Global Gateway

Peru Country Window:

Energy System Transformation Outlook (ESTO)

GET.transform
Transforming Energy Sectors Globally

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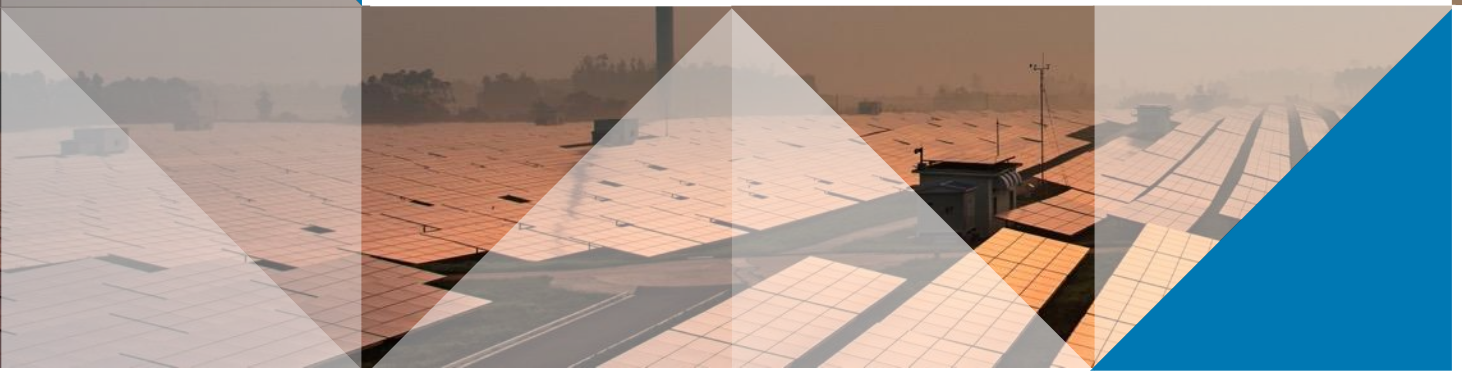
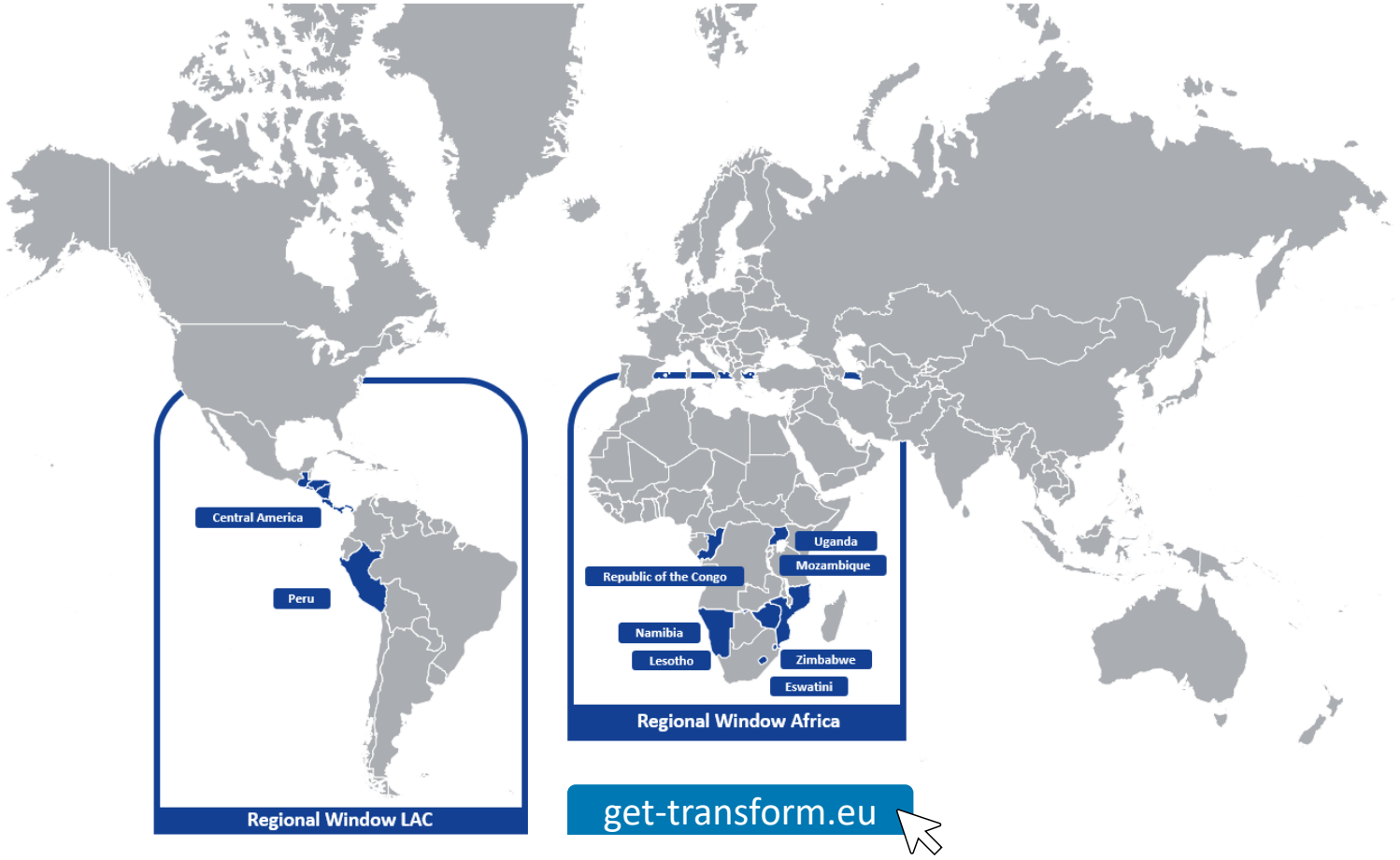
ABOUT GET.transform



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



GET.transform Workstreams

LONG TERM ENERGY PLANNING

Developing integrated energy and power system investment plans, outlining development paths for energy sector transformation

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

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

Design and management of solicited auctions as well as market-driven mechanisms for procuring on-grid energy

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

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PERU ESTO

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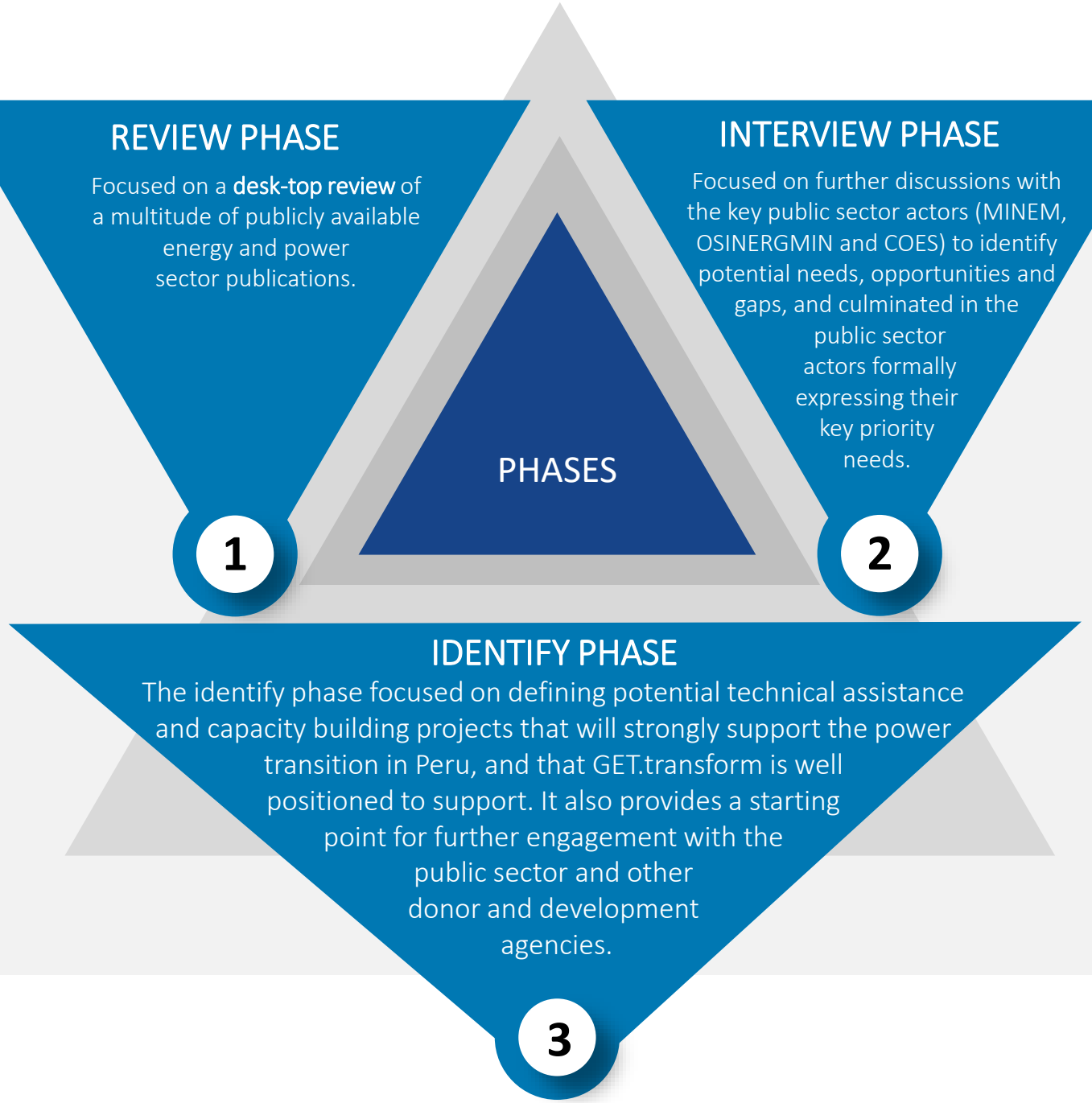
Foreword

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.



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.

Peru‘s Energy Vision

“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

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Energy Transition Agenda

PILLARS

The 3 As:
- Accessibility
- Affordability
- Acceptability

STRATEGIES AND GOALS

- Energy mix clean and sustainable
- Energy efficiency
- Fuel substitution
- Electrical mix decarbonised
- Electrification of energy consumption
- Use of renewables in the electricity sector
- Sustainable transport
- Promotion of new technologies (batteries, hydrogen, geothermal energy and others)
- Regional energy integration

IMPLEMENTATION

- Energy Transition Law*

"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

(*) To be proposed by MINEM

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Strategy for the MINEM

Agenda

Infrastructure:

- Promote the execution of the Investment Projects in Transmission
- Rural electrification
- Conclude the Peru-Ecuador electrical interconnection process and initiate others

Ongoing Regulatory modifications:

- Modification of the Law 28832 to promote renewable energies
- Distributed Generation
- Standards of energy efficiency for lighting

Modernisation of the regulatory framework:

- Update the National Energy Policy to 2050
- Develop the National Energy Plan to 2050
- Create an Energy Planning Office
- Third Reform of the Electricity Subsector
- Expansion of electricity generation, transmission and distribution
- Electric Mobility promotion
- Road map for H2V

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

PERÚ Ministerio de Energía y Minas

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Peru's Energy Transition Targets & Regulatory Indicators

Targets

Emissions reduction[1]	Total net emission below 179 MtCO2e	2030
	Net zero emissions (strategy in development)	2050
Renewable Energy[2]	20% of electricity generation	2030
	100% of electricity generation (strategy in development)	2050
Energy Efficiency		
Distributed Generation		
Green Hydrogen[3]	Proposed strategy: 12 GW electrolyzer capacity ~1 USD/kgH2	2050
Electromobility[4]	Incorporate 6,700 electric buses and 171,000 electric vehicles in the next ten years	2032

Regulatory Indicators*

Source: own elaboration based on GET.transform study, overview energy assessment of Latin America and the Caribbean

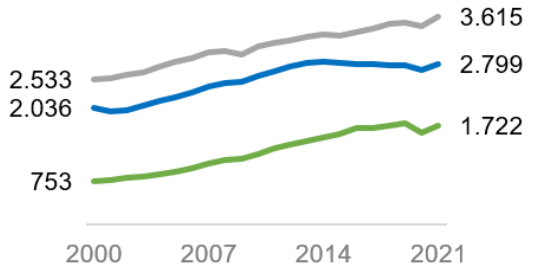
(1) Nationally Determined Contributions - https://unfccc.int/NDCREG
(2) Law of climate emergency (published January 2022)
(3) https://www.bnamericas.com/en/news/h2-peru-publishes-its-proposal-for-a-green-hydrogen-roadmap-in-peru
(4) https://gestion.pe/economia/gobierno-estima-que-177000-vehiculos-electricos-estaran-circulando-en-peru-hacia-2030-nndc-noticia/

*The Regulatory Indicators for Sustainable Energy (RISE) by ESMAP are absolute scores from 1 to 10 calculated with Pass or no-pass questions related to sub-indicators. https://rise.esmap.org/indicators

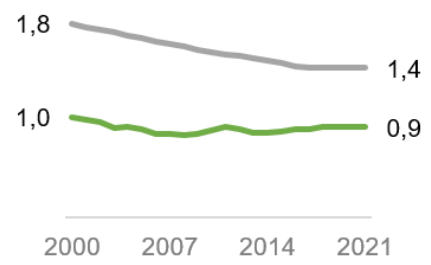
Energy Snapshot

World
South America
Peru

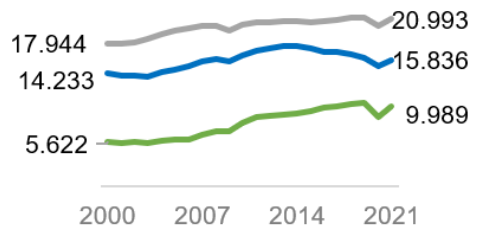
Per capita electricity consumption (kWh/person)



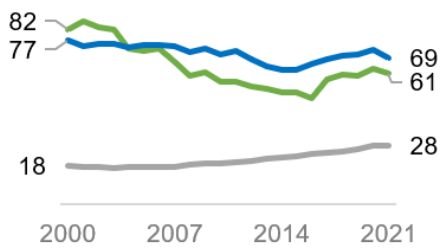
Energy intensity (kWh per 2011$ PPP)



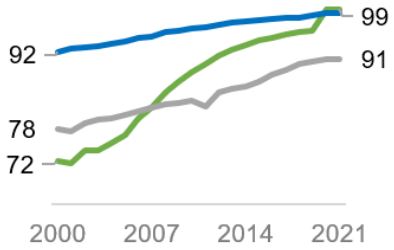
Per capita energy consumption (kWh/person)



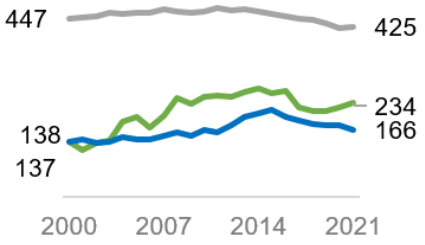
Renewable share of electricity (%, incl. Hydro)



Access to electricity (%)



Electricity carbon intensity (grams of CO2eq. per kWh)



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

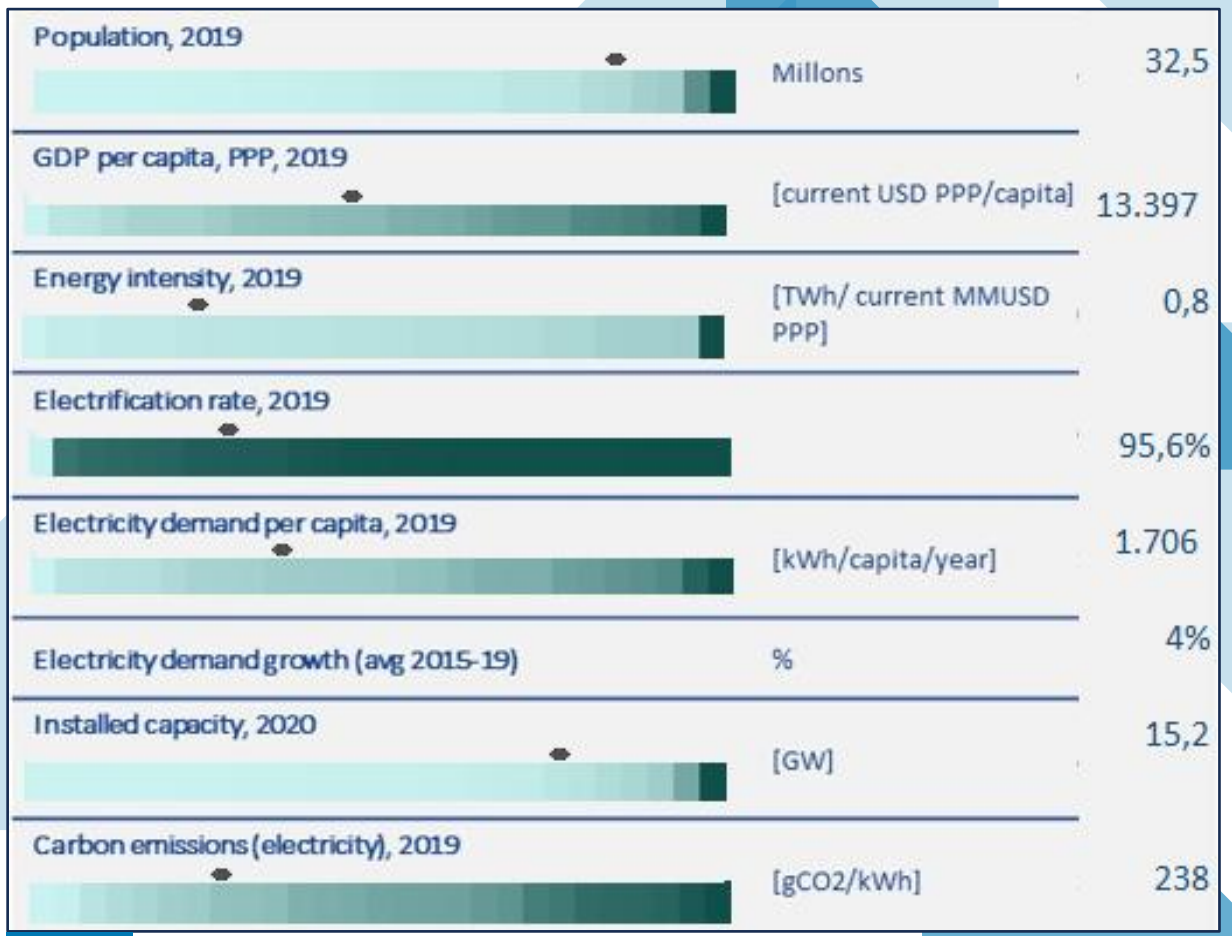
The electricity and energy consumption per capita have increased in the last 20 years, still below the average.

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: continuous 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.



KPIs

Source: Own elaboration based on World Bank, OurWorldInData.org, HubEnergia.org, IADB

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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

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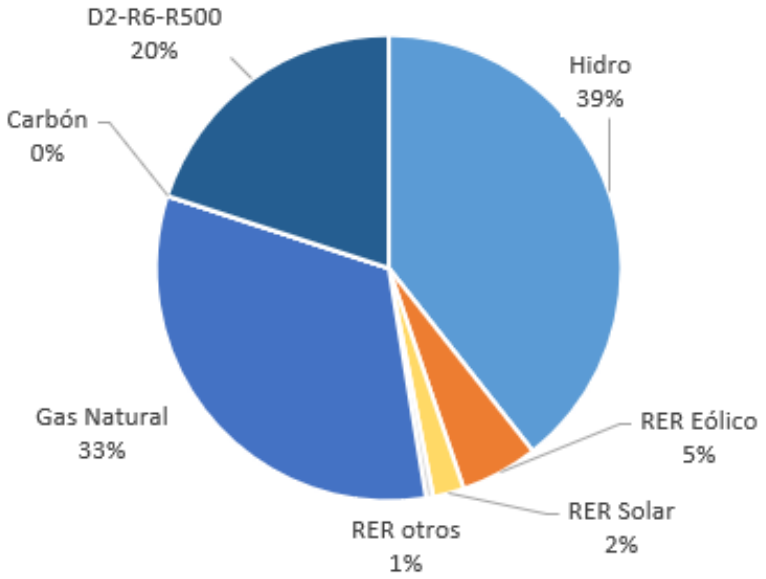
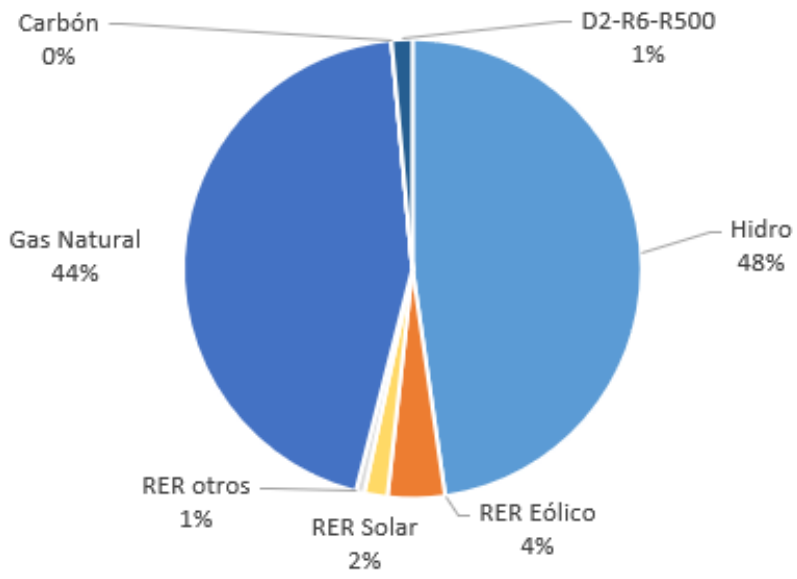
Generation Mix & Installed Capacity

13.1 GW
Capacity (Effective, Dec.2023)



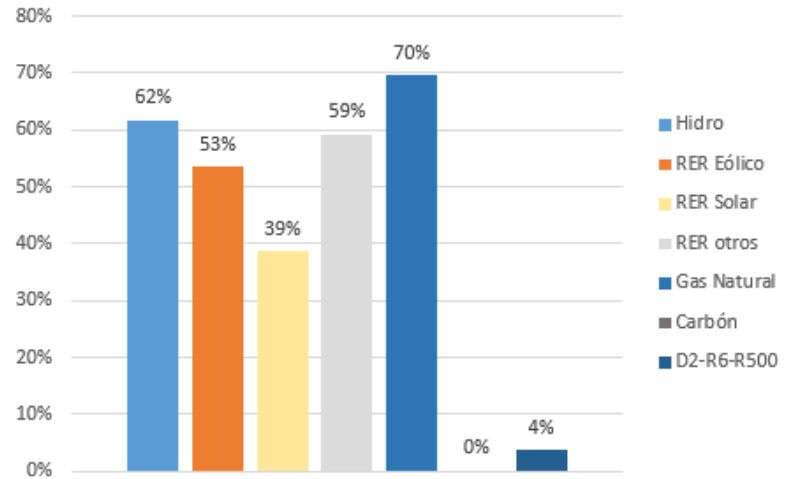
A large proportion of generation capacity is for liquid fuels; however, it is used only if there is a relevant unavailability in the system.

58.4 TWh
Energy production (2023)



More than 90% of the energy produced is covered by hydroelectric and natural gas plants, solar and wind renewables are growing.

Capacity Factor
by resource (2023)



The factor for natural gas is growing the last years. Very good factors for wind and solar resources.

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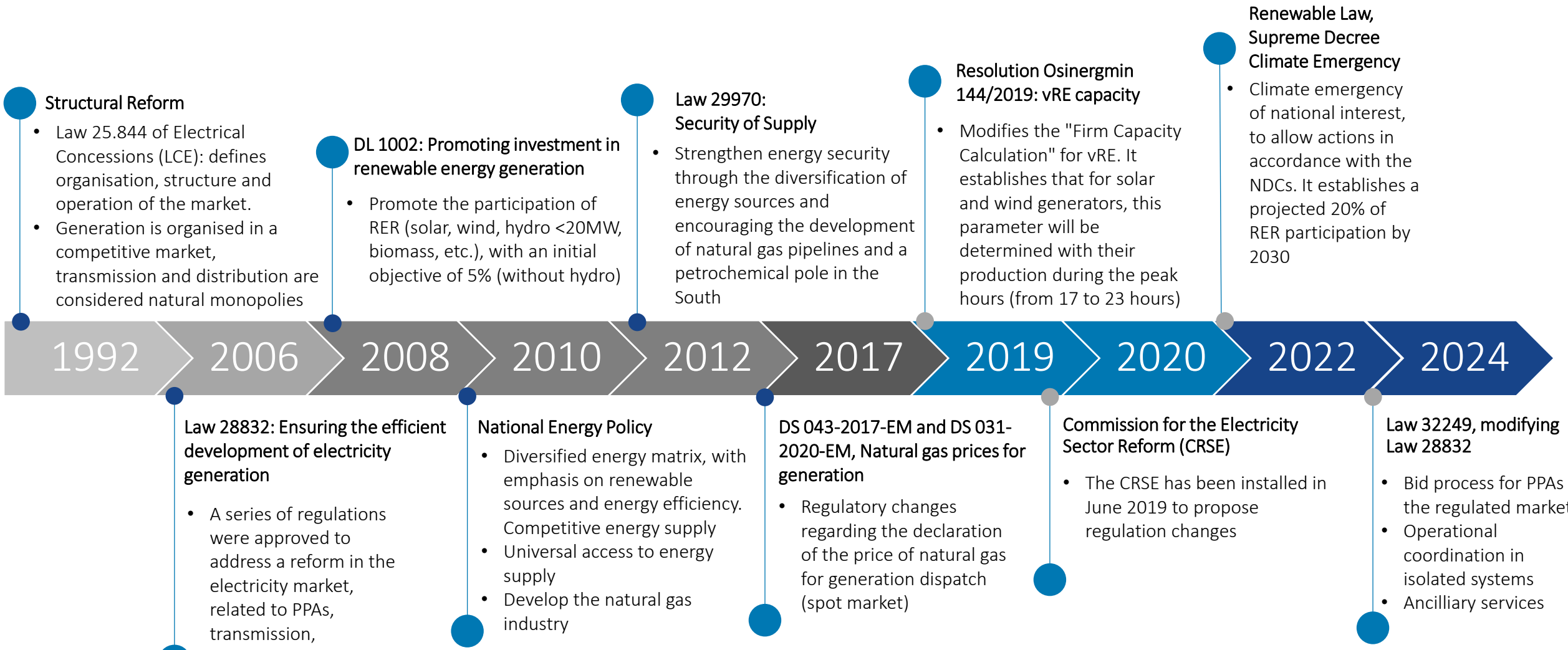
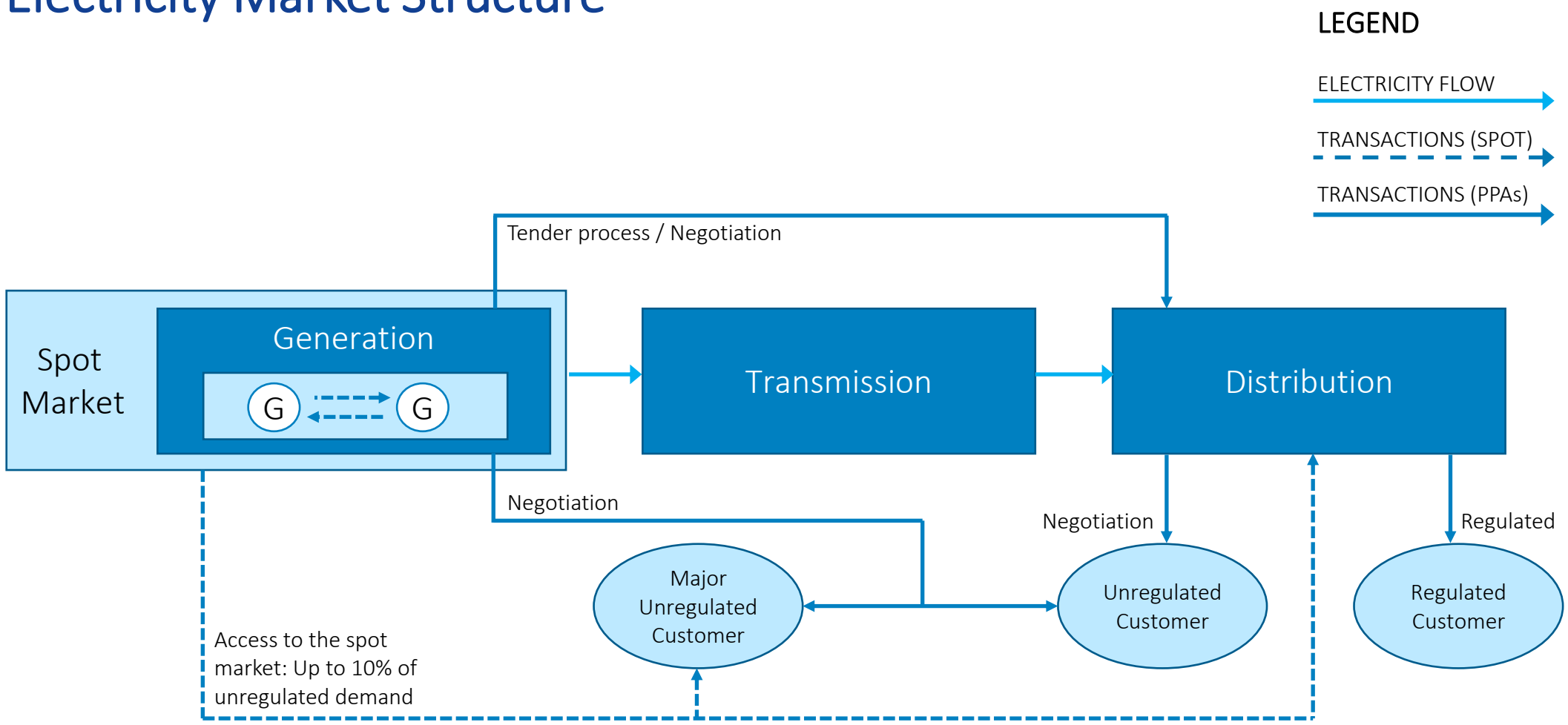
Regulation and Energy Policy Instruments



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, authorisations, 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)	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	PERÚ Ministerio del Ambiente Indecopi Sociedad Nacional de MINERIA PETROLEO Y ENERGIA SPR Asociación Peruana de Energías Renovables	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



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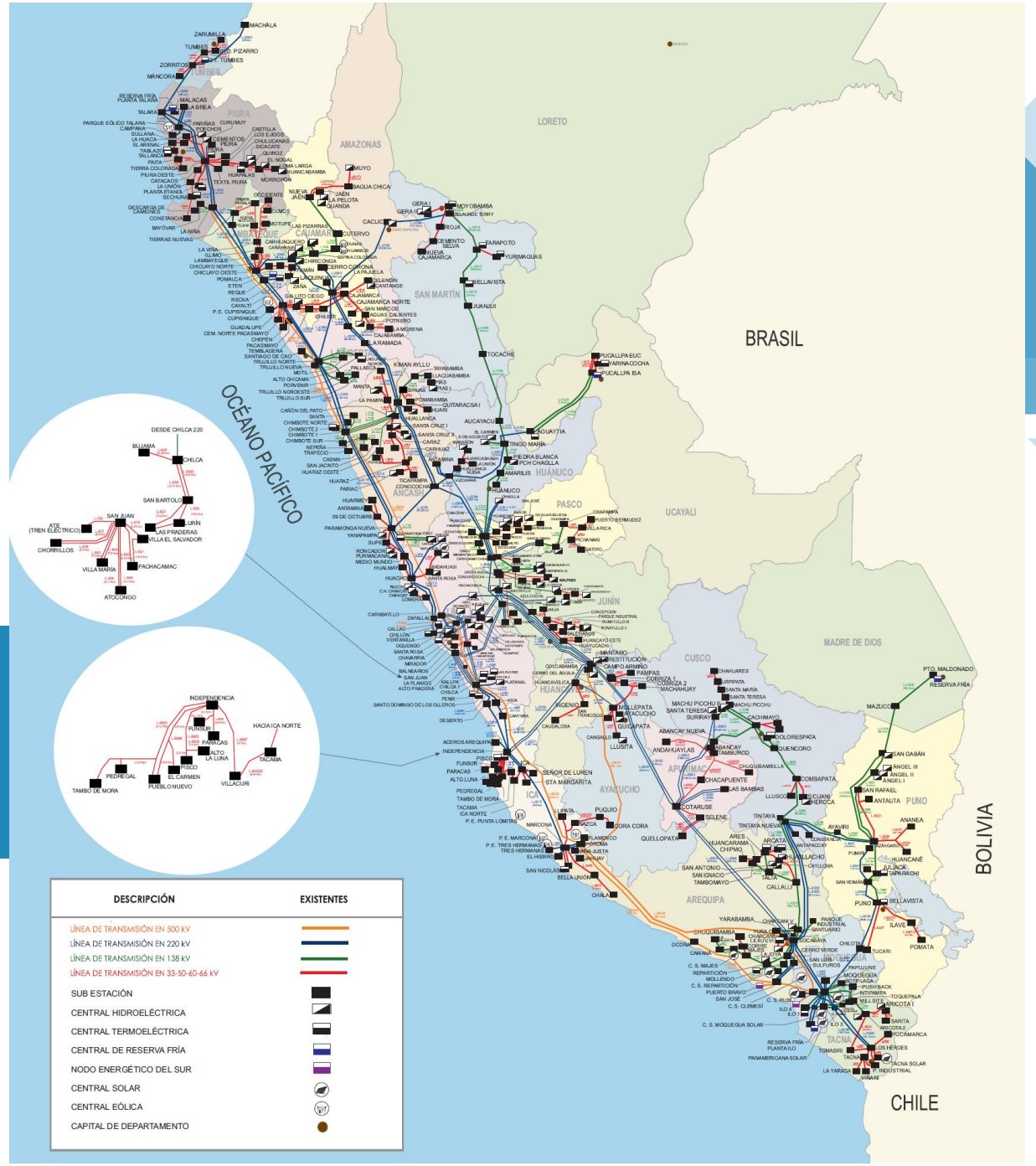
Electricity Grid Map

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

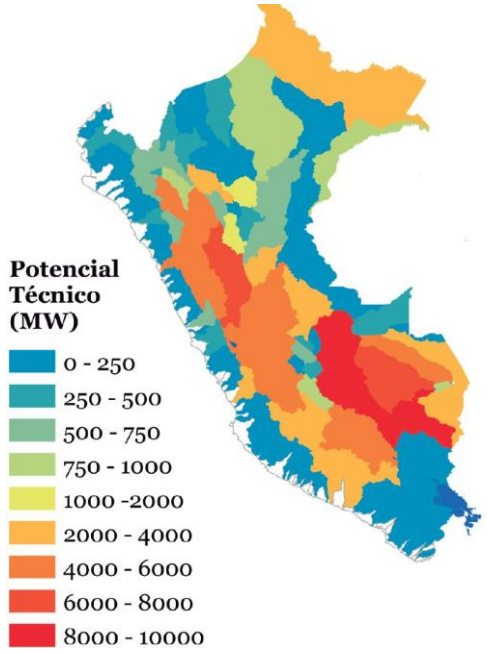
90%



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

Available Resources for Electricity Generation

Hydro

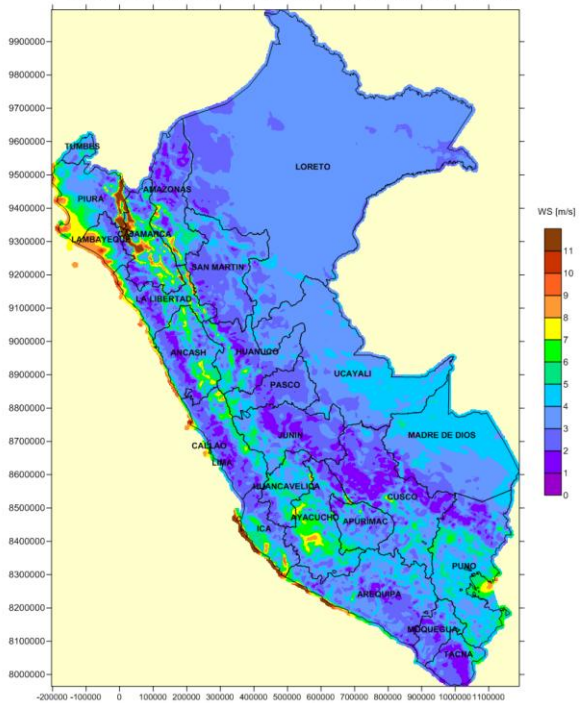


70,000 MW of potential projects (mainly in Atlantic basins)

Natural Gas

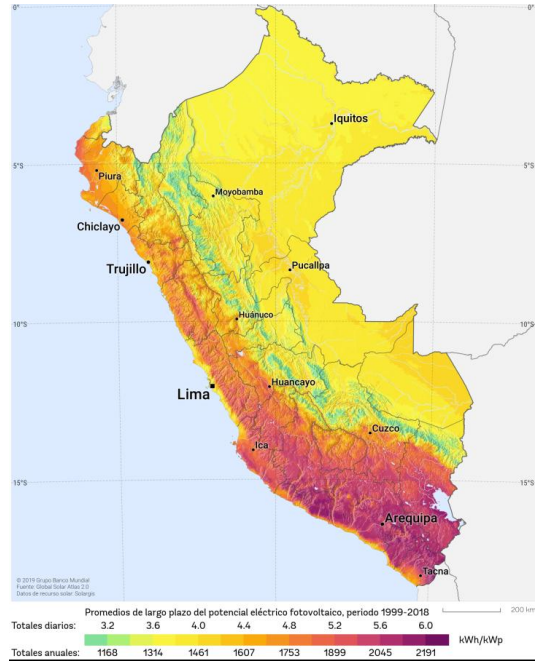
Camisea field currently supplies domestic market and export

Wind



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

Solar



World-class indicators for solar radiation in the South

Sources: MINEM, COES

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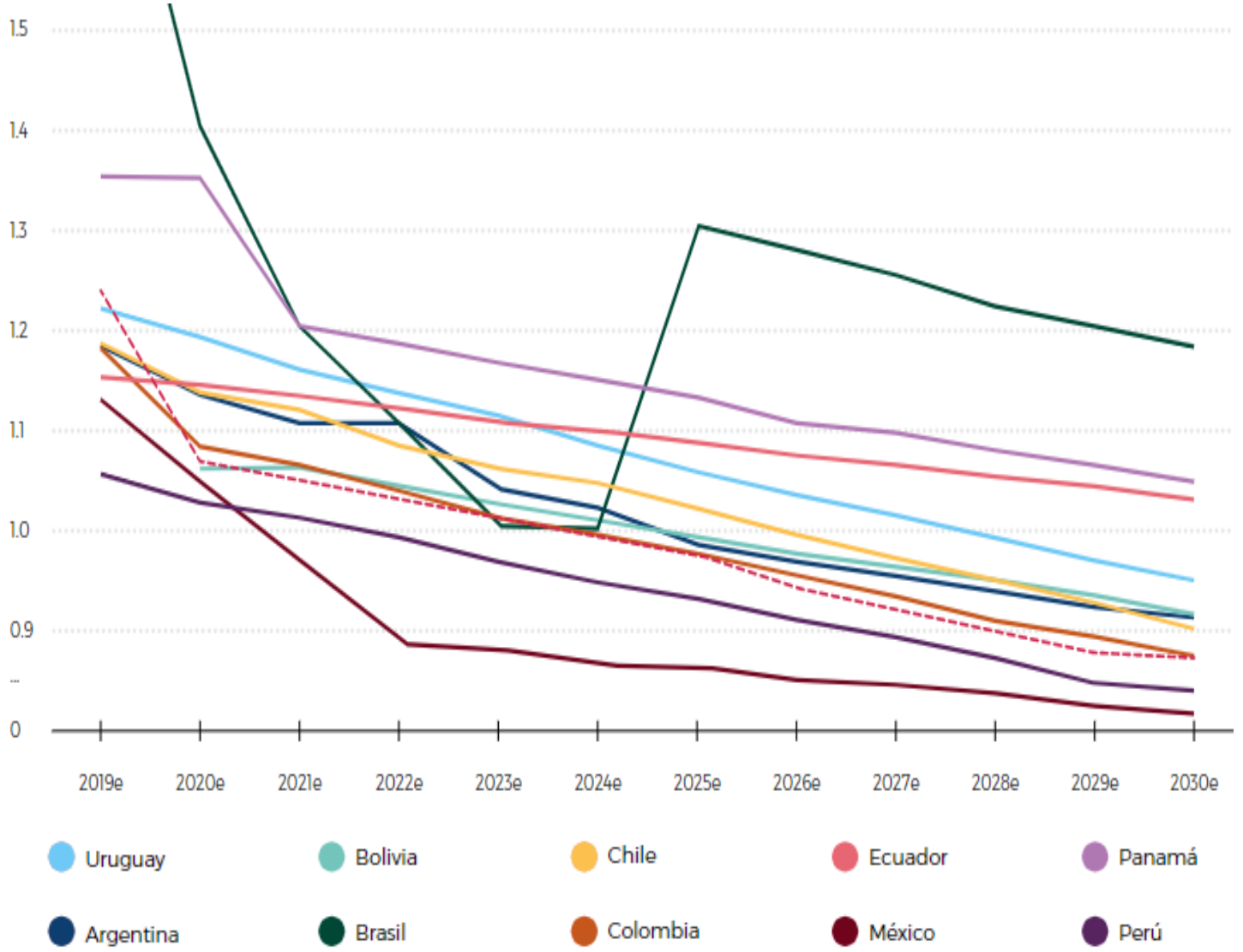
Wind: Capital Cost Estimation 2019-2030, USD mil./MW



"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

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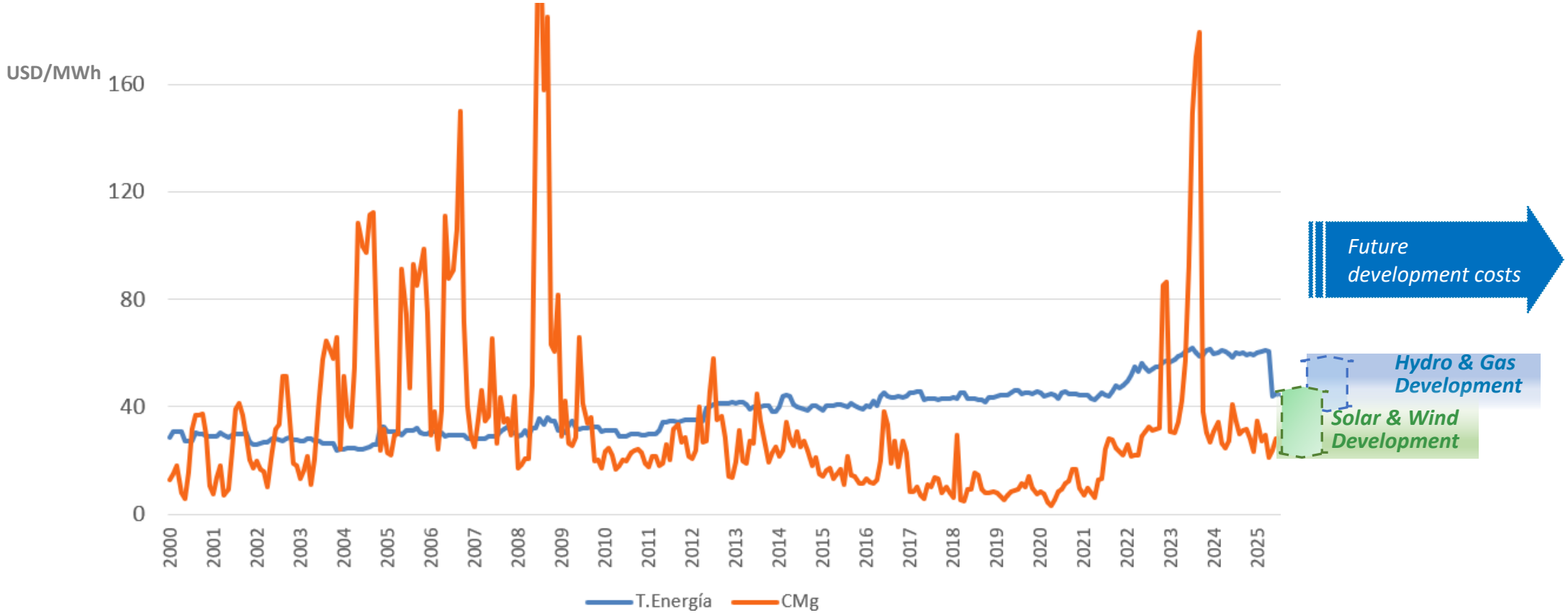
Electricity Scenarios

Historical : Marginal cost in the interconnected system



Source: COES for marginal cost, own estimation in development costs

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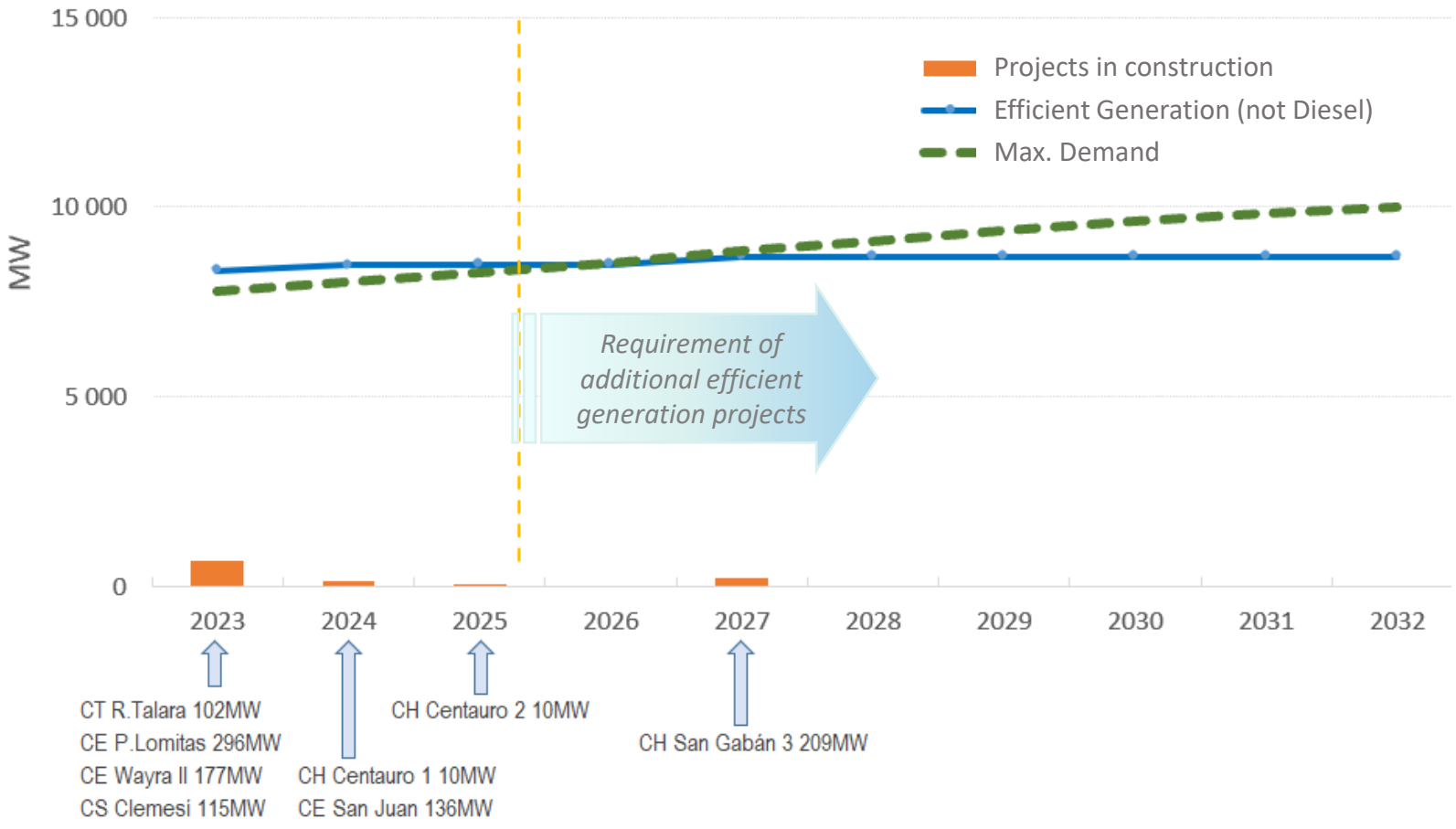
Electricity Scenarios

Projection: Capacity Supply(*) and Demand



(*) Diesel generation not included

Source: COES, 2023 Balance entre la oferta de generación eficiente (hidroeléctrica, gas natural, RER) versus demanda en estiaje – Escenario de Demanda Media.

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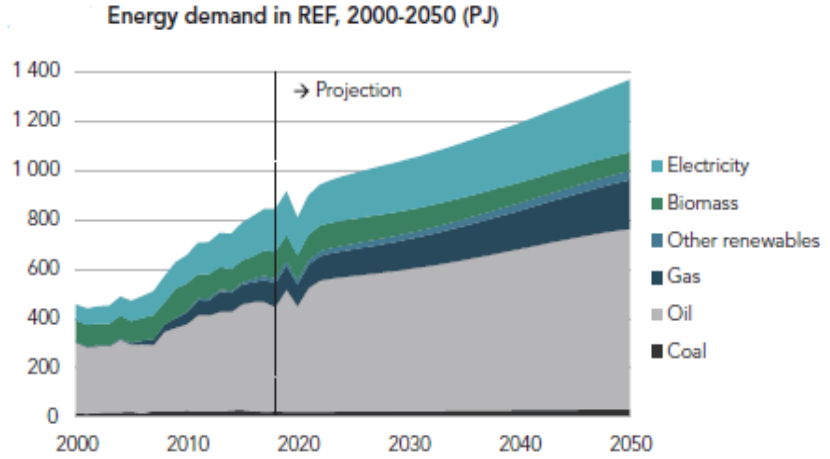
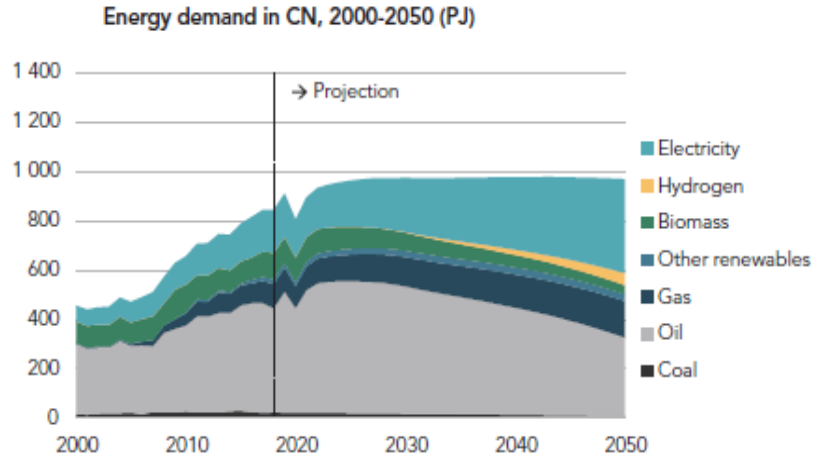
Long-Term Energy Scenarios

APEC Study

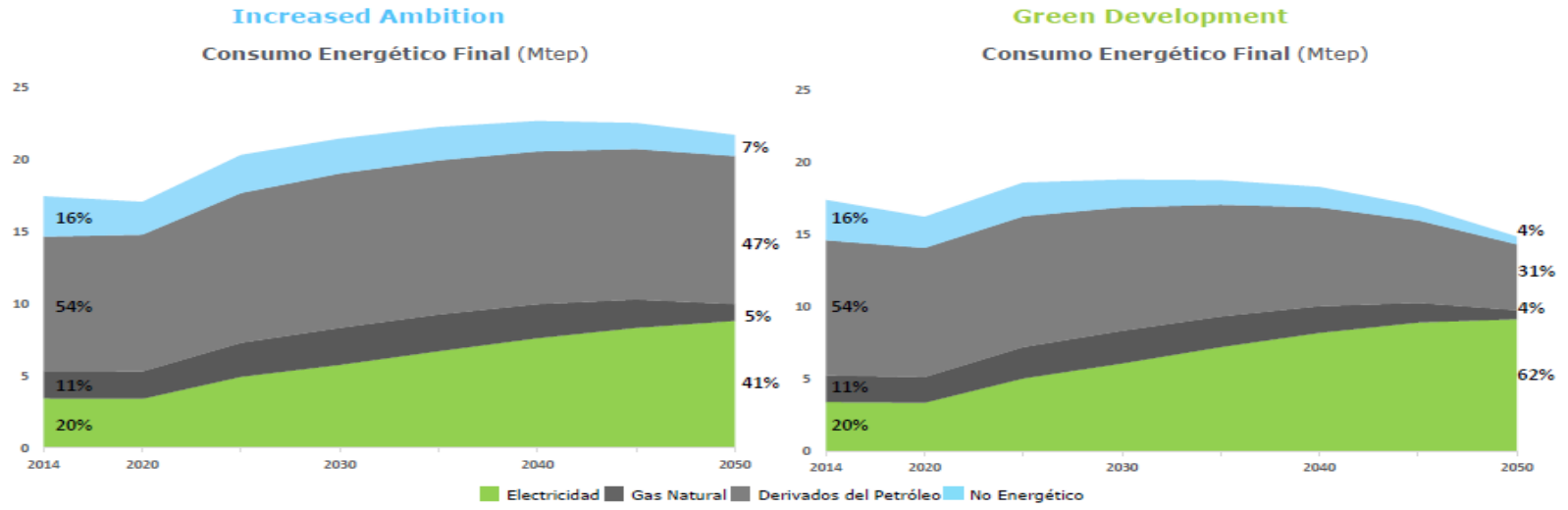
- Document: APEC Energy Demand and Supply Outlook 8th Edition
- Comparison of the Referential Scenario (REF) and the Carbon-neutral Scenario (CN)





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.



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

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GET.transform Advisory Services

Overarching Activities	Capacity Building			
	Technical Assistance			
Key Topics	Governance and Consultation	Grid Codes	Power Sector Strategy	Integrated Electrification Planning
	Scenarios and Modelling	Transmission System Planning and Operation	Governance	Mini-Grid Framework
	Adoption and Communication	Distribution System Planning and Operation	Market Mechanisms	Public Mini-Grid Incentives

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State of Play

LONG TERM ENERGY PLANNING | RENEWABLE ENERGY GRID INTEGRATION | ON-GRID REGULATION & MARKET DEVELOPMENT | OFF-GRID REGULATION & MARKET DEVELOPMENT

National Energy Plan - MINEM
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.

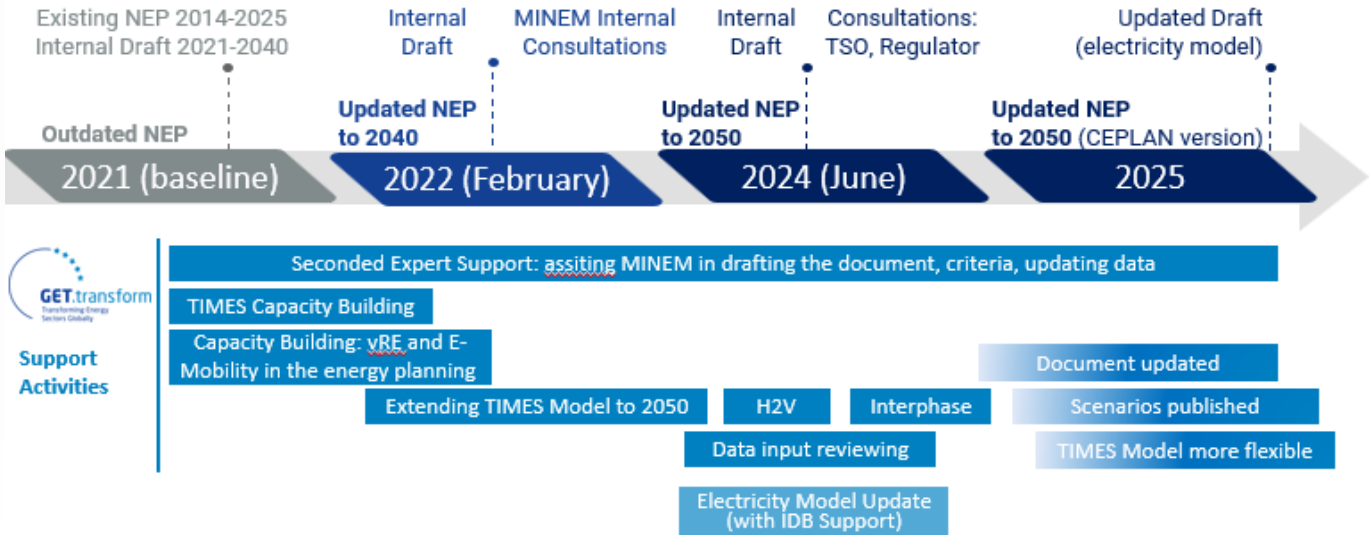
These studies should be related each other.

The Energy Policy was issued in 2010.
In each process (studies and policies), a consultation process should be considered.

Different Sector Studies within MINEM:

- Renewable Energy Plan
- Referential Plan for Energy Efficiency Use
- Hydrocarbon Plan
- Electricity Plan
- Rural Electrification Plan

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



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State of Play

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 interphases between models and a more flexible structure
- National Energy Plan to 2050 (edition 2025)
- Include Distribution aspects in NEP
- Capacity building in energy planning and modeling.
- Energy surveys' methodology (end users)
- Energy Planning governance
- Renewable Energies National Plan
- Update of the energy policy
- Interphase between different plans within the energy sector
- Hydro/RER complement (storage)

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State of Play

LONG TERM ENERGY PLANNING

RENEWABLE ENERGY GRID INTEGRATION

ON-GRID REGULATION & MARKET DEVELOPMENT

OFF-GRID REGULATION & MARKET DEVELOPMENT

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.

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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

State of Play

LONG TERM ENERGY PLANNING

RENEWABLE ENERGY GRID INTEGRATION

ON-GRID REGULATION & MARKET DEVELOPMENT

OFF-GRID REGULATION & MARKET DEVELOPMENT

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.

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

State of Play

LONG TERM ENERGY PLANNING

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ON-GRID REGULATION & MARKET DEVELOPMENT

OFF-GRID REGULATION & MARKET DEVELOPMENT

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.

Identified Technical Assistance OPPORTUNITIES

- Capacity Building on off-grid Renewable Energy market

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Technical Assistance Options

LONG TERM ENERGY PLANNING

- Support in the development and subsequent adoption of the National Energy Plan (PEIN)
- Develop one or two future scenarios (SF) as part of PEIN 2050
- Enhancing data and modeling representation in TIMES
- Capacity Development Package in Energy Planning (Data, Tools, Processes)
- Analysis of input files for TIMES energy model
- Support in the development of the National Energy Policy
- Develop an 'Interface' tool to connect TIMES data with planning documents
- Supporting the development of best practices for the development of hydrogen roadmaps in the APEC region

RENEWABLE ENERGY GRID INTEGRATION

- Analysis of the use of storage technologies to stabilise the southern part of the SEIN
- Piloting vRE forecasting and optimised day-ahead scheduling
- Development of a methodology for the analysis of the capacity to integrate solar and wind in the transmission

ON-GRID REGULATION & MARKET DEVELOPMENT

- Application Guideline for distributed generation
- Support in regulation related to Energy Biding process and Isolated Systems Operational coordination
- Support in the regulation on Smart Metering Infrastructure
- Support the project that eliminates the exemption for NCRE from providing Primary Frequency Regulation
- Support the development of market mechanisms for ancillary services

OFF-GRID REGULATION & MARKET DEVELOPMENT

Activities supported by GET.transform: Ongoing | Planned | Completed | Not Covered

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3

COUNTRY WINDOW SET-UP

Country Window Setup

Country

- 1 x Country Coordinator
- 1 x Technical Advisor (50%)
- GIZ Country Office Peru, Cluster: Cities

GET.transform HQ

- 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.

Technical Assistance Partners

- 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 (concluded in 2024)

Distribution Network Development Framework

Improve the technical and regulation framework of the Smart Grids

Support the Ministry of Energy and Mines and public electricity companies

Support to renewable and efficiency energy projects

GET.TRANSFORM

Power Sector Transformation

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)

On- and Off-Grid Regulation and Market Development

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

SFF H2V

Green Hydrogen Development

Support the development of the green hydrogen in Peru

Coordination with the Ministry of Energy and Mines

Strategic and capacity development

Alignment with Other Development Partners

EU-SUPPORTED

GET.TRANSFORM	EUROPEAN INVESTMENT BANK	EUROCLIMA	INTERNATIONAL DEVELOPMENT BANK	WORLD BANK
Power Sector Transformation	Renewable Energy for Climate Action, LAIF Renewable Energy	Climate Policy Support	Power Sector Transformation	**Energy and Climate**
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) On- and Off-Grid Regulation and Market Development • Attractive energy market for developers and investors seeking clean investments and diversification	Promotion and implementation of energy matrix change in the forest, 60 to 80 vulnerable communities Capacities in social and environmental risks Loan facility: COFIDE	Support in the implementation of the NDC, through technical studies Ministry of Energy and Mines / Ministry of Environment	Support on electricity system planning, in power generation and transmission grid expansion Support on green hydrogen strategic development and technical analysis Support the development of the Peru-Ecuador electricity interconnection and other regional initiatives.	Support on energy policy Support in strengthening climate change adaptation and promoting decarbonised development. Promotion of the development of a greener electricity supply with reduced greenhouse gases.

Thank You for Your Attention

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