours of operation.
- Excellent chemical and structural stability.

CarboDoH2 drives efforts towards the design and synthesis of advanced nanostructured catalysts with strong emphasis on cost-effective raw materials and scalable processes as key pillars. ■

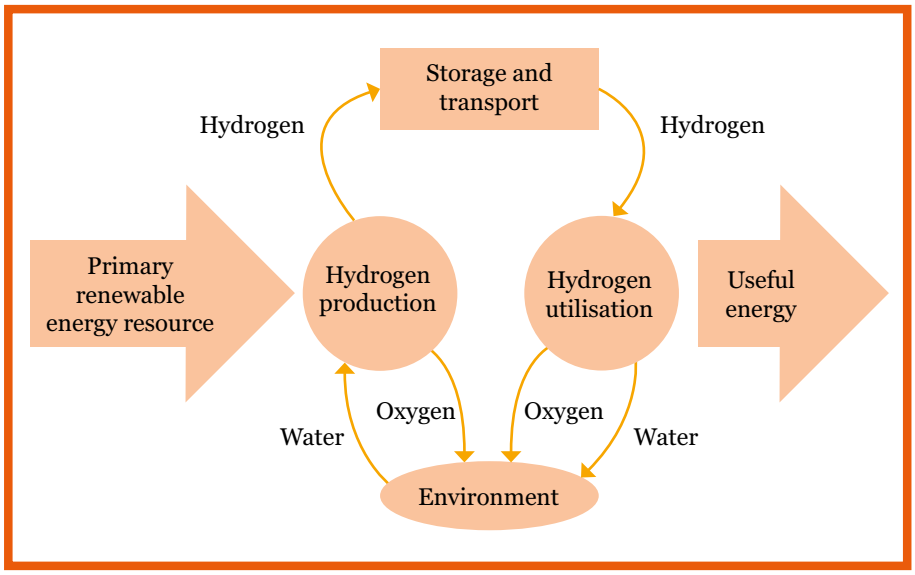


Figure 1: Hydrogen life cycle derived from renewable energy

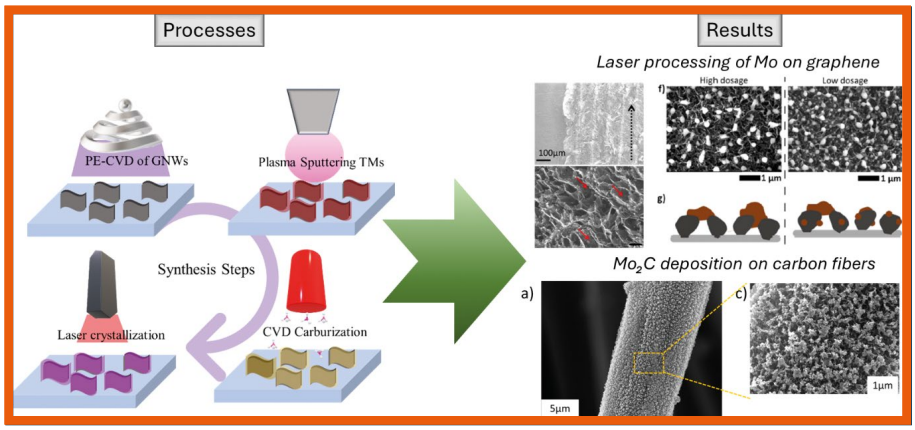


Figure 2: Overview of the included processes and key results of the project.

Key publications

S. Chaitoglou, Y. Ma, R. Ospina, G. Farid, J. Serafin, R. Amade Rovira, E. Bertran-Serra ACS Appl. Nano Mater. 2024, 7, 22631−22639

S. Chaitoglou, A. Klini, N. Papakosta, Y. Ma, R. Amade, P. Loukakos, E. Bertran-Serra J. Phys. Chem. Lett. 2024, 15, 3779−3784

S. Chaitoglou, R. Ospina, Y. Ma, R. Amade, X. Vendrell, J. Rodriguez-Pereira, E. Bertran-Serra Journal of Alloys and Compounds 2024, 972,172891

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UNIVERSITAT DE BARCELONA

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APOLLO: Reaching new heights in solar recycling

By **Ivana Koláčková,** FENIX TNT

The photovoltaic (PV) industry is experiencing a crucial moment in its development. With an ever-increasing number of installations, there is an equally growing challenge: the environmental impact of PV waste. In 2020 alone, the global PV industry generated approximately 400,000 tonnes of future waste, and this number is expected to surge to an estimated 5.5 million tonnes annually by 2050.

By then, 60–78 million tonnes of raw materials will be locked up in the end-of-life (EOL) PV modules. Within the European Union, the situation is just as alarming, with 150,000 tonnes of PV waste expected to be produced annually by 2030. This presents an urgent challenge for the industry, one that is further highlighted by the fact that many of the PV systems installed decades ago were never designed with end-of-life management in mind.

The majority of these ageing PV systems were built with little consideration for future disassembly and recycling. As these modules approach the end of their 25-year lifespan, an innovative solution is required to recover the raw materials they contain, from silicon to critical metals. Current recycling methods are far from sufficient.

Traditional recycling processes for crystalline silicon modules focus on recovering only aluminium and glass. While glass, the largest mass component of a PV module (making up 70% of its weight), is often recovered, it is typically of poor quality, contaminated with other materials, and can only be used for low-value applications such as insulation. The challenge for the PV industry, therefore, is clear: how can we recover these materials at a high enough quality to make them useful for manufacturing new PV systems?This is where the APOLLO project enters the picture. One of the critical breakthroughs in the APOLLO project lies in improving the sorting of PV waste. Ultimately, the goal of the APOLLO consortium is to recover 93% of the materials by mass from legacy and future PV modules, making them suitable for reuse in new products. Traditional recycling has not focused on the pre-sorting phase, resulting in mixed materials and low-value outputs. APOLLO aims to address this by developing a system that categorizes glass by its specifications early in the recycling process, ensuring it can be reused in high-value applications such as new solar glass or even architectural glass.

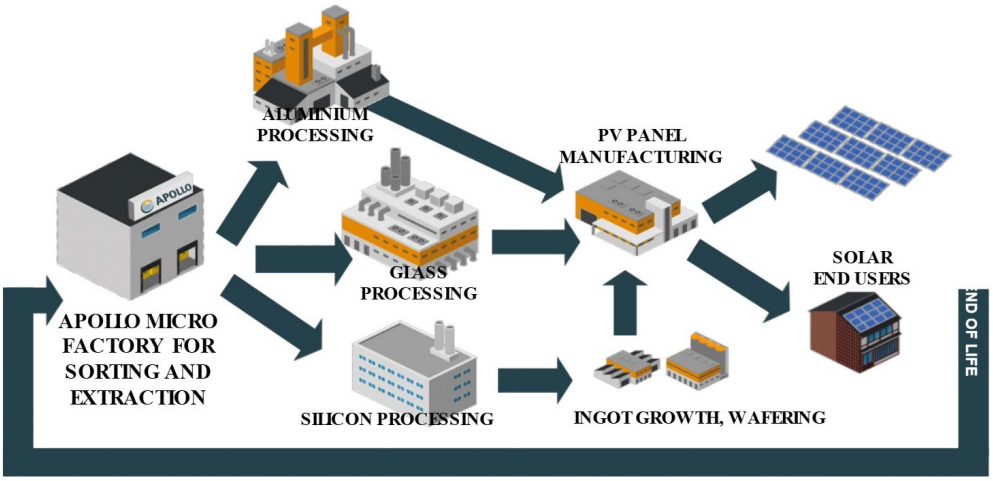
A key innovation of the APOLLO project is its advanced extraction process for recycling valuable materials from PV waste. Traditional recycling methods rely primarily on physical separation techniques, which are often ineffective in recovering high-value elements like silver, copper, and lead. APOLLO is developing a new method that combines ultrasound technology with low-impact, environmentally friendly chemical processes. This approach is designed to efficiently and cost-effectively extract and separate these materials, minimizing environmental impact and significantly increasing the economic value recovered from PV waste.

Once these materials are extracted, the next step is refining them to a level of purity suitable for use in new products. Currently, the recovered silicon from PV waste is contaminated and cannot be used directly to manufacture new solar cells. APOLLO's solution involves refining the silicon through innovative gas phase purification processes to remove contaminants like boron and phosphorus.

The refining process, which has already been successfully demonstrated at the lab scale, results in significantly lower environmental impacts compared to the production of virgin silicon. This breakthrough offers a promising pathway for incorporating recycled silicon into new solar modules, reducing the reliance on raw materials and cutting the carbon footprint of PV production.

The final step in the APOLLO project is the development of a digital platform that will track the lifecycle of PV modules through the use of Digital Product Passports (DPPs). These DPPs will provide a trusted and transparent system for tracing the materials in PV waste streams, ensuring that they can be safely and efficiently reused. It will help create a circular economy for the PV sector, enabling more efficient recycling, reducing waste, and ensuring that valuable materials are recovered and reused.

Looking ahead, the need for effective PV recycling solutions will only grow as more solar panels reach their end of life. The APOLLO project is not only addressing the immediate challenges of recycling legacy PV systems but is also preparing the industry for the challenges posed by the next generation of solar technologies, such as perovskite-based PV panels. ■



About APOLLO project

The APOLLO research has been made possible by being co-funded by the European Union under Grant Agreement No. 101122277, the State Secretariat for Education, Research and Innovation (SERI), and UK Research and Innovation (UKRI). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

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Coordinator: FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV

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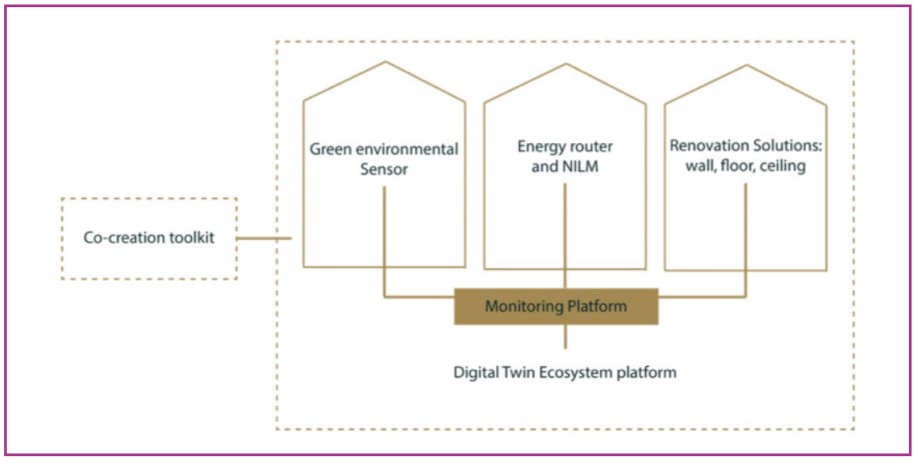
State Secretariat for Education, Research and Innovation SERI

Co-funded by the European Union

Innovate UK

Herit4ages:
Smart solutions for a sustainable and inclusive cultural heritage



By **Ivana Koláčková,** FENIX TNT

Europe's historic buildings are more than just structures of stone and timber; they are the living embodiment of our shared cultural identity. For centuries, they have withstood the test of time, their resilience serving as a testament to the craftsmanship and ingenuity of past generations. Yet, as society transitions to a low-carbon future, these heritage buildings face an existential challenge: how can they be preserved while meeting modern comfort, sustainability, and energy efficiency standards?

The Herit4ages project is taking on this challenge, demonstrating that it is possible to enhance the performance of these buildings without compromising their architectural and cultural integrity.

Heritage buildings often suffer from inadequate thermal performance, with many lacking proper heating or cooling systems. Those that do have climate control mechanisms frequently struggle with high energy costs due to the need to regulate large interior volumes. The Herit4ages project is working to bridge this gap by developing innovative, cost-effective, and reversible solutions that can be replicated across Europe. More than just renovation, it aims to redefine how we integrate our past into a sustainable future.

Herit4ages aligns with key European sustainability policies, tackling the unique challenge of energy-efficient renovation in heritage sites where energy-upgrading materials and methods might conflict with conservation laws. By developing non-intrusive, digitalized, and environmentally conscious solutions, the project is redefining sustainable heritage preservation, ensuring historic structures meet modern energy and comfort standards while safeguarding their cultural integrity.

The project is testing internal retrofitting solutions that utilize heritage-friendly materials and insulation techniques to improve thermal comfort while respecting their cultural integrity by being reversible. Herit4ages also introduces cutting-edge solutions such as the Digital Twin Ecosystem (DTE), a monitoring system that enables real-time assessment of energy efficiency, structural conditions, and environmental parameters, allowing for optimized energy use and predictive maintenance. Complementing this, innovative environmental sensors detect temperature, humidity, and air quality shifts that could accelerate material degradation. The project also pioneers the Smart Energy Router for use in heritage buildings. This is an intelligent energy management system integrating

"Heritage buildings often suffer from inadequate thermal performance, with many lacking proper heating or cooling systems"

renewable sources, battery storage, and grid electricity, using non-intrusive load monitoring (NILM) to regulate energy consumption which can be easily adapted for residential use.

Herit4ages also prioritizes human-centric design. The Co-Creation Toolkit encourages community involvement in the renovation process, ensuring that interventions align with local cultural values and social needs. This inclusive approach promotes acceptance and engagement among stakeholders, from local residents to heritage conservation authorities.

These solutions are being tested in five culturally significant buildings across Europe. They include: Spain's Canduela Heritage Lab, an experimental site within a 13th-century Romanesque hermitage, and the Posada Santa María la Real, an 18th-century monastery-turned-hotel; Italy's University of Bologna Historical Engineering Building with its Modernist façade. In Funchal (Portugal) heritage social housing will be included. In Estonia, Korporatsioon Vironia, a Neo-Renaissance cultural monument used as offices.

By seamlessly integrating digital tools, renewable energy solutions, and socially inclusive design, the project is proving that sustainability and cultural preservation are not mutually exclusive. Instead, they are two sides of the same coin - ensuring that our architectural legacy remains not a relic of the past, but a vibrant and functional part of our future. ■

About Herit4ages project

The Herit4ages project is funded by European Union under Grant Agreement No. 101123175. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

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Coordinator: UNIVERSITY COLLEGE CORK - NATIONAL UNIVERSITY OF IRELAND, CORK

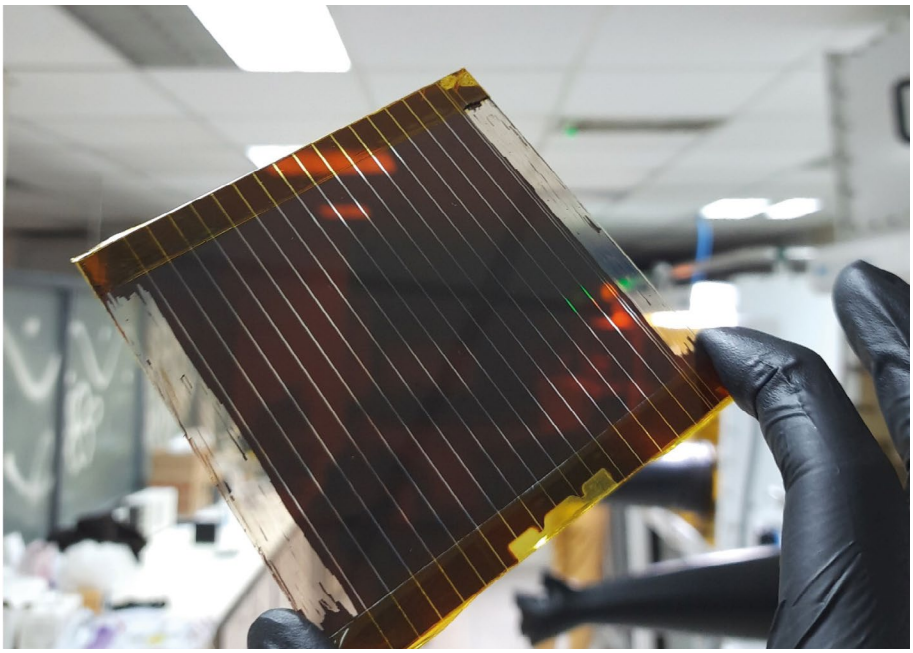
Website: www.herit4ages.eu

Project funded by:

Funded by the European Union

PERSEUS and the Future of Renewable Energy

By **Ivana Koláčková,** FENIX TNT



Europe's energy landscape is undergoing a significant change, driven by the increasing demand for renewable energy sources and the urgent need to decarbonize the economy. In recent years, solar energy has become a major player in Europe's renewable energy sector, with solar power capacity in the European Union (EU) increasing at an unprecedented rate.

In 2024 alone, the EU added a record-breaking 66 GW of new solar capacity, pushing the total solar power capacity to 320 GW, a 25 % increase from the previous year. Projections suggest that this growth will continue and solar energy, already one of the most competitive forms of renewable power, is probably going to play a central role in Europe's energy transition.

However, traditional photovoltaic technology faces several challenges that limit its broader adoption. The global solar market is largely dominated by Asian, particularly Chinese, manufacturers, raising concerns about energy security and supply chain dependencies.

Additionally, conventional silicon-based solar panels have limitations in integration options, particularly in urban environments, due to their weight, aesthetics, and rigid structure. Performance losses in low-light conditions and the efficiency cap of single-junction silicon cells further constrain their potential. The PERSEUS project, a key initiative in Europe's solar energy revolution, is addressing these issues by advancing the large-area module production, improving long-term stability, and developing high-throughput manufacturing processes to bring perovskite solar technology to commercial viability.

The PERSEUS project focuses on perovskite-based solar cells (PSCs), a promising next-gen technology that is lighter, cheaper, and more efficient than traditional silicon cells. PSCs have reached a lab efficiency of 27 % in 2025 up from 3.8 % in 2009. However, scaling them for commercial use is challenging due to lab and real-world performance differences. PERSEUS is tackling this by developing large-area PSC modules for various applications, such as floating photovoltaics, building-integrated

photovoltaics, agri-photovoltaics, and urban solar solutions.

While PSCs have already reached industrial-scale production in China and are being explored by several European players, real-world performance still lags behind laboratory results. The PERSEUS project is tackling this issue head-on by developing large-area PSC modules for a variety of applications, including floating photovoltaics, building-integrated photovoltaics, agri-photovoltaics, and urban solar solutions. These modules are designed to meet the diverse needs of the energy market, from high-efficiency solutions for building-integrated applications to durable modules for use in floating and agricultural systems.

In the PERSEUS project, researchers are focused on developing three distinct architectures of large-area PSCs: single-junction opaque modules, semi-transparent modules, and 4T perovskite + copper indium gallium selenide (CIGS) tandem modules. Each of these designs targets specific applications and performance characteristics. The single-junction opaque modules are optimized for general utility-scale applications, while the semi-transparent modules are tailored for use in building-integrated photovoltaics.

The tandem modules, which combine perovskite with CIGS, aim to achieve even higher efficiency by stacking multiple materials with different absorption properties. These tandem modules are expected to outperform single-junction PSCs in terms of efficiency. One of the key goals of the project is to demonstrate the ability to manufacture these modules at large scales while maintaining high performance, durability, and cost-effectiveness.

As renewable energy technologies continue to evolve, it is essential that the regulatory framework keeps pace with these advancements. The project is collaborating with policymakers to ensure regulations support digital innovations in energy. By focusing on interoperability, PERSEUS facilitates seamless data exchange among stakeholders and promotes secure, open-source platforms, driving digitalization in line with the EU's Green Deal objectives.

The project's innovations will be tested in real-world conditions across several pilot sites in Europe. These pilots are crucial for refining the technologies developed by PERSEUS before they are deployed on a larger scale and will be used as showcases for reluctant consumers, proving the high efficiency and longevity.

In the coming years, the project's legacy will be measured not only in technical breakthroughs but in its ability to drive systemic change - transforming the way we produce and consume energy in the digital age. The future of clean energy is no longer a question of possibility, it is a question of urgency. ■

About PERSEUS project

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Website: www.perseus-project.eu

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Project funded by:

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State Secretariat for Education, Research and Innovation SERI

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TREASURE: Accelerating 100% sustainable district heating with Pit Thermal Energy Storage

By **Ivana Koláčková,** FENIX TNT

With the growing need for energy system flexibility and the rise of renewable energy sources like solar and wind, thermal energy storage becomes essential to balance supply and demand. The EU-funded initiative, TREASURE, aims to utilize the potential of Pit Thermal Energy Storage (PTES) for district heating networks and accelerate the adoption of large-scale PTES solutions to phase out fossil fuels and establish 100% renewable district heating systems across Europe.

A fully decarbonized European energy system requires significant capacity for heat storage to accommodate the fluctuating availability of renewable energy. PTES systems offer a unique solution, maximizing the storage of solar, geothermal heat or waste heat during warmer periods and deploying it when demand rises. TREASURE's core goal is to develop robust, safe, and cost-effective PTES solutions that are scalable across Europe's diverse climatic zones.

Through the targeted development of components, integration processes, and collective improvements in design and building protocols, TREASURE brings together a wide group of experts and market-driven partners to develop scalable and secure methodologies for implementing PTES systems.

A central focus of TREASURE is to demonstrate robust, safe, and economically viable PTES solutions across Europe. The project is developing and monitoring seven large-scale PTES demonstrations in five countries, with storage capacities ranging from 18 000 m³ to 500 000 m³. These sites provide different geographical conditions, including the local environmental and energy source variations. Importantly, economic competitiveness is prioritized, ensuring the PTES systems are financially attractive to district heating companies. Apart from technology, social acceptance is crucial, and TREASURE is actively studying how different countries across Europe view large-scale thermal energy storage to develop measures that encourage public and policy-maker support.

To ensure scalability and replication there is a need to understand that achieving fully renewable heating systems will require efficient design, smart integration of energy storage, and cost-effective deployment. To that end, TREASURE works closely with more than 15 satellite initiatives across Europe. These partnerships ensure the rapid transfer of knowledge, best practices, and support for permitting and financing challenges. Plans to increase societal acceptance are also integral, helping ensure a successful adoption of PTES systems. Working closely with the satellite initiatives is the basis for an effective spread of the experiences in the project, and a source of direct interactions leading to better quality and application of the project developments and achievements. All

new PTES initiatives are kindly invited to join the existing group, strengthening the corporation and learning from the collaboration.

Additionally, TREASURE aims to develop smart system integration concepts that maximize the share of renewable heat in district heating networks. This will involve developing secure thermal energy storage systems that can interface seamlessly with broader heating infrastructures. By improving these systems, district heating companies will be able to address operational challenges related to peak demand and fluctuating energy supply. Key to this process will be monitoring data from existing systems, which will help simulate future performance and optimize the design and function of new systems.

The duration of the whole process, from idea through planning, design, building, to commissioning and operating, is very long at the moment, up to seven years. To get better grips on this process, a number of internal workshops are organised, each addressing one of the main phases in the project. After the first workshops, we can already identify a number of challenges that, when addressed, would lead to a shortening of the project duration. One of these is a lack of experience with the new technologies with officials involved in permitting and legislation. In the further course of the project, a dedicated workshop for permitting and legislation is planned. People interested in this are invited to get into contact with us.

Whether it's overcoming regulatory hurdles in France or addressing environmental challenges in Serbia, TREASURE stands as a unique initiative increasing awareness and implementation of renewable, efficient, and user-accepted PTES systems that can play a crucial role in Europe's energy transition. ■

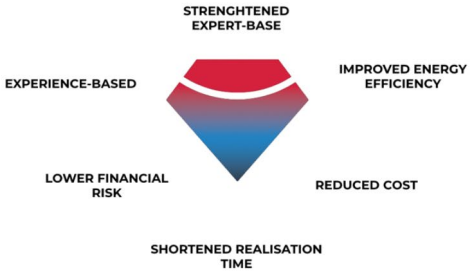

Figure 1: TREASURE Project Ambitions

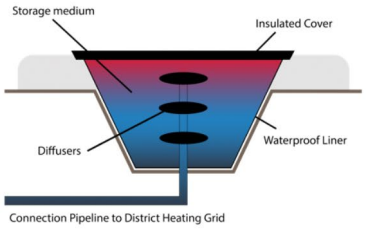

Figure 2: TREASURE Pit Thermal Energy Storage (PTES) System

About TREASURE project

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Website: www.treasure-project.eu

Coordinator:AEE - INSTITUT FUR NACHHALTIGE TECHNOLOGIEN (AEE)

Project funded by:

Funded by the European Union

GoNEXUS: Advancing the WEFE governance to better manage our resources

GoNEXUS
Integrated solutions for water, energy, food and ecosystems

Launched in June 2021, the European Horizon 2020 project GoNEXUS will come to an end this May, with significant progress being made in establishing a governance system based on the Water-Energy-Food-Ecosystem Nexus (WEFE Nexus) approach. In a world where economic prosperity and well-being are closely tied to the efficient and sustainable management of natural resources, the increasing demand for water, energy and food, and its impacts on ecosystems, must be considered. These four sectors are interlinked and interdependent, which raises food and energy security challenges and the need for mutually beneficial responses across borders.

Today, migration pressure, food price shocks, water shortages and energy market imbalances are real risks that need to be anticipated and effectively managed. Through eight in-depth case studies focused on river basins in Europe and Africa, GoNEXUS addressed efficient and sustainable governance of the WEFE Nexus, fostering synergies to achieve long-term resilient economic, environmental, and social goals.

"Governance of the WEFE Nexus is essential for achieving sustainable resource management by acknowledging the interconnections among these vital sectors", noted Manuel Pulido Velázquez, GoNEXUS coordinator, director of the Research Institute of Water and Environmental Engineering (IIAMA), and director of the Climate Change Chair at the Technical University of Valencia (UPV), Spain. He went on to point out that "effective governance in the WEFE context fosters coordination across sectors, minimises resource conflicts, and strengthens resilience to climate change and socio-economic challenges".

Enhancing energy efficiency and security

In the energy sector, the WEFE's governance is particularly transformative, as it promotes the integration of renewable energies by ensuring that water availability is considered in hydroelectricity, bioenergy and cooling systems for thermal power plants. It also contributes directly to enhancing energy security.

According to Manuel Pulido Velázquez, addressing demands for land and water for energy production is key to reducing vulnerability to resource

shortages: “Effective governance enhances efficiency by encouraging innovations such as wastewater reuse for cooling power plants, integration of solar energy in irrigated agriculture, and encouraging cross-sector collaboration by facilitating partnerships between public services, policymakers, and industry for more sustainable energy production.”

GoNEXUS activities highlighted the need to expand the adoption of renewable energy sources in Europe, including bioenergy, solar photovoltaics and biomass from agroforestry waste. This diversified energy mix will support the transition to a circular bioeconomy, encouraging alternative energy solutions to reduce reliance on fossil fuels, and contributing to the EU’s decarbonisation efforts.

Encouraging stakeholder participation

Over the past three years, GoNEXUS activities have been designed to follow a collaborative approach through a series of “Dialogues” targeting stakeholders on the global, European, and river basin scale. “The Nexus issues are highly complex and require the mobilisation of different types of knowledge, knowledge of stakeholders in the energy, water, environment, agricultural production and food sectors, etc., in addition to scientific knowledge”, explained Laura Seguin, GoNEXUS partner at the BRGM, the French geological survey.

Stakeholder participation played a crucial role in defining, refining and validating scenarios, models, and solutions for decision-making from global to local/basin level. During the Dialogues, stakeholders explored the projections outlined in the scenarios to discuss risk management across the Nexus sectors. They also helped the GoNEXUS team better understand existing conflicts and trade-offs within the WEFE Nexus; misaligned sectoral policies, synergies, and uncertainties: “Simulating the evidence of the WEFE Nexus and the impact of solutions through models are like virtual laboratories”, spotted Kyra Baumann, analyst at adelphi. Furthermore, “stakeholder involvement and engagement play a significant role in policy formulation. When implementing solutions, there is a need to involve everybody”, underpinned Gerald Mundonwa from the Zambezi Watercourse Commission (ZAMCOM) and GoNEXUS partner.

Based on existing data and the results of the Dialogues, a Solutions Evaluation Framework (SEF) was developed to ensure that the solutions are technically, socially and politically feasible, efficient, and sustainable. Additionally, it serves as a guide for processing raw scenario data and model toolbox results – a set of analytical tools to assess the current situation and project future challenges related to climate change.

Focus on the Zambezi Watercourse

In early February 2025, the third and final round of Dialogues took place in Livingstone, Zambia. This was an essential milestone in the ongoing discussions on sustainable water and energy development in the Zambezi watercourse, providing valuable insights and fostering stakeholder collaboration. The eight riparian states sharing the watercourse (Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia, and Zimbabwe) have already established a Zambezi Strategic Plan, and the value was to align this regional policy document with the WEFE Nexus analysis and approach.

One of the key findings of research by Polytechnic University of Milan (POLIMI), one of GoNEXUS partners, is the impact of a recent rapid reduction in the cost of renewable energy technologies, which presents both opportunities and challenges. A critical point raised by the POLIMI team during the Dialogue deliberations is the vulnerability of hydropower to hydroclimatic variability.

Like many other regions, the Zambezi River Basin is experiencing an increase in current and forecast extreme weather events that pose significant risks to hydropower infrastructure. These climate change impacts require anticipatory action to ensure the resilience and sustainability of energy systems. The study highlights the importance of re-operating existing systems and carefully considering the design or construction of new infrastructure capable of adapting to these environmental challenges.

GoNEXUS partner ETH Zurich conducted high-fidelity modelling of the Zambezi water catchment, accounting for changes in the balance of inflows and outflows due to a climate change and the policies on reservoir operation and irrigation allocation provided by the POLIMI system optimisation model.

The main conclusions of these Dialogues are that the higher frequency and number of days of low flows will increase; extreme flows, including floods, will occur and the development of reservoirs may lead to a reduction in flows in the Indian Ocean.

The Zambezi case study highlights the importance of implementing WEFE Nexus governance. While climates, geographies, socio-economic and political contexts vary globally, managing resources in the face of climate change remains a major challenge that requires anticipation and a coordinated plan of action. ■

On the path to a green future: the importance of bottom-up initiatives in cities

The European Youth Energy Forum's unique bottom-up approach is a leading example of citizen engagement in the energy transition.

By **Bettina Päri**, EUSEW Young Energy Ambassador

Why should we consider engaging citizens?

Active citizen participation in the energy transition receives attention in the sustainable energy sector. However, when it comes to broader public awareness, the topic gets notably less limelight, and citizen participation in bottom-up projects is still considerably low. What is the reason for that and how do we address this problem?

To achieve the 100 Net-Zero-Cities target by 2030, applying bottom-up initiatives is necessary for a full-scale change. Solely implementing top-down initiatives might leave people feeling dismissed, whereas bottom-up projects offer a direct channel for people to engage, hence motivating them to initiate changes. This is important, not only in the context of cities. By implementing these, the energy transition can be done with the citizens, not to the citizens. One such bottom-up initiative I have had the chance to be involved in is the European Youth Energy Forum.

The outcomes of the European Youth Energy Forum

In October, 50 young professionals and students were selected to gather at the European Youth Energy Forum (EYEF). The Forum is organised by the European Youth Energy Network and brings together young people and other energy stakeholders to discuss the energy transition. For two months, six teams met online every week to work on six policy proposals centred around the role of cities in the energy transition. According to the participants,

"Solely implementing top-down initiatives might leave people feeling dismissed"

the most critical issues to tackle were energy poverty, community engagement and interdisciplinary collaboration, residential energy optimisation, electric mobility, financing mechanisms in the energy sector, and energy-efficient urban planning. The event itself is an example of a bottom-up initiative involving the public.

As a concrete example, during the work on the community engagement and interdisciplinary collaboration proposal, a programme was suggested, in which a position for a community energy ambassador would be created. This person would help citizens make sustainable decisions on an individual level by acting as an informative body inside the community. Therefore, these ambassadors would **help bridge the information gap between citizens and technical energy topics**. This initiative specifically shows how people outside the green energy sector could participate in the transition, given also that the ambassador is chosen from within the community itself. Apart from this initiative on Community Energy Ambassadors, other proposals were focusing on: green commuting, more opportunities for residential participation, University-Powered Energy Communities, the impact potential of small cities and on sustainable urban actions. Take a closer look at all of the proposals.

As a result of this event, a position paper came to daylight. Gathering the six proposals, it was published with the title: Sustainable Cities of the Future. This report presents concrete, bottom-up solutions that can be implemented in various contexts. All six proposals were presented at this year's Conference of Parties in Baku.

The outcomes of the Youth Energy Forum underline that to achieve net-zero cities, and to ensure a successful energy transition, we need the citizens on board. The aforementioned report is one example of how to do this in practice, but there are numerous other success-stories, as is highlighted below. By taking initiative on the grassroot level, and by involving all citizens, we take yet another step towards creating a more sustainable future for all. ■

About the author

Bettina Päri is a 21-year-old student at University of Tartu, Estonia, studying in the branch of economics and German studies. Currently, she is fulfilling her studies at the University of Potsdam, Germany, where she is researching the effects the energy crisis of 2022 had on Germany's clean energy consumption. She is actively participating in youth-led initiatives such as European Youth Energy Forum 2024, European Youth Day 2025, as well as tackling clean energy education and awareness in Potsdam. Bettina is focused on contributing in every way possible and making the voice of young people heard in the clean energy transition.

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The green transition at a crossroads: how equity can take it forward

A Green and Social Deal in the EU will ensure a just and equitable transition, balancing climate action with social protection for vulnerable groups.

By **Eliza Barnea**, EUSEW Young Energy Ambassador

As the new European Commission took office, debates regarding the bloc's priorities for the future in a time of permacrisis were in full swing. From the COVID-19 pandemic, the Russian full-scale invasion of Ukraine, the energy crisis and ever-more frequent natural disasters, the events of the past years have kept the EU in a constant stream of crisis response. Yet today's challenges are structural in nature and long-term in breadth. The cost of living, the international security landscape, the state of democracy and climate change were some of the top priorities that brought people to the polls in the EU election with the highest turnout of the past 30 years.

Perhaps the most transformative in its potential impact is the EU ambition to spearhead the transition to climate neutrality. Yet this has been met with mounting frustration on the part of workers - frustration which has been exploited by extremist political discourse across Europe. As seen in the recent disrupted elections in Romania, the rise of populist movements risks taking us back to square one by questioning the very notion of climate change. The future of the European Green Deal (EGD) and the Fit for 55 package seems still uncertain, yet the need for action is becoming more urgent with every passing moment. According to the Emissions Gap Report published by UNEP in October, the world is on course for a temperature increase of up to 3.1°C. This is more than double the threshold of 1.5°C which governments worldwide committed to upholding almost 10 years ago through the Paris Agreement.

The disastrous effects of climate change have continued to ravage the continent this year, resulting in human and material losses worth tens of billions of euros. As a result, EU election results clearly display the need to better address perceived tensions between environmental objectives and social equity. Climate policy can only work if we also address societal needs.

Climate action and social justice, two sides of the same coin

One poignant example of the interconnectedness between climate

"Agriculture is not the only strategic sector where the push for faster climate action is disproportionately affecting the most vulnerable"

action and social justice is the 2024 wave of farmers' protests across Europe. A common point of contention is the strict EU environmental regulations and recently agreed-upon trade deal between the EU and the South American trade bloc Mercosur. According to French farmers, the trade deal will flood the EU market with cheap products, developed with loose environmental standards. In response to the farmers' discontent, the Commission withdrew the Sustainable Use Regulation proposal, which sought to halve the use of pesticides by 2030 in a bid to build sustainable food production chains and support biodiversity restoration.

But agriculture is not the only strategic sector where the push for faster climate action is disproportionately affecting the most vulnerable. The green transition is a whole-of-economy, generational process, a paradigm shift that will reverberate in local communities as much as in geopolitical dynamics.

Some important steps have been taken, from the targets to phase-out coal or fossil fuel boilers to the introduction of the Emissions Trading System for buildings and road transport (ETS2) starting 2027. But while these are essential measures for driving down GHG emissions in the EU, their effect can come as a double-edged sword, to be felt within and beyond the borders. A lack of mitigation of the disproportionate transition costs on the most vulnerable EU citizens bears the risk of further deepening intranational inequalities, fuelling extremism and Eurosceptic sentiments. Outside EU borders, the race to electrification risks displacing polluting activity, driving up environmental and social damage in resource-rich countries and increasing the risk of conflict and displacement in already fragile regions. These are only a few of the negative externalities that cannot be ignored if we want to make the promise of a fairer, greener economic model a reality for all of us and the EU a global leader in the process.

The Social Climate Fund & the Just Transition Fund, an integrated approach to climate action

In this context, it is undeniable that the way forward for the green legislation of the EU executive needs to be a Green and Social Deal, which carefully intertwines social and environmental protection measures along the value chains. EU's Just Transition Mechanism and the Social Climate Fund are such instruments. If well implemented, they can alleviate the disproportionate impact of green policies on vulnerable groups, while creating opportunities for everyone.

Created in 2023, the Social Climate Fund ((EU) 2023/955) will pool revenues from auctioning allowances from the newly created ETS2 covering CO2 emissions from fuel combustion in buildings, road transport and small industry. It is expected to mobilise over EUR 86 billion over the 2026 – 2032 period, supporting EU countries in addressing the increasing challenge of energy and transport poverty. Tackling the structural causes of energy poverty and providing long-term relief to the most vulnerable is essential for ensuring the legitimacy of one of the most important EU instruments for climate action, the EU Emissions Trading System. Access to these funds will depend on the development of national Social Climate Plans and payments will be conditioned by social and climate targets. These must be done in a participatory way, ensuring that interests of those affected are represented and proposed investments respond to local challenges.

Another essential instrument aimed at balancing social equity and climate action is the Just Transition Fund (JTF, (EU) 2021/1056)). Adopted in 2021, the JTF came as an acknowledgment that achieving the bloc's 2050 objective of climate neutrality will pose disproportionate challenges on regions dependent on declining polluting industries, with highly-specialised workforce and scarce employment alternatives. Part of the Just Transition Mechanism, the JTF has a budget of over EUR 17.5 billion over 2021–2027. It aims to tackle in an integrated manner the cross-sectoral challenges arising in the decarbonisation of mono-industrial regions, and especially coal regions.

In many ways, the foundational principles of the JTF are part of the solution for adapting the future policies to the challenges and realities of the green transition. With a focus on territoriality and place-based development, JTF's targeted support was conditioned by the drafting of Territorial Just Transition Plans (TJTPs) at regional level. In line with the Partnership Principle, the drafting and implementation of TJTPs coagulated diverse stakeholders around a common goal. In many ways, the participatory process unlocked by the JTF has created a best practice precedent essential to the success of the green transition, creating the synergies for local ownership and broader public buy-in. The JTF is now laying the foundation for a green economy, in an ambitious approach unimaginable to coal-dependent and mono-industrial regions just a decade ago.

In Latvia, EUR 1.8 million are allocated to improving the skills of local governments and regional specialists and mitigating the socio-economic consequences of climate change. In Greece, the JTF will provide dedicated support to energy communities for developing self-production initiatives in lignite regions. In the Romanian coal-region of Jiu Valley, the JTF will support the development of a robotics hub for youth on the site of a former mine. In September, CEE Bankwatch Network and 41 other European organisations launched a joint statement asking

> "Perhaps the most transformative in its potential impact is the EU ambition to spearhead the transition to climate neutrality"

European decision-makers to continue and strengthen the JTF in the next financial period to ensure that "no one is left behind on the EU's path to climate neutrality".

The way forward for the green transition

Creating a level playing field in the green transition must be a priority through the next Multiannual Financial Framework. As the next long-term EU budget will be negotiated, the focus must remain on continuing the ambitious work already started through the EGD.

Areas of prioritisation should centre on providing adequate financing for targeted support with a territorial approach, based on significant social dialogue, collective bargaining and transparent shared management. Protecting those most affected by mainstreaming strong social and environmental conditionalities and addressing the linkages between social and climate change vulnerability must be guiding principles. Accessing public money should also come with public responsibilities towards the common good. This means supporting local authorities with financial and non-financial tools to develop the knowledge necessary to guide their cities and villages towards climate neutrality. Bringing climate action and its benefits closer to the citizens remains essential for ensuring long-term public acceptance and supporting the behavioural change needed to have sustainability embedded as a societal value.

Additionally, efforts must continue to fill the gaps on sustainable food systems and animal welfare, green industrial transformation and green public procurement in line with EGD objectives, especially on efficiency, sufficiency and circularity. Finally, the external footprint on labour rights and environmental protection of EGD policies and trade agreements must receive increased attention if we are to take the lead in the global transition towards sustainability and act as catalyst for security and prosperity.

A just green transition is an unprecedented opportunity for creating the paradigm shift necessary to tackle the triple crisis of climate change, biodiversity loss and pollution, in a transformative, rather than reformative manner. As laid out in the Fit for 55 Package, the green transition is "an opportunity to reduce systemic inequality" and bring forward a new economic model that holds the well-being of people and the environment at its core. The mission of advancing this forward-looking political vision must be upheld by European institutions and national governments alike.

The promise of the European Green Deal for a fair transition towards a greener, more equitable economic model is perhaps the most ambitious endeavour undertaken by the EU since its foundational promise. Similarly to when the 1950 Schuman Declaration put forward the proposal for what would become the EU, achieving this momentous objective requires "creative efforts proportionate to the dangers which threaten it". A choice should not have to be made between protecting the environment, the economy or the people. Transforming the economy so it serves all people and our environment, this must be the way forward. ■

About the author

Eliza Barnea is a development expert, with extensive policy and project management experience, with roles in public/non-governmental sector and international organisations. Her work centres on the social inclusion – green transition nexus, having worked closely with the European Commission and the Romanian government at all levels to advance a more equitable transition to a low-carbon economy. She currently coordinates the campaign for a Just Transition for Bankwatch Romania, an environmental NGO, and acts as a County Lead for the technical assistance provided to the Romanian Government for the preparation of the Social Climate Plan. She is part of the EU Network of Just Transition Experts, JTPeers Expert Database, and is a 2024 EU Young Energy Ambassador.

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Turning electricity bills into tools for climate action and social justice

Energy bills are an enormous burden on Europe's least well-off, but there are ways to make the situation fairer for all

By **Marine Cornelis**, Executive Director and Founder, Next Energy Consumer, EUSEW Digital Ambassador

"Fixed-price tariffs feel safer but hide the benefits of renewable energy. People lose the opportunity to save when the wind blows, or the sun shines."

What if your electricity bill could help fight climate change and tackle inequality? Europe's energy transition is not just about counting solar panels and wind turbines: it is about making the system work for everyone. Well-designed bills and fair electricity tariffs can make clean energy affordable and accessible, but today's prices often leave the most vulnerable behind. What needs to change, and how can we act now?

The real cost of energy inequity

When energy prices skyrocket, the hardest hit are always those least able to pay. Across the EU, households paid an average of 29 cents per kilowatt-hour in 2023; more than many could afford. The 2021 crisis exposed deep flaws in how electricity is priced. Tariffs designed without equity in mind have left vulnerable families unable to cope with volatile bills, and energy poverty is increasing.

The shift to renewables and dynamic tariffs, while essential, do not automatically fix this. Many people cannot afford solar panels or smart appliances, let alone shift their time of use to benefit from cheaper, greener electricity. A fair energy system needs to account for these gaps.

Are our tariffs doing more harm than good?

The way we pay for electricity influences behaviour. In theory, dynamic tariffs encourage people to use energy during cheaper, greener times of the day. Yet, for many, they bring risks. Without the money to buy flexible devices or the time to adjust consumption, these households are left paying the highest prices when bills spike.

Fixed-price tariffs feel safer but hide the benefits of renewable energy. People lose the opportunity to save when the wind blows, or the sun shines. Worse, these tariffs often lock consumers into long and pricey contracts, making switching costly and complicated. There is a middle ground—but we are not there yet.

What would fair pricing look like?

Pricing electricity is not one-size-fits-all. Households are diverse: a family in a poorly insulated flat has different needs than someone charging an electric car at home. To make tariffs work for everyone, policymakers and regulators need to create the ground for price stability with flexibility. For example, rising block tariffs provide a basic amount of electricity at a lower rate, with higher prices for greater use. These work well for low-income households but must be carefully designed to avoid encouraging energy inefficient behaviours.

Solar panels and smart technology also help. Sub-meters, which separate essential from flexible energy use, could let families control costs more easily. Simple, transparent billing systems and real-time apps could make tariffs easier to understand, even for those who are not tech-savvy. But making these tools widely available is a hurdle that cannot be ignored.

How can we redesign tariffs to work for everyone?

Here are five ideas to start:

1. Make bills clearer and fairer: Ensure social tariffs reach the energy-poor through better automation and collaboration between the various entities responsible for social protection and energy to guarantee affordability for vulnerable households. In Italy, the introduction of automated allocation of the energy bonus in 2021 has tripled the number of households benefiting from the reduction directly on their electricity and gas bills (to 4 million)
2. Support prosumership and flexible consumption: Offer programs that make smart appliances or renewable energy sources like solar panels affordable for lower-income households. For example, the Greek government's is shifting lower off-peak electricity tariffs from nighttime to midday, to align energy use with renewable generation.
3. Protect consumers from volatility: For example, rising block tariffs, while uncommon in the EU, can combine cheap basic levels of consumption with dynamic tariffs above essential levels. Besides, as planned in the Electricity Market Design Directive (2024),in case of a recognised crisis, Member States can step in and apply temporary protections to shield consumers from unbearable spikes.
4. Rethink taxes and levies: Shift the burden away from electricity to make green solutions like heat pumps more attractive than fossil fuels. This could require a reform of the Energy Taxation Directive to reduce excise duties for renewable electricity.
5. Bring people into the process: Indeed, the introduction of dynamic tariffs hasn't been as dynamic as expected in many markets. But as large suppliers are to introduce them in 2025, making sure people are part of the design process is critical. For example, mobilising citizen panels and focus groups to involve underrepresented communities in tariff design would be relevant. Citizens' Panels, such as the one on Energy Efficiency by the European Commission, have demonstrated their impact in bridging the gaps and fostering trust.

Useful links

1. Boosting participation in the energy transition by Green European Foundation (GEF) and Heinrich-Böll-Stiftung European Union
2. Hirth, L., Mühlenpfordt, J. and Schlecht, I. (2023). Electricity tariffs for price security and flexibility. Designing a dynamic tariff with price hedging
3. European Environment Agency and ACER (2023) Flexibility solutions to support a decarbonised and secure EU electricity system.

Where do we go from here?

The energy transition is a shared challenge. Hitting climate targets is one thing, but it has to be the opportunity to foster fairness, dignity, and opportunity. Electricity tariffs might seem technical, but they touch every household and shape how we engage with the system.

We cannot wait for the perfect solution. By taking small, practical steps, Europe can move toward a system where energy is clean, affordable, and fair for all. Let us not just talk about change. Let us build it, one kilowatt-hour at a time. ■

About the author

Marine Cornelis founder of Next Energy Consumer and the Energ' Ethic podcast,combines analysis and thought leadership with actionable dissemination for businesses and projects across Europe, Africa, the Middle East and Latin America. With 15 years of experience spanning consumer protection, energy poverty, and digital transformation, she champions gender equity, diversity, and community empowerment. Her work acts as a bridge between stakeholders, blending human, technical, and political insights to ensure that people's experiences drive the transition narrative. Through her Energ' Ethic podcast, she shares inspiring stories driving global energy and climate progress

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What do you do when your bathtub leaks? Do you open the tap wider – or do you fix the leak?

If current wasteful practices continue, renewable energy consumption will add to fossil fuel consumption, instead of replacing it.

By **Nathalie Hemeleers**, Director of EU Affairs at the Solar Impulse Foundation, an EUSEW partner organisation.

The world we live in is stuck in the past. The technologies allowing us to exploit resources have remained largely unchanged since the industrial revolution. Our economy is characterised by waste and inefficiency.

Consider that internal combustion engines lose more than two-thirds of the energy we put into them, and more than a quarter of our drinking water is lost every year due to preventable and treatable leaks in the distribution network. Or consider that a third of the food we produce is thrown away – wasting not just the final product but all the energy and resources used to produce it and transport it to where it is meant to be. We can do so much better.

The value of energy efficiency

Energy efficiency is not a new concept, especially for EU lawmakers. It does not only allow us to save resources, but also (and maybe more importantly for many?) money. It has been estimated that around $4.5 trillion could be saved annually thanks to energy efficiency.

Also, energy efficiency in buildings alone can almost halve seasonal peak demand (up to 49.5% reduction) every year by 2050, avoiding stranded assets and non-necessary investments in grids. €44.2 billion could be saved every year, making the much-needed investments in EU's distribution grid more cost effective!

Why is it so difficult to implement?

Energy efficiency is still seen by many as a restriction of business opportunities. We need to change that narrative.

In a time where competitiveness is on top of policy-makers' attention, efficiency should be seen as a close ally. By investing in efficient production systems, costs


Photo: Unsplash

> "Energy efficiency is still seen by many as a restriction of business opportunities. We need to change that narrative."

are reduced, giving businesses a double competitive advantage of producing at a lower cost and in a cleaner way.

Solutions are within reach

And good news, innovative efficient solutions exist! The Solar Impulse Foundation has identified and labelled more than 1,500 existing solutions that can make this paradigm shift a reality, in virtually any sector of society.

They are available today, open source, on www.solarimpulse.com. These are just a few among the many already existing, showing that the shift we are calling for is realistic and within reach.

Financing efficient solutions

Now, mobilising public and private capital to invest in clean and efficient solutions and modernise our economies will be key.

New business models have to emerge, those that are rewarding efficiency. EU institutions and financial stakeholders have to propose new financing tools that will tackle the double challenge of high CAPEX and higher risk for businesses, especially for SMEs.

A modernised economy based on efficiency is a qualitative economy that has as a key driver the continuous optimisation of resources.

Efficiency as the cornerstone of progress

The fundamental goal is to achieve heightened efficiency in various sectors, prioritising sustainable practices and minimising waste. Basically, accomplishing more (and better) with fewer resources, thereby contributing to a reduced environmental footprint.

Decarbonisation is no longer the end goal, but becomes a consequence of a modernisation process, one that creates jobs and economic activity. ■

Recommended links

1. https://solarimpulse.com/solutions-explorer
2. https://www.eib.org/en/stories/servitisation-energy-efficiency-sme

About the author

Nathalie Hemeleers is Director of EU Affairs at the Solar Impulse Foundation, one of EUSEW partners. Her objective is to push for the modernisation of our legislative framework in order to create incentives for the acceleration of the adoption of clean solutions. Following Bertrand Piccard's tour of the world with his solar plane, the Solar Impulse Foundation has been busy with gathering and labelling more than 1,500 solutions that are clean and affordable. The Foundation is now working on creating an enabling framework for the adoption of these solutions.

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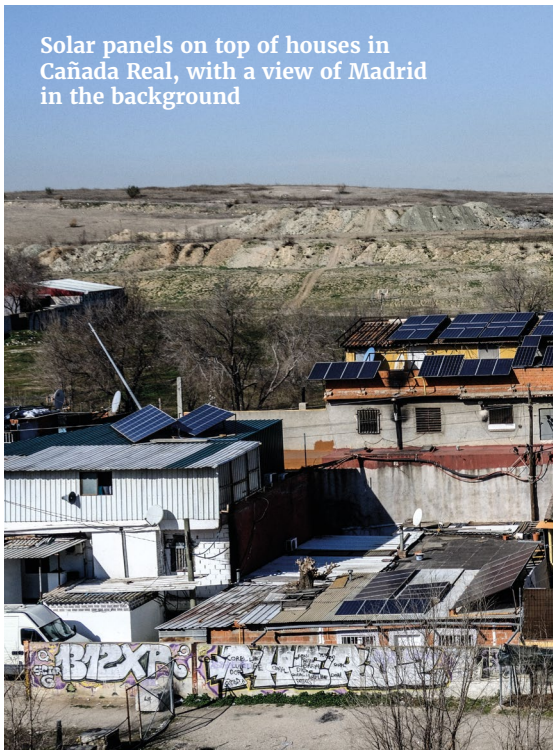
Left in the dark

Europe's largest shanty town faces anxious verdict after battling fifth winter without electricity

By **Harriet Barber**, in Cañada Real



Solar panels on top of houses in Cañada Real, with a view of Madrid in the background

When the lights went out in Cañada Real in early October 2020, thousands of families thought they were experiencing a common power cut. They lit candles, turned on their torches and waited. But the hours turned into days, and then weeks, and now, more than four years and five biting winters later, they still do not have power.

Researchers have described the crisis as "a collective disconnection case of unprecedented magnitude in Europe", with around 4,000 people, including an estimated 1,800 children, affected. "Without electricity, we live worse than they did in the seventeenth century," says Dolore Bruno, a 42-year- old resident.

The blackout started when the energy provider implemented technical changes to the local power distribution infrastructure. Because Cañada Real is an informal settlement, it has always been difficult for residents to agree legal contracts with utility providers, and as a result, most people have relied on irregular connections to nearby electricity networks for decades.

In 2020 new capacity requirements were applied unilaterally to the local power distribution infrastructure of which most residents were informally connected. Sixty percent of the settlement's 8,000-strong population, those living in sectors 5 and 6, were effectively cut off with no notice.

The energy provider Naturgy later blamed illegal, intensive and irregular use of electricity, saying it overloaded the system and triggered emergency shutdowns. Meanwhile the regional government of Madrid, at least initially, said cannabis farms had crashed the electricity supplies.

But now, in a groundbreaking decision published at the end of February, the European Committee of Social Rights (ECSR) has condemned the State, determining that Spain has breached multiple articles of the Revised European Social Charter, including the rights of adequate housing and decent living conditions. It has called on all administrations to find an "urgent" solution.

The social cost of blackouts

The first houses in Cañada Real, which is located just a 15-minute drive from the edge of Madrid and sprawls across 15km, were built in the 1950s and 1960s by Spanish migrants arriving from impoverished rural areas. Later, as other shanty towns across the outskirts of the capital were demolished, more settlers arrived, including migrants from Morocco and Romania. Most residents today live in precarious situations, with an estimated 90 percent facing poverty.

Houda Akrikez, a 38-year-old mother of three, has lived with her family in Cañada Real since 1993, when she was nine years old. Back then, she says, her family had a normal supply of electricity and a life not dissimilar to those of her peers. "We were like all families in Spain," she says.

But today, her life is far removed. "How do you manage a house without electricity?" she asks. "How do you cook without an oven, preserve food without a fridge, wash clothes without a machine? How can the children complete their homework – which is all digital now?"

Akrikez has two teenage daughters and an 18-month-old, and says Cañada Real's children feel the brunt of the crisis. "When the children wake up, everything is dark and cold. They want to heat some food, but they can't. They can't use the toaster. They can't have a warm shower. They can't do their homework, which is all online. There are such basic things that any other child can have, but ours can't," she says.

The cold she describes is a common issue for residents. Many of the homes are made of brick and cement, but at least half of inhabitants live under corrugated roofs and tarpaulins. Out on the streets, families gather around fires to warm their hands, and absorb as much light from the grey skies as possible.

"We shake from the cold, sometimes we climb into our beds to find they are frozen," Akrikez says.

The World Health Organization's guidelines prescribe 18°C as a minimum comfort indoor temperature, but data from an autumn 2021 survey found that only temperatures below 17°C were reported. A later report by the Carlos III University of Madrid found temperatures in the most used rooms of the resident's homes above 40°C in summer and below 10°C in winter.

To stave off the cold, many people burn wood or cardboard, while others have bought butane gas cookers and firewood heaters. But such survival techniques are dangerous, residents say, leading to a spike in fires and carbon monoxide poisoning.

Thirty-nine-year-old Antonio Molina says his one-year-old granddaughter was rushed to hospital that morning because of suspected poisoning. "She became intoxicated because of the gas," he says.

Early into the power outage, the home of Akrikez, who founded and leads the neighbourhood's Tabadol Association, caught on fire while she was out protesting. "The whole house set on fire because of a fallen candle. My children were asleep inside," she says. "The house was full of smoke, but we rescued them."

Filed in the complaint to the


Image: Harriet Barber

European Committee of Social Rights were a list of medical reports, including the case of carbon monoxide poisoning in a 17-year-old girl due to a butane gas cooker, and the death of a 74-year-old man linked to extreme cold. During the 2023/24 winter, 25 people were poisoned by gasoline generators and two fires caused by candles, local media reported.

"If we survive the freeze, we die from carbon [monoxide] and fire," says Akrikez.

Education, too, has become an issue. Multiple families say their children only attend school a few times a week because they are not able to wash every day. Antonio Fernandez was 12 when the outage started. "We couldn't go to school because our clothes were dirty," the now 16-year-old says. "My education was taken away from me."

Researchers have described the situation as one of "extreme energy poverty". "There's really no similar case in Europe," says Ulpiano Ruiz-Rivas, a professor at Carlos III University, who has conducted research in Cañada Real since 2019.

Precarious remedies

On top of butane gas cookers, residents have also invested in diesel generators, batteries and firewood heaters. Solar panels now line many of the roofs of the structures, though not all residents are.

In sector 5 another solution has been found, with residents self-organising to take over the management of their local distribution network.

Gladys Zambrana, 43, of the neighbourhood association, explains that the citizens joined together to pay for electricity transformers. "We paid a lot for it, we fix it if it breaks, nobody can touch it," she says. The citizens now adjust the aggregated electricity demand, by disconnecting parts of the sector in turns, to meet the new capacity requirements.

Zambrana shows a WhatsApp group where hundreds of members organise the supply. "Today we have electricity, but tonight we will not," she says. "We ration it." The strategy allows approximately 300 houses to have access to electricity on certain times and days.

"The community has made an arrangement to diminish their consumption, and they have established cut-offs," says academic Ruiz-Rivas. "They keep their consumption terribly low – they're aware that if it is cut off, it might not come back on."

Solutions within reach

With multiple authorities sharing varying degrees of responsibility for Cañada Real, which is also known as "Europe's largest shanty town," residents say they fall through the cracks.

Those involved are the government of the Autonomous Community of Madrid, as the main sponsor of the regional agreement for Cañada Real, Naturgy Energy Group, as the parent company of the DSO in charge of the local distribution grid, and various municipalities in which the settlement is administratively located.

Locals say they only see politicians around election times, and that for the most part they are sidelined. "We are completely isolated here," says Akrikez. Manuela Mayoral Silva, project coordinator at NGO Associacion Barro, says: "Nobody wants to assume responsibility for bringing electricity back."

Naturgy Energy Group says the lack of supply continues because of "overloads in the network due to high non-localized consumption" and says it is not possible to re-establish supply because of "safety reasons due to the precariousness of the connections and the overloading of the grid." It also says residents have been given information about how to contract the supply, and if their applications comply "with legal requirements" they will be connected.

Madrid City Council says its priority is relocation, adding that it has relocated 308 families and signed an agreement for the distribution of cylinders, stoves, petrol cards for generators and firewoods. It says that "access to electricity supply through a stable or regularised network is an issue that goes beyond the powers of Madrid City Council."

"Zambrana shows a WhatsApp group where hundreds of members organise the supply. 'Today we have electricity, but tonight we will not,' she says."

Nonetheless, the ECSR ruling determined that Spain has failed to guarantee minimum living standards for the affected families and has not taken sufficient measures to restore supply or find alternative solutions.

It denounced Madrid's relocation plans, saying "reasonable deadlines" had not been set, with some relocations not scheduled until 2034,14 years after the start of the power outages.

It noted that stigmatisation and discriminatory statements have worsened the situation, after hearing testimonies from children that they hide where they live from their classmates, due to fears of being deemed dirty or related to criminality.

The ECSR also said that states cannot "outsource" their human rights duties to energy companies, and has told Spain that it must guarantee the supply of electricity over prioritising the interests of any private company.

While Madrid City Council says it respects the ECSR's decision, it continues to say that the only solution is relocation. A source says that "the ruling does not oblige the Spanish public administrations to reestablish the electricity supply, but to carry out actions that guarantee effective access to quality housing."

Akrikez, who does not want to be relocated and says she wants to stay in her home and pay for her electricity. "We want to pay, but they won't let us," she says. "I think it's because they want to move us so they can expand Madrid and build new apartment blocks here."

To date, no tangible results have been made in addressing supply disconnections, and the feeling among residents is largely one of despair. "People are tired of fighting," says Akrikez. "They have taken away our lives." ■

Upcoming events 2025

1. **Large Scale Solar Europe**
   March 25-26 | Lisbon |
   https://lss.solarenergyevents.com/

2. **Heat Pump Technologies**
   April 2-3 | Milan | www.heatpumptechnologies.it

3. **EC CleanTech**
   April 8 | Brussels |
   https://cinea.ec.europa.eu/programmes/innovation-fund/2025-cleantech-conference-advancing-europes-clean-industrial-transformation_en

4. **Energy Cities**
   April 8 -10 | Besancon |
   https://energy-cities.eu/besancon-2025/

5. **Wind Europe**
   April 8 -10 | Copenhagen | windeurope.org/annual2025

6. **Industrial Decarbonisation Europe 2025**
   April 9-10 | Amsterdam |
   events.reutersevents.com/energy-transition/industry-europe

7. **SolarEx**
   April 9-10 | Istanbul | solarexistanbul.com/en

8. **AEE Europe Energy Conference**
   April 23-24 | Paris | https://aeeeurope.org

9. **Green Tech for Ports and Terminals**
   April 29-30 | Gothenburg |
   https://greentech.ptievents.com/

10. **ees (Electrical Energy Storage) Europe**
    May 6-7 | Munich | www.ees-europe.com

11. **Invest in African Energy 2025**
    May 13-14 | Rotterdam | invest-africa-energy.com

12. **10th International Conference on Sustainable and Renewable Energy Engineering (ISCREE)**
    May 13-16 | Nice | invest-africa-energy.com

13. **World Hydrogen Summit**
    May 20-22 | Rotterdam |
    https://www.world-hydrogen-summit.com/

14. **21st International Conference on the European Energy Market**
    May 27-29 | Lisbon | eem25.pt

15. **Lisbon Energy Summit**
    June 3-4 | Lisbon | www.lisbonenergysummit.com

16. **Green Week - Circular Economy**
    June 3-5 | Brussels |
    https://environment.ec.europa.eu/news/green-week-2025-circular-solutions-competitive-eu-2025-01-22_en

17. **Wood Mackenzie Gas, LNG & The Future of Energy Conference**
    June 10-11 | London |
    www.woodmac.com/events/gas-lng-future-energy

18. **EU Sustainable Energy Week**
    June 10-13 | Brussels |
    https://sustainable-energy-week.ec.europa.eu/index_en

19. **Hydrogen & P2X**
    June 11-12 | Copenhagen

20. **PCIC Energy Europe**
    June 17-19 | Düsseldorf | pcic.energy

21. **Connecting Hydrogen Europe**
    June 18-19 | Madrid |
    www.connectinghydrogeneurope.com

22. **Carbon 2025 The World Conference on Carbon**
    June 29 - July 4 | Saint-Malo |
    https://premc.org/carbon2025/

23. **Large Scale Solar - Southern Europe**
    September 16-17 | Athens |
    https://lssse.solarenergyevents.com/

24. **Carbon Capture Technology Expo**
    October 21-23 | Hamburg |
    https://www.carboncapture-expo.com/

25. **Smart City Expo/World Congress**
    November 4-6 | Barcelona |
    https://smart-cities-marketplace.ec.europa.eu/news-and-events/events/smart-city-expo-world-congress-2025

26. **Wood Mackenzie Hydrogen Conference**
    November 12-13 | London |
    www.woodmac.com/events/hydrogen-conference

27. **ENLIT Europe 2025**
    November 18-20 | Bilbao |
    https://www.enlit-europe.com/

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European Commission

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