

NET ZERO WORLD INITIATIVE

Accelerating Global Energy System Decarbonization

COP28 Outcomes Report

EXECUTIVE SUMMARY

Angela Ortega Pastor (NREL), Ashley Books (DOE), Naim Darghouth (LBL), Dan Gaspar (PNNL)



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Net Zero World COP28 Outcomes Summary

Net Zero World, launched at COP26, is a flagship U.S. effort to partner with countries in accelerating transitions to clean energy systems. This initiative brings together world-class experts and resources from 10 U.S. Department of Energy national laboratories and nine U.S. government agencies. Collaboratively, they work with technical and government representatives from Argentina, Chile, Egypt, Indonesia, Nigeria, Singapore, Thailand, and Ukraine to advance decarbonization in these economies.

The initiative leverages energy and sectoral modeling to strengthen partners' national net-zero plans and policies, offering essential information to achieve clean energy and climate targets. Net Zero World collaborates with in-country teams for concrete actions that amplify the program's impact through several priority energy decarbonization actions.

Beyond technical assistance, Net Zero World partners with countries, U.S. government investment agencies, multilateral development banks, and other organizations to technically de-risk projects, aid in financing instrument design and implementation, and connect projects with investors. The goal is to mobilize \$10 billion in investment by 2025.

The supporting network includes leading philanthropies like Breakthrough Energy, Rockefeller Foundation, Global Energy Alliance for People and Planet, Bloomberg Philanthropy, ClimateWorks, and Marc and Lynne Benioff. Additionally, Net Zero World collaborates with international partners such as the World Bank, Asian Development Bank, Inter-American Development Bank, European Bank for Reconstruction and Development, German Corporation for International Cooperation, International Atomic Energy Agency, and the International Energy Agency.

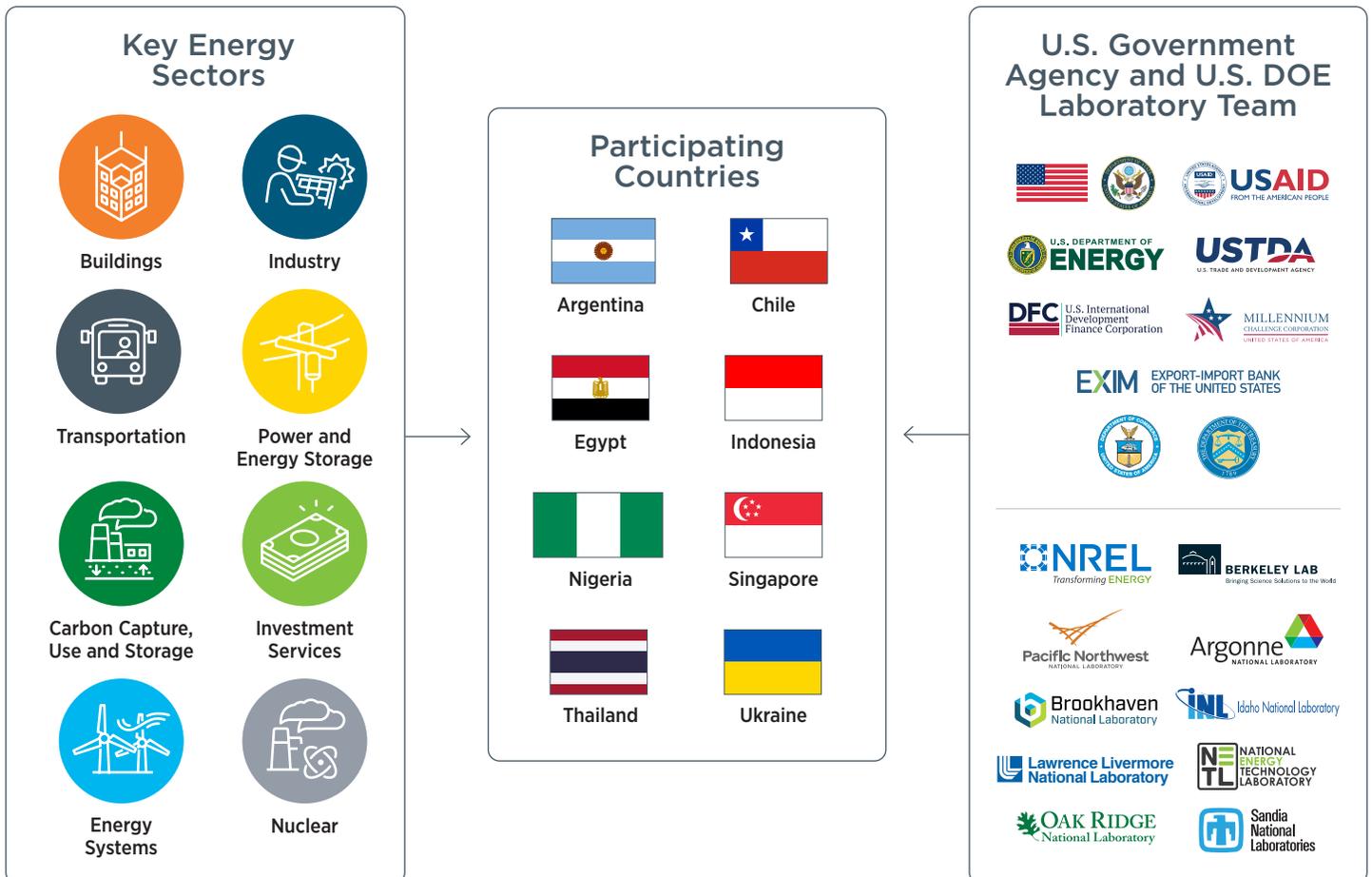


Figure 1. Key Sectors, Partners, and Cross-Lab Team

Our Progress

Net Zero World has been actively involved in energy-sector wide modeling, technical cooperation on country implementation actions, and investment mobilization actions, to assist partner countries in enhancing their net-zero strategies. These models, which simulate how energy is produced, distributed, and used, help assess the impacts of various energy policies and technologies.

Our Modeling in Action:

- In **Indonesia**, energy modeling supported the development of plans to transition from coal power and shaped the Just Energy Transition Partnership (JET-P) plans.
- In **Nigeria**, specialized energy modeling, using the [Low Emissions Analysis Platform](#) (LEAP) and the [Global Change Analysis Model](#) (GCAM), is being utilized to plan changes in the electricity and transportation sectors and inform potential carbon market designs.
- In **Chile**, LEAP and GCAM models provided crucial data for electrification planning, emission reduction, and evaluation of air quality and job benefits linked to these changes.
- In **Ukraine**, [TIMES](#)-Ukraine and [GCAM](#)-Ukraine models contributed to enhancing the National Energy and Climate Plan, highlighting opportunities across various sectors and technologies to accelerate clean energy transitions.

Advancing Priority Actions:

- Collaborating with Tocopilla, **Chile**, to repurpose over 400 MW of retired coal plants into new clean energy systems and promote economic growth.
- Working with **Indonesia** on a national roadmap to identify clean energy alternatives for coal-dependent industries, with a focus on low-carbon battery manufacturing and electric vehicle applications.
- Partnering with **Nigerian** distribution utilities on pilot projects to demonstrate the benefits of and develop methods for scaling up distributed renewable energy.
- Collaborating with **Singapore** on subsea interconnections to enhance regional energy connectivity and facilitate the integration of clean energy.
- Assisting **Ukraine** in deploying distributed renewable energy and storage systems for critical infrastructure and evaluating opportunities for modular nuclear energy systems to enhance system resiliency.

These examples are followed by a more detailed discussion in subsequent sections

Scaling up Investment:

Net Zero World has provided technical review and analytic support for Argentina's Energy Transition Plan and Energy Efficiency Policy, contributing to securing a \$350 million loan from the Inter-American Development Bank. In Indonesia, the initiative's

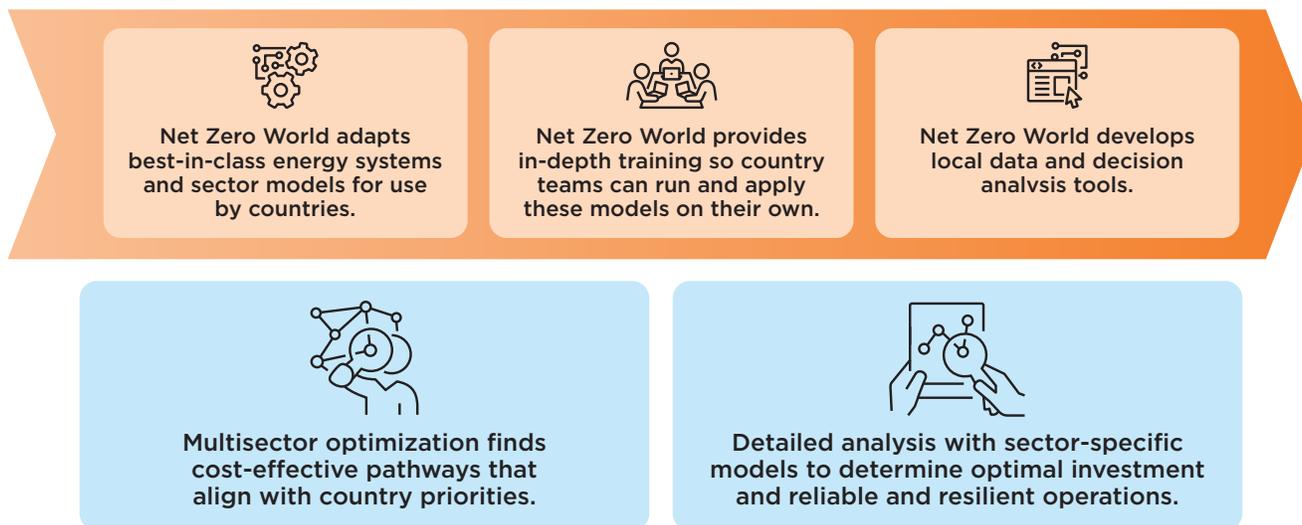


Figure 2. Net Zero World initiative is focused on ‘pathway modeling.’ This involves creating detailed roadmaps that outline how each country can transition to a sustainable energy system, linking these roadmaps to practical technology solutions and financial resources to make these transitions achievable and equitable.

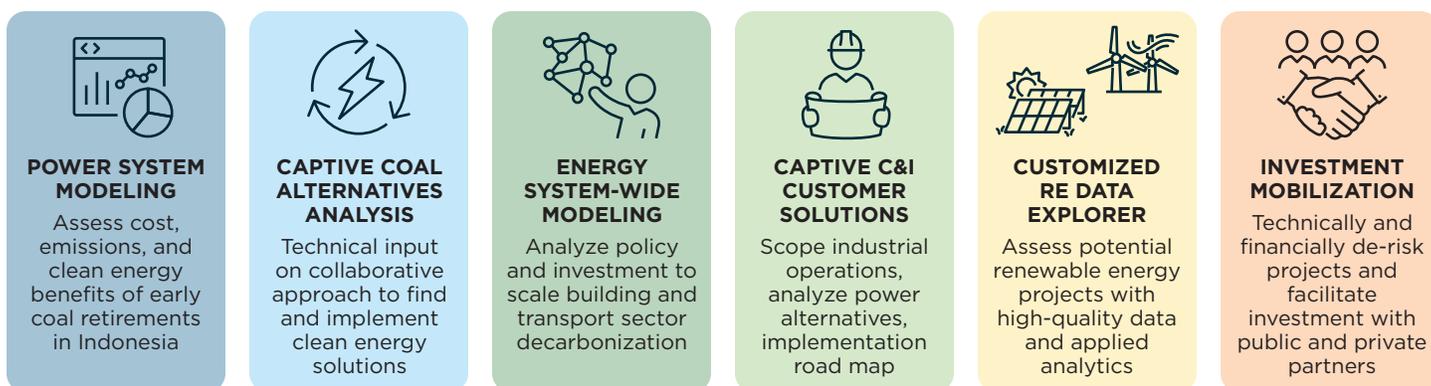


Figure 3. Net Zero World analysis, technical assistance, and decision support for Indonesia's JETP

work under the JETP's \$20 billion Comprehensive Investment and Policy Plan has informed targets for restricting captive coal use and integrating zero-emission solutions in captive power plants.

Net Zero World, in partnership with tQ Automation, a U.S. company, received funding for feasibility studies and designs to transform 500 MW of diesel plants in Indonesia into renewable systems, potentially attracting up to \$2 billion in investment for cleaner and more accessible electricity in remote island communities. In Chile, the initiative is aiding in mobilizing investment for renewable energy integration and district energy projects. These examples are followed by a more detailed discussion in subsequent sections.

Empowering the World's Energy Leaders:

Net Zero World has trained over 200 individuals across more than 30 institutions in partner countries, covering topics such as energy efficiency, energy system sectoral modeling, power and transportation decarbonization strategies, and strategies for just energy transition and economic development.

In May 2023, women leaders from government agencies in seven partner countries participated in the Climate Smart Women's Energy Leadership Program, a two-week training at Lawrence Berkeley National Laboratory and the National Renewable Energy Laboratory. They received instruction on power and storage systems, just transition, and building technologies, with ongoing mentoring and coaching from national lab staff. The participants developed and presented action plans tailored to their countries, proposing implementations of net-zero actions and expanding women's leadership in the clean energy transition.

Net Zero World's Strategic Approach to Investment Mobilization

- **Feeding into Financial Planning:** Conducting detailed studies to comprehend the costs, benefits, and risks of carbon emission reduction plans in energy systems. For instance, these studies have shaped a \$20 billion plan in Indonesia targeting coal use reduction in the power sector.
- **Leveraging Financial Tools:** Developing or improving financial instruments (like revolving loan funds), fiscal policies (such as tax rebates), and other mechanisms to generate capital for clean energy technology. For example, the initiative is informing the Energy Transition Fund in La Pampa, Argentina, potentially raising up to \$15 million for the fund.
- **De-Risking Projects:** Providing technical support for initial assessments, detailed studies, and design plans to reduce financial risks in clean energy projects. In Indonesia, feasibility studies and engineering designs are underway for small island mini-grid projects, aiming to mobilize up to \$2 billion.



Figure 4. U.S. Secretary of Energy Jennifer Granholm and Director of International Science and Technology Collaboration Maria DiGiulian pose with women from Net Zero World countries at the first Climate Smart Women's Energy Leadership program in May 2023.

Country Cooperation: Moving Toward Secure, Sustainable Futures



Who we work with:

Net Zero World is partnering with Argentina's Energy Secretariat within the Ministry of Economy, technical institutes, the Argentine Wholesale Electricity Market Clearing Company, and the provincial government of La Pampa.

What we do:

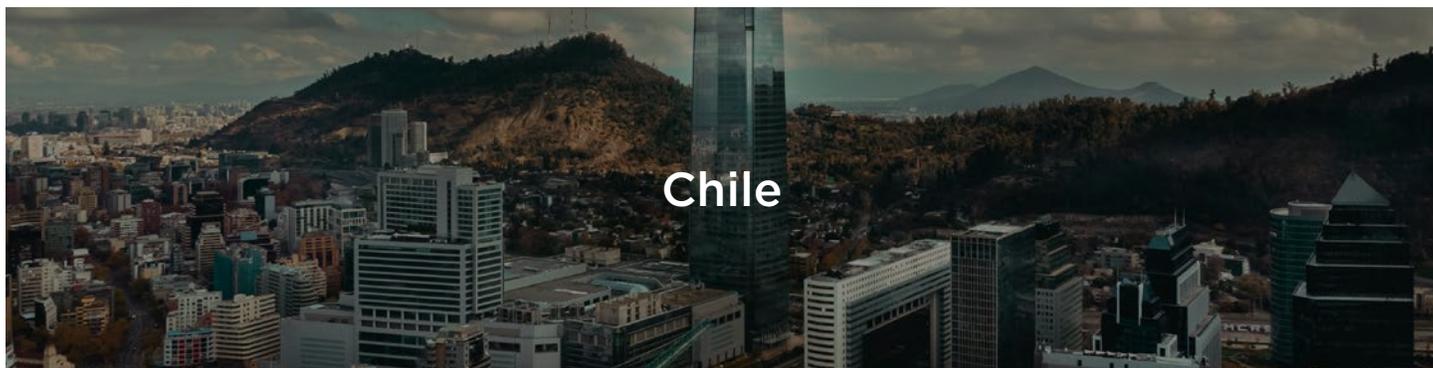
This partnership aims to support Argentina's efforts to achieve carbon neutrality by 2050, focusing on expanding renewable energy, enhancing energy efficiency in buildings, mapping carbon capture, utilization, and storage (CCUS) resources, and transforming energy policies and infrastructure. Net Zero World is supporting the Government of Argentina in using tools such as LEAP, MESSAGE, and Engage, for energy sector modeling to identify decarbonization pathways and investment opportunities. The initiative has identified cost-effective carbon emission reduction methods in Tierra del Fuego¹ and energy-saving measures² for schools in La Pampa. Additionally, Net Zero World is involved in analyzing carbon storage potential and supporting the identification of a carbon storage pilot project in Argentina.

¹ Reducing carbon emissions by 97% in Tierra del Fuego can be cost-effective for the province's power sector. This does not account for the costs of electrification of end uses nor possible increased cost of decarbonizing the mainland's power sector. Further analysis is recommended.

² Early findings indicate that schools in La Pampa can cut their gas usage by 50% to 70% and electricity use by 5% through simple energy-saving measures. These include better control of natural light, insulating walls and roofs, improving windows, sealing air leaks, and using more efficient heating systems.

What's Next:

- Co-developing models for renewable energy and grid capacity expansion to enable high penetration of low-emission generation technologies. This will increase Argentina's confidence in deploying up to 87% renewable energy under their ambitious 2050 energy transition strategy.
- Informing and supporting clean energy fund investments in energy efficiency, renewable energy, and grid infrastructure in La Pampa. This will attract additional financing and funds by de-risking and increasing the impact of La Pampa's existing energy transition revolving loan fund.
- Integrating power system planning into regional energy models to support energy transitions at the subnational level, such as in La Pampa and Tierra del Fuego. This will define the potential contribution of provinces to national energy transition targets at the distribution and transmission level.
- Strengthening national and subnational building energy codes, retrofit guidelines, and energy efficiency procurement programs. This could reduce energy consumption in new buildings by over 20% by 2030 and up to 50% by 2050.
- Supporting the development of CCUS storage resource assessments and associated cost curves to inform Argentina's national atlas and the development of concrete CCUS project proposals. This will create a replicable model and methodology for CCUS in Argentina to achieve net-zero carbon emissions by 2050.



Who we work with:

Net Zero World is collaborating with Chile's Ministry of Energy, other federal agencies, the City of Tocopilla, and various organizations.

What we do:

Net Zero World is working with Chilean partners using [LEAP](#) and [GCAM](#) models to guide energy sector strategic planning and decarbonization efforts. The initiative aims to help Chile meet its Nationally Determined Contribution goals, including peaking greenhouse gas emissions by 2025 and reducing black carbon emissions by 25% by 2030 from 2016 levels. The work focuses on strengthening Chile's power decarbonization plan, which includes phasing out coal by 2040, advancing the electrification of various sectors, and integrating renewable energy sources. Net Zero World is also identifying and piloting grid-enhancing technologies, in line with Chile's commitment to achieving greenhouse gas neutrality by 2050. This involves building awareness of advanced technologies (such as dynamic line rating) and regulatory changes to incentivize adoption and utilization.

A key area of focus is just transitions in coal-reliant communities like Tocopilla. Net Zero World is facilitating socially responsible project design and repurposing 400 MW of coal capacity for sustainable economic activities. This support includes technical exchanges with U.S. cities, tailored webinars, and community-based capacity building. Additionally, Net Zero World is contributing technical expertise to implement district energy systems, a crucial part of Chile's goal to connect 500,000 users to these systems by 2050.

What's Next:

- Furthering the use of models for long-term strategic planning, particularly in electrification and decarbonization, to improve Chile's national modeling capabilities. This incorporates cost-benefit analysis and local pollutant projections, enabling a more in-depth examination of decarbonization strategies and financial implications that can lead to new or adjusted planning and investment decisions.
- Quantifying potential energy and cost savings, emission reductions, and identifying financing models and regulatory frameworks for district energy projects. This analysis will optimize the costs, economic and environmental benefits, and performance of diverse district energy solutions across different climate zones in Chile and inform the development of local energy policies and investment programs.
- Building upon work in communities like Tocopilla, focusing on accelerating the shift from coal to net-zero technologies. Net Zero World's just energy transition work in Tocopilla emphasizes showcasing work retraining programs, net-zero technologies (including pilot program opportunities), and education. This will be replicable across other Chilean communities historically dependent on coal power generation.
- Developing solutions for integrating renewable energy more efficiently into the grid, with a focus on reducing curtailment through improved grid technologies. As Chile's power decarbonization progresses, grid expansion, typically spanning several years, becomes crucial. Through support to the government of Chile, new regulations could be developed to incentivize the adoption of grid-enhancing technologies in new transmission infrastructure to reduce renewable energy curtailment.



Who we work with:

Net Zero World is working with Egypt's Ministry of Petroleum and Mineral Resources and the Ministry of Electricity and Renewable Energy.

What we do:

Net Zero World is supporting Egypt's goals to reduce greenhouse gas emissions in the electricity sector by 37% by 2030 and in the oil and gas sector by 65%. A primary focus is developing an in-house modeling unit, comprising representatives from the Ministry of Petroleum and Mineral Resources, the Ministry of Electricity and Renewable Energy, and the Ministry of Planning and Economic Development. Supported by Net Zero World, this unit will enhance Egypt's capacity in energy modeling and strategy, aiding in expanding renewable electricity and adopting efficient, low-cost energy solutions. Additional activities involve energy sector-wide modeling and technical collaboration to advance the transition to renewable energy and explore carbon capture and storage options.

What's Next:

- Executing energy sector-wide modeling to support Egypt's transition to renewable energy. This will help the country meet its climate mitigation targets efficiently and cost-effectively.
- Continuing the development of the cross-ministry Egyptian modeling center, enhancing capacity for energy strategy and policy analysis. In-house modeling will enable Egypt to identify efficient and least-cost methods for meeting its climate goals.
- Conducting detailed analysis of carbon capture opportunities through enhanced oil recovery. This study will lay the groundwork for a model carbon management demonstration project in Egypt.



Who we work with:

Net Zero World is collaborating with Indonesia's Ministry of Energy and Mineral Resources, the National Development Planning Agency (Bappenas), the Just Energy Transitions Partnership, state-owned electricity company Perusahaan Listrik Negara, the Ministry of Public Works and Public Housing, the Institute for Essential Services Reform, and other relevant organizations.

What we do:

This partnership supports Indonesia's ambitious climate goals, including a 29% reduction in greenhouse gas emissions by 2030. Net Zero World is working with Indonesia on a national roadmap, announced by the White House, focusing on using domestically mined nickel to promote local low-carbon battery manufacturing and electric vehicle deployment. The initiative is collaborating with tQ Automation, a Texas-based energy service consulting company, in a public-private partnership. This involves transitioning island energy from diesel generators to clean community microgrids at five remote sites in eastern Indonesia, as part of the Just Energy Transitions Partnership. This project aims to replace 500 MW of diesel with clean energy alternatives and mobilize up to \$2 billion in clean energy investments.

What's Next:

- Advancing clean energy transition planning in coordination with the U.S. Agency for International Development to accelerate the integration of new renewable energy sources and support policy reforms under the JETP comprehensive investment and policy plan. This effort, identified as a priority by Presidents Biden and Widodo, is part of the U.S. and Indonesia's

Comprehensive Strategic Partnership and will evaluate coal phase-out scenarios, renewable energy pricing, and electrification modeling.

- Conducting analysis to support the development of Bappenas infrastructure development plans and organizing training on advanced modeling tools for local energy planners. Net Zero World modeling and training of local technical staff are crucial to ensuring analyses appropriately reflect Indonesia's island-specific and evolving energy landscapes.
- Developing a nickel-to-battery-to-electric vehicle roadmap, supporting the transition to electrified transportation, and fostering low-carbon technology adoption. This promotes the establishment of clean, high-value battery supply chains, aligning with JETP goals by meeting world-class environmental and labor standards.
- Concluding ongoing feasibility studies, mobilizing investment for deploying microgrids in five small island communities, collaborating with local and international stakeholders to finalize the national replication and scale-up roadmap, and beginning joint efforts to implement the roadmap. These actions will enhance investor confidence in deploying renewables in remote island environments and facilitate the sustained mobilization of finance.
- Advancing whole-building cooling recommendations for JETP investments and developing and implementing "train-the-trainer" programs for building energy efficiency. These efforts build upon prior Net Zero World work in Indonesia, contributing to energy efficiency and peak electricity demand reduction from cooling applications. Establishing local knowledge of building energy efficiency is crucial to ensuring sustainable outcomes and cultivating a robust ecosystem of trained experts.



Who we work with:

Net Zero World partners with Nigeria's newly-formed National Council for Climate Change, the Department of Climate Change within the Federal Ministry of Environment, and the Energy Transition Office. This collaboration also involves the Federal Ministry of Power, the Energy Commission of Nigeria, the National Upstream Petroleum Regulatory Commission, and local distribution utilities, aiming to accelerate Nigeria's progress towards its net-zero goal by 2060 and build confidence for raising its net-zero ambitions and timeline.

What we do:

Net Zero World provides energy modeling assistance and training, advances the deployment of distributed energy resources, and works to reduce methane emissions in the oil and gas sector. Collaborating with two local distribution companies—Abuja Electricity Distribution Company in Abuja and Ikeja Electric in Lagos—the program supports technical impact assessments for renewable embedded generation pilot projects. These projects aim to address challenges in evaluating, siting, and integrating renewable energy projects. As of November 2023, both companies have identified pilot project sites and procured suppliers, with launches planned within a year.

Net Zero World is also working with the Nigeria Upstream Petroleum Regulatory Commission to implement new methane mitigation guidelines for the oil and gas sector. The initiative provides training and technology assessment for detecting and fixing methane leaks and assists in designing and validating reporting frameworks. Plans are underway to collaborate more closely with local oil and gas operators next year, piloting and localizing leak detection, remediation, and methane reporting and verification technologies in the field.

What's Next:

- Utilizing system-wide modeling to support the evaluation of energy policies, with a focus on transportation decarbonization and transitioning to renewable and efficient energy use. This effort builds upon the preceding year's work, aligning directly with

Nigeria's expressed priority sectors and commitments to the White House's Net Zero Government Initiative.

- Advancing methane mitigation strategies and technology localization, including leak detection and remediation, with independent oil and gas producers to support Nigeria's low-carbon strategy. Fugitive emissions from the oil and gas sector are major contributors to Nigeria's energy sector emissions, and the government has prioritized methane reduction in this sector, as outlined in its Nationally Determined Contributions. Collaboration with the government of Nigeria, startups, large corporate and industrial consumers, and oil and gas producers will showcase and implement global best practices in technologies for mitigating oil and gas methane, accelerating the adoption of these critical technologies at scale.
- Embedding tools and capacity with local utilities to evaluate, plan, and integrate scaled distributed energy resources, including data collection, energy system management technologies, and advanced planning tools. This will enhance system planning and operations, prerequisites for scaled deployment of higher shares of variable renewable energy and other distributed resources such as battery energy storage, electric vehicles, and demand-side management technologies.
- Analyzing the economic and emissions impacts of various options for reinvesting savings from fossil fuel phase-out into sustainable energy projects, promoting energy independence, economic diversification, and equitable outcomes. This builds on a direct request from Nigerian government counterparts from late 2023.
- Significantly scaling partnerships with the private sector for technology piloting and localization, responding to clear demands from government and private sector actors for support in localizing decarbonization technologies—from technology benchmarking and performance metrics sharing to detailed technology assessments and in-situ field testing and piloting of new technologies such as BESS, on-site renewable power generation, electric vehicles, biofuels, and leak detection and remediation, and other methane mitigation technologies in the oil and gas sector.
- Launching collaborations at the subnational level, in light of the 2023 law empowering individual states to make policies and regulations for the generation, transmission, and distribution of electricity. Nigeria's 36 states will need support as they navigate a period of subnational energy sector reform. This includes supporting best practice-sharing and design for subnational power markets, integrated resource planning, and more.



Who we work with:

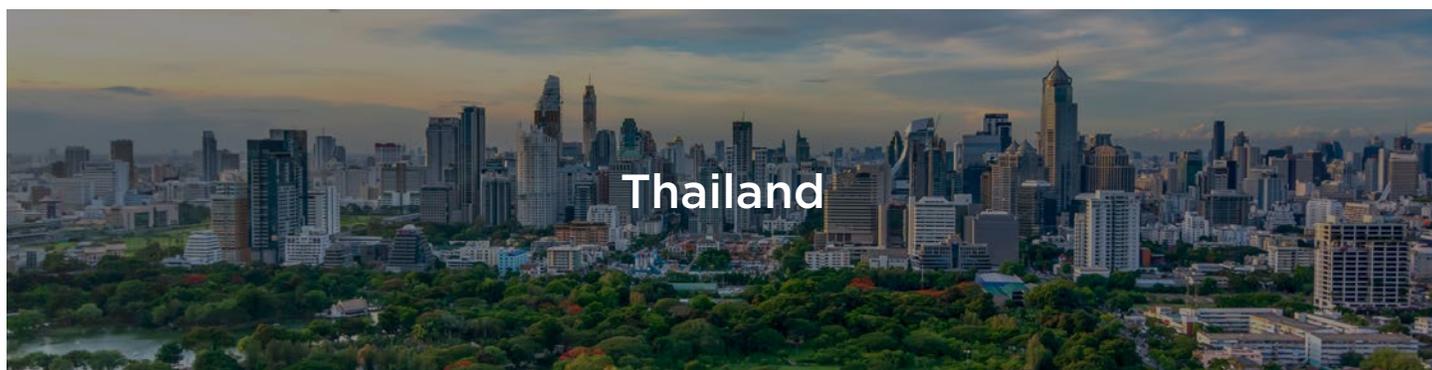
Net Zero World partners with Singapore's Ministry of Trade and Industry and the Energy Market Authority.

What we do:

Net Zero World supports Singapore's goals of peaking emissions by 2030 and striving for net-zero emissions in the latter half of the century. The collaboration focuses on the technical feasibility and cost of increasing regional power grid integration through long-distance subsea interconnections. Net Zero World has identified several factors to consider when siting an interconnection in the South China Sea, such as the risk of anchor strikes due to heavy shipping traffic and the need to avoid existing infrastructure and geologic hazards. The analysis suggests that risks can be mitigated with site-specific design and increased cable burial depth. The economic opportunity of an interconnected Association of Southeast Asian Nations region is significant, including job creation in renewable energy and interconnection construction and maintenance.

What's Next:

- Conducting an analysis of the renewable energy supply-demand landscape and grid infrastructure of the Association of Southeast Asian Nations (ASEAN) countries, considering potential additional subsea interconnections. This technical analysis will support regional interconnection planning, enabling increased renewable energy deployment and lowering energy costs across Southeast Asia.
- Coordinating with regional partners to conduct peer exchange and capacity building related to subsea interconnections in Southeast Asia. Enhancing understanding of the opportunities and challenges of subsea interconnections will facilitate regional dialogue and cooperation on grid connectivity.
- Assessing the necessary legal and governance frameworks, as well as financing arrangements needed for regional energy connectivity. Addressing legal and financial feasibility complements Net Zero World's technical feasibility assessments, moving project planning forward and aiding in the realization of these ambitious regional energy integration goals.



Who we work with:

Net Zero World collaborates with Thailand's Ministry of Energy, the Electricity Generating Authority of Thailand, and other key agencies and technical partners. This partnership supports Thailand's commitment to achieving carbon neutrality by 2050 and net-zero emissions by 2065.

What we do:

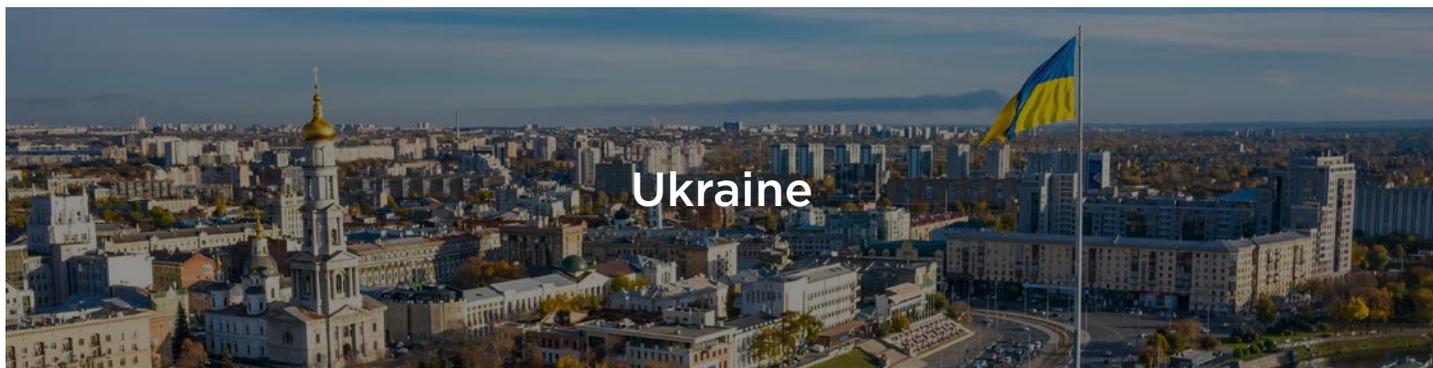
This collaboration focuses on improving energy and power system modeling, energy storage deployment and planning, and building energy efficiency. Net Zero World is enhancing institutional capacity in energy modeling with the Energy Policy and Planning Office, employing LEAP models to identify decarbonization strategies, particularly in the industrial sector. The initiative is also investigating the use of repurposed battery energy storage systems (BESS) to augment Thailand's renewable energy and electric vehicle charging capabilities, addressing technical and economic challenges in scaling up BESS adoption. As part of this effort, Net Zero World hosted a U.S. study tour on BESS safety and standards for Thai delegates, including visits to U.S. companies specializing in BESS systems that store large amounts of energy in fixed locations like



Figure 5. Figure 6. The Electricity Generating Authority of Thailand delegation visits B2U in Lancaster, CA, as part of a U.S. study tour on second-life BESS technologies.

What's Next:

- Strengthening energy sector-wide modeling to support Thailand's updated Nationally Determined Contribution goals, focusing on carbon neutrality by 2050 and net-zero greenhouse gas emissions by 2065. Enhancing the Energy Policy and Planning Office's capacity enables the Ministry of Energy to independently evaluate emerging technologies and policies that can support deeper decarbonization, especially in hard-to-abate sectors such as industry.
- Conducting power systems modeling to determine energy storage needs, with a particular interest in understanding how second-life BESS can address utility requirements. Planning for sufficient energy storage is vital for enabling a high renewable energy grid in Thailand.
- Providing technical and investment assistance to the Electricity Generating Authority of Thailand on the deployment of second-life BESS pilots and supporting longer-term BESS management planning. Successfully and safely deployed pilot projects will demonstrate the longer-term potential and de-risk investments in second-life BESS projects.
- Initiating stakeholder engagement with the Thai Housing Authority to evaluate the energy-, cost-, and emissions-saving potential from adopting efficient building codes and advanced building technologies in low-income housing developments. Collaboration with the Thai Housing Authority for highly efficient housing development can serve as a model for other developers in Thailand to adopt improved standards that lower emissions and increase comfort for residents.



Who we work with:

Net Zero World collaborates with Ukraine's Ministry of Energy, the Ministry for Communities, Territories and Infrastructure Development, and the Ministry for Environment and Natural Resources. The partnership supports Ukraine's goal of achieving net-zero emissions by 2050.

What we do:

Net Zero World focuses on transitioning Ukraine's energy sector from predominantly coal to a mix of renewables, nuclear, and biofuels. The initiative supports the deployment of distributed energy resources, including solar panels and energy storage, at critical sites like Merefya and Chortkiv. It conducts analysis to guide larger-scale distributed energy resource deployment and enabling policies. The program is also building capacity in nuclear energy, including training in emerging technologies such as small modular reactors and hydrogen/ammonia production. Additionally, Net Zero World supports the development of building energy efficiency programs to strengthen codes and standards and develop high-performance building pilot projects. These efforts contribute to Ukraine's National Energy and Climate Plan, offering insights into effective decarbonization strategies and supporting the country's reconstruction and alignment with the European Union's energy policies.

What's Next:

- Strengthening energy and climate plans with advanced modeling, including joint analysis for the National Energy and Climate Plan and sectoral strategies. This is essential for prioritizing actions to rebuild Ukraine's economy.
- Supporting renewable energy capacity expansion for critical infrastructure sites through comprehensive modeling and analysis. A decentralized energy system can be more resilient, improving the energy security of local communities, and can increase clean energy exports to Europe.
- Enabling small modular reactor capacity with models and training modules, aligning with Ukraine's decarbonization activities. These can help the Government of Ukraine become a world leader in small modular reactor deployment to produce clean hydrogen and heat for industrial processes.
- Supplying energy efficiency modeling software and tools to underpin national policy decisions, supporting Ukraine's transition to more energy-efficient building practices.



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