Long-term Energy Planning in Chile

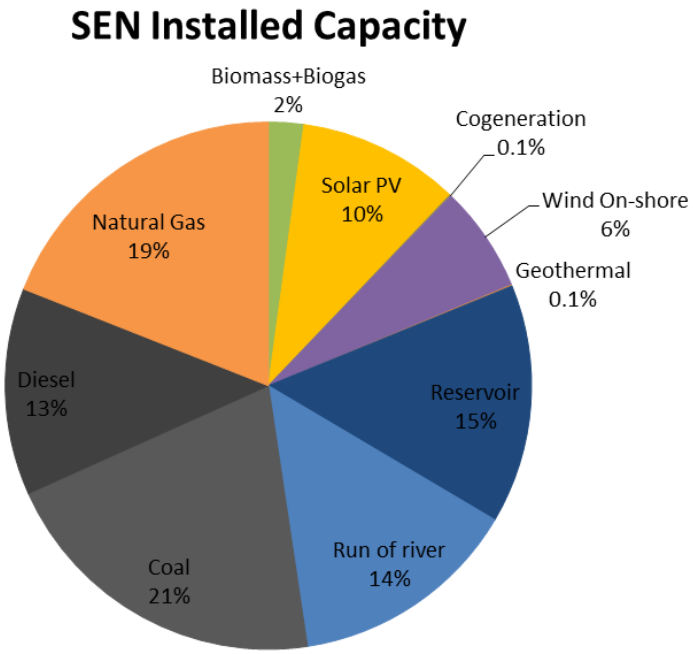
Ministerio de Energía

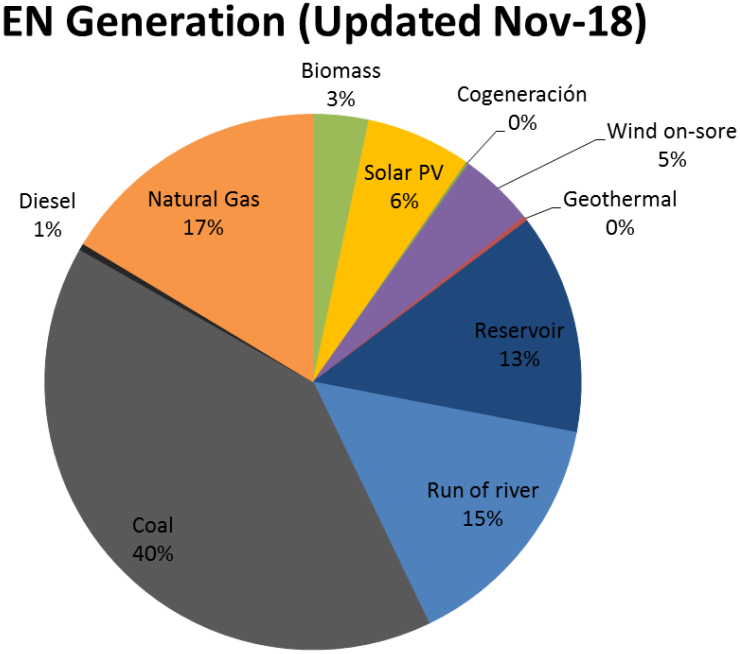
Gobierno de Chile

Prospective and Regulatory Analysis Division

November 2018

Chilean context





Energy Scenarios under the electric transmission regulation

In Chile the regulation on electric transmission expansion has two main components:

1. Long-term energy planning (Ministry of Energy): Energy planning. 30 years simulation. Updated every 5 years.

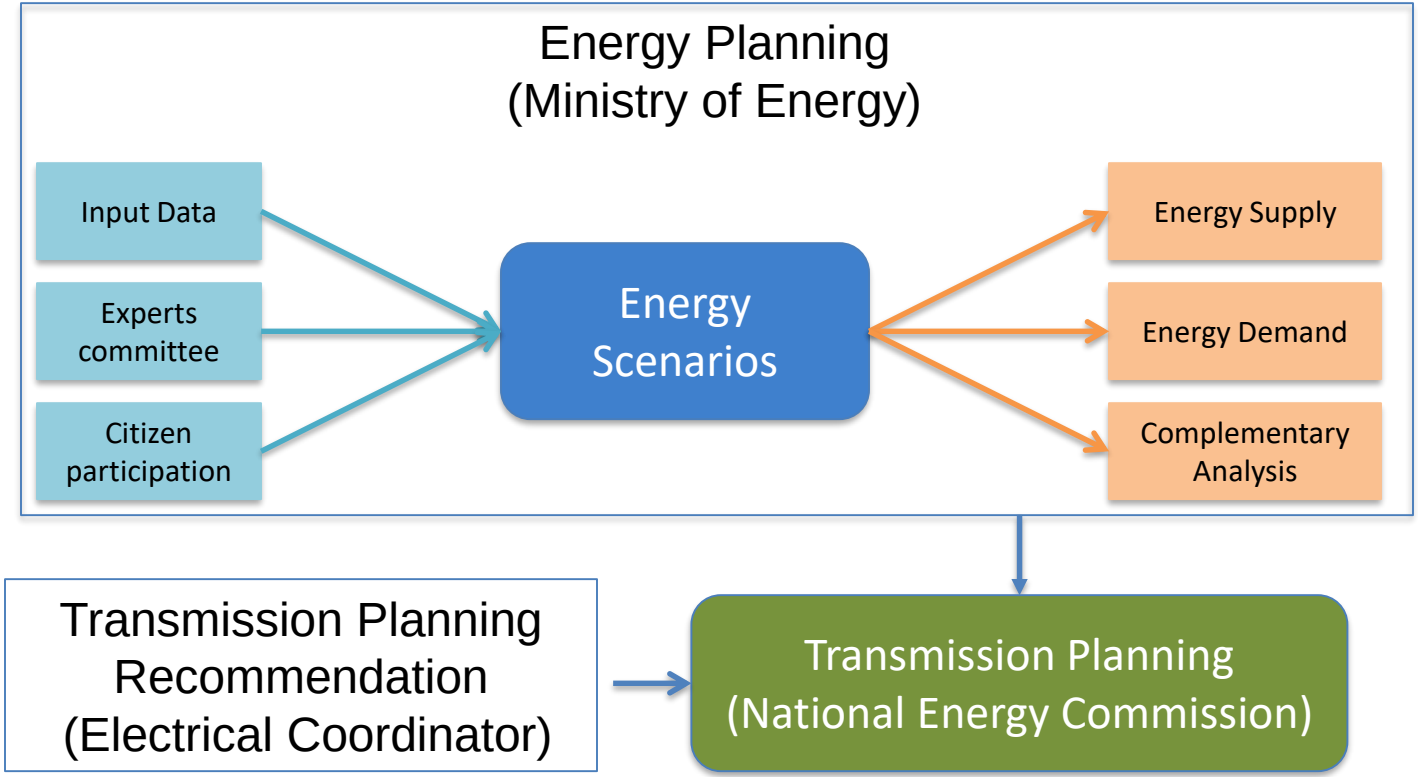
2. Transmission expansion plan (National Energy Commission): Transmission planning. 20 years simulation. Updated every year.

Considerations on the Energy Planning

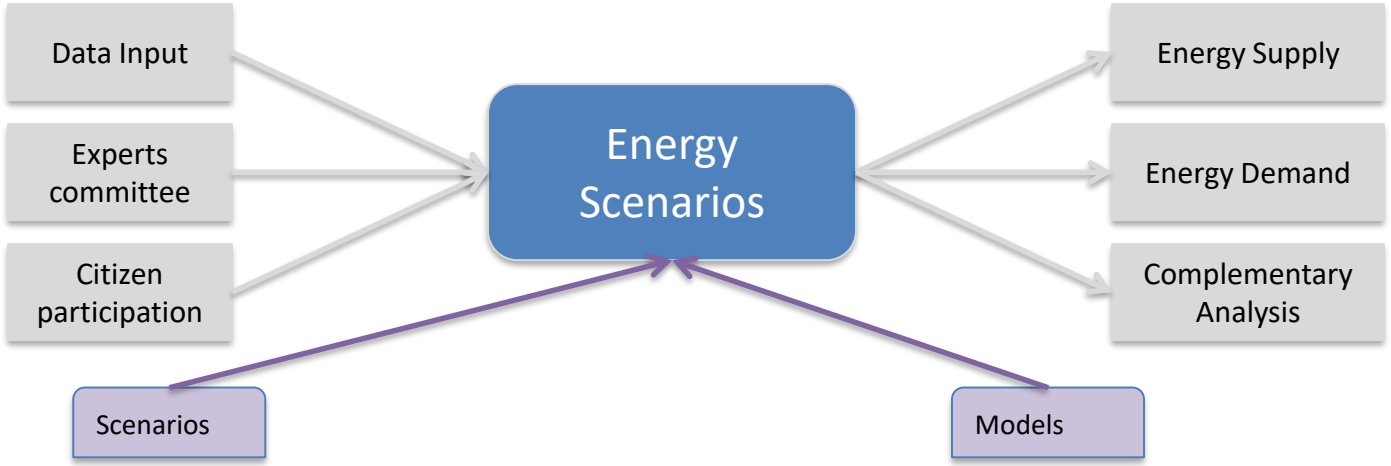
The energy planning process has to include **energy demand and supply projections, considering**:

1. Renewable generation areas or poles
2. Distributed generation
3. International energy exchanges
4. Relevant environmental policies
5. Energy efficiency goals
6. Strategic energy plans of each region in the country

Long-term Energy Planning



Long-term Energy Planning



- Identify the main variables that have high impact and uncertainty in the future energy sector
- These variables are projected
- Create every scenario as a believable story

- The energy demand model (Econometric simulation base on LEAP) is limited to the available information
- The electric expansion model PET (Co-optimize Gx+Tx) doesn't include short term constraints.
- The electric expansion model PET doesn't give the amount of flexibility needed for the future.
- The distributed generation model (Econometric simulation) is focused on the residential sector.

LTEP process

Factors	Scenario A	Scenario B	Scenario C	Scenario D	Scenario E
1) Projects social disposition	+ Cost & with CCS	Free	Cost & with CCS	+ Cost	+ Cost
2) Energy demand	Low	High	Media	Low	High
3) Battery storage technological change	High	Low	Medium	Medium	High
4) Environmental externalities costs	Current	+High	Current	Current	+High
5) NCRE CAPEX	Low	Low	Medium	High	Low
6) Fuel prices	Medium	High	Low	Low	High

LTEP results

The principals result for Chile in the process 2016-2018 process are:

- By 2050 there will be 40% of **electric vehicles** and **100 % electric buses.**
- By 2046, 100-150 000 households with **distributed generation**.
- By 2030, 60% of **renewable generation** in all scenarios, and in 2 scenarios we reach **90% by 2046**. (Without considering the undergoing process of decarbonization)
- Two scenarios show the need to upgrade **LNG regasification terminals.**
- The **international interconnections** shows bidirectional flows, that exports energy during solar hours and importing energy in the night.

Main achievements of first process

- **Participatory process** in every stage
- First ever long-term energy planning process, including e-mobility, electric heating and distributed generation projections.
- A **methodology** to define energy scenarios was established
- It has become a **validated source of information** for the energy sector, and a support for policy analysis and design.

Improvements for next process

Energy scenarios

- **Scenarios:** to include other uncertainty factors in order to make more representative scenarios
- **Models:** to improve current methodology in order to include transmission issues and short-term constraints; continuous improvement of demand model

Energy supply

- **Generation expansion plans:** continuous work with the National Energy Commission for generation expansion plans integration into transmission expansion process
- **Long and short-term analysis:** to study a methodology to feedback generation expansion model

Complementary analysis

- **Resiliency:** to include other variables linked with the concept, besides climate change.
- **Distributed generation:** to build a model for penetration estimation in commerce and industrial economic sectors
- **Energy demand profile:** to visualize hourly effects with higher penetration of distributed generation and e-mobility on the energy demand profile and possible impacts onto electrical distribution infrastructure

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Thank you

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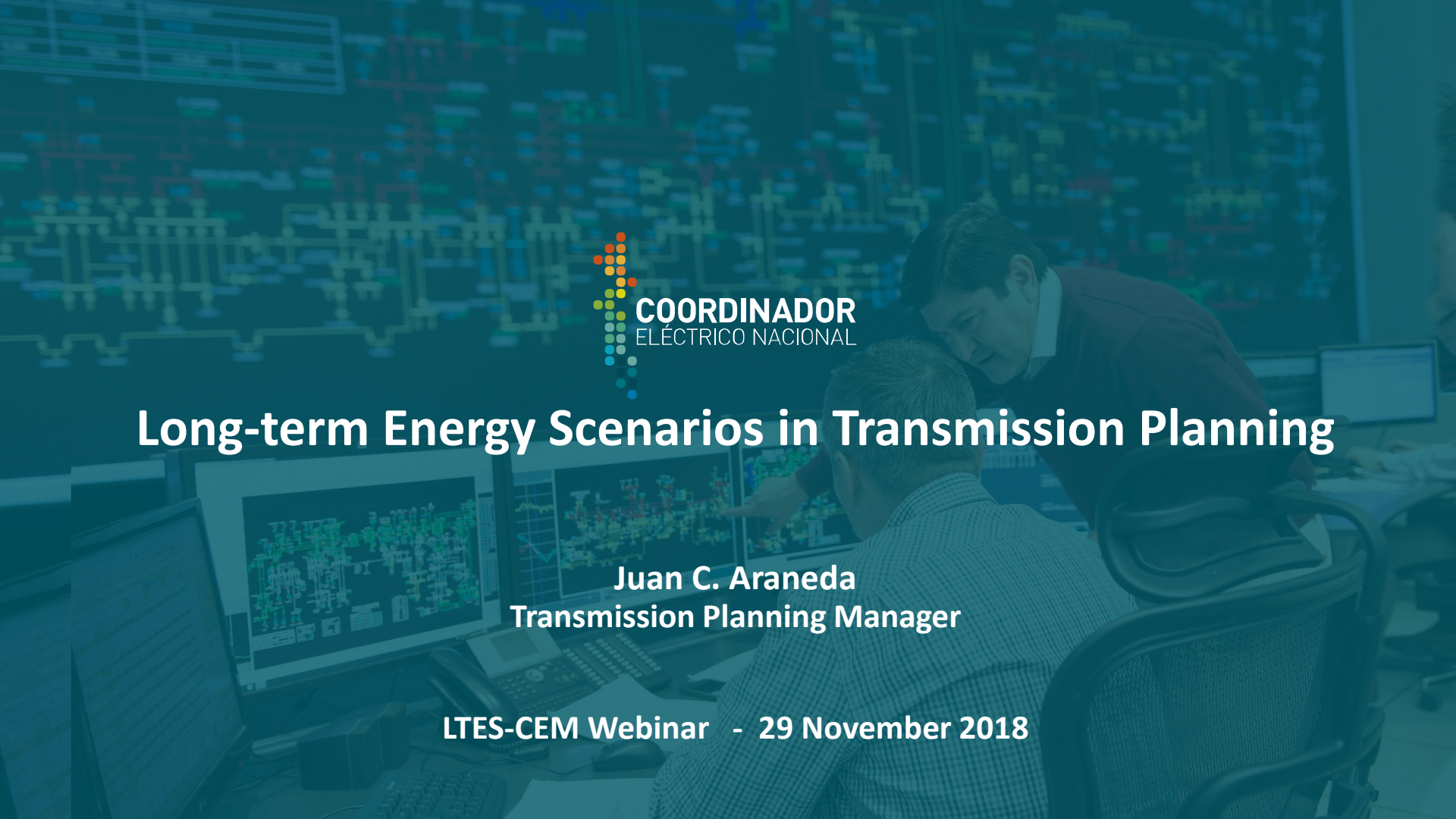


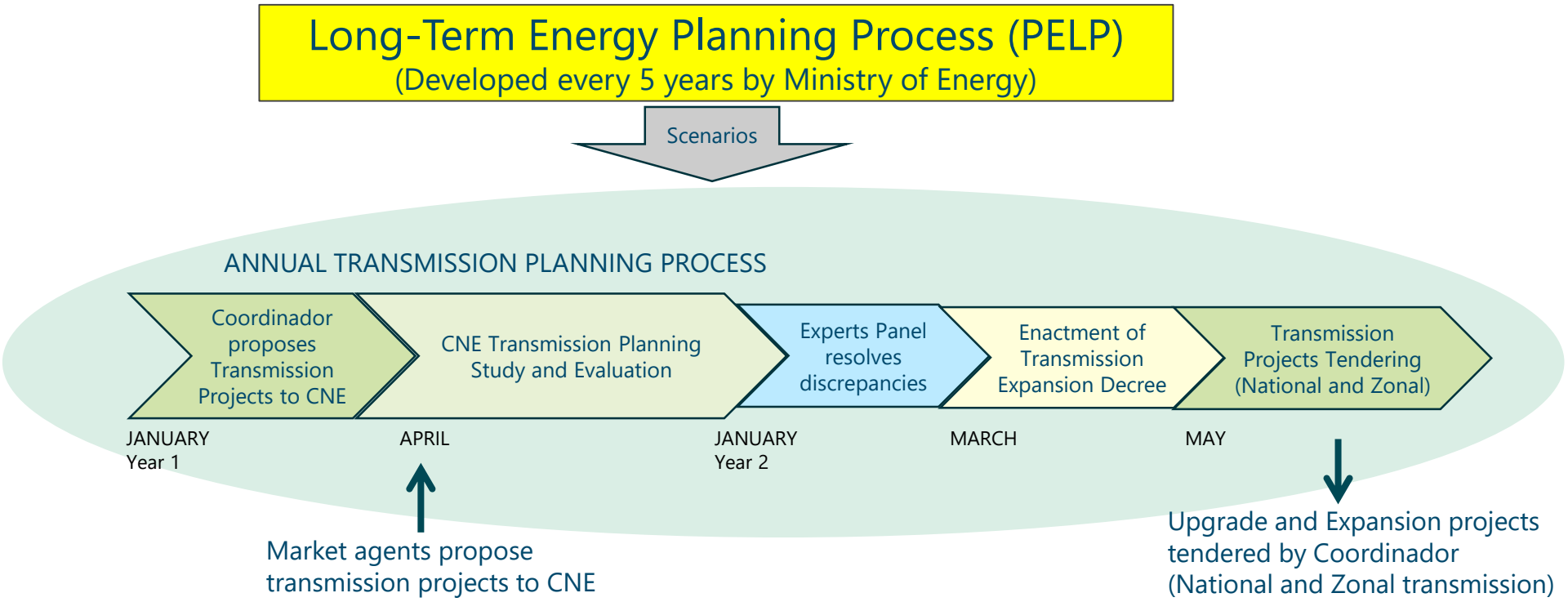
COORDINADOR
ELÉCTRICO NACIONAL

Long-term Energy Scenarios in Transmission Planning

Juan C. Araneda
Transmission Planning Manager

LTES-CEM Webinar - 29 November 2018

Transmission Planning and Delivery (Electricity Law 20.936/2016)



New Transmission Planning Criteria (Electricity Law 20.936/2016)

- Minimize supply **risks**, considering events, such as:
  - cost increase or **unavailability** of fuels
  - delays or **unavailability** of energy infrastructure
  - **Natural disasters** or **extreme hydrology conditions**

- **Promote the offer and facilitate competition** in order to supply consumers at **minimum price**

- **Economically efficient** and **necessary** projects in the different energy scenarios

- **Modification of existing** transmission facilities in an efficient way

Transmission planning must include **roominess** and **redundancies** in order to incorporate all previous criteria

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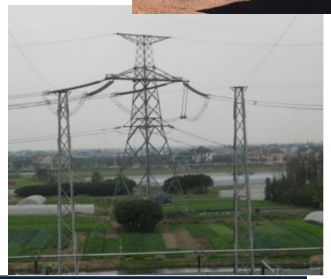
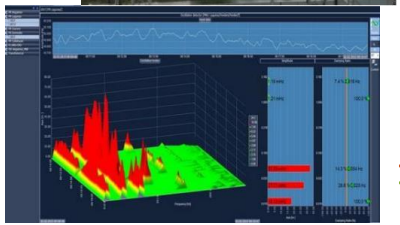
1. **Adequacy:**
   - CAPEX < NPV[Δ(OPEX+CENS)]
2. **Security of Service:** N-k criteria
   - Resilience: resist LPHI events
3. **Competition:** Open Access to the Grid
4. **Sustainability:** Efficient use of Territory
5. **Robustness:** Long Term Vision and Flexibility

Flexible Transmission Market Oriented

- Transmission support associated to Variable Renewable Energy (VRE):
  - Size and location of reserves
  - Hydro, solar and wind forecasting
  - Inertia constraints
  - Battery Energy Storage Systems – BESS:
    - Expansion deferral
    - Congestion relief
- Flexible AC Transmission Systems: FACTS
- HVDC Transmission Systems:
  - Long distance of Renewable potential
  - Back-to-Back converters (interconnections)
- Smart grid: SIPS, WAMPAC, DLR





TRANSMISSION PLANNING PROCESS 2018
CO-OPTIMIZATION GENERATION – TRANSMISSION

Stage 1

- Generation-transmission optimization multi-node simplified

✓ *Gx optimal location*

✓ *Gx investment to minimize Gx+Tx costs.*

Stage 2

- One node optimization with long-term operational constraints

✓ *Optimal integration of RVE with operational feasibility*

✓ *Flexibility options*

Stage 3

- Operational simulation and evaluation of the transmission system

✓ *Optimal Tx expansion proposal per scenario*

✓ *Proposal of resources to provide flexibility*

Stage 4

- Decision making with robust planning transmission tools

✓ *Optimal Tx expansion plan*

✓ *Requirements of resources that provide flexibility*

Why to CO-OPTIMIZE?

Transmission expansion must consider Generation options, location and costs, in order to optimize the total system investment and operational costs

Long-term **LOCATION SIGNALS** via Optimal Transmission

SCENARIOS OF NEW GENERATION CAPACITY

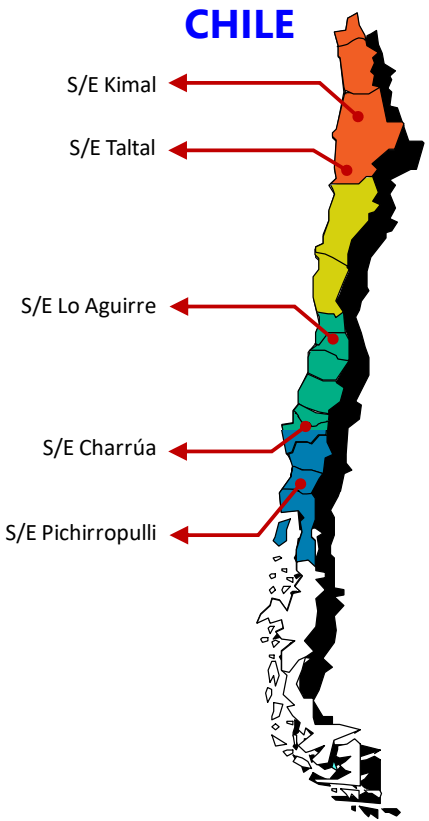
Main Assumptions		Data according to PELP		
		Scenario A-Base	Scenario B	Scenario C
Investment Costs of Renewable Generation Technologies	CSP	Referential	High	Referential
	Solar-PV	Referential	Low	Referential
	Wind	Referential	Low	Low
	Geothermal	Referential	Referential	Referential
	Hydro	Referential	Referential	Referential
Storage Systems	BESS	Referential	Low	Referential
	Hydro Pumping	Referential	Low	Referential
Investment Costs of other Technologies		Referential	Referential	Referential
Environmental Constraints and Social Opposition to Projects		High	High	High
Fuel Costs		Referential-ITP	Referential-ITP	Referential-ITP
Electricity Demand Forecasting		Base-Coordinador	Base-Coordinador	Base-Coordinador

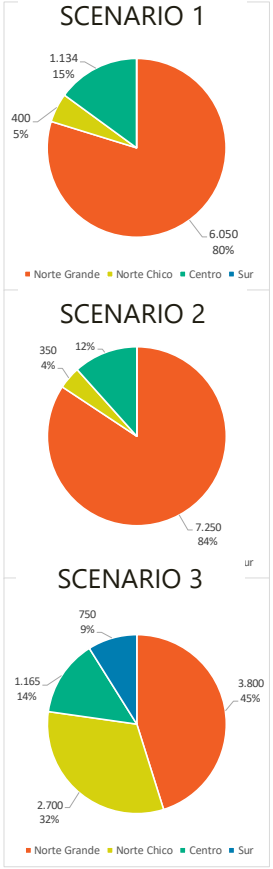
Referencial cost for all generation technologies

Low cost for solar-PV and wind technologies

Low cost for wind technology

SCENARIOS OF NEW GENERATION CAPACITY IN 2030

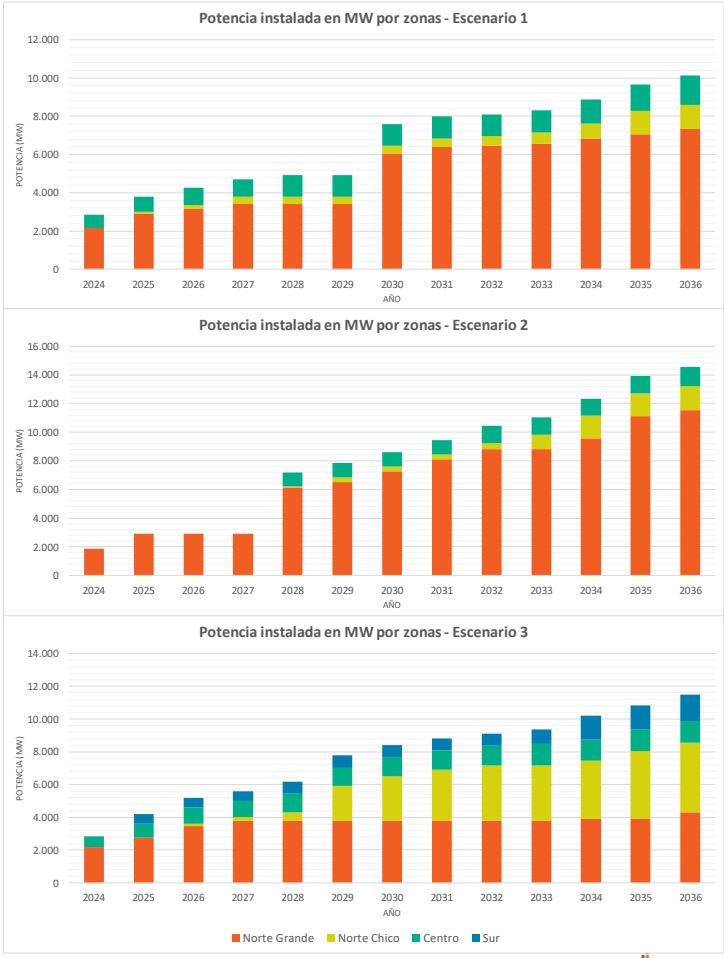




Solar: **97%**
Wind: **0%**
Other: **3%**

Solar: **99%**
Wind: **1%**
Other: **0%**

Solar: **88%**
Wind: **10%**
Other: **2%**



NATIONAL TRANSMISSION NETWORK DEVELOPMENT