

Summaries of plenaries - 46th IAEE Conference in Paris: Energy solutions for a sustainable and inclusive future – June 15-18, 2025 - <https://www.iaee2025paris.org/>

Geopolitics, Energies, Climate change policies: what's up? - Opening Plenary Session

By Elias Zigah (PhD candidate, University Paris-Saclay, elias.zigah@centralesupelec.fr)

Session Chair:

Pr. Amy Myers Jaffe (New York University)

Speakers:

Dr Fatih Birol (Executive Director, International Energy Agency)

Pr Christian Gollier (Toulouse School of Economics)

M. Stéphane Michel (General Director Gas, Renewables & Power, TotalEnergies)

Keynote of Gala Dinner:

Ms. Claire Waysand (Executive Vice President, in charge of Corporate Secretariat, Strategy, Research & Innovation and Communication, Engie)

Abstract

The opening session of the 46th IAEE International Conference in Paris convened leading voices from policy, industry, and academia to address the critical challenges shaping the global energy landscape. Chaired by Professor Amy Myers Jaffe of New York University, the session underscored a world grappling with profound uncertainty. Keynotes and discussions navigated the escalating tension between energy security, affordability, and climate action, a trilemma intensified by geopolitical conflicts, economic shifts, and the immense energy demands of new technologies like artificial intelligence (AI). A consensus emerged on several key points: the energy transition is advancing, demonstrated by a historic pivot in investment toward clean energy; however, it is imperilled by grid infrastructure bottlenecks, critical mineral scarcities, the high cost of decarbonisation, and a growing political backlash in Western nations. Speakers issued a call to action for economists to develop integrated, system-level solutions and robust market designs to ensure the transition is resilient, affordable, and socially acceptable.

1. Context and Welcome: Ambition Anchored in Pragmatism

The conference commenced in Paris, a city symbolic of global climate ambition as the home of the Paris Agreement and the International Energy Agency (IEA). In a welcome video, the Minister of State for France underscored the conference's theme, "Energy solutions for a sustainable and inclusive future," and affirmed France's commitment to a pragmatic energy transition. The address paid homage to the legacy of economists like Marcel Boiteux, former CEO of EDF, whose vision shaped France's energy policy, stressing the vital role of high-quality, evidence-based research in navigating the current complex environment. The minister's remarks clearly show the host nation's strategy, which integrates industrial and energy policy to bolster national resilience and security. France's strategy involves significant investment in six new EPR2 nuclear reactors and small modular designs, coupled with an aggressive expansion of renewables, particularly offshore wind, to secure a reliable and affordable energy supply as a prerequisite for a strong industrial base. This introduction established the session's core premise: climate ambition must be anchored in pragmatic, system-level thinking that integrates energy security and economic competitiveness.

Disclaimer: All these summaries have been prepared by non-expert economists to reflect their possible understanding of the plenary discussions for a global audience. It does not claim to provide a comprehensive or fully accurate account of the content. The document has been produced under the supervision of Pr. Cédric Clastres and Dr Christophe Bonnerly.

2. Keynote — “The Age of Electricity”: Investment Pivot, Demand Drivers, and New Exposures

Dr. Fatih Birol, Executive Director of the IEA, delivered a data-centric keynote address, asserting his guiding principle that “data always wins.” He declared that a historic structural shift is underway. Global energy investment has reached \$3.2 trillion, with investment in clean energy \$2.2 trillion now double that of fossil fuels \$1.1 trillion. This 2:1 ratio marks a dramatic acceleration from parity in 2015. It has placed global electricity investment 50% higher than that for oil, gas, and coal combined, with China accounting for nearly 30% of the total. Dr. Birol identified this as the dawn of the “Age of Electricity,” with demand projected to grow six times faster than overall energy demand in the coming decade. This surge is propelled by three powerful new drivers: electric vehicles, which have soared from 5% to over 25% of global car sales in just four years; air conditioning, now the single largest source of incremental electricity demand; and artificial intelligence, whose data centres depend on reliable 24/7 load profile, with a medium-sized data centre consuming as much electricity as 100,000 households.



However, Dr. Birol warned that this new era brings a formidable set of new exposures. The geopolitics of energy has expanded from a focus on fuel supply to the security of power networks, undersea cables, and cyber risk, as evidenced by recent suspicious incidents in the Baltic Sea. He pointed to recent events, such as NATO being forced to patrol undersea cables in the Baltic, as evidence that electricity networks are becoming critical geopolitical targets. Physical bottlenecks loom in critical minerals, especially copper, where the 17-year average lead time for a new mine creates a significant supply risk. While he confirmed that the “golden age” of gas is fading, he noted that a massive expansion of LNG capacity of 300 bcm is still expected by 2030, reshaping market dynamics.

Dr. Birol concluded with a powerful reminder of the profound energy injustices that persist, noting that 600 million people in Sub-Saharan Africa still lack access to electricity, and over 500,000 women die prematurely each year from the lack of clean cooking facilities, a crisis he termed the “number one gender issue” globally.

3. Market Reality Check: Insecurity, Affordability, and Systemic Failures

The subsequent panel discussion grounded these structural shifts in the stark realities of the current market. Professor Christian Gollier of the Toulouse School of Economics described the landscape as “deep uncertainty,” a sentiment echoed by Stéphane Michel, President of Gas, Renewables & Power at TotalEnergies. Mr. Michel argued that a new era of geopolitical conflict, supply-chain fragmentation, and the end of near-zero interest rates has fundamentally redefined the investment calculus for capital-intensive decarbonisation, forcing a rebalancing of the energy trilemma with a renewed focus on security of supply.



This new macro-environment has exposed affordability and public acceptance as binding constraints on the energy transition. As articulated by Claire Waysand, EVP at ENGIE, the transition risks failure without public support, which is contingent on affordability and reliability. Professor Gollier detailed a growing political “backlash” in advanced economies, driven by a public awakening to the high implicit costs of many decarbonisation measures, such as synthetic aviation fuels, far exceeding current carbon prices. Mr. Michel reinforced this point, stating bluntly that customers are unwilling to pay a green premium and that demand for expensive solutions like green hydrogen is almost entirely compliance-driven.

The panellists converged on diagnosing systemic failure, identifying grid infrastructure as a primary bottleneck. The discussion revealed that piecemeal rules and a lack of system-level thinking have led to market distortions, such as negative power prices and long grid connection queues, which signal a misallocation of capital. Professor Jaffe delivered a sharp critique of mainstream energy-economy models, challenging the academic community to integrate the macro-risk feedback, such as the significant GDP losses at high warming levels projected by the reinsurance industry, currently absent from most forecasts.

4. Proposed Solutions: Coalitions, Carbon Architecture, and Market Design

The panel proposed concrete solutions centred on better policy architecture and market design in response to these systemic challenges. To counter the problem of free-riding among nations, Professor Gollier advocated for a “coalition of the willing.” This bloc of ambitious countries would align on a meaningful internal carbon price and enforce it externally via a carbon border adjustment mechanism (CBAM). To ensure equity and encourage broader participation, he suggested that revenues from the CBAM could be used to capitalise a climate fund for adaptation and mitigation in developing economies.

Concurrently, Mr. Michel directly challenged the economists in the room to move beyond theory and focus on the practical design of power markets. He framed the division of labour clearly: while engineers are developing technological solutions like batteries, it is the job of economists to design market structures that can explicitly procure and remunerate the system services flexibility, adequacy, and resilience that a renewable-heavy grid needs to function reliably. This requires moving toward market designs that internalise intermittency costs and turn today’s negative prices and grid backlogs into investible signals for the resources the system truly needs.

5. Analytical Conclusion — The Core Conflict and the Mandate for Economics

The opening session exposed a fundamental credibility gap between stated net-zero trajectories and observed market signals. This core conflict emerges from two perspectives that shed light on different sides of the same problem. For firms, as Mr. Michel argued, halting fossil investment while demand persists would spike prices and erode public support for the transition. Meanwhile, as Professor Gollier noted, persistently high oil prices and risk premia signal investor doubts about the durability of long-term climate policy. Together, these views expose the chasm between policy promises and investible rules, the central challenge of the transition. Resolving this challenge is the explicit mandate for the energy economics community.

The session concluded that closing the pledge-performance gap requires stable, predictable institutions, carbon prices that travel across borders, border adjustments that reduce leakage, and power-market designs that pay for reliability. The charge given to economists was to design these market architectures and reform analytical models to internalise reliability, affordability, and risk, making the energy transition financeable, politically viable, and socially legitimate.

The lingering question, posed by Dr. Birol and Professor Jaffe, of whether there will be enough electricity to power the AI revolution, served as a stark reminder of the monumental scale of the challenge ahead.

Climate Policies: Delivering a fair, efficient and timely energy transition - Dual Plenary Session 1.1

By Hayeon NAM (MsC, hayeon.kate@gmail.com)

Session Chair:

Aude Pommeret (University of Savoie Mont Blanc)

Speakers:

Katheline Schubert (Paris School of Economics)

Ying Fan (Beihang University)

Mark Jaccard (Simon Fraser University)

Aude Pommeret, professor at University Savoie Mont Blanc, chaired the session. In her opening speech, she highlighted the strong political opposition to efficient carbon pricing. As a result, climate policy often relies on alternatives like green subsidies. However, considering that the effectiveness and cost of energy transitions depend on policy and mechanism design, relying primarily on subsidies may not be the wisest approach. At the same time, policies must be perceived as fair to ensure a successful transition. In such a context, designing fair instruments without compromising efficiency becomes a key concern. Three experts joined as keynote speakers to discuss possible approaches: Katheline Schubert of Paris School of Economics on the cost of politically acceptable instruments in a general equilibrium model of the power sector; Ying Fan of Beihang University, on applying this question to China’s low-carbon transition; and Mark Jaccard of Simon Fraser University on sector-specific policy effectiveness in Canada.



The first speaker, Kathline Schubert focused on the political difficulty of implementing carbon pricing. Economists generally view it as the optimal instrument for internalizing CO₂ externalities. It directly incentivizes households to cut emissions, generates revenues for redistribution, and stimulates green innovation. However, public resistance remains strong as the French Yellow Vest movement illustrated. To many citizens, carbon pricing appears unfair and regressive, while subsidies seem less costly and more equitable. This leads to a central issue of policy acceptability: why do societies favor command-and-control instruments and subsidies over carbon pricing, and what are the welfare costs of such preferences?

To address this issue, Schubert's joint work with Aude Pommeret and Francesco Ricci, investigates the "costs of acceptability." The paper models an economy where governments, unable to implement the optimal increasing carbon pricing, opt for constant or low carbon pricing combined with subsidies for renewable energy. Using both analytical modeling and its application to the European energy transition, the authors estimate the welfare and fiscal costs of the second-best strategy compared to the first-best carbon pricing. The results showed that if carbon prices are set at sufficiently high levels, the costs of relying on subsidies are moderate. On the other hand, when carbon pricing remains low, subsidies must be maintained permanently, leading to substantial welfare losses and heavy fiscal burdens. The findings suggest that although subsidies may be more politically acceptable, depending on them can substantially increase the overall cost of the transition.

Building on the discussion of policy acceptability, Ying Fan turned to China's energy transition, highlighting the power system as the core sector for achieving the country's carbon neutrality target by 2060. Since 2015, the share of non-fossil energy in power generation has increased from 27% to 41% in 2024, with wind and solar driving this rapid expansion. This growth has intensified the flexibility challenge, requiring coordination across generation, transmission, storage, and market mechanisms.

To study these challenges, Fan presented a transition model combining short-term economic dispatch with long-term capacity expansion planning of the power system. This model incorporates renewable uncertainty and an exogenous carbon price trajectory reaching about \$115 per ton of CO₂ in 2050. Simulations demonstrated that wind and solar dominate, coal declines only after 2030, and transmission capacity increases significantly, particularly from northern resource-rich regions to the rest of China.

Fan then analyzed several policy instruments. Combining an environmental tax with carbon pricing reduces coal's share, promotes interprovincial transmission and health benefits. Storage policies are also important with solar dependent much more heavily on storage than wind. Last, demand-side measures such as time-of-use EV charging to support valley-filling can improve flexibility, though consumer willingness to shift charging differs between home and public locations.

Achieving China's 2060 carbon neutrality target will require a long, complex, and costly power system transition. Technological advancement provides the foundation, policy and market design serve as the key to guiding the process, and active demand-side participation unlocks additional potential to manage economic, social, and operational hurdles.

The final speaker, Mark Jaccard, opened his presentation by quoting James Buchanan, the 1986 Nobel Prize winner in economics, who urged economists to consider the political context and constraints under which policy decisions are made. Using this quote, Jaccard emphasized that economists often overstate the role of carbon pricing without accounting for the real-world limitations faced by elected officials. In Canada, he noted, the plurality electoral system makes opposition in swing ridings particularly decisive, so even a relatively small share of strongly opposed voters can determine electoral outcomes.

Jaccard categorized policy instruments into three broad types: carbon pricing (taxes or cap-and-trade), regulations, and subsidies. He centered his talk on Flexible Regulations (FlexRegs), which set performance standards but allow firms to trade compliance, pay penalties, or choose technology-neutral approaches. He explained that such flexibility reduces compliance costs and lets firms realize low-cost reductions first. Evidence from California's Air Resources

Board revealed that most greenhouse gas reductions were achieved through various types of regulations, many of which were flexible, rather than through carbon pricing systems.

Other Canadian case studies demonstrated these dynamics in practice. In British Columbia, the serious carbon tax was implemented alongside low carbon fuel standards and clean electricity standards that prevented new fossil fuel plants. Modeling results to 2030 showed that the carbon tax achieved relatively modest emission reductions at low cost, whereas flexible regulations achieved larger reductions at higher cost. Surveys revealed that public support for carbon taxes was far lower than for FlexRegs, even when respondents were informed that the latter were more expensive.

At the federal level, Jaccard's team modeled scenarios to 2050 comparing efficient carbon tax, efficient FlexRegs, and politically constrained carbon tax implementations with lump-sum payment. They found that both efficiently designed carbon tax and FlexReg produced similar GDP outcomes, but politically constrained carbon tax underperformed in terms of GDP growth over time. He stressed that economists must integrate political constraints into their advice and consider a range of instruments, including FlexRegs and subsidies. Jaccard concluded that providing policy recommendations as if advising a benevolent despot is unrealistic and that economists should work with policy analysts and public opinion experts to help politicians balance economic efficiency with political acceptability.

Conclusion

Designing climate policy is never just about economic efficiency. Schubert showed that even well-intentioned subsidies can come with significant welfare and fiscal costs, despite its higher acceptance to the public than carbon pricing. Fan illustrated how these challenges play out in China, where achieving carbon neutrality by 2060 requires careful planning across technology, markets, and consumer behavior. Jaccard reminded us that political realities like electoral constraints in Canada, could make FlexRegs and subsidies more effective in practice than carbon pricing alone. Taken together, successful climate policy must reconcile economic, political, and social considerations, indicating that efficiency, equity, and acceptability all play a role in the transition to a low-carbon future.

Energy Poverty in the World: Improvement or Increasing Gap? - Dual Plenary Session 1.2

By Laura Natalia Beltran Genera (MsC, ln.beltrang@gmail.com) and Alice Mevel (MsC, alice.mevel@psemail.eu)

Session Chair:

Pr Anna Creti (Paris Dauphine PSL University)

Speakers:

Pr Anna Alberini (University of Maryland)

Dr Stuti Khemani (World Bank)

Pr Roula Inglesi-Lotz (University of Pretoria)

This plenary explored global energy poverty and its relationship with widening economic disparities and the just energy transition. Speakers addressed three dimensions: definitions and measurement (Pr Alberini), policy design and institutional constraints (Dr Khemani), and the social justice implications (Pr Inglesi-Lotz).

Anna Alberini opened the discussion with a survey of how energy poverty is defined and measured across contexts. In high-income countries, energy poverty typically refers to households unable to afford adequate heating or cooling, or those facing high energy cost burdens relative to income. In low-income and developing countries, the concept broadens to include complete lack of access to electricity, dependence on unsafe fuels for cooking, and infrastructure unreliability.

Pr Alberini noted the absence of a single agreed-upon metric. Common measures include the “10% rule” (households spending more than 10% of income on energy), arrears on utility bills, and inability to keep homes at a safe temperature. But these are typically self-reported, irregular, and fail to capture seasonal effects or persistence over time. She pointed out that data is often cross-sectional rather than longitudinal, making it difficult to trace causality or long-term trajectories.

Energy poverty is the result of a combination of structural, economic and environmental factors that tend to occur alongside broader income poverty. However, unlike income poverty, energy poverty can be triggered by external shocks over short periods, such as unpredictable spikes in energy prices caused by global crises like the pandemic or the war in Ukraine. These events cause fluctuations in supply. Energy poverty can also be triggered by policy reforms, such as the removal of energy subsidies or the liberalisation of tariffs, which reduce the affordability of energy for the poorest. Furthermore, climate change exacerbates the issue by increasing energy demand due to more frequent and severe extreme temperatures.

Pr Alberini pointed out that the transition to electricity systems could exacerbate energy poverty for the most vulnerable people if policies are not well defined. She gave the example of shifting to electricity, particularly through carbon pricing channels, which may initially increase costs before long-term benefits are realised, putting further short-term pressure on vulnerable people. Moreover, poor housing, particularly poorly insulated homes, increases energy demand, requiring additional energy to cool or warm residential spaces and resulting in higher costs. She concluded by emphasising that these diverse and often co-occurring causes must be identified in order to create effective policies to support the most vulnerable people.

On the other hand, Stuti Khemani challenged the assumption that direct subsidies and progressive tariffs necessarily alleviate energy poverty. Drawing on World Bank research, she argued that these approaches can produce counterproductive general equilibrium effects. In South Asia, for example, subsidies have distorted electricity pricing, discouraged infrastructure investment, and entrenched political patronage systems.



Dr Khemani emphasized that energy poverty in regions like sub-Saharan Africa is fundamentally tied to institutional capacity. Without improving state capacity, revenue collection, and local governance, scaling up access will not be sustainable. Her framework treats energy poverty as a constrained optimization problem—balancing SDG7 goals with tight fiscal and political limits.

She pointed to East Asia, particularly China, as a case where rural electrification was successfully embedded in broader local economic strategies. In contrast, countries that rely solely on subsidies without institutional reform tend to see stagnation or regression. She also noted the importance of local governance: evidence from India shows local politicians were less inclined to support free electricity than national-level counterparts, possibly because they face more direct accountability.

Her recommendations emphasized the importance of solid policies to reduce energy costs and encourage investment in infrastructure, particularly renewable energy. Delinking tariff setting from welfare policy is an essential part of this. This would give utilities, whether private or public, greater freedom and reduce the threat of political intervention. Utilities must also be reformed to create incentives for innovation, lower costs and increase service reliability, while keeping tariff structures financially acceptable and consumer-friendly.

Alongside these reforms, local governments must become more effective in directing public spending towards poverty reduction through targeted welfare transfers, investment in roads and infrastructure, and access to credit markets. Local institutions must also be strengthened. Local institutional changes can enhance legitimacy, provide subsidy reforms more effectively, and improve fiscal ability. As electrification spurs local economies, increased property values can be leveraged through taxation to support ongoing infrastructure needs. Together, these policies can create a sustainable and equitable framework for expanding energy access and overcoming structural barriers to productive electricity use.

Roula Inglesi-Lotz extended the discussion to justice and inequality. She began by pointing out how subjective the concept of energy poverty is—many people in rural areas may not consider themselves “poor” in energy terms simply because they’ve never had access or alternatives. This highlights a key issue: energy poverty is not only a question of access, but of affordability, quality, reliability, and consumer agency.

She presented global data that confirms progress in reducing energy poverty has been regionally uneven. Sub-Saharan Africa stands out as the only region where the number of people without electricity has increased, driven by population growth. Access to clean cooking fuels remains particularly low in both Africa and parts of Asia.

Pr Inglesi-Lotz distinguished between Global South and Global North experiences: while the former struggles with basic access and reliability, the latter faces affordability and hidden energy poverty. She cautioned against blanket policies, pointing to intra-country disparities and the risk of poorly targeted subsidies reinforcing inequalities.

She also problematized the notion of a “just” energy transition. For many in sub-Saharan Africa, the urgency is not about decarbonization but about securing basic access. The transition risks widening the access gap unless carefully managed. For instance, South Africa’s solar panel subsidy disproportionately benefited wealthier households who could afford the up-front investment, excluding the poor and destabilizing the grid.

Pr Inglesi-Lotz added that the energy transition can be a powerful tool for tackling energy poverty if it is planned and implemented with equity, security and sustainability in mind. Targeting infrastructure investments at the specific needs of vulnerable individuals can provide access to modern, secure and clean energy services, which also improves health and wellbeing and creates new jobs that can lift communities out of economic poverty.

To prevent energy poverty from being exacerbated, the forthcoming challenges must be anticipated, such as job losses in the fossil fuel sector, stranded assets and higher energy prices resulting from the introduction of new technologies. Unless these transformations are managed effectively, they are likely to affect poor households disproportionately. Pr Inglesi-Lotz also noted that resilient and responsive institutions are key to mitigating these risks. She mentioned that corruption-free, high-quality regulation and good governance can facilitate targeted investment and ensure that energy transformation policies are inclusive, resilient, and maximally transformative for all.

Conclusion

The panel converged on a few core themes: energy poverty is multifaceted and context-dependent; solving it requires more than subsidies or technical fixes—it demands coherent, long-term policy grounded in local institutions and economic development. Global disparities are likely to widen unless energy access is integrated into broader strategies for fiscal reform, state-building, and equitable development.

Sustainable Electricity Generation: Enabling Electrified Uses - Plenary Session 2

By Alice Mével (MsC, alice.mevel@psemail.eu) and Shruti Gupta (MsC, shruti.25gupta@gmail.com)

Session Chair:

Dr Yukari Yamashita (Executive Director, Institute of Energy Economics)

Speakers:

M. Marc Benayoun (Group Senior Executive Vice-President, Customers & Energy Services, EDF)

Pr Catherine Wolfram (MIT Sloan School of Management)

Dr Christian Zinglersen (Director of European Union Agency for the Cooperation of Energy Regulators)



This plenary session examined how the main constraints of decarbonisation have shifted away from technology towards economics and governance. Renewable electricity is increasingly abundant, but its integration depends on flexible, price-responsive demand, credible carbon pricing and strong institutional frameworks. The three contributions focused on Europe's stagnant demand, the global spillovers of carbon pricing, and the governance gaps in power markets and grids.

Marc Benayoun argued that Europe has entered a "post-growth" demand regime. In France, electricity consumption in 2024 remained around 8 per cent below the 2018–2019 average, returning to levels last seen in 2003–2004. The trend is continental: in the United Kingdom, industrial load has fallen by more than 30 per cent since the early 2000s.

He explained this decline through three mechanisms: (1) de-industrialisation, as high energy prices and weak policy coordination pushed heavy industry abroad; (2) corporate efficiency contracts, exemplified by La Poste's retrofit of one million square metres of buildings, which saves more than 20 GWh annually; and (3) residential behavioural change, as households reduced their usage after the 2022 price shock and maintained these habits with the help of EDF's EDF & Moi/Écowatt application, which now has over 50 million users and smart meters connected to monitoring tools.

The combination of stagnant demand and fast renewable deployment has created oversupply. France recorded more than 400 hours of negative wholesale prices in 2024, compared with 180 in 2023 and none in 2022. This erodes merchant revenues and even EDF's integrated margins. At the same time, electrification has slowed: sales of heat pumps fell by 35 per cent when subsidies were paused, electric-vehicle registrations declined after changes to bonus-malus rules, and hydrogen offtakers remain cautious while contract-for-difference schemes await EU approval.

M. Benayoun warned that demand-side electrification is not self-sustaining and requires policy support to be effective. He proposed three levers: (1) durable capital incentives for technologies such as heat pumps and electric vehicles; (2) integrated programmes that link efficiency with electrification to absorb surplus renewable generation; and (3) expanded capacity and flexibility markets to monetise demand response and storage. He also pointed out that policy asymmetry across EU member states is economically incoherent, as countries have heterogeneous starting points and face different challenges.

Catherine Wolfram turned the discussion to the global geopolitics of carbon pricing. She argued that carbon markets are now the main engine of climate policy, with 17 of the G-20 economies applying some form of carbon price. Russia, Saudi Arabia and the United States remain the main exceptions. In the U.S., she explained, three factors block progress: (1) the country's status as a leading oil and gas exporter, (2) the reserve-currency privilege that shields it from external pressure, and (3) deep political polarisation that leaves both left and right sceptical of carbon markets. Ironically, she noted that a further U.S. retreat from climate leadership could accelerate reforms in other blocs.

The EU's Carbon Border Adjustment Mechanism (CBAM), due to take effect in January 2026, will apply the EU carbon price to imports of steel, cement, aluminium, fertilisers, hydrogen and electricity, adjusted for any levy paid in the country of origin. Anticipating this, Turkey, Brazil and China are expanding their emissions trading systems to ensure charges are collected domestically. The EU and the UK are also exploring market linkage, signalling the emergence of a more interconnected global carbon-pricing web.



Pr Wolfram illustrated these dynamics with Mozambique's Mozal aluminium smelter, which runs largely on hydro-power. Today, Mozal sits around the 20th percentile of the global cost curve. Once coal-based competitors face a €90 per tonne CBAM levy, Mozal could move up to the 5th percentile, securing a competitive advantage. If Mozambique introduced a €50 per tonne domestic carbon tax that was credited against EU charges, it could generate revenue worth about 1 per cent of GDP without undermining the smelter's position. Exporting aluminium in this way effectively embeds renewable electricity at around €2 per exported MWh, far cheaper than exporting electrons directly or in the form of liquefied hydrogen, which costs €180–220 per MWh.

She concluded that carbon pricing can reward countries with clean electricity resources, provided they invest in robust grids and credible monitoring and verification systems. Far from being a form of regulatory colonialism, CBAM can create opportunities for African economies to pursue green industrialisation while capturing new fiscal revenues.

Christian Zinglensen focused on the mismatch between Europe's rapid renewable build-out and its lagging market and grid frameworks, which he described as a "plumbing crisis." Although average prices have eased since 2022, volatility remains severe. Intraday swings of more than €50 per MWh occur on 70 per cent of trading days, and Spain saw a spread of €180 per MWh in April 2024. Negative-price hours have increased more than tenfold since 2021. Meanwhile, imported liquefied natural gas (LNG) still sets the seasonal margin, meaning global gas shocks continue to shape European power bills.

He identified three governance gaps: (1) cross-border bottlenecks, as only 17 out of 27 EU countries comply with the rule to offer at least 70 per cent of interconnector capacity to the market, leaving renewable surpluses stranded while neighbouring states pay peak prices; (2) locked-out flexibility, since nine countries lack legal frameworks for aggregators, and most consumers remain on flat tariffs that provide no incentive to shift demand, excluding batteries, electric vehicles and smart-home devices from system balancing; and (3) unchecked grid spending, as transmission system operators plan €500–800 billion of investment through 2030, often without first optimising existing assets through digitalisation and dynamic pricing.

Dr Zinglensen argued that Europe should (1) reward flexibility before adding new grid infrastructure, (2) finance interconnectors on a benefit-sharing basis, and (3) give ACER sanctioning powers to ensure compliance. Using a humorous *The Simpsons* clip, he illustrated that adding imperfect policy fixes—such as subsidising electrolysers to absorb excess supply—only worsens distortions. For him, only market and governance reforms can turn renewable abundance into a reliable supply, stable prices and competitiveness.

For concluding remarks as moderator, Yukari Yamashita framed the debate within the "twin pressures" of decarbonisation and energy security. She cautioned that Asia should not assume electricity demand will rise in a straight line as devices proliferate, underlined that ASEAN steel exporters to Europe will need credible carbon data, and warned that without regional regulators, Asia's grid upgrades could prove costlier and less flexible.

Overall, the plenary underscored that the challenge of sustainable electricity generation no longer lies in technology but in governance, economics and institutions. Without stronger demand-side support, coordinated markets and effective regional cooperation, abundant renewable capacity risks becoming stranded rather than powering the next wave of electrified growth.

Key Takeaways

- Decarbonisation challenges lie more in economics, governance and institutions than in technology.
- Europe's electricity demand is stagnating while renewable capacity continues to grow, creating oversupply and price volatility.
- Carbon pricing, especially CBAM, is reshaping global markets and may enable green industrialisation in countries with clean power resources.
- Europe's market and grid frameworks are lagging behind renewable deployment, leading to volatility and stranded capacity.
- Stronger policy support for electrification, coordinated carbon pricing and robust governance reforms are essential to ensure renewables drive sustainable growth.

Dual Plenary Session 2.1 - Gas based solutions for sustainable future? perspectives on Hydrogen, Biogas and CCS

By Laura Natalia Beltran Gerena (MsC, ln.beltrang@gmail.com) and Hayeon NAM (MsC, hayeon.kate@gmail.com)

Session Chair:

Pr Olivier Massol (Université Paris Saclay)

Speakers:

Pr Christian Von Hirschhausen (DIW Berlin),

Dr Yukari Yamashita (Institute of Energy Economics)

Ms Marie-Claire Aoun (Director of Strategy and institutional relationships, Teréga)

Olivier Massol, who holds the position of professor at Centrale Supélec et University Paris Saclay, chaired the session. In his opening speech, he emphasized that recent shocks have exposed vulnerabilities in global gas markets, particularly in Europe, resulting in profound shifts. This turbulence has dispelled the idea of gas as a simple “transition fuel”, necessitating a careful balance between affordability, security, and decarbonisation. In response to these challenges, the session aimed to critically reassess a range of technologies both old and new. Three experts joined as keynote speakers: Christian Von Hirschhausen of TU Berlin et DIW Berlin; Yukari Yamashita of Institute of Energy Economics; and Marie-Claire Aoun of Teréga. Each of them proposed a combination of solutions that included low-carbon hydrogen, biomethane, and Carbon Capture Storage (CSS). They also highlighted the challenges associated with them, such as high costs, inconsistent policies, and integration into existing systems.



Energy transformation should be approached from a long-term perspective. The first speaker of the event, Christian Von Hirschhausen, opened the discussion by introducing Cesare Marchetti, who originated the concept of CCS.

M. Marchetti was an Italian physicist and systems analyst who in the 1960s first introduced the concept of energy transition in the form of energy substitution theory. He defined energy transition as the long term technical substitution of wood by other fuels such as coal, oil, natural gas and hydrogen. Although his ideas do not fully explain the dynamics of today's energy transitions, his work continues to influence current thinking.

After, Pr Von Hirschhausen turned his focus to more recent developments, and discussed his recent work which focuses on the need for a voltaic pipeline and a Europe without Russian exports. His research shows that if the infrastructure is used efficiently, Europe can survive without Russian gas — highlighting the importance of more flexible and adaptive infrastructure use. He also identified two main challenges in the current hydrogen market: first, its structural design and second, the balance between centralized and decentralized production and consumption. The latter issue is particularly problematic because localized production, the logical offshoot of decentralization, requires the supply of specialized pipelines and the optimal functioning of local industrial clusters, which are currently insufficient.

In the final part of his presentation, Pr Von Hirschhausen gave a historical overview of CCS technology and its more recent iterations. CCS was originally discussed in the 1920s, when CO₂ was first separated in the US. Despite its long history, CCS suffers from a mismatch of projected use and widespread adoption. A more contemporary version of this technology, Direct Air Capture (DAC), is even less known to the public. Among its mechanisms, chemical absorption and electrochemical methods are similarly competitive in technology and comparable in market share. The key question is how these approaches will evolve over the coming decades, and how much time will need to reach maturity. The future is uncertain, and many energy and climate scenarios in the IPCC and elsewhere tend to repeat familiar social and technological patterns. Efficient use of existing infrastructure, improved market design, localized hydrogen solutions, and technological innovation in CCS and DAC will be crucial for ensuring a sustainable and resilient energy future.

The second speaker Yukari Yamashita begins the discussion on hydrogen by noting that achieving carbon neutrality requires a multi-pronged approach, incorporating energy efficiency measures, widespread electrification and innovative solutions for sectors where electricity is not sufficient. Hydrogen can indeed play a pivotal role in the energy transition era, as it is a versatile, low-carbon fuel capable of addressing current gaps in the transition. Unlike electricity, it can decarbonise “hard-to-abate” sectors such as industrial heat and heavy transport. Its ability to store energy also makes it invaluable for balancing the intermittent nature of renewable sources. She points out, for instance, that surplus wind or solar power can be used to produce hydrogen via electrolysis, which can then be stored and used

during periods of low renewable generation. Moreover, ammonia and synthetic fuels (e-methanol) further expand hydrogen's utility by serving as transportable carriers, though questions linger about their lifecycle emissions.

Nevertheless, Dr Yamashita noted that economic and political challenges must be taken into account. Electrolysis and CCS remain costly, and hydrogen's low energy density requires expensive infrastructure upgrades. Import-dependent nations such as Japan also face logistical complexities, such as converting hydrogen to ammonia for transport and back again. Furthermore, cross-border standards for hydrogen trade and carbon accounting are lacking, creating market uncertainty. Lastly, price volatility and shifting export policies make long-term planning difficult.

Dr Yamashita emphasized the need for rapid technological advancements, particularly in reducing the cost of green hydrogen, as well as stronger international collaboration to establish standards and secure demand. While Japan's feasibility studies and CCS projects represent progress, scaling up hydrogen production to meet net-zero targets will require unparalleled public-private sector collaboration. In her closing remarks, Yamashita struck a cautious yet optimistic tone, stating that hydrogen is not a magic solution, but that with targeted innovation and cooperation, it could form the foundation of a clean energy future.

The third speaker of the event was Marie-Claire Aoun of Teréga. Teréga is the French gas transmission system operator and storage operator, representing 14% and 25% of the French gas pipeline network and gas storage capacity. Ms Aoun emphasized Teréga's commitment to expand its business portfolio beyond gas transmission, to include a new role as an operator of "infrastructure molecules," transporting hydrogen and CO₂.

Global gas consumption is declining, but renewable gas, in particular biomethane from methanation, is increasing in France. Under French law, the country must meet 15% of its gas consumption from renewable gas by 2030. The production cost of biomethane remains high compared to natural gas, but this price gap can be bridged by valorizing the other positive externalities that biomethane provides. For example, it supports agriculture, creates jobs, and contributes to the circular economy. In addition, as biomethane fits into existing gas networks without new infrastructure investments, it allows an easier transition to renewable energy compared to other sources.

Alongside renewable gases, electrification is essential to achieving carbon neutrality. Nevertheless, not all uses can be electrified. In this context, hydrogen offers a promising solution. European countries aim to expand hydrogen production through electrolysis, prioritizing decentralized infrastructure by building electrolyzers and encouraging local consumption until centralized models are in place. High-demand regions like Germany and the Iberian Peninsula, including Portugal and Spain with strong solar potential, are main targets.

The BarMar project, which plans to create a hydrogen corridor from Portugal and Spain, through France, to Germany, exemplifies this strategy. To reduce capital expenditures of the project, existing gas pipelines were repurposed by replacing compressors where feasible and redundant lines that were freed up due to declining natural gas demand were used. Despite these efforts, implementing hydrogen infrastructure presents difficulties, particularly regarding the economic model and business plan. Securing regulatory visibility is therefore vital to secure long-term market commitment.

As for Carbon Capture, Utilization and Storage (CCUS), Ms Aoun emphasized the importance of the "utilization" part. This is because there is potential for biogenic CO₂ from biomass in the southwest region of France, which could be used for power-to-gas or e-fuels. Like hydrogen, several projects are in progress, pipelines transporting CO₂ to storage sites. CCUS is also seen as a promising avenue for industrial emitters constrained by the EU ETS, since they are expected to lose access to free quotas in the near future.

Conclusion

The energy transition for a sustainable future requires diversified and integrated approaches. No one solution alone can fully address the triple challenge of affordability, energy security, and decarbonization. Technologies that have been debated from hydrogen and biogas to CCS and DAC, are all promising but each of them also faces economic, technological, and regulatory issues. From the discussions, it is very clear that there is a need for smarter use of infrastructure, adaptive market design, and stronger international cooperation to enable these solutions to be deployed at scale and become affordable.

Energy decentralised markets and environmental policies in territories: an efficient bottom up scheme - Dual Plenary Session 2.2

By Rowena Mathew (PhD Candidate, University of Savoie-Mont-Blanc, rowena.mathew@univ-smb.fr)

Session Chair:

Pr Yannick Perez (University Paris-Saclay)

Speakers:

Pr Michael Caramanis (Boston University)

Pr Ricardo Ranieri (Pontifical Catholic University)

Pr Laurens de Vries (Delft University of Technology)

Dr. Caramanis mentioned that uncertainty from wind and solar generation is increasingly evident in operational planning, from day-ahead and week-ahead markets all the way to real-time balancing and transmission management. Market clearing processes are evolving to address these challenges, with robust LMP (Locational Marginal Pricing) and adaptive DLMP (Distributed Locational Marginal Pricing) methods being developed.

Both individual assets and the system as a whole face risk. For renewable generation, this includes uncertainty in available capacity at the asset level and correlated impacts at the system level. Demand, meanwhile, often exhibits price inelasticity, especially in areas such as EV charging and HVAC usage. Storage is expected to play a key adaptive role in the day-ahead market and in SCED (Security Constrained Economic Dispatch). Congestion management and contingency planning are also critical, particularly as transmission constraints can amplify risk.

On the demand side, certain loads effectively behave like storage at scale, especially at the wholesale level. California's "duck curve" highlights the challenge: solar generation creates steep net load peaks that require costly catch-up in dispatchable generation. Wind forecasting is another important tool; specialized companies in the U.S. now provide forecasts ranging from 5 minutes to 50 hours ahead, using granular models at 5x5 km resolution to capture the risks of uncertain wind generation.

The newRAMP (Risk Assessment Management Paradigm) framework has emerged as a way to integrate risk into energy market operations. Market-based reserve planning is becoming essential under conditions of highly uncertain renewable generation. Since total generation is distributed differently across time and space, location awareness is critical: reserves must be deployed effectively to alleviate transmission congestion and reduce short-term marginal costs across locations. Reconfiguring transmission and distribution networks can also help improve reliability and efficiency.

Studies have been carried out in the U.S., such as modeling the Southwest Power Pool (SPP) in PSO and benchmarking performance. One of the key findings is that socially optimal scheduling requires acceptable pricing mechanisms that support distributed decision-making. However, achieving this under non-convex market conditions remains an emerging challenge.

Uncertainty in both net demand and centralized renewable generation is proving to be a game-changer. Power flows often move from high-supply to high-demand regions, which risks overloading transmission paths. Once capacity limits are reached, electricity cannot be moved further, making line congestion avoidance crucial. On the edges of the transmission and distribution system, radial substations with no interconnection raise concerns about power quality and end-user supply reliability.

Cost structures show that generation accounts for about 50% of total costs, transmission for 5%, and distribution for 45%. This suggests that both centralized transmission-level management and decentralized, interactive, adaptive distribution-level management must be considered. Overloading risks are also growing eg. widespread EV charging can overload service transformers and drastically reduce their lifespan. Case studies, such as DLMP-based equilibrium pricing in upstate New York on sunny days, further demonstrate how renewable variability and localized conditions shape cost outcomes.



Dr. Ranieri started his address with some history about Chile's electricity markets, mentioning that Chile was the first country to liberalize its electricity markets in the 1970s, setting an influential example for others in the region. The country introduced straightforward energy laws and implemented a central dispatch system. Its electricity sector was restructured into separate markets for generation, transmission, and distribution. While transmission operated as a mix of monopoly and open access, generation was fully liberalized. A significant portion of output, nearly one-third, was consumed directly by mining companies, with electricity sold to them under direct contracts.

In recent years, energy systems worldwide have been shifting away from traditional top-down centralized planning toward more decentralized, bottom-up approaches. These new schemes allow generation and demand to be managed at the local, municipal, or prosumer level, often through distributed energy resources (DERs) such as rooftop solar, microgrids, and PMGDs (Pequeños Medios de Generación Distribuida). Policy and governance frameworks are increasingly designed to respond to local needs, embedding projects within communities.

This bottom-up approach has important social and political implications. It transforms opposition into support by moving beyond "Not In My Backyard" resistance. Participation, legitimacy, and fairness are fostered through economic inclusion, community ownership, and resource localization. However, the model also introduces challenges. Coordination gaps, system fragmentation, balancing difficulties, and the lack of standardization can limit effectiveness. In some cases, local projects are invisible to system operators, provide no frequency control, and disconnect automatically during disturbances.

Governance and implementation risks add further complexity. Technical constraints, knowledge gaps, and misalignments between system operations, grid services, policy objectives, market signals, social movements, and cybersecurity concerns all contribute to vulnerabilities. For instance, Chile's power system grew from 240 power plants in 2010 (60 of which were small-scale under 9 MW) to more than 1,000 by 2025, including over 100 small-scale plants. Managing such a diversified and distributed system presents a significant challenge.

Hybrid governance frameworks are therefore emerging as a solution. By combining bottom-up participation with top-down oversight, they provide clearer regulatory boundaries, equitable access mechanisms, and stronger balancing arrangements. Without such mechanisms, decentralized systems are exposed to serious risks. Spain and Chile have both experienced blackouts that illustrate these vulnerabilities. In Chile, a transmission line failure in 2025 disconnected the northern and southern grids. Around 10% of the system, comprising small solar plants, automatically disconnected when frequency dropped below the safety threshold. The blackout began at 3 p.m. and cascaded through the system, taking nearly nine hours to restore.

These events underscore the need for a strong digital foundation to support bottom-up energy systems. Intelligent forecasting, smart grids with two-way communication, and real-time monitoring are essential to ensure resilience and stability. Without such infrastructure, bottom-up approaches risk becoming "bottom-out" failures, undermining both system reliability and public confidence.

Dr. De Vries believes that skepticism remains around the long-term role of local renewable energy in Europe's urban areas. Even net zero cities will continue to rely on the grid, particularly in winter months when local generation potential is insufficient. Most European cities lack the spatial capacity for significant renewable deployment, although cooling demand often aligns better with local generation. As a result, the strongest economic rationale for local energy markets lies in alleviating network congestion. Beyond this, distributed renewable energy (DRE) integration is supported primarily as a means to stimulate local flexibility and resilience.

Designing effective market structures remains complex. Nodal pricing is one approach, but it must be complemented by additional tariffs to recover the fixed costs of grid infrastructure. Incentives for network users are therefore not yet fully optimal, mirroring challenges also seen in the U.S. and Europe has adopted a combination of connection charges, network tariffs, and congestion management tools. Nonetheless, longer-term studies consistently show that full decarbonization and electrification will require massive new investments in the electricity grid. Local flexibility markets can help reduce these costs by 10–20%, but they are not a complete substitute for network reinforcement.



Price formation is shaped by renewable penetration and demand elasticity. With limited renewable generation, inelastic demand amplifies price volatility. With ample renewable supply, downward pressure can drive prices to zero or even negative levels. However, simulations suggest that zero-price events occur only 10–20% of the time, indicating that demand-side participation is essential in smoothing outcomes.

The DEMOSSES project, led by Dr. De Vries as a PI, is addressing these barriers to flexibility. It aims to assess regulatory and market constraints, while coupling partner models to express flexibility without requiring confidential data exchange. Yet a persistent “chicken-and-egg” problem remains: to model the future electricity system, analysts need data on the flexibility of large consumers, but those consumers require clearer price signals to justify investing in flexibility.

Several additional issues complicate the transition. In Europe, network charges remain the primary barrier to flexibility. In the Netherlands, net metering for solar has become problematic, while time-of-use (TOU) tariffs offer a more promising solution. Another challenge is enabling multi-day flexibility: while electricity storage remains costly, heat can be stored more cheaply, making it a priority for market design. European wholesale markets may therefore need to incorporate “micro-forward” structures to capture these opportunities.

Hydrogen is now a formal policy priority in the Netherlands, where it is positioned as a centralized green energy source. However, regulators face uncertainty regarding industrial demand for hydrogen and the scalability of electrolysis. Alternative pathways to decarbonization, such as heat networks and geothermal systems, may offer more immediate efficiency gains, especially since 40% of electricity demand in the Netherlands is related to heating.

Overall, local markets represent only part of the broader solution. Even in well-insulated, net zero cities, the central grid will remain indispensable. While the long-term contribution of local markets is limited, they provide valuable complementary flexibility, helping to reduce costs, support integration of renewables, and enhance system resilience. Coherent market design remains the critical challenge to ensure that both centralized and decentralized elements work together effectively

Energy networks, decentralization and connected consumers: a new role for grids - Dual Plenary Session 3.1

By Laura Natalia Beltran Gerena (MsC, ln.beltrang@gmail.com) and Hayeon NAM (MsC, hayeon.kate@gmail.com)

Session Chair:

Chloé Le Coq (Université Paris Panthéon-Assas)

Speakers:

Pr Paul L. Joskow (MIT)

Pr Chiara Lo Prete (Penn State University)

M. Thomas Veyrenc (Member of the Executive Board, Managing Director in charge of Economy, Strategy and Finance, RTE)

The traditional model of large, centralized power plants delivering electricity to passive consumers is evolving. Chloé Le Coq of Université Paris Panthéon-Assas chaired the session and highlighted how consumers are becoming more active in the energy system through solar panels, electric vehicles, and smart devices. The grid itself is also evolving: neighbors are forming microgrids, and the boundary between producers and consumers is becoming blurred. Supply and demand are now more dynamically connected than ever. This dual plenary session explored key questions, including how to manage increasingly complex electricity networks, what being truly connected means for consumers, and whether decentralization can lead to a more efficient, resilient, and accessible energy system. Three experts joined as keynote speakers: Paul L. Joskow of MIT; Chiara Lo Prete of Penn State University; and Thomas Veyrenc of RTE.



The first speaker of the event, Paul L. Joskow, opened the discussion by pointing out that economic research has mostly focused on generation and transmission, while distribution has been neglected. L. Joskow argued that as decarbonization progresses, distribution network economics deserves more attention. The increasing use of electrification, such as electric vehicles (EV), electrical heat pumps, rooftop PV, batteries, and storage, offers limited flexibility but has a significant impact on distribution networks. These changes are making electricity demand more diverse in terms of peak times and load profiles.

Massive investments are being proposed to accommodate these new applications. An example from Massachusetts shows that around one-third of substations will need expansion to support future EV and heat pump penetration. Consumer electricity bills also reflect this shift. Delivery charges are rising faster than energy supply costs, which are actually declining. L. Joskow emphasized that this is a common phenomenon across the US. Public policy goals are being funded through electricity bills rather than general taxation, as this approach is more implicit and less visible to the public.

Facing these issues, Time Of Use (TOU) pricing has been proposed to shift electricity demand away from peak hours. However, a study by MIT found that poorly designed TOU schemes can cause unintended new demand spikes immediately after prices go down. These sudden surges trigger reliability issues on the distribution network and require substantial investments to maintain system reliability. In response, a Canadian field experiment suggested that pairing TOU pricing with utility-managed charging, where the utility controls the EV charging schedule, effectively shifted load without this issue. Although heat pump usage patterns create less pronounced peaks than EVs, combining new loads add significant complexity. This means that, even with utility-managed charging, distribution companies may still face challenges in balancing demand across a wide range of devices.

Consequently, distribution economics must be prioritized in energy transition planning, and field experiments are essential for understanding actual consumer behavior. Providing price signals and allowing consumers to self-manage their usage may offer a more effective approach. Yet consumers are not fully rational, which underscores the need for innovative pricing schemes that were originally designed for the collective generation network but are now implicitly applied to the semi-individual network.

Chiara Lo Prete followed the discussion by addressing the growing interdependence between natural gas and electricity systems in the U.S., particularly during winter storms, which have caused over \$100+ billion in damages and 1,400 deaths since 1980. These extreme weather events reveal fundamental vulnerabilities in energy infrastructure as demand spikes simultaneously for both heating and electricity generation.

Their research revealed several systemic flaws in the current energy market. A key issue is that natural gas serves two critical roles: it heats 45% of U.S. households and generates 42% of the nation's electricity (up dramatically from just 17% in 1980). This dual dependence creates competing demands that intensify during winter emergencies. Three structural problems exacerbate this situation: (1) rigid long-term gas contracts that penalise power plants for necessary flow variations; (2) day-ahead gas markets that close too early (by 9:30 am) to accommodate real-time generator needs; and (3) local distribution companies (LDCs) withholding reserves due to misaligned incentives that prioritise regulatory compliance over overall system efficiency. As Lo Prete emphasized, these interconnected issues collectively undermine the resilience of the energy system during critical periods.

Pr Lo Prete proposed several policy solutions, including implementing "shaped flow" contracts with volumetric pricing to better match power plant needs, creating day-ahead reallocation mechanisms for gas reserves, and adjusting regulatory frameworks to encourage LDCs to release unused gas during emergencies. Australia's successful implementation of day-ahead auctions was highlighted as a potential model for improving system resilience while maintaining affordability and reliability. She emphasized the urgency of reforming gas markets to match electricity's flexibility needs, ensuring reliability amid escalating climate risks. Lastly, Lo Prete emphasized that significant research continues to model their potential impacts and implementation pathways.



The last speaker, Thomas Veyrenc, on the other hand, presented RTE's analysis, which highlighted the complex evolution of Europe's energy markets. These markets initially prioritized market integration and depoliticization in the early 2000s, but have since seen renewed government intervention, particularly in setting decarbonization targets. This shift has necessitated comprehensive planning, as demonstrated by RTE's 2050 energy study. This study moved beyond narrow cost comparisons, such as LCOE, to evaluate the full cost of the system, including flexibility, grid investments and the need for cross-border interconnection. The study revealed that the cost of grid modernization would triple to match generation investments, providing a crucial insight that had previously been missing from public debate.

The study outlined three core pillars for France's grid strategy: (1) replacing aging infrastructure while adapting to climate change, (2) integrating new low-carbon generation (renewables and nuclear) and demand-side solutions, and (3) reinforcing high-voltage transmission to accommodate shifting generation patterns, such as westward wind and nuclear expansion. These measures are crucial for France to meet its net-zero targets, especially given that industrial consumers still rely on fossil fuels and the importance of cross-border coordination is growing.

A key challenge lies in balancing political, technical and market-driven priorities. For instance, the nuclear versus renewables debate hinges on capital costs and technological progress, while grid investments must align with long-term generation shifts. RTE's work highlights that achieving decarbonization requires more than just new generation capacity, since it also requires a fundamental rethink of grid planning that integrates climate resilience, flexibility, and European cooperation.

Conclusion

This session emphasized the urgent need to modernize energy grids to facilitate decentralization and climate resilience. Joskow emphasized the importance of better distribution planning for electrification, while Lo Prete proposed gas market reforms to prevent winter crises. Veyrenc, meanwhile, outlined France's grid overhaul for renewables and nuclear power. They all agree that successful energy transitions require integrated technical, economic and policy solutions. As grids evolve, collaboration between all stakeholders will be essential in building reliable, affordable and sustainable systems.

Energy Access in Developing Countries: Renewables or Fossil Fuels? - Dual Plenary Session 3.2

By Shruti Gupta (MSc, shruti.25gupta@gmail.com) and Alice Mével (MSc, alice.mevel@psemail.eu)

Session Chair:

Ricardo Raineri (*Pontifical Catholic University*)

Speakers:

Dr Axel Pierru (Vice President, Knowledge & Analysis, KAPSARC)

Dr Vibha Dhawan (Director General, TERI)

Pr Ujjayant Chakravorty (Tufts University)

This session addressed the core development dilemma facing the Global South: how to expand energy access equitably while transitioning toward cleaner energy sources.

Axel Pierru argued from the perspectives of fuel importer and exporter that energy access in developing nations cannot be reduced to "renewables versus fossil fuels." He showed—using cross-country data—that electrification strongly bi-directionally correlates with GDP per capita but also depends on policy decisions, import dependency, and institutional capacity.

Countries fall into two broad groups: (1) those with high access but dependent on energy imports and (2) those with low access but resource-rich. Within this context, many have expanded electricity access primarily through fossil-based infrastructure, including coal and diesel generators. He examined the trade-offs:

- Fossil generators: low upfront cost, high running costs and emissions.
- Renewables + battery storage: low operating costs, low emissions, but capital-intensive and intermittent.



On clean cooking energy, Dr Pierru presented case studies from East Africa and West Asia where biomass dependence incurs massive social costs—from non-renewable deforestation to women’s lost labor time. He suggested LPG as a practical clean alternative but stressed that affordability, financing, and infrastructure are key.

Gulf states (GCC) are building out local renewables supply chains to:

- Capture high-value jobs and diversify away from oil & gas economies, and
- Hedge against transition risks: (e.g. future carbon border taxes and import-reliance shocks). This may entail, at least in the short run, paying a small premium over China’s cost advantage.

He warned against “low-access equilibrium traps” caused by subsidized electricity pricing that distorts investment signals and degrades grid reliability, citing examples from South Africa and Nigeria.

Way Forward: Low countries need assistance to adapt to decarbonization. Pragmatic approaches are needed from global institutions to balance low-carbon transitions with energy access, particularly by reconsidering restrictions on financing natural gas projects in resource-rich regions like Africa.

Vibha Dhawan provided an overview of India’s transition. While village-level electrification is complete, supply quality remains uneven—especially in rural and agricultural regions. With 300+ sunny days per year, solar energy has emerged as a low-cost, decentralized option for both households and farms. Agrivoltaics and solar irrigation are central to this strategy, along with a push for rooftop solar through subsidies and free electricity schemes.

She discussed how India’s energy policy increasingly blends renewables with rural development. Innovations like Agrivoltaics, solar irrigation systems, solar-powered cold storage chains, distributed food processing, and successful programs such as “pay-as-you-go” mini-grids and “Light a Billion Lives, are being piloted as income multipliers.

Yet clean cooking fuel adoption lags despite LPG subsidies. Capital investment for solar and storage remains a barrier. Dr Dhawan called for better-designed carbon markets and skilling programs to ensure transitions are inclusive. She also noted institutional innovation, including India’s National Green Hydrogen Mission and solar-powered transport infrastructure, as long-term enablers.

Ujjayant Chakravorty provided micro-level evidence from India and long-run econometric analysis from the Philippines. In India, his research revealed that rural biomass collection is not just subsistence-driven, it’s also commercial. Households farther from forests often collect and sell more fuelwood, drawn by higher scarcity prices, locking communities into environmentally degrading cycles.

In the Philippines, Pr Chakravorty exploited a historical electrification policy that prioritized municipalities above 100,000 residents. Forty-five years later, those municipalities have significantly more infrastructure and lower electricity prices, but no measurable income gains. Instead, the main long-run effect was population migration—people moved toward cheaper, better energy.

These findings challenge conventional metrics. Short-term studies might overlook transformational outcomes like demographic shifts or infrastructure buildout. Chakravorty stressed that reliable, affordable energy does not automatically translate to economic growth—it often requires complementary assets like skills, capital, and market access. He also highlighted that rural households often have low willingness to pay, making cost recovery for energy programs difficult. Yet, improving energy access in developing countries presents a highly cost-effective strategy for CO₂ abatement—significantly cheaper than mitigation efforts in wealthier nations.

Conclusion

Across all speakers, a common message seemed to be that energy access must be viewed as context-driven. Technology choice matters, but not as much as affordability, governance, infrastructure, and social inclusion. Fossil fuels may have a role in transitional strategies, especially where natural gas is locally available, while renewables are essential for long-term sustainability.

Capital costs, financing models, and regulatory systems will determine whether solutions are accessible at scale. Equally, energy transitions cannot be delinked from local development strategies, especially in rural and agricultural areas.

Policy frameworks will need to balance the imperatives of access, equity, and decarbonization, while remaining tailored to local constraints. Perhaps most importantly, these transitions require long time horizons, cross-sectoral coordination, and a willingness to prioritize real-world outcomes.

The challenge: Energy solutions for a sustainable and inclusive future: Which recommendations? - Closing Session

By Elias Zigah (PhD candidate, University Paris-Saclay, elias.zigah@centralesupelec.fr) and Shruti Gupta (MSc, shruti.25gupta@gmail.com)

The Closing Ceremony of the 46th International Association for Energy Economics (IAEE) International Conference, held on 18 June 2025 at the Palais des Congrès in Paris, marked the culmination of three days of debate under the theme “Energy Solutions for a Sustainable and Inclusive Future.” The session combined recognition of research excellence, a gesture of climate solidarity, and wide-ranging reflections on the future of energy economics. It also looked ahead to upcoming conferences and paid tribute to the organisers whose efforts made Paris 2025 such a success.

The awards segment opened with the Best Poster Award. Out of 59 posters submitted, four finalists were shortlisted. After careful deliberation, the jury awarded the prize to Jacob Thrän (Imperial College London) for “Levelised Cost of Demand Response: comparison of energy storage and demand response using the levelised cost framework.” His study systematically compared technologies such as pumped hydro, lithium-ion batteries, hybrid heat pumps, and vehicle-to-grid schemes, breaking costs down into investment, operations, rebound effects, and end-of-life. The jury highlighted its policy relevance, noting how demand-side flexibility can mitigate price volatility in renewable-rich power systems.



The Best PhD Student Paper Award followed. Seven papers were eligible, of which four were shortlisted. The prize was awarded to Maureen Kizza Lugolobi for her research on “Policy advancement for the interpretation of Indigenous knowledge and biogas-based clean cooking in Uganda: a pathway to climate resilience.” Combining quantitative regressions with qualitative field analysis, her research showed how Indigenous knowledge can be integrated into modern energy strategies. The jury praised its clear message, methodological depth, and direct applicability to policy, pointing to lessons that extend well beyond Uganda.

A symbolic act of climate solidarity came next. Cédric Clastres, Chair of the Organising Committee, presented a donation to Geres, represented by its President Marie-Noëlle Reboulet. This French NGO supports sustainable

development and energy access projects worldwide. The contribution, made possible by participants’ voluntary carbon-offset payments, embodied the conference’s commitment to match intellectual debate with tangible climate action.

The centrepiece of the closing session was a roundtable of former IAEE presidents, invited to reflect on the plenary themes and draw lessons for the future. Peter Hartley (Rice University), Gürkan Kumbaroğlu (Boğaziçi University), Ricardo Raineri (Pontificia Universidad Católica de Chile), Yukari Yamashita (Institute of Energy Economics, Japan), and Edmar de Almeida (Federal University of Rio de Janeiro) offered perspectives shaped by diverse academic and regional experiences.

Reflections: While all stressed the difficulty of ranking such a broad programme, several plenaries stood out. The session on sustainable electricity generation and enabling electrified uses was praised for balancing academic rigour with business insight, highlighting Europe’s paradox of flat demand alongside expanding



renewables. The debate on gas-based solutions for a sustainable future was deemed crucial for hard-to-abate sectors, examining hydrogen, biomethane, and carbon capture. The discussion on energy access in developing countries resonated as a reminder that poverty and inequality remain central to the transition. Other reflections pointed to the importance of geopolitics, carbon pricing, and energy networks, confirming the breadth of issues confronting energy economists.



From these sessions, several themes emerged. Electrification remains central but depends on robust grids, flexibility markets, and institutional reform. Gas-based solutions, though costly, are unavoidable for industries where electrification alone cannot suffice. Energy access continues to expose the tension between development needs and climate goals, particularly in countries like India, where renewable ambitions coexist with coal expansion. The geopolitics of energy now centres as much on critical minerals and supply chains as on oil and gas. And climate policy must reconcile efficiency with acceptability: while carbon pricing is most effective, public preference often lies with subsidies and direct controls.

ment models and subsidy design. Institutional bottlenecks, such as protracted permitting and fragmented regulation, were seen as equally binding. Regional perspectives reinforced these points: Texas and Australia illustrated how electricity and gas markets can destabilise each other during crises; South America faces a choice between becoming a fossil exporter or a renewable hub, depending on finance and policy clarity; and Asia struggles to balance surging demand with sustainability under weak institutional frameworks.

Gaps: The panel also identified gaps. Financing the transition was described as under-addressed, with calls for future conferences to devote plenary attention to invest-

Looking forward, the ceremony announced the IAEE Mediterranean and Central Asia Conference to be held in Antalya, Turkey, on 4–6 December 2025, with abstract and paper deadlines in August and October. The 47th IAEE International Conference was confirmed for Santiago, Chile, on 19–22 July 2026, under the theme “Bridging Continents, Fueling Progress: Energy Development in a Global Context.” The Chilean organisers highlighted the country’s unique position as both an importer of hydrocarbons and a potential exporter of green hydrogen and renewable electricity.

The final moments were dedicated to acknowledgments. Cédric Clastres thanked speakers, participants, and especially student volunteers, stressing that their contributions were essential to the success of Paris 2025. A special tribute was then paid to Christophe Bonnery, who after fifteen years leading the French affiliate and decades of service to IAEE, is stepping into retirement. On behalf of the IAEE Council, Edmar de Almeida presented him with a recognition of his career. With emotion, Bonnery remarked that “this is not finished for me,” signalling his ongoing commitment to the association. The French affiliate was hailed as a “stronghold of IAEE,” and many participants described Paris 2025 as “the best IAEE conference I have ever attended.” The presence of a large number of young scholars and students was also widely praised as a sign of renewal for the association. Volunteers and staff, including Olga and her team, were warmly applauded for their dedication.



IAEE Paris 2025 closed, then, with both celebration and reflection: recognition of research excellence, a tangible act of climate solidarity, and candid dialogue about the challenges of financing, governance, and geopolitics. The community left Paris not only with memories of an exceptionally successful meeting, but also with a collective mandate: to deepen analysis, broaden representation, and ensure that energy economics remains at the heart of the transition—next in Antalya, and then in Santiago.