

NET ZERO WORLD INITIATIVE

Accelerating Global
Energy System
Decarbonization

Net Zero World 2024 Achievements

Angela Ortega Pastor (NREL), Ron Benioff (NREL), Dan Gaspar (PNNL), Derina Man (NREL), Naim Darghouth (LBNL), Bethany Speer (NREL), Carolyn Szum (LBNL), Hyekyung (Clarisse) Kim (ANL), Nan Zhou (LBNL), Daniella Rough (NREL), Riccardo Bracho (NREL), Sharlissa Moore (PNNL), Bruce Hamilton (ANL), Tim Reber (NREL), Nalinrat Guba (NREL), Nazar Kholod (PNNL), and Chun Chun Ni (LBNL)



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UNITED STATES OF AMERICA

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List of Acronyms

ASEAN	Association of Southeast Asian Nations
BESS	battery energy storage system
DOE	U.S. Department of Energy
ETP	Energy Transition Partnership
GCAM	Global Change Analysis Model
GIZ	Gesellschaft für Internationale Zusammenarbeit
JETP	Just Energy Transition Partnership
LEAP	Low Emissions Analysis Platform
NDC	nationally determined contribution
PV	photovoltaics
RETAP	Renewable Energy Technology Platform

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Net Zero World Initiative 2024 Achievements

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 (DOE) national laboratories and 9 U.S. government agencies. Collaboratively, they work with government leaders and technical representatives from Argentina, Chile, Egypt, Indonesia, Nigeria, Singapore, Thailand, and Ukraine to advance clean energy transitions in these economies. Through advanced energy and sectoral modeling, Net Zero World helps these countries strengthen their national clean energy strategies and policies, providing key insights for achieving clean energy and climate goals. The initiative engages in deep technical collaboration with local teams to implement specific measures and pilot projects to accelerate country-driven clean energy transitions. In addition to providing technical support, Net Zero World partners with in-country institutions, U.S. investment agencies, multilateral development banks, private firms, and other organizations to reduce project risks, develop and implement financing solutions, and connect projects to investors.

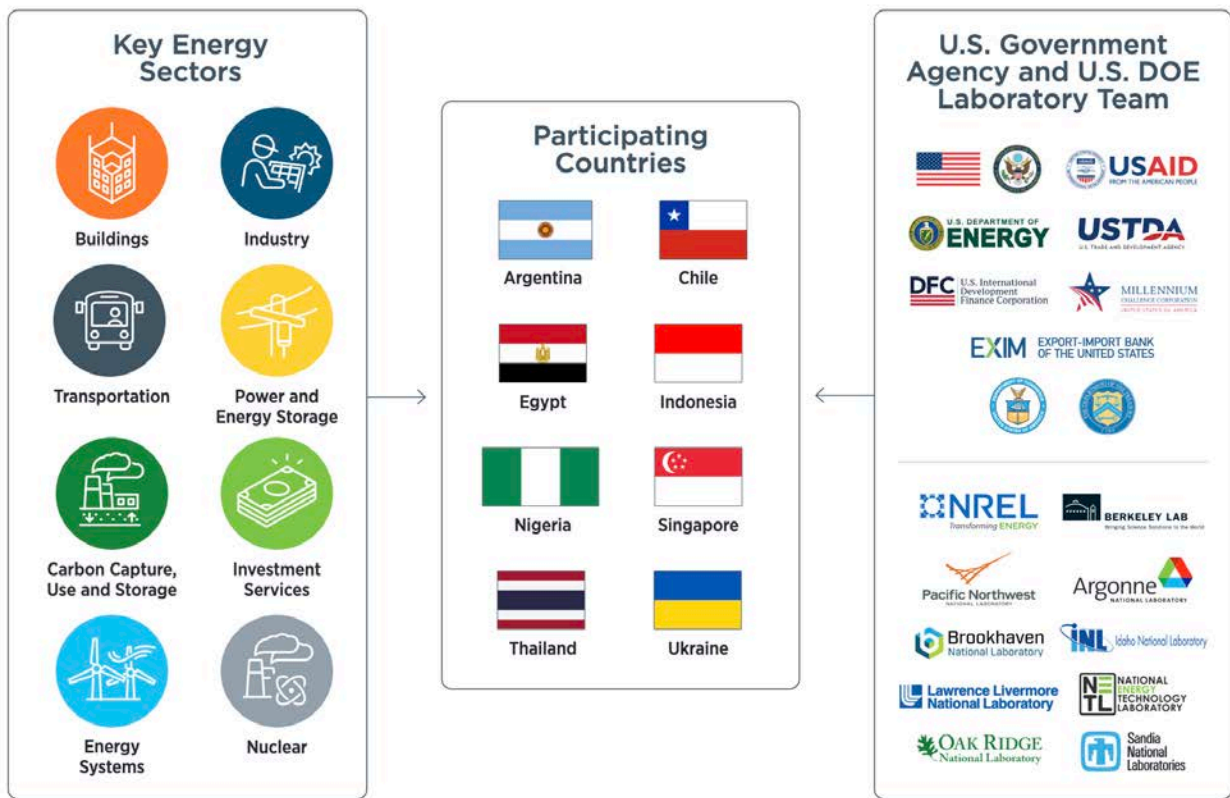


Figure 1. Key sectors, partners, and cross-lab teams

Our Progress

Net Zero World has been deeply engaged in energy-sector modeling, technical collaboration on country-specific implementation, and efforts to mobilize investment to help partner countries achieve their clean energy transition goals and priority actions.

Our Modeling in Action

- Net Zero World has played a key role in enhancing **Argentina's** ability to conduct comprehensive energy system modeling using the Low Emissions Analysis Platform (LEAP) and MESSAGE tools. By using these models, Net Zero World is supporting Argentina's 2050 Energy Transition Strategy, focusing on integrating large-scale renewable energy while evaluating decarbonization pathways. These models have already been applied in Tierra del Fuego, where early analysis has shown how emissions from the power sector could be cost-effectively reduced by 97%, providing a blueprint for national decarbonization efforts.
- In **Chile**, Net Zero World's modeling initiatives are informing the country's revised national energy strategy, using the LEAP model. Projections suggest that Net Zero World-supported scenarios could reduce national emissions by up to 50 million tons annually by 2050. This modeling work is helping Chile plan its transition to renewable energy, with a focus on phasing out coal and integrating wind and solar power into the grid.
- In **Egypt**, Net Zero World is helping the Ministry of Electricity and Renewable Energy and the Ministry of Petroleum and Mineral Resources establish an energy-system-wide modeling center. Using TIMES, the unit aims to help Egypt assess renewable energy integration options and plan for low-carbon development, aligning energy policies with the country's climate goals.
- In **Indonesia**, Net Zero World is using advanced modeling to support the country's energy transition, focusing on battery-to-electric vehicle clean energy manufacturing and the diesel-to-renewable transition for small islands. Net Zero World's modeling team is also training and collaborating with Indonesia's National Planning Agency and Ministry of Energy and Mineral Resources to improve national power sector modeling and pathways to coal phase-down while expanding renewable energy and battery energy storage systems (BESS) and assisting with nuclear power feasibility assessments. This work compliments the Indonesia Just Energy Transition Partnership (JETP), with Net Zero World's models playing a central role in determining energy pricing and electrification strategies.
- In **Nigeria**, Net Zero World is providing modeling assistance to advance the deployment of distributed energy resources and support large-scale renewable energy integration. Using tools like LEAP, Net Zero World is helping Nigeria evaluate energy transition policies, focusing on decarbonizing the transportation and power sectors. This modeling has also supported the deployment of 8 MW of renewable embedded generation in collaboration with local distribution companies, optimizing feeder models and site designs. Additionally, Net Zero World's energy modeling is informing Nigeria's Net

Zero Investment Strategy, aligning decarbonization pathways with financing and investment opportunities to ensure renewable energy and low-carbon projects are integrated into the country's broader development plans.

- In **Thailand**, Net Zero World is focused on enhancing energy system modeling to support the country's NDCs. Working closely with the Energy Policy and Planning Office, Net Zero World is using the LEAP tool to help Thailand assess decarbonization pathways, particularly in the industrial sector.
- Net Zero World is working to strengthen **Ukraine's** capacity for long-term energy system modeling through training on the TIMES model and Global Change Analysis Model (GCAM). The advanced TIMES-Ukraine model was used to develop Ukraine's National Energy and Climate Plan approved by the Government of Ukraine in June 2024. Net Zero World has been working on modeling for the Long-Term Low Emission Development Strategy, with a focus on the energy-water-land nexus and aligning the country's energy strategy with European Union policies.

Advancing Cooperation on Global Decarbonization Modeling

In August 2024, Net Zero World, in partnership with the International Atomic Energy Agency, hosted the third annual Net Zero World–International Atomic Energy Agency modeling workshop at Argonne National Laboratory. This 2-week program brought together 31 participants from 11 countries, including Argentina, Chile, Egypt, Indonesia, Nigeria, Thailand, and Ukraine. The workshop provided an in-depth, hands-on approach to advanced energy modeling, helping countries enhance their national decarbonization planning efforts.

Participants worked alongside DOE lab modelers to simulate scenarios addressing long-term energy transitions, with a focus on integrating nuclear energy, renewables, and advanced storage systems into their national energy grids. The modeling efforts were closely aligned with each country's climate goals, providing critical data and insights to inform policy development, energy system planning, and investment strategies.

The Net Zero World–International Atomic Energy Agency workshop was not only a platform for technical learning but also facilitated cross-border collaboration between national experts and international partners, including DOE, the World Bank, and other multilateral organizations. The workshop continues to play a crucial role in building national capacities for energy modeling and decarbonization strategy development, ensuring that countries are equipped with the tools and expertise needed to achieve their climate targets.

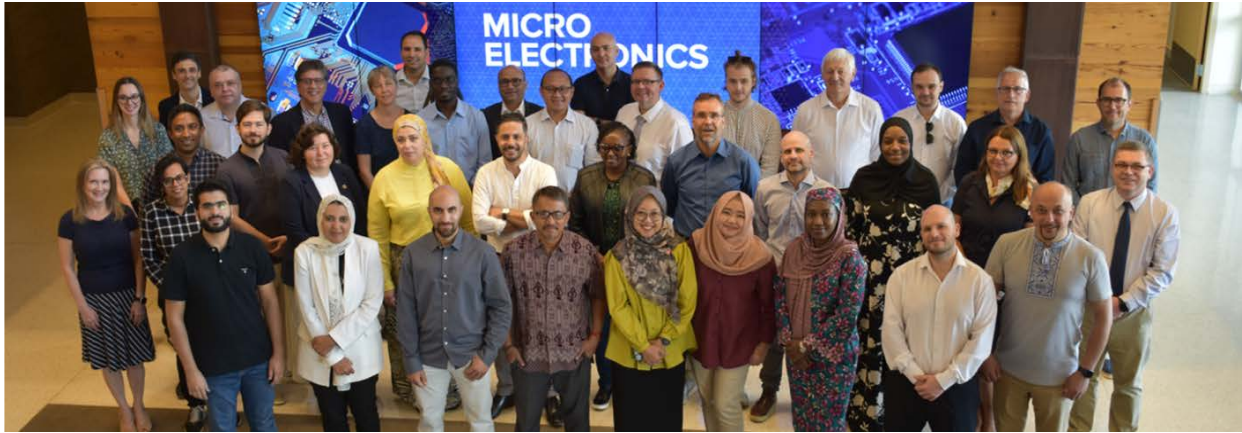


Figure 2. Thirty-one participants attended the Third Annual Net Zero World–International Atomic Energy Agency Modeling Workshop at Argonne National Laboratory for in-depth joint modeling to enhance national decarbonization planning.

Advancing Priority Projects and Policies

Net Zero World continues to drive forward priority projects and policy initiatives that support the clean energy transitions important to partner countries. The focus has been on scaling renewable energy deployment, decarbonization pathways, and integrating new technologies to meet national and regional energy goals.

- Net Zero World is working closely with **Argentina** to enhance energy efficiency in buildings and accelerate the integration of distributed solar generation in the country’s power system. The focus on improving energy efficiency in buildings, especially in schools and social housing, is critical for reducing energy demand and lowering emissions. A comprehensive analysis has been conducted to model the energy and cost savings achievable through upgrades such as improved insulation, air sealing, and the adoption of 2021 International Energy Conservation Code standards for roofs, walls, and windows. In the province of La Pampa, this work is projected to reduce annual natural gas use per floor area by 35% and electricity use by 10% in social housing. These improvements not only lower energy bills but also ease the burden on the national grid by reducing demand, especially during peak times. Net Zero World has also conducted power flow and techno-economic modeling to assess the viability of deploying 32 MW of distributed photovoltaics (PV) to resolve voltage regulation challenges and reduce electricity costs in La Pampa. The findings show that strategic deployment of localized solar generation can significantly and cost-effectively bolster existing grid resilience while also positioning La Pampa to become a net exporter of renewable energy to the national grid, offering economic benefits through reduced costs compared to bulk power market costs. The findings from La Pampa highlight the significant potential for decarbonization and grid modernization through distributed generation, which could serve as a model for other provinces across Argentina.
- Net Zero World is supporting **Chile’s** transition from coal, with a key effort centered around Tocopilla, where the closure of a 280-MW coal plant is providing an opportunity to shift the region's economic base toward clean energy technologies. Net Zero World is helping develop a plan for the establishment of PV recycling businesses, promoting green

jobs and local economic revitalization. This initiative aligns with Chile's broader goal of reducing its reliance on coal, as the country aims to phase out coal-fired power plants by 2040. Net Zero World is supporting Chile's efforts to advance district energy heating projects by enhancing the modeling of district energy systems across pilot projects. This work aims to provide accurate data to guide policy and investment decisions focused on energy efficiency and carbon reduction. Efforts are also underway to improve building and climate data collection and to evaluate energy efficiency measures like window films for inclusion in national energy models. Net Zero World is also helping Chile with the deployment of grid-enhancing technologies and dynamic line ratings, critical for optimizing the grid's performance and reducing renewable energy curtailment. This work includes offering technical advisory support for Chile's National Power Decarbonization Plan.

- In **Egypt**, Net Zero World is providing guidance for the establishment of an in-house energy-system-wide modeling center, enabling the country to develop policies that integrate renewable electricity and meet its existing climate goals. Net Zero World will also be working on exploring carbon monetization options for the country's energy and industrial production through evaluating geological carbon dioxide storage resources in major sedimentary basins.
- In **Nigeria**, Net Zero World is supporting the development of methane mitigation policies in collaboration with the Nigeria Upstream Petroleum Regulatory Commission. Net Zero World's technical assistance for leak detection and remediation technologies is helping shape new methane guidelines for the oil and gas sector. Additionally, Net Zero World is helping Nigeria's policymakers design policies to support the scaling of distributed energy resources and renewables, particularly through pilot projects with local distribution companies. Net Zero World has partnered with Ikeja Electric and Abuja Electricity Distribution Company to deploy 8 MW of renewable embedded generation, optimizing feeder models and site designs to improve grid performance and assessing hosting capacity for further renewable energy integration. The Net Zero World team, in partnership with the African Development Bank and the Transmission Company of Nigeria, is providing a workshop series and advice on the value of integrating battery storage for grid support. Furthermore, in response to Nigeria's Electricity Act 2023, which transfers regulatory authority for the power sector from the federal government to the country's 36 states, Net Zero World is in the early stages of providing support to subnational governments as they take on an expanded role in energy sector governance. This will include state-wide energy sector planning and market design, along with technical and advisory support to help state-level governments with subnational integrated resource planning and the design of renewable energy markets.
- Net Zero World is collaborating with **Singapore** to enhance regional energy connectivity and facilitate the integration of renewable energy sources through subsea interconnections. These long-distance interconnections are designed to bolster Singapore's energy security by enabling the transfer of renewable energy between Southeast Asian nations. Net Zero World's technical and economic feasibility assessments are bolstering the Association of Southeast Asian Nations (ASEAN) power

grid, which has the potential to drive down emissions and lower energy costs for participating countries.

- **Thailand** aims to achieve carbon neutrality by 2050 and net-zero greenhouse gas emissions by 2065, and Net Zero World is providing key support in reaching these goals. A critical component of this collaboration is the development of BESS, in partnership with the Electricity Generating Authority of Thailand. Pilot projects involving second-life batteries will lay the groundwork for broader BESS deployment, which will in turn support the integration of renewable energy and enhance grid reliability across the country.
- In **Ukraine**, Net Zero World is focusing its efforts on strengthening the country's National Energy and Climate Plan, helping align Ukraine's energy policies with European Union standards. Net Zero World's modeling and technical assistance are playing a key role in shaping policies that support renewable energy deployment. Additionally, Net Zero World's work on distributed energy resources is informing strategies to increase energy security by decentralizing energy production, particularly for critical infrastructure. A 10-MW mini-grid project in Merefa, supported by Net Zero World, serves as a pilot for expanding distributed renewable energy across the country. Net Zero World's work with Ukraine is set to expand in 2025, with the expansion of efforts across key work streams, including distributed energy resource deployment, buildings, industry, methane emissions reduction, and transport, among others.

Scaling Up Investment

Net Zero World continues to support partner countries in mobilizing investments to accelerate their clean energy transitions. By providing **technical assistance, policy guidance, and strategic investment frameworks**, Net Zero World is helping countries unlock substantial financing for renewable energy projects, grid modernization, and decarbonization efforts.

- Net Zero World is focusing its efforts in **Argentina** on supporting the establishment of a revolving loan fund in the province of La Pampa. This fund, which aims to include an inflation rate guarantee, is expected to mobilize \$40–\$50 million for energy efficiency and renewable energy retrofits in buildings. As the project progresses, the focus is shifting toward national-scale implementation. Net Zero World will be evaluating opportunities to support private financing for energy efficiency under the national Energy Efficiency and Reconversion Program and work with U.S. investment agencies and the private sector to conduct studies to de-risk investment in transmission expansion and carbon capture, utilization, and storage projects.
- Net Zero World is actively working with the World Bank to develop a 10-GW offshore wind roadmap for **Chile**, representing a \$4–\$6 billion investment opportunity. This project aims to help Chile attract private and public investments for large-scale offshore wind development. Additionally, Net Zero World's energy modeling is helping the government identify key sectors for renewable energy integration, creating a pathway for future investments in grid-enhancing technologies and renewable power generation.

- In **Indonesia**, Net Zero World is working closely with local and international partners to mobilize more than \$300 million in investment for transitioning 276 MW of island energy systems from diesel to renewable power in the remote Terluar, Terpencil, and Tertinggal regions. This includes conducting feasibility studies and developing engineering designs for hybrid renewable energy mini-grids across five locations within these regions as a starting point. Through collaboration with JETP, Net Zero World is playing a crucial role in buildings and transport electrification cost-benefit analyses and project evaluations, which directly feed into JETP investment plans for these sectors. This work includes detailed assessments of the economic and environmental benefits of energy-efficient building designs and low-carbon transport solutions, helping Indonesia access more than \$5 billion in clean energy investments and inform sectoral strategies aligned with the country's long-term decarbonization goals. Additionally, Net Zero World's work on the Battery-to-Electric Vehicle Roadmap is attracting significant interest from investors focused on renewable energy for mineral processing and other battery and electric vehicle supply chain development.
- In **Nigeria**, Net Zero World is playing a key role in developing the country's Net Zero Investment Strategy. This strategy aims to align decarbonization pathways with financing opportunities, ensuring that renewable energy and low-carbon projects are integrated into Nigeria's national development plans. Additionally, Net Zero World is working with subnational governments to create market frameworks that facilitate private investment in distributed energy resources, particularly through regulatory support for state-wide energy sector planning and renewable energy market design. These efforts aim to help Nigeria attract both domestic and international investments to scale up renewable energy deployment and energy sector reforms.
- In **Singapore**, Net Zero World is focused on supporting the country's efforts to enhance regional energy connectivity and scale up renewable energy integration. Through technical and economic feasibility assessments, Net Zero World is helping Singapore, and the region identify investment opportunities in subsea interconnections, which will enable the import and export of renewable energy across Southeast Asia. A key part of this work includes exploring ownership, cost-sharing, de-risking mechanisms, and financing models to inform the \$2 billion–\$3 billion subsea interconnection investment opportunity.

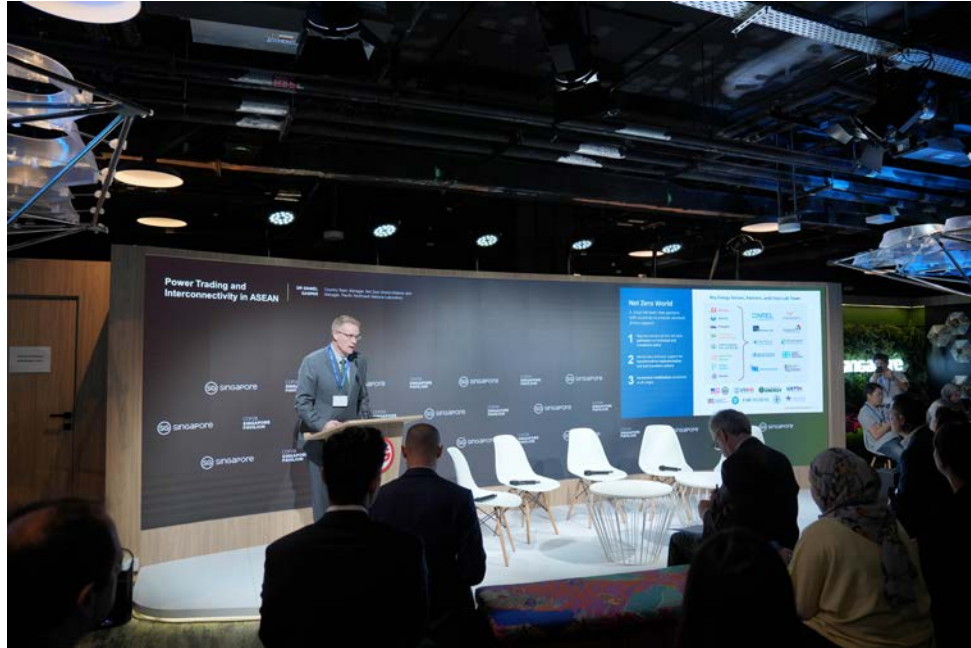


Figure 3. Power trading and interconnectivity in the ASEAN event at COP28

- Net Zero World is working to mobilize financing for critical clean energy mini-grids in **Ukraine** as part of the country’s efforts to enhance energy resilience. A techno-economic analysis was conducted for a 10-MW mini-grid in Merefa, with an estimated capital requirement of \$9–\$12 million for labor and equipment. This mini-grid project serves as a pilot with significant potential for national replication, offering opportunities for further investment in decentralized energy systems.

Empowering the World's Energy Leaders

Net Zero World has trained almost 400 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 approaches for just energy transitions and economic development.

In September 2024, Net Zero World launched the second cohort of the **Women Energy Leaders** program, bringing together accomplished women from six partner countries—Nigeria, Ukraine, Indonesia, Thailand, Chile, and Argentina—for training and mentoring. The 2-week training program, held from September 9–20 at Argonne National Laboratory and the National Renewable Energy Laboratory, provided a comprehensive mix of technical training and leadership development. Participants engaged in hands-on workshops, covering topics such as energy storage systems, high-performance buildings, electric mobility, and strategies for just energy transitions. A key component of the program was the development of individualized action plans by each participant, tailored to the specific clean energy ambitions and needs of their home countries. These action plans, supported by ongoing mentorship and technical guidance from Net Zero World experts, are designed to equip participants to drive tangible clean energy progress in their countries. The Women Energy Leaders program continues to foster a global network of women leaders who are leading the transition toward a clean and equitable energy future.



Figure 4. The Women Energy Leaders 2024 cohort at Argonne National Laboratory

Country and Regional Highlights

Argentina

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

Argentina is making steady progress in its clean energy transition, with ongoing support from Net Zero World. As the country works toward its goal of carbon neutrality by 2050, Net Zero World is actively supporting Argentina in aligning its policies, investment strategies, and technical planning to meet this objective.

A key initiative in this process is the development of the Energy Transition Fund, a revolving loan fund designed to mobilize \$40–\$50 million for energy efficiency and renewable energy retrofits in public buildings, particularly in the region of La Pampa. With a proposed inflation rate guarantee, the fund is structured to reduce financial risk for investors and ensure steady progress toward Argentina's energy transition goals.

In addition to financial mechanisms, Net Zero World is providing technical assistance to help Argentina refine its energy modeling and planning. Through the use of the LEAP and MESSAGE models, Net Zero World is helping Argentina develop long-term generation and transmission capacity expansion models that support the country's broader 2050 Energy Transition Strategy. These models have already been applied in Tierra del Fuego, where Net Zero World's analysis suggests emissions from the power sector could be reduced by 97%, serving as a potential model for other regions.



Figure 5. The Net Zero World team delivered an in-country presentation on cap-and-trade mechanisms in May 2024.



Figure 6. Participants at a carbon storage workshop hosted by Net Zero World in Argentina

What's Next

- Explore models for national replication and expansion of the La Pampa revolving loan fund
- Support the design and development of a cap-and-trade or emissions trading system, with workshops and preliminary designs throughout 2025
- Expand carbon dioxide storage capacity assessments from La Pampa to additional provinces
- Model sector-specific greenhouse gas emissions caps to achieve Argentina's NDC and long-term net-zero targets
- Support the implementation of large-scale energy efficiency programs, starting in La Pampa and replicating in other provinces, including support for designing a national energy efficiency recognition program similar to ENERGY STAR®.

Chile

Who We Work With

Net Zero World is collaborating with Chile's Ministry of Energy (MoE) including the MOE representative to the northern Antofagasta region (SEREMI), Chile's Ministry of Environment, the Municipality of Tocopilla, the University of Antofagasta, the University of Arturo Prat, the University of Kansas, the Dwayne Peaslee Technical Training Center, the World Bank, Engie, and AES.

What We Do

Chile is making steady progress toward its clean energy goals, with a strong focus on transitioning from coal to renewable energy, supported by Net Zero World. A key effort is centered around Tocopilla, where the closure of a 280-MW coal plant is creating an opportunity to shift the region's economic base toward clean energy technologies. Net Zero World is helping develop a plan for the establishment of PV recycling businesses, promoting green jobs and driving local economic revitalization.

To further support this transition, Net Zero World facilitated a U.S. study tour for Chilean stakeholders, including government officials, community leaders, and industry representatives. The tour provided insights from successful clean energy transitions in similar regions (Lawrence, Kansas, and Coshocton, Ohio), focusing on agrivoltaics (dual-use solar projects) and second-life PV repurposing facilities. These exchanges are informing Chile's strategy for repurposing coal infrastructure and scaling up renewable energy deployment in coal-dependent regions. During this visit, Chile's Tocopilla Sister City Committee formalized a partnership with Lawrence, Kansas, to foster long-term collaboration on clean energy initiatives, economic development, and knowledge exchange, supporting Tocopilla's transition from coal to sustainable energy solutions.



Figure 7. Members of the Tocopilla Net Zero World–Sister City Stakeholder Committee visited the National Renewable Energy Laboratory as part of their U.S. study tour, which also included stops in Lawrence, Kansas, and Coshocton, Ohio, to share experiences of transitioning away from coal.



Figure 8. Members of the Tocopilla Net Zero World–Sister City Stakeholder Committee visit Lawrence, Kansas

Net Zero World is helping Chile advance district energy heating projects by improving the modeling of district energy systems across pilot sites, providing data to inform policy and investment decisions on energy efficiency and carbon reduction. Additional efforts are underway to enhance building and climate data collection and assess the inclusion of energy efficiency measures like window films in national energy models.

Net Zero World is also supporting Chile as the country deploys grid-enhancing technologies and dynamic line ratings to optimize grid performance and reduce renewable energy curtailment, while also providing technical advisory services for the country's National Power Decarbonization Plan.

Chile is also positioning itself as a leader in offshore wind energy. In collaboration with the World Bank, Net Zero World is supporting the development of a 10-GW offshore wind roadmap to guide policy and investment decisions. This roadmap outlines key steps for attracting private sector investment and identifying necessary regulatory adjustments to facilitate offshore wind development.

Net Zero World's efforts are helping Chile integrate more renewable energy into the grid, reduce emissions, and foster economic development through clean energy projects, while supporting the country's goal of achieving carbon neutrality by 2050.

What's Next

- Support development of business models and workforce development plans for Tocopilla's PV recycling businesses. Collaborate on pilot project development and review.
- Support work to develop job training, educational programs, and research exchanges in Tocopilla.
- Finalize offshore wind roadmap, including wind resource modeling, bathymetry assessments, and technology evaluations.
- Conduct cost-benefit analyses for new mitigation measures to inform the update of Chile's NDC.
- Provide technical assistance for district energy pilot projects, including improved tender processes, workshops, and training.

Wind Energy Resource Data for the Energy Transition Across South America

In collaboration with the **Rockefeller Foundation**, Net Zero World is launching a regional project to develop high-resolution historical wind resource data for **Argentina, Chile, and Brazil**. This 20-year dataset will provide critical insights into both onshore and offshore wind energy potential, filling a significant gap in public data access for stakeholders across national governments and private sectors. These countries currently lack comprehensive wind resource data needed for advanced power system modeling, project feasibility assessments, and policy development, all of which are vital to future bankable wind energy deployment.

The datasets will serve a range of stakeholders.

- **Private sector partners** will use the data to assess and develop onshore and offshore wind projects.
- **Government agencies and system operators** will apply the data to long-term energy planning.
- **Researchers** will leverage the data for power system modeling, particularly under scenarios influenced by climate change and extreme weather events.

By supporting data-driven analysis, this project is designed to drive economic growth, enhance energy resilience, and accelerate the deployment of wind and solar energy across the region. This initiative aligns with Net Zero World's broader efforts to promote clean energy transitions and economic development throughout South America. **Regional partners** include the **Global Energy Alliance for People and Planet**, the **Inter-American Development Bank**, and the **U.S. Agency for International Development**.

Egypt

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, along with other in-country partners.

What We Do

In Egypt, Net Zero World is focusing on supporting the country's energy system modeling, carbon storage and monetization, and renewable energy integration efforts. Egypt has set ambitious targets to reduce greenhouse gas emissions by 37% in the electricity sector and by 65% in the oil and gas sector by 2030.

Net Zero World's work in Egypt includes helping the government develop a carbon monetization plan, with a focus on the oil and gas and electricity industries. By identifying opportunities for carbon monetization, Net Zero World is helping Egypt reduce emissions while maintaining energy production.

In addition to carbon storage and monetization, Net Zero World is working with Egypt's Ministry of Petroleum and Mineral Resources and Ministry of Electricity and Renewable Energy

to establish a joint-energy modeling unit. This unit will play a crucial role in long-term energy planning, enabling the government to assess renewable energy integration options, design cost-effective energy solutions, and plan for low-carbon development. Net Zero World's support is helping Egypt align its energy policies with its climate goals, ensuring the country remains on track to meet its emissions reduction targets while expanding the use of renewable energy.

What's Next

- Contribute to Egypt's Energy Sustainable Development Strategy with plans for renewable energy and carbon storage
- Continue evaluation of geological carbon dioxide storage resources for industrial applications, including calculating injection and transport costs for select source-sink pairs.

Nigeria

Who We Work With

The primary points of contact for Net Zero World in Nigeria to date have been Nigeria's National Council for Climate Change, the Department of Climate Change within the Federal Ministry of Environment, and the Energy Transition Office. Much of the work is also done in collaboration with the Federal Ministry of Power, the Energy Commission of Nigeria, the National Upstream Petroleum Regulatory Commission, local distribution utilities, the national transmission company (TCN), and subnational governments and in-country technical institutes. The Minister of State for Petroleum resources team and the Nigerian National Petroleum Company Limited also collaborate through Net Zero World.

What We Do

Net Zero World is continuing its support for Nigeria's Energy Transition Plan, which targets net-zero emissions by 2060. In 2024, efforts have focused on scaling up distributed renewable energy resources, building local capacity for BESS, mitigating methane from the oil and gas production, and providing energy system modeling assistance to support development of an investment plan for Nigeria's energy transition.

A key achievement this year has been the deepened collaboration with Ikeja Electric Distribution Company and Abuja Electricity Distribution Company. Net Zero World has provided extensive technical assistance to support the deployment of 8 MW of renewable embedded generation projects. Through more than a dozen bi-weekly technical sessions, the Net Zero World team worked closely with distribution company engineers to develop feeder models using the OpenDSS power distribution simulator. This collaboration enabled the companies to optimize the siting and design of renewable projects. As a result, both Ikeja and Abuja Electricity Distribution Company have identified and secured suppliers for renewable energy generation projects sized at 3.5 MW and 4.4 MW, respectively, advancing their ability to integrate distributed PV into the grid.

To further scale up renewable energy and replace high-emission diesel generators—which currently supply nearly 60% of Nigeria's electricity—Net Zero World is also supporting

additional distribution companies, such as Eko Electric Distribution Company. The team is developing a detailed hosting capacity assessment to evaluate how much distributed generation the existing grid infrastructure can accommodate. This initiative will provide critical insights into necessary grid upgrades, distributed energy resource integration strategies, and policy frameworks for expanding renewable energy adoption in Nigeria.



Figure 9. Amudi Chioma Felistas Edeh addresses the audience at Argonne National Laboratory, sharing insights from her work as a national desk officer in Nigeria’s climate and energy transition space.

In parallel, Net Zero World also recently began an in-depth training program on the fundamentals of battery energy storage deployment and integration with TCN to lay the groundwork for BESS planning and deployment in Nigeria.

In addition to technical support for distribution companies, Net Zero World will be spearheading the establishment of an energy-system-wide modeling hub, in collaboration with the Nigerian government and local universities. This hub will be designed to enhance Nigeria’s in-country capacity to model pathways for meeting the Energy Transition Plan’s goal of achieving 250 GW of installed renewable energy capacity by 2050. This effort is beginning with development of a Net Zero Investment Plan to help steer investment in Nigeria’s NDC and LTS implementation.

Moreover, Net Zero World is working with Nigeria’s Upstream Petroleum Regulatory Commission to develop methane mitigation guidelines for the oil and gas sector. This collaboration includes providing technical training on leak detection and remediation technologies.

What’s Next

- Assist subnational governments as they assume a larger role in energy sector governance as a result of Nigeria’s Electricity Act 2023, which transfers regulatory authority for the power sector to the subnational level. This support will include state-wide energy

planning and market design, along with technical and advisory services to help states develop integrated resource planning and design renewable energy markets at the subnational level.

- Co-develop a financing strategy for NDC and long-term strategy implementation, with training on financing mechanisms.
- Equip stakeholders with tools for BESS planning and provide technical input for BESS standards and hybrid power system modeling.
- Develop a vision and roadmap for a modeling hub, in consultation with the Nigerian government, academia, and donor partners, that will focus on system-wide modeling approaches to inform NDC, LTS and other long-term decarbonization plans and pathways.

Advancing BESS Deployment in Africa: Enhancing Technical Capacity, Policy Frameworks, and Regional Collaboration

In 2024, Net Zero World, with support from the **Rockefeller Foundation**, launched the **Advancing BESS Deployment in Africa** initiative to support the integration of BESS into the electricity grids of African countries. As the cost of BESS technology continues to decline and performance improves, African nations are recognizing the potential of BESS to enhance grid reliability while enabling higher levels of clean energy integration. Net Zero World is already working closely with the TCN and the African Development Bank to provide in-depth capacity-building for BESS technology development and integration. The African regional BESS initiative is designed to build on the foundational work in Nigeria to provide technical assistance, promote knowledge-sharing, and foster regional collaboration to accelerate the deployment of BESS technology across the continent.

The initiative will unfold in three distinct phases.

- **Phase I** focuses on virtual workshops and consultations, engaging key stakeholders, including regulators, utilities, and energy ministries. These workshops will initially concentrate on countries prioritized by the **Global Energy Alliance for People and Planet**, providing foundational knowledge on BESS technologies and their role in supporting clean energy transitions.
- **Phase II** will establish a **regional forum** for ongoing discussions and in-person workshops, where stakeholders can share best practices, address challenges, and collaborate on strategies for effective BESS deployment.
- **Phase III** will offer **in-depth technical assistance** to selected countries, helping them develop or refine BESS-related policies and align their long-term clean energy targets with the integration of advanced energy storage solutions.

Indonesia

Who We Work With

Net Zero World is collaborating with Indonesia's Ministry of Energy and Mineral Resources, the National Development Planning Agency (BAPPENAS), JETP, state-owned electricity company Perusahaan Listrik Negara, the Ministry of Public Works and Public Housing, the Ministry of Industry, the Institute for Essential Services Reform, and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers Indonesia chapter, among others.

What We Do

In Indonesia, Net Zero World is continuing its efforts to support the country's clean energy transition through several key initiatives. A major focus has been the transition of island energy systems from diesel generators to renewable energy mini-grids. Net Zero World is working closely with Indonesia's Ministry of Energy and Mineral Resources and Perusahaan Listrik Negara to conduct techno-economic analyses for converting diesel generators to hybrid renewable energy systems at 12 island sites. The goal is to develop a national roadmap to replace 600 MW of diesel with clean energy solutions across remote island communities. This year, Net Zero World worked on feasibility studies and engineering designs for five island sites, with support from the U.S. Trade and Development Agency and the U.S. Agency for International Development. These efforts will inform future tenders and help scale up clean energy solutions across additional sites.



Figure 10. Faricha Hidayati from Indonesia's Ministry of Energy and Mineral Resources presents her action plan at the National Renewable Energy Laboratory, discussing innovative solutions for Indonesia's energy transition.

Through JETP, Net Zero World is conducting cost-benefit analyses and project evaluations in the buildings and transport sectors, directly informing JETP’s sectoral investment plans; in addition, the work with JETP is driving efforts to replace captive coal-fired power plants in industrial zones with clean energy alternatives. As part of this collaboration, Net Zero World is working closely with the JETP Secretariat to deliver technical workshops and develop the Clean Energy for Battery-to-Electric Vehicle Roadmap, outlining strategies for building a low-carbon battery supply chain and integrating renewable energy into industrial processes, such as electric vehicle manufacturing. Net Zero World’s work also includes the formation of the Energy Infrastructure Analysis Working Group in collaboration with the Ministry of Energy and Mineral Resources and BAPPENAS. This group is using an energy system modeling platform that helps local modelers and energy planners assess decarbonization pathways at both the national and subnational levels. The modeling work is guiding Indonesia’s infrastructure development and investment planning, with a particular focus on scaling renewable energy and electrifying transport systems.



Figure 11. Indonesian partners presenting at the B2EV workshop hosted in March 2024 in Jakarta, Indonesia

What's Next

- Collaborate with the Ministry of Energy and Mineral Resources to develop a geothermal energy roadmap
- Support development of a national strategy for converting diesel-based community mini-grids to clean energy
- Demonstrate clean energy alternatives for the pulp and paper industry through a case study and collaborate on a similar study for the nickel industry

- Provide analysis and decision support for the JETP, focusing on transportation decarbonization, including e-mobility pilots and a charging infrastructure roadmap.

Singapore

Who We Work With

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

What We Do

Singapore is continuing its efforts to enhance regional energy connectivity and integrate more renewable energy into its grid, with support from Net Zero World. The country’s goal of peaking emissions by 2030 and achieving net-zero emissions in the second half of the century is being advanced through collaborative initiatives with Net Zero World and regional partners.

A major focus of Net Zero World’s work in Singapore has been on the technical feasibility and economic analysis of subsea interconnections. These long-distance interconnections aim to increase regional power grid integration and enable the transfer of renewable energy between Southeast Asian countries. Net Zero World is working with Singapore’s Ministry of Trade and Industry and the Energy Market Authority to assess the technical challenges and opportunities of subsea interconnections, identifying key risks such as shipping traffic and geologic hazards. The analysis has shown that, with site-specific design and increased cable burial depth, these risks can be mitigated, unlocking significant potential for renewable energy trade and enhancing energy security across the region.

The work on advancing regional interconnectivity included developing an open-source GridPATH capacity expansion model for ASEAN. This model built on prior regional work, national power sector plans, technology costs, and renewable energy potential. It was validated using inputs from the AIMS III model and updated information on renewable energy targets and power development plans. The analysis shows that, without large-scale interregional transmission, achieving net-zero would require significant investments in additional domestic generation capacity, mainly solar PV and hydrogen power plants. Thus, redirecting these investments to interconnectors could lower overall costs for the region.



Figure 12. Net Zero World's Dan Gaspar presenting on the interconnection work with Singapore at COP28

In addition to its work on interconnections, Net Zero World is helping the region develop policies and financial frameworks to support the deployment of renewable energy. By collaborating closely with the Southeast Asian countries on energy planning, Net Zero World is promoting greater cooperation among countries in the region to scale up renewable energy and reduce overall energy costs. This regional approach aligns with Singapore's long-term net-zero energy goals, positioning the country as a leader in clean energy innovation and grid modernization.

What's Next

- Address legal and governance frameworks for cross-border energy trading and develop financing models for transmission infrastructure
- Provide technical assistance and capacity-building for cross-border electricity trade.

Thailand

Who We Work With

Net Zero World collaborates with Thailand's Ministry of Energy, the Electricity Generating Authority of Thailand, the National Energy Technology Center, and other key agencies and technical partners, including a strategic partnership with Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

What We Do

Thailand is making significant progress in decarbonization analysis, energy storage planning and deployment, and addressing residential building sector emissions with support from Net Zero World. The country's commitment to achieving carbon neutrality by 2050 and net-zero greenhouse gas emissions by 2065 is being strengthened through Net Zero World's energy modeling and capacity-building efforts.

A key focus for Net Zero World has been enhancing Thailand's ability to model and assess decarbonization strategies using the LEAP tool. By working closely with the Energy Policy and Planning Office, Net Zero World is helping Thailand develop models that support policy planning for its National Energy Strategy, particularly in the industrial sector, which is a major contributor to the country's carbon emissions. Net Zero World and GIZ have worked together to further support high-impact energy modeling through a community of practice effort with the Energy Policy and Planning Office and leading local researchers that looks to replicate and accelerate the connections between sector data, modeling, policy integration, and NDC/national climate ambition achievement.



Figure 13. Net Zero World hosted an in-country LEAP modeling training for Thai partners.

Net Zero World is also advancing BESS in Thailand. In partnership with the Electricity Generating Authority of Thailand and National Energy Technology Center, Net Zero World is supporting the development of BESS planning and pilot projects. These projects focus on establishing key testing and safety protocols for battery use, including second-life battery applications. Net Zero World and GIZ have also worked with the Electricity Generating Authority of Thailand and National Energy Technology Center to launch a BESS knowledge platform to help tackle key areas such as repurposing used electric vehicle batteries to store renewable energy and addressing the need for reliable energy storage in a grid with increasing shares of variable renewable energy. While the knowledge platform serves as a BESS ecosystem and solution incubator, the pilot project work looks to establish proof of concept for broader BESS adoption. These efforts are bringing forward Thailand's goal of expanding its renewable energy target of more than 50% with integrated battery storage.



Figure 14. Pimpa Limthongkul, a co-founder of the Electric Vehicle Association of Thailand and the Thailand Energy Storage Technology Association presents her action plan at the Women in Energy Leaders 2024 Culmination Event hosted at the National Renewable Energy Laboratory.

Additionally, Net Zero World is collaborating with the Ministry of Energy’s Department of Alternative Energy Development and Efficiency to explore building energy efficiency standards in residential housing. This initiative is exploring a housing energy standard that could interface with Thai financial and policy institutions and align incentives for adoption to ensure home efficiency technologies are affordable, available, and easy to understand. Net Zero World’s ongoing support is helping the Department of Alternative Energy Development and Efficiency develop the technical solutions needed to achieve its national energy efficiency plan targets.

What’s Next

- Continue supporting the Energy Policy and Planning Office’s decarbonization modeling capacity and Net Zero World and GIZ Energy Modeling Community of Practice workstreams, including starter models for other industrial sectors (i.e. pulp and paper, food and beverage, and chemical subsectors).
- Develop a BESS strategy for long-term decarbonization, with research on circularity and waste management of BESS materials. Support Net Zero World and GIZ BESS knowledge platform on energy storage research and applications in the power and transport sectors.
- Work with the Department of Alternative Energy Development and Efficiency on developing energy-efficient residential building standards. Explore the opportunity for Net Zero World to support residential building energy efficiency policy development, specifically for low-income housing.

Regional Technical Exchange for Power Systems Operators, Regulators, and Ministries in Southeast Asia

In 2024, Net Zero World, with support from the **Rockefeller Foundation**, initiated work on the **Regional Technical Exchange for Power Systems Operators, Regulators, and Ministries in Southeast Asia program**. This program aims to address the pressing operational and policy challenges faced by system operators, regulators, and ministers across ASEAN countries as they work to integrate renewable energy into their existing power grids. Southeast Asia's substantial renewable energy resources hold great promise for enhancing the region's energy security and sustainability. However, the integration of these resources poses significant challenges, particularly the need for better coordination between policymakers and system operators.

Policymakers often lack the technical and operational insights required to develop effective renewable energy policies, while system operators may struggle to align their operations with new and evolving policy frameworks. This misalignment can result in inefficiencies, regulatory hurdles, and the underuse of available renewable energy resources.

In response, Net Zero World, in collaboration with the **Global Power System Transformation Consortium**, the **ASEAN Centre for Energy**, and the **Heads of ASEAN Power Utilities/Authorities**, has developed a multifaceted initiative. The exchange offers a platform for facilitated discussions, hands-on training, and expert workshops, providing technical support from the Global Power System Transformation Consortium network to ensure that policymakers and system operators can work together effectively.

Ukraine

Who We Work With

Net Zero World collaborates with Ukraine's Ministry of Energy, the Ministry of Economy, the Ministry for Communities and Territories Development of Ukraine, and the Ministry of Environmental Protection and Natural Resources, along with various technical institutes.

What We Do

Net Zero World is supporting Ukraine as the country enhances energy security and advances its clean energy transition, despite the challenges posed by the ongoing war. Net Zero World conducted a technical analysis for the installation of solar PV systems with BESS at facilities in Sheptytsky (formerly Chervonograd), Chortkiv, Chernihiv, and Merefya. These mini-grid feasibility studies serve as a pilot for scaling up distributed energy systems across Ukraine, helping decentralize energy production and reduce dependence on traditional power sources.

Net Zero World is also working to build Ukraine's capacity for long-term energy planning. Net Zero World helped Ukraine develop its first National Energy and Climate Plan. The advanced TIMES-Ukraine model, developed by the Institute for Economics and Forecasting and updated with the help of the Net Zero World experts, is now used to develop the Low-Emissions Development Strategy up to 2050. Meanwhile, the GCAM model offers crucial insights into the

energy-water-land nexus, which will guide policy decisions on renewable energy deployment, grid modernization, and emissions reductions to reach net zero by 2050.

In addition to its work on renewable energy and distributed systems, Net Zero World is supporting Ukraine's plans to decarbonize industry. For example, Net Zero World is working with the Green Transition Office at the Ministry of Economy to develop a roadmap to decarbonize the cement industry.

What's Next

Net Zero World's work with Ukraine is set to expand over the next 3 years. As part of these efforts, Net Zero World will support its Ukrainian partners as they:



Renewable Energy Laboratory

- Conduct **system-wide modeling** to support continued development of national decarbonization strategies, enhance modeling capacity with TIMES-Ukraine and GCAM-Ukraine models (NDC-2 and carbon market analysis), and establish the Ukrainian Energy and Climate Modeling Forum to improve collaboration between policymakers, modelers, and donors.
- Carry out **regional energy system analysis** to identify priority actions across Ukraine and Moldova to enhance energy integration with the European electricity grid.
- Advance **renewable energy and storage** to support the deployment of distributed power generation through techno-economic analysis for microgrid pilot projects in schools, kindergartens, and hospitals; conduct a country-wide assessment for rooftop solar PV potential; and enhance capacity by using state-of-the-art models and tools for analysis of distributed energy resource projects to scale up their adoption, focusing on resilience for critical facilities.
- Support Ukraine's **nuclear energy** engineering students to bolster national capacity for future **nuclear** power needs, including possible small modular reactor deployment.
- Support the Ministry for Communities and Territories Development in achieving the target of near-zero emissions buildings and enhancing capacity for using open-source modeling tools to inform the adoption of energy-efficiency measures.
- Reduce **methane emissions** by informing the development of a methane reduction strategy, and improving monitoring, reporting, and verification protocols for methane emissions.
- Support the implementation of the new National Transportation Strategy, identify **clean transportation** technologies and infrastructure needs, and provide technical assistance to address infrastructure and investment needs for decarbonizing transportation.
- Conduct analysis and develop roadmaps for decarbonizing key **industries**, such as cement, fertilizers and steel; enhance capacity for industrial decarbonization through training programs and peer exchanges; and support investment mobilization through techno-economic analysis for decarbonizing key industrial sectors.

Partnerships

Net Zero World works closely with prominent philanthropies such as Breakthrough Energy, the Rockefeller Foundation, the Global Energy Alliance for People and Planet, and others to jointly support country clean energy priorities. Net Zero World also collaborates with key international partners, including the Energy Transition Council, the Energy Transition Partnership (ETP), GIZ, the World Bank, the African Development Bank, the Asian Development Bank, the Inter-American Development Bank, the European Bank for Reconstruction and Development, the International Atomic Energy Agency, the International Energy Agency, and the International Renewable Energy Agency.

Partners can tap into Net Zero World's capabilities through direct program support, co-funding technical assistance, in-kind support, or investing in specific areas such as technology pilots, workforce development, or policy and market design that support specific partner programs and priorities.

Global Alliance for People and Planet BESS Consortium

The Global Alliance for People and Planet, through the BESS Consortium, is working with partner governments worldwide to advance BESS pilot projects and foster enabling environments that encourage BESS investments. The Net Zero World cross-lab team is providing a range of support to the BESS Consortium, offering technical, analytical, advisory, and capacity-building services. In the near term, the team is providing technical advisory for the design and integration of current BESS projects. In the mid-term, they will focus on identifying additional BESS project pipelines and developing technology performance data. Over the longer term, the team will lead capacity-building efforts, regional learning initiatives, and knowledge-sharing on technology assessments, standards, testing, and certification to support the replication and scale-up of BESS projects across regions. Net Zero World is also partnering with the Global Alliance for People and Planet on other power sector joint activities with Indonesia and Nigeria and exploring collaboration in Vietnam and other countries.

GIZ Partnership

The Net Zero World Initiative has partnered with GIZ GmbH to help accelerate global energy transitions. With over 50 years of experience in international cooperation for sustainable development, GIZ works in areas such as economic development, energy, the environment, and peace and security.

This partnership aims to support countries as they increase their climate ambitions, advance energy transitions, and become regional leaders with focuses on joint delivery of support to countries of common engagement. To enhance collaboration, GIZ and Net Zero World have created working groups focused on community energy transitions and benefits sharing, high-ambition energy planning, battery storage, and women's leadership programs. These groups will exchange best practices, coordinate efforts closely, and identify joint activities that can maximize the collective impact of their initiatives.

Southeast Asia ETP

The Southeast Asia ETP is a multi-donor platform managed by the United Nations Office for Project Services that provides deep support to Southeast Asian countries in advancing clean energy transitions. ETP leads a broad range of multi-year clean energy studies, project development, and policy design programs with government and technical partners in Indonesia, the Philippines, and Vietnam, along with related regional initiatives.

Net Zero World is partnering closely with ETP in Indonesia on the analysis and design of building, industry, and transport JETP projects, with ETP leading the end-use and electrification JETP working group, and on wind energy modeling. Net Zero World and ETP are also exploring broader collaboration in Southeast Asia.

Net Zero World–Energy Transition Council Partnership

During the Energy Transition Council Ministerial meeting on May 22, 2024, the Energy Transition Council announced a new partnership aimed at advancing clean energy transitions in priority areas identified by partner countries. The Energy Transition Council currently supports 11 partner countries across Asia and Africa, including Bangladesh, Egypt, India, Indonesia, Kenya, Laos, Morocco, Nigeria, Pakistan, the Philippines, and Vietnam.

The collaboration between the Energy Transition Council and Net Zero World will focus on joint efforts in countries where both programs are active, such as Egypt, Indonesia, Nigeria, and Vietnam, as well as any future partner countries. This partnership will involve mutual participation in meetings of ministers and senior government officials to enhance knowledge exchange, increase ambition, and coordinate activities. Additionally, the two programs will explore opportunities to better align their support for countries' clean energy transitions and expand assistance where possible, while also co-hosting regional dialogues and peer-learning programs to foster regional and global collaboration.

Renewable Energy Technology Platform (RETAP)

Experts from the Net Zero World lab framework are supporting India's renewable energy transition through RETAP under the United States–India Strategic Clean Energy Partnership. RETAP was created to deepen bilateral collaboration, with a focus on advancing renewable energy and enabling technologies in a results-oriented, time-bound framework. The platform is designed to accelerate the development and scaling of new and emerging renewable technologies. Initially, RETAP is focusing on green/clean hydrogen, offshore wind energy, long-duration energy storage, and geothermal energy. Other emerging technologies may be prioritized in the future.

RETAP leverages the Net Zero World cross-lab model to bring together expertise and innovation. One key milestone was the completion of long-duration energy storage potential modeling in Sienna, identifying sodium-ion and flow batteries as the most promising technologies for pilot projects. In addition, a series of knowledge exchange webinars were conducted, showcasing U.S. lab capabilities and U.S. government initiatives for long-duration energy storage. These efforts are contributing to India's target of achieving 500 GW of renewable energy, as well as unlocking the untapped potential of geothermal energy through

resource-mapping, advanced drilling techniques, and enhanced reservoir management and power generation technologies.

Furthermore, RETAP delivered a final draft of wind-electrolyzer site selection guidance from the GreenHEART initiative, helping identify promising locations for hydrogen production in India. This guidance supports India's goal of achieving cost-competitive \$3/kg-hydrogen production, driving progress toward large-scale renewable hydrogen deployment.

DOE Collaboration With South Africa in Support of the Just Energy Transition Plan

DOE and the national laboratories (Lawrence Berkeley National Laboratory and the National Renewable Energy Laboratory) are partnering with Power Africa and Net Zero World to collaborate with South African stakeholders on the clean energy transition and decarbonization, with a focus on five key areas of support.

- Modeling optimal pathways for electricity decarbonization and investment to help South Africa achieve its climate goals through coal fleet retirement, renewable energy integration, and demand-side management
- Identifying and coordinating specific technical tasks to accelerate the shift from coal to clean energy sources
- Assessing the near- and medium-term impacts of ambitious renewable energy deployment on transmission infrastructure
- Collaborating with municipalities on resource planning, grid operation, governance, demand-side management, and the integration of new energy vehicles
- Providing tools and sharing international best practices to support the revision of municipal tariff structures.

DOE Lab-to-Lab Cooperation with Vietnam Toward a Clean, Secure Energy Transformation

DOE lab experts from Net Zero World are working to identify and mobilize key energy sector workstreams with Vietnam's Institute of Energy under the Ministry for Industry and Trade. This lab-to-lab Net Zero World engagement seeks to advance actionable and highly tailored implementation pathways to achieve energy system decarbonization.

The Net Zero World engagement with Vietnam was announced as part of the U.S.–Vietnam bilateral partnership upgrade in 2023. This partnership will coordinate with and complement existing U.S. government energy sector technical assistance.



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