# ENERGY TRANSITION IN THE RESIDENTIAL SECTOR COOKING AND HEATING APPLIANCES IN LATIN AMERICA

## Current situation and proposals to accelerate transition

Results of a recent study for the Global Methane Hub

January 2025

UNA INICIATIVA DE:
Global Methane Hub

IMPLEMENTADO POR:
EBP
Stanford University
UNIVERSIDAD MAYOR
Universidad de los Andes Colombia
30 años futuro latinoamericano

# THE PROJECT

TRANSICIÓN ENERGÉTICA A NIVEL RESIDENCIAL

**1 year project by the Global Methane Hub**

**OBJECTIVE:**

Elaborate technical inputs and promote the adoption of programs and policies that facilitate the energy transition at the residential level

**THROUGH:**

***Diagnosis:***

*Recollect data, homogenize information and analyse the current situation and trends with regard to energy transition in the residential sector, specifically cooking and heating*

***Scientific evidence:***

*Measure contamination caused by appliances that use natural gas, in 98 homes in 3 Latinamerican countries*

***Policy proposals:***

*Evaluate different policy instruments that would promote energy transition in the residential sector. With a focus on cooking and heating*

# THE SCOPE

## *Colombia*

***Measurement:***
*23 houses @ Bogota*
***Policy:***
*20 existing policy instruments*
*15 proposed policy actions*

## *Brasil*

***Measurement:***
*30 houses @ Sao Paulo*
***Policy:***
*15 existing policy instruments*
*13 proposed policy actions*

## *Chile*

***Measurement:***
*45 houses @ Santiago and Temuco*
***Policy:***
*25 existing policy instruments*
*20 proposed policy actions*

TRANSICIÓN ENERGÉTICA A NIVEL RESIDENCIAL
Cocción y Calefacción en América Latina

# KEY MESSAGES

Emission factors for global contaminants, especially Methane, have been underestimated significantly and require adjustment

Residential sector electrification is advancing but still far away from its potential (Chile furthest advanced)

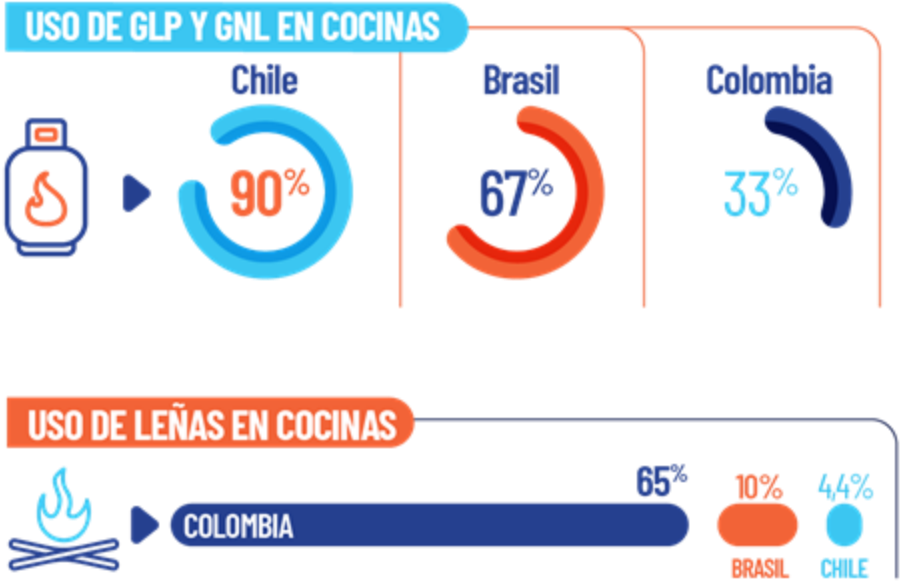
In Chile electricity is competitive with natural gas, LPG and wood

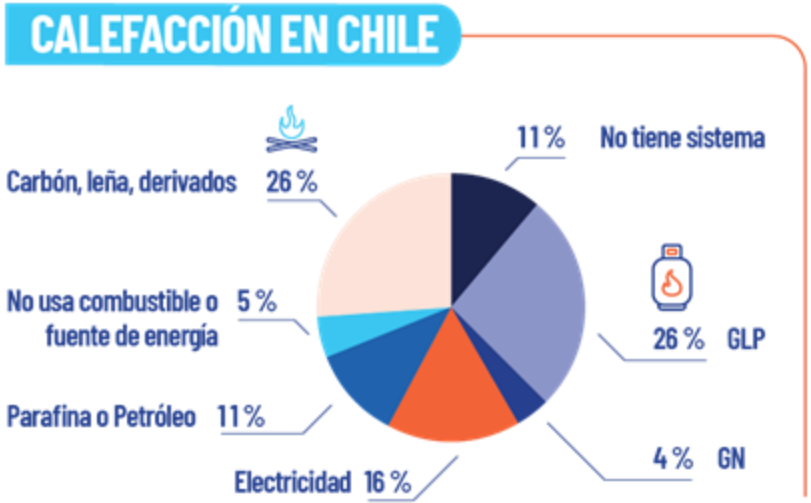
We need concerted action including financial guarantees, replacement programs, information platforms, but also carbon pricing and adjustments in the grid at the utility level

We need to make gradual changes, but not regard natural gas a transition fuel for the residential sector

# CURRENT SITUATION





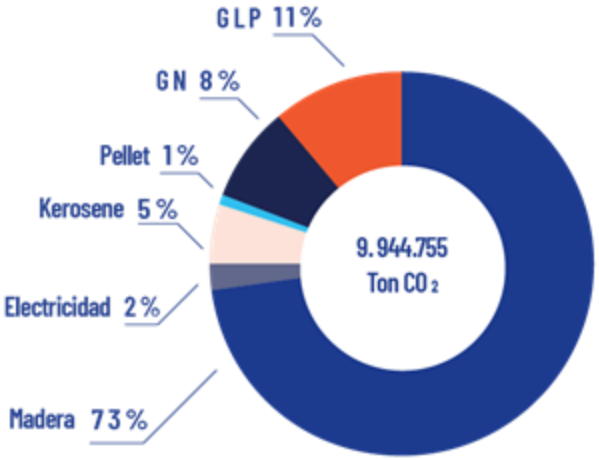

The predominant energy sources are **firewood** and **gas**!
However, emphasis amongst these two varies between the countries

# EMISSIONS - EXAMPLE CHILE

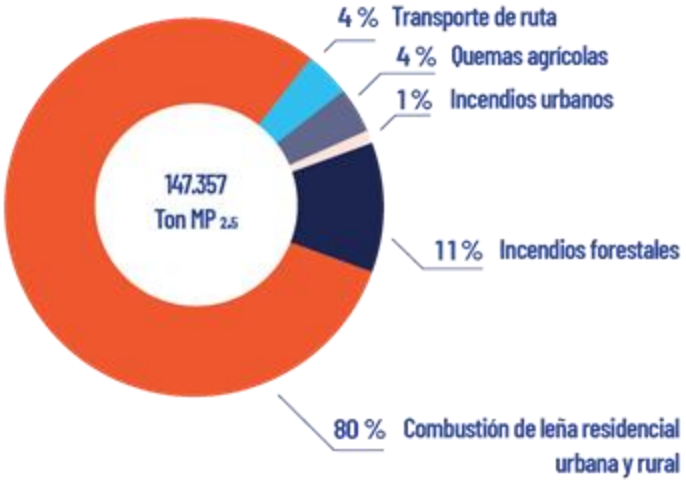
The residential sector in Chile is responsible for **22%** of the country's $CO_2eq$ emissions. (including biomass)

# EMISSIONS – EXAMPLE CHILE

Emissions associated with residential sector **heating**, by energy source, 2022



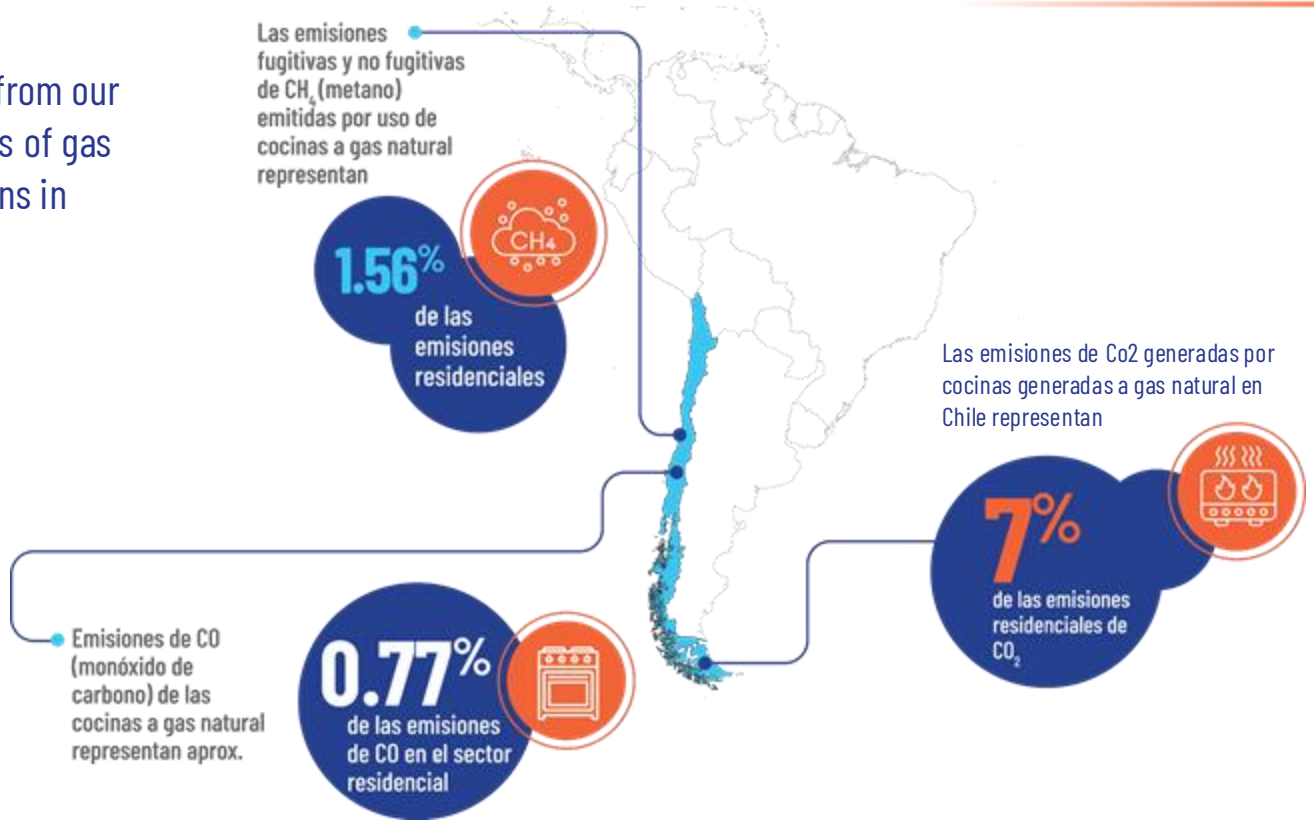

**Particulate Matter 2.5 (PM2.5)** Emissions, Chile, 2021



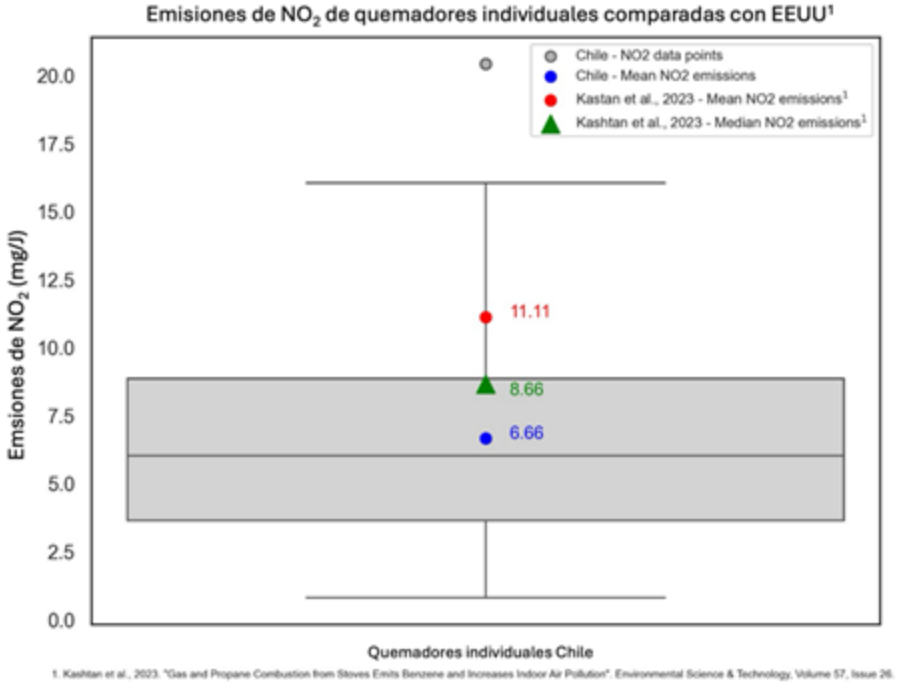

*Source: Transición Energética Residencial. https://sites.google.com/ffla.net/proyectogmh/inicio?authuser=0*

# EMISSIONS – EXAMPLE CHILE

Some results from our measurements of gas stove emissions in **45 homes:**



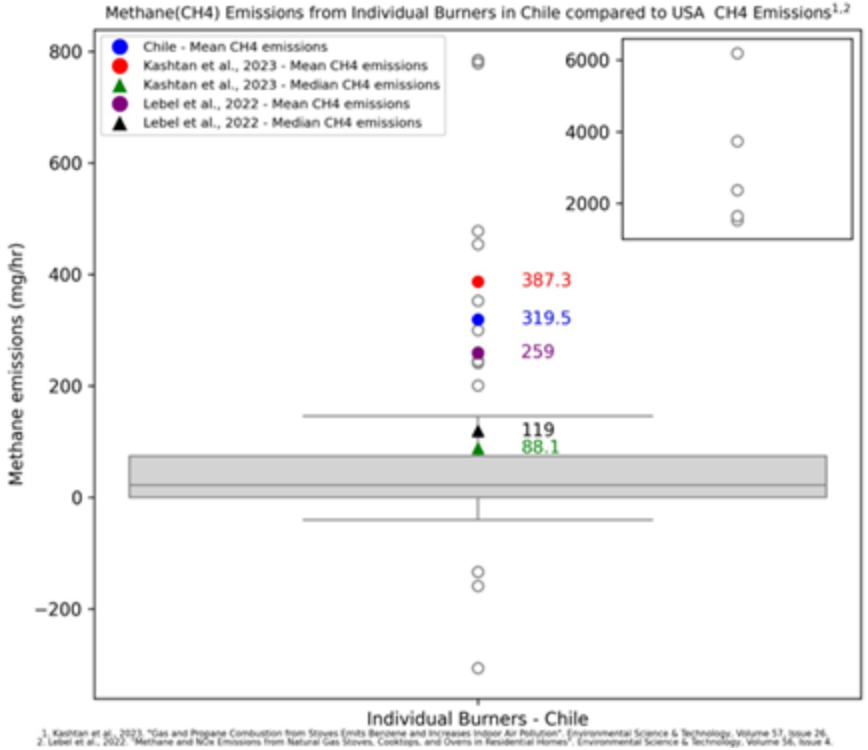
# EMISSIONS – EXAMPLE CHILE




*Source: Transición Energética Residencial.* https://sites.google.com/ffla.net/proyectogmh/inicio?authuser=0

Although Chile has **average $NO_2$ emissions** (6.66 mg/J, blue dot), **lower** than those of the United States (11.11 mg/J, red dot), the **variability of emissions in Chile is very high** (between 1 and 21 mg/J). Therefore, it is estimated that there may be **health risks** for people in poorly ventilated homes that consider prolonged cooking periods, which underlines the **urgent need to improve ventilation in kitchens** or **change the energy source to electricity.**

# EMISSIONS – EXAMPLE CHILE




1. Kashtan et al., 2023, "Gas and Propane Combustion from Stoves Emits Benzene and Increases Indoor Air Pollution". Environmental Science & Technology, Volume 57, Issue 26.
2. Lebel et al., 2022. "Methane and NOx Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes". Environmental Science & Technology, Volume 56, Issue 4.

*Source: Transición Energética Residencial.*
https://sites.google.com/ffla.net/proyectogmh/inicio?authuser=0

**Methane** must be taken into account!

Average $CH_4$ emissions in Chile around 320 mg/h (blue dot).

Much higher than Kastan et al., 2023 (88.1 mg/h) (green) or Lebel et al., 2022 (119 mg/h) (black dot).

Data in Chile with **more variability** than the studies in the USA, and remain between Kashtan and Lebel levels.

# EMISSIONS – EXAMPLE COLOMBIA

Some results from our measurements of gas stove emissions in **23 homes:**

**CO2 emissions from natural gas stoves are**

**58%** of residential emissions (without firewood emissions)

**NOx emissions generated by the use of gas stoves in Bogotá constitute approximately:**

**1.5%** of total emissions in the city of Bogota

**9.7%** **of total CH4 emissions in Bogota are emissions resulting from cooking stoves based on natural gas**

# EMISSION FACTORS NATURAL GAS AS PER PROJECT RESULTS

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Comparison between emission factors resulting from the study and those from the IPCC

| | Emission factors resulting from the study | | Emission factors published in IPCC |
|---|---|---|---|
| | Emission factor study Difference to IPCC | | Emission factor IPCC for Natural Gas (kg/TJ) |
| | CO2 (kg/TJ) | CH4 (kg/TJ ) | CO2 | CH4 |
| **Colombia** | 56.850 | 31,75 | 56.100 | 5 |
| How many times different to IPCC | 1,013 | **6,4** | | |
| **Chile** | 84.910 | 199,12 | | |
| How many times different to IPCC | 1,514 | **39,8** | | |
| **Brasil** | 20.440 | 49 | | |
| How many times different to IPCC | 0,36 | **9,8** | | |

*Fuente: Cuadro 2.4, Capitulo 2 IPCC. Factores de emisión por defecto para la combustión estacionaria en la categoría RESIDENCIAL (kg de gas de efecto invernadero por TJ sobre una base calórica neta)*

Need for adjusting national emissions inventories

**So as to better reflect these emissions**

# EMISSION FACTORS ELECTRICITY

| Country | Emission factor electricity grid (tCO2eq/MWh) | |
|---|---|---|
| | Electricity grid | Natural Gas (IPCC factors) |
| Colombia | 0,11 | 0,20 |
| Chile | 0,16 | 0,20 |
| Brasil | 0,03 | 0,20 |

Electricity has no local emissions

**Today the best available alternative is electricity**

# COMPARED COMPETITIVENESS– TCO for cooking – example Chile

| Type of Cost | Cost in USD | | |
|---|---|---|---|
| | Electric Induction Cooktops | Natural Gas Cooktops | LP Gas Cooktops |
| Purchase cost | 284 | 116 | 116 |
| Installation Cost | 42 | 28 | 28 |
| Operation cost | 525 | 730 | 673 |
| TCO | **852** | **874** | **817** |
| CH4 Social Benefit | 7 | - | - |
| TBO | **7** | - | - |
| Cost-Benefit | **-845** | **-874** | **-817** |

**Assumptions for Total Cost of Ownership and Social cost-benefit analysis**:

20 years life span; Discount rate of 5,5% ; Resident without access to subsidies for electricity or gas; A simple standardization was developed based on a market analysis, to facilitate the comparison of technologies. The investment costs are highly variable; Social price of carbon: 63 US$/tCO2; NOx green Tax in Santiago de Chile: 42.104 US$/ton; Electricity, Natural gas, LP gas and wood costs: 0,21 USD/KWh (Enel 2025), 0,2 USD/KWh (Metrogas, 2025), 0,19 USD/KWh (Gasco, 2025) and 0,03 USD/KWh (Sernac, 2024), respectively.

# COMPARED COMPETITIVENESS– TCO for cooking – example Chile

| Type of cost | Cost in USD | |
|---|---|---|
| | Electric Induction Cooktops | Wood Stove |
| Purchase cost | 284 | 495 |
| Installation Cost | 42 | 126 |
| Operation cost | 525 | 142 |
| TCO | **852** | **764** |
| CO2 Social Benefit | **72** | - |
| CH4 Social Benefit | **5** | |
| NOx Benefit | **1.425** | - |
| TBO | **1.502** | - |
| Cost-Benefit | **651** | **-765** |

Electric cooking is, in Chile, very competitive with other energy sources for cooking, within a range of +/- 10% of Total Cost of Ownership. And with large environmental benefits especially compared to Wood.

**Assumptions for Total Cost of Ownership and Social cost-benefit analysis**:

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# COMPARED COMPETITIVENESS– TCO for cooking – example Colombia

| Type of Cost | Cost in USD | | |
|---|---|---|---|
| | Electric Induction Cooktops | Natural Gas Cooktops | LP Gas Cooktops |
| Purchase cost | 322 | 91 | 91 |
| Installation Cost | 36 | 38 | 30 |
| Operation cost | 832 | 207 | 234 |
| TCO | **1.191** | **336** | **355** |
| CH4 Social Benefit | 0,68 | - | - |
| TBO | **0,68** | - | - |
| Cost-Benefit | **-1.190** | **-336** | **-355** |

**Assumptions for Total Cost of Ownership and Social cost-benefit analysis**:

20 years life span; Discount rate of 9% ; Resident without access to subsidies for electricity or gas; A simple standardization was developed based on a market analysis, to facilitate the comparison of technologies. The investment costs are highly variable; Carbon tax: 5,88 US$/tCO2eq; Electricity, Natural gas, LP gas and wood costs: 0,241 USD/KWh, 0,083 USD/KWh, 0,094 USD/KWh and 0,03 USD/KWh, respectively (Status Report: Residential electrification in Brazil, Chile and Colombia 2024)

# COMPARED COMPETITIVENESS– TCO for cooking – example Colombia

| Type of cost | Cost in USD | |
|---|---|---|
| | Electric resistance Cooktops | Wood Stove |
| Purchase cost | 222 | 303 |
| Installation Cost | 38 | 19 |
| Operation cost | 832 | 77 |
| TCO | **1.092** | **399** |
| CO2 Social Benefit | **5,91** | **-** |
| CH4 Social Benefit | **0,44** | |
| TBO | **6,34** | **-** |
| Cost-Benefit | **-1.086** | **-399** |

Electric cooking is, in Colombia, not competitive with other energy sources for cooking.

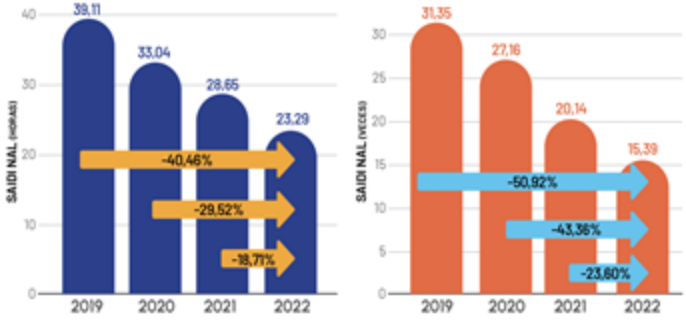
**Assumptions for Total Cost of Ownership and Social cost-benefit analysis**:

20 years life span; Discount rate of 9% ; Resident without access to subsidies for electricity or gas; A simple standardization was developed based on a market analysis, to facilitate the comparison of technologies. The investment costs are highly variable; Carbon tax: 5,88 US$/tCO2eq; Electricity, Natural gas, LP gas and wood costs: 0,334USD/KWh, 0,083 USD/KWh, 0,094 USD/KWh and 0,03 USD/KWh, respectively (Status Report: Residential electrification in Brazil, Chile and Colombia 2024)

# ACCESS TO ELECTRICITY

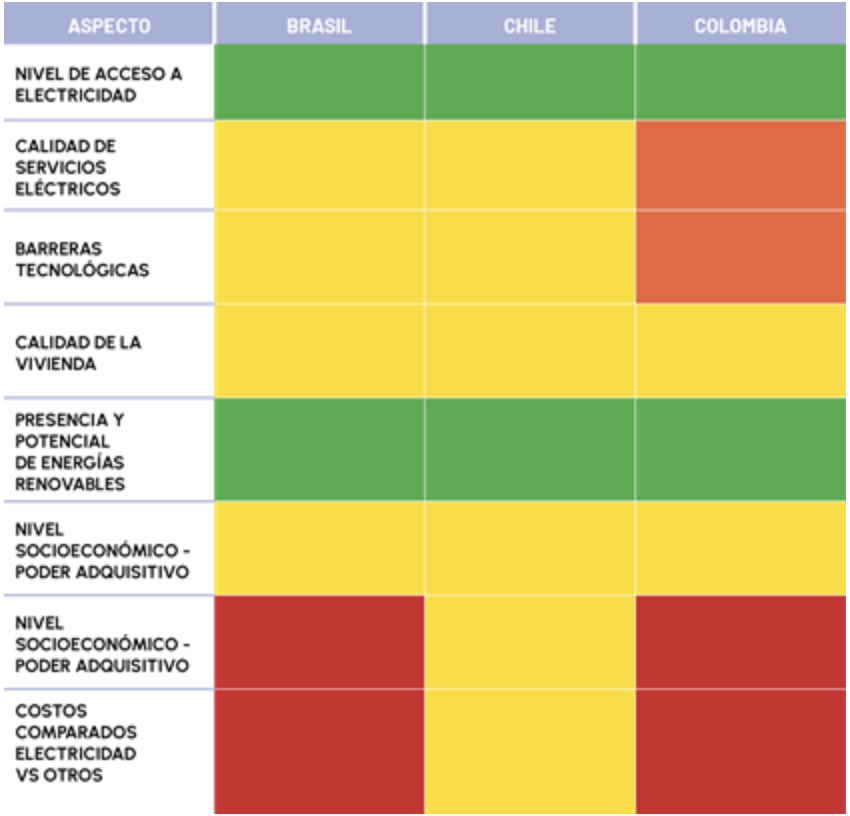
| | |
|---|---|
| Chile y Brasil | 100% |
| Colombia | 99% |

## INTERRUPTIONS IN COLOMBIA




The quality of electricity access is crucial to understanding the level of readiness for electrification.
Service interruption levels in the three countries range between 13 and 25 hours, with a frequency of 5 to 15 times, decreasing rapidly in last years. In OECD countries, the average is 1.3 hours with a frequency of 0.9 times (IEA, 2018). This means that **the three countries are still far from the average standards of OECD countries, but improving continuously**.

# READY FOR ELECTRICITY?



| ASPECTO | BRASIL | CHILE | COLOMBIA |
|---|---|---|---|
| NIVEL DE ACCESO A ELECTRICIDAD | | | |
| CALIDAD DE SERVICIOS ELÉCTRICOS | | | |
| BARRERAS TECNOLÓGICAS | | | |
| CALIDAD DE LA VIVIENDA | | | |
| PRESENCIA Y POTENCIAL DE ENERGÍAS RENOVABLES | | | |
| NIVEL SOCIOECONÓMICO - PODER ADQUISITIVO | | | |
| NIVEL SOCIOECONÓMICO - PODER ADQUISITIVO | | | |
| COSTOS COMPARADOS ELECTRICIDAD VS OTROS | | | |

The level of readiness for residential electrification can be considered **moderate**, with some challenges that need to be addressed, particularly in the case of Colombia.

The existing policies in the three countries aim, on one hand, for a transition towards cleaner fuels.

However, there is **no systematic strategy in these countries to drive and promote residential electrification.**

# EXISTING POLICIES

## 1 CHILE

### SELECTED POLICIES

**National Energy Policy 2050:**
It aims for 100% zero emissions by 2050 and 80% renewable energy by 2030. It promotes distributed renewable energy, energy efficiency in buildings, electrification of heating to replace wood, and mandatory energy labeling for appliances.

**Energy Efficiency Law:**
It promotes the efficient use of energy in households by enabling subsidies and incentives for the installation of efficient electrical systems based on renewables.

**Decontamination Plans:**
Elaborated for municipalities, provide a framework to act through different instruments, including Residential Wood Stove Replacement Programs

### EXAMPLES OF SPECIFIC PROGRAMS OR INSTRUMENTS

**Programa de recambio de calefactores a leña**
Ministerio del Ambiente

**Programa Casa Solar**
Ministerio de Energía y Agencia de Sostenibilidad Energética

**Programa Comuna Energética**
Ministerio de Energía y Agencia de Sostenibilidad Energética

# EXISTING POLICIES

## 2 COLOMBIA

## SELECTED POLICIES

- **National Energy Plan:**
  It encourages energy efficiency, decentralization of consumption, and the need for incentives and education for households.
- **Indicative National Action Plan for Energy Efficiency (PROURE) 2022-2030:**
  It defines key actions and measures for efficient energy management to be implemented across different consumption sectors, through energy impact and cost/benefit analysis.
- **Road Map for Net Zero Buildings:**
  It sets goals for reducing operational carbon and embedded carbon to achieve net-zero carbon buildings by 2050.
- **National Plan for the Replacement of Wood:**
  Plan directed at the reduction of the use of Wood for cooking. For 2026 by 10,1%, for 2030 by 34,3% and for 2050 87,3%.

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## EXAMPLES OF SPECIFIC PROGRAMS OR INSTRUMENTS

**Ley 145: Deducción tributaria para instalaciones solares**

**Plan Nacional de Sustitución de Leña -** Unidad de Planeación Minero Energética (UPME)

**Fomento de Comunidades energéticas Decreto 2236 de 2023 -** Ministerio de Minas y Energía.

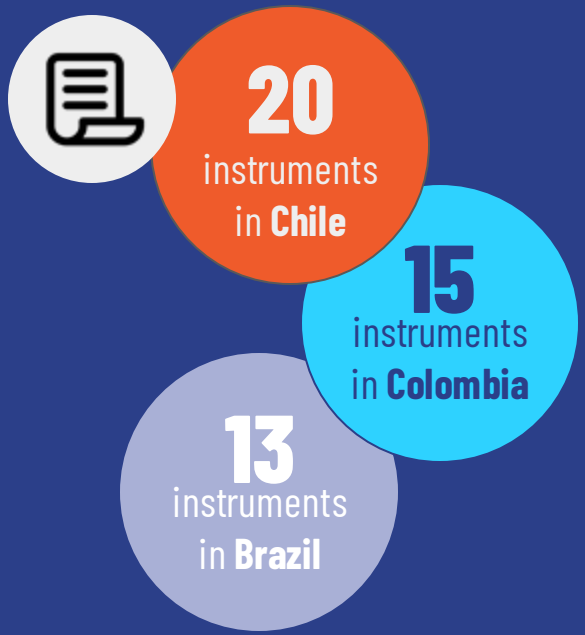
# EXISTING POLICIES

**There is a large number of existing policy instruments**

**BUT:**

- There is a lack of coordination and articulation
- There is a lack of strategic orientation, with clear goals
- Instruments have not been evaluated and improved sufficiently
- In Chile electricity is competitive regarding natural gas, LPG and wood, policy instruments that imply small, transitory incentives, could make a big difference if these were oriented strategically
- Carbon prices, where they exist, have left out the residential sector and in the case of Colombia left out natural gas
- Subsidies for the use of gas are counterproductive both in Colombia and in Chile
- Funds for subsidy programs for electricity consumption could be used more effectively on energy efficiency and replacement programs
- Brazil has to be treated as a special case given the strong presence of biofuels

# PROPOSED POLICIES: Instruments to facilitate change




The proposed instruments aim to:

- Create an **Energy Transition Strategy** for the Residential Sector
- Strengthen **distribution networks** and residential electrical installations
- Implement appliance **replacement programs**
- Provide more **information** to consumers
- Ensure that energy prices reflect their true costs, including **environmental and health costs**

# PROPOSED POLICIES: Examples for Chile

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## Examples for instruments not requiring new laws

- Create a residential **information** platform
- Equip social (and non-social) housing with **energy-efficient devices and with roof top solar energy, through transitory partial subsidies and/or ESCO type financing combined with risk guarantee fund**
- **Program to complement gas stoves with portable induction cooktops**
- Program for **replacing wood stoves and woodfire kitchens** with electric appliances,
- **Combine solutions** for heating and refrigeration
- Improve appliance **labeling systems**
- **Program to regularize and improve residential electrical systems**

## Examples for instruments that require new laws

- Reform electricity **distribution regulation**
- **Carbon content tax** on fossil fuels, including for residential use
- **Electrification requirements** for new urban constructions

# PROPOSED POLICIES: Final message

**We can, and should, act now**

**We have to do this in a coordinated way, with a strategic view and clear goals**

**In our opinion, the Ministries of Energy in Chile and in Colombia are interested to push this agenda and there would be an opportunity to link up further at the international level**

Website Spanish (full information and reports): https://proyectogmh.ffla.net/

Website English (with partial information): https://proyectogmh.ffla.net/en/residential-energy-transition/


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