Peru Country Window:

Energy System Transformation Outlook (ESTO)





GET.transform is co-funded by



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COUNTRY WINDOW

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ABOUT GET.transform







ABOUT GET.transform





European technical assistance programme supporting national and regional public partners in Africa and Latin America

- To advance their power sector transformations; and
- To contribute to knowledge sharing and mainstreaming of country and regional experiences.





What is GET.transform?

- Technical assistance (TA) and capacity building for the **public sector** to establish conducive policy and investment frameworks for the transition of the energy sector
- Hub of expertise with > 50 renowned (inter)national energy experts
- Implementation through regional and country windows with expert staff on the ground incl. secondments
- Scaling across countries through collaboration with regional institutions and other TA initiatives



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GET.transform Workstreams





GET.transform Workstreams

LONG TERM ENERGY PLANNING



G

RENEWABLE ENERGY GRID INTEGRATION

Updating of technical power system planning and operational procedures that enable the operation of renewable energy dominated power systems ON-GRID REGULATION & MARKET DEVELOPMENT

DEVELOPMENT Supporting institutional reforms that allow for new market actors and renewable energy participation: market model design, nondiscriminatory grid access, cost-reflective services

Design and management of

solicited auctions as well as

procuring on-grid energy

market-driven mechanisms for



OFF-GRID REGULATION & MARKET DEVELOPMENT

Supporting off-grid electrification planning and data management frameworks

Developing mini-grid regulatory frameworks and technical standards and designing award mechanisms for procuring off-grid energy





PERU ESTO







Foreword

The purpose of the Energy System Transformation Outlook (ESTO) is to document a high-level summary of the electricity landscape in Peru and to present the outcome of a high-level overview and assessment that followed a 'review, interview, identify' approach.

REVIEW PHASE

Focused on a **desk-top review** of a multitude of publicly available energy and power sector publications.

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PHASES

INTERVIEW PHASE

Focused on further discussions with the key public sector actors (MINEM, OSINERGMIN and COES) to identify potential needs, opportunities and gaps, and culminated in the public sector actors formally expressing their key priority needs.

IDENTIFY PHASE

The identify phase focused on defining potential technical assistance and capacity building projects that will strongly support the power transition in Peru, and that GET.transform is well positioned to support. It also provides a starting point for further engagement with the public sector and other donor and development agencies. The ESTO is not a formula of what should be done by the country or the public sector actors.

The ESTO is a means of obtaining feedback to enrich our understanding of the power sector in Peru and to identify support activities and synergies with other donor and development agencies.



"A decentralized, reliable, flexible, resilient, cybersecure and environmentally friendly system, which meets demand through centralized and distributed energy resources that compete under the same conditions and, with affordable and fair prices and tariffs for the final consumer that reflect the real costs in the chain of generation, transmission, distribution and commercialization, enabled by digitalization, automation and greater connectivity of systems".

> Jaime Luyo K., Vice Minister of Electricity June 2023



Energy Transition Agenda



"Countries with considerable energy and mineral resources have the opportunity to define an economic and social development strategy for the coming decades, the "golden age", towards a productive diversification of goods and services with a high technological component, participating competitively at the regional and global level."



Source: presentation of the Vice Minister of Electricity of the MINEM, June 2023

Strategy for the Short-Term

Agenda

Infrastructure:

- Rural electrification
- Transmission projects

Modernisation of the regulatory framework:

- Modification of the Law 28832 to promote renewable energies
- Distributed Generation
- Minimum standards of energy efficiency for lighting
- Electric Mobility promotion
- Road map for H2V



Ministerio de Energía y Minas



Source: presentation of Jaime Luyo K., Vice Minister of Electricity, Jun 2023

Strategy for the Mid-Term

Agenda

- Update the National Energy Policy to 2050
- Develop the National Energy Plan to 2050
- Create an Energy Planning Office
- Conclude the preparation of Third Reform of the Electricity Subsector
- Promote investments in the expansion of electricity generation, transmission and distribution
- Promote the execution of the Investment Projects in Transmission
- Execute 115 rural electrification projects
- Conclude the Peru-Ecuador electrical interconnection process and initiate others



J Ministerio de Energía y Minas



Source: presentation of Jaime Luyo K., Vice Minister of Electricity, Jun 2023

Peru's Energy Transition Targets & Regulatory Indicators

	Emissions reduction ⁽¹⁾	Total net emission below 179 MtCO2e	2030	Ø
		Net zero emissions (strategy in development	^{t)} 2050	Ø
	Renewable Energy ⁽²⁾	20% of electricity generation	2030	Ø
	Lifergy	100% of electricity generation (strategy in d	levelopment) 2050	Ø
Taurasta	Energy Efficiency			Ċ
Targets	Distributed Generation			đ
	Green Hydrogen ⁽³⁾	Proposed strategy: 12 GW electrolyzer capacity ~1 USD/kgH2	2050	Ø
	Electromobility ⁽⁴⁾	Incorporate 6,700 electric buses and 171,00 vehicles in the next ten years	0 electric 2032	Ø
Degulatory Indicate	Energy Efficienc Regulatory Indic	• y : Multidimensional cator (ESMAP, 2019)	10	2
	Renewable Ener Regulatory Indie	gy : Multidimensional cator (ESMAP, 2019) 1	•	4,3
ce: own elaboration based on (1) Na cransform study, overview (2) Lan gy assessment of Latin (3) htt ica and the Caribbean roa (4) htt cir	tionally Determined Contributions - <u>h</u> v of climate emergency (published Ja ps://www.bnamericas.com/en/news/ idmap-in-peru ps://gestion.pe/economia/gobierno-e sulando-en-peru-hacia-2030-npdc-no	https://unfccc.int/NDCREG anuary 2022) /h2-peru-publishes-its-proposal-for-a-green-hydrogen- gestima-que-177000-vehiculos-electricos-estaran- ticia/	*The Regulatory Indicators fo by ESMAP are absolute scores Pass or no-pass questions rela https://rise.esmap.org/indicat	r Sustainable Energy (RI s from 1 to 10 calculated ated to sub-indicators. tors

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Energy Snapshot



Source: OurWorldInData.org and data.worldbank.org

Key Figures

Economy

Population: 33 million

The economy of Peru is an emerging, social market economy characterised by a high level of foreign trade.

Energy

The electricity and energy consumption per capita have increased in the last 20 years, still below the average.

Access to electricity has improved due to government programmes.

Availability of renewable energy resources for generation (solar, wind, hydro), also natural gas.

Energy Snapshot

- Electricity demand in Peru has grown strongly in the last 20 years, mainly thanks to the mining and construction sectors' demand growth.
- Hydroelectricity and thermal generation (mainly natural gas and diesel for reserve) represent most of the electricity mix.
- Electricity spot prices mainly driven by weather patterns and regulated natural gas price (from Camisea field). Seasonality of spot prices.
- Peru owns significant gas reserves (Camisea field, among others), well exploited, but gas does not deserve all regions in Peru. A project of gas pipeline (GSP) to transport gas to the South is been discussed.
- Wind/Solar: low deployment and growing participation.
- Electricity interconnection with Ecuador, Peru being mainly exporter, project with Chile in study. Interconnections with Bolivia, Brasil and Colombia haven't progressed so far.





National Peruvian Energy Policy

2010-2040

- Diversified energy matrix, with emphasis on renewable sources and energy efficiency
- Competitive energy supply
- Universal access to energy supply
- Enhance efficiency in the production chain and energy use
- Self-sufficient in the energy production
- Develop an energy sector with minimal environmental impact and low carbon emissions within a framework of Sustainable Development.
- Develop the natural gas industry, and its use in household activities, transportation, commerce and industry, as well as efficient electricity generation
- Strengthen the energy sector governance
- Integration with the regional energy markets



PERÚ Ministerio de Energía y Minas



Source: D.S. 064-2010-EM, National Energy Policy, MINEM

Generation Mix & Installed Capacity

0%

44%

RER otros

1%



13.1 GW

58.4 TWh Energy production (2023)



A large proportion of generation capacity is for liquid fuels; however, it is used only if there is a relevant unavailability in the system.

More than 90% of the energy produced is covered by hydroelectric and natural gas plants, solar and wind renewables are growing. The factor for natural gas is growing the last years. Very good factors for wind and solar resources.

Capacity Factor

by resource (2023)

70%



4%

0%

Hidro

RER Eólico

RER Solar

RER otros Gas Natural

■ Carbón

D2-R6-R500

Regulation and Energy Policy Instruments

Structural Reform

1992

- Law 25.844 of Electrical Concessions (LCE): defines organisation, structure and operation of the market.
- Generation is organised in a competitive market, transmission and distribution are considered natural monopolies

DL 1002: Promoting investment in renewable energy generation

 Promote the participation of RER (solar, wind, hydro <20MW, biomass, etc.), with an initial objective of 5% (without hydro)

Law 29970: Security of Supply

2012

 Strengthen energy security through the diversification of energy sources and encouraging the development of natural gas pipelines and a petrochemical pole in the South

Resolution Osinergmin 144/2019: vRE capacity

2019

 Modifies the "Firm Capacity Calculation" for vRE. It establishes that for solar and wind generators, this parameter will be determined with their production during the peak hours (from 17 to 23 hours)

Renewable Law, Supreme Decree Climate Emergency

 Government declared the climate emergency of national interest, in order to allow actions in accordance with the NDCs. It establishes a projected 20% of RER participation by 2030

2022

> 2008

2010

Law 28832: Ensuring the efficient development of electricity generation

2006

 A series of regulations were approved to address a reform in the electricity market, related to PPAs, transmission, generation market, and electricity rates

National Energy Policy

- Diversified energy matrix, with emphasis on renewable sources and energy efficiency. Competitive energy supply
- Universal access to energy supply
- Develop the natural gas industry

DS 043-2017-EM and DS 031-2020-EM, Natural gas prices for generation

2017

 Regulatory changes regarding the declaration of the price of natural gas for generation dispatch (spot market)

Commission for the electricity sector reform (CRSE)

2019

• The CRSE has been installed in June 2019 to propose regulation changes



Key Stakeholders in Current Power Supply Market

Institution		Description
Ministry of Energy and Mines (MINEM)	PERÚ Ministerio de Energía y Minas	The Ministry of Energy and Mines (MINEM) defines the national energy policies, regulates topics from the energy sector, and oversees the granting, supervision, maturity, and termination of licenses, authorizations, and concessions for generation, transmission, and distribution activities. There are three sub sectors: electricity, hydrocarbons and mining.
Regulatory Agency for Investment in Energy and Mining (Osinergmin)	Organismo Supervisor de la Inversión en Energía y Minería	Osinergmin (Organismo Supervisor de la Energía y Minería) is an autonomous public regulatory entity. It controls and enforces compliance with legal and technical regulations related to electrical, hydrocarbon, and mining activities; and with the obligations stated in the concession contracts. Osinergmin is in charge of publishing the regulated tariffs and also supervises the regulated processes required by distribution companies to purchase energy from generators.
Power System Operator (COES)	COES	COES (Comité de Operación Económica del Sistema) is Peru's power system operator. The entity is in charge of coordinating the operation and dispatch of the transmission network and the generation units (TSO) in the National Interconnected Electric System ("SEIN"), which is the only relevant interconnected system in Peru. It is also in charge of the transactions in the wholesale electricity market (spot market), and the planification of the transmission network.
Public and Private Sector Entities	Vertica Ministerio del Ambiente Constantional de MINERIA PETROLEO Y ENERGIA	 Further Key Players: The Ministry of Environment (MINAM)'s mandate is to design, establish, and execute government policies concerning the environment. INDECOPI: Peruvian Competition Authority, prevents the risks of engaging in anti-competitive behaviour in the markets. SNMPE, the National Society of Mining, Oil and Energy, is the most important union of the sector in the country that brings together more than 140 companies in the energy and mining sector. SPR is the Peruvian Energy Renewables Association.



Electricity Market Structure

LEGEND





Electricity Grid Map

Historically, hydraulic resources and natural gas (mainly from Camisea) are used for electricity generation, together they supply more than 90% of the electricity demand.





Source: MINEM, COES Note: Feb. 2023, max. demand 7600 MW (HP)



Available Resources for Electricity Generation



70,000 MW of potential projects (mainly in Atlantic basins)

Camisea field currently supplies domestic market and export

20,000 MW (best areas in the North and Centre of the coast)

World-class indicators for solar radiation in the South

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Wind: Capital Cost Estimation 2019-2030, USD mil./MW



"Currently, Peru has the lowest CAPEX for onshore wind technology in the region: USD 1.05 million/MW, together with Mexico. This is due to very specific optimal conditions present in the wind farms that were awarded in the RER auctions in Peru, the capacity factors increased to 53%."...

Source: World Bank 2019, Wood Mackenzie



Electricity Scenarios







Electricity Scenarios

Projection: Capacity Supply^(*) and Demand



(*) Diesel generation not included



Long-Term Energy Scenarios



- Document: APEC Energy Demand and Supply Outlook 8th Edition
- Comparison of the Referential Scenario (REF) and the Carbon-neutral Scenario (CN)







Deloitte Study

- Document: Hoja de Ruta de Transición Energética hacia un Perú sin emisiones 2030 - 2050
- Comparison of the Increased ambition Scenario and the Green development scenario.

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Source: APEC <u>https://www.apec.org/Groups/SOM-Steering-Committee-on-Economic-and-Technical-Cooperation/Working-Groups/Energy</u>, Enel <u>https://www.enel.pe/es/sostenibilidad/transicion-energetica-peru-2050.html</u>

GET.transform Advisory Services

	LONG TERM ENERGY PLANNING	RENEWABLE ENERGY GRID INTEGRATION	ON-GRID REGULATION & MARKET DEVELOPMENT	OFF-GRID REGULATION & MARKET DEVELOPMENT
	Capacity Building			
	Knowledge Products			
Overarching	Peer-to-Peer Exchanges			
Activities	Technical Assistance			
	Governance	Grid Access Codes & Grid Impact Studies	Market Model Design	Integrated Electrification Planning
	Scenarios & Modelling	Transmission System Planning & Operation with vRE	Economic and Technical	Economic & Technical Regulation
	Adoption & Implementation	Distribution System Planning & Operation with vRE	Regulation	Procurement of Access Technologies
Key Topics	Investment Opportunity Promotion	Introduction of Sector-Coupling Technologies	Procurement of RE Generation	Productive Use of Energy



Opportunities and Challenges

LONG TERM **RENEWABLE ENERGY ENERGY PLANNING GRID INTEGRATION** Untapped renewable energy potential: solar py, Good renewable energy resources close to the wind, storage, distributed generation, electricity transmission network. production and use of hydrogen as fuel. Preparation of the TSO for a higher share of Large resources of gas (Camisea) to meet renewables (solar and wind) is not a specific domestic demand. mandate. Capacity oversupply, low gas prices, market design and lower growth rates of demand slowing down new investments in vRE. Competitive natural gas prices and large share of hydroelectricity pose a challenge to the participation of vRE. Negative energy balance of trade despite potential competitive resources.



Attractive energy market for developers and investors seeking clean investments and diversification.

Capacity oversupply, low gas prices, market design and lower growth rates of demand slowing down new investments in vRE.

Negative energy balance of trade despite potential competitive resources.



OFF-GRID REGULATION & MARKET DEVELOPMENT



ENERGY PLANNING

RENEWABLE ENERGY GRID INTEGRATION

National Energy Plan - MINEM

LONG TERM

The long-term National Energy Plan (NEP), is the responsibility of the MINEM, specifically of the Direction of Energy Efficiency.

Transmission Expansion Plan

The electricity system operator (COES) develops the mandatory transmission plan, which considers the referential generation and transmission projects in a 10-year horizon. The MINEM approves the transmission projects to be built in a 5-years horizon.

Sector Studies

- Mandatory: National Energy Plan, Renewable Energy Plan, Electricity Transmission Plan, Rural Electrification Plan, Energy Efficiency Plan.
- Non mandatory studies: Electricity National Plan.

These studies should be related each other.

The Energy Policy was issued in 2010.

In each process (studies and policies), a consultation process should be considered.



ON-GRID REGULATION & MARKET DEVELOPMENT



OFF-GRID REGULATION & MARKET DEVELOPMENT

Different Sector Studies within MINEM:



National Energy Plan development (NEP) and GET.transform support:



LONG TERM ENERGY PLANNING



RENEWABLE ENERGY GRID INTEGRATION

ON-GRID REGULATION & MARKET DEVELOPMENT



OFF-GRID REGULATION & MARKET DEVELOPMENT

Identified Technical Assistance OPPORTUNITIES

- Enhance data (historical) and modeling representation (TIMES)
- Electricity National Plan: Electricity model represented in TIMES
- Update of optimisation features: Increasing the modeling features with a more flexible structure
- National Energy Plan to 2050 (edition 2023 and 2024)
- Include Distribution aspects in NEP

- Energy surveys' methodology
- Energy Planning governance
- Renewable Energies National Plan
- Update of the energy policy
- Interphase between different plans within the energy sector
- Hydro/RER complement (storage)



LONG TERM ENERGY PLANNING



RENEWABLE ENERGY GRID INTEGRATION

Grid Operations

The system is integrating renewable energies (vRE) without relevant changes in the technical regulations.

The grid codes for Renewable Power Plants connected to the system could be reviewed and updated.

In case of the participation of storage alternatives, such as batteries, there is not regulation and sometimes is not considered in the sector plans.

A higher share of vRE implies additional requirements for the supply/demand balance. The ancillary services should be updated accordingly.

Electricity Interconnection

There is the opportunity to develop the interconnection to neighborhood countries not only because of economical reasons, but also to complement the development of the electricity generation with renewable resources.



ON-GRID REGULATION & MARKET DEVELOPMENT



OFF-GRID REGULATION & MARKET DEVELOPMENT

Identified Technical Assistance OPPORTUNITIES

- Technical and Regulatory Recommendations to Improve VRE forecasting (pilot forecasts and regulatory draft)
- Review of the Grid Code (vRE Generation)
- Technical requirements to increase the participation limit of vRE
- BEES: regulatory framework development
- Ancillary Services for a higher level of vRE
- Power System Stability Study
- Exchange with other SOs in the region and capacity building on Renewable Energy Integration

* OPPORTUNITIES GET.transform is already supporting.



LONG TERM ENERGY PLANNING



RENEWABLE ENERGY GRID INTEGRATION

The Peruvian energy market structure has been evolving, for both electricity and hydrocarbon sub sectors. In case of the electricity market:

The system will be incorporating a higher share of generation with renewable energies. The price signals have influenced the demand behavior.

VRE in the Electricity Interconnected System

The current renewable power plants are being constructed:

With the current market rules

With the current technical requirements

Those issues need to be reviewed if the system is going to incorporate a significant higher share of vRE.

Distributed Generation

The distributed generation is growing, with little or no regulation standards or guidelines to assist the customers to develop these installations.



ON-GRID REGULATION & MARKET DEVELOPMENT



Identified Technical Assistance OPPORTUNITIES

- Collaboration with OSINERGMIN (WFER event, gender)
- Barriers for vRE investments
- Permitting processes for small scale generators
- Electricity demand curve evolution
- Electromobility
- Distributed Generation: modeling business cases

* OPPORTUNITIES GET.transform is already supporting.



LONG TERM



RENEWABLE ENERGY GRID INTEGRATION

MINEM published the Rural Electrification Plan.

For the rural and isolated electricity systems:

- 96% of the electricity demand is in the national interconnected system.
- The Ministry of Energy and Mines has a specific directorate responsible to attend the electrification of isolated systems.
- There are specific regulatory mechanisms to develop this market segment.



ON-GRID REGULATION & MARKET DEVELOPMENT



OFF-GRID REGULATION & MARKET DEVELOPMENT

Identified Technical Assistance OPPORTUNITIES

• Capacity Building on off-grid Renewable Energy market



COUNTRY WINDOW SETUP







Country Window Setup

Country	GET.transform HQ	Technical Assistance Partners
 1 x Country Coordinator 1 x Technical Advisor (50%) GIZ Country Office Peru, Cluster: Cities 	 1 x LAC Partnerships coordinator for overarching CW strategy support. 1 x Advisory Services Focal Point for LTEP and RE-Integration. 1 x Advisory Services Focal Point for Policy and Regulation. 	 Expert Consulting Pool for LTEP and RE- Integration. Expert Consulting Pool for Policy and Regulation.



Interaction with GIZ Peru Energy Portfolio

ELECTRIC DISTRIBUTION 4.0	GET.TRANSFORM	SFF H2V	
Distribution Network Development Framework	Power Sector Transformation	Green Hydrogen Development	
Improve the technical and regulation framework of the Smart Grids Support the Ministry of Energy and Mines and public electricity companies	 Long-Term Energy Planning Support the development of the National Energy Plan to 2050 Renewable Energy Grid Integration Support of the preparation of the TSO for a higher share of renewables (solar and wind) 	Support the development of the green hydrogen in Peru Coordination with the Ministry of Energy and Mines	
Support to renewable and efficiency energy projects	 On- and Off-Grid Regulation and Market Development Attractive energy market for developers and investors seeking clean investments and diversification 	Strategic and capacity development	



Alignment with Other Development Partners

GET.TRANSFORM	EUROPEAN INVESTMENT BANK	EUROCLIMA	INTERNATIONAL DEVELOPMENT BANK
Power Sector Transformation	Renewable Energy for Climate Action, LAIF Renewable Energy	Climate Policy Support	Renewable Energy, Green Hydrogen
 Long-Term Energy Planning Support the development of the National Energy Plan to 2050 	Promotion and implementation of energy matrix change in the forest, 60 to 80 vulnerable communities	Support in the implementation of the NDC, through technical studies	Support on electricity system planning, in power generation and transmission grid expansion
 Renewable Energy Grid Integration Support of the preparation of the TSO for a higher share of renewables (solar and wind) 	Capacities in social and environmental risks	Ministry of Energy and Mines / Ministry of Environment	Support on green hydrogen strategic development and technical analysis
 On- and Off-Grid Regulation and Market Development Attractive energy market for developers and investors seeking clean investments and diversification 	Loan facility: COFIDE		Support the development of the Peru Ecuador electricity interconnection.



Thank You for Your Attention



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