Exploring Colombia's Energy Transition Roadmap

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1. Climate Change - challenges and opportunities
2. Energy Transition Roadmaps - managing the transition
3. Colombian Energy Transition Roadmap – pursuing a sustainable development path

Key streams of the Paris Agreement

Three pillars drive the interest of the private sector

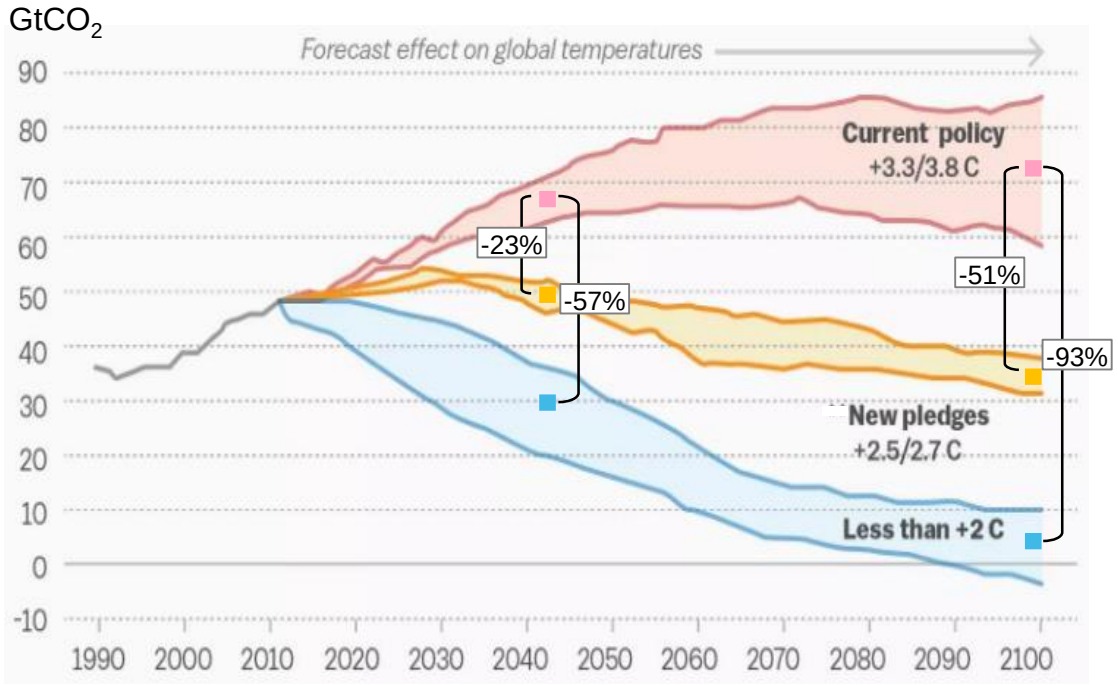
- **Ambition** - Long term goal of keeping raising temperature "well below 2°C" with efforts to stay within 1.5°C:
  - Emission peak "as soon as possible"
  - Carbon neutrality in the second half of the century
  - More than 95% of global emissions covered

- **Transparent Governance -** A transparent framework foreseeing:
  - **Clear and transparent** NDCs to be periodically upgraded
  - **"Highest possible ambition" through NDC** (Nationally Determined Contributions)
  - **5 years pledge review system**

- **Climate Finance**
  - **Public Finance –** confirmation of the commitment to mobilize 100 Bn USD/yr to climate finance (not backed by the current level of pledges)
  - **Carbon Markets-** Reference to carbon trading through "mitigation outcomes" and new project-based crediting mechanism

Global emission trends ($GtCO_2$)

The 2°C and 1.5°C goal calls for much more ambition

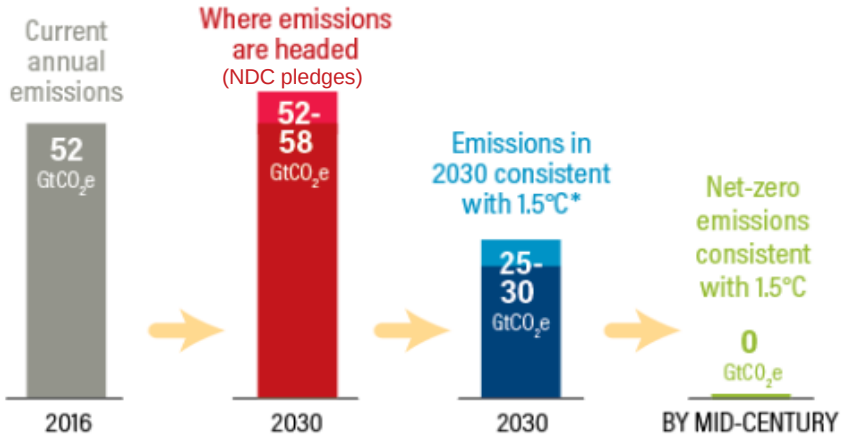


Source: Climate Action Tracker 2016

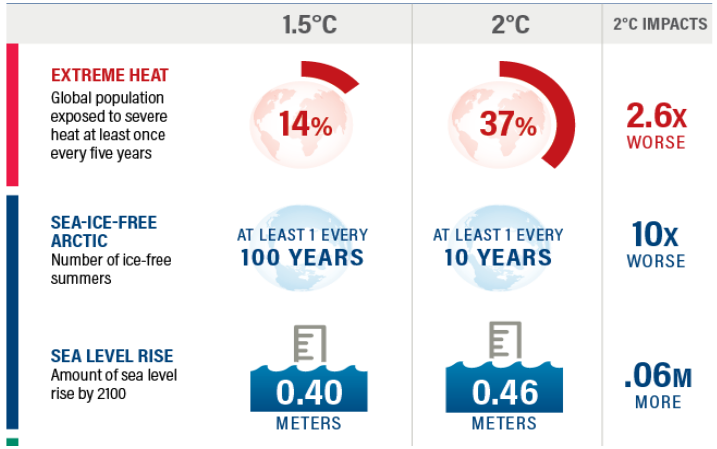
Translating IPCC 1.5°C Special Report

Fully decarbonised electricity key lever for 1.5°C target

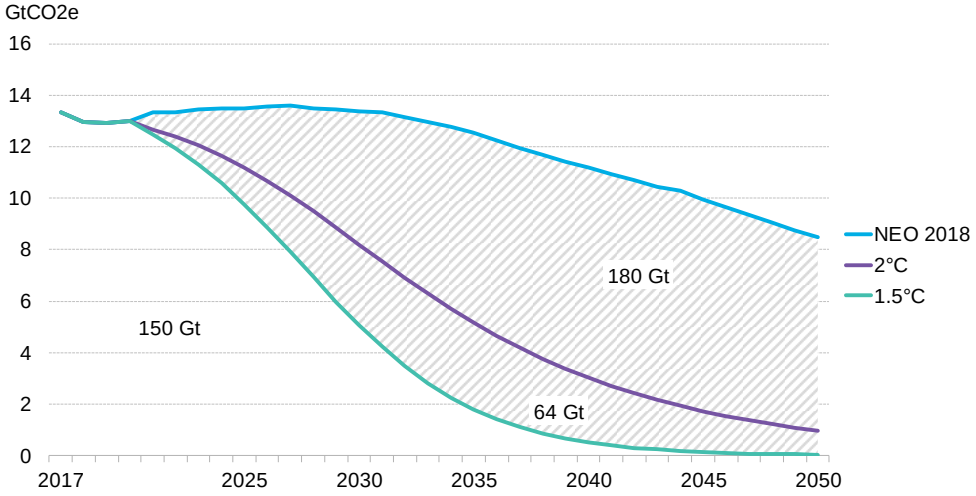
Global emission targets



Climate change impacts (from 1.5°C to 2°C)

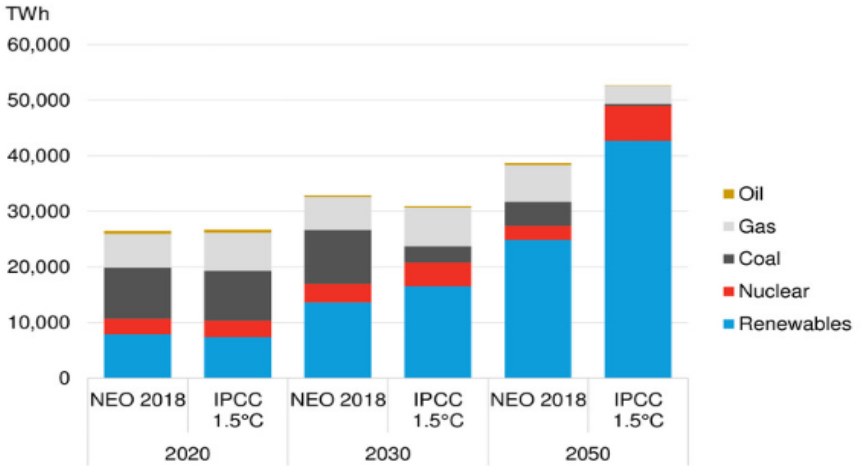


Global power sector emissions in NEO 2018 vs 2°C and 1.5°C pathways



Source: BNEF 2018, NEO – New Energy Outlook Report

Electricity generation in 2020, 2030 and 2050 (NEO2018 vs IPCC1.5°C)



Source: BNEF 2018, NEO – New Energy Outlook Report

Diversified energy transition policy drivers

Together with climate change, other important policies are accelerating the transition

Environment

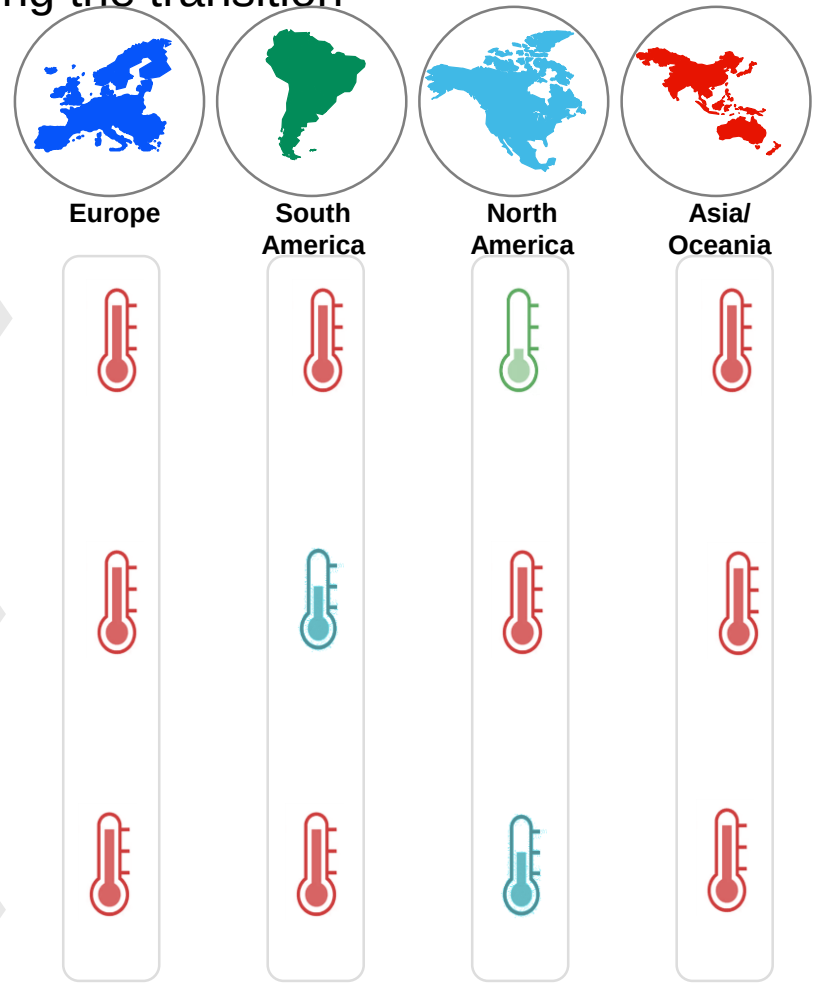
Air quality and environmental sustainability

Geo-Politics

Security of primary energy supply

Industrial Development

Economic competitiveness vs green growth

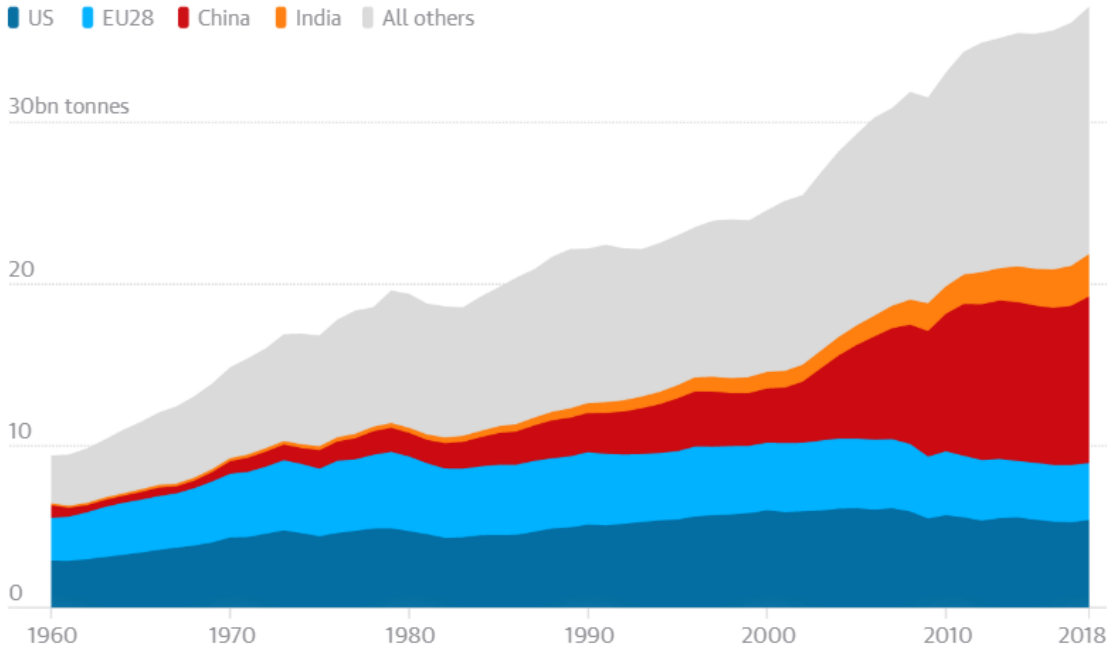


Note: Qualitative evaluation. Regions are subject to national peculiarities

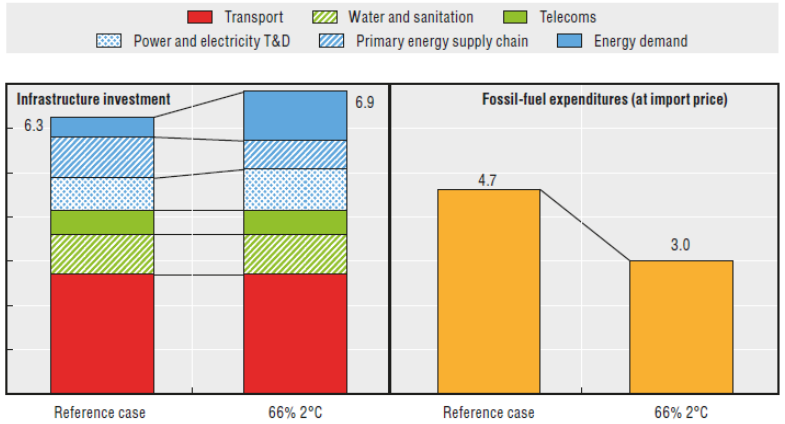
… concrete results slow to come

Stopping GHG emission trends requires $ trillions, but creates the same opportunities

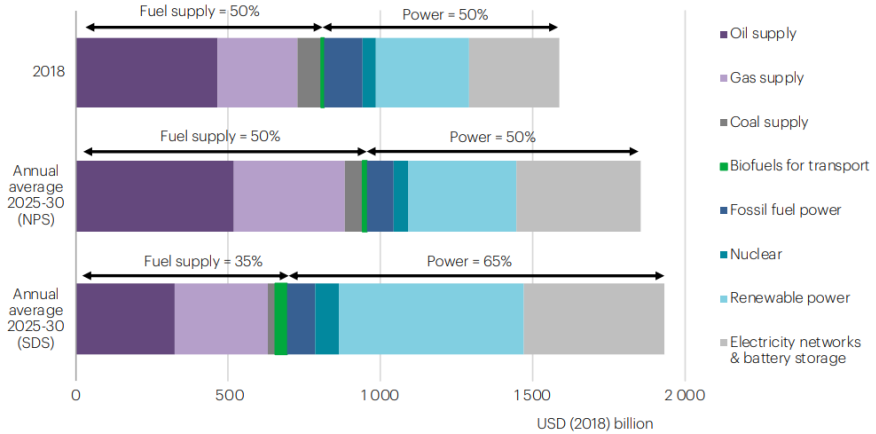
Annual GHG emissions increased between 1960 and 2018 by 27 billion tCO_2e - peaking in 2018 in 37.1 billion. Despite mitigation efforts, GHG emissions continue to increase (Global GHG emissions)*



Infrastructure investments increase 0.6 trillion, fuel expenditures decrease 1.7 trillion. Between 2°C and BAU, Considerable increments seen in power and energy demand (infrastructure and fossil-fuel spending)**



Additional investments in the Energy supply between 270 and 350 billion. New Policies and Sustainable development scenarios invest more resources in RES, Network D&D and BESS (Global energy supply investments) ***



* Guardian graphic. Source: University of East Anglia, Global Carbon Project)
** Investing in climate, Investing in growth, OECD 2017
*** World Energy Investment, iea 2019

1 Climate Change – Challenges and opportunities

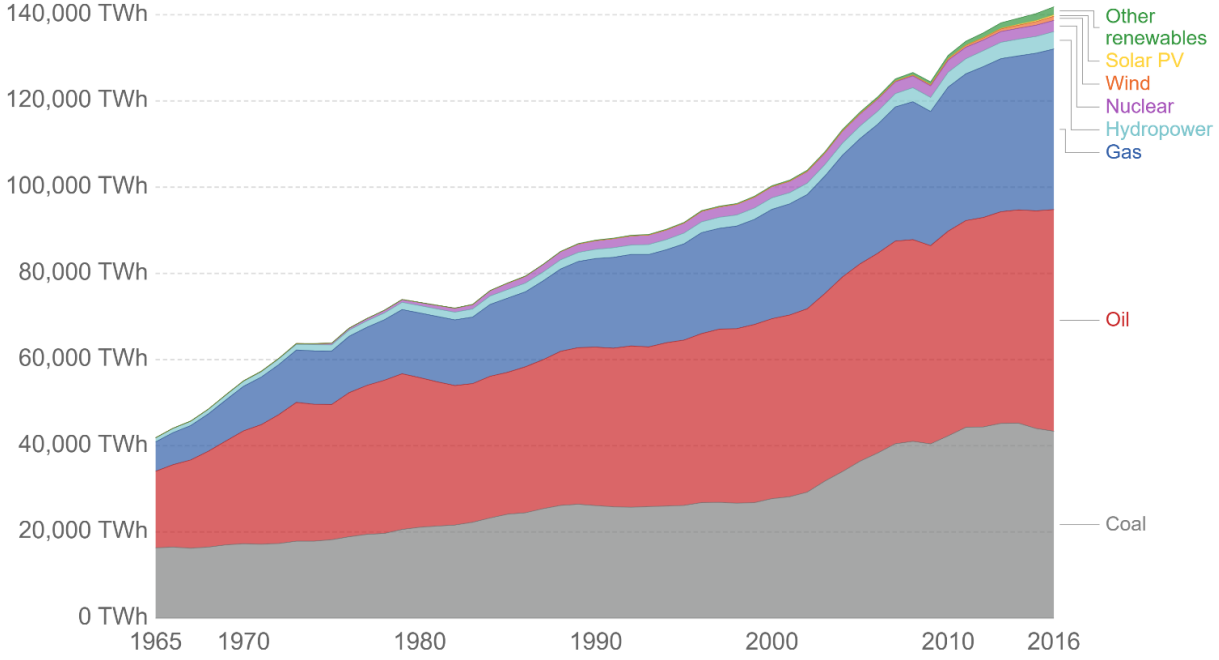
2 Energy Transition Roadmaps - managing the transition

3 Colombian Energy Transition Roadmap - pursuing a sustainable development path

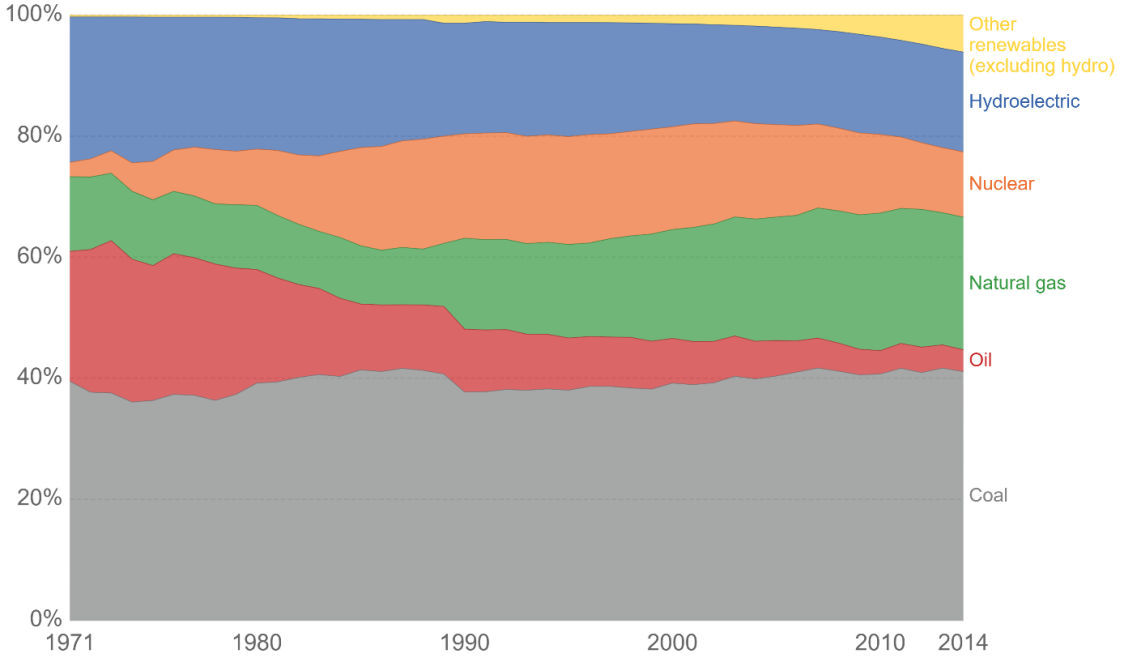
Global Energy Transition underway

Global energy demand supplied with carbon energy vectors, with electricity leading the transition to cleaner energy sources

Primary energy consumption has tripled in 50 years. In 2016, 90% of primary energy is covered by fossil fuels (Global primary energy consumption)*



In 2014 RES represent more than 20% of electricity generation. Although nuclear decline lead to gas and coal share growth (Global share of electricity generation)**

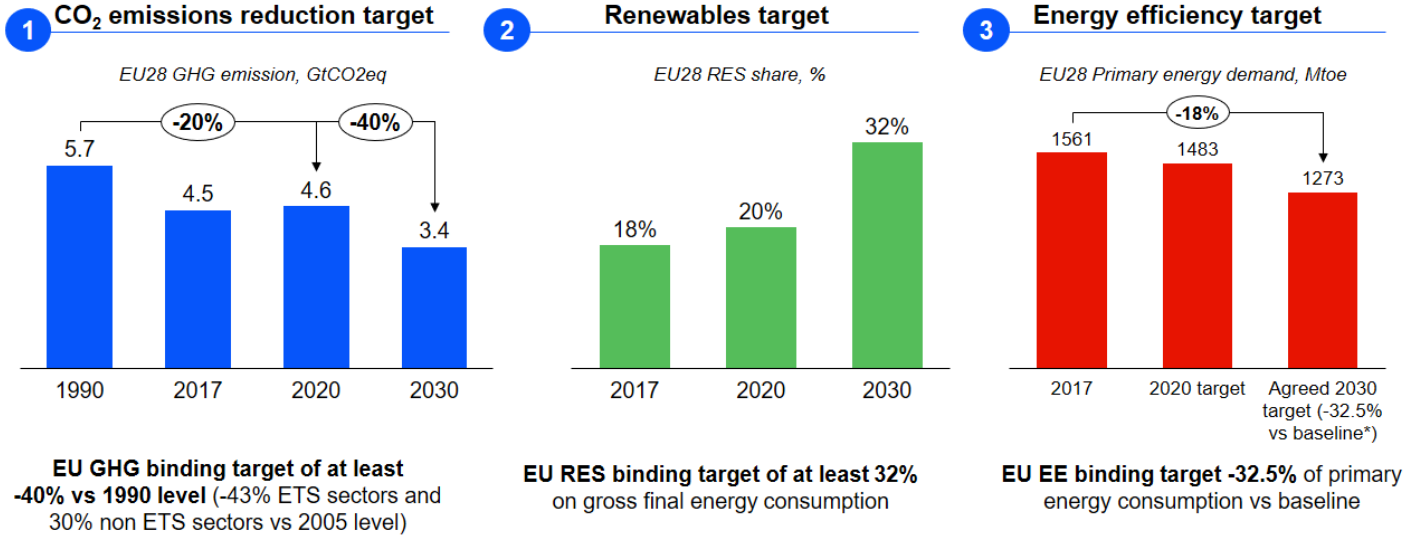


* Our world in data, 2019 (BP Statistical Review 2016)
** Our world in data, 2019 (International Energy Agency)

The energy transition can be accelerated

European case shows effectiveness of government and stakeholder involvement

Ever evolving and increasingly ambitious process towards a **New Green Deal**



EU GHG binding target of at least -40% vs 1990 level (-43% ETS sectors and 30% non ETS sectors vs 2005 level)

EU RES binding target of at least 32% on gross final energy consumption

EU EE binding target -32.5% of primary energy consumption vs baseline

Green Deal for Europe in first 100 days in office putting forward the first ever European Climate Law setting the 2050 target into law:

- **Commission would put together "a comprehensive plan" to increase the 2030 goal to 50%, if not 55%** "in a responsible manner
- **Perspectives for European carbon neutrality by 2050**, going from 80 to 95%
- **European Central bank considering quantitative leasing**, dropping investment rates focusing on green actions

Energy Transition Roadmaps

Translate COP21 global commitments at country and regional levels

Accelerating the energy transition at National Level: roadmaps to support Governments in implementing the energy transition fully exploiting the three key levers of emission free electricity, digitalized grids, electrification

Supporting transparent and stable policy and regulatory frameworks: supporting Governments and UN Institutions in implementing the Paris Agreement with clear and effective Climate and Energy Plans reflected in transparent NDCs*

Promoting effective climate finance programs and market mechanisms: cooperation with National Governments, UNFCCC institutions and other Stakeholders (e.g. Development Banks, NGOs) to design effective up-scaled and streamlined financing tools and market mechanisms to support the energy transition

* NDC - Nationally Determined Contribution: national targets and related climate-energy policies foreseen by the Paris Climate Agreement

Enel's Energy Transition Roadmap Projects

Building consensus on the right path to meet the Paris Agreement goals

Scenario analysis

*…**build a sustainable long term policy scenario** taking into account characteristics of each geography and leveraging on renewables, electrification and grid digitalization*

Policy Recommendations

*….define **a set of policy recommendations triggering the needed investment** for an efficient, sustainable and low carbon economy*

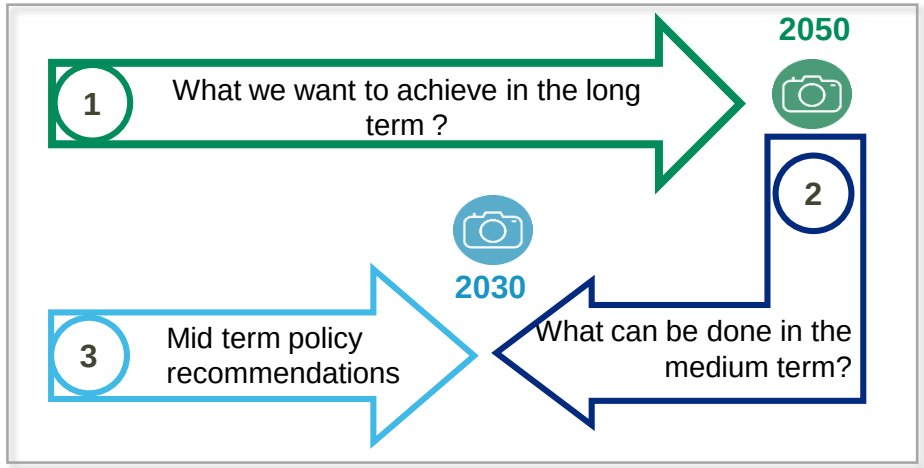
Stakeholders engagement

***…. involvement of multiple stakeholders** along the whole process for defining and shaping the long term vision and mid term actions*

Energy Transition Roadmaps approach overview

A simplified approach to explore the role of Enel's industrial levers within the 2050 pathways

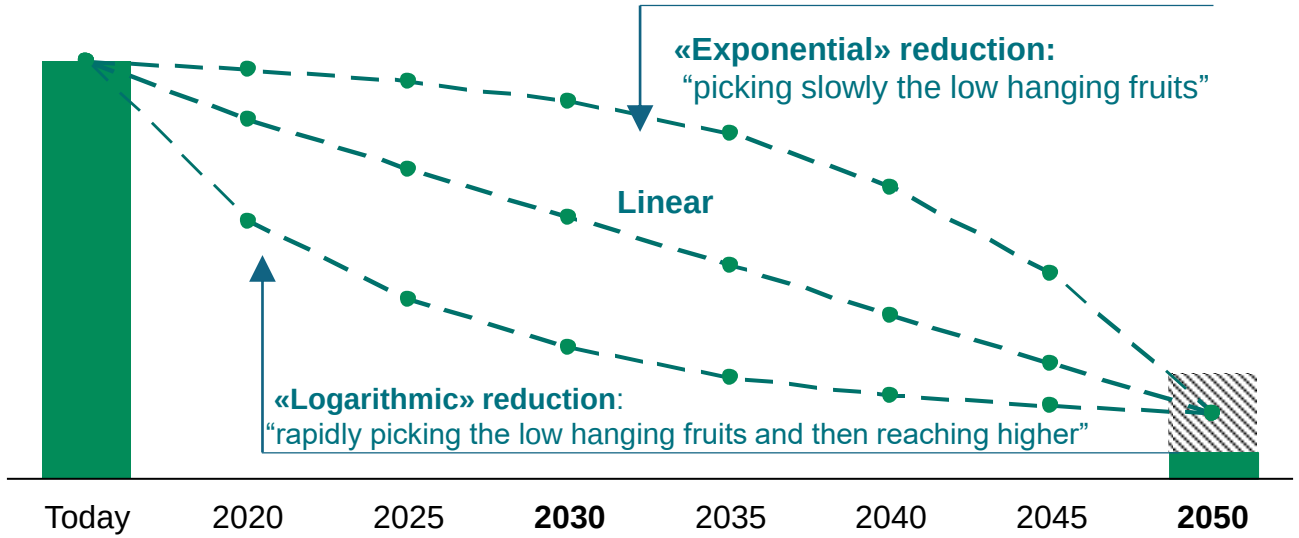
4 Steps Projects



4 Stakeholder engagement aimed at disseminating Enel's vision

A trajectory consistent with the 2050 GHG goal requires a step-change in policy action in the direction of higher reliance on low emissions electricity across different end-uses

3 Main Sectorial GHG Emissions Paths*

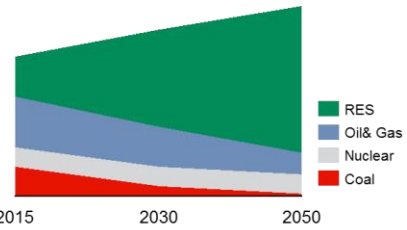


3 Industrial Levers

1 Emission Free Power generation

Electricity generation

TWh/yr

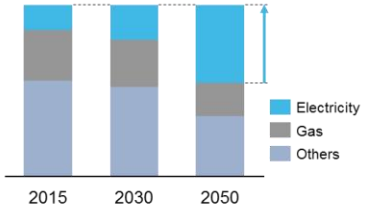


3 Infrastructure Development & Digitalization

2 Switch to Energy Vectors with lower emissions

Final energy consumption

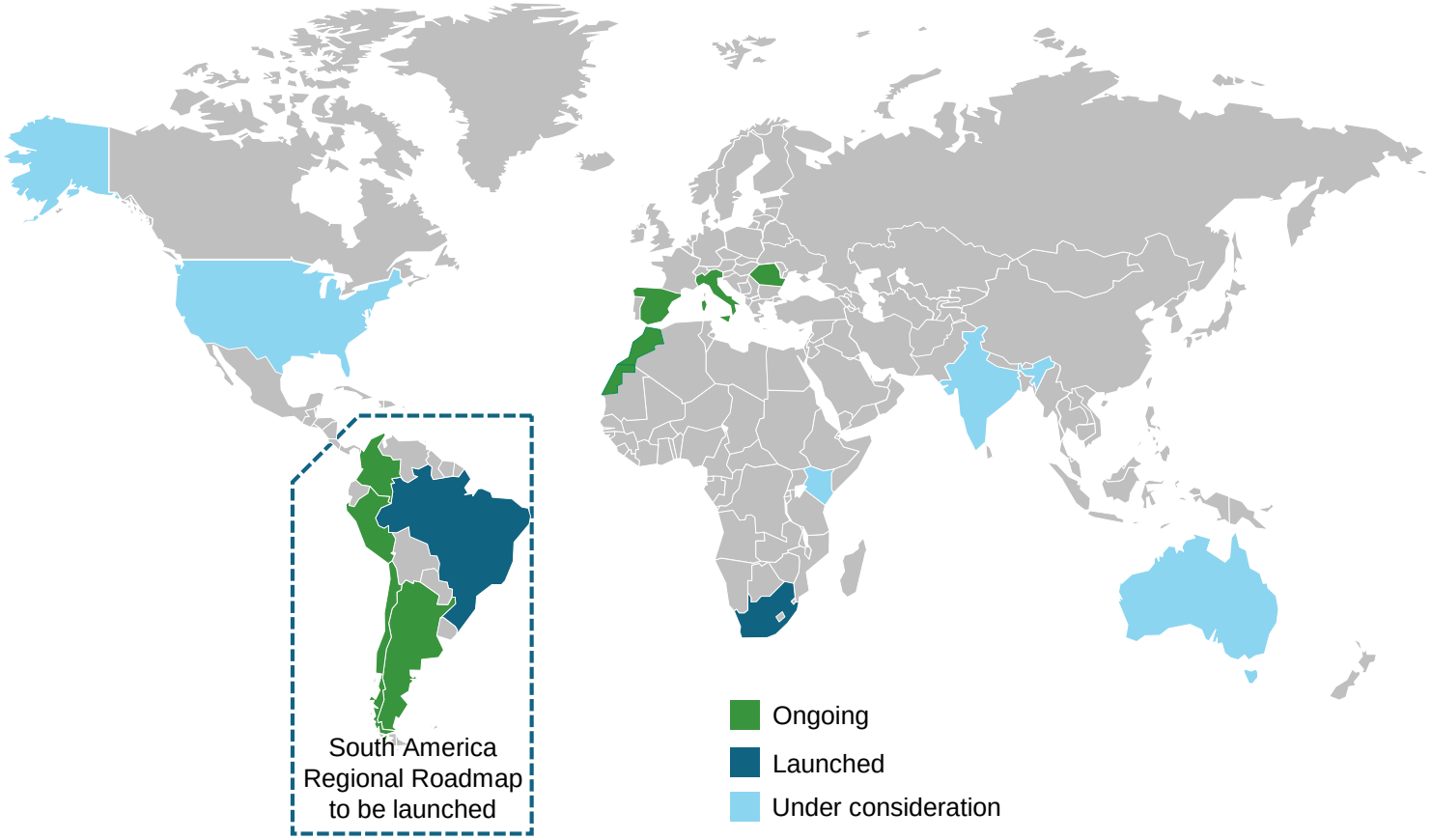
%



* Illustrative graph

Enel experience on the Energy Transition

Exploring medium and long term policy scenarios across different geographies



Ongoing

- Spain
- Italy
- Romania
- Colombia
- Argentina
- Morocco
- Chile
- Peru

Launched

- South Africa
- Brazil

Under Consideration

- India
- Australia
- Kenya
- USA*

*selected states

Enel experience on the Energy Transition

Case Study of Future-E in Italy

The Enel Future-E Project

Repurposing more than 20 sites

SOCIAL SUSTAINABILITY

- Creating shared value for our business and for local communities
- Redeployment of ENEL employees within other company divisions
- Local capacity building through ad hoc training programs
- Promoting local employment as well as new development opportunities for local communities

ECONOMICAL SUSTAINABILITY

- Creation of economic development through site reconversion, promoting the potentiality of local lands and communities
- Business development opportunities
- Promotion of local natural, cultural and artistic excellences and assets

ENVIRONMENTAL SUSTAINABILITY

- Protecting the environment and local lands and communities
- Reusing materials and revitalizing site features
- Reducing CO_2 emissions

INNOVATION

- Development of start-ups and new businesses
- Enhancing creative thinking and solutions
- Leveraging on new partners in ICT, new technologies

FUTUR-E | 17 August 2018

Montalto di Castro: from power station to smart village

SUSTAINABILITY | 24 May 2018

A theme park in the new life of the former Trino power station

SUSTAINABILITY | 30 November 2017

Futur-e, new life to the Portoscuso plant

SUSTAINABILITY | 09 March 2018

Futur-e gives new life to the Campomarino turbo-gas power plant site

Enel and Milan Polytechnic present the strategy to lo

South America Roadmap (SAR)

Galvanizing a regional sustainable energy transition

SUPPORT

***From national to regional**: country based Energy Transition Roadmaps will support the development of a South American long term vision and Enel's Industrial Plan.*

***SAR combines all major results from the single roadmaps** and promotes specific recommendations with aggregated value for the region*

ENGAGE

*Under the SAR umbrella, Enel Americas will engage and **mobilize regional stakeholders** (public and private sector, regional and international organization) around the common goal of a sustainable energy transition*

REINFORCE

*Insights and findings from **SAR will reinforce and feedback ongoing national Energy Transition Roadmaps**, supporting countries' strategy to build an investment framework which enhances the development of an efficient, sustainable and low carbon economy*

Learning from the Energy Transition Roadmaps

A smooth and just transition poses clear challenges across the full length of the value chain

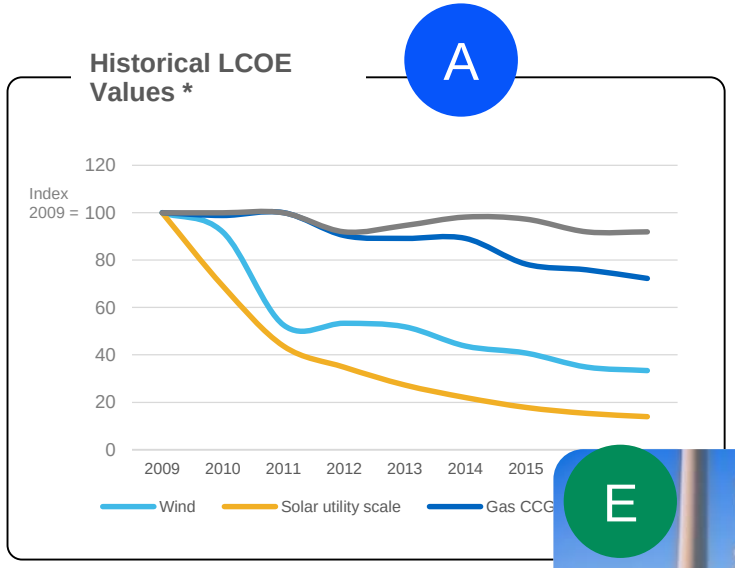
A Taking advantage of renewables' falling costs

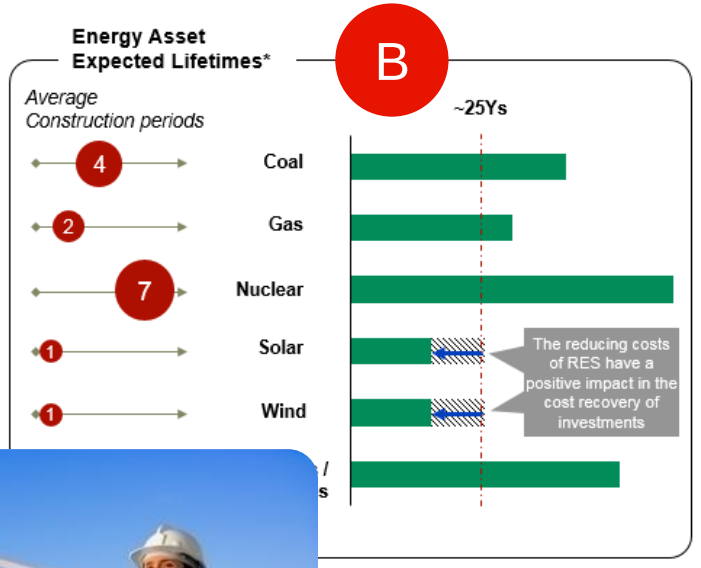
B Managing a just and smooth phase out of fossil assets

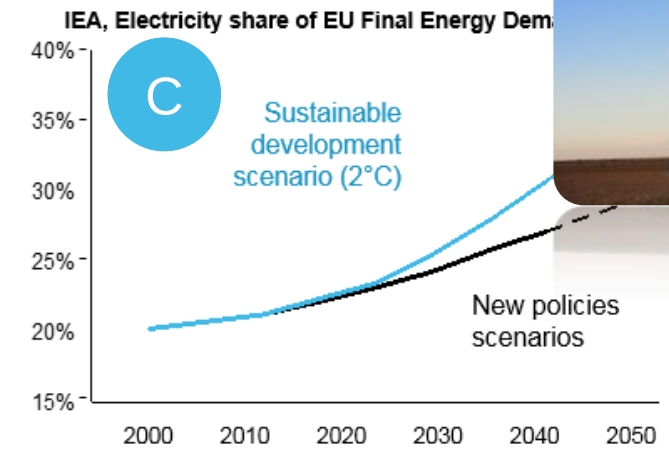
C Fully exploiting electrification opportunities

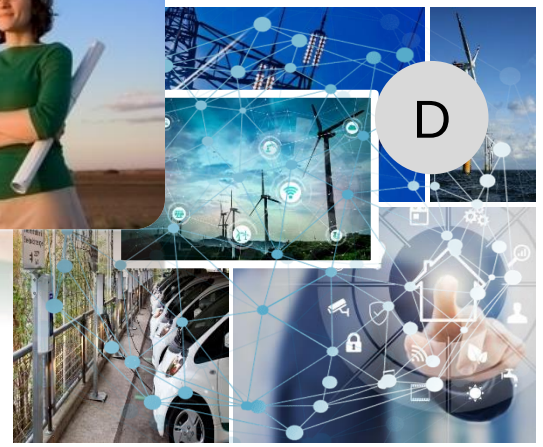
D Giving a central role of upgraded, smart grid

E Ensuring effective jobs conversion and re-skilling









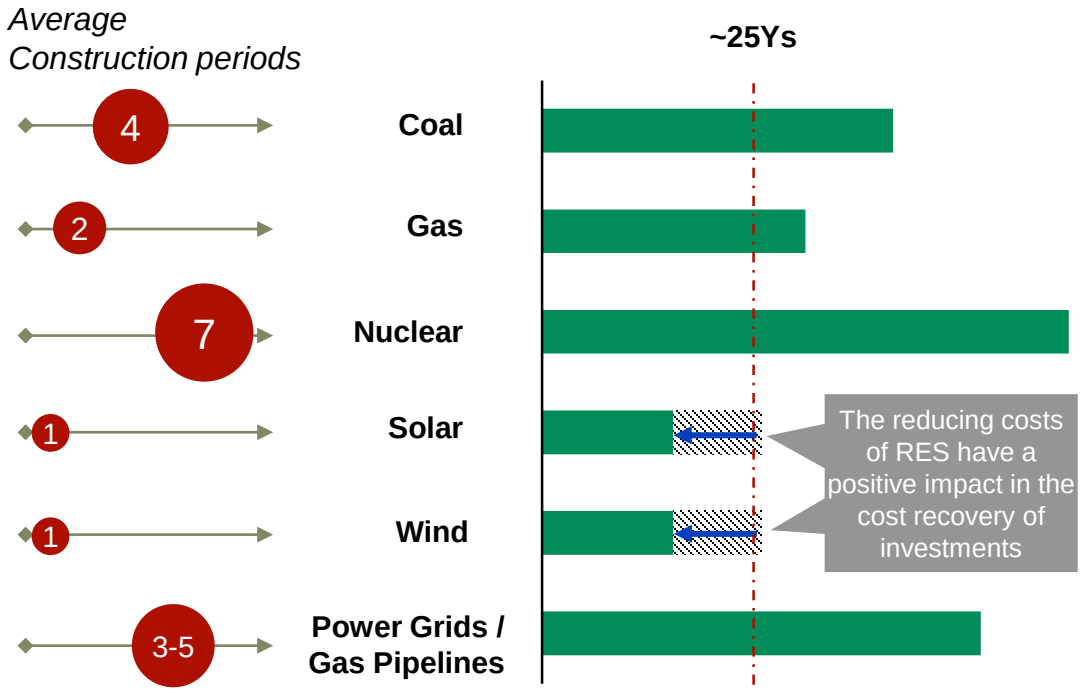
Sources: * BNEF; **IEA, Projected cost of generating electricity 2015, Harvard Landscape Infrastructure 2012

Lessons Learnt – Exploiting RES falling costs

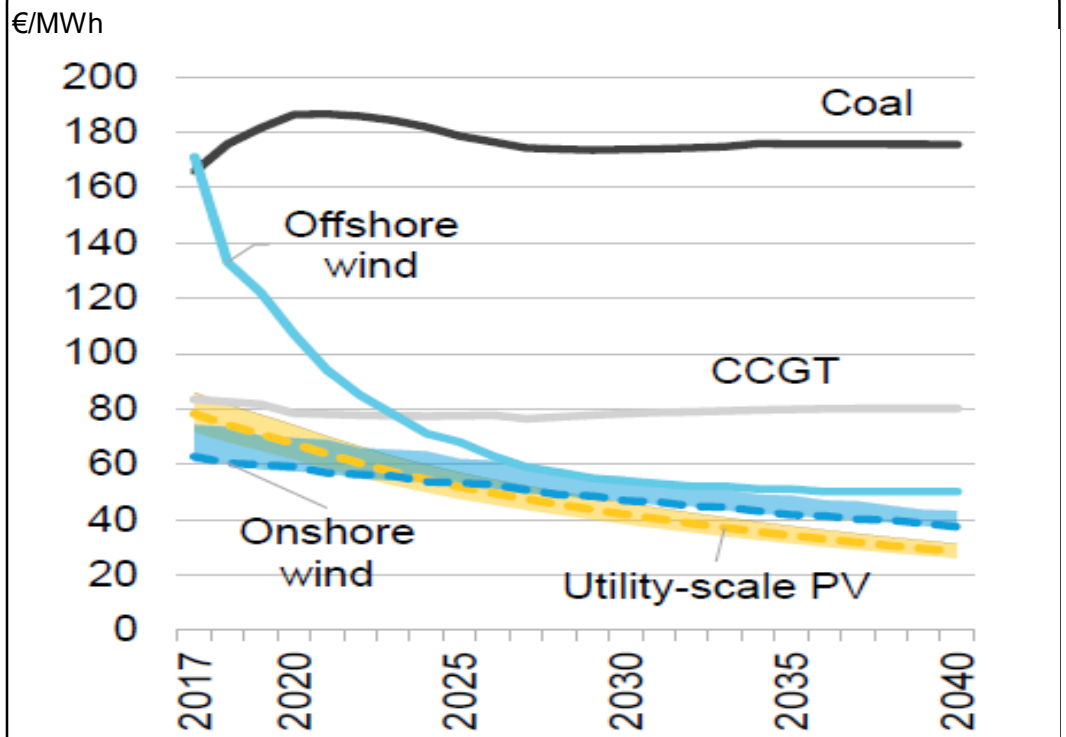
Falling RES costs reduce LCOE and payback times leaving fossil fuel assets stranded

A

Energy Asset Expected Lifetimes*



LCOE projection**



* Source: IEA, Projected cost of generating electricity 2015, Harvard Landscape Infrastructure 2012

** Source: Bloomberg New Energy Finance, 2017, example for Germany including EU ETS carbon price

Challenges and solutions for a Just Energy Transition

Reaping the full benefits of decarbonization needs a special attention for the social dimension

B

Benefits of decarbonization
Net effects* of energy transition at 2030*

❑ **Production values**

- **+113 / +145** billion Euros
- **+14 / +23** billion Euros
- **+7 / +8** billion Euros
- **+2 / +3** billion Euros

❑ **Employment**

- **+997,000 / +1,415,000** jobs
- **+98,000 / +173,000** jobs
- **+73,000 / +97,000** jobs
- **+30,000 / +52,000** jobs

Estimation of the impacts of additional services than can be **activated by electrification**

Challenges
To be tackled for a smooth energy transition

❑ **Industrial Competitiveness**

- Reduction of industrial production related to thermal technologies
- Strengthening of the electric technologies value chains
- Guaranteeing adequate investment levels
- Facing skills mismatch and integration of the workforce

❑ **Distributive effects**

- Ensuring social assistance and support to people negatively affected by transition
- Guaranteeing equal access to the benefits
- Avoiding unfair distribution of costs
- Create cost-reflecting and efficient energy market

To be addressed with different types of **economic and societal measures**

Recommendations
Measures on people and technologies

- **Value chains conversion toward electric technologies:** Energy Transition Investment Bonds, National Energy Clusters on electrification technologies, innovative financial schemes for mature technologies, raise awareness
- **Managing job losses and opportunities:** social measures for workers (e.g. early retirement), European Energy Transition Fund, new educational programs (e.g. Circular Economy, “Green Erasmus”)
- **Addressing energy poverty**: index for measuring energy poverty, social tariffs/ subsidies for low-income households
- **Fair redistribution of costs:** revise cost items within the electricity bill, remove improper taxes/ levies from electricity bill

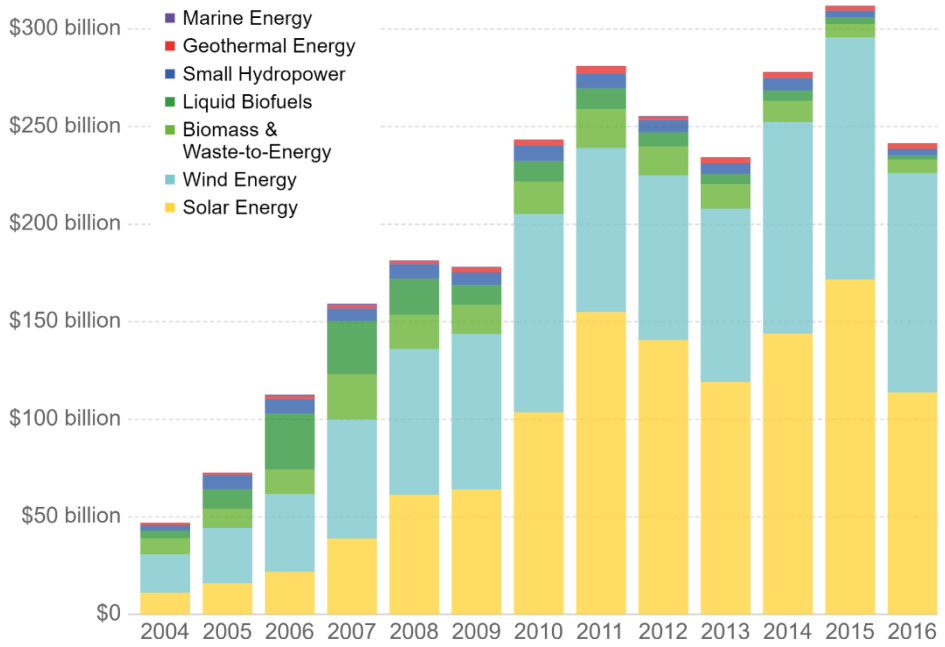
Identifying and valuing in EU **best practices put in place at international level**

* Just E-volution 2030, The European House – Ambrosetti, to be published in September 2019

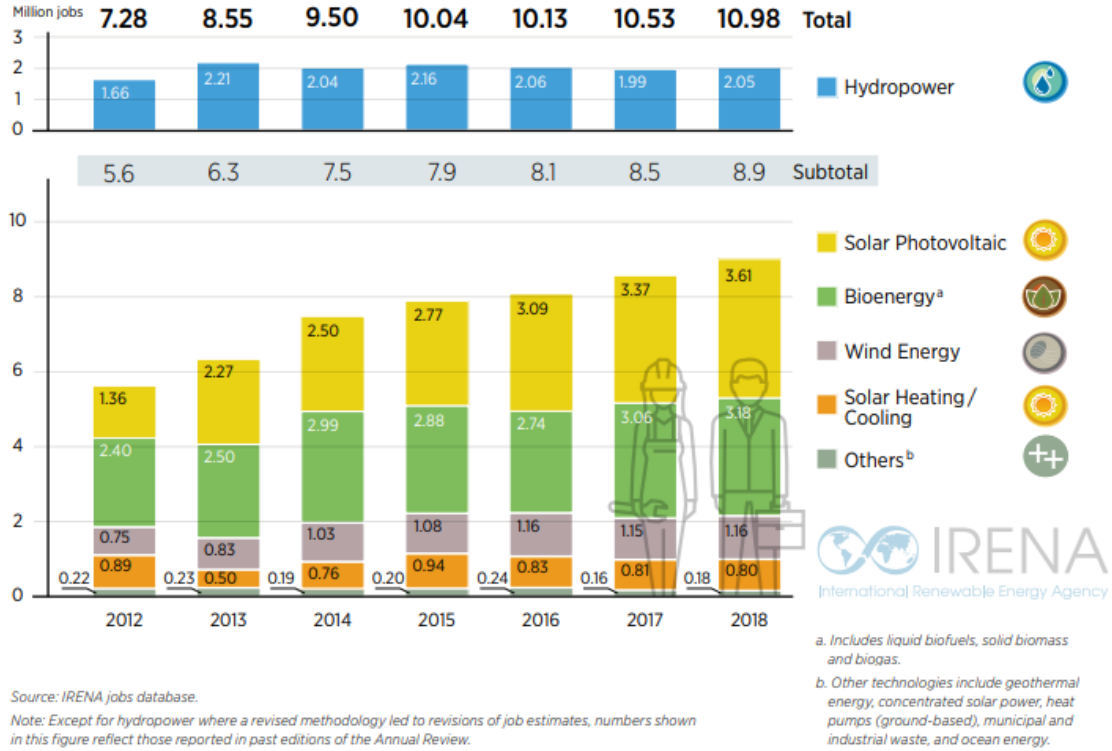
Investment and employment during the Transition

RES investments and employment are enablers for a just transition

In 12 years RES investments have grown almost 600%. Investments peaked in 300 billions (2015), solar energy close to 50%. (RES investments, 2004-2016) *



The RES sector has added 3.31 million jobs in 6 years. From those, 2.25 million in solar photovoltaic. (Global Renewable energy employment, 2006-2018)**



Source: IRENA jobs database.

Note: Except for hydropower where a revised methodology led to revisions of job estimates, numbers shown in this figure reflect those reported in past editions of the Annual Review.

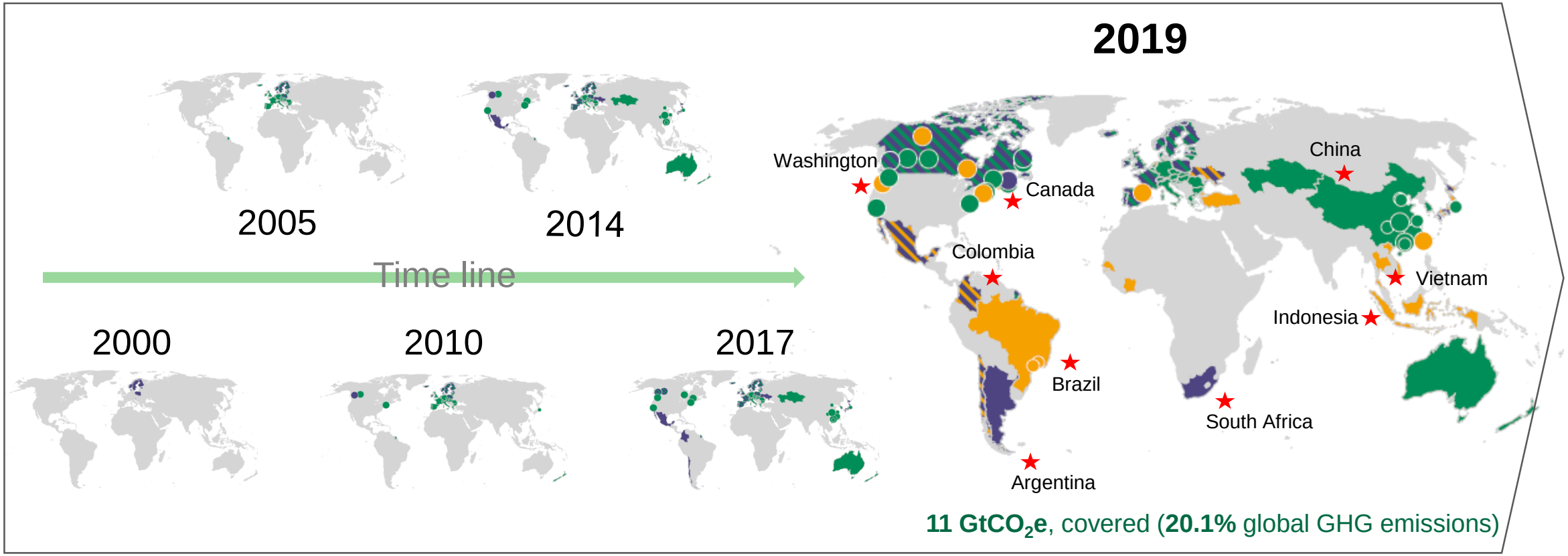
a. Includes liquid biofuels, solid biomass and biogas.

b. Other technologies include geothermal energy, concentrated solar power, heat pumps (ground-based), municipal and industrial waste, and ocean energy.

* Our world in data, 2019 (IRENA 2018)
** Renewable energy jobs, IRENA 2019

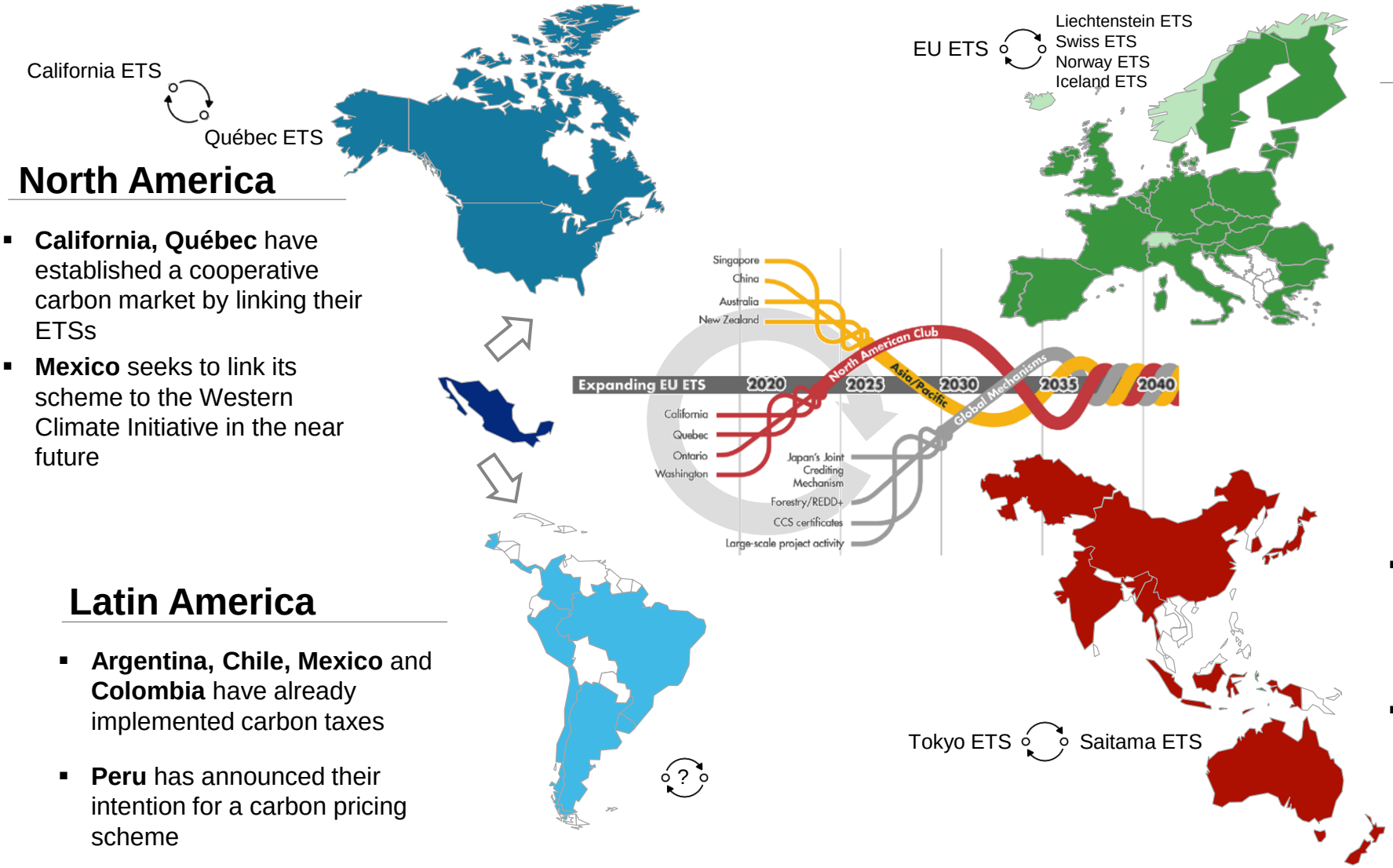
Spreading from local to global schemes

Carbon pricing increasingly implemented to support the transition



Source: Carbon Pricing Dashboard, World Bank

Regional agreements evolving to create joint markets



North America

- **California, Québec** have established a cooperative carbon market by linking their ETSs
- **Mexico** seeks to link its scheme to the Western Climate Initiative in the near future

Latin America

- **Argentina, Chile, Mexico** and **Colombia** have already implemented carbon taxes
- **Peru** has announced their intention for a carbon pricing scheme

Europe

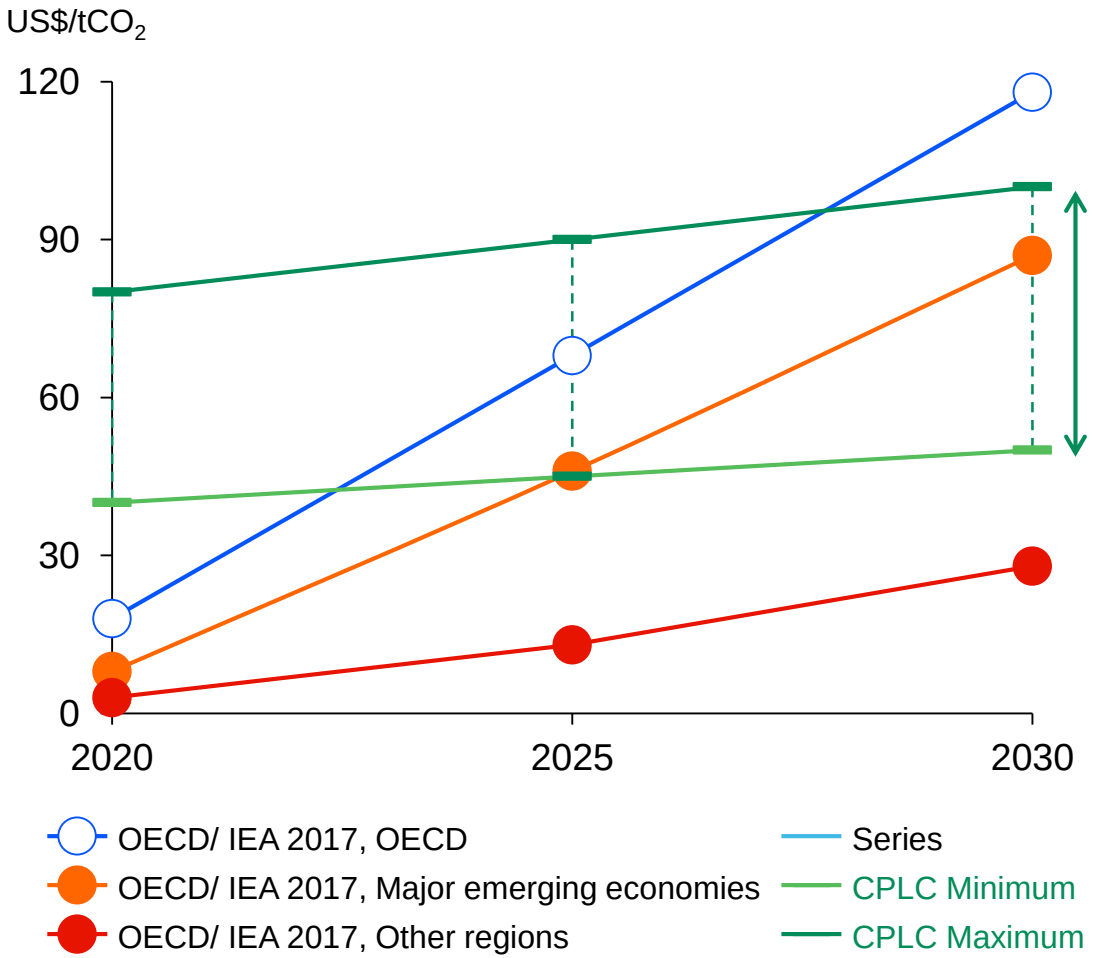
- **EU ETS was linked in 2007** with **Norway**, **Iceland** and **Liechtenstein** becoming the first international agreement for emissions trading
- **In 2015 EU ETS** was linked to **Swiss** ETS

Asia Pacific

- **China, Japan and Korea** are exploring areas for cooperation and potential linking between the ETSs
- **China** and **Korea** have started discussions on a potential collaboration on carbon markets with **New Zealand**

Carbon Pricing tomorrow and beyond

The need for a low carbon framework calls for increasing carbon prices



OECD
BETTER POLICIES FOR BETTER LIVES

- **Governments need to raise carbon prices** much faster to meet their commitments on cutting emissions
- **Carbon pricing gap** compares actual carbon prices and real climate costs and it is estimated at EUR 30/tCO_2
- **Carbon prices will meet real costs in 2095**, at the current pace of convergence

CP LC CARBON PRICING LEADERSHIP COALITION

- **Carbon pricing offers a powerful policy lever** in the fight to climate change
- Carbon pricing supports **decarbonization** while stimulates **competitiveness, job creation** and **innovation**
- **Knowledge sharing**, targeted technical analysis and dialogues promote adoption and accelerate implementation

Source: Carbon Pricing Corridors - The Market View, CDP, page 22 - adjusted

Carbon pricing and government's revenues

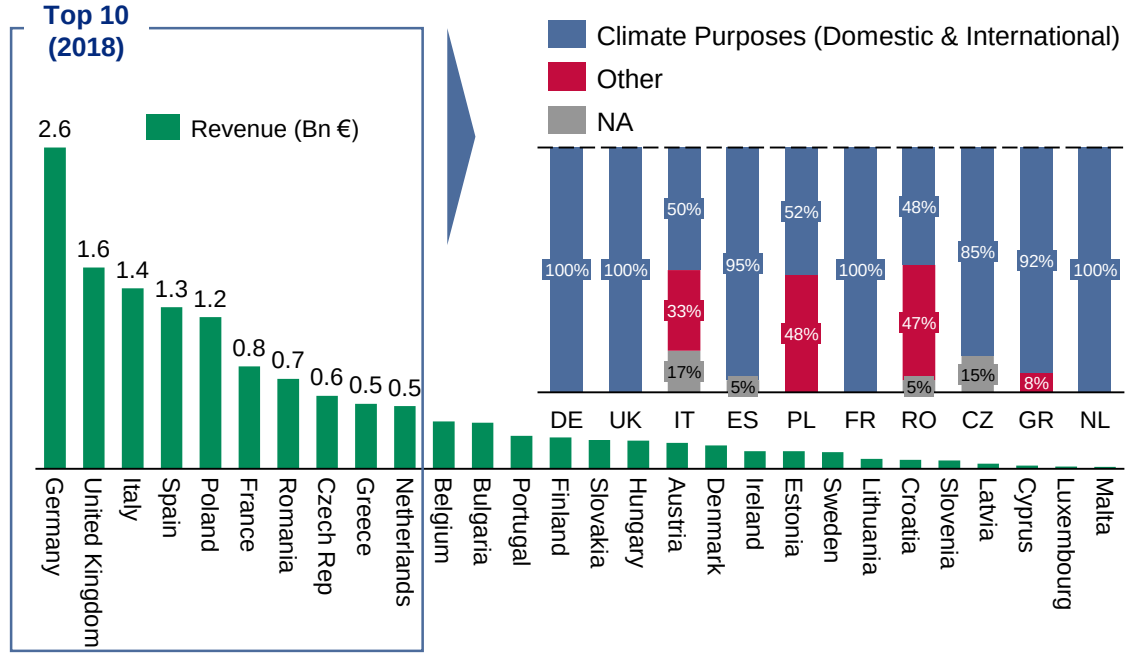
Rising carbon prices and related revenues will support the transition

Carbon markets account for environmental externalities while generating 44 billion USD in revenue for governments in 2018**

But most importantly !!

Carbon pricing initiatives are not simply another tax, but markets to efficiently allocate mitigation efforts and use revenues to create new opportunities in a green economy

EU-ETS case



- **2012-17 total revenues from EU ETS auctions exceeded EUR 35 billion** – on average EUR 5 billion per year
- **EUA generated in 2018 an overall 14.1 billion € revenues and** they provide an substantial sources for almost all Governments
- **Average price tripled in 2018** while **volumes decreased of ~ 3.7%** vs. previous year
- **EU Member States spent/ planned to spend 80% of auction revenues on advancing climate and energy objectives**

Source: GSE report, 2018; European Commission - Analysis of the Use of Auction . Revenue by the Members States Report, 2017

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Colombia overview

Challenges and opportunities for a sustainable development

Economic growth and development*

- Between 3 and 4% long-term GDP growth (forecasts for 2030-50). In line with historic growth and high for Latin America
- 27% of the population under poverty line, 15% decrement in 10 years (2017)
- 49.7 GINI index, 14% reduction in 20 years (2017)

Energy sector***

- Fossil fuel industry represents 3.5% of GDP and 32.4% (including mining raw materials) of exports (2017)
- Clean power generation mix, but vulnerable to climate change

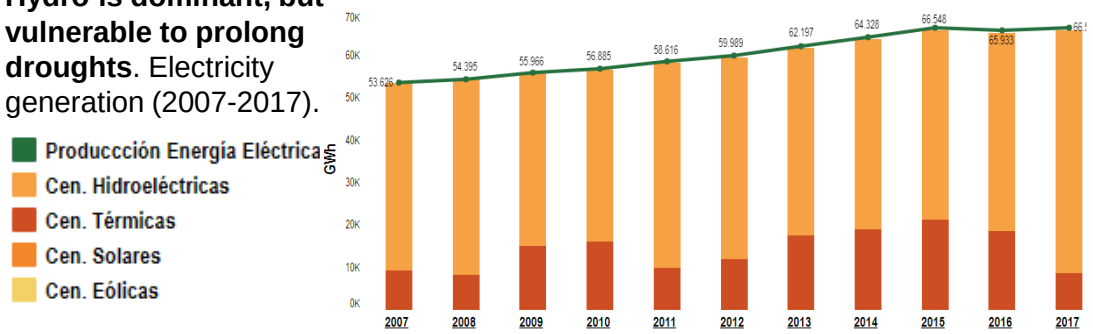
GHG emissions, commitments and vulnerability**

- 0.64% of global emissions (2010)
- Land use (58.2%) and energy (31.2%) sectors are the main contributors to GHG emissions (2010)
- 1.8tCO_2 emissions per capita (three times lower than global average) (2014)

Investments for the clean economy transition****

- NDC requires 1.02 billion 2016 USD per year (0.75 billion current investment gap)
- Investments 38% public, 62% private

Hydro is dominant, but vulnerable to prolong droughts. Electricity generation (2007-2017).



* World Bank and growth projections from Green Growth, International Monetary Found and others
** Colombian NDC and World Bank
*** World Bank and National Energy Balance (2017)
**** Crecimiento en el largo plazo, DNP (2018)

Colombian Energy Transition Roadmap

Supporting an effort lead by Universidad de los Andes*

Phase 1: NDC baseline updated — Completed

Phase 2: Mitigation scenarios

Phase 3: Economic instruments for the transition — Ongoing

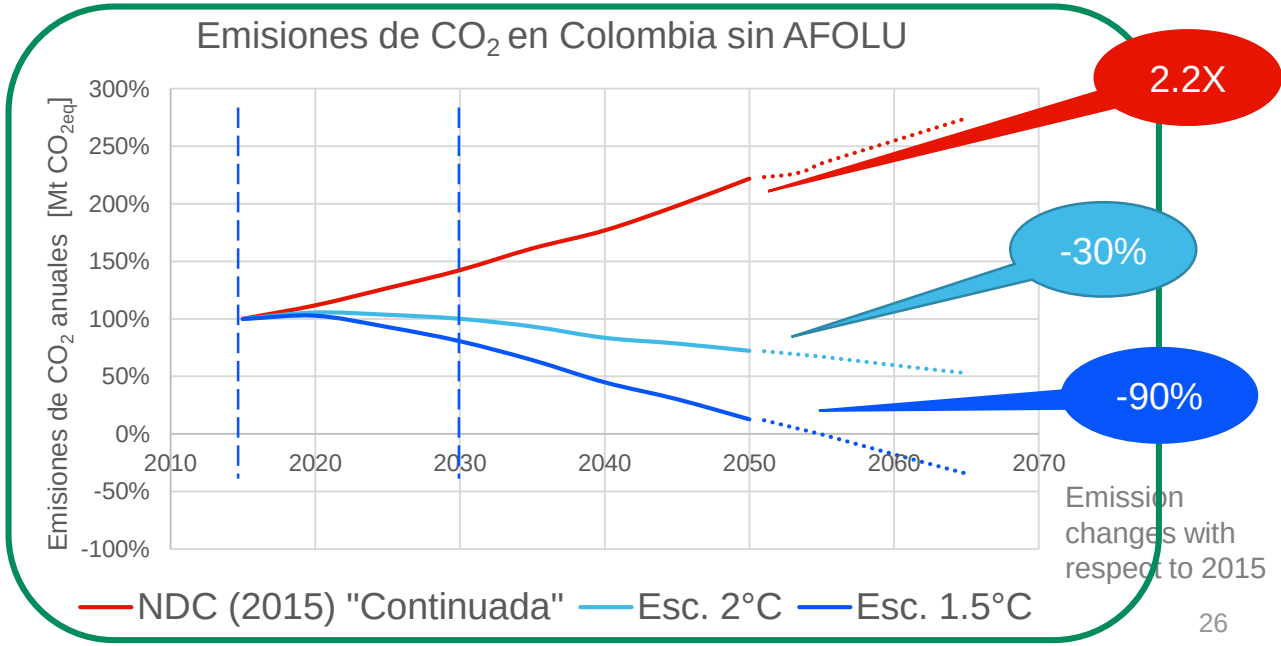
Phase 4: Result socialization with involved stakeholders — Pending

* Cadena, A; Guevara, J; Delgado, R; Espinosa, M; Morillo, J; Luna, E; Ardila, D; Hidalgo, C; Herrera, C Jimenez, D; Angel. V; Torres, N;

Universidad de los Andes (preliminary results)

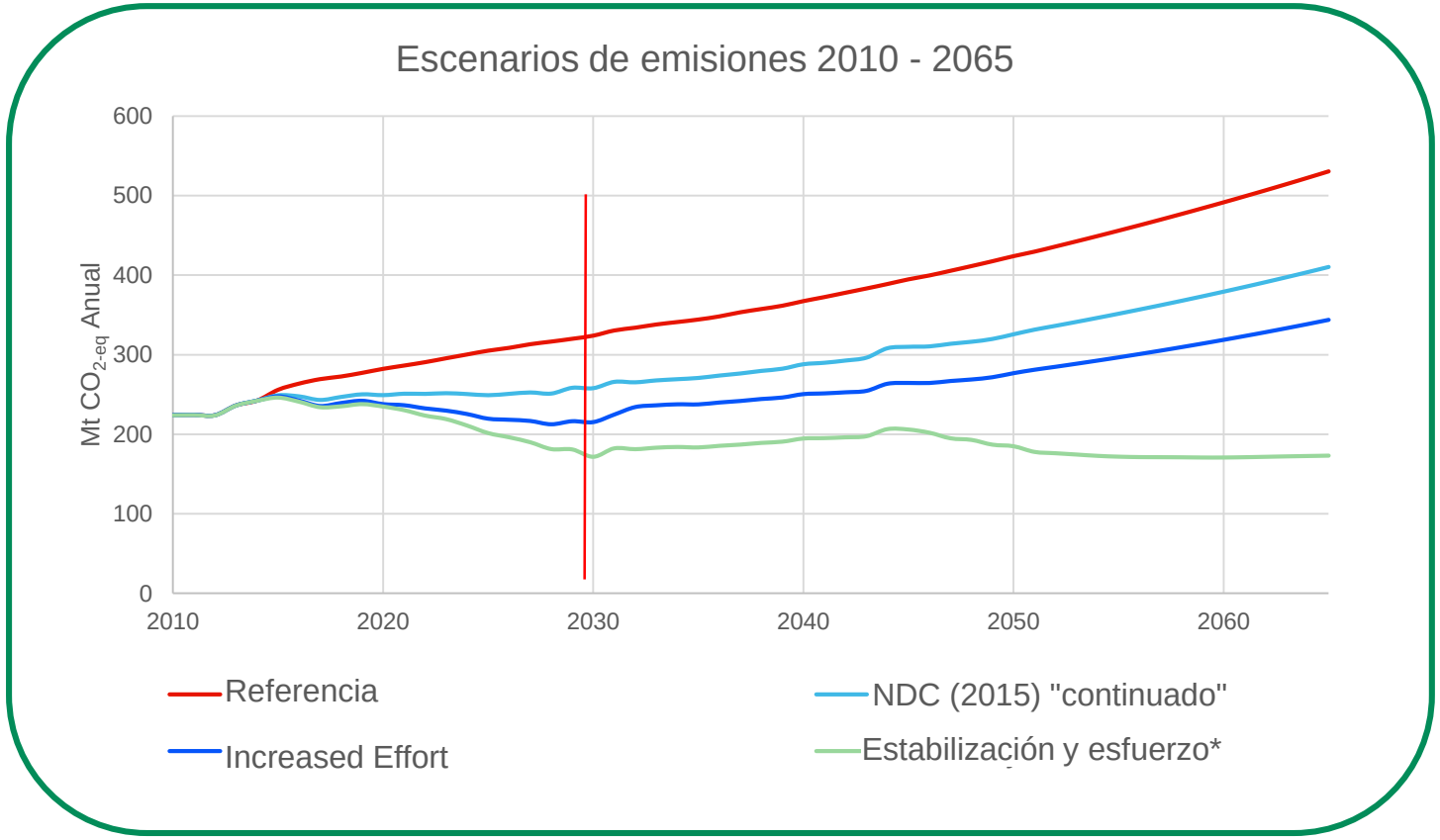
- GHG emission trajectories
- Power sector
- Other sectors
- Cross-sectoral decarbonisation

To accomplish environmental objectives, substantial deviation from NDC are needed. Required by science emission pathways (2°C and below 2°C) increase the ambition from the Colombia NDC (Colombian emissions without LUCLUF).



Escenarios nacionales de emisión

Escenarios de emisión todos los sectores y gases en Colombia



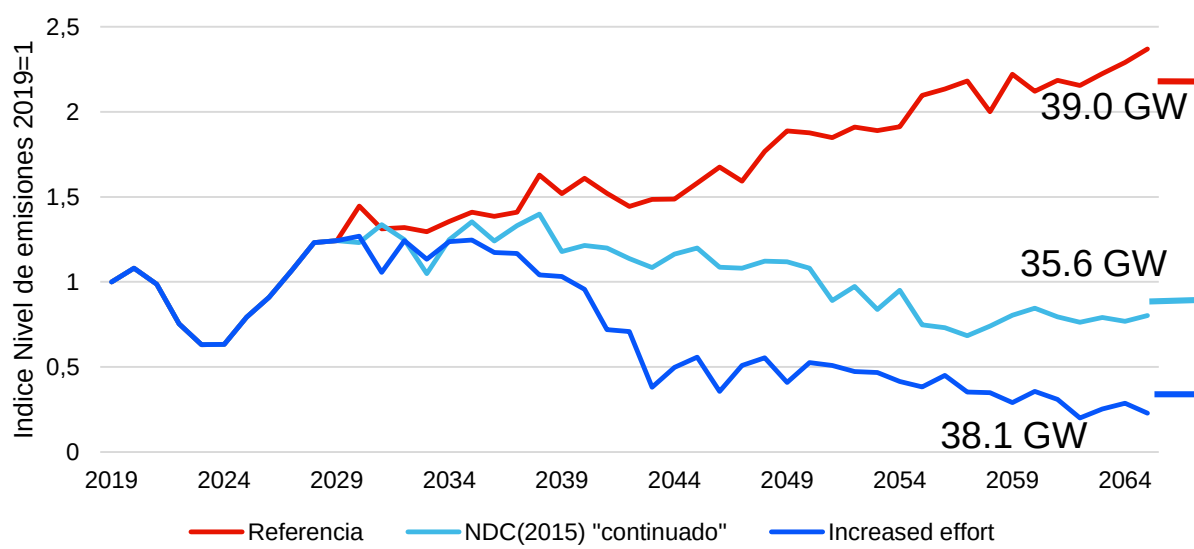
Crecimiento de las emisiones con respecto a 2015

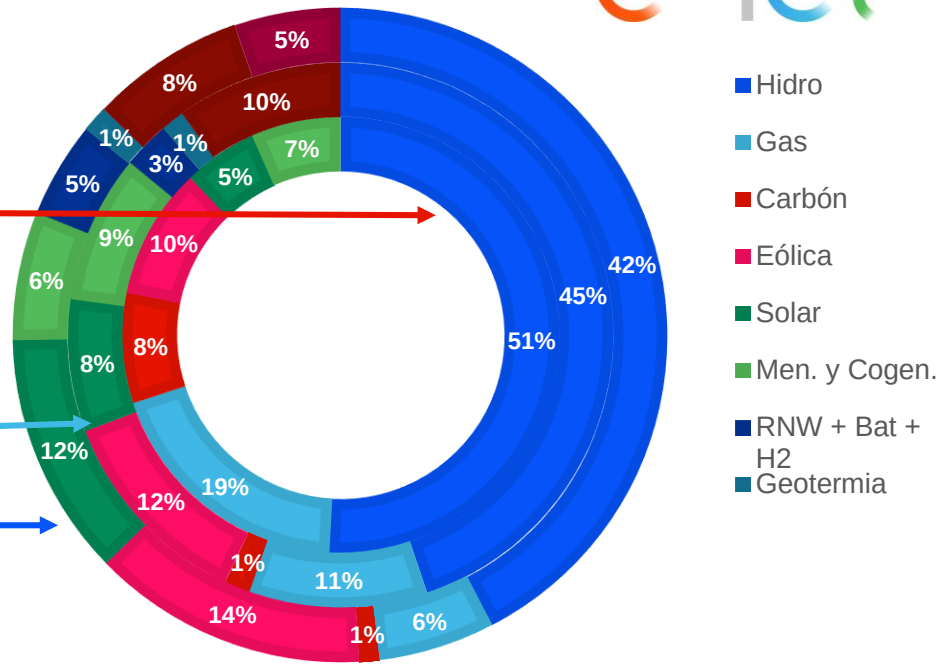
	2050	2065
Referencia	1.66	2.07
NDC (2015) "continuado"	1.31	1.65
Increased Effort	1.12	1.39
Estabilización y esfuerzo*	0.75	0.70

*en desarrollo

Escenarios sectoriales

Generación eléctrica





Universidad de los Andes

(preliminary results)

- GHG emission trajectories
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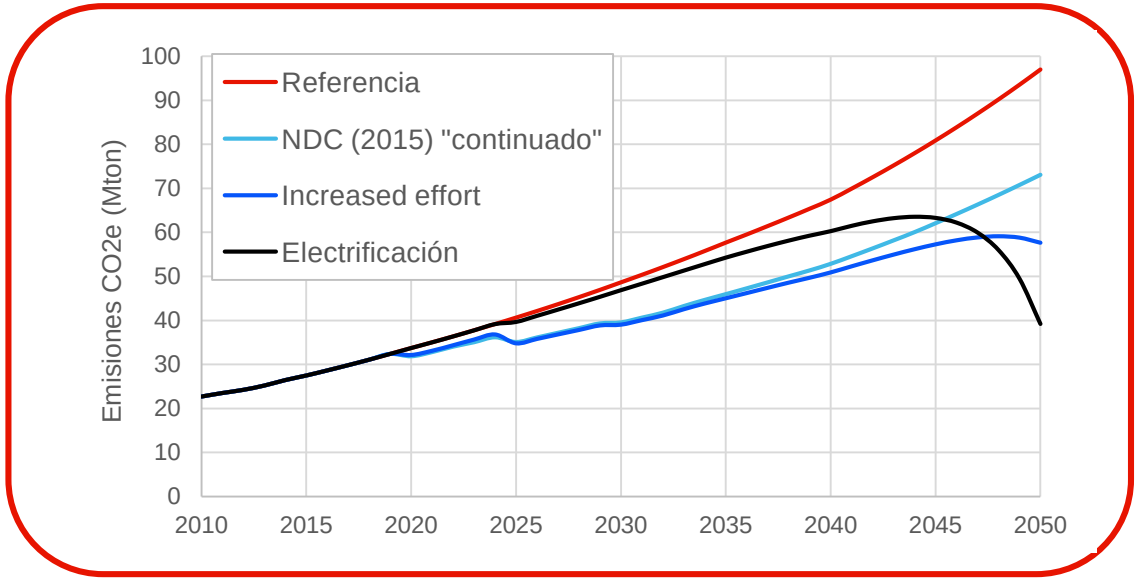
Escenario	Crecimiento de las emisiones con respecto a 2019		
	2030	2050	2065
Referencia	1.44	1.87	2.30
NDC 2015 “continuado”	1.23	0.74	0.8
Increased effort	1.26	0.52	0.22

Escenarios sectoriales

Transporte



Universidad de los Andes

(preliminary results)

- GHG emission trajectories
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- Other sectors
- Cross-sectoral decarbonisation

	Crecimiento de las emisiones con respecto a 2015	
	2030	2050
Referencia	1.77	3.53
NDC 2015 “continuado”	1.44	2.66
Increased effort	1.42	2.10
Electrificación*	1.71	1.42

*en desarrollo

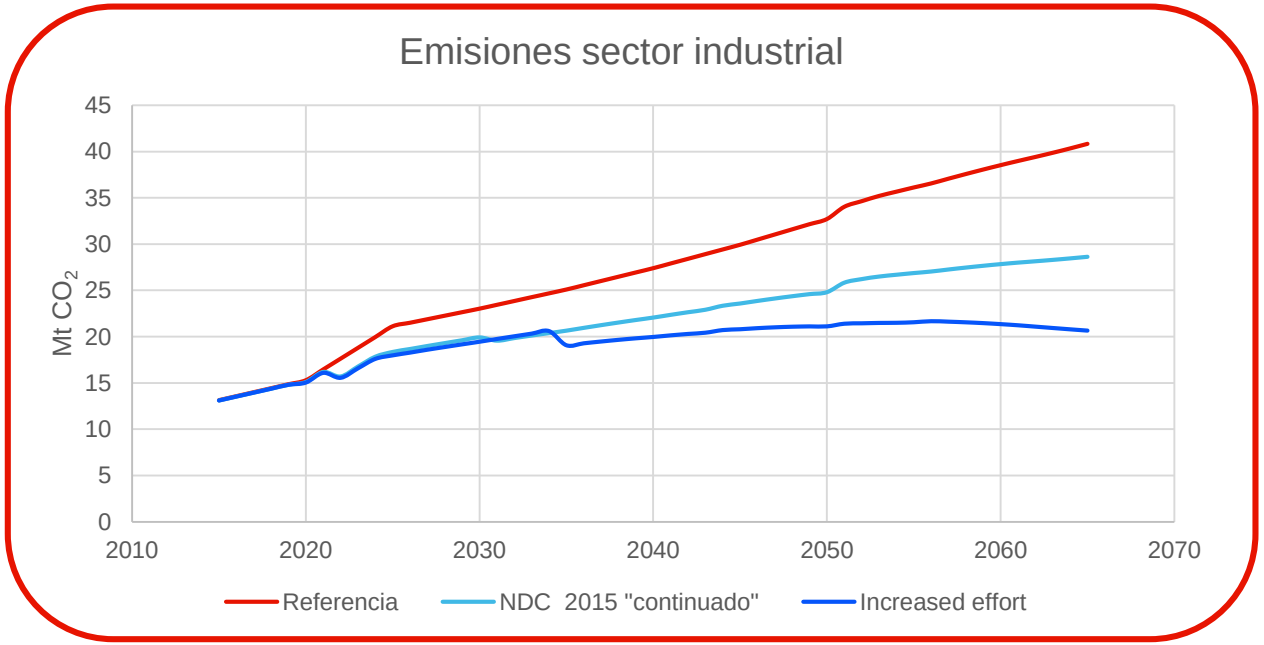
Escenarios	Descripción
NDC 2015 “continuado”	16 medidas en diferentes segmentos: estándares de rendimiento, sustitución de combustibles, sistemas públicos de bicicletas, renovación y chatarrización flota carga, carga multimodal.
Increased effort	NDC + electrificación 30% flota en 2050 Electrificación: transporte privado, transporte público convencional y BRT, carga urbana.
Electrificación	Electrificación 100% flota en 2050 Electrificación: transporte privado, transporte público convencional y BRT, carga urbana.

Universidad de los Andes

enel codensa - emgesa

Escenarios sectoriales

Industria



Universidad de los Andes

(preliminary results)

- GHG emission trajectories
- Power sector
- Other sectors
- Cross-sectoral decarbonisation

	Crecimiento de las emisiones con respecto a 2015	
	2050	2065
Referencia	2.49	3.11
NDC 2015 “continuado”	1.89	2.18
Increased effort	1.61	1.57

Escenarios	Descripción
NDC 2015 “continuado”	Mejora en eficiencia de calderas y otros equipos , Sustitución de carbón por biomasa
Increased effort	Mejora en eficiencia de calderas y otros equipos , Sustitución de carbón por biomasa, Captura de CO2 y almacenamiento geológico

Universidad de los Andes

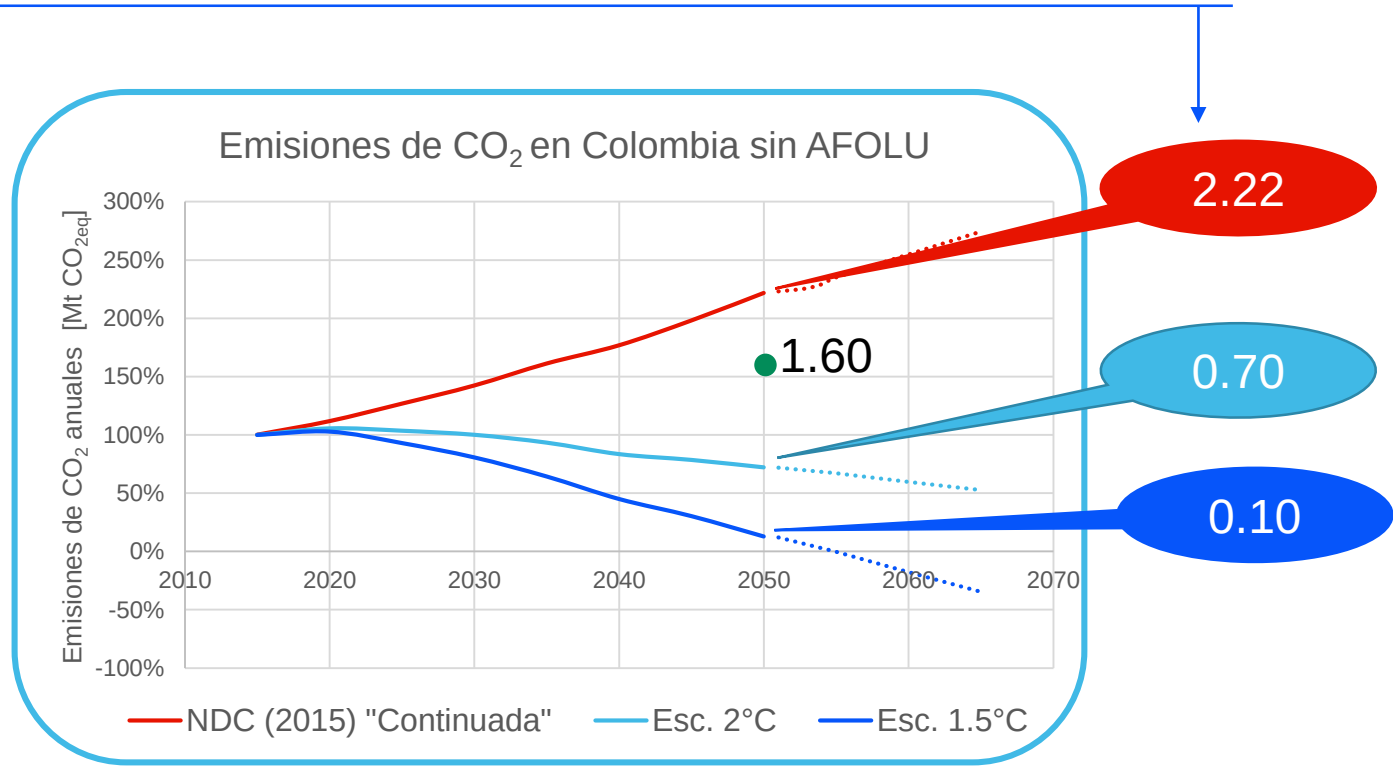
enel codensa - emgesa

Escenarios sectoriales

Crecimiento de emisiones consolidado

	Crecimiento en 2050 con respecto a 2015*			
	Generación	Transporte	Industria	**Total Agregado**
Referencia	1.87	3.53	2.49	2.81
NDC 2015 “continuado”	0.74	2.66	1.89	2.22
Increased effort	0.52	2.10	1.61	1.60
Electrificación*		1.42		

*en desarrollo



* Excepto generación eléctrica cuyo año de referencia es 2019

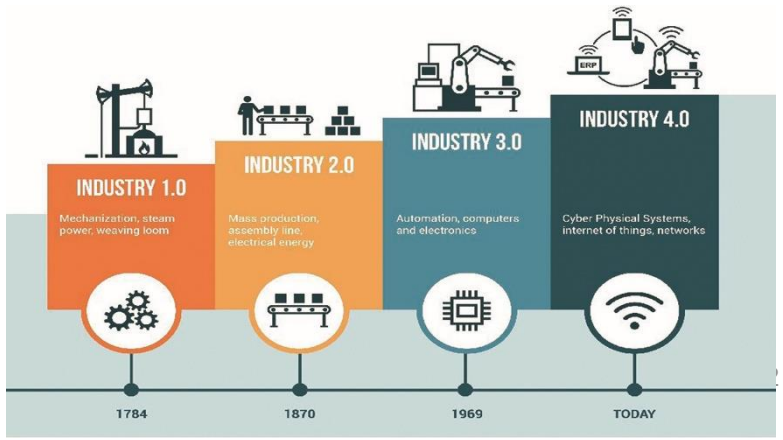
Colombian transition to a low carbon economy

Transition to a low carbon economy is possible, but requires cross sectoral action and cannot be limited to the energy sector

Four fundamental pillars provide guidelines for an accelerated transition in the energy sector …

- Optimal generation mix
- Network development and digitalization
- Electric mobility
- Carbon pricing

… but broader cross sectoral policies should balance the welfare and prosperity for present and future generations



Conclusions and key messages

Transforming climate change from a challenge to an opportunity

A

Climate change requires fast and **coordinated actions from governments and private sectors** across all geographical scales

B

The Energy Transition Roadmaps will continue to support the **transparent regulatory framework** and the **economic instruments** necessary to align stakeholders interests with sustainable societies

C

Development of RES, a digitalized network and electrification of demand are the only way to balance energy security, equity and environmental sustainability for present and future generations in Colombia

D

South American Energy transition for more ambitious and **coordinated actions at the regional level**