Climate Compatible Growth

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Training Energy Modellers to Support Climate Transition in LMICs: Lessons from a decade of experience

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Summary

Energy system modelling has become central to discussions on developing sustainable systems, supporting both energy access expansion and the global energy transition. The upcoming G20 Global Energy Planning Coalition only exemplifies the importance of this. Low- and Middle-Income Countries (LMICs) face particular challenges in developing technical capacity to conduct their own transition planning. The OpTIMUS Community, in partnership with CCG, has accumulated more than a decade of experience of international collaboration around the design and implementation of capacity-building programmes for energy modellers. This brief reflects upon the lessons learned from this experience, as well as some of the latest innovations in process, to distil a set of ten principles for good practice. These principles are of broad interest and application and can help to ensure that future capacity-building efforts are accessible to participants, sustainable over time, and impactful in their delivery. They cover all aspects of capacity building from curriculum content and technical tools and data to progressive skills-building and certification, community support, targeted training, and international cooperation.

Key Policy Recommendations

- To make capacity-building programmes as accessible as possible, build them around open source and open access tools and data, incorporate analysis of live policy issues from participants' home countries, and adopt simple, user-friendly software interfaces
- To ensure that capacity-building efforts are sustainable, develop progressively more demanding curricula which incorporate incentives for skills development, provide continuing support through community networks, and train trainers, including academics who can integrate models into university curricula for the longer term.
- To increase the impact of capacity building, ensure that training is targeted towards the right people at the right time, that policymakers and academics are trained side by side to strengthen the science–policy interface, and leverage technical, human, and financial resources from across the international community.

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Introduction

In the pursuit of sustainable energy systems, energy system modelling has become a critical input. Such models are invaluable for simulating alternative energy futures and identifying scenarios that can meet both development and decarbonisation objectives at least cost. Almost every country now incorporates scenarios developed by such models into their Long-Term Strategies and decarbonisation plans. In response to this demand, international organisations, academia, and the private sector have significantly increased the number of energy models available worldwide. However, uptake of such models in Low- and Middle-Income Countries (LMICs) can be challenging due to lack of technical capacity, paucity of data, and limited access to software and information infrastructure. Going forward, the G20 Global Energy Planning Coalition aims to further support this uptake, with a large emphasis on capacity building in energy systems modelling.

Best Practice Principles

CCG, building on almost a decade of experience from the members of the OpTIMUS Community, has spent the last five years developing a distinctive partnership-based approach to capacity building that ensures accessibility, sustainability, and impact [1]. Based on this experience, the following best practices emerge from reflection as being essential for effective and efficient energy modelling capacity-building in LMICs. These 10 principles draw extensively on past experience, while at the same time continuously shaping future practice. They may be particularly relevant to consider at a time when the international community is poised to scale-up capacity-building efforts.

1. Use open source and open access tools and data.

CCG's capacity-building programmes are anchored in an ecosystem of open source modelling tools (such as MAED, OnSSET, OnSTOVE, OSeMOSYS, CLEWS, FinPlan, FlexTool, among others) that have been developed

OpTIMUS: The Open Tools, Integrated Modelling and Upskilling for Sustainable Development (OpTIMUS) Community is a global community of practice which aims to advance open source software, knowledge development, and capacity building for modelling tools for sustainable development. Members include international organisations and academic institutions such as the Abdus Salam International Centre for Theoretical Physics (ICTP), Energy Sector Management Assistance Program, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), International Atomic Energy Agency (IAEA), International Energy Agency (IEA), International Renewable Energy Agency (IRENA), KTH Royal Institute of Technology, Loughborough University, Open University, Simon Fraser University, Sustainable Energy for All (SEforALL), UK aid, United Nations Department of Economic and Social Affairs (UN DESA), United Nations Development Programme (UNDP), United Nations Economic Commission for Africa (UNECA), University of Cambridge, University of Oxford, World Bank Group (WBG), and the World Resources Institute. Climate Compatible Growth is also a member of this initiative.

over the years by a variety of different partners. These include universities, such as KTH Royal Institute of Technology (Sweden), and international organisations, such as IAEA, IRENA, and UNDESA. The use of open source modelling tools brings a wide range of benefits [2], with many tools now being considered as effective as their costlier commercial counterparts [3]. Moreover, in the context of LMICs, the fact that these tools can be freely accessed removes a major financial barrier associated with proprietary software. This ensures that trainees can continue to make use of the software when they return to their home institutions and ultimately develop their own adaptations of the open source code.

Open source models are particularly powerful for capacity building when combined with open access data. CCG has developed Starter Data Kits, covering some 70 countries, which compile all relevant model input data from a wide variety of publicly available datasets published by a swathe of international organisations. This means that trainees can get started straightaway with a version zero model that generates preliminary results almost immediately based on these initial data. There is evidently always scope for trainees to question and improve the initial data provided, based on more updates or accurate national sources of data to which they may have privileged access. Such validation and enhancement of input data is highly desirable and an important part of the training process. Nonetheless, the possibility of getting started so quickly is very rewarding and motivating for participants.

2. Make practical exercises directly relevant to the country context

Capacity-building activities often rely on generic or abstract practice cases on which trainees hone their skills. However, based on CCG's experience, the outcomes of capacity-building activities are much richer when the participants apply their own knowledge in practical exercises that address real and topical policy challenges from their home countries. At Energy Modelling Platforms (see Principle 3 for more details), students are required to choose a concrete practical application for their chosen modelling tool that is directly relevant to their work. Drawing on Starter Data Kits, enhanced by customised data that they bring from their own countries, students receive individual guidance to develop model scenarios that can shed light on the policy questions that motivate their learning. Students' vested interest in the issues they analyse provides a powerful motivation and also ensures the exercise will be useful for them upon their return to work.

3. Keep teaching material and tools as simple and accessible as possible

In conducting capacity building in LMICs, it is vital to keep the teaching material and tools as simple as possible, given that many institutions and practitioners lack access to adequate hardware, up-to-date software, or sophisticated practices. For instance, even packages like Moodle, which are widely used to share teaching materials, are not necessarily accessible to institutions in LMICs, and simpler vehicles for disseminating materials – such as PowerPoint presentations and PDF files – often work better.

Many modelling tools are code based (for example using Python) and require the user to have extensive coding skills. In LMICs, it is far less common for technical experts, such as energy professionals, to also be proficient in coding. As a result, it is best to avoid tools which require extensive skills in coding and instead use tools that incorporate user-friendly interfaces to make the modelling exercise easier. This enables practitioners to start using tools much sooner than if they also had to develop coding proficiency. User interfaces also make it much easier to pass on modelling skills

to others, thereby contributing to a virtuous circle of capacity building. To aid this, CCG developed ClicSAND for supporting OSeMOSYS uptake [4], and UNDESA has developed MUIO, a model user interface for OSeMOSYS [5] and CLEWs uptake.

4. Provide progressive capacity-building interventions

In LMICs, it is important for capacity-building programmes to be progressive and sustained. Short-lived, one-off capacity-building interventions are unlikely to be very fruitful in contexts where trainees may lack access to further technical support or learning resources, posing significant risks that acquired knowledge may rapidly erode. CCG's capacity-building programmes have gradually built up to offer several distinct stages of skills development.

First, students can acquire foundational skills in energy modelling tools and analytical methodologies through self-administered online courses offered through the OpenLearn Collection (OLC), which is hosted by the Open University. These courses are designed to provide both theoretical knowledge and basic hands-on experience with modelling tools. As of June 2024, there are 16 courses on offer in English, with a growing number being translated into Spanish and French. International partners such as the World Resources Institute, Sustainable Energy for All, and Politecnico di Milano have contributed by adding their energy modelling courses to the collection. Some 1,520 students have completed courses and certificates have been awarded across a variety of countries, mainly Africa and Asia (**Figure 1**).

Second, students who successfully complete courses on the OLC can apply for places to pursue further training at the *Energy Modelling Platforms* (EMP). The first EMP was first conducted in 2011 at the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy. Since 2021, CCG has led the operational aspects of the EMP, organising ten EMP events in three different regions (Africa, Latin America, and Europe) and training over 600 individuals (mainly from Africa: see **Figure 2**). A regional EMP for Asia-Pacific will be added in 2025. Across different events, training has been offered in 12 different modelling tools, of which by far the most popular have been OSeMOSYS and CLEWS (**Figure 3**). Participation is free of charge, with costs being

Figure 1: *Geographical distribution of OpenLearn Collection certifications*

Figure 2: *Geographical distribution of Energy Modelling Platform participants*

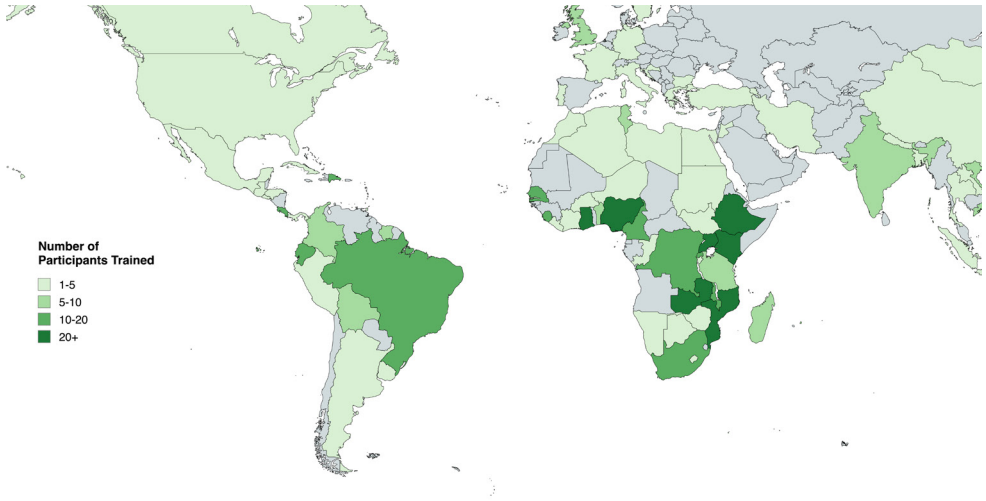
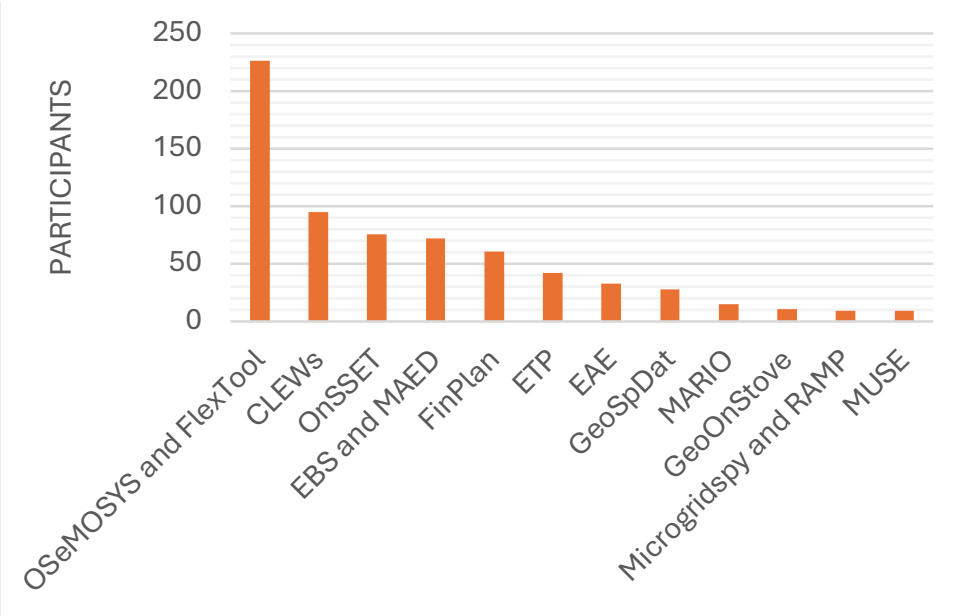


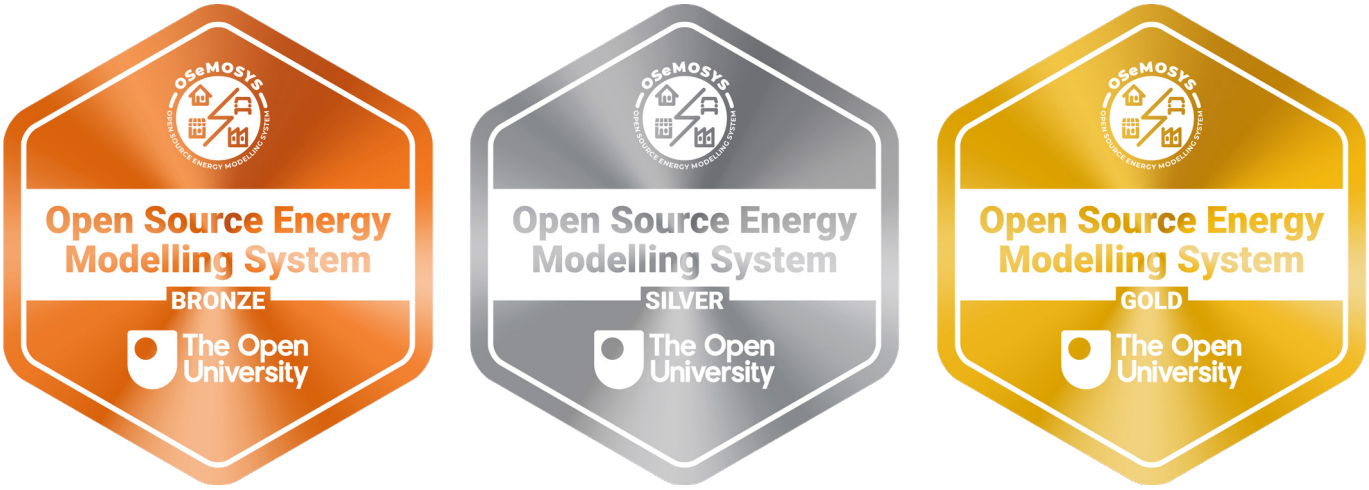
Figure 3: *Distribution of Energy Modelling Platform participants across tools*



covered by CCG and co-funders (such as the World Bank Group, the International Energy Agency, and 2050 Pathways Platform). EMPs provide the opportunity for trainees to deepen their knowledge of the chosen modelling tool over a period of three weeks, with the first week being online and the second two weeks being conducted in-person. Training takes place in relatively small groups with low student–teacher ratios, and trainees get significant one-on-one time with instructors. By the end of the EMPs, trainees have acquired the ability to work independently using the modelling tool for decision support.

Third, the planned introduction of a new certification system of LinkedIn badges issued by the Open University will both ensure that trainees' skills can be formally recognised and identified and provide incentives for continued

Figure 4: *Illustration of planned Open University LinkedIn badges certifying progressive technical proficiency*



skills development. Participants successfully completing the EMP would qualify for a bronze badge and would be able to earn silver and gold badges, designating higher levels of proficiency, by working towards additional goals such as the publication of a paper based on the use of the modelling tools (see **Figure 4**). A trainee's eligibility for higher grade badges is to be rigorously determined by established experts in the field, and support for continued skills progression will be provided through the Energy Modelling Community (EMC) (see Principle 5, below).

5. Sustain capacity-building support via community networks

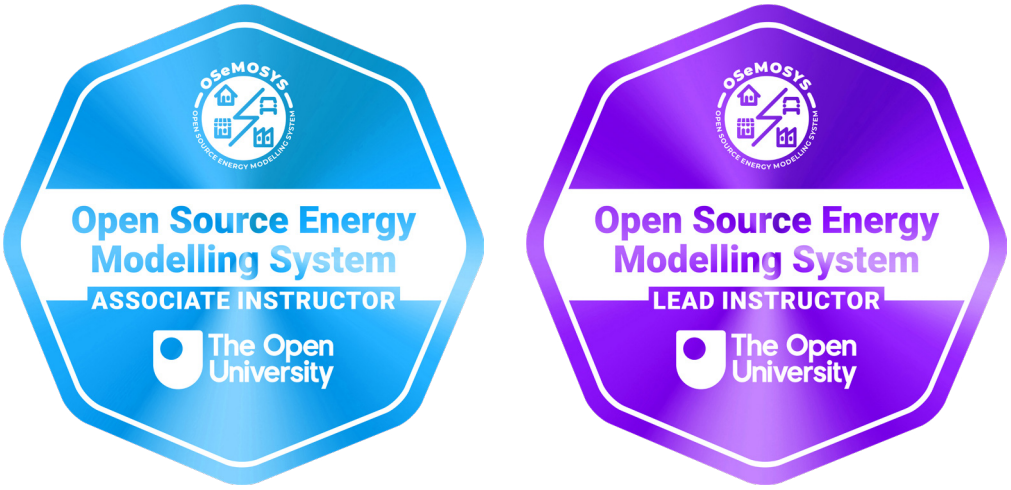
Despite reporting high levels of satisfaction with the EMP, students have noted that, up to now, there has been no continuing capacity-building support beyond the in-person training. This has led to the recent launch of the *Energy Modelling Community* (EMC), which aims to provide sustained technical support to EMP alumni and the wider modelling community. This support is being offered via an ongoing programme of monthly online interactions that include troubleshooting clinics, training sessions, technical webinars, and wider professional development opportunities. The idea is that this ongoing accompaniment will help alumni to avoid skills erosion and provide them with further opportunities to build skills, which will be further incentivised within the certification framework provided by the new Open University LinkedIn badge system (outlined in Principle 4). An important objective of the community is to broker peer-to-peer support by creating a strong network among practitioners.

6. Adopt a train-the-trainer approach

As capacity-building programmes mature, it becomes increasingly feasible and desirable to shift towards a train-the-trainer approach. Trainers can identify alumni who are both technically capable and possess good teaching skills, and invite them back as supporting instructors. This can be a particularly effective way to increase skills retention and promote the spread of knowledge. With more trainers available locally, the need for support from outside institutions decreases, and the potential longevity of the benefits increases. This approach has been validated by many international organisations, such as the IAEA, which has had a dedicated train-the-trainer programme for several years.

CCG has increasingly called upon its EMP alumni to support lead trainers in subsequent capacity-

Figure 4: *Illustration of planned Open University LinkedIn badges certifying progressive proficiency as a trainer*



building events and aims to formalise this process going forward. There will be LinkedIn badges, certified by the Open University, as part of a rigorous process for alumni to become trainers, initially as supporting instructors then progressing to lead instructors (see Figure 5). The badges will also provide a publicly recognised accreditation that clearly indicates the availability of teaching capacity in the Global South, thereby removing reliance on external trainers and promoting South–South collaboration for capacity building.

7. Embed skills in academic institutions for longer-term sustainability

Capacity-building events, especially those provided by international organisations, are typically targeted at the ministry level, supporting representatives of energy planning units or equivalent. The issue with this approach is that, very often, due to government turnover, the technical staff involved also change. This leads to knowledge drain and may force capacity building to start afresh with new personnel. To avoid this problem, or at least to ensure a higher level of knowledge retention within a country, it is ideal to incorporate academic institutions in capacity-building strategies from the start. Since universities are not subject to the same political churning of personnel, acquired skills will remain embedded in a country for the long term, and government's can continue to benefit as the science–policy interface is simultaneously strengthened (see Principle 8). Furthermore, as universities are institutions of higher education, training academics also opens the possibility of enriching university curricula. This ensures that skills development is sustained and becomes mainstreamed into future generations of locally trained professionals, thereby reducing reliance on external expertise. CCG has observed that academic alumni of the EMPs spontaneously began to integrate modelling tools into local master's degree programmes. For example, at Makerere University Business School, in Kampala, Uganda, OSeMOSYS and MAED have been incorporated in Master's and PhD programmes. This prompted the development of the Flatpack initiative, which actively promotes and supports the integration and embedding of open source energy modelling tools into graduate curricula in LMICs. Strathmore University in Kenya has been the first to successfully complete a Flatpack process.

8. Train the right people at the right time

The longevity of skills acquired through capacity building depends on the extent to which trainees have opportunities to apply these skills

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relatively quickly in their everyday professional work. To maximise impact, capacity building should therefore be targeted towards people who have a concrete need to make use of the acquired skills, at a time when these skills are of immediate relevance to them. For example, if the Ministry of Energy in a country is expected to deliver an energy transition plan in the following year, targeting their energy planning unit for capacity building can be ideal for knowledge retention and use. This is because the team will actively use their new knowledge in creating the product, and they will also be equipped to conduct future revisions and updates of the plan. An illustration of this was CCG's recent collaboration with the IEA in Uganda to provide capacity-building support to the team in the Ministry of Energy charged with developing Uganda's Energy Transition Plan, which was launched at COP28 in Dubai.

This experience has prompted CCG to develop the concept of 'bootcamps'. These offer the opportunity for teams of professionals from a particular country to attend EMPs with the specific goal of training for the skills they need to deliver a particular timebound piece of analytical work. Teams are allocated a 'coach' who works with them before, during, and after the EMP training to support them in the delivery of their output. This can be for periods ranging from 6 to 24 months, and it could entail participation

in multiple EMPs. Such teams could be made up of policymakers needing to develop a high-profile policy document or academics aiming to produce an important piece of academic research. Teams could be put forward directly by the countries themselves or through the facilitation of international organi-sations under technical assistance programmes.

9. Training policymakers alongside academics

In many LMICs, there can be a disconnect between technical expertise available within local universities and government policymaking circles. This can make government over-reliant on external advice and represents a missed opportunity to capitalise on local knowledge. Nevertheless, there can be real communication challenges between both sides, with scientists often struggling to communicate technical analysis in clear and simple language, and policymakers lacking the foundational proficiency to engage in such discussions. These issues are further exacerbated in areas, such as climate transition, where inter-disciplinary collaboration is required.

To overcome these issues, CCG has aimed to ensure a good mix of policymakers and academics at EMP events, with a typical split of roughly one-third policymakers and two-thirds academics. Under ideal circumstances, academics and policymakers from the same country attend simultaneously, which increases the probability of subsequent collaboration. However, as long as there is representation from both categories within the study groups, there is scope for dialogue to take place (both formally and informally), for different perspectives to emerge, and ultimately for both groups to learn to speak the same language. Two features of CCG's capacity-building programmes are particularly helpful in this regard. First, all students are required to take an OLC course on political economy before attending EMPs, which helps raise awareness of the political dimension of their work. Second, all students must develop their communication skills by making a succinct, high-level presentation of their policy issue, modelling results, and the practical implications to the entire assembly of students and instructors at EMPs.

10. Cooperate with like-minded organisations to the fullest extent

In supporting capacity building in LMICs, it is important to acknowledge that there are several organisations, with various models, that conduct such activities. They range from international organisations and NGOs, to northern-funded research programmes/projects. When navigating such a congested space, it is important to cooperate and not compete. Very often, organisations will benefit from each other by coming together and conducting capacity-building activities and exercises. CCG has acted in a cooperative manner since its inception, partnering with all relevant institutions where possible and conducting capacity-building jointly.

The EMP is precisely a platform that provides a shared space for a wide range of partners to contribute to capacity-building efforts based on their respective comparative advantages. Some partners contribute by providing modelling tools (such as IAEA and IRENA), others by sending instructors (such as the World Resources Institute, Politecnico di Milano, etc.), and others by providing infrastructure (ICTP, UNECA) or funding student participation (such as World Bank and 2050 Pathways Platform). Integrating all these efforts allows the whole to become more than the sum of its parts.

Conclusion

The capacity-building actions recommended in this policy brief are based on many years of learning and practice. Throughout this period, they have proven effective in ensuring that capacity is built in a sustainable manner. They are also contributing to the development of various capacity-building innovations that are designed to further amplify the application of the principles. Such principles may offer useful guideposts as the G20 works towards establishing a global coalition to advance energy planning for the climate transition through intensified capacity-building efforts.

In summary, the principles help promote the accessibility, sustainability, and impact of capacity-building programmes. Principles 1–3 promote accessibility through the use of open source tools and Starter Data Kits, the incorporation of practical exercises of immediate policy relevance to each student's country context, and the adoption of simple, user-friendly tools that do not presuppose coding expertise. Principles 4–7 promote sustainability by creating a structure for the progressive development of skills, supported through an ongoing community network, and focusing on training trainers who are embedded in local institutions of higher education. Principles 8–10 enhance impact by ensuring that training is targeted to the right people at the right time, that the science–policy interface is strengthened, and that international partners work together to leverage each other's strengths. While certainly not exhaustive, these principles are considered vital in any capacity-building effort within the current energy transition landscape.

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