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:
- United Kingdom
- United States

### Operating Agent:
- NREL

### 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:

### Factsheet:
[www.nrel.gov/docs/fy22osti/83658.pdf](http://www.nrel.gov/docs/fy22osti/83658.pdf)

### Requests:
Now accepting Ask an Expert requests!
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

Source: Chilean NDC mitigation proposal

Source: Ministry of Energy
Overview of Chile’s power sector

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

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

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/
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

NationalEnergyCommission

Electricity and Fuels Superintendency

National Independent System Operator

Generation

Transmission

Distribution

Customers

- 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

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

- Private
- Natural monopoly with regulated prices
- Electrical concessions regime and electricity supply tenders
- Distributed generation (small and residential)
- Quality of services
- Regulated (≤500 kW) free customers (≥5MW)
- Electricity supply tenders / power purchase agreements
- Demand can not participate in the pool

Panel of Experts
Chile Greenhouse gas emissions

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.

Source: Chile Ministry of Energy
Chilean renewable energy resources

+80 times greater technical potential than actual installed capacity

Source: Chile Ministry of Energy
History and future of the system

Figure. Historical and Projected Power Generation Mix in Chile

- **2009:** LNG terminals and new coal plants
- **2013–2014:** Renewable takeoff
- **2021–2022:** Entry of committed renewable projects
- **2040:** Complete coal phase out

Key points:
- **2004:** Natural gas supply cuts
- **1998–1999:** Severe drought

Legend:
- Storage
- Pump
- Solar CSP
- Solar FV
- Wind
- Run of river
- Small hydro
- Hydro dam
- Geothermal
- Biomass
- Diesel
- Natural gas
- Coal

Preliminary Report
PELP 2023–2027
Long-term Energy Planning
Preliminary results

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

CARBON TAX

COAL PHASE OUT

USD/tonCO2

Coal capacity (MW)

2020 2030 2040 2050 2060

2019 2024 2029 2034 2039

Recovery Carbon Neutrality Accelerated Carbon Neutrality
Long-term Energy Planning Preliminary results

Recovery
181 TWh by 2050
94% renewables
62% VRE

Carbon Neutrality
235 TWh by 2050
98% renewables
70% VRE

Accelerated Transition
288 TWh by 2050
100% without emissions
72% VRE

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

37% of installed capacity is NCRE

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

Lo Aguirre

Projected Projections for the Future

Installed capacity [MW] 2023

Thermoelectric
Hydro
Solar
Wind
Geothermal

13,702
7,230
6,356
3,879
95

Kimal

Lo Aguirre
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

Annual NCRE: 61% - 76%
Block NCRE: 43% - 69%

- ACERA- sin carbon 2030
- CEN-E1
- CEN-E2
- PELP- sin carbon 2030
- PELP- sin carbon 2025
- DES 30 seco
- DES 30 húmedo
- CEN-E3
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

51 proyectos
- Solar FV: 40; 78%
- Solar FV + Eólico: 1; 2%
- Eólico: 1; 2%
- Hidro pasada: 5; 10%

6119 MW
- Solar FV: 4.086
- Solar FV + Eólico: 949
- Eólico: 907
- Hidro pasada: 178
Penetration of distributed energy sources

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

2) New regulations in the connection
   - Setting new rules for DER's with storage systems
   - Technical studies to determine the capacity of some DER's to prevent congestions
   - Standards in construction contracts (schedules, deadlines, etc)
   - New rules for the development of a public information platform

3) Increase in the participation

Prices in Chilean North 220 kV

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<th>Average CMg, 2022</th>
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Taken from electrical substation “Crucero 200 [kV]”

Evolution of installed capacity of SER and DER

Source: National Comission of Energy
Chilean electrical Grid Operation

Figure. Total Generation per Hour (2022)

Source: 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

- **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]
- [2021-MinE] Energy Policy 2050 (Updated) [English]
- [2021-MinE] Long Term Energy Planning 2023-2027 [English]
Rest of Webinar Series

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