

Power Sector Decarbonization Action Plan Series: Chile

October 17, 2023

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Webinar & Speaker Introductions

Moderated by Jal Desai, National Renewable Energy Laboratory

October 17, 2023

Agenda

- Overview of the Clean Energy Solutions Center
- Overview of the 21st Century Power Partnership
- Presentation from Ministry of Energy, Chile
- Q&A

Webinar Speakers



Prateek Joshi

Energy Engineer,
**National Renewable
Energy Laboratory**



Jal Desai

Systems Engineer,
**National Renewable
Energy Laboratory**



Alex Santander Guerra

Head of Energy and Environmental
Studies and Policy Division,
Ministry of Energy Chile



Matías Paredes Vergara

Energy Planning and Regulation Analyst,
Energy Planning and New Technologies Unit,
Ministry of Energy Chile

Overview of the Clean Energy Solutions Center

Presented by Jal Desai, National Renewable Energy Laboratory

October 17, 2023

The Clean Energy Solutions Center



OBJECTIVE

To accelerate the transition of clean energy markets and technologies.

RATIONALE

Many developing governments lack capacity to design and adopt policies and programs that support the deployment of clean energy technologies.

AMBITION/TARGET

Support governments in developing nations of the world in strengthening clean energy policies and finance measures

ACTORS

Leads:



Operating Agent:



Partners:

More than 40 partners, including UN-Energy, IRENA, IEA, IPEEC, REEEP, REN21, SE4All, IADB, ADB, AfDB, and other workstreams etc.

ACTIONS

- **Deliver** dynamic services that enable *expert assistance, learning, and peer-to-peer sharing of experiences*. Services are offered at no-cost to users.
- **Foster** dialogue on emerging policy issues and innovation across the globe.
- **Serve** as a first-stop clearinghouse of clean energy policy resources, including policy best practices, data, and analysis tools.

UPDATES

Website:

www.cleanenergyministerial.org/initiatives-campaigns/clean-energy-solutions-center

Factsheet:

www.nrel.gov/docs/fy22osti/83658.pdf

Requests: Now accepting Ask an Expert requests!

The Clean Energy Solutions Center



Ask an Expert Service

- Ask an Expert is designed to help policymakers in developing countries and emerging economies identify and implement **clean energy policy** and finance solutions.
- The Ask an Expert service features a network of more than **50** experts from over **15** countries.
- Responded to **300+** requests submitted by **90+** governments and regional organizations from developing nations since inception



Training and Capacity Building

- Delivered over **300** webinars training more than **20,000** public & private sector stakeholders.



Resource Library

- Over **1,500** curated reports, policy briefs, journal articles, etc.



For additional information and questions, reach out to Jal Desai, NREL, jal.desai@nrel.gov

Overview of the 21st Century Power Partnership

Presented by Prateek Joshi, National Renewable Energy Laboratory

October 17, 2023

21CPP Objectives: Power System Transformation

Accelerate the transition to clean, efficient, reliable, and cost-effective power systems.

**Evolving Generation
Portfolios**

**Electrification of
Transport,
Buildings, and
Industry**

**Smart Grid, Energy
Efficiency &
Demand Response**

**Cross Cutting Issues:
Operations,
Transmission,
Distributed Generation,
Market Design**

**Coordinated Power
System Planning,
Building, and Operating
Best Practices**

*Peer-learning, knowledge-
sharing, and technical
assistance*

Coordinating with related CEM Campaigns

21CPP: Focus Areas

Annual Program of Work often includes:

- “Thought Leadership” studies that focus on generic power system transformation topics across the world
- In-country technical assistance, often as part of a larger development assistance effort, focused on *Planning, Building, and Operating best practices for decarbonizing power systems*.
 - High-resolution grid integration studies often highlight this work.
- Information exchange, capacity building, fellowship programs, and other exercises to share lessons-learned and knowledge transfer.

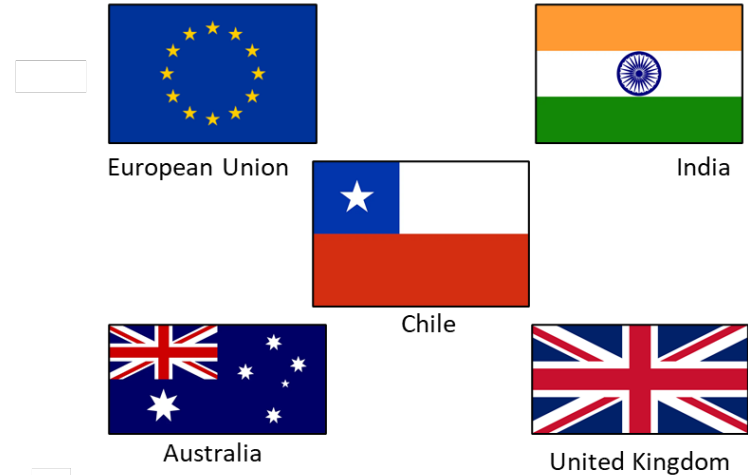
21CPP: Recent Activities

2021-2022:
Released a collaborative report for energy ministers on lessons learned for rapid decarbonization of power sectors.



2022-2023:

Worked with a first cohort of countries to develop Action Plans for power sector decarbonization based off the report.



March 2023: Workshop on transmission planning and operations

May 2023: Workshop on resource adequacy and grid flexibility

21CPP: Planned Activities

2023-2024:

Webinar series to discuss details of Action Plans in the first cohort.



Work with a second cohort of countries to develop Action Plans to be released at CEM15 in Brazil.

Potential for technical workshops, thought leadership report, etc.

Chile's Action Plan for Power Sector decarbonization

Presented by Alex Santander and Matías Paredes, Ministry of Energy of Chile

October 17, 2023

Overview of Chilean Energy Policy



Energy Scenarios initiative 2009–2011, 2012, 2018 (ongoing)

Several studies from universities, UNDP, etc.

Citizen Technical Parliamentary Commission 2011



ECLP2050
DESCARBONIZANDO Y ADAPTANDO CHILE

2020-2021
Long Term Climate Strategy and Carbon Budgets

2018-2019
Coal Phase Out by 2040 Agreement
NDC and Carbon Neutrality Target



Advisory Commission for Electrical Development (CADE) 2011

National Energy Strategy 2012



2021
Long-Term Energy Planning 2023-2027
Climate Change Law



Mitigation Action Plans and Scenarios (MAPS) 2012–2016

Surfing towards the future: Chile on the 2025 horizon



2022
Update of the Energy Policy



Energy Agenda 2014

Energy Policy 2050, 2015



2023
Decarbonization Plan Roundtable



Long-term energy planning (PELP), 2017 (ongoing)

Energy Route 2018

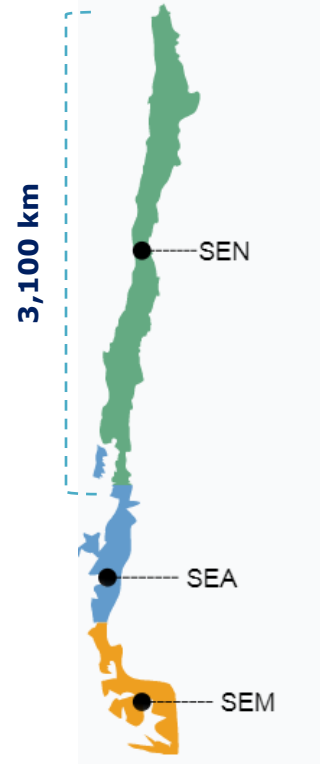


Source: Chilean NDC mitigation proposal

Source: Ministry of Energy

Overview of Chile's power sector

Figure. Organization of Chile's Electric Grid



Long System



One main system (*Sistema Eléctrico Nacional - SEN*)

+

Two isolated and smaller systems (*Aysén - SEA and Magallanes - SEM*)

Source: <http://energiaabierta.cne.cl/>



Electrification

Around 99% of the population



Renewable Transition

Increasing RE instantaneous penetration of solar and wind power
67% Solar & Wind*



Coordinated companies

703 in 2023



Curtailment

5.3% RE generation curtailed during 2022

* Maximum during 2022

Institutionality



Ministry of Energy



National Energy Commission



Electricity and Fuels Superintendence



National Independent System Operator



Panel of Experts

Responsible for **developing and coordinating the agenda, policies and standards** for the proper operation and development of the energy sector, ensuring its compliance, and advising the Chilean government on related matters.

Technical organization **responsible for defining the tariffs and technical standards** to which companies must adhere to produce, generate, transmit, and distribute energy. The National Energy Commission is responsible for regulating Chile's energy sector.

Monitor the proper operation of electricity, gas and fuels, in terms of safety, quality and price. Responsible for **overseeing the energy sector** in Chile.

The National Electric Coordinator is an autonomous, technical, and independent body governed by public law, responsible for coordinating the operation of the national electricity system, **ensuring economical and secure electricity supplies**, and guaranteeing open access to transmission systems.

Its function is to **solve, through opinions of binding effect, discrepancies and conflicts** that, according to the law, arise due to the application of the electricity and gas services legislation that the electricity, gas services, and other companies submit for their review.

Key players

Ministry of Energy

National Energy Commission

Electricity and Fuels Superintendency

National Independent System Operator



Generation

- Private
- Free prices and free competition
- Short term dispatch based on costs (variable costs)
- Wholesale market: energy, capacity, ancillary services; business: spot market, free customers, and electricity supply tenders



Transmission

- Private
- Monopoly with regulated tariffs
- Open access/fees
- Postage stamp methodology
- Centralized planning



Distribution

- Private
- Natural monopoly with regulated prices
- Electrical concessions regime and electricity supply tenders
- Distributed generation (small and residential)
- Quality of services



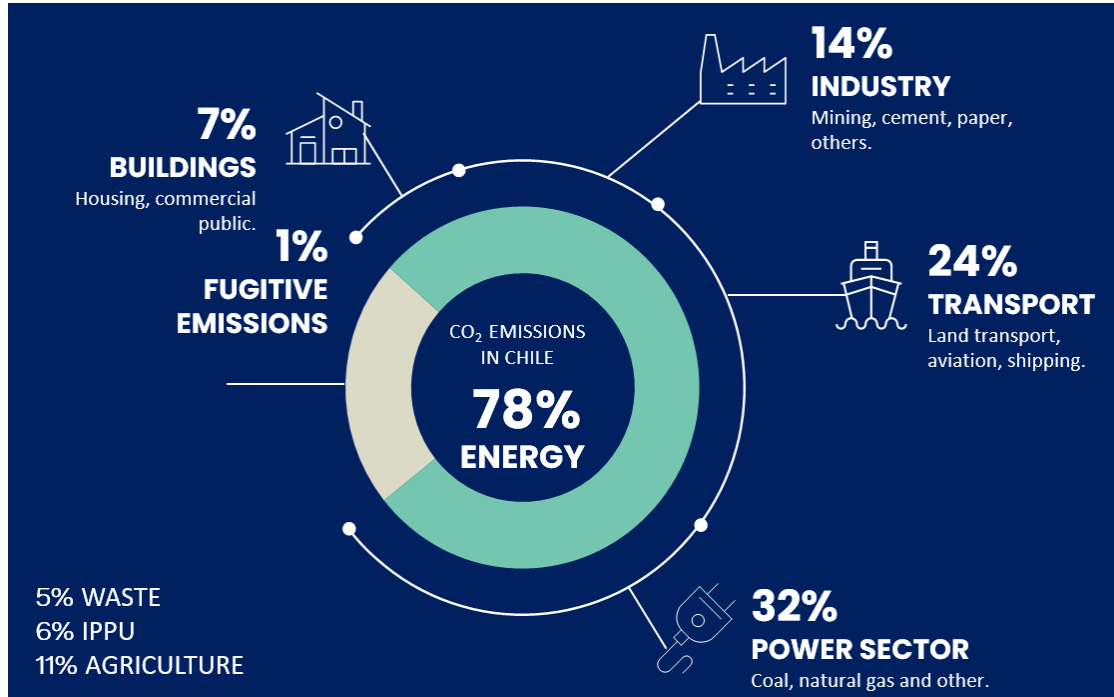
Customers

- Regulated (≤ 500 kW) free customers (≥ 5 MW)
- Electricity supply tenders / power purchase agreements
- Demand can not participate in the pool

Panel of Experts

Chile Greenhouse gas emissions

Figure. Sources of Greenhouse Gas Emissions in Chile



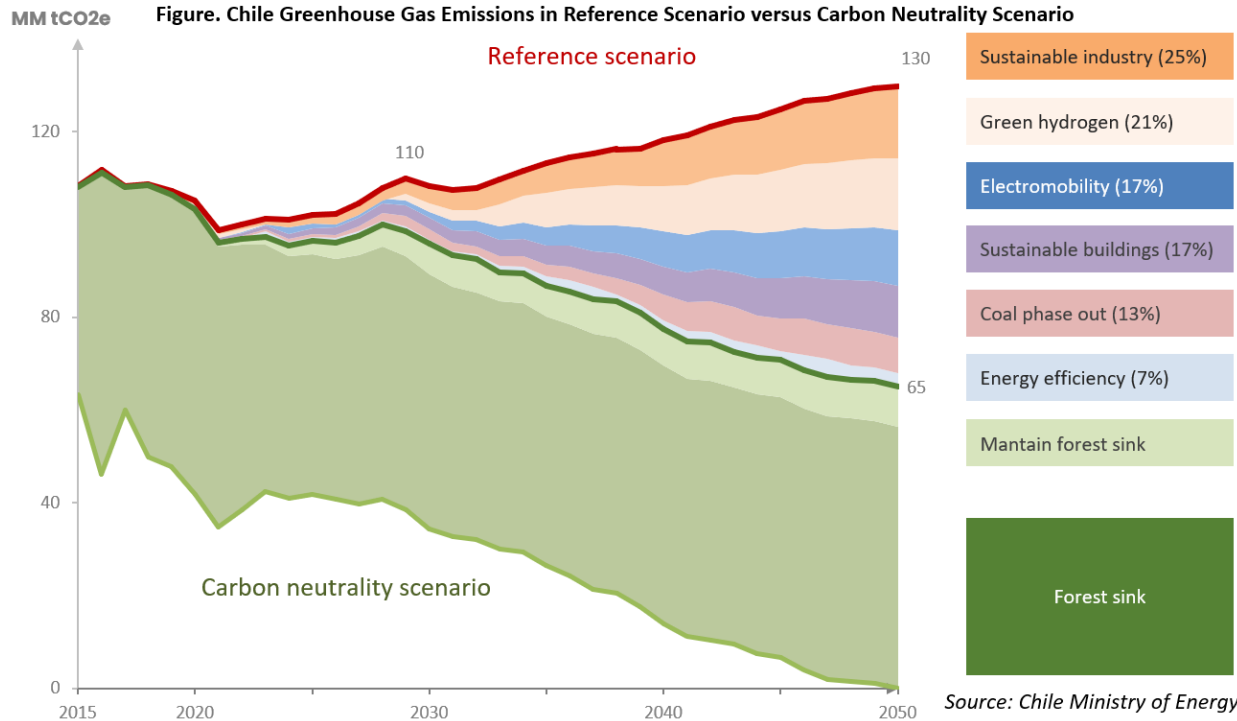
Energy transition
as a solution for
the climate
change crisis and
air pollution.



Inventario Nacional de
Emisiones GEI Chile 2020
Ministry of Environment

Source: Chile Ministry of Environment

Chile carbon neutrality pathway

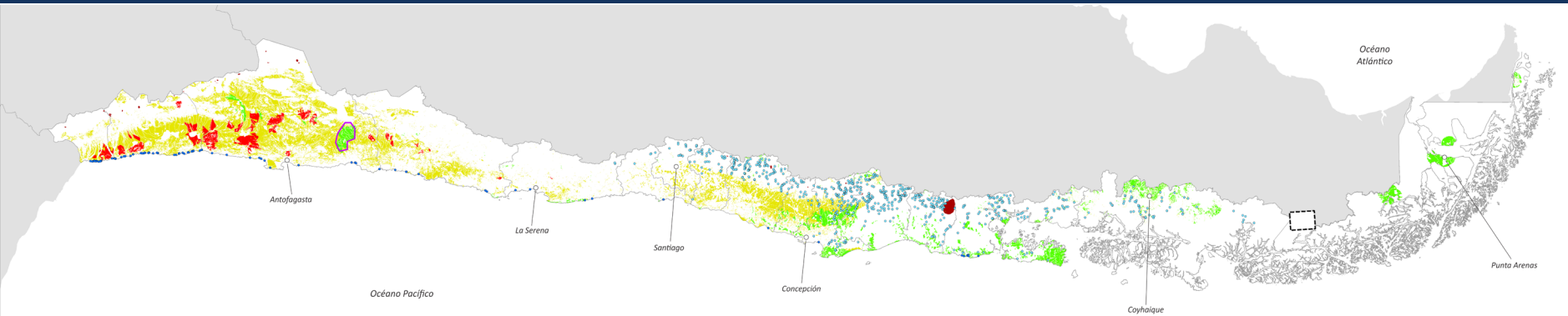


6 important mitigation actions towards net zero: a country commitment.



Carbon Neutrality for the Energy Sector
Ministry of Energy

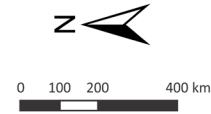
Chilean renewable energy resource



Potenciales de Energías Renovables PELP 2023-2027

Leyenda

- Eólico
- Geotérmico
- Solar CSP
- Solar Fotovoltaico
- Potenciales Centrales Hidroeléctricas
- Potenciales Centrales de Bombeo Costeras
- Área de Reserva de Taltal



Potenciales con descuento de áreas superpuestas entre tecnologías. Para la provincia de Palena y las regiones de Aysén y Magallanes, el potencial se limita hasta 20 km desde los sistemas medianos. Fuente: División Energías Sostenibles (agosto, 2021)

+80 times greater technical potential than actual installed capacity

Tecnología	Potencial (GW)
Solar FV	2,086
Wind	81
Solar CSP	152
Geothermal	4
Hydro	10
Pumped Hydro	42
Total	2,375

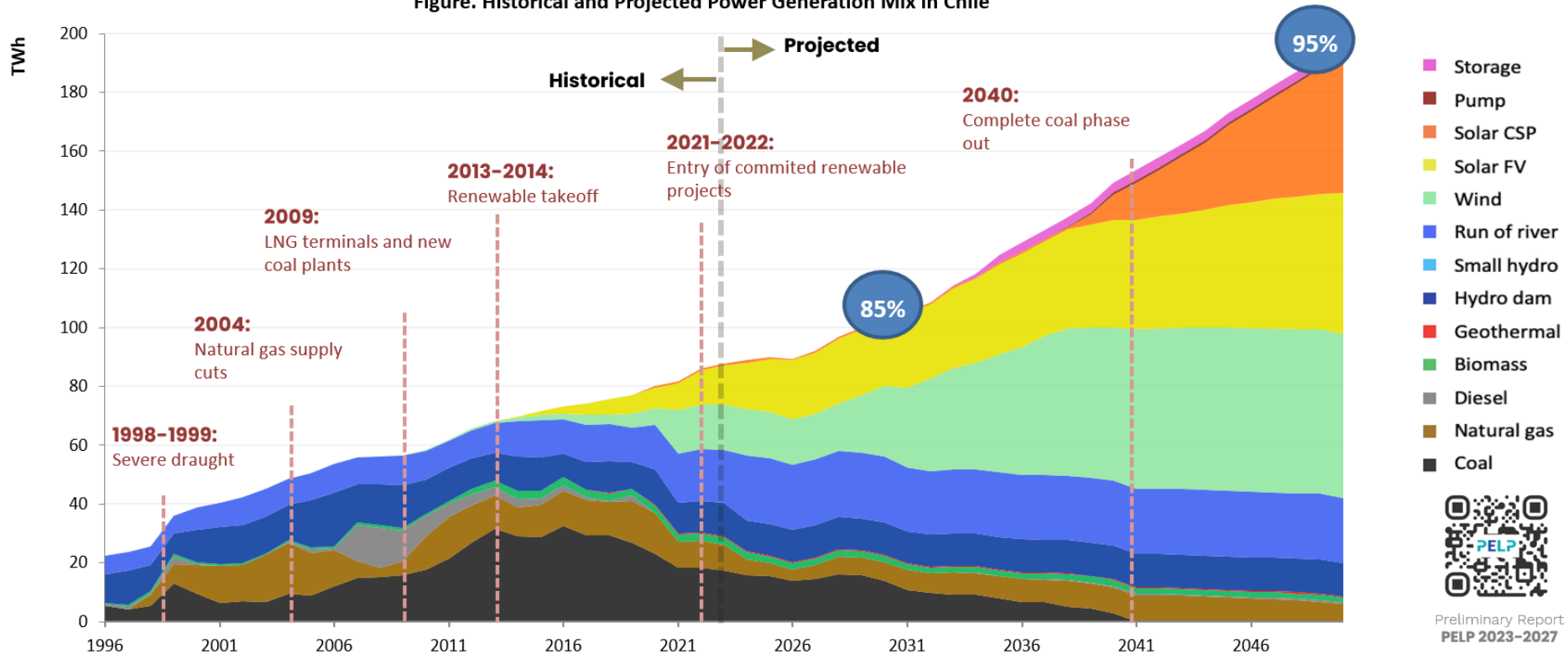


Renewable Potential
Ministry of Energy

Source: Chile Ministry of Energy

History and future of the system

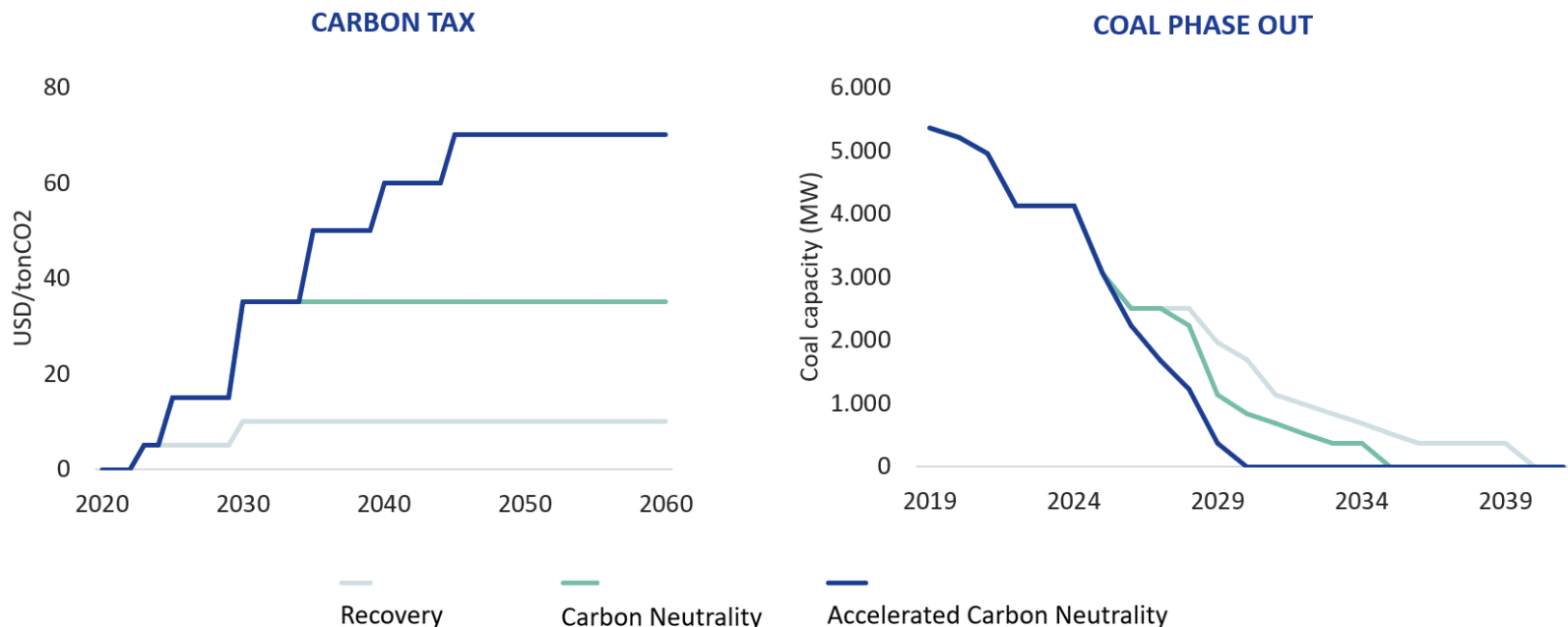
Figure. Historical and Projected Power Generation Mix in Chile



Long-term Energy Planning

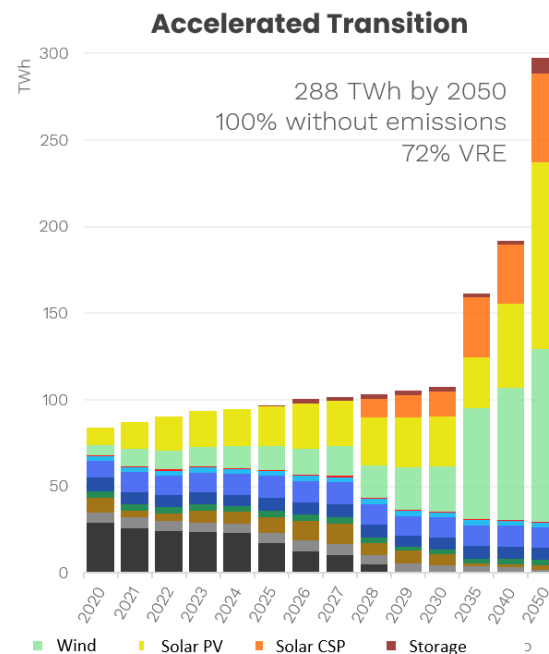
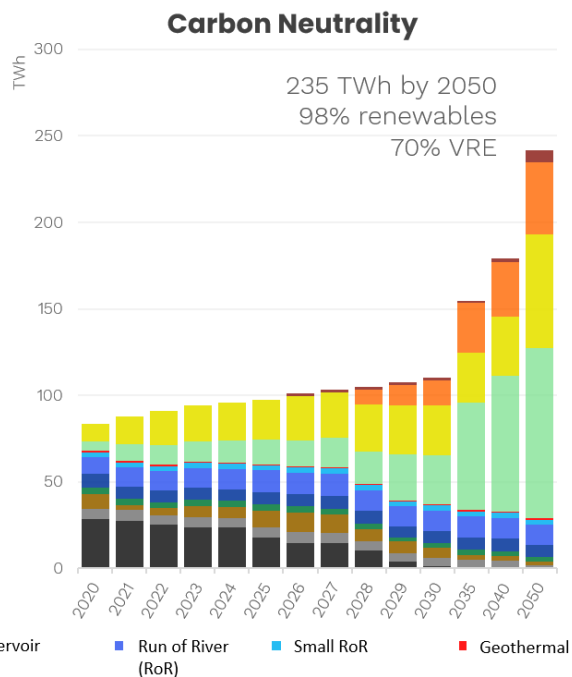
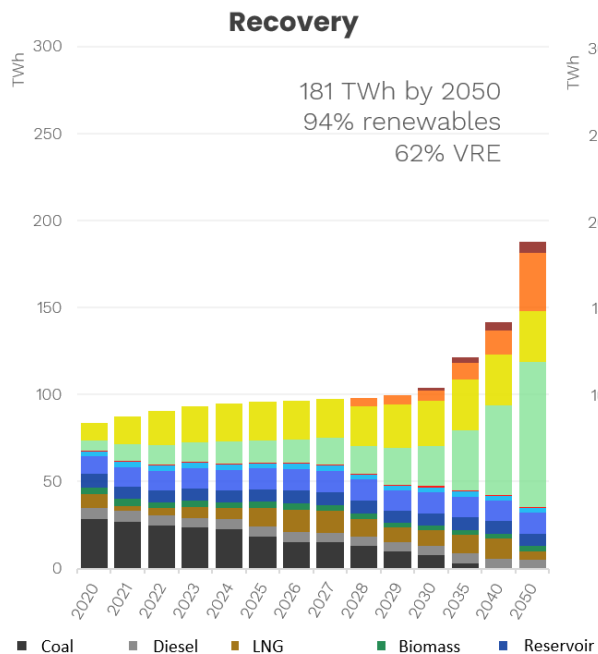
Preliminary results

Figure. Carbon Tax and Coal Phase Out in Chile Long Term Energy Planning



Long-term Energy Planning

Preliminary results



VRE: Variable Renewable Energy (Solar PV and Wind)

Power sector infrastructure snapshot



34,083 MW
Installed capacity until January 2023



83,375 GWh
Annual energy generation in 2022

Wind + Solar = 32.7% of Installed Capacity

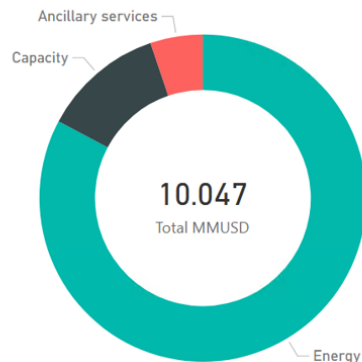


1,193 MW
Total coal capacity phased out from 2018 to 2022, 22% of total, 64% by 2025

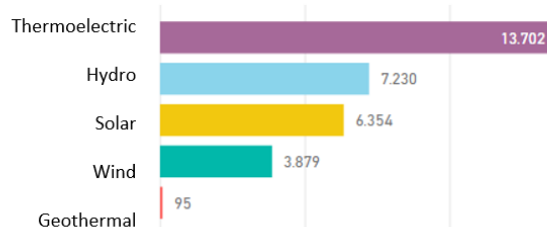


27,920 GWh
Annual NCRE (non-conventional renewable energy) generation during 2022, 33.5% of total

Electrical Market



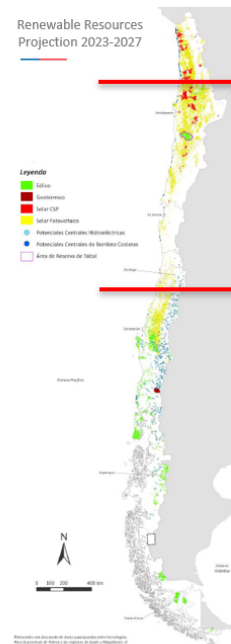
Installed capacity [MW] 2023



37% of installed capacity is NCRE

Projections for the Future

Renewable Resources Projection 2023-2027



Kimal

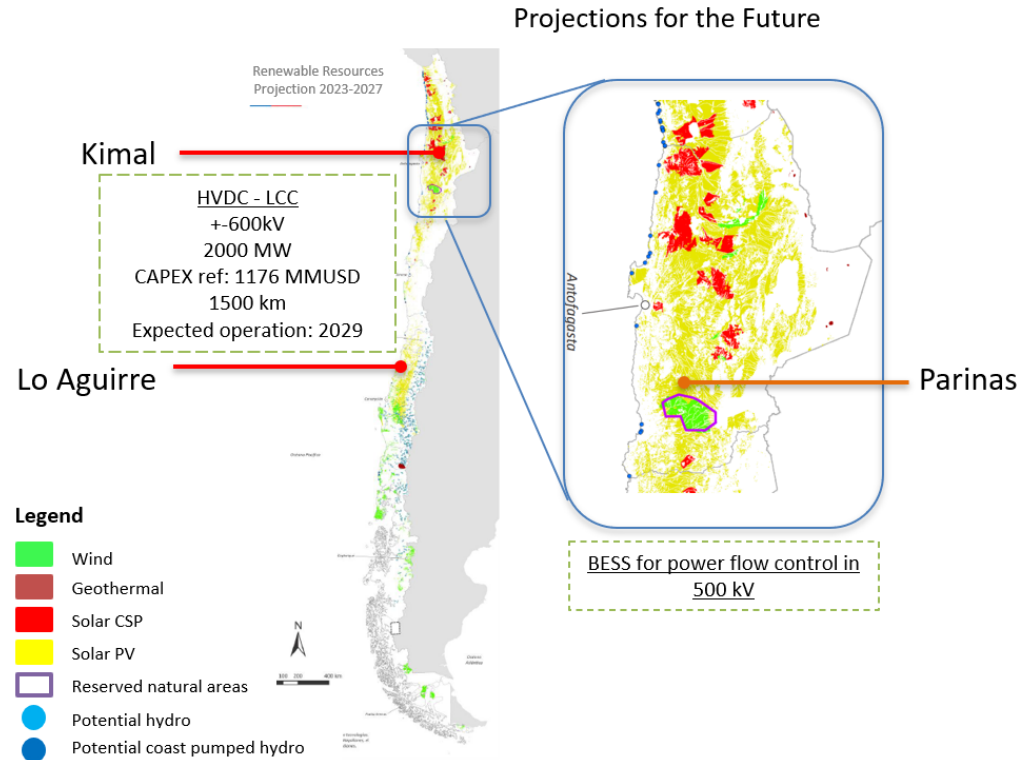
HVDC - LCC
+600 kV
2000 MW
CAPEX ref: 1176 MMUSD
1500 km
Expected operation: 2029

Lo Aguirre

Transmission

Plans to face the transmission challenges:

1. Law project for the promotion of urgent and broad consensus matters in terms of Transmission:
 - a) Efficient development of transmission buildings
 - b) Promotion of competition and storage
 - c) Climate change and electric sector: enabling infrastructure for the energy transition, territorial planning and ordering, emissions-free power grid operation
2. Schedule for the second time of the renewables:
 - a) Storage in strategic S/E, using public land
 - b) Open season for urgent buildings
 - c) Others
3. Transmission expansion plan: includes BESS for flow control in 500 kV at S/E Parinas.



Chilean electrical regulation changes



- Fast **decarbonization strategy**
- Law of **energy storage systems** (Stand alone projects, payment in energy and power markets)
- Law project of renewable energy establishing new **energy quota obligation** (60% annual participation and 40% block participation by 2030 and time-related obligation)
- Law project for the promotion of urgent and broad consensus matters in terms of **Transmission**
- Fast-grow of **distributed energy** resources.
- Fair energy transition, energy poverty (Methodologies for the adhoc location of vulnerable clients-tariffs equity)

Promotion of renewable energy

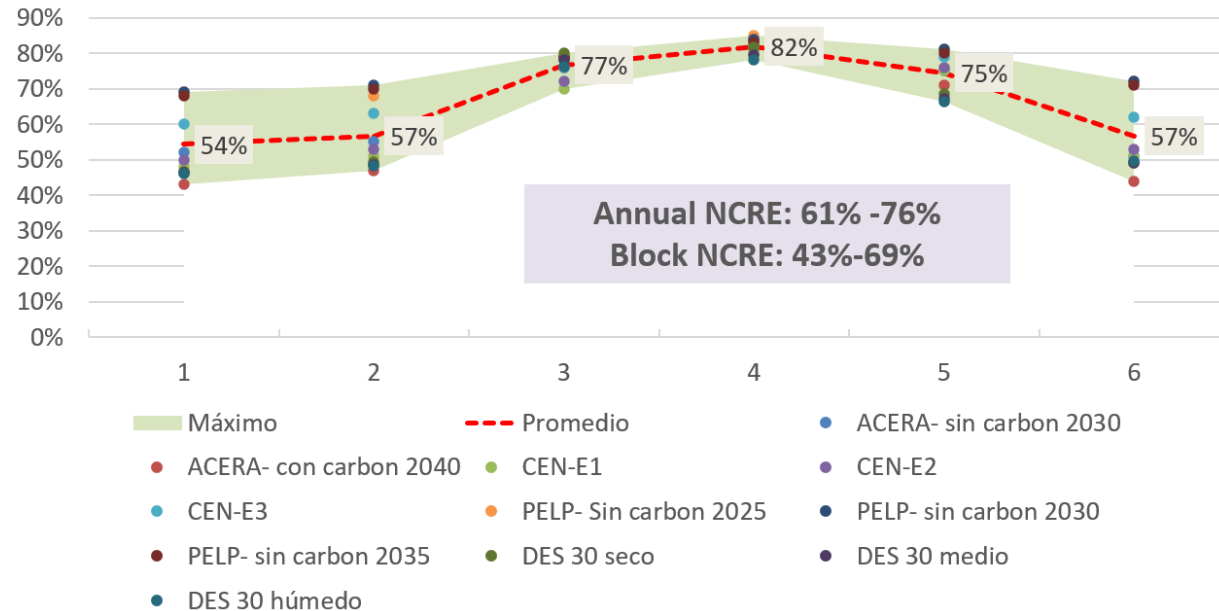
Law project for the promotion of renewable energies

Annual participation: 60%

Block Participation: 40%

To 2030

Average NCRE participation in the different scenarios

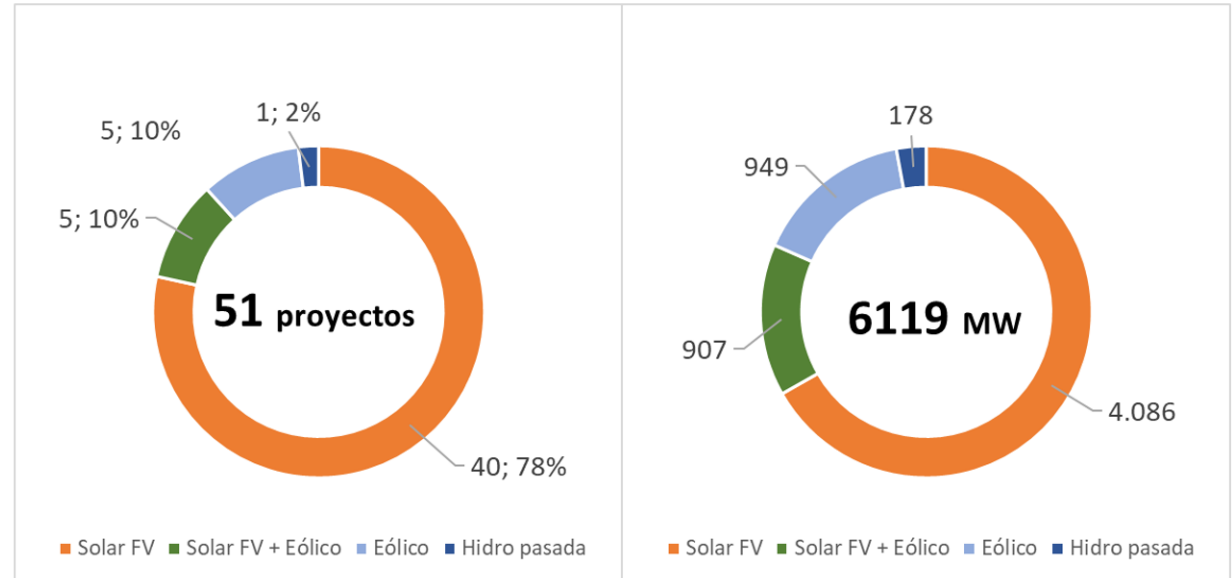


Promotion of renewable energy

Law modification for the promotion of storage:

- Stand alone projects
- Payment in energy and power markets

Projects with storage are growing



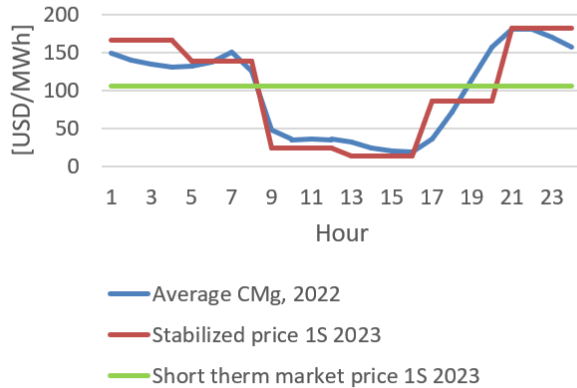
Penetration of distributed energy sources

1) Update in the competition conditions: 1 to 6 hour blocks

2) New regulations in the connection

3) Increase in the participation

Prices in Chilean North 220 kV



Taken from electrical substation "Crucero 200 [kV]"

Setting new rules for DER's with storage systems

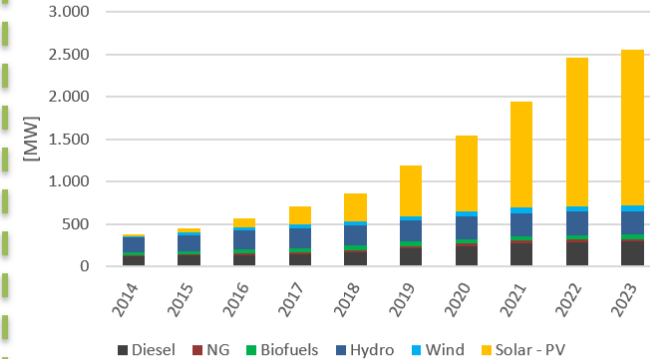
New rules for the development of a public information platform

Technical studies to determine the capacity of some DER's to prevent congestions

Standards in construction contracts (schedules, deadlines, etc)

And others...

Evolution of installed capacity of SER and DER



SER: Small Energy Resources (< 9 [MW])
 DER: Distributed Energy Resources (< 9 [MW] and connected to the distribution grid)

Source: National Commission of Energy

Chilean electrical Grid Operation

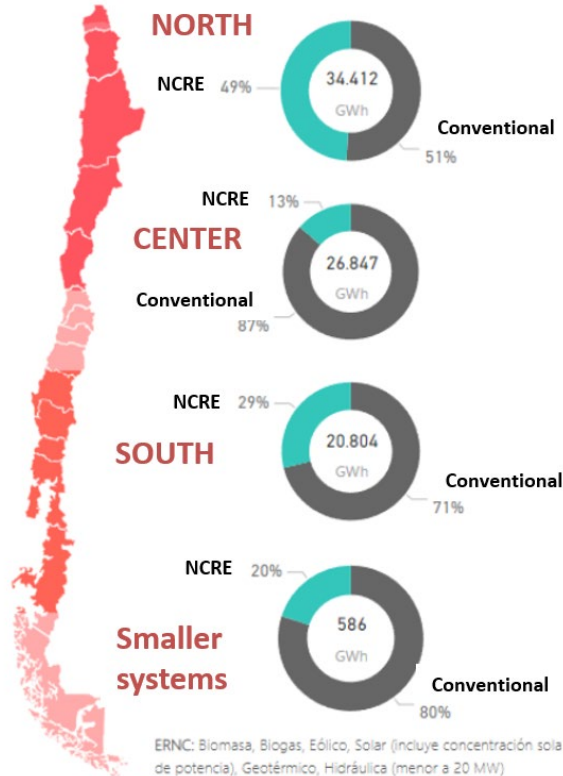
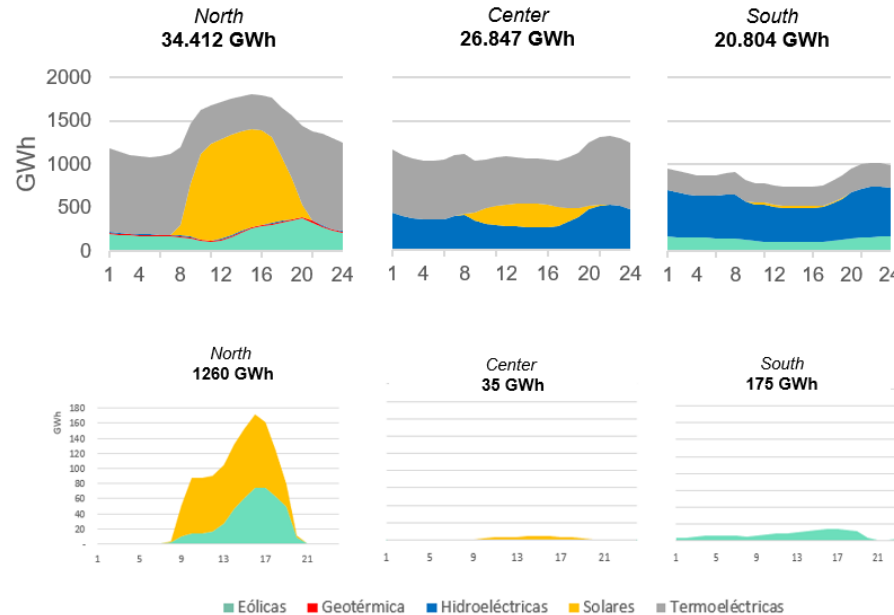


Figure. Total Generation per Hour (2022)



ce: Ministry of Energy

Projected system demand and generation

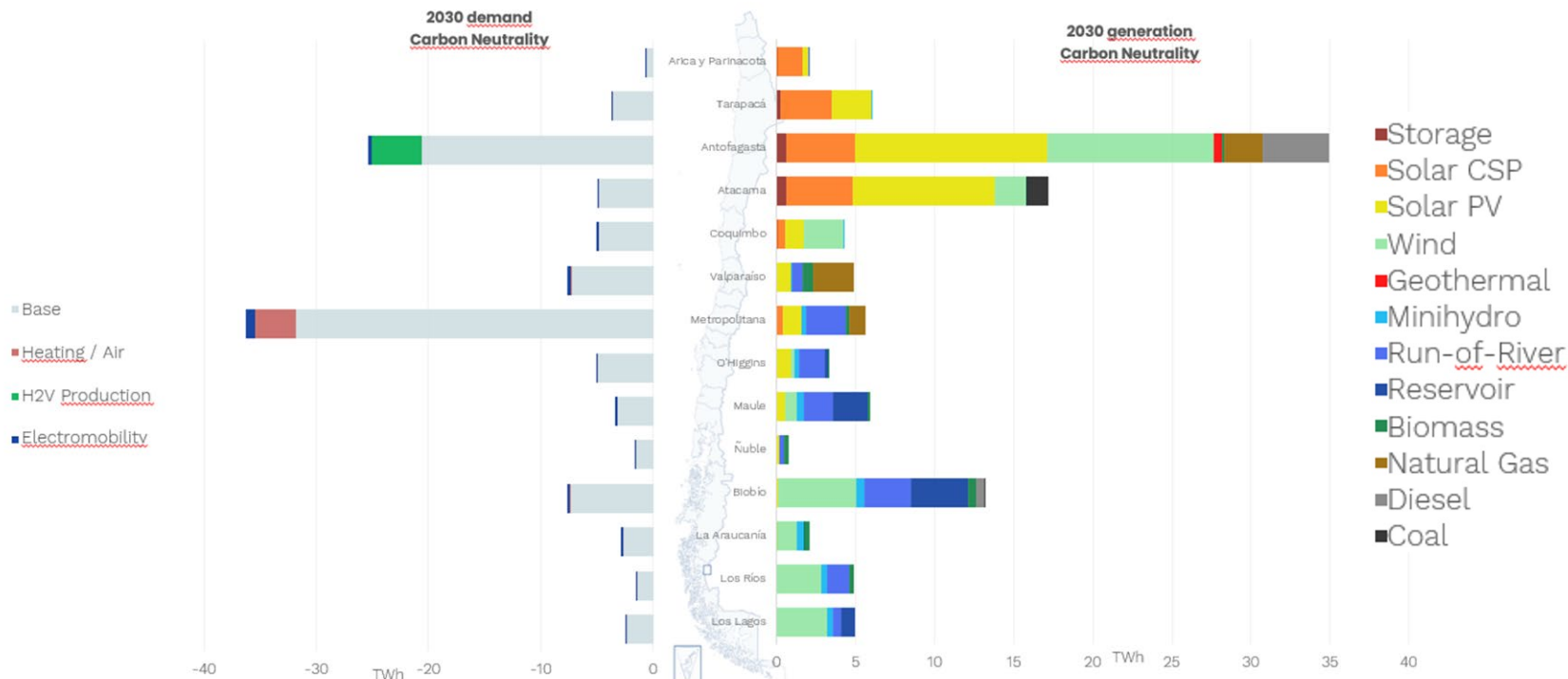


Figure. Electricity Demand and Generation by Territory for 2030 in Carbon Neutrality by 2050 Scenario

Source: Ministry of Energy

Projected system demand and generation

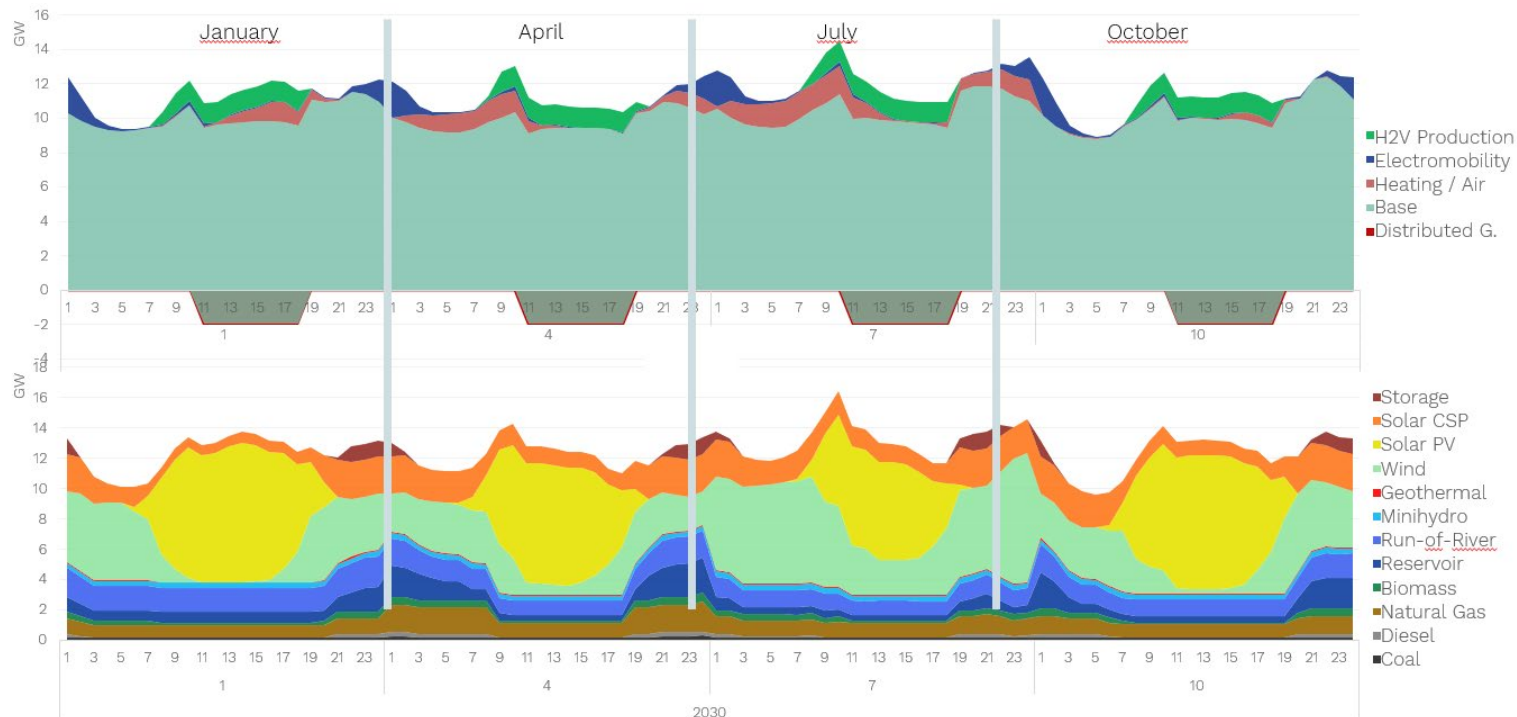


Figure. Electricity System Operation (Demand and Generation) for 2030 in Carbon Neutrality by 2050 Scenario

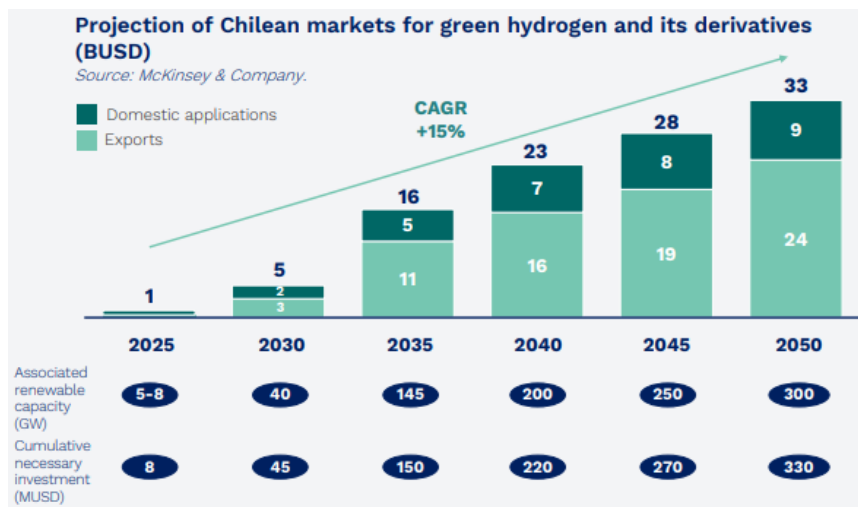
Source: Ministry of Energy

Green hydrogen and Lithium National Strategies

Green Hydrogen

The National Green Hydrogen Strategy seeks to position Chile as one of the largest producers and exporters of green hydrogen in the world.

- This due to the great VRE potential that would produce a low-cost Hydrogen, with zero emissions.



Lithium (announced)

The National Lithium Strategy is a set of measures that seek to incorporate the Chilean State in the productive sector in a sustainable way. Some of the most relevant actions that make up this possible are:

- Create the National Lithium Company.
- Create a Network of Protected Salt Flats and ensure the use of technologies with low environmental impact in the Salt Flats already under exploitation.
- Create a Technological and Public Research Institute for Lithium and Salt Flats.
- Incorporate the Chilean State in the productive activity of the Atacama's Salt Flat.

Source: Ministry of Energy

Grid digitalization

We are working on different topics to digitize the information of our complete electric system

Working on

Net demand management studies:

- Identification of barriers and development of proposals

Traceability of the electricity

- Specially to recognize the use of clean electricity

Cybersecurity technical standard

- Operating Network system
- How to manage it

And more...

Future Challenges

Inclusion and use of the Smart-meters:

- Management of large amounts of data

Net demand:

- Inclusion of controlable loads that respond to the grid changes

And more...

References



- [\[2019-MinE\] Decarbonization Table \[Spanish\]](#)
- [\[2019-Stakeholders\] Coal Phase Out and Reconversión Agreement \[Spanish\]](#)
- [\[2019-MinE\] NDC Mitigation Proposal Link \[English\]](#)
- [\[2019-MinE\] Carbon Neutrality 2050 \[English\]](#)
- [\[2021-MinE\] Energy Policy 2050 \(Updated\) \[English\]](#)
- [\[2021-MinE\] Long Term Energy Planning 2023-2027 \[English\]](#)

Rest of Webinar Series



The graphic features a background image of a large solar farm with rows of solar panels stretching across a landscape. On the left, a black box contains the text "21st Century POWER PARTNERSHIP Accelerating the transformation of power systems" with a colorful logo. The right side has a blue background with white text: "Power Sector Decarbonization Action Plan Series", "Australia", "October 31, 2023", and "10:00 AM UTC+11". At the bottom, logos for the Clean Energy Ministerial and Clean Energy Solutions Center are displayed.

21st Century
POWER PARTNERSHIP
*Accelerating the transformation
of power systems*

Power Sector
Decarbonization
Action Plan Series

Australia

October 31, 2023
10:00 AM UTC+11

CLEAN ENERGY
MINISTERIAL
Advancing Clean Energy Together

CLEAN ENERGY
SOLUTIONS CENTER
AN INITIATIVE OF THE CLEAN ENERGY MINISTERIAL

- **Australia spotlight:
October 31**
- European Commission
spotlight: mid-November
- Others: to-be-scheduled

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Thank You!