Clean Energy Transitions Programme

Annual report 2021

International Energy Agency

INTERNATIONAL ENERGY AGENCY

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Abstract

The Clean Energy Transitions Programme (CETP) has enabled the International Energy Agency (IEA) to significantly expand and deepen its global engagement and to support emerging economies' transition to clean, resilient, sustainable energy systems. In 2021 the CETP marked its fourth full year since its launch at the 2017 IEA Ministerial Meeting, and the programme has steadily grown in size and impact.

The CETP Annual Report 2021 aims to provide all CETP donors and partners with insights on the programme's accomplishments, outputs and efforts across all areas of work. The report highlights activities and achievements for each priority country and region (Brazil, Mexico, Latin America, the People's Republic of China, India, Indonesia, Southeast Asia and Africa). It then discusses cross-cutting activities, implemented globally.

Recognising the excellent results achieved under the CETP, which are presented in the Annual Report 2021 and previous editions, at the IEA Ministerial Meeting in March 2022 representatives from 15 IEA member countries and the European Commission, on behalf of the European Union, reaffirmed their commitment through the CETP to further strengthen IEA capabilities to accelerate the transformation towards a global net zero energy system, in line with the IEA's strengthened clean energy mandates and Programme of Work.

Acknowledgements, contributors and credits

The Clean Energy Transitions Programme (CETP) is made possible by the collaboration and partnership of our priority countries and regions, as well as the support and leadership of International Energy Agency (IEA) member governments and other partners – specifically, the Agence Française de Développement (AFD), Australia, Canada, Denmark, the European Commission, the Energy Foundation, Finland, Germany, Italy, Japan, the Netherlands, New Zealand, Sweden, Switzerland and the United Kingdom. Our gratitude goes to them for their support and belief in the CETP.

The CETP co-ordination team would like to thank all workstream heads and their respective teams for their leadership: Nick Johnstone (data and statistics); Brian Motherway and Melanie Slade (energy efficiency); Paolo Frankl and César Alejandro Hernández Alva (electricity); Laura Cozzi, Blandine Barreau and Daniel Crow, as well as Tom Howes and Sara Moarif (policy advice and modelling); Tim Gould and Simon Bennett (investment and financing); Laura Cozzi and Daniel Wetzel (sustainable recoveries); Timur Gül and Per-Anders Widell (sectoral work); Paolo Frankl and Jeremy Moorhouse (sustainable bioenergy); Per-Anders Widell and K.C. Michaels (Technology Collaboration Programme network); Simon Bennett and Jean-Baptiste Le Marois (innovation); Brian Motherway, Vida Rozite and Emi Bertoli (digitalisation); and Rebecca Gaghen and Masatoshi Sugiura (global relations).

The IEA's leadership continues to guide and support the CETP – Fatih Birol (Executive Director), Mary Warlick (Deputy Executive Director), Keisuke Sadamori (Director of Energy Security and Markets), Mechthild Wörsdörfer (previously Director of Sustainability, Technology and Outlooks) and Claire Bouteille (Chief Management Officer). Special thanks are also due to colleagues in IEA Corporate Services who have provided invaluable support to the CETP, notably, Rachael Boyd, Evan Pelz and Jeremy Lagelee (Office of the Legal Counsel); Deborah Barry-Roe and Ruth Fishwick (Financial Administration); and Fleur Grimaud (Human Resources), as well as Jad Mouawad (Head, Communications and Digital Office).

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Overview of the Clean Energy Transitions Programme 2021

Introduction to the Clean Energy Transitions Programme

Following the achievements at the 26th Conference of the Parties (COP26) in Glasgow in December 2021, more than 70 countries, including the biggest polluters – the People's Republic of China (hereafter, "China"), the United States and the European Union – have set a net zero target, covering about 76% of global CO_2 emissions. While this growing political consensus is a significant step along the way to achieving the goals of the Paris Agreement, more efforts are needed to ensure targets are turned into action across the principal energy use sectors of the major and emerging economies. A massive surge in clean energy investment is needed to put emissions on a different course, notably in emerging and developing economies. The central aim of the International Energy Agency (IEA) Clean Energy Transitions Programme (CETP) is to support the development of energy policies which can unlock the investment needed to accelerate the transition to a net zero energy system.

In the first phase of the CETP, the IEA was tasked with prioritising work with six countries and three regions: Brazil, China, Indonesia, India, Mexico and South Africa; and Latin America, Southeast Asia and Africa. The approach at country level has been step-by-step and country-driven, with initial activities typically focused on immediate short-term priorities – to demonstrate the value of drawing on IEA capability. As the agency has built greater trust, so has the scope for impact on a wider range of areas. Flexibility within CETP funding has enabled the programme to respond quickly to the priorities the government identifies.

Governance

Through the first phase of the CETP, the programme was co-ordinated through the CETP's Funders Strategy Group and bilateral discussions with countries and institutions supporting the programme. The Funders Strategy Group provides a forum for supporters to engage in strategic conversations about the CETP's objectives, development and implementation, as well as helping to ensure that the IEA's efforts complement other bilateral and multilateral collaborations.

Within the IEA, the CETP operates across the Secretariat and co-ordinates a number of interrelated projects and cross-sectoral initiatives led by various IEA departments and units. The work of the CETP is guided by an internal steering group, a central co-ordination team and the senior management, which together ensure an efficient use of time and resources. Senior staff from across the IEA participate in the steering group, which ensures co-ordination among areas of

work, projects and cross-sectoral initiatives led by different IEA divisions and teams, including with IEA work outside the CETP framework. The steering group also advises senior management on the allocation of resources for the different workstreams under the CETP.

The central co-ordination team leads the CETP work and is located in the IEA's Strategic Initiatives Office. It is responsible for overall quality control and strategic management, fund-raising, dissemination of key messages, information sharing, reporting, and co-ordination within the IEA Secretariat as well as with funders. The Legal Adviser, the Communications and Digital Office, Human Resources and the Financial Administration support the team. CETP activities are also supported by Country Officers located in the Global Energy Relations Office, by contractors in Brazil, India and Indonesia, and by energy efficiency co-ordinators in Indonesia, Mexico and India.

Future direction

The CETP has been a critical instrument for the modernisation of the IEA and is transforming the relationship between the agency and the world's largest current and future energy-consuming countries. The programme has strengthened the IEA's capacity to achieve real-world impact with these partners by drawing on the vast scope of the agency's expertise and ability to combine data and evidence-driven analysis with strategic policy and regulatory implementation activities.

New Mandates for the IEA published at the IEA Ministerial in March 2022 and a new Joint Commitment by CETP donors call on the IEA to take a leading role in the energy sector transformation in light of climate change. This includes expanding IEA activities, which support decision-makers in turning commitments into practical actions. In order to deliver on the growing expectations and demands of member countries, it is timely to reassess how the work of an enhanced CETP is organised.

In the new CETP Joint Commitment, participating countries are supporting a common strategic framework for action to accelerate the transition to a net zero energy system. The framework envisages a programme of activity over the coming years under the following three pillars:

1. Accelerating National Transitions
2. Strengthening Multilateral Coordination
3. Informing Global Energy Dialogue

The first pillar, **Accelerating National Transitions**, has and will continue to cover the bulk of the work of the CETP. The key focus is to support emerging and developing economies in developing and implementing timely strategies for achieving national energy goals. In terms of prioritisation, the IEA's current aim

through 2022 is to deepen partnerships with existing CETP focus countries: continuing, or lightly expanding, activity with China, India and Indonesia; and developing more breadth in our work with Brazil, Mexico and South Africa. In addition, plans are under way to expand activity in Argentina, Egypt, Oman, Thailand and Viet Nam. Looking further ahead, the Secretariat welcomes input from the CETP Funders Strategy Group as we consider the potential for developing additional programmes as part of the development of a longer-term co-ordinated strategy.

Through the first phase of the CETP, the IEA played a growing role as an international forum facilitating dialogue on energy transition. Through numerous workshops, events and meetings, some highlighted earlier and others in the country chapters, the agency brought together policy makers from across the IEA family to share best practice and enable co-ordinated approaches to common challenges. Under the second pillar, **Strengthening Multilateral Coordination**, the IEA proposes to leverage the CETP to strengthen its role as a facilitator of multilateral approaches and encourage closer collaboration among funders and major economies to scale energy efficiency, clean energy technologies, and to transition energy demand sectors, including through effective collaboration with other relevant fora and partnerships.

Under the third pillar, **Informing Global Energy Dialogue**, the IEA will utilise the CETP platform to ensure that the agency's understanding of the barriers and solutions for the development and deployment of clean energy technologies are unlocking related investment as part a secure and people-centred transition.

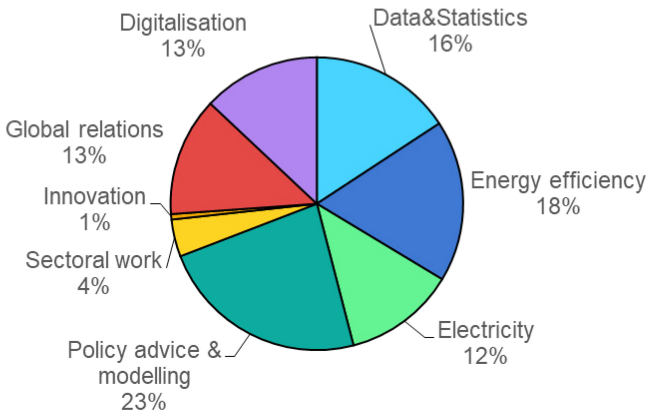
Highlights of the 2021 activities

The CETP has been a critical instrument for the implementation of IEA modernisation. It is through the CETP that the agency has realised its mandate to "open the doors", and has created value in our engagement with association countries. Through a step-by-step approach, our work has been tailored to and driven in partnership with governments, which allowed the agency to develop strong relationships in the countries and regions covered by the programme. The major emerging economies are increasingly turning to the IEA as a trusted, independent voice covering all fuels and all technologies, and as a gateway to IEA member states' best practice.

The CETP now supports a significant proportion of the agency's work, with activities covering the vast scope of expertise, including data and statistics, energy efficiency, electricity and renewables, modelling and policy advice, sectoral approaches, innovation, and others. As we have built trust with partners in focus countries, we have had the opportunity to have great impact on a wider range of areas, and the flexibility of CETP funding has enabled the IEA to adapt the programme quickly in accordance with the countries' evolving priorities.

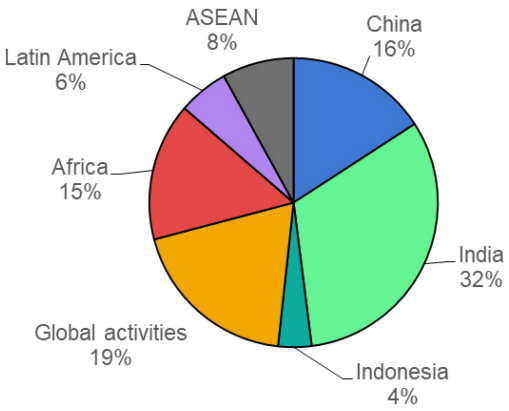
In 2021, the largest share of CETP funding supported the policy and modelling workstream. This included major outputs, such as the report *An Energy Sector Roadmap to Carbon Neutrality in China*, *India Energy Outlook*, *Air Quality and Climate Policy Integration in India*, and others. Energy efficiency was the second-largest area of activity, with major outputs in all focus countries and regions. Electricity, digitalisation and global relations work also accounted for important shares of CETP funding, together with data and statistics work, a crucial activity, which allows for the delivery of all the other workstreams.

CETP activities in 2021 by workstream



As in previous years, India, China and Indonesia together with regional activities in the Association of Southeast Asian Nations (ASEAN) accounted for the biggest share of the CETP funding. An important part was dedicated to cross-cutting global activities supporting all countries and regions. The programme's work in Africa (including in South Africa, and sub-Saharan and Middle East and North Africa [MENA] regions) expanded in 2021 and accounted for 15% of the programme expenditure.

CETP activities by country/region



Note: These figures are provided for information purposes only. Formal financial reports will continue to be provided in established and agreed formats to member countries via the Committee on Budget and Expenditure and to individual donors via financial report.

2021 country highlights

China

- The IEA's strong relationship with China was confirmed through multiple high-level exchanges this year, including a keynote speech by the IEA Executive Director Fatih Birol at the 2021 International Dialogue on Clean Energy Transitions, held in Beijing on 25 September 2021, as well as bilateral meetings between the IEA Executive Director and China's Climate Envoy Xie Zhenhua and Ministry of Ecology and Environment (MEE) Vice-Minister Zhao Yingmin.
- This enabled close co-operation with the Chinese administration, companies and research institutions. Human resources and exchanges provided additional insights and institutional support, including a senior secondee form China's National Energy Administration (NEA) based in Paris who is able to facilitate our work with a wide range of energy institutions in China.
- A key deliverable this year included the development of *An Energy Sector Roadmap to Carbon Neutrality in China*. This important piece of work drew heavily on our modelling capability to build a detailed scenario analysis that fulfils the ambition of China's pledge. This was well received by Chinese partners.
- Equally significant were our contributions to China's 14th Five-Year Plan (FYP) on the power sector transformation and clean energy policies. Our work on the FYP was warmly welcomed by the Director-General of the NEA, who requested ''further assistance" of the IEA.
    - Alongside this we assisted China on the design of its national power sector reform and advised grid operators and market regulators on the effective design of the country's power markets and support schemes to facilitate a high-renewables system.

- On energy efficiency, we worked closely with the National Development and Reform Commission to agree priorities on digitalisation, data and indicators, and again input policy recommendations to the 14th Five-Year Plan.
- Finally, and in close co-operation with the MEE, we supported the Chinese government in the design and implementation of its emissions trading scheme (ETS). Our recommendations and the in-depth report on The Role of China's ETS in Power Sector Decarbonisation resulted in strengthening the new draft of the regulation.

India

- The IEA's well-established exchanges with India in 2021 included work at the national level, as well as direct support for policy development at the regional level. State-level engagement is particularly important in the case of India because of the devolved nature of Indian energy regulation. At the same time, we maintained a strong partnership with the National Institution for Transforming India (NITI) Aayog to ensure that learning from this work can support the development of effective policy nationwide.
- A major milestone at the national level was the publication of the India Energy Outlook in February 2021. This explored opportunities and challenges ahead for India as it seeks to ensure reliable, affordable and sustainable energy for a growing population. The virtual launch of the report attracted a wide audience.
- Other major deliverables at the national level included the provisions of policy support for incentivising rooftop solar PV in collaboration with Ministry of New and Renewable Energy (MNRE); the publication of the Air Quality and Climate Policy Integration in India report in May, which demonstrates how well-designed energy policies can contribute to both air pollution reduction and climate change mitigation in tandem; and the launch of the Renewables Integration in India report in July. The launch event had participation from across the Indian government and included an active question-and-answer session with attendants from around the world.
- At a subnational level, we continued the state-level exchanges on renewable energy integration established in 2020 and provided renewable energy roadmaps, as well as policy support to overcome the barriers in renewable integration.
- On energy efficiency, we focused on supporting the introduction of solutions into post-Covid recovery packages, as well as working sectorally – for example by developing a national Roadmap for Mainstreaming Energy Efficiency into Residential Buildings. We also developed a policy package to promote energy efficiency in small and medium-sized manufacturers in India, and continue to support the discussions around industry sector benchmarking and wider decarbonisation efforts.
- Finally, we provided capacity building and technical assistance to Indian institutions to collect and produce high-quality data, which are of course indispensable in tracking the energy system transition and informing public policies.

Indonesia

- The IEA-Indonesia Energy Transition Alliance is the single largest country programme in the CETP by resource allocation. Over the past two years, the agency and the Ministry of Energy and Mineral Resources (MEMR) of Indonesia have substantially scaled up co-operation across a variety of priority areas.
- Throughout 2021, we continued to provide long-term assistance on power system enhancement, which was focused on tailored solutions to help Indonesia overcome a range of barriers, such as insufficient investments in grids and lack of flexibility of the generation fleet. We also provided tailored guidance on effective renewables remuneration mechanisms for the upcoming Presidential Decree on Renewables.
- On energy efficiency, the IEA worked with the MEMR to review and redesign its industry energy management reporting system and to develop a website with best practice information for industry on energy efficiency. The reporting system and website won the 2021 TOP 45 Public Service Innovation Award at the 2021 National Public Service Innovation Competition event. We also worked with the MEMR on the energy efficiency in industrial processes to review and redesign its industry energy management reporting system.
- Finally, we supported the development of regulations for electric vehicles (EVs) and a land-based transport roadmap in co-operation with the MEMR.

Brazil

- The longstanding relationship of the IEA with Brazil deepened in 2021 through co-operation on energy efficiency in several priority sectors: freight transport, pulp and paper, and buildings (which included contributions to Brazil's Energy Efficiency Atlas).
- The IEA provided ongoing support to Brazil's Ministry of Mining and Energy on the development of regulation linked to the new architecture of the country's electricity market, including a series of virtual technical dialogues on reliability and adequacy mechanisms, discussing international experiences and their applicability in the Brazilian context. We also provided the Brazilian partners with technical inputs which were incorporated into new "Guidelines for the consideration of environmental benefits in the power sector".
- And on innovation, we launched Inova-e with Brazilian and international partners to create an open platform with data and analysis on energy research and development (R&D) investment, with the view to inform policy making and the country's energy innovation strategy.

Africa

- A significant part of the programme in 2021 was dedicated to Africa, and specifically building capacity on energy data, statistics and modelling across 10 sub-Saharan African countries.

- We also provided policy recommendations on accelerating clean energy transitions throughout three African regions with the aim of fostering deeper regional collaboration, through the *Clean Energy Transitions in the Sahel* report, released in September 2021. The report built on *Clean Energy Transitions in North Africa*, released in September 2020, and will be followed by a report on the Horn of the Africa region in 2022.
- Throughout the year, we worked closely with regional organisations such as the African Union Commission and African Energy Commission and continued to deepen our engagement with South Africa and Morocco and several other major economies on the continent.

ASEAN

- The IEA's strategic partnership work with ASEAN continued to grow. As part of the ASEAN-IEA Cooling Partnership we worked closely with regional partners to deliver the Roadmaps Towards Sustainable and Energy-Efficient Buildings and Cooling in ASEAN project.
- We were a major partner of the ASEAN Secretariat supporting the development of multilateral power trade and initiatives to increase transmission infrastructure.

Multilateral dialogue

- Throughout 2021, the IEA continued to facilitate multilateral dialogue on sectoral aspects of clean energy transitions. As the Secretariat for the Biofuture Platform, we provided technical and policy guidance on sustainable bioenergy in emerging economies, with a particular focus on advanced biofuels. And in May 2021, we hosted the Biofuture Summit II, which included 40 sessions with more than 200 speakers.
- On energy efficiency, the IEA worked closely with the United Kingdom (UK) government and other leading governments under the auspices of the Super-efficient Equipment and Appliance Deployment (SEAD) Initiative. Ahead of COP26, 14 countries signed the Joint Statement on the Call to Action, which aims to double the efficiency of four key products – refrigerators, industrial electric motor systems, lighting and air conditioners – by 2030. This was the largest-ever appliance energy efficiency initiative. Our work here continues to expand in scale and could be extended to other technologies and sectors, as well as serving as a model for convening actors to explore how to harmonise approaches to measurement and standardisation, and to raise collective ambition.
- Through the Technology Collaboration Programmes (TCPs), the IEA provides a platform for governments to work together to advance research, development, demonstration and commercialisation of energy technologies. In 2021, thanks to CETP support, the IEA released two handbooks to guide efforts to make international co-operation more effective and more global: Expanding the global reach of the TCPs and Enhancing collaboration between multilateral initiatives. These publications stimulated dedicated discussion sessions at the TCP Universal

Meeting 2021 in October 2021, in collaboration with Mission Innovation, the Clean Energy Ministerial (CEM) and other multilateral initiatives.

- The IEA has also supported member states and partners in their efforts to advance and implement EV policies through co-ordination of the CEM's Electric Vehicles Initiative. With co-finance support from the CETP, the IEA was able to take an active role as an executing agency within the Global E-mobility Programme funded by the Global Environment Facility (GEF), and for the first time receive funds from the GEF. The programme, launched at COP26, will support 27 low- and middle-income countries with their shift to electro-mobility. The IEA will lead the work of two global thematic working groups (electric light-duty vehicles [LDVs]; charging infrastructure, grid integration and batteries) and the setting up of the monitoring framework to track policy and market development within the programme. The IEA is working closely with the United Nations Environment Programme (UNEP), which holds the main responsibility for the co-ordination of the work but also other agencies, such as the European Bank for Reconstruction and Development and the Asian Development Bank.
- The Sustainable Recovery Tracker released in October 2021, which measures global recovery plans against the target level of spending agreed by countries to mitigate the effects of the Covid-19 crisis, has been quoted in both the G20 Ministerial and Leaders communiqués.

Cross-cutting activities

Since the start of the CETP, the IEA has rapidly expanded analytical work to shape the international understanding of the barriers and solutions for accelerating the development and deployment of clean energy technologies.

Thanks to the CETP support, we have vastly expanded coverage of data on different fuels and energy balances in focus countries and regions of the programme.

- We have continued to provide quantitative assessments, analytical tools and recommendations to support delivery of clean energy financing, particularly from development finance institutions and private investors, as well as improved investment conditions that support the development of robust project pipelines in the project's activity areas.
- Through this, we noted a progressive shift toward earlier publication of data from CETP focus countries. In addition, there has been more systematic generation of early estimates for important data points, e.g. early estimates of emissions in China and elsewhere.
- This has been achieved through extensive series of capacity-building activities on data for example. In 2021, we provided personalised training to 125 energy statisticians from CETP focus countries and regions.
- Capacity-building activities also focused on energy efficiency – in 2021, over 1 000 participants received training in English, Spanish, Portuguese and Bahasa.

CETP value added

The CETP is one of the key mechanisms strengthening the delivery of IEA mandates as defined by its members.

Many IEA member countries already have significant bilateral programmes in the countries and regions of CETP focus. At the national level, the CETP aims to bring additional value through leveraging the IEA's core competences on data and analysis, and by drawing on a range of international policy best practice. The IEA's credibility as an authority on all technologies and all energy markets ensures the agency is well positioned as a neutral and technical thought partner.

The programme has also strengthened dialogue on energy between the IEA's membership and emerging and developing economies. IEA platforms, such as the SEAD Initiative or the Biofuture Platform, are enabling closer international co-operation on energy policy, which is essential for accelerating the transition to a net zero energy system. At the same time, the analytical outputs of the programme have supported the membership in shaping the agenda on energy within other international fora.

Finally, the CETP continues to be the mechanism through which the IEA has brought value to non-member countries. It underpins the opening of doors to the outside world that so many IEA members have supported. And as trends of energy consumption shift south and east, engaging with association countries is going to be critical for ensuring that IEA members retain a strong voice in influencing global energy policy.

Activities in Brazil

Energy efficiency

In 2021, the IEA deepened engagement with Brazil on energy efficiency in several priority sectors, chiefly: freight transport, pulp and paper, and buildings.

- Joint analysis with Brazil's Energy Research Office (EPE) on the efficiency of Brazil's road freight sector: Road Freight Transport Brazil 2021, International Benchmarking, a comparative analysis of trends, policies and programmes, which highlights international case studies relevant for improving future policy in Brazil. Additional outputs include a launch webinar (October 2021) and dedicated chapter in Brazil's Energy Atlas 2021 (January 2022).
- Publication of two joint chapters in the 2020 Brazil Atlas of Energy Efficiency, Indicators Report, also with EPE. The first considers the impacts of the Covid-19 crisis on energy efficiency and provides an overview of behaviour changes in transport and households. The second chapter explores the evolution of Brazil's cement sector since the 1970s, with a particular focus on energy efficiency and carbon emissions. Key highlights include an analysis of how Brazil has modernised its cement industry to become a global leader, and opportunities for further efficiency gains and emissions reductions.
- Launched the IEA-CAF (Development Bank of Latin America) online course Energy Efficiency in Buildings for Brazil with a webinar featuring experts from the Ministry of Mines and Energy (MME), Procel and the programme of Learning Energy Efficiency Networks, available in Portuguese, Spanish and English. So far, 50 people have completed the course in Portuguese. Another release of the course is planned for 2022.
- Support for tracking co-benefits of energy efficiency of Esplanada Eficiente, a programme for retrofitting public buildings in Brazil. The indicators will be introduced to other programmes in 2022 to increase tracking and awareness of the multiple benefits of energy efficiency programmes.

Electricity

In 2021, the IEA continued work with Brazil's MME and the EPE to support the development of new power sector regulation. Activities included a series of webinars underpinned by joint analysis with the EPE on reliability mechanism options. This collaboration is part of a wider programme of activity on power market modernisation, including partners from other Latin American countries.

During the webinars, different transition mechanisms were discussed, including the potential separation of the current Garantia Fisica scheme towards a market with separate products for energy and a peak capacity. The IEA set out the benefits of a technology-neutral approach and proposed a set of transition

strategies accounting for legacy contracts. As a result of this engagement, the IEA has been invited to provide targeted advice on the modernisation process, with activities on regional interconnection, climate resilience and corporate procurement for clean energy continuing in 2022.

Policy advice and modelling

At the request of Brazilian partners, the IEA has provided additional policy support on carbon pricing policy. This has included a series of webinars and closed-door technical exchanges on implementing carbon pricing, and involved stakeholders from the private sector, government and academia. IEA representatives presented on various aspects of carbon pricing policy design and potential market impact. Public webinars were co-organised with the government of Brazil, and the IEA convened international experts on emissions trading schemes from the subnational governments of Quebec and California to share their experience with Brazilian stakeholders.

The IEA organised four closed-door technical exchanges between April and July 2021 with Brazil's EPE and MME to discuss in more detail the various design aspects of a possible carbon market in Brazil. The first dialogue focused on the fundamentals of carbon pricing, with a focus on carbon markets and the electricity sector. The second discussed the objectives for an ETS, the interaction with companion policies and the scope for the ETS. The third one focused on how to set an emissions cap for the ETS. Finally, the fourth dialogue discussed the various methods for emissions allowance allocation and the potential use of offsets in the Brazil ETS.

In January 2022, the EPE and the MME launched a public consultation on the proposal of law 14.120/2021, which includes the development of guidelines for environmental benefits, namely carbon markets, in Brazil. The text of the consultation reflects many of the recommendations that the IEA provided to the government of Brazil during the closed-doors technical dialogues, and the IEA's contribution is widely acknowledged. The proposed guidelines include technical details for the adoption of an ETS with cap-and-trade to cover multiple sectors beyond the electricity sector in Brazil. The public consultation period closed on 7 February 2022, after which the EPE and the MME were taking into account the feedback received for next steps.

Technology innovation

Since early 2019, the Energy Big Push (EBP) has promoted sustainable energy development in Brazil with a focus on innovation. The Brazilian Centre for Strategic Studies and Management (CGEE) led the project together with the EPE, the Economic Commission for Latin America and the Caribbean (ECLAC) and the

IEA, with contributions from leading institutions and experts of Brazil's energy innovation ecosystem.

As part of these efforts, in March 2021 the CGEE and EPE, alongside the UK-supported Energy Programme for Brazil, held a workshop on energy innovation metrics: tracking progress of clean energy innovation in Brazil. The aim was to develop processes and tools providing evidence about gaps and opportunities in innovation for a sustainable energy transition in Brazil which will prepare the background for the launch of the platform. The workshop gathered Brazilian energy innovation officials and institutions, as well as thematic experts, to discuss the use of metrics to track clean energy innovation progress, data and information requirements, and methodologies for collecting and processing data to feed the energy innovation platform. The discussions took place online with simultaneous translation in Portuguese and English.

The Inova-e platform was also officially launched in August 2021 in order to create an open platform with data and analysis on energy R&D investment, with the view to inform policy making and the country's energy innovation strategy. The Inova-e digital platform was developed to make data on Brazilian investments in research, development and demonstration (RD&D) in energy accessible to diverse audiences. This platform aims to deepen the understanding of investment trends in RD&D in energy and support various organisations including the EPE, the MME and the Ministry of Science, Technology and Innovation in the formulation and promotion of public policies, research and new investments in the area of energy innovation. The strategic information made available at Inova-e was organised in a single database providing an unprecedented overview of innovation efforts in the energy sector in Brazil. The platform hosts data collected and analysed through EBP.

At the launch event, several Brazilian officials emphasised the important role the IEA played in supporting the development of the platform. Among other contributions, the IEA provided methodology and support for data collection and analysis, notably to ensure compatibility with globally collected data in IEA databases. In 2021, the IEA included Brazilian data for the first time in its R&D budget reports, illustrating achievements under the IEA Clean Energy Transitions Programme.

In June 2021, the Podcast Inova-e No. 5: Meaningful indicators for R&D and Innovation, which features IEA speakers, was published to promote the project, leveraging the official channel of the EPE. The full episode is available on Spotify.

Activities in Mexico

Energy efficiency

- In 2021, the IEA agreed on a programme of activities on energy efficiency with the Energy Secretariat (SENER), defining areas of co-operation and planned projects for 2021-2022 to be implemented with SENER and the Energy Efficiency Commission (CONUEE). The programme covered all end-use sectors (industry, transport, buildings and appliances).
- The co-operation is overseen by a co-ordination committee consisting of SENER, CONUEE and the IEA. For the initial phase of implementation, SENER suggested limiting implementation to the webinar series.
- Under the work programme, the IEA held a joint webinar on 21 October, Covid-19 recovery: Supporting economic and social policy with energy efficiency. The webinar included an introduction by Heberto Barrios Castillo, Deputy Secretary of Energy Transition at SENER, and Brian Motherway, Head of Energy Efficiency at the IEA; 270 people from 17 countries attended the webinar.

Regional focus – Latin America

Energy efficiency

The IEA continued engagement with countries in Latin America throughout 2021, deepening co-operation with Chile and the Central American Integration System (SICA) region, and facilitating dialogue on efficient equipment and appliances:

- Joint International Conference on Heating and Cooling with Chile's Ministry of Energy in October 2021, which featured international and Latin American perspectives on the challenges of decarbonising the heating and cooling sectors.
- Exchanges on equipment and appliance standards in the region, including:
  - A report for SICA on global perspectives on standards and labelling for motors.
  - Three technical presentations for SICA on standards and labelling, one each for efficient air conditioners, motors and lighting.
  - A regional webinar on appliances as part of the SEAD Initiative.
- Presentation of IEA work on energy efficiency in buildings with Colombia, including online training tools.

Electricity

IEA activity on power sector flexibility and energy security included participation in a series of round tables organised by the Ministry of Energy of Chile focused on retail market reform and smart grid strategy. This was a multi-stakeholder process bringing together representatives from multiple regions, governmental levels and various sectors of society – academia, industry, civil society, utilities, etc., and the results will be included in the country's 2050 Energy Policy Strategy. During the exchanges, the IEA was also invited to provide recommendations that could help strengthen Chile's smart grid strategy, which would increase user engagement and the reliability of digital infrastructure.

IEA input has been included in the final summary of the sessions and will be carried forward into the final 2050 strategy, as well as through the preparation of the country's 2050 net zero roadmap slated for publication in 2022.

Policy advice and modelling

Policy work in Latin America in 2021 focused on carbon pricing and climate resilience. In January, we published the Climate Impacts on Latin American Hydropower report, which provided recommendations on how to enhance the climate resilience of Latin American hydropower through a climate risk and impact assessment, and by introducing potential resilience measures. It qualitatively assessed climate risks to Latin American hydropower plants in 13 Latin American

countries and examined potential climate impacts quantitatively, comparing three climate scenarios. Based on the assessment, it identified measures to enhance climate resilience and provided detailed policy recommendations.

The report was followed in March by a webinar, Climate Change and Hydropower in Latin America, where speakers from governments, international organisations and development banks (the World Meteorological Organization [WMO], Brazil's EPE, the International Hydropower Association, the Inter-American Development Bank [IDB] and Resilienceshift among others) discussed impacts of climate change and explored measures to enhance climate resilience and shared the latest findings and best practices in the region.

In June 2021, we held a meeting of SICA Energy Directors on climate resilience. The IEA presented its work on climate resilience and proposed the topic as a potential area of collaboration with the members of SICA. The topic was included in IEA's memorandum of understanding with SICA.

Throughout the year, we also organised a series of invite-only virtual workshops to explore the experience with carbon pricing policies in Latin America and relevant to the Latin American context. The three workshops in April, July and September were organised in collaboration with the International Carbon Action Partnership (ICAP) and Konrad-Adenauer-Stiftung (KAS), and explored opportunities and limitations to provide insights for decision-makers seeking to implement carbon pricing, with a focus on the electricity sector. The events, with the common title Carbon Pricing and the Electricity Sector in Latin America, included keynote presentations from the executive secretary of the Latin American Energy Organization (OLADE) and World Bank senior managers.

Sectoral work

Hydrogen

Low-carbon hydrogen represents a major opportunity for Latin America in a net zero emissions world, a region privileged with exceptional renewable energy resources. However, low-carbon hydrogen deployment depends on many technologies that are still under development, and considerable cost reductions will be needed to enable applications that may not be suitable for direct electrification. The next decade will be crucial for realising the potential of low-carbon hydrogen in Latin America, and much can be done today to develop and demonstrate emerging technologies and prepare the ground for their future scale-up.

The momentum for the fuel is growing, with many countries in the region developing long-term hydrogen strategies and a strong project pipeline, including several gigawatt-scale projects for export beyond the region. Supporting this

trend, in August 2021, we released the Hydrogen in Latin America report. In the report we analysed both the region's potential to play a major role in the future low-carbon hydrogen landscape and the role that low-carbon hydrogen could play in Latin America's own clean energy transitions. The report's recommendations for policy makers were identified and prioritised in direct exchanges with representatives of ministries of energy of 11 countries in the region to ensure they can be directly applicable in the Latin American context.

Digitalisation

As part of the Digital Demand-Driven Electricity Networks (3DEN) project, we finalised a preliminary analysis in selected Latin American countries on the state of implementation of smart meters and other digital technologies and identified opportunities and barriers. This analysis, together with the content drawn from the digitalisation panel's discussion at the November 2020 OLADE Energy Week, fed into the commentary Consumers can transform Latin America's power systems: Here's how, published on 18 February. The commentary summarised the key issues involved in advancing digitalisation and the demand side in Latin America, and included a call to action and invitation to join 3DEN.

Under the 3DEN project, a consultative group was established in 2020 to advise on technical issues and support the implementation of 3DEN. It comprises 37 members, including from Brazil, Chile and Colombia. The network created through this group proved valuable for the 12 July workshop on Peer-to-Peer, Community Self-Consumption and Transactive Energy in Latin America, as it allowed organisers to bring on board relevant panellists from Brazil and Chile. The IEA and the Users TCP supported the Colombian EIA University in the organisation of this workshop.

Alongside this, we have supported a range of digitalisation and energy efficiency discussions in the region:

- on 9 March, presentation on the system benefits of digitalisation and energy efficiency at a webinar organised by the IDB on Innovative Schemes to Promote the Financing of Investment in Energy Efficiency and Distributed Generation in Latin America
- on 24 March, contributions to the launch event of the Prospection in Energy Digitalization in Chile Report, a milestone study for the country's digitalisation trajectory
- on 10 May, a round table organised at the request of the Ministry of Mining and Energy of Colombia on advanced metering infrastructure, focusing on key issues for rolling out such infrastructure and determining strategies for cost allocation and tariff reform
- on 1 December, presentation on maximising the value and sustainability of electricity through digitisation at Colombia's association of distribution companies.

Activities in China

Energy efficiency

In 2021, the IEA highlighted the main insights from the abridged Chinese version of the Energy Efficiency Market Report 2020 in a commentary on the multiple benefits of energy efficiency and how they can support China in achieving its national targets. Within a week of introducing the report on the China Council for an Energy-Efficient Economy's WeChat account and website, it reached a wide audience including local stakeholders, such as the Chinese National Institute for Standardization and State Grid Energy Research Institute.

New engagements with sector-specific players helped deepen sector-level energy efficiency progress in China, and included a presentation at the China Electricity Council's International Conference on Energy Industry and Innovation on Accelerating Net Zero Transition through Digitalisation. The IEA also held a successful webinar on Evolving Energy Service Companies in Emerging Economies in July 2021, which discussed the role of governments and policy makers in supporting the energy service company (ESCO) industries and the evolution of different ESCO models and markets in China, India, Mexico, South Africa and the Asia-Pacific region.

Following the interest in the topic, in 2021, the IEA developed a report on Evolving ESCOs in China in collaboration with the Energy Management Conservation Association of China. It highlights critical success factors of China's remarkable ESCO market growth, including the government's strategic support measures. Based on a joint survey across ten local ESCOs, the report outlines the challenges and opportunities digitalisation brings to the ESCO industry. The report was published online in August 2021.

The 7th joint workshop with Tsinghua University in November brought together around 60 global and local academics, practitioners and private players to exchange their expertise on efficient and green buildings, with a special focus on the role of buildings in achieving carbon-neutrality pledges.

The Energy Efficiency Division contributed to clean energy policy recommendations for China's 14th FYP to ensure it reflects the role of energy efficiency in accelerating China's clean energy transition.

Electricity

China's electricity market reform projects included in the 14th FYP are of crucial importance to the future of China's energy transition path and can influence directly the trajectory of the world's CO_2 emissions for the years to come. The IEA has been involved in a sustained dialogue with Chinese authorities over the last years and has become a trusted partner in China's policy discussions on power markets. In 2021, thanks to direct support from the CETP, this co-operation focused on:

- Providing insights into China's power sector transition with policy options and technological innovation to facilitate the clean energy transitions towards achieving carbon neutrality before 2060.
- Advising grid operators and market regulators on the effective design of the country's power markets to facilitate a high-renewables system.
- Supporting the National Energy Administration (NEA) in the preparation of its 14th FYP on energy, providing recommended targets to follow a rapid decarbonising pathway.

In January 2021, the IEA hosted a round table discussion on electricity markets and low-carbon support mechanisms in collaboration with China's NEA. It also explored the coexistence of electricity markets, market-based renewable support mechanisms and carbon trading, in order to understand and discuss what the best policy mix is to ensure deployment of renewables with market-based instruments. The results of those exchanges with the Chinese government led to further requests for support and advice on issues related to electricity markets and low-carbon transitions.

In February 2021 the IEA submitted policy considerations for the NEA (translated to Mandarin) as part of its 14th FYP planning procedure. The 91-page document reviewed the status of China's previous FYP, assessed implementation successes and challenges, and provided policy advice for China's 14th FYP for power, renewable heat and renewable transport fuels. In March 2021, the NEA sent an acknowledgement letter to the IEA and confirmed interest in further collaboration.

In April 2021, the IEA organised its 2nd China's Power Sector Transformation webinar with the China Electric Power Planning & Engineering Institute (EPPEI), the Royal Danish Embassy in Beijing and the Danish Energy Agency, with support from China's NEA, the French Development Agency (AFD) and the European Commission. The focus of this webinar is on cutting-edge energy technologies and deployment options that have triggered significant interest and debate in the power sector in China including digitalisation and smart grids, battery storage, distributed energy resources, green hydrogen, and sector coupling and electrification. The event introduced successful cases and lessons learned internationally with input from international and Chinese experts. The discussion touched on technical innovation in the power sector, highlighting the critical role of

supporting policy and regulatory aspect for bolstering the clean energy transitions in China towards carbon neutrality by 2060.

In May 2021, the IEA partnered with the Danish and Norwegian energy agencies to deliver two workshops dedicated to integration of variable renewables in power markets and to tradable green certificates, respectively.

In November 2021, the Renewable Energy Division released Renewables 2021, which included a detailed forecast of power, transport and heat in China, including a dedicated translated section provided to the Chinese government. This report was launched in China in January 2022, together with the IEA's Liaison Office at EPPEI and the NEA, which secured the participation of a number of senior officials.

In December 2021, the IEA and the NEA convened in an internal expert workshop to discuss the IEA's 14th FYP inputs, as well as applications for renewable electricity, in transport and renewable heat to identify common priority areas. Xiang Haiping, chief engineer of the NEA, opened the workshop with Paolo Frankl, Head of the Renewable Energy Division at the IEA. Chen Yongsheng, head of the NEA Office of Affairs, New and Renewable Energy Department, introduced China's 14th FYP on renewable energy. Xie Hongwen, deputy chief economist, at the China Renewable Energy Engineering Institute (CREEI), discussed the application of bioenergy in China, and Xing Yiteng, head of the NEA New and Renewable Energy Division, New and Renewable Energy Department, summarised renewable heat and cooling in China. Experts from the IEA's Renewable Energy Division presented the IEA recommendations on renewable electricity, renewable fuels in transport and renewable heat and cooling. Ren Yuzhi, Deputy Director-General of the NEA New Energy Department, closed the session with Keisuke Sadamori, Director of Energy Markets and Security, IEA.

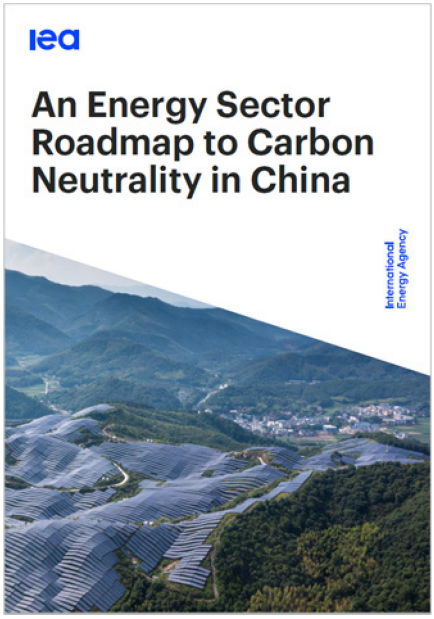
Overall, thanks to the close and productive dialogue with Chinese authorities, the IEA has been able to create an environment supportive of an ambitious approach to power market reforms in China. The dialogue on power markets with Chinese partners and other international stakeholders continues in 2022, as the IEA was invited to present is work on power system flexibility, globally and in China, at a workshop organised jointly by the German and Danish energy agencies in January 2022.

Policy advice and modelling

An Energy Sector Roadmap to Carbon Neutrality

A ground-breaking achievement of the programme was the release of An Energy Sector Roadmap to Carbon Neutrality in China developed in response to the Chinese government's invitation to the IEA to co-operate on long-term strategies by setting out pathways for reaching carbon neutrality in China's energy sector.

The publication would not have been possible, however, without the background work – supported by the CETP – on the China-specific analytics in the World Energy Outlook. CETP funding has allowed the IEA to reinforce its modelling capacity to obtain a more granular representation of China's decarbonising pathways in the World Energy Model. It has also helped reinforce overall sectoral modelling capabilities, which in turn supported more robust analytical work featured in various IEA's publications, such as the annual World Energy Outlook and the China Roadmap.



Building on the modelling and analytical capacity, the IEA, in close collaboration with multiple Chinese experts, released the report An Energy Sector Roadmap to Carbon Neutrality in China in September 2021. This analysis shows that achieving carbon neutrality fits China's broader development goals, such as increasing prosperity, strengthening technology leadership and shifting towards innovation-driven growth. The main pathway in this roadmap – the Announced Pledges Scenario – reflects China's targets declared in 2020, according to which CO_2 emissions will peak before 2030 and carbon neutrality is achieved before 2060. The roadmap also explores the implications of a faster transition to 2030 – the

Accelerated Transition Scenario – and the socio-economic benefits it would bring beyond those associated with reducing the impact of climate change. It also discusses technology challenges and innovations required to achieve such transition, and concludes with a series of policy considerations to inform China's energy debate.

Fu Sha, programme director of Low Carbon Economic Growth and director for strategy and planning, Energy Foundation China; Jiang Liping, vice-president, State Grid Energy Research Institute; and Gao Shiji, director-general of the Institute for Resources and Environment Policies, Development Research Center of the State Council. Launch of An Energy Sector Roadmap to Carbon Neutrality in China in Beijing, 29 September 2021. Photo credit: IEA YouTube channel.

"China's many strengths make it well-placed to successfully carry out its own transition to carbon neutrality while also demonstrating international leadership in technology and energy policy making." [1]

The CETP supported new analysis critical to the roadmap, and provided foundations that will span many future reports, namely improved understanding of China's industrial sectors (CO_2 emissions from the steel and cement sectors in China alone are higher than the European Union's total CO_2 emissions), China's power sector, China's energy employment, and emerging low-carbon solutions such as carbon capture, utilisation and storage (CCUS) and low-carbon hydrogen. In the development of these analytical products, the IEA was able to deepen relationships with key Chinese experts on these topics, for instance Tsinghua University; the Energy Research Institute of the National Development and Reform Commission (NDRC); Beijing Normal University; Renmin University of China; Energy Foundation China; State Grid Energy Research Institute; the Chinese Academy of Social Sciences; the Ministry of Industry, Science, and Technology; Development Research Center of the State Council; and the National Center for Climate Change Strategy and International Cooperation.

This report was a result of the commitment of Chinese and international partners to address key climate issues and achieve a clean energy transition. Building upon

[1] IEA (2021), An Energy Sector Roadmap to Carbon Neutrality in China.

the political will developed through various high-level exchanges between the IEA and Chinese counterparts, the report benefited from far-reaching discussions between the IEA Executive Director Fatih Birol, China's Special Envoy on Climate Change Xie Zhenhua, and China's Minister of Ecology and Environment Huang Runqiu, which addressed major energy and climate issues, including the findings of the IEA's Global Roadmap to Net Zero by 2050.

The China roadmap has received much attention, being featured in many widely read publications, such as China Energy News, Caixin, Xinhua News, S&P Global headlines, and many prominent energy periodicals. The event was viewed live by over 670 000 people on various Chinese media platforms, unprecedented for an IEA launch event, and sparked a lively discussion across Chinese and international platforms about China's ability to accelerate near-term decarbonisation actions. The report was also cited regularly by officials from countries other than China, as they prepared their final negotiations leading up to COP26.

We organised a series of publicly available events in order to further publicise the findings of the roadmap and delivered multiple closed-door presentations to CETP funders and other IEA member states.

Emissions trading scheme

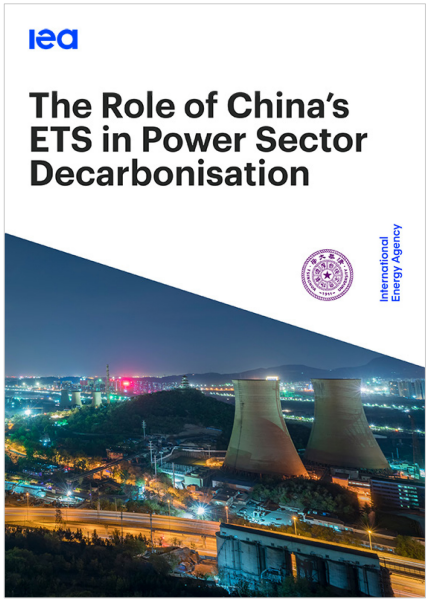
In 2021, the IEA continued to advise China on the design of its national ETS through tailored publications on the potential effects of China's ETS, direct discussions with China's Ministry of Ecology and Environment (MEE) policy makers responsible for ETS implementation, and close partnership with leading Chinese experts.

China officially launched the implementation of its national ETS in 2017 and started operation in 2021. Initially covering the power sector, which accounts for over 40% of China's energy-related CO_2 emissions, the ETS is the largest in the world and set to subsequently be expanded to other energy-intensive sectors. China's national ETS could be an important market-based instrument to help the country meet its recently enhanced climate goals to have CO_2 emissions peak before 2030 and achieve carbon neutrality before 2060. China's ETS is set to form a key element of the multilayered policy approach to driving towards sustainable energy transition, so the design and implementation of the national system opened an opportunity for direct policy impact. CETP funding has allowed the IEA to have this direct policy impact and to build up a detailed understanding of this key policy instrument.

With the overarching goal to provide insights and analysis on the ETS and the ongoing power sector reform and other low-carbon policies on energy conservation, renewable energy, and control of coal supply and consumption, the IEA has produced a series of analyses to inform policy makers and help move policies towards more ambitious goals. As part of these efforts, the IEA has organised

various technical exchanges and events to share approaches and experiences between Chinese experts and the international expert community. It has also built steady government support through a series of meetings at a high level with the MEE.

With the feedback and support from the MEE and in close collaboration with Tsinghua 3E Institute and various international and national stakeholders including local institutions, the private sector, non-governmental organisations, academia, think tanks and international organisations, the report The Role of China's ETS in Power Sector Decarbonisation was published in April 2021. The IEA-Tsinghua joint report launch event brought together international and Chinese experts, and featured opening remarks from the chief economist of China's National Center for Climate Change Strategy and International Cooperation (NCSC), a senior project officer from the AFD, and the head of the IEA Energy and Environment Division.



This report explored how China's ETS can spur emissions reductions from electricity generation and support power sector transformation. It also analysed how the particular design of China's ETS affects overall power sector emissions, technologies and costs, and regional distribution. It closes with recommendations on how China's ETS can play a stronger role in incentivising cost-effective and structural power sector decarbonisation to support the country's long-term climate ambitions.

In 2021, we also began modelling work with Tsinghua University 3E Institute to examine the interplay of China's ETS with its renewable portfolio standard policy in the electricity sector, along with possible ETS enhancements and their implications.

Overall, the IEA's recommendations and engagement with Chinese partners, supported by the CETP, resulted in enhanced capacity and closer partnership with Chinese stakeholders, and contributed to a more ambitious design of Chinese climate policy.

Chinese officials including Special Climate Envoy Xie, MEE Minister Huang and MEE Director-General Li have expressed appreciation in high-level meetings in 2020 and 2021 for IEA inputs on the implementation of China's national ETS and welcomed further co-operation, inputs and policy dialogues on ETS design and international experiences.

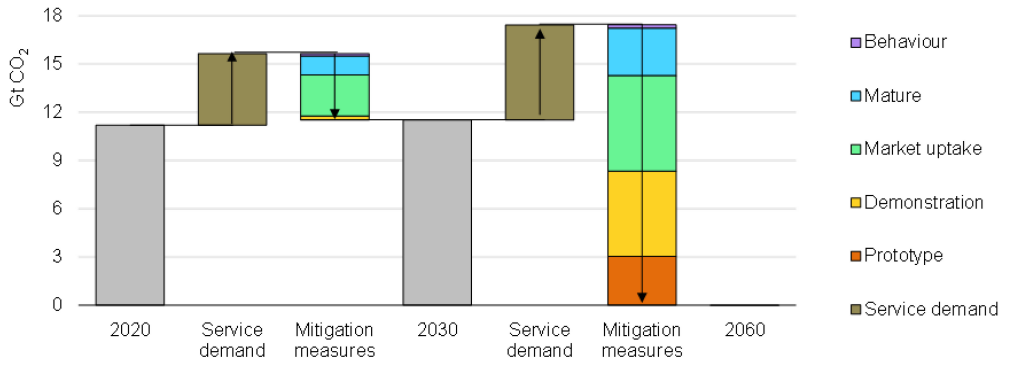
Sectoral work

Technology innovation

CETP work on clean energy innovation policy and tracking with China ramped up significantly in 2021 in support of the China roadmap. The Chinese government recognises that reaching carbon neutrality by 2060 will not be achievable without a major acceleration in clean energy innovation, and Chapter 6: Innovation for carbon neutrality, presented possible pathways by which it might pursue technological innovation to meet climate goals. Such innovation, which is expected to be a major driver of economic growth in the coming decades, is presented by China as standing at the confluence of three major strategic national objectives:

- technological leadership: to become "the top innovation-oriented country by 2035" and "the world's major science centre and a highland of innovation"
- innovation-driven growth: to build a "new momentum" for high-quality economic development, with scientific and technological achievements as the "main battlefield of the economy and society"
- tackle environmental challenges: to achieve the vision of an "ecological civilisation", including a peak in CO_2 emissions before 2030, carbon neutrality before 2060, and tackling air, water and land pollution.

CO_2 emissions reductions by current technology maturity category in China in the APS



Note: APS = Announced Pledges Scenario.
Source: IEA (2021), An energy sector roadmap to carbon neutrality in China.

More than 90% of the CO_2 emissions reductions by 2030 are from technologies readily available today whereas about half of the reductions in 2060 relative to 2030 come from technologies that are currently only at the prototype or demonstration phase

As one of the world's largest energy markets and an emerging leader in clean energy innovation, China is expected to be home to many first-of-a-kind energy projects and products, especially in heavy industry. China has become a major exporter of clean energy technology in recent decades. With its R&D resources and world-scale companies, China has the potential to help ensure that critical technologies for carbon neutrality globally are available this decade, especially in emerging market and developing economies. Announcements in support of the 14th FYP recognise the importance of international co-operation alongside other policy mechanisms.

In April 2021, China's Ministry of Science and Technology (MOST), the Administrative Centre for China's Agenda 21 (ACCA21) and the IEA co-organised a closed-door workshop on Strategic priorities for China's energy innovation in the 14th Five-Year Plan. Invited speakers and participants came from institutions including ACCA21, China Academy of Building Research, China Academy of Science, China Automobile Technology and Research Centre, China Coal Research Institute, China Energy Engineering Corporation, EPPEI, China National Renewable Energy Centre, NEA, MOST, Tsinghua University, and Zhejiang University. The discussions gathered Chinese government officials, academics, and energy innovation and technology experts from leading local institutions with the goal to examine the priorities for energy innovation in reaching carbon neutrality goals in China. The workshop featured a session on CCUS technologies, which presented latest findings from IEA-ACCA21 collaborative analysis and provided information on potential new projects in coming years.

Detailed analysis of the status of policy, institutions and metrics of energy innovation in China was performed by the IEA in support of the China roadmap and will be published as a stand-alone companion piece in early 2022.

Digitalisation

On 12 April, 3DEN contributed with a presentation on smart power systems and distributed energy resources to the China's Electric Power Sector Transformation – 2nd Webinar, co-hosted by the IEA, under the framework of CETP, the EPPEI, the Royal Danish Embassy in Beijing and Danish Energy Agency (DEA) with support from China's NEA, the AFD and the European Commission.

On 8 July, 3DEN presented ways to accelerate net zero transitions through digitalisation at the China Electricity Council's International Conference on Industrial and Energy Internet Innovation.

Activities in India

Energy efficiency

The IEA's 2021 activities on energy efficiency focused heavily on industry, residential buildings and transport, and, continuing our 2020 analysis, on how energy efficiency could support a green economic recovery across sectors.

The IEA has been developing an energy efficiency policy package approach: a combination of regulation, information and incentive measures to create the adequate conditions for energy efficiency improvements. This has been pursued for all end-use sectors and supported the identification of areas where the legislative framework in India could be reinforced.

Buildings

In collaboration with the buildings team at India's Bureau of Energy Efficiency (BEE), the IEA made significant progress in the development of the Roadmap for Mainstreaming Energy Efficiency in Residential Buildings in India, despite delays caused by the impact of Covid-19 on the BEE.

The roadmap aims to mainstream energy efficiency in residential buildings in India and facilitate the adoption of the Eco-Niwas Samhita building code and other voluntary green building standards and star labelling. It provides key recommendations for seven action areas, spanning new and existing buildings, building materials, system operations, sustainable energy, urban planning, and resilience.

The discussions and findings from the roadmap development have also fed into the IEA and BEE joint Report on Energy Efficiency in the Context of Economic Stimulus in India. Data and insights from this work also fed into the development of the India Energy Outlook 2021, particularly the chapter on urbanisation.

Textiles industry

The IEA has developed a policy package to promote energy efficiency in small and medium-sized textile manufacturers in co-operation with The Energy and Resources Institute (TERI). Based on existing analysis and publications, the project identified the largest energy savings potential at national level, targeting specific subsectors and clusters for deeper analysis, through on-the-ground interviews and surveys. The project then identified detailed opportunities and barriers regarding energy efficiency within the textiles industry, as well as setting out additional non-energy-related benefits from improvements in the sector. This included improving working conditions for women – the largest share of the

workforce in what is the second-largest employer after agriculture – and addressing other environmental issues, such as reducing the use of water.

Originally developed as an internal report, the textiles work has gained a lot of attention in the discussions on industry decarbonisation and support to micro, small and medium-sized enterprises (MSMEs) to enhance their competitiveness. The IEA presented an Integrated Policy Package, which was based on the findings of the textiles work to the 20th Meeting of the SAMEEKSHA platform (Small and Medium Enterprises: Energy Efficiency Knowledge Sharing) for promoting energy efficiency in Indian MSMEs on 17 December 2021.

Industrial processes

In 2021, the IEA continued the exchanges with the BEE on the development of sectoral benchmarks for industrial sectors under the Perform, Achieve, Trade (PAT) Scheme. Several high-level and technical exchanges on industrial benchmarking were held by the BEE with support from the IEA. A literature review was developed as a basis for the BEE sectoral benchmarking and target setting for the next cycle of PAT. Several technical consultations with the BEE on industry decarbonisation were held throughout 2021, discussing options for linking the PAT scheme with a carbon trading mechanism and highlighting the multiple benefits of the PAT scheme and an integrated trading approach.

Transport

With regard to transport, the IEA has enabled cross-country experience exchanges on the design of fuel economy standards and implementation modalities between the government of Indonesia and the BEE. The IEA is currently developing a case study on fuel economy standards in India to support the standard definition process in Indonesia, with a particular focus on the freight sector.

The freight sector is a key cross-cutting theme across CETP countries, reflecting their energy use and air pollution impacts. High-level analysis of India's freight mode energy intensity, energy shares by freight mode and case studies on best practice was undertaken, working with the IEA's in-country consultant and the Council on Energy, Environment and Water (CEEW). This contributed to broader work looking at transport decarbonisation. The analysis continued the insights gained through the IEA's analysis on freight benchmarking and international comparisons for Brazil.

At the beginning of 2021, the IEA also examined the impacts of Covid-19 on urban transport while considering current and planned actions on urban transport infrastructure in emerging economies as part of a webinar series. An India-specific webinar in January 2021 examined how modal shifts and social distancing were

linked to better walking and cycling infrastructure provision as well as opportunities for EV charging infrastructure in Hyderabad and Pune.

Sustainable recoveries

The IEA continued to support the BEE in identifying possible energy efficiency measures that could help stimulate a green and sustainable economic recovery from the impacts of the Covid-19 pandemic. Building on the IEA's Sustainable Recovery Report 2020, as well as articles on the potential for energy efficiency to support a clean economic recovery, the IEA developed a discussion paper outlining the opportunities for energy efficiency measures, the possible short- and long-term benefits, and recommendations on how to use India's existing policies and programmes to deliver these measures. A series of stakeholder discussions in January 2021 served to refine the paper, which was submitted to the BEE in late spring 2021. After approval from the BEE, the insights of the paper also informed the exchanges between the BEE and the Ministry of Power on the possible measures for an economic recovery plan for India. Following the second wave of Covid-19 in India, the discussion paper was further updated, and the IEA continued to engage in regular exchanges with the BEE on how to progress energy efficiency in the context of economic recovery. India's Union Budget 2022/23 as presented on 1 February 2022 is well aligned with several of the recommendations of the economic stimulus paper; for example, the announcement that ESCO models would be used to pursue energy efficiency in large commercial buildings.

Finally, the IEA has continued to support the BEE's contribution to global dialogue on energy efficiency by showcasing successful Indian policies and providing platforms for collaboration, such as the 3% Club and the Energy Efficiency Hub. The IEA has also continued supporting the BEE in its leadership role in the SEAD Initiative and COP26 campaigns, including the COP26 Product Efficiency Call to Action. In collaboration with the World Bank, the IEA also organised a successful webinar on evolving ESCOs in emerging economies in July 2021, which discussed market enablers and highlighted different ESCO models such as the Indian Super-ESCO EESL (Energy Efficiency Services Limited).

Electricity

Renewable investment

IEA work to support the transition of Indian power markets has continued at both national and regional levels. Unlocking the Economic Potential of Rooftop Solar PV in India was released in May 2021, following a workshop organised in collaboration with the CEEW and the MNRE of India. The IEA and CEEW jointly drafted the report in the context of the government's target on renewables and rooftop solar, with the aim of setting out the benefits and opportunities for

achieving rapid deployment. The report recommended the adoption of a holistic policy approach for all distributed energy resources to maximise the value of rooftop solar in combination with EVs and storage. Finally, in November 2021 the IEA released Renewables 2021, which included a forecast of power, transport and heat for India as well as a dedicated section on the prospects for India's ethanol blending requirement.

State-level analysis of renewables integration

Following the success of previous modelling work and workshops on renewables integration organised with Maharashtra (February 2020) and Gujarat (October 2020), we convened a similar event for the state of Karnataka in January 2021 and encouraged further engagement with state governments and NITI Aayog. Each workshop resulted in an analytical report, building on previous analytical studies done by IEA or partners and feedback from state governments and other partners including NITI Aayog; the Center for Study of Science, Technology and Policy (CSTEP); Indian Institute of Technology Kanpur; Centre for Energy Regulation; and Prayas (Energy Group). The report from the Karnataka workshop was prepared by the IEA and reviewed by Indian partners including the Bangalore Electricity Supply Company Limited, Karnataka Power Transmission Corporation and Karnataka State Load Dispatch Centre and published in October 2021.

In order to accompany activity at the state level, the IEA published Renewables Integration in India in July 2021. The report was produced following extensive engagement with Indian national- and state-level institutions, and focused on issues often directly identified or requested by Indian stakeholders. Modelling and analysis built on both the Gujarat state-level model, as well as a further refinement of the India five-regions model consistent with the World Energy Outlook scenarios. Areas of focus included demand-side response, new insights on transmission side, analysis of CO_2 and operational costs, evolution of demand (with focus on cooling demand in slums and its role in a just transition), and system strength and inertia (requested by several state-level system operators). The final report was presented in partnership with NITI Aayog and was well received by Indian partners, with the Additional Secretary at the Ministry of Power describing the report as a repository of vast knowledge for stakeholders in India. A commentary summarising the results (Power system flexibility will be essential for India to reach its renewable energy targets) was also published on the IEA website.

Following the significant interest generated through the various exchanges with Indian states, the IEA agreed to develop a State-Level Renewable Energy Knowledge-Sharing Platform. The objective of this online platform is to support power decarbonisation by enabling the mutual learning and technical co-operation between Indian states and international experts. The platform is envisioned as a centre for discussion and provides a natural extension of the state-level work results delivered so far under the programme.

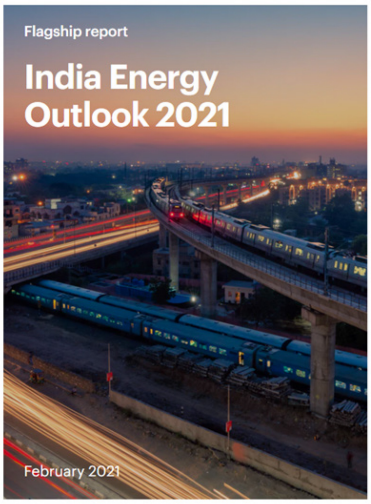
Hydropower

In October 2021, the IEA, together with CSTEP, hosted a webinar on Indian hydropower. The webinar brought together national and international experts to discuss the latest hydropower development, and what were the drivers and challenges for sustainable development of hydro projects in India. The second session of the webinar also provided insights on the role of hydropower in providing flexibility to the power system. The workshop was opened by Shri S.K.G. Rahate, Additional Secretary of the Ministry of Power, and attended by many high-level industry stakeholders. It has created a significant impact, notably by triggering robust links with industry, with potential further collaboration activities in 2022.

Policy advice and modelling

The CETP supported two major publications providing analysis and guidance on Indian energy policies. India Energy Outlook published in February 2021 explored the opportunities and challenges ahead for India as it seeks to ensure reliable, affordable and sustainable energy to a growing population. The report examined pathways out of the crisis that emerged from the Covid-19 pandemic, as well as longer-term trends, exploring how India's energy sector might evolve to 2040 under a range of scenarios. The report maps out the possible energy future for

India, the levers and decisions that brings it about, and the interactions that arise across a complex energy system. Based on a detailed review of existing or announced energy reforms and targets, the India Energy Outlook report aims to provide a coherent framework in which to consider India's choice and their implications.



"India has made remarkable progress in recent years, bringing electricity connections to hundreds of millions of people and impressively scaling up the use of renewable energy, particularly solar," said Dr Fatih Birol, the IEA Executive Director. "What our new report makes clear is the tremendous opportunity for India to successfully meet the aspirations of its citizens without following the high-carbon pathway that other economies have pursued in the past. The energy policy successes of the Indian government to date make me very optimistic about its ability to meet the challenges ahead in terms of energy security and sustainability."

The Air quality and climate policy integration in India report was released in May 2021. It assessed the intersection of air pollution, energy and climate change policies in four different areas: captive power plants, road transport electrification, clean cooking and industrial efficiency. In doing so, it shows how a more integrated approach could maximise co-benefits. It was produced based on IEA scenario analysis, including International Institute for Applied Systems Analysis (IIASA) outputs on air pollutant emissions, as well as additional modelling on air pollutant concentrations conducted by TERI. The analysis drew on extensive consultations with Indian partners and stakeholders. These involved detailed discussions with several policy research institutes working on air pollution and climate policies in India (CEEW, Centre for Research on Energy and Clean Air, Centre for Science and Environment, Institute for Energy Economics and Financial Analysis, WRI India, World Bank) to analyse approaches, findings, policy contexts and conclusions. The consultations included a meeting with the Ministry of Environment, Forestry and Climate Change in March with participation of

Additional Secretary Ms Richa Sharma and Joint Secretary Mr Naresh Pal Gangwar to receive their feedback and comments on the initial findings of the analysis.

In June 2021, the IEA and TERI organised a joint launch event to formally present the findings of the report. Ms Mechthild Wörsdörfer, former Director Sustainability, Technology and Outlooks at the IEA; Mr Abhay Bakre, director-general, BEE; and Ms Vibha Dhawan, director-general, TERI gave welcome remarks to stress the relevance of the topic for India today. Mr Sumit Sharma, former director, Earth Science and Climate Change at TERI, moderated a successful panel discussion with speakers from the Central Pollution Control Board, NITI Aayog and the Indian Ministry of Petroleum and Natural Gas. Nearly 90 participants joined the online event with women making up more than 45% of the audience.

The publication of the report inspired various exchanges with Indian partners in 2021. For example, the IIASA published the report on its website. In August 2021, India's CSTEP asked the IEA to participate in the International Day of Clean Air for Blue Skies. And in December 2021, NITI Aayog approached the IEA with a request to conduct analysis on climate and air pollution benefits of a clean road transport transition in India. After two scoping meetings with counterparts in NITI Aayog's e-mobility division, the Environment and Climate Change (ECC) unit developed a project proposal on this topic, with the objective to publish a country report at the end of 2022.

Sectoral work

Clean fuels

In July 2021, the IEA convened the India Bioenergy Workshop bringing together domestic and international experience in deploying biogas and municipal solid

waste (MSW)-to-energy. The event was co-organised by India's MNRE and CEEW, and explored how international experiences in innovative policy making and technology developments for accelerating the deployment of biogas and MSW-to-energy might be applied in the Indian bioenergy sector.

Technology innovation

Innovation was also an important theme of our work in India in 2021. This included:

- A new analysis of the projected market value of clean energy equipment in India and the world, as an indication of the considerable rewards accruing to successful innovators in these new value chains. The analysis was subsequently widely reported in the World Energy Outlook.
- A working-level dialogue in September 2021 between emerging and developing economies on commercialising clean energy innovations co-organised with Accelerating Growth of New India's innovations (AGNIi), an initiative of India's Ministry of Finance and Office of the Principal Scientific Adviser.
- Launch of a joint project with the IIT Delhi to bring together ten emerging and developing countries and exchange lessons on clean energy innovation policy as a forum for spreading effective policy experiences beyond advanced economies.
- Serving as a knowledge partner for Techtonic, a new start-up challenge run by Social Alpha and backed by the Government of India via its support for India's Clean Energy International Incubation Centre and Atal Incubation Centres. It was open to applicants from all over the world as part of India's effort to support international co-operation on clean energy innovation through Mission Innovation.

Working-level dialogue between emerging and developing economies on commercializing clean energy innovations

Summary: As efforts towards clean energy transitions gather momentum globally, emerging and developing countries will play an important role in shaping outcomes. While emerging and developing countries have distinct market conditions and development priorities, a knowledge gap exists in terms of the awareness of the common energy innovation challenges. There is no forum for these countries to share their technology priorities and cooperate to help their clean energy innovators to scale up internationally. The IEA and AGNIi (Government of India) are hosting a working-level workshop on 30th September 2021 among such countries to discuss national priorities, challenges and success stories in supporting clean energy technology innovation and investments. The target audience for this first discussion is relevant public investment bodies responsible for technology innovation, commercialisation and foreign direct investment (FDI).

Digitalisation

On 2 March, the IEA Director of the Office for Energy Markets and Security inaugurated the India Smart Utility Week (ISUW), presenting 3DEN work on digitalisation and smart grids. ISUW is the reference event for smart grids in India and is organised by the India Smart Grid Forum.

The IEA has also initiated mapping of stakeholders, initiatives, projects and regulation in regard to power system modernisation in India. In this context, 3DEN contributed to the IEA commentary Power system flexibility will be essential for India to reach its renewable energy targets, published on 27 July 2021.

Activities in Indonesia

The IEA-Indonesia Energy Transition Alliance is the largest single country programme in the CETP by resource allocation. Over the past two years, the agency and the MEMR of Indonesia have substantially scaled up co-operation. Following the signature of a two-year joint work programme at the 2019 IEA Ministerial Meeting between the IEA and MEMR, the agency was invited to support the development and implementation of a presidential regulation on renewable energy. This included early financial and investment analysis on different models for renewable power remuneration, followed by a system integration analysis of the Cirata 145 MW floating solar installation – one of the world's largest. Complemented by an ongoing techno-economic modelling of the Java-Bali power system, this multi-year project forms the backbone of the IEA's power system work in Southeast Asia. The iterative successes of this project have generated high-level interest from the government and resulted in a growing number of high-profile and impactful projects on carbon pricing in the power sector, energy finance, energy efficiency, EVs and power tariffs – almost all of which feed directly into government policy making.

The IEA Executive Director and Minister of Energy and Mineral Resources, recognising the strength of ongoing collaboration, as well as Indonesia's growing importance to the global energy system, created the IEA-Indonesia Energy Transition Alliance in 2021. Since the launch of the alliance, energy transitions have been successively elevated within the government's priorities, and with it, collaboration with the IEA. Energy transitions are now one of three central priorities for Indonesia's G20 Presidency, and the minister has played a key role in the IEA's work on People-Centred Clean Energy Transitions.

Following the onset of the Covid-19 pandemic, the IEA also pivoted to match energy policy support for Indonesia, with efforts to react to radically altered energy markets. Over the course of 2021, MEMR reacted to the pandemic, as well as to rapidly changing international discussions around climate, energy and pandemic recovery, by revising its energy policy direction. This direction now includes net zero roadmapping, energy planning for the new capital city, and analysis of potential approaches to an ETS. The IEA's work on energy security has changed in step with this, to focus more heavily on renewables integration and power system modelling, as well as electrification, efficiency and access, and has undergone internal realignments including bringing on new staff capacity to meet proposed activities. In a demonstration of the ministry's trust in the agency's work, the IEA has been formally requested to take on these high-profile and high-impact policy activities.

Finally, the Minister of Energy and Mineral Resources of Indonesia has requested that the IEA develop a net zero roadmap for the energy sector. This would be the

first net zero roadmap produced by the IEA for an emerging economy, and could be extremely impactful towards Indonesia's energy and climate planning. As a result, the agency has recalibrated its internal planning to deliver this project. This work was launched in September 2021, and formally begun after COP26 to align with the government's time frame, with an expected completion time of the end of the second quarter of 2022.

Energy efficiency

The IEA's work on energy efficiency in 2021 focused on policy reform and improving data collection methods and reporting.

Industry reporting system and data collection

On industrial energy efficiency, the IEA has been working with the MEMR to review and redesign its industry energy management reporting system and to develop a website with best practice information for industry on energy efficiency. In 2021, the reporting system and website won the 2021 TOP 45 Public Service Innovation Award at the 2021 National Public Service Innovation Competition (SINOVIK) event that is commissioned by the Ministry of Empowerment of State Apparatus and Bureaucratic Reform.

Supporting policy prioritisation and tracking progress, in particular in the industry sector, the IEA also released two online training courses: Energy Efficiency Indicators: Fundamentals on Statistics; and Essentials for Policy Making translated into Bahasa Indonesia. The training was formally launched in Indonesia in July 2021 and was attended by over 200 Indonesian stakeholders. In addition, the IEA organised a series of workshops on benchmarking for the pulp and paper and textiles sectors in Indonesia, with attendees from both government and industry. The IEA will be continuing its work with the Indonesian government on indicators and benchmarking for the industry sector in 2022.

Transport

In 2021, the IEA continued work initiated in 2020 supporting the MEMR on the development of a new ministerial regulation on public EV charging stations. The initial focus of our support was on providing international experience on battery swapping for two-wheelers. The focus in 2021 was on EV testing with technical exchanges set up between the Indonesian government and the European Commission's Joint Research Centre. The exchanges examined different testing procedures and how these could be adapted for Indonesia, e.g. in terms of modifications of equipment to allow the testing of two-wheelers.

The IEA is also providing support to the Directorate General of New and Renewable Energy and Energy Conservation (EBTKE) on the development of a land-based transport roadmap. The roadmap examines the role of different

transport energy efficiency measures in achieving energy saving policy scenarios. Measures include improvements in vehicle efficiency through electrification and fuel economy standards, as well as travel efficiency through a shift to more sustainable modes. The outcomes of the roadmap are feeding into the IEA's 2022 Net Zero Roadmap for Indonesia.

Fuel economy

IEA support on Indonesia's development of fuel economy standards was another key theme of 2021. The IEA took part in several high-level exchanges with the Indonesian government, enabling the IEA to lay out the importance of fuel economy standards and the IEA's previous work in this area. The IEA was subsequently invited to provide support and develop an associated work plan. Reflecting the growing energy demand of the freight sector in Indonesia and the importance of energy efficiency in this sector, the focus of the work was on trucks and will commence in January 2022. Following discussions between the IEA and the EBTKE, a work plan for industry was developed. In order to deliver it, further on-the-ground work will be necessary, and a consultation process was started in 2021 to find local consultants.

Global dialogue

Finally, the IEA has continued to support Indonesia’s contribution to global dialogue on energy efficiency by providing platforms for collaboration and policy exchange. In 2021, Indonesia signed up to the SEAD Product Efficiency Call to Action along with 13 other signatories, making the Call to Action the largest global commitment to appliance energy efficiency ever. In 2022, the IEA will be supporting Indonesia to realise its ambition on product efficiency and also support its G20 presidency.

Electricity

In 2021, the IEA delivered a series of analytical studies and events focusing on Indonesia power system enhancement and renewables integration in liaison with the MEMR, the State Electricity Company (Perusahaan Listrik Negara [PLN]) and other national institutions. This included a detailed analysis of the Java-Bali power system in the context of Indonesia’s 2025 renewable energy targets. This task entailed a detailed techno-economic modelling to assess the system requirements and flexibility options. Preliminary results were presented to the MEMR and PLN at the end of 2021. A web article illustrating the system integration analysis of a 145 MW floating solar PV plant done by the IEA in 2020 was published on 21 January 2022.

In parallel, the IEA organised a series of webinars focused on the institutional framework for setting reliability standards (12 January 2021), enabling

interconnections and attracting grid investments (23 February 2021), and supporting the deployment of smart grids (19 and 26 February 2021). The webinars involved representatives of all major national power market stakeholders, including the Indonesian Minister of Energy and Mineral Resources Arifin Tasrif, and were supported by various CETP workstreams at the IEA. The outcomes of the webinars have been incorporated into recommendations to be published in the report of the power system enhancement, which is planned for release in the first quarter 2022.

In March and April 2021, on request of the MEMR and PLN, the IEA held a further webinar to share international best practice and experiences on renewable energy integration with Indonesian partners. In addition, the IEA provided a brief document providing insights and recommendations on the accounting periods and tariffs to incentivise renewable electricity, which has been used to inform the ministry's regulation on power wheeling for renewable energy.

Policy advice and modelling

Building on the successful co-operation on power system enhancement, in the second quarter of 2021, the IEA was invited to support Indonesia's development of an ETS. Due to policy planning delays, the project was paused until September 2021, when the ECC unit and the OECD-Clean Energy Finance and Investment Mechanism programme concluded an agreement to jointly complete the project with MEMR. The first phase of the project consisted of a series of technical focus group discussions (FGDs), convening experts to provide insights and lessons on topics specifically identified by stakeholders as relevant to Indonesia's ongoing policy process to establish an ETS for its electricity sector. To date, there have been two FGDs, the first on 23 November 2021 and a second on 14 December 2021.

The opening FGD examined approaches to ETS schemes in the power sector and featured experts from the Ministry of Environment and Forestry, the Directorate General of Electricity, PLN, Tsinghua University (China), and the Korean Institute of Energy Economics. The December FGD focused on the implementation and technical design elements of ETS schemes and invited experts from the IEA, ICAP, the European University Institute, Catapult UK and KobiZE, Poland to share their knowledge. Almost 200 participants from Indonesia joined each event. Another two FGDs are planned for 2022 along with a final paper summarising the outcomes of each event.

Sectoral work

Collaboration with the Indonesian government on energy technology focused mostly on EVs, particularly two- and three-wheelers. A series of technical exchanges took place through March and April, culminating in a technical meeting

with the ministry and PLN in May 2021. A technical summary note on the outcomes of the workshop on EV testing, prepared with the Joint Research Centre of the European Commission, was also provided to the Indonesian partners in May 2021. The success of this technical exchange has led to the IEA being invited to provide policy analysis and advice directly into the government's ongoing EV strategy and associated white paper. Several further consultative dialogues are now planned to advance this task.

Digitalisation

In July 2021, the IEA held a workshop on smart cities with Bandung city officials to discuss practical applications of the findings of the Empowering Cities for a Net Zero Future report in the Indonesian context.

Regional focus – Southeast Asia

The IEA has continued to support ASEAN work on energy policy integration through 2021. Under the chairmanship of Brunei Darussalam in 2021, ASEAN took steps to advance energy security policy work, including on low-carbon fuels and technologies (hydrogen, CCUS, etc.), multilateral power trade and finance. Gas programming has been pushed forward as countries in the region react to rapidly shifting and uncertain global gas market conditions, and to potential new climate and energy plans. The IEA supported regional-level efforts on power market development and is in active discussions with Cambodia on supporting its chairmanship. This work complements IEA's engagement at the ASEAN level, including through the Clean Energy Future Initiative for ASEAN and the recently announced Asian CCUS Network, all under the ASEAN Ministers' of Energy Meeting framework.

Energy efficiency

In 2021, the IEA led the development of Roadmaps Towards Sustainable and Energy-Efficient Buildings and Cooling in ASEAN. The project was a collaboration with ASEAN member states through the Energy Efficiency & Conservation Sub-Sector Network (EE&C-SSN), the ASEAN Secretariat and the ASEAN Centre for Energy (ACE), and aimed to address increasing energy demand and emissions and improve collaboration among stakeholders in the region. The development of the roadmaps was accompanied by a series of webinars, workshops and technical working group meetings. Both roadmaps will be published in April 2022.

In 2021, the IEA and Singapore's Energy Market Authority provided annual training events under the Singapore-IEA Regional Training Hub for the fifth year running. The 2021 event was held online and focused on low-carbon buildings. The training consisted of lectures, discussions and practical exercises that focused on two major topics: energy-efficient, clean and zero-carbon buildings by design; and smart and energy-efficient building systems and operations. The training drew 210 participants from 17 countries, which also supported the development of additional case studies for the roadmaps.

Other regional activity included a webinar on Advancing Buildings Energy Efficiency in Southeast Asia Webinar in May 2021. It drew 191 participants, including speakers from the Philippines, Indonesia, Singapore and the World Bank. The IEA also launched its Online Course for Energy Efficiency in Buildings for Asia. This course consists of four modules that, together, provide an introduction to energy efficiency in buildings. It is a comprehensive introduction into the many decision levels and options involved in advancing energy efficiency in buildings.

Electricity

Multilateral power trade

In 2021, the IEA continued work with ASEAN technical bodies and subsector networks on multilateral power trade. This included participation in capacity-building events, and policy analysis and support. Most significantly the IEA conducted a detailed review of the AIMS III Phase 2 final report as part of the Technical Review Group and in collaboration with ACE. The report has now been submitted to ASEAN member states and the IEA has been invited to participate in the next phase of this project. Additionally, the IEA provided a review of the Terms of Reference for the Phase 3 study to be carried out during 2022 and 2023.

The extensive knowledge the IEA has built up in partnership with ASEAN in turn informed work on low-carbon fuels, including a forthcoming report which sets out how low-carbon fuels can contribute to decarbonisation in Southeast Asia. In this context, IEA experts have been in negotiations with ASEAN stakeholders, including the ASEAN Council on Petroleum (ASCOPE), around supporting the ASEAN Plan of Action for Energy Cooperation programme areas on a Trans-ASEAN Gas Pipeline and on Regional Energy Policy and Planning as they relate to gas market development. These negotiations took place through the 2021 ASEAN chairmanship of Brunei Darussalam though have unfortunately slowed down due to the increased level of Covid-19 infections in the region.

In July 2021, the IEA submitted a proposal on gas market analysis to ASCOPE. Council members recognised the importance of the proposal, and elevated it to present for endorsement at their annual council meeting on 25 October 2021. This proposal aims to strengthen the analytical and policy capacity of ASEAN stakeholders to develop and navigate a modernised and responsive regional energy market. This in turn is intended to enhance the energy security of the region and will involve substantial collaboration between the IEA and various ASEAN stakeholders, including energy companies and governments across 2021 and part of 2022.

Analysis of regional power markets

In February 2021, the IEA released a report setting out how Southeast Asia can reach clean energy targets by investing in transmission. This presented an analysis of different business models for attracting private investment in transmission for countries across Southeast Asia as well as a framework for evaluation.

Thailand was a particular focus for regional outreach on power market design, and the IEA completed a study on Thailand power system flexibility. The report was launched in June 2021 with the Electricity Generating Authority of Thailand

(EGAT) and the Ministry of Energy of Thailand and examines flexibility from both the technical and contractual perspectives. For technical flexibility, the report analyses the value of technical flexibility options, including power plants, pumped storage hydro and battery energy storage systems. For contractual flexibility, the report analyses the impacts of existing power purchase agreement and fuel supply contract structures on system flexibility. This report provides recommendations for the system to be able to use the full range of flexibility options in the most cost-effective and secure way. This analysis was accompanied by further work with EGAT and the Ministry of Energy on the Thailand Flexibility project.

Other IEA activities in the region included participation in the Asia Clean Energy Forum deep-dive session on power system flexibility in June 2021 and through workshops on hydrogen and CCUS. IEA participation in the forum is planned to continue under Cambodia's 2022 ASEAN chairmanship, including further collaboration on policy and regulatory frameworks, and market analysis.

Policy advice and modelling

Thailand was also a focus for policy advice, with a report on The Potential Role of Carbon Pricing in Thailand's Power Sector released in April 2021, which was the result of a collaboration with the Thailand Greenhouse Gas Management Organisation (TGO). Based on in-depth modelling of Thailand's power system in 2019 and 2030, the report explored how carbon pricing could potentially spur emissions reductions from electricity generation and support power sector transformation in Thailand. The study also highlighted some of the potential challenges of implementing carbon pricing in the power sector and relevant policy insights for Thailand to cost-effectively achieve clean energy transition and support its long-term climate ambition. This analysis drew on extensive consultation with Thai stakeholders, including two consultation meetings held in December 2020 and February 2021 with the TGO and representatives from the Energy Policy and Planning Office, the Department of Alternative Energy Development and Efficiency, EGAT and industries. In April 2021, the IEA and TGO organised a joint launch event to present the key findings of the report, which included 100 participants from various government and research institutions in Thailand.

The collaboration on this report also served as a basis for the continued work on climate and energy policy integration work. In April 2021, the IEA organised a kick-off meeting to discuss next steps on carbon pricing, renewable and efficiency policy integration analysis. Work on two reports began in 2021, one focusing on international experience and one as a Thailand case study on the topic of carbon pricing, renewable and efficiency policy integration; these will be finalised and released in 2022.

In September 2021 the IEA participated in a capacity-building workshop aimed at increasing understanding of and technical capabilities for carbon pricing policies

in the ASEAN region. The closed-door workshop was co-organised by ACE and the Brunei Climate Change Secretariat; Brunei highlighted carbon pricing as a key instrument for advancing low-carbon transition under its National Climate Change Policy. In December 2021, the IEA also presented insights from CETP work on carbon pricing at the webinar carbon pricing instruments in the power sector organised by the United Nations Framework Convention on Climate Change (UNFCCC) Regional Collaboration Centre in Bangkok.

Technology innovation

In June 2021 the IEA and the ASEAN Secretariat organised an online workshop, Stimulating Innovation Towards High-Efficiency Cooling Solutions. The webinar was part of the collaboration with ASEAN on energy efficiency mentioned above. The event brought together expert policy makers, compliance experts, academics and engineers, as well as industry representatives from across Southeast Asia to share their knowledge and experience on innovation to support energy-efficient space-cooling appliances. Their expertise will be invaluable to inform the net zero roadmap process.

Activities in Middle East and North Africa

In 2021, the MENA programme initiated work in Oman and Egypt. This has substantially increased IEA standing and visibility in the region, with Egypt successfully joining the IEA as an association country on 3 March 2022.

The joint Oman-IEA Ministerial Dialogue on Clean Energy Transitions and economic resilience took place in September and followed a joint op-ed between the IEA's Executive Director and Iraq's deputy prime minister on the need for collaboration between the producer economies and other countries looking to stimulate clean energy transitions, published by The Guardian on the 1st of September 2021. Oil- and gas-producing economies of MENA are particularly affected by climate change, and ministers and undersecretaries from across the region (including Algeria, Egypt, Iraq, Kuwait and the United Arab Emirates) joined to explore ways to leverage clean energy transitions to ensure broader economic resilience.

The Ministerial Dialogue – co-hosted by Oman's Minister of Energy and Minerals Mohammed bin Hamad Al-Rumhi and IEA Executive Director Fatih Birol – addressed the particular challenges that energy transitions present for economies in MENA, as well as the tangible opportunities for those countries to increase economic resilience and prosperity for the region and its people. The dialogue included CETP funders and IEA member countries. Part of the event was dedicated to future low-carbon exports, which supports regional bilateral engagement with Japan on this issue. As a result of this closer dialogue, Petroleum Development Oman has agreed to send a secondee to the IEA for two years to support technical work on supply chain analysis for clean energy technologies.

The joint Oman-IEA Ministerial Dialogue on Clean Energy Transitions and economic resilience, September 2021

The joint op-ed in The Guardian, by IEA Executive Director Fatih Birol and Iraqi Deputy Prime Minister and Finance Minister Ali Allawi, was subsequently translated into Arabic and published in Annahar, a pan-Arab publication. Minister Allawi heads a ministerial committee reviewing the country's efforts to address climate change. In the article, Dr Birol and Minister Allawi emphasised the opportunities for decarbonisation in the particular context of the oil producer countries. They called for more international support for clean energy transition in the region, and warned that an energy transition that fails to engage with fossil fuel-producing countries and their needs could have profound implications for regional and international security and the stability of global energy markets. The article was very well received, with the deputy prime minister personally writing to the IEA Executive Director to stress its importance, and conveying that he had received considerable positive feedback.

Activities in South Africa

Energy efficiency

Energy Efficiency in Emerging Economies programme

The IEA has been supporting the South Africa Department of Mineral Resources (DMRE) to develop indicators and benchmarking in the industry sector, in particular for the pulp and paper and automobile sectors. The focus has been on engaging with key stakeholders of the sector to create a momentum and collect better data, perspectives and recommendations from all sides: government officials, industry associations, academics and research institutions. This work was built around the IEA's indicators online training courses. A roll-out was launched through a webinar, highlighting the importance and role of data and indicators in policy making. This webinar was the first of a series, with the following ones targeting relevant invitees from the two industry sectors selected. These initial steps have allowed the gathering of initial data and engagement with local stakeholders. This will be pursued in 2022.

On the buildings sector, the IEA has been supporting DMRE and in particular the South African National Energy Development Institute (SANEDI) in the development of their energy performance certificates and the management of the database for certifications. This follows one-on-one webinars we had organised in previous years with selected countries and SANEDI officials to share best practices. In 2021, SANEDI further pushed the development of the energy performance certificate database with the IEA playing a central role, sharing contacts for SANEDI to carry out interviews on specific topics. In October, SANEDI participated in a dialogue, convened by IEA and AGNIi India, between emerging and developing economies on commercialising clean energy innovations in order to share perspectives on clean energy innovation and its challenges in South Africa.

Policy advice and modelling

Power and gas market transitions

In 2021, the IEA initiated work with the Petroleum Agency of South Africa (PASA) and with DMRE on South Africa's power and gas markets. The work was underpinned by demand and supply projections included in the IEA Net Zero 2050 Global Energy Sector Roadmap. PASA agreed to share internal assessments of gas as a transition fuel in South Africa in order to address security of energy supply as well as support the country's economic recovery. A follow-up meeting was

organised in mid-September to discuss future collaboration. The IEA is also engaged with PASA as it recently commissioned consultants to provide a study on the socio-economic impacts of domestic oil and gas development in South Africa. The IEA will be reviewing this study.

Carbon markets

In 2021, we also continued to support South Africa in two workstreams related to the implementation of carbon pricing. The first analysis focused on implications of using benchmarks in the power sector to determine tax-free allowances under the carbon tax, to incentivise improved emissions intensity. The second examined environmental aspects of fuel tax reform, including the potential role of the carbon tax within the fuel tax system, as part of the South African Treasury's work on Covid-19 recovery and stimulus measures. Both pieces of analysis responded to specific policy challenges, and were developed through regular technical consultation sessions with the Treasury with representatives from the DMRE. Due to the national budgeting processes, the publication of the papers has been postponed to 2022.

Just transition

In 2021, South Africa engaged closely with the work of the Global Commission for People-Centred Clean Energy Transitions, on which the South African Minister of Mineral and Energy Resources, Gwede Mantashe, served as a commissioner. South Africa, through the DMRE, requested the IEA's support to review their document Toward a Just Energy Transition Framework. The IEA consolidated inputs across the agency and shared these by mid-December with DMRE.

Digitalisation

The IEA has been working on digitalisation as a means to reach new levels of energy efficiency – a workstream of major interest for South Africa. The IEA has held various exchanges on the topic with South Africa stakeholders and is ensuring South Africa is invited to take part in all relevant workshops.

Activities in Nigeria

Policy advice and modelling

The objective of IEA engagement with Nigeria has been to support the identification of clean energy transitions aspects of the Economic Sustainability Plan. At the request of the Nigerian government, the IEA also provided written comments on the new Petroleum Bill, which finally was passed by the legislature in June 2021. The note sent to the Office of the Vice President (OVP) covered the different links of the gas value chain (production, infrastructures and end users markets) and addressed a list of suggestions and recommendations on model gas production contracts, flaring and fugitive emissions regulation, investment support in infrastructure, access to networks and tariff methodology, security of supply, and end-user pricing.

The IEA is also implementing a detailed work programme with Nigeria to build capacity for CCUS development and deployment. The first milestone of the programme was a detailed briefing on CCUS prepared by the IEA for the Nigeria OVP on 21 May 2021. The detailed briefing included an update on global developments and identified key opportunities for CCUS in Nigeria (in natural gas processing, power generation, low-carbon hydrogen production, CO_2 use and carbon removal).

Following this briefing, the IEA CCUS Unit worked closely with the OVP to develop a comprehensive work programme (over two to three years) to support CCUS capacity building. The work programme has five areas of activity: development of a CCUS strategy; technical assessments; legal and regulatory frameworks; stakeholder engagement; and capacity building. Recognising the need for external funding to implement any CCUS project in the region, the IEA arranged a trilateral meeting in July 2021 with the Federal Government of Nigeria (FGN) and the World Bank CCS Trust Fund to discuss possible support. The FGN has subsequently made a formal request to the World Bank for funding to support the activities outlined in the IEA work programme.

As the first public activity under the agreed work programme, the IEA and Nigeria's OVP co-organised a workshop in September 2021, Facilitating Nigeria's Energy Transition through CCUS Development. The workshop brought together around 150 Nigerian and international experts to identify and discuss key opportunities, barriers and needs for CCUS.

Activities in Senegal

Policy advice and modelling

The IEA team has engaged in various technical exchanges with the Ministry of Petroleum and Energy (MPE) focusing mostly on clean energy transitions in gas markets and the power sector. The MPE has requested IEA support related to gas market transition in the country. The resulting technical call, which took place on 29 April 2021, included discussions on long-term outlook, with the objective to provide figures concerning the long-term evolution (2040-2050) of the gas markets on a global and regional scale. Participants also discussed the medium-term outlook with the objective to provide additional information on the evolution of the gas market up to 2025 based on the latest available forecasts. As a follow-up, the IEA prepared a synthesis of the elements related to the long-term gas outlook based on the latest World Energy Outlook 2020 and Gas 2021 report at the request of the MPE. The tailored analysis was delivered in June 2021.

Exchanges between the IEA and Senegal's MPE also focused on methane emissions. The ministry invited the IEA to provide lessons learned and best practices on methane emissions regulation, as well as on related topics such as environmental management of oil and gas production operations or the introduction of local content in oil and gas sector investments. The material was provided by the IEA to the MPE in the last quarter of 2021.

In parallel, the country's power market and renewable energy integration have become an important focus of the technical exchanges with MPE. Various discussions between March and September concerned the current share of variable renewables, targets for wind and solar deployment over the next few years, planned renewable energy projects and auctions, and ongoing studies on renewable integration in Senegal. The aim was to define in detail possible engagement and the IEA's contribution that would bring more value to Senegal.

Regional focus – Africa

Energy efficiency

The IEA has continued to engage with key regional actors: Southern Africa Centre for Renewable Energy and Energy Efficiency, Eastern Africa Centre for Renewable Energy and Energy Efficiency, ECOWAS (Economic Community of West African States) Centre for Renewable Energy and Energy Efficiency, and African Development Bank. This has ensured key IEA initiatives and publications were shared across the region through workshops and discussions, most specifically key insights from the IEA Sustainable Recovery Report, Energy Efficiency Market Report, Net Zero Emissions report and others.

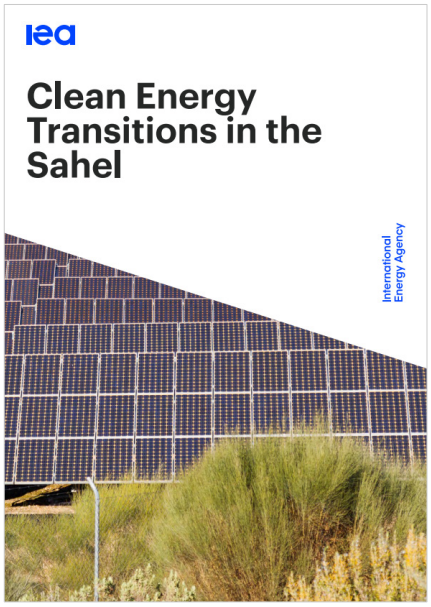
Discussion with regional actors has also focused on ensuring that material published by the IEA is accessible to regional stakeholders through translations and digital promotion, inviting local partners to participate in wider discussions.

As part of the SEAD Initiative, the IEA took part in an ongoing dialogue with regional counterparts and organised focused regional discussions ahead of COP26 to promote engagement and raise the ambition for appliances energy efficiency policy.

The Regional Roadmap for Buildings and Construction in Africa 2020-2050, launched in 2020, was also used as a guideline for recommendations in 2021 as part of ongoing discussions with regional policy makers and professionals. These discussions will be pursued in 2022 to provide support for future national recommendations.

Policy advice and modelling

The IEA aims to support the broader African countries with their transformative energy sector priorities and the implementation of clean energy transitions in the continent by sharing expertise to enhance data, inform decision-making and guide policy implementation. In September 2021, the IEA released the Clean energy transitions in the Sahel report. The report identifies pathways and makes recommendations to accelerate clean energy transitions in six Sahelian countries (Burkina Faso, Chad, Mali, Mauritania, Niger and Senegal). Its aim is to take stock of current energy trends in the Sahel and illustrate policy-relevant best practices that can help speedily advance energy access, energy sector development and the transition of the region's energy systems towards the use of ever-cleaner sources. The report highlights key policy recommendations and opportunities to help policy makers build future energy systems based on clean, affordable and efficient energy sources and practices.



The official launch of the report took place on 30 September 2021 and was designed as an inter-regional conference, organised with the support of the MPE of Senegal, and gathered high-level country representatives, regional and international energy sector leaders, experts, and other stakeholders to discuss how best to accelerate clean energy transitions in Sahel. The full recording in French and in English are available online.

Soon after the launch of Sahel report, the IEA initiated the work on a third region from sub-Saharan Africa, which is the Greater Horn of Africa Region. This ongoing work seeks to document pathways to sustainable development of energy systems in eight countries from the Intergovernmental Authority on Development, namely: Djibouti, Eritrea, Ethiopia, Kenya, Somalia, South Sudan, Sudan and Uganda. The IEA had kick-off meetings with focal points from the different governments and is aiming to release a third report on Clean Energy Transitions during the third quarter of 2022.

Other events in the region included:

- Webinar IEA Africa Academy: Climate Impacts on African Hydropower organised in February 2021 to present the key findings of the Climate Impacts on African Hydropower report and share the ongoing and upcoming work on climate impact and resilience.
- Presentation on the 3DEN project and digitalisation at the Sustainable Digital Transformation Dialogues Africa Regional Event, co-organised with the International Telecommunication Union (ITU) in September 2021.

Global activities

Data and statistics

New data products, expanded coverage and methodological developments

The work on data and statistics is cross-cutting in nature and supports delivery of outputs of all other workstreams. The CETP's support in 2021 brought about a significant increase in coverage of data series for CETP focus countries and regions. For example, the February release increased coverage, from 28 countries in the February 2020 release to 39 countries in the February 2021 release. The additional new non-OECD data in the 2021 release included Argentina, China, El Salvador, Guyana, India, Malta, Morocco, Panama, Paraguay, Singapore, South Africa and Thailand. In terms of accession countries, Colombia submitted annual fuel and energy price data to the IEA for the first time in early 2021 and Costa Rica submitted annual fuel data for the first time in the fourth quarter of 2021.

The IEA has developed a new project with the objective to collect early data on electricity fuel mix for countries where such data can be available. New data for the following countries was added over to the World Statistics and Balances in the course of 2020-21: Equatorial Guinea, Guyana, Lao PDR, Madagascar, Palestinian Authority, Rwanda and Uganda.

In 2020, we also initiated a project to improve the quality of the solid biofuels data. It was taken forward in 2021, with further assessment and survey design through the establishment of working relationships within the relevant offices of the IEA member countries and beyond, with partner organisations such as the Food and Agriculture Organization. We developed a model to estimate solid biofuels to be applied to 30 countries.

In parallel, we started a project with TERI for India-specific work in order to assess all data sources available in India that could be used to improve the coverage and data quality. Between January and May 2021, TERI helped to improve the IEA time series on solid, liquid and gaseous biofuels used in India and identify reliable sources for continuous data updates in coming years.

Other databases where coverage has expanded thanks to CETP support included the energy efficiency indicators. The addition of data from Argentina, Chile and Uruguay expanded Latin American coverage significantly. Co-operation established with South Africa in 2021 will result in the inclusion of the country in the next edition.

Other significant developments include expanded coverage of: emergency oil data and the Joint Oil Data Initiative (JODI) (e.g. Brazil); monthly electricity data (i.e. six new non-OECD countries); and the RD&D data (two non-members added for the first time). In addition, the information expanded at the country level for provisional year-1 for the oil trade, to enhance timeliness for countries not covered by Monthly Oil Statistics, in co-operation with the IEA Oil Market Report. There has been a major overhaul of the world energy prices database to enhance time granularity including weekly, monthly, quarterly and yearly data based on both research and working with key partners.

In addition, CETP resources have been used to analyse internal processes to assess how data from non-OECD countries can be produced in a more efficient manner and how to adapt the frequency of releases in order to obtain an accurate global picture.

With respect to emissions data, the IEA:

- Produced an earlier release of balances and emissions (February).
- Expanded the coverage of the April release of balances and emissions to cover the IEA family.
- Enhanced the coverage of the provisional-year statistics and emissions data at a six-month lag (currently emissions data cover 70% of global emissions).
- Expanded the coverage of carbon factors product to around 50 more countries with secondary source (UN Statistics Division) energy data.
- Integrated estimates of emissions from fuel combustion and fugitive for all gases, to upgrade the CO_2 emissions from fuel combustion into a new GHG emissions from energy data product.

The IEA also launched a project with the aim to develop a set of new indicators at a granular level that could assess the extent to which countries are transitioning towards “cleaner” energy systems. In 2021, this work progressed with the development of indicators at the country-year-sector/technology level based on micro-data, including:

- Measures of invention and international co-invention in clean energy technologies based on patent data.
- New measures of corporate R&D analogous to measures presently collected for public RD&D, but based on firm-level data.
- Measures of entrepreneurship based on firm entry and early-stage financing.

The above data are being complemented by gender-disaggregated data (as a contribution to the Clean Energy Education and Empowerment [C3E] project). In addition, with respect to the specific question of micro-data work on gender diversity, indicators on the demographics of employment and senior management in the energy sector are also in preparation, with a data portal to be made available in 2022.

IEA has advanced scraper development work for "close to real-time" data on electricity generation and demand for selected regions in the world. Automatic scheduled updates of the information allow for data to be accessible to all IEA analysts daily. Preparatory work has been undertaken on real-time natural gas data.

Capacity-building activities

Training on data and statistics

There were a number of important developments in 2021 with respect to training and capacity building in the area of data and statistics, including:

- State-level training in Maharashtra (India). This activity is the follow-up of the December 2018 classroom training for national stakeholders and one-day International Energy Forum also targeting some state-level officials. This event focused on the needs of state-level officials working on energy statistics. The workshop consisted of a series of six webinars, lasting 100 minutes each. Depending upon resources, it could be complemented when travel restrictions are lifted by classroom one-day events. The project is to pilot for one or two states before expanding to grouping of states later on.
- Regional workshop on energy statistics for the Sustainable Development Goal 7 (SDG7) indicators jointly designed with the Statistical, Economic and Social Research and Training Centre for Islamic Countries within their Webinar Series on Statistical Experience Sharing. The workshop addressed focal points from national statistical offices and experts from around 20 countries and organisations, with the objective of describing data needs and highlighting opportunities and gaps to track SDG7 progress.
- Regional energy efficiency indicators workshop jointly designed with Asia-Pacific Economic Cooperation (APEC) (Joint APEC-IEA Training Workshop) on end-use energy consumption data, facilitating information exchanges and discussions among member economies and international energy organisations, with the objective to improve the global energy efficiency data, through knowledge sharing, lectures, exercises and discussions, with participants from around 20 countries (IEA and non-IEA members of APEC) and organisations.
- Global training workshop on RD&D data (Working together to enhance global energy RD&D data collection), within the innovation programme, jointly organised with Mission Innovation. This workshop aimed to support countries to collect the highest-quality energy technology RD&D budget data, with the objective of driving improvements by exchanging experience and practices.
- New format for the Statistics Online Training, with a focus on specific subjects and a more in-depth training through exercises. This is the adaptation of the Paris flagship training provided twice a year by the Energy Development Corporation to energy statisticians worldwide, due to current travel restrictions. Content and

training methods have been adapted to the online conditions. More than 80% were non-member country participants.

Training on energy efficiency

In 2021, organising in-person energy efficiency training and capacity-building events was prevented by the Covid-19 pandemic, and the programme continued to develop its online training offer. Emphasis has been put on developing high-value online courses that will remain relevant when face-to-face training resumes with the potential for tens of thousands of people to now benefit from energy efficiency indicators training. The English version of the online training courses developed by the IEA are now all available on one integrated IEA e-learning platform.

Capacity-building highlights in 2021 included:

- Asia launch of the global English version of the 40-hour online training course on energy efficiency in buildings, originally developed with CAF, on the IEA's e-learning platform in May. The course was specifically launched as part of the Advancing Buildings Energy Efficiency in Southeast Asia Webinar. So far, more than 300 people have enrolled in the course.
- Brazil launch of the Portuguese version of the 40-hour online training course on energy efficiency in buildings in May. So far, 50 people have completed the course in Portuguese.
- Launch of the seven-hour course on Sustainable Energy Policies for Smart Cities in February, an open-access version of the Singapore live online training that took place in September 2020. So far, more than 140 people have enrolled in the course.
- Roll-out of the two online courses on energy efficiency indicators in South Africa in June in partnership with the South African DMRE. The roll-out was designed as a two-way process aiming to develop a data collection plan for the country's pulp and paper and automotive industry sectors.
- Launch of online energy efficiency indicators courses for Latin America, through an event designed within the energy efficiency programme, targeting data and policy practitioners in the region, leveraging on the networks of partner organisations such as OLADE, SICA and ECLAC, and with participation of experts from Mexico and Colombia.
- Roll-out of the Bahasa version of the two online courses on energy efficiency indicators in Indonesia in July targeting long-term data collection plans for the country's pulp and paper, textile, and services industry sectors. So far, about 300 people have enrolled in the course.
- Together with the Energy Market Authority of Singapore, we continued our collaboration as part of the Singapore-IEA Regional Training Hub and delivered in July the Singapore-IEA Low-Carbon Buildings Training, a two-day-long live online

training event which gathered 198 participants from over 17 countries. Trainees taking part in this event had to submit a short homework exercise to receive their certificate of completion.

Electricity

In April 2021, the IEA released a series of reports on Electricity Security to support the acceleration of clean energy transitions. The Power Systems in Transition – the first deliverable in the series – surveyed the ongoing multiple transformations in the electricity sector. The report addresses three key aspects of electricity security through transition: energy transitions with more variable renewables, cyber risks, and climate impacts. In addition, the roles of new technologies and demand-side response, and electrification of other sectors are explored. Examples and case studies of all these changes are taken from power systems around the world, with best practice and recommendations identified to guide policy makers as they adjust to the various trends under way.

The Electricity Security series also covers other aspects of clean energy transitions:

- The report on Secure Energy Transitions covers the areas of system adequacy, investment signals in market design, flexibility, system balancing and stability in power systems transitioning to low-carbon energy.
- The report on Cyber Resilience focuses on using real-world examples to identify and manage cyber risks to electricity systems.
- The report on Climate Resilience provides an analysis on the impact of climate change on the entire value chain of electricity systems.
- Analytical frameworks for electricity security defines outages, describes approaches to assessing how much they cost, and outlines the institutional responsibilities to prevent and/or react to them.

Other activities to advance progress on clean electricity included:

- 8th Annual Electric Power Research Institute (EPRI)-IEA workshop Challenges in Decarbonisation: Building a Resilient Net-Zero Future. This public webinar, opened by Dr Fatih Birol, IEA Executive Director, and Dr Arshad Mansoor, president and CEO, EPRI, gathered a broad range of representatives from government, system operators, utilities, business and academia leading the transformation of power systems as part of energy transitions around the globe. Spread over three days, the workshop series included expert presentations and panel discussions on flexibility and resilience in decarbonised energy systems and a holistic look at electrification, as well as various sessions on climate resilience.
- 12th Clean Energy Ministerial high-level side event What's next for power system flexibility in May 2021. The event was co-organised with the International Smart Grid Network and included two panels, one where senior researchers and practitioners discuss the next steps for power system flexibility, followed by a strategic discussion by ministers and high-level representatives from the Power

System Flexibility network, relating directly to the insights of the previous discussion and discussing what is needed for the next five to ten years.

- Presentation of the Electricity Security series at a webinar organised by the International Atomic Energy Agency (IAEA) in June 2021.
- Presentation of the Electricity Security series to Mexican Energy Forum at the Mexico Autonomous Institute of Technology (ITAM) in September 2021.
- Various keynote speeches at EnergyNautics events: E-mobility symposium, Solar & Storage Integration Workshop and Wind Integration Workshop in September 2021.
- Web commentary by the IEA's Executive Director, The world's electricity systems must be ready to counter the growing climate threat, published in July 2021.

Policy advice and modelling

Climate resilience

As a continuation of our work on assessing climate change-related risks, in June 2021, we released the Climate Resilience Policy Indicator, which aims to assess the level of climate resilience of each country by comparing the level of climate hazard that the country is facing against its policy preparedness. The report provides a framework to assess climate resilience in key energy and climate policies and mobilise further action. The analysis showed that over 85% of the countries in the IEA member and association countries are already exposed to a medium or high level of climate hazard risks in terms of heat, drought, flood and cyclones. India, China and Mexico are among the highest-ranked. These findings can encourage countries to consider climate resilience of the energy sector in their national plans, and see examples of how other countries have done so.

The release of the indicator was accompanied by a series of presentations:

- Policy preparedness for climate resilience of the energy sector at the London Climate Action Week event in June 2021: This IEA event discussed how policy measures can enhance climate resilience of the energy sector and build a resilient future. The event explored the ongoing efforts of diverse countries to address climate risks, introducing useful tools and best practices. Discussions in this event contributed to raising awareness of the important role of climate resilience policies and developing effective policy measures to build resilient energy systems.
- The UN Development Programme (UNDP) Central Asian regional workshop on energy sustainability and climate resilience: The IEA shared its latest key findings with government representatives and international organisations.
- Climate Resilience Events at COP26 in November 2021: The IEA co-organised three events on climate resilience on COP26 Energy Day, inviting speakers from Asia, Latin America and Africa. Two events were organised at Resilience Hub with ICF to discuss collaborative actions to mainstream climate resilience into national energy planning and for the global clean energy transition.

Emissions trading systems

In addition to country-focused activity on carbon trading, the IEA participated in the UNFCCC Asia-Pacific Climate Week, organising a virtual side event on carbon pricing. During this webinar, international and regional experts discussed opportunities and challenges of implementing carbon pricing instruments in the Asia-Pacific region, with focus on carbon pricing in power sector transition, examining different national circumstances and sharing country experiences. The IEA experts presented insights from work with CETP focus countries, stakeholders and experts.

In November 2021, the IEA co-organised the two-day virtual event Carbon Pricing Dialogue in the Asia Pacific, with ICAP and KAS. This workshop aims to create a platform for policy makers and experts in the Asia-Pacific region to share progress with, and discuss various technical topics in, designing and implementing carbon pricing policies. The first day of the event was a high-level public webinar to bring together politicians and legislators to share progress in climate action and carbon pricing development. The second day was technical exchange focused on carbon pricing's role in leading coal phase-out in the Asia-Pacific region. Politicians, government officials and experts from China, Indonesia, Kazakhstan, Malaysia, Singapore, Thailand and Viet Nam spoke at the event, with over 100 participants.

Finance

Support provided by the CETP allowed the IEA to deepen its analytical work resulting in the flagship report Financing Clean Energy Transitions in Emerging and Developing Economies, which was produced in collaboration with the World Bank and the World Economic Forum.

The report was based on an analysis of successful projects and initiatives, including almost 50 real-world case studies. The aim was to address the challenge of funnelling investment towards clean energy transitions in these economies. The report demonstrates that concerted international efforts are needed for a sustainable and resilient future in the developing world. It calls for a focus on channelling and facilitating investment into sectors where clean technologies are market-ready, especially in the areas of renewables and energy efficiency, but also laying the groundwork for scaling up low-carbon fuels and industrial infrastructure needed to decarbonise rapidly growing and urbanising economies. It also calls for strengthening sustainable finance frameworks, addressing barriers on foreign investment, easing procedures for licensing and land acquisition, and reforming policies that distort local energy markets.

> **"There is no shortage of money worldwide, but it is not finding its way to where it is most needed. Governments need to give international public finance institutions a strong strategic mandate to finance clean energy transitions in the developing world."**
>
> 
> Fatih Birol
> IEA's Executive Director

The report was launched in June 2021 at an online event livestreamed on the IEA YouTube channel. The IEA Executive Director provided opening remarks, followed by representatives of the institutions collaborating on the special report – Mari Pangestu, managing director of development policy and partnerships at the World Bank, and Børge Brende, president of the World Economic Forum. The event included a high-level round table discussion with Mark Gallogly, expert senior adviser to the US Special Presidential Envoy for Climate; Amani Abou-Zeid, commissioner for infrastructure and energy, African Union Commission; Gurdeep Singh, chairman and managing director of NTPC; and Nandita Parshad, managing director, sustainable infrastructure, European Bank for Reconstruction and Development.

A series of presentations followed the official launch. Between June and September 2021, the report was presented to audiences in the United States, Japan, Africa, Latin America (Chile), Southeast Asia and Europe and also in direct exchanges with various public and private financial institutions.

The CETP support also allowed the IEA to bring a more global perspective to its World Energy Investment 2021 by covering more countries and perspectives on innovation investment. The report, published in June 2021, presented the latest data and analysis of how energy investment flows are recovering from the shock of the Covid-19 pandemic, including full-year estimates of the outlook for 2021. It examined how investors are assessing risks and opportunities across all areas of fuel and electricity supply, efficiency and R&D, against a backdrop of a recovery in global energy demand as well as strengthened pledges from governments and the private sector to address climate change.

The CETP allowed us to produce the chapter on R&D and innovation, which provided detailed analysis of public and corporate spending, demonstrating that for many energy technologies, increased public funding is needed to assume most of the risks of basic research and first-of-a-kind demonstration projects, as well as leveraging private investment in R&D and steering it towards priority needs for future net zero emissions energy systems.

In 2020, trends in energy innovation spending diverged between governments and corporations. IEA tracking showed a clear albeit gradual trend towards higher government spending on low-carbon energy R&D, while private-sector energy R&D spending dropped as the pandemic caused corporate budgets to be cut or led to underspending on projects. Market uncertainties and lower sales revenues have reduced the funds available to entrepreneurs seeking to scale up new technologies. At the start of 2021, the signals for investment in low-carbon energy innovation are positive and they come from both public and private sources. As core elements of their plans to transition their energy systems to net zero emissions, major economies including China, Japan and the United States have highlighted innovation and proposed increased levels of funding. In China, documents in support of the 14th FYP 2021-2025 give a central role to energy innovation: China's National Science and Technology Major Projects budget could rise above the current level of around USD 3 billion per year and include more energy-related projects.

In March 2021, we published Clean Energy Investing: Global Comparison of Investment Returns, a joint report by the IEA and the Centre for Climate Finance & Investment of the Imperial College Business School. In this report, we analysed financial performance of listed renewable energy companies in different geographies: advanced economies, China, emerging markets and developing economies excluding China, and globally. The objective was to provide more

transparent market data to institutional investors and policy makers who are interested in investing more in clean energy companies

Sustainable bioenergy

In 2021, the IEA continued to support the work of the Biofuture Platform, providing technical and policy guidance on sustainable bioenergy in emerging economies, with a particular focus on advanced biofuels. The Biofuture Platform is a government-led, multi-stakeholder initiative designed to take action on climate change and support the Sustainable Development Goals by promoting international co-ordination on the sustainable low-carbon bioeconomy. It was launched in November 2016 at the COP22 climate talks in Marrakesh and the IEA was invited to act as the official facilitator at COP24 in December 2018.

In May 2021, we hosted the Biofuture Summit II, which included 40 sessions with more than 200 speakers. IEA Executive Director Dr Fatih Birol provided the keynote address, sharing the results of the IEA Net Zero by 2050 roadmap. The summit gathered IEA member countries, representatives of CETP focus countries, and industry representatives with Lanzatech, Indian Oil, Braskem and others. The summit was organised by the Brazilian Ministry of Foreign Affairs as Biofuture Platform chair and host, and the Bioenergy Research Program from the State of São Paulo Research Foundation, with support from the Brazilian Trade and Investment Promotion Agency and the IEA, among several other partners. It brought together the world´s foremost experts in policies, innovation, science and market outlook in the bioenergy and bioeconomy sectors.

During the summit in May, the Biofuture Platform members shared the Bioenergy Policy Blueprint, which aims to provide countries with the methodologies, tools and practical guidance to evaluate and improve the impacts and effectiveness of

their bioenergy and bioeconomy policies. Commenting on the Policy Blueprint, Brazil's secretary for foreign trade and economic affairs, Sarquis José Buainain Sarquis, said, "It will provide structure and clarity to the lessons learned over the years, helping to build the foundations of a sustainable future."

In June 2021, the IEA together with the Clean Energy Ministerial (CEM) launched the Bio-based substitution challenge during the 12th CEM meeting. The campaign's mission is to enable the reduction of GHG emissions and foster a circular economy by showcasing pathways by which countries, companies and consumers can substitute sustainable bio- and waste-based products for their fossil equivalents. It aims to substitute 10% of fossil carbon fuels, chemicals and materials for bio- and waste-based equivalents by 2030 from a 2019 baseline.

In December 2021, we initiated a Sustainability Workstream of the Biofuture platform in order to:

- Convene stakeholders to develop evidence-based understandings of sustainable bio-based feedstock availability.
- Document conditions required for biomass feedstocks to provide fuels, chemicals and materials to drive impactful reductions in GHG emissions while generating jobs and rural prosperity.
- Enumerate policies and regulations that minimise waste, increase sustainable biomass production, and de-risk biomass use.

Hydrogen

With CETP support, the IEA Global Hydrogen Review report was launched in October 2021 and presented by IEA Executive Director Fatih Birol at the Hydrogen Ministerial meeting in Japan.

Global Hydrogen Review 2021 builds on the Future of Hydrogen report that was released in 2019 for Japan's G20 presidency and includes deeper analysis and projections of hydrogen costs and consumption, including data from the Asia-Pacific region.

The report's purpose is to review global on-the-ground developments of hydrogen production and use with the aim to provide decision-makers with the most updated information to support actions and policy development that enable the scale-up of low-carbon hydrogen. The Global Hydrogen Review is to date the most comprehensive global hydrogen analysis, including in-depth tracking and analyses of hydrogen policies, supply, demand, investments, trade and regional developments.

The IEA, as the co-ordinator of the CEM's Hydrogen Initiative, seeks to find synergies between the initiative and the main identified areas of interest among emerging and developing countries related to low-carbon hydrogen fuels and technologies.

Additional activities related to hydrogen included a senior expert webinar, Hydrogen and the role of synthetic fuels in power system flexibility, organised in the framework of the 2021 Berlin Energy Transition Dialogue in March 2021. The objective of the event was to highlight selected promising technological approaches and discuss near-term policy priorities to enable scalability.

Global E-Mobility Programme

At COP26 in December 2021, the IEA together with the GEF and UNEP launched the Global E-Mobility Programme. The programme is set up to support more than 50 low- and middle-income countries (27 with direct GEF funding) with a shift to e-mobility. The scope of the work includes among other things building institutional capacity, supporting the development of e-mobility strategies and roadmaps, and establishing e-mobility policy frameworks and financial support to pilot EVs on the ground. The IEA has been selected as an executing agency under the programme with the responsibility to deliver knowledge products and tools through the two global thematic working groups: electric light-duty vehicles; and charging infrastructure, grid integration and batteries.

Since the launch of the programme at COP26, the IEA has established the working groups and organised the first meetings in November 2021. A public webinar was organised in December 2021 to gather inputs for the development of a policy brief on public charging infrastructure deployment and business models. Senior officials and experts from government, the private sector, international organisations, academia and other stakeholders participated in the meeting. Draft work plans with abstracts for all planned knowledge products were developed and presented to the working group participants.

In its initial phase, the GEF Global E-Mobility Programme included Antigua and Barbuda, Armenia, Burundi, Chile, Costa Rica, Côte d'Ivoire, India, Jamaica, Madagascar, Maldives, Peru, Seychelles, Sierra Leone, Saint Lucia, Togo, Ukraine and Uzbekistan. The new countries now joining the programme include Albania, Bangladesh, Ecuador, Grenada, Indonesia, Jordan, the Philippines, South Africa, Sri Lanka and Tunisia, in addition to support for regional initiatives. Beyond this list of countries, the IEA intends to engage and involve interested CETP countries in the work as well.

Methane

Methane is a potent GHG with important implications for climate change. Although methane has a much shorter atmospheric lifetime than CO_2 – around 12 years, compared with centuries for CO_2 – it absorbs much more energy while in the atmosphere. Thus, while methane tends to receive less attention than CO_2, reducing energy sector methane emissions will be critical for avoiding the worst effects of climate change. As fossil fuel operations generated around one-third of all methane emissions from human activity, action on methane is therefore one of the most effective steps the energy sector can take to mitigate climate change. Considering average natural gas prices from 2017-2021, around 40% of current methane emissions from oil and gas operations could be avoided with measures that would have no net cost. Policy makers have at their disposal well-established policy tools that have already been demonstrated in multiple contexts to drive these emissions reductions.

In order to encourage adoption of policy solutions, the IEA released Driving Down Methane Leaks from the Oil and Gas Industry: A Regulatory Roadmap and Toolkit in January 2021 and Curtailing Methane Emissions from Fossil Fuel Operations in October 2021. The IEA Executive Director has also joined the Global Methane Pledge, a commitment by more than 100 countries worldwide to cut global methane emissions from human activity by 30% by 2030.

In 2021, the CETP supported the dissemination of the results of our work on methane. Thanks to the programme's funding, the Regulatory Roadmap was translated into Russian, French, Arabic, Spanish and Mandarin, to facilitate dissemination among policy makers in regions with the potential for biggest impact, e.g. the Middle East and Central Asia. The CETP also supported the design of a series of capacity-building exercises. The first training session for Iraq was delivered in November 2021 in co-operation with UNEP, and others are expected to follow in the first half of 2022.

Technology innovation

In 2021, the CETP funded work on energy technology innovation that continued to focus on three objectives: enhancing the tracking of innovation spending and outputs; supporting innovation policies through reviews and best practice exchanges; and promoting international collaboration and participation in energy innovation partnerships, such as through the IEA TCPs and contributions to Mission Innovation.

In recognition of the common challenges faced by many emerging market and developing economies in their efforts to enhance capacities to develop clean energy technologies, CETP activities expanded to include global studies of effective policy practice and knowledge-sharing dialogue between national policy

experts. In several cases, these efforts are filling gaps in global knowledge, and hold significant insights for IEA members as well as emerging economies.

Reliable and timely data are essential for tracking trends in clean energy innovation. CETP continued to support the IEA to research and estimate public R&D spending in non-member countries, as well as global corporate R&D spending and clean energy start-up deals. In May 2020, the IEA and Mission Innovation convened a joint workshop to support countries to collect the highest-quality energy technology RD&D budget data, with the objective of driving improvements by exchanging experience and practices. Presentations and interactive discussions leveraged the breath of expertise across countries, also highlighting new areas of collaboration within the international community. Presentations and interactive discussions, involving nearly 100 online participants from 30 countries and 67 organisations, leveraged the breadth of expertise across countries, and highlighted new areas of collaboration within the international community. In October 2021, we also released a database on Energy Technology RD&D Budgets, drawing on data submitted through the IEA's annual questionnaire. With CETP funding, the IEA was also able to provide support to the Mission Innovation Secretariat and country teams, particularly in the lead-up to the 6th Mission Innovation Ministerial and the launch of MI 2.0 and specific missions. The IEA has also been invited to sit on Mission Innovation's Technical Advisory Board in 2022.

In the area of data, the Patents and the Energy Transition report, published in April 2021, provides intelligence on the innovation trends across the energy system, in particular low-carbon energy technologies. It draws on the latest information available in patent documents and the combined expertise of IEA analysts and European Patent Office examiners. It is based on an updated international classification of low-carbon innovation that provides a widely used standard for consistent and robust analysis of patents for technologies contributing to climate change mitigation. The results of this and other tracking activities were discussed by us at the event Delivering on the Green Deal: How competitive and innovative is our clean energy sector? in October 2021.

Two working-level dialogues were held in September 2021 between emerging and developing economies on commercialising clean energy innovations and energy innovation policy frameworks. The first of these was co-organised with AGNIi, an initiative of India's Ministry of Finance and Office of the Principal Scientific Adviser. The second was co-organised with the IIT Delhi and led to the launch of a project to develop case studies of ten emerging and developing country experiences. Across the two events, 13 countries participated: Brazil, Chile, Colombia, Egypt, Ethiopia, India, Indonesia, Kenya, Mexico, Morocco, Nigeria, Oman and South Africa.

Detailed analysis of how governments support clean energy start-ups was undertaken in 2021 in response to broad interest in this recently emergent topic

from governments. In particular, emerging economies typically do not have strong innovation traditions and multinational corporate energy technology companies, and they view start-ups as a promising route for launching and growing clean energy leadership in novel technology fields. Initial research highlights the important role that policy will play, a message that was conveyed by us at the UNFCCC Global Innovation Hub launch in November 2021. The results of the analysis, which strongly feature emerging economies among the leading case studies, will be published in early 2022.

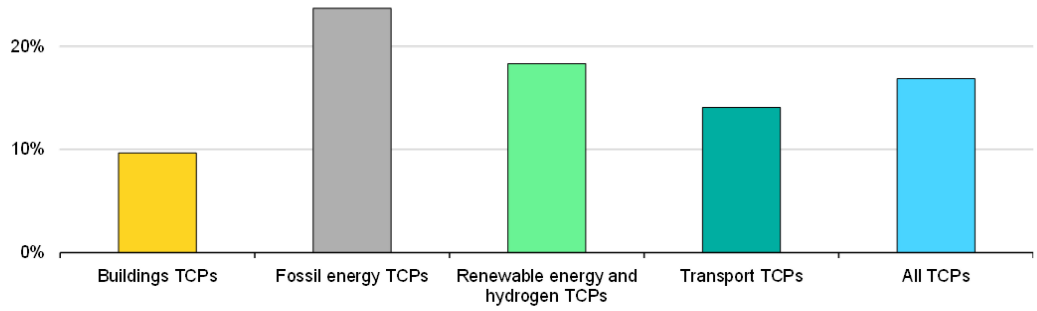
In October 2021, in co-operation with the IEA Experts' Group on R&D Priority-Setting and Evaluation and the IEA Committee on Energy Research and Technology, we organised a workshop on Evaluating the impacts of energy innovation policies. The workshop took a global view of experiences in this area, with participation from Brazil, Chile, Colombia, Ethiopia, Kazakhstan and Morocco alongside IEA members. The interest of the Brazilian electricity regulator, ANEEL, was particularly important for guiding the structure and content of the discussion, which feeds into the development of ANEEL's forthcoming revised R&D regulation.

There is an opportunity for multilateral initiatives for clean energy innovation to work closer together. In the last two decades, there has been a proliferation of new platforms for countries to address common energy challenges. As discussed at our round table Promoting collaboration among multilateral initiatives for energy innovation in July 2021, a co-ordinated approach among these platforms can help increase their respective value added and impact. This includes sharing good practice for collaboration, exploring areas for joint work and avoiding duplication. We prepared two handbooks in 2021 to guide efforts to make international co-operation more effective and more global:

- Expanding the global reach of the TCPs in 2021 – a handbook which collects TCPs' good practice and experience to broaden their reach, as well as guidance on what TCPs are and how they function for decision-makers in prospective member countries, focusing on key benefits of membership. It identified three core themes where TCPs may exchange learnings and suggestions to foster enhanced participation looking forward.
- Enhancing collaboration between multilateral initiatives – a handbook providing recommended actions for governments to create an opportunity to enhance co-ordination and foster collaboration between multilateral initiatives – both existing and new ones – to broaden their reach and increase their impact while ensuring the optimal allocation of resources for international co-operation.

These publications stimulated dedicated discussion sessions at the TCP Universal Meeting 2021 in October 2021, in collaboration with Mission Innovation, the CEM and other multilateral initiatives.

Share of TCP members that are IEA association, accession or other non-member countries, in selected technology focus areas and all TCPs



Note: Participation numbers as of 24 August 2021.
Source: IEA (2021), Expanding the Global Reach of the TCPs.

Sustainable recoveries

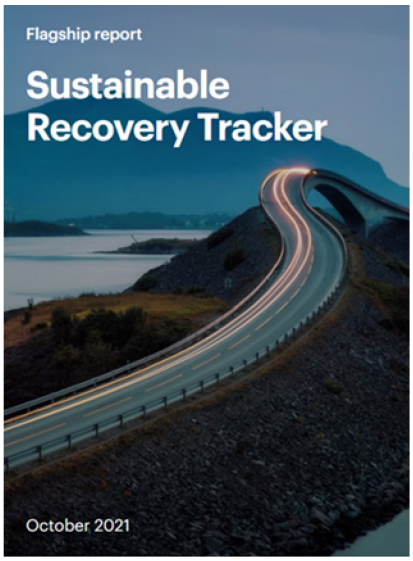
In response to the Covid-19 pandemic and the ensuing economic crisis, governments worldwide have mobilised an unprecedented amount of fiscal support aimed at stabilising and rebuilding their economies – over USD 16 trillion, based on the latest International Monetary Fund (IMF) estimates. The IEA Sustainable Recovery Plan, developed in 2020 in collaboration with the IMF, estimated that if governments mobilised USD 1 trillion in clean energy investments each year from 2021-2023, they would boost the global economy, create millions of jobs and put emissions onto a Paris-compliant trajectory. Many countries have identified clean energy measures as a priority within their fiscal support measures.

Building on the Sustainable Recovery Plan, in October 2021, the IEA released the Sustainable Recovery Tracker, which measures global recovery plans against this target level of spending by:

- Monitoring energy-related policies and government spending on clean energy measures by country and by sector in the wake of the pandemic.
- Evaluating the actual impact on total public and private recovery spending on clean energy measures.
- Projecting the effect on global CO_2 emissions trends.
- Estimating the impact on global clean energy employment.

The tracker relies on new, extensive policy analysis conducted by the IEA, including new modelling to estimate how much government spending mobilises private-sector participation by region and measure type and will be updated periodically to provide up-to-date assessments of how recovery plans are affecting clean energy investments and global emissions.

The Sustainable Recovery Tracker also provided data results for the IEA World Energy Outlook 2021 and the Energy Efficiency and Renewable Energy market reports, and was quoted in both the G20 Ministerial and Leaders communiqués, which encouraged the IEA to keep updating its analysis on the topic.



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G20 ROME LEADERS' DECLARATION

24. We will deliver national recovery and resilience plans that allocate, according to national circumstances, an ambitious share of the financial resources to mitigating and adapting to climate change and avoid harm to the climate and environment. We acknowledge the Sustainable Recovery Tracker developed in cooperation with the IEA, encouraging its update. In order to deploy the full potential of zero, low-emission, innovative, modern and clean solutions, we will collaborate to accelerate the development and deployment of the most efficient and effective solutions and help them rapidly achieve cost parity and commercial viability, including to ensure access to clean energy for all, especially in developing countries. We commit to scale up public Research, Development and Deployment. We will increase our cooperation on enhanced country-driven capacity building and technology development and transfer on mutually agreed terms, including through key global initiatives and joint or bilateral projects on the most efficient solutions in all sectors of economy.

Source: Extract from the G20 Rome Leader's Declaration. © Italian Government, Presidency of the Council of Ministers, October 31, 2021.

Employment

Our CETP-supported work within the innovation workstream also focused on potential impacts of energy transitions on employment. We analysed potential uneven impacts across sectors, communities, regions and countries and proposed actions to mitigate adverse effects through development of a database and modelling that featured in the World Energy Outlook 2021, as well as publications such as the Sustainable Recovery Tracker, the Recommendations of the Global Commission on People-Centred Energy Transitions, and an online commentary The importance of focusing on jobs and fairness in clean energy transitions.

Digitalisation

IEA efforts under the CETP digitalisation workstream involved supporting the work of the Italian presidency of G20 under the joint Energy Transition and Climate Sustainability area with analytical work, presentations during institutional meetings and collateral events, and inputs to support G20 negotiations.

Smart cities

In terms of analysis, the IEA investigated opportunities, challenges and policy solutions that can help city-level governments capture the significant value in efficient and smart digital energy systems, regardless of their unique context.

The resulting report Empowering Cities for a Net Zero Future: Unlocking Resilient, Smart, Sustainable Urban Energy Systems was published on 22 July and officially launched by IEA Executive Director Fatih Birol at the G20 Energy and Climate Joint Ministerial Meeting on 23 July. This work was also recognised in the G20 Energy-Climate joint Ministerial Communiqué.

In order to build a community of practice, the IEA engaged with more than 125 experts and practitioners from more than 40 countries, through one-to-one exchanges and two experts' round tables in April 2021. The experts' round tables focused on the issues to be tackled in the G20 report, case study suggestions, lessons learned and best policy practices.

The round tables and discussions were instrumental in collecting on-the-ground experiences and results and enabled the IEA to illustrate the report with more than 100 best and innovative practice case studies and examples.

The dissemination actions resulted in several articles published online in various countries and regions, including Canada, China, Japan, India, Italy, the United States and the European Union. The report was also well received by local authorities in Indonesia, with representatives from Bandung province inviting the IEA to present the main findings of the report to a livestreamed webinar on 29 July. The main findings were also presented in a variety of other events, including COP26, Artificial Intelligence (AI) World Congress, World Climate Forum Asia, Innovate4Cities and Vienna Energy Forum. As of 31 December 2021, the report page had been viewed 11 400 times from almost 8 000 users from 98 countries.

Digitally enabled business models

Finally, the IEA provided analysis to 3DEN on digitally enabled business models. This included inputs gathered from experts and organisations during an invitation-only round table in July 2021. Representatives from 31 organisations from both the public and private sectors exchanged views on the role of digitalisation in enabling energy-relevant business models, and provided insight on how to evaluate the performance of digitally enabled business models in the energy sector. Analysis also focused on the potential role of digital business models in facilitating clean energy transitions, with a particular focus on energy efficiency and demand-side flexibility. The resulting article The potential of digital business models in the new energy economy was published in January 2022.

Other outputs of the digitalisation workstream included contributions to a wide range of events and publications, including:

- The 3DEN and CEM Power System Flexibility Campaign joint expert webinar on Strategies for Digitalisation of Electricity Systems on 25 February.

- The 1st Energy Transition and Climate Sustainability Working Group Meeting in March 2021, where we focused on the role of smart grids to abate CO_2 emissions and provided an overview on the importance of sustainable energy cities and the role played by digitalisation.
- The Energy Transitions Working Group Workshop on Resilient, Smart and Sustainable Cities: The Role of Innovative Technologies, Efficiency and Circularity for a Climate Neutral Future in April 2021, where we presented on smart grids and digitalisation for sustainable energy cities, with a particular focus on opportunities offered by digital technologies.
- On 15 June, the IEA contributed with insights on digitalisation and 3DEN at the webinar on connectivity, computing power, digital infrastructure and domain integration: Building the digital backbone of the smart city, as part of the Forum Europe's Conference The Future City: The Core of the Green and Digital Transitions in Europe.
- On 22 June, the IEA presented on how to improve access to clean energy services at the side event of Ministerial Thematic Forums for the High-Level Dialogue on Energy, organised by the ITU on International Standards and Sustainable Green & Innovative Power Solutions to Bring Broadband Internet Connectivity to Rural and Remote Areas.
- In order to strengthen the message around the importance of digitalised power systems for energy security, 3DEN also contributed to the IEA commentary The world's electricity systems must be ready to counter the growing climate threat, published on 12 July.
- 3DEN also participated in the Vienna Energy Forum on 6 July, intervening in an event organised by the ITU on Unlocking the potential of digital technologies for a sustainable energy transition.
- The AI World Congress 2021, gathering an international audience and held in hybrid mode in Busan and virtually on 2 September, represented an opportunity to disseminate the key messages around digitalisation and the role of cities to a broader audience.
- A commentary Distributed energy resources for net zero: An asset or a hassle to the electricity grid?, published in September 2021.
- In September, the IEA produced a blog entry focusing on smart charging for Economist Intelligence Unit.
- The IEA also intervened in and moderated the World Climate Forum Asia at Ecosperity Week panel on building climate resilience and innovation for decarbonised infrastructure, aired on 30 September.
- A chapter in Development Co-operation Report 2021: Shaping a Just Digital Transformation: Chapter 19, Bridging energy gaps with digital solutions.
- As part of the G20 cities report dissemination efforts, the IEA participated in a discussion on urban emissions, impacts and vulnerabilities as part of a post-pandemic green recovery approach, at the Innovate4cities conference, on 12 October.

- On 27 October, the IEA participated in the webinar by the Global Smart Energy Federation and the International Smart Grid Action Network TCP, “System Challenges and Opportunities in Electric Vehicle Integration with the Grid”, with a keynote contribution to global knowledge exchange on the topic. This event represented an opportunity to strengthen engagement with major international smart grids initiatives.
- The IEA also actively participated in COP26 side events, namely on energy transitions for 1.5 °C, scaled and enabled by energy efficiency, innovation and digitalisation, and on the launch of Mission Innovation Cities Mission on 9 November.
- On 11 November, the IEA co-organised a side event at COP26, led by the ITU, with UNFCCC and the UN Industrial Development Organization, on Unlocking Net Zero in Cities through Sustainable Digital Transformation and Innovative Solutions.
- 3DEN analysis also fed into the Energy Efficiency 2021 market report, published in November, which saw one-third of its content specifically looking at how digitalisation can increase the scale of energy efficiency and how digital energy efficiency can contribute to support clean energy transitions, including by supporting demand-side flexibility.
- Finally, on 1 December, at the Users TCP Academy, the IEA presented recent analysis from the Energy Efficiency Market Report 2021, including a focus on digitalisation, which gathered interest and questions from the audience.

CETP contribution to IEA flagship analysis

Many major IEA publications have benefited from improved data, analysis and collaboration with priority countries and other emerging economies. The CETP directly supported various IEA flagship analytical products released in 2021, including (in alphabetical order):

- Air quality and climate policy integration in India
- Clean energy transitions in the Sahel
- Climate Impacts on Latin American Hydropower
- Climate Resilience Policy Indicator
- Electricity Security including Power Systems in Transition
- Empowering Cities for a Net Zero Future: Unlocking Resilient, Smart, Sustainable Urban Energy Systems
- Energy Efficiency 2021
- An Energy Sector Roadmap to Carbon Neutrality in China
- Energy Technology RD&D Budgets database
- Enhancing collaboration between multilateral initiatives
- Evolving ESCOs in China
- Expanding the global reach of the TCPs in 2021
- Global Hydrogen Review 2021
- Hydrogen in Latin America
- India Energy Outlook 2021
- Net Zero 2050 Global Energy Sector Roadmap
- Patents and the Energy Transition
- The Potential Role of Carbon Pricing in Thailand's Power Sector
- Recommendations of the Global Commission on People-Centred Energy Transitions
- Renewables 2021
- Renewables Integration in India
- The Role of China's ETS in Power Sector Decarbonisation
- Southeast Asia can reach clean energy targets by investing in transmission
- Sustainable Recovery Tracker
- Thailand power system flexibility
- Unlocking the Economic Potential of Rooftop Solar PV in India
- World Energy Outlook 2021

The CETP has also supported numerous online articles and commentaries mentioned above.

Acronyms and abbreviations

3DEN	Digital Demand-Driven Electricity Networks
ACCA21	Administrative Centre for China's Agenda 21
ACE	ASEAN Centre for Energy
AFD	French Development Agency
AGNIi	Accelerating Growth of New India's innovations
APEC	Asia-Pacific Economic Cooperation
ASCOPE	ASEAN Council on Petroleum
ASEAN	Association of Southeast Asian Nations
BEE	Bureau of Energy Efficiency
C3E	Clean Energy Education and Empowerment
CAF	Development Bank of Latin America
CCUS	carbon capture, utilisation and storage
CEEW	Council on Energy, Environment and Water
CEM	Clean Energy Ministerial
CETP	Clean Energy Transitions Programme
CGEE	Centre for Strategic Studies and Management
CO_2	carbon dioxide
CONUEE	Energy Efficiency Commission
COP26	26th Conference of the Parties
CSTEP	Center for Study of Science, Technology and Policy
DMRE	Department of Mineral Resources
EBP	Energy Big Push
EBTKE	Directorate General of New and Renewable Energy and Energy Conservation
ECC	Environment and Climate Change
ECLAC	Economic Commission for Latin America and the Caribbean
ECOWAS	Economic Community of West African States
EESL	Energy Efficiency Services Limited
EGAT	Electricity Generating Authority of Thailand
EPE	Energy Research Office
EPPEI	Electric Power Planning & Engineering Institute
EPRI	Electric Power Research Institute
ESCO	energy service company
ETS	emissions trading scheme
EV	electric vehicle
FGD	focus group discussion
FGN	Federal Government of Nigeria
FYP	Five-Year Plan
GEF	Global Environment Facility
GHG	greenhouse gas
IAEA	International Atomic Energy Agency
ICAP	International Carbon Action Partnership

IDB	Inter-American Development Bank
IEA	International Energy Agency
IIASA	International Institute for Applied Systems Analysis
IMF	International Monetary Fund
ISUW	India Smart Utility Week
ITU	International Telecommunication Union
JODI	Joint Organisations Data Initiative
KAS	Konrad-Adenauer-Stiftung
MEE	Ministry of Ecology and Environment
MEMR	Ministry of Energy and Mineral Resources
MENA	Middle East and North Africa
MME	Ministry of Mines and Energy
MNRE	Ministry of New and Renewable Energy
MOST	Ministry of Science and Technology
MPE	Ministry of Petroleum and Energy
MSMEs	micro, small and medium-sized enterprises
MSW	municipal solid waste
NEA	National Energy Administration
NITI	National Institution for Transforming India
OECD	Organisation for Economic Co-operation and Development
OLADE	Latin American Energy Organization
OVP	Office of the Vice President
PASA	Petroleum Agency of South Africa
PAT	Perform, Achieve, Trade
PLN	State Electricity Company Perusahaan Listrik Negara
PV	photovoltaic
R&D	research and development
RD&D	research, development and demonstration
SANEDI	South African National Energy Development Institute
SDG7	Sustainable Development Goal 7
SEAD	Super-efficient Equipment and Appliance Deployment
SENER	Energy Secretariat
SICA	Central American Integration System
SINOVIK	National Public Service Innovation Competition
TCP	Technology Collaboration Programme
TGO	Thailand Greenhouse Gas Management Organisation
UK	United Kingdom
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WMO	World Meteorological Organization

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