GIORNATA DI STUDIO

LE ATTIVITÀ DELL'UNIVERSITÀ DI PISA SUL TEMA DEGLI EFFETTI DEL CAMBIAMENTO CLIMATICO

GHG Emissions in industrial activities: the role of technologies for their management and reduction.

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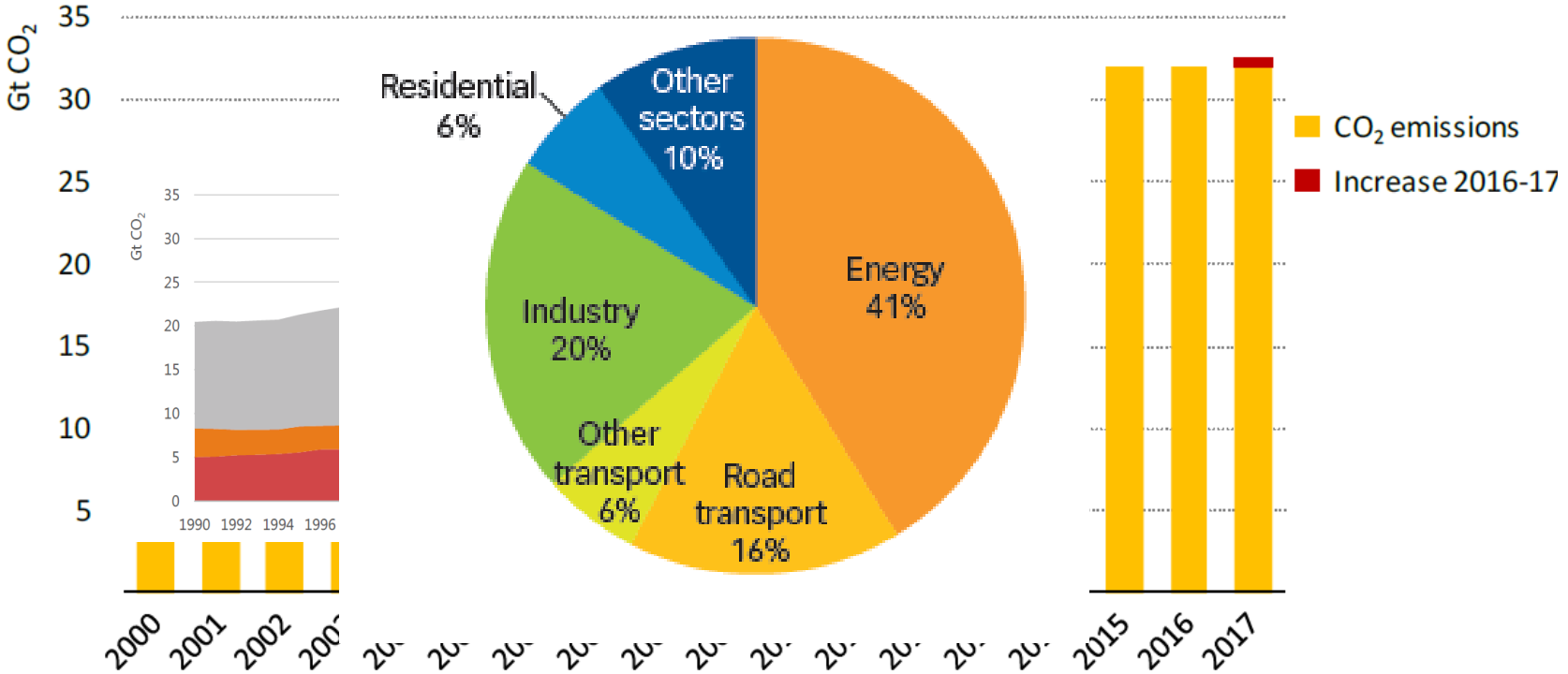
Dipartimento di Ingegneria Civile e Industriale.

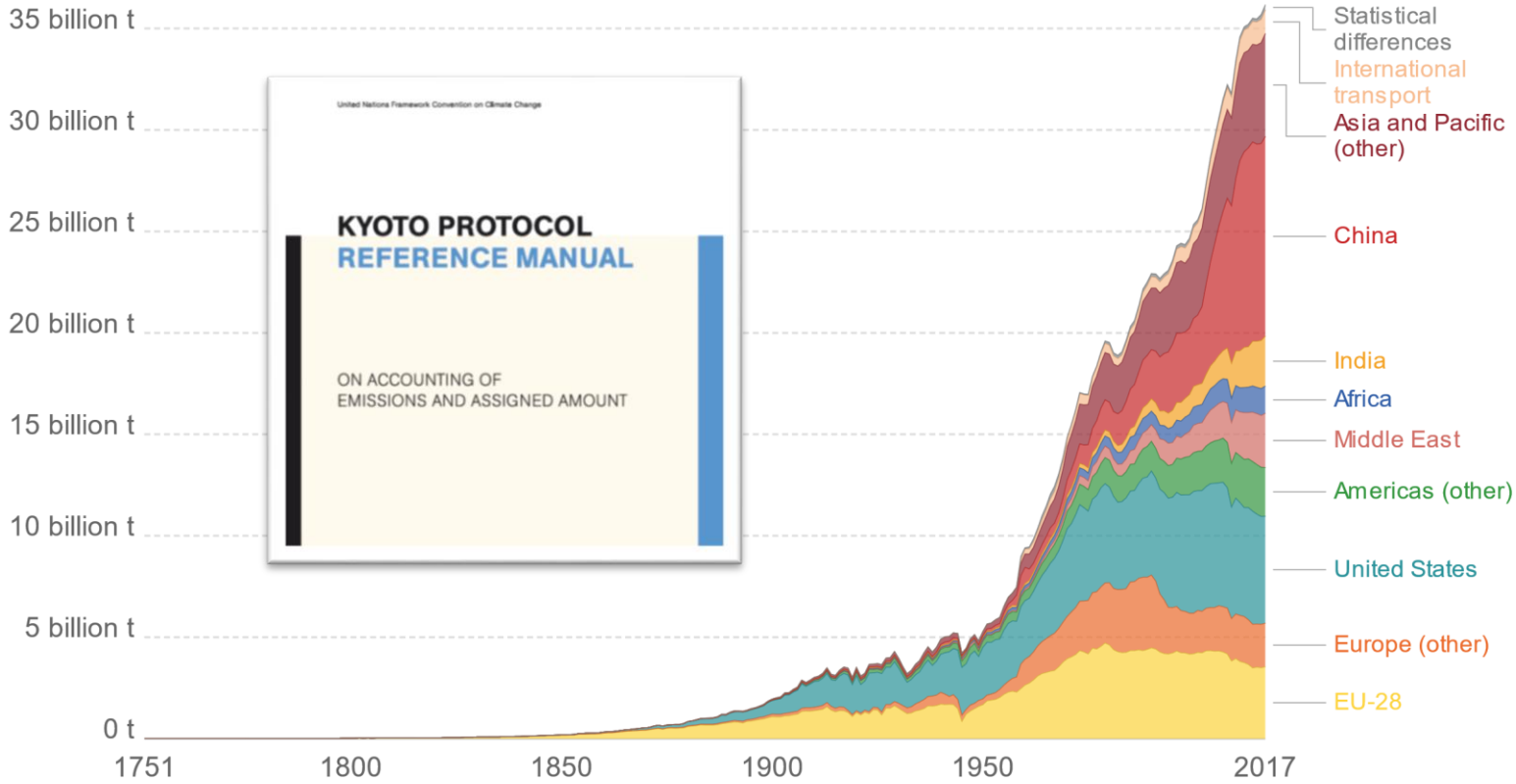
Pisa, 6 Dicembre 2019

Global energy-related CO_2 emissions, 2000-2017

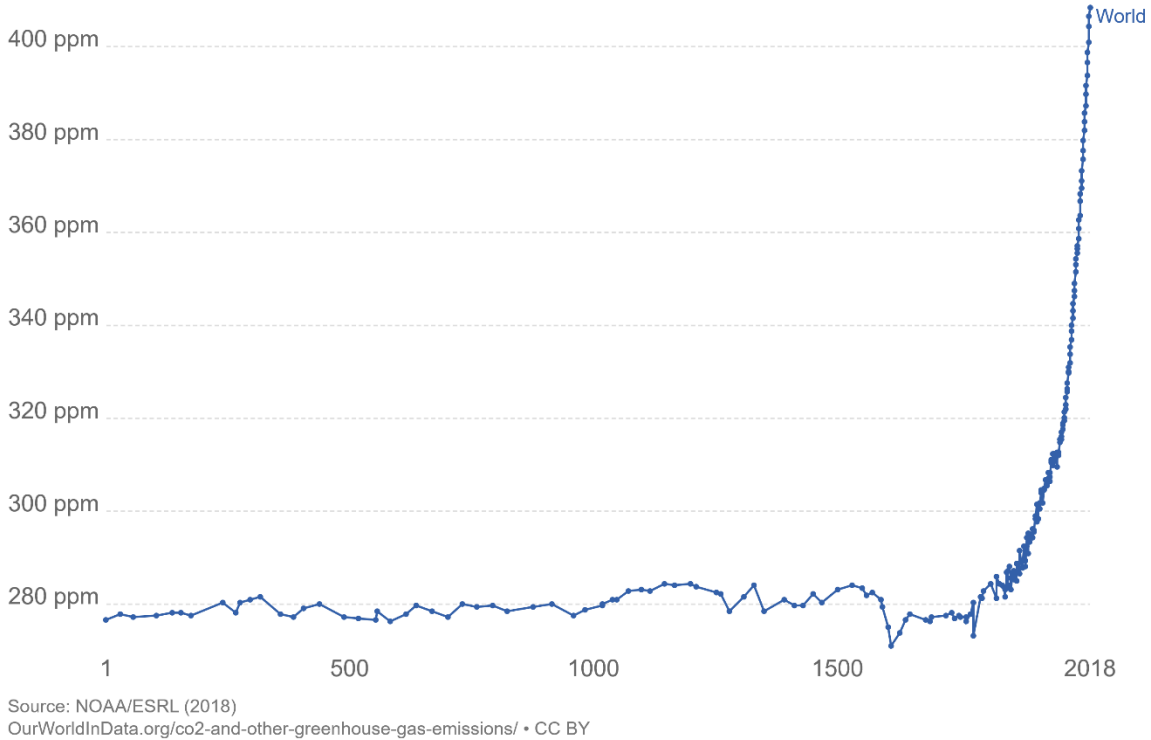


https://www.iea.org/

Annual total CO2 emissions by region



Global CO2 atmospheric concentration



While enabling over 200 years of industrialization and development, the use of coal, oil and gas have contributed substantially to the rise in atmospheric carbon dioxide (CO2) from **275 ppm in 1750 to 400 ppm today**.

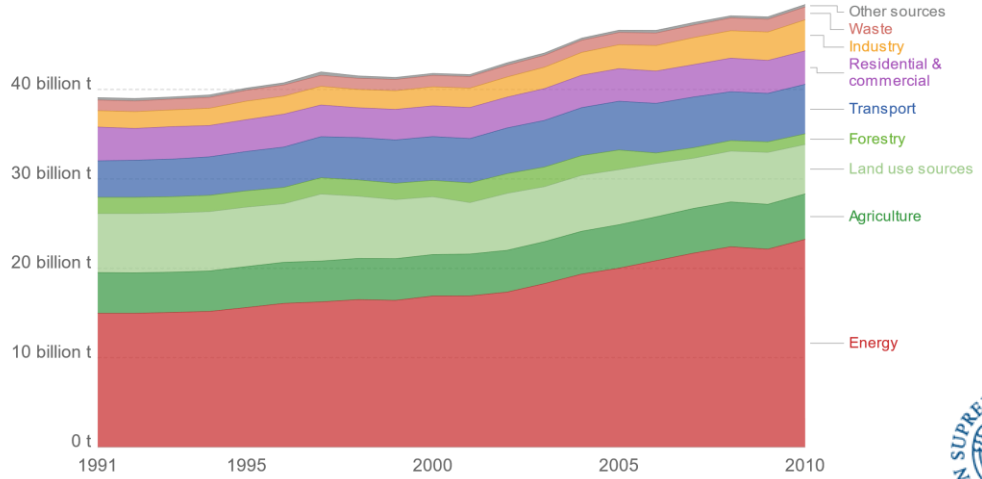
Breakdown of total greenhouse gas emissions by sector, measured in tonnes of carbon-dioxide equivalents (CO_2e).

MAIN GREENHOUSE GASES

Greenhouse Gas	Chemical Formula	Pre-Industrial Concentration	Concentration in 2005	Atmospheric Life (years)	Anthropogenic Sources	Global Warming Potential (GWP)
Carbon-dioxide	CO_2	280 ppm	379 ppm	Variable	Fossil Fuel Combustion Land Use Conversion Cement Production	1
Methane	CH_4	700 ppb	1774 ppb	12	Fossil Fuel Rice Paddies Landfill Waste Livestock	21
Nitrous oxide	N_2O	275 ppb	319 ppb	114	Fertilisers Combustion Industrial Processes	310

Ewings, 2007

- **Carbon dioxide equivalents** measures the total greenhouse gas potential of the full combination of gases, weighted by their relative warming impacts (methane, N_2O, others)
- Non-energy sectors such as cement **production agriculture, farming, forestry and land-use change** are also major contributors to GHG emissions, and are equally or more difficult to mitigate.



The **United Nations Framework Convention on Climate Change** is the main international agreement on climate actions. The UNFCCC entered into force on 21 March 1994.

> *«the growing accumulation of man-made greenhouse gases (GHG) would enhance the greenhouse effect, resulting on average in an additional warming of the Earth's surface by the next century, unless measures were adopted to limit emissions»*

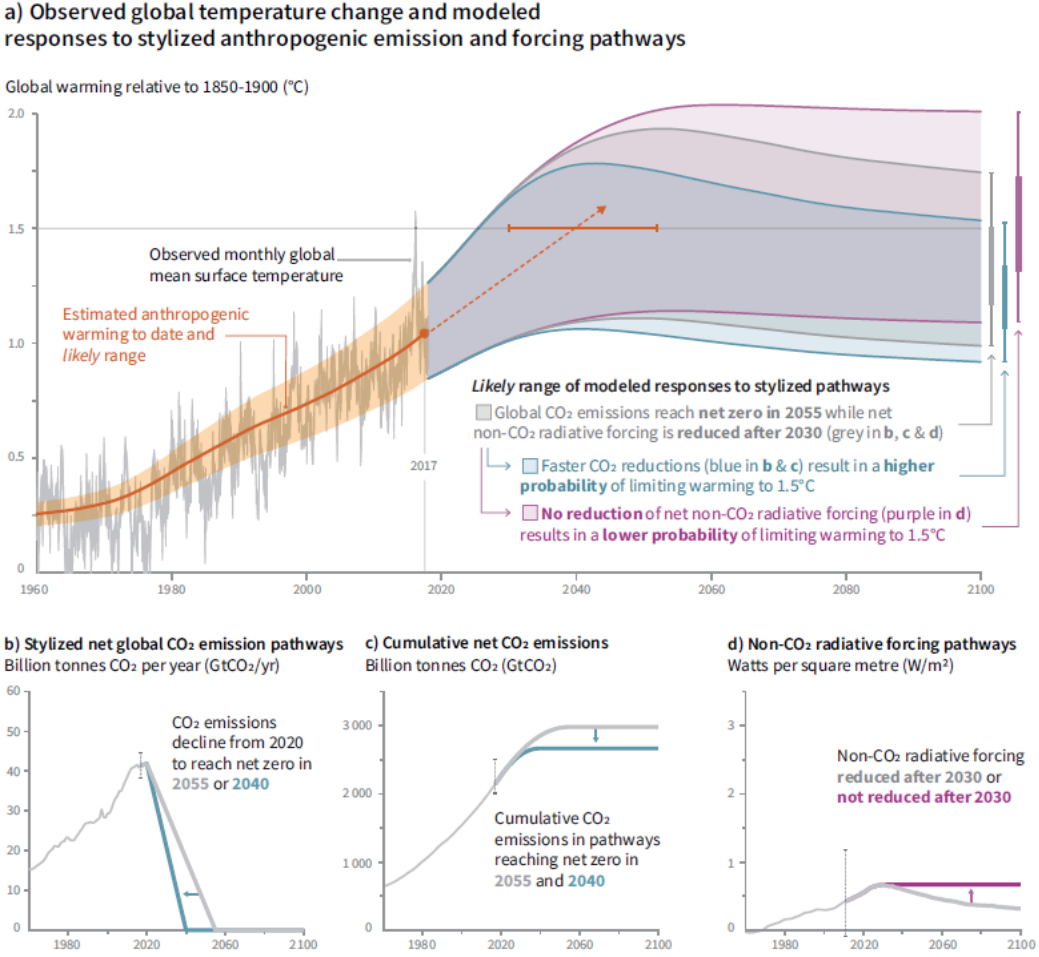
Today, it has near-universal membership. The 197 countries that have ratified the Convention are called Parties to the Convention.

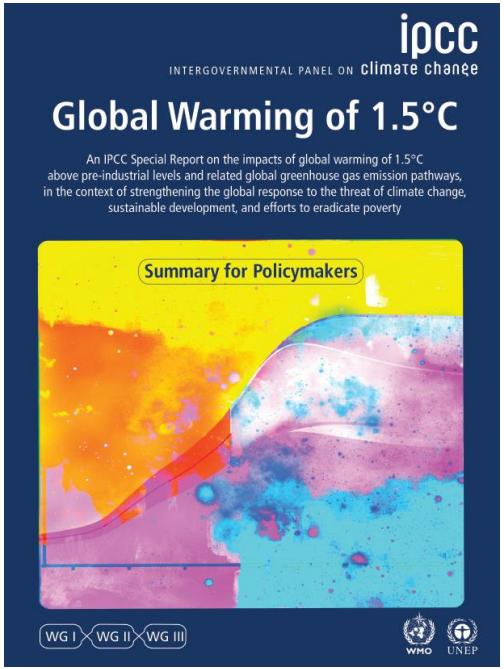
Since then there has been two issues related to the UNFCCC:

- Ratification of the Doha amendment to the **Kyoto Protocol** *(country reduction targets***)** , which concerns commitments under the second period, running from 2013-2020.
- **Paris Agreement – or COP21** is a new global climate change agreement covering all UNFCCC countries, its ratification, implementation and enters into force in 2020.

The Paris agreement sets out a global action plan to put the world on track to avoid dangerous climate change **by limiting global warming to well below 2°C and pursuing efforts to limit it to 1.5°C.**

https://www.cop25.cl/#/



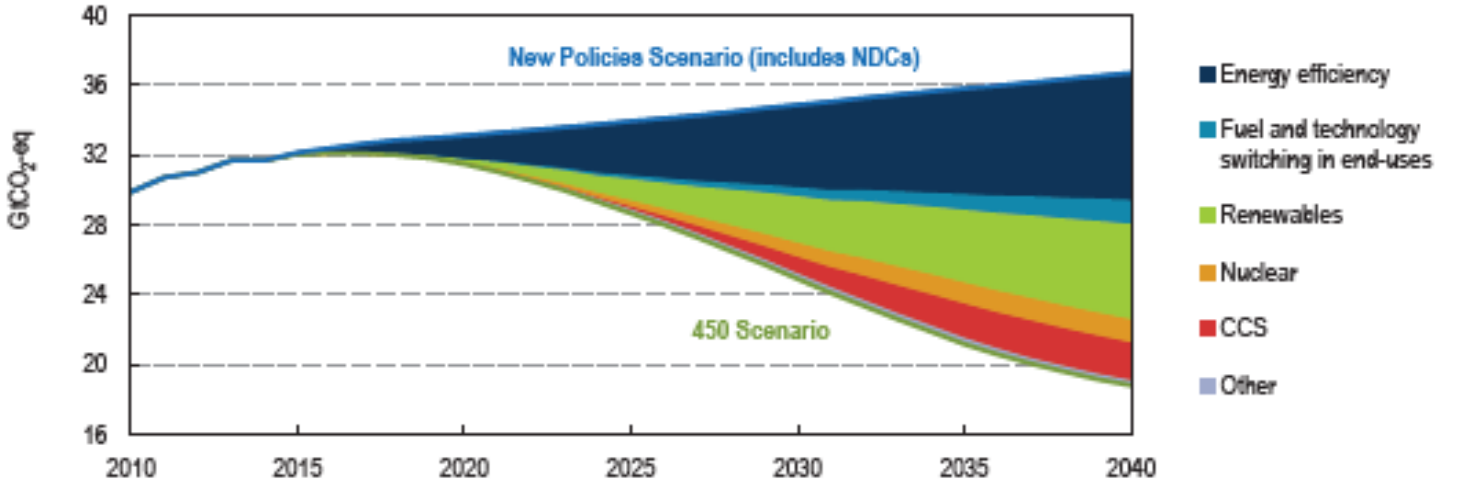


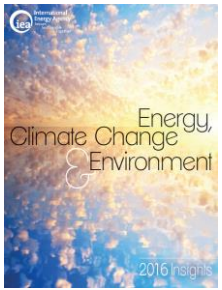
The IPCC was created to provide policymakers with regular scientific assessments on climate change, its implications and potential future risks, as well as to put forward adaptation and mitigation options.

ipcc
INTERGOVERNMENTAL PANEL ON climate change
Global Warming of 1.5°C

Measures are needed !

Measures needed to surpass current NDCs to reach 2°C trajectory (450 Scenario), through 2040





Note: The New Policies Scenario (NPS) is the central scenario of the World Energy Outlook and includes the energy-related components of NDCs submitted by 1 October 2015.

Source: Adapted from IEA. (2015b), World Energy Outlook 2015.

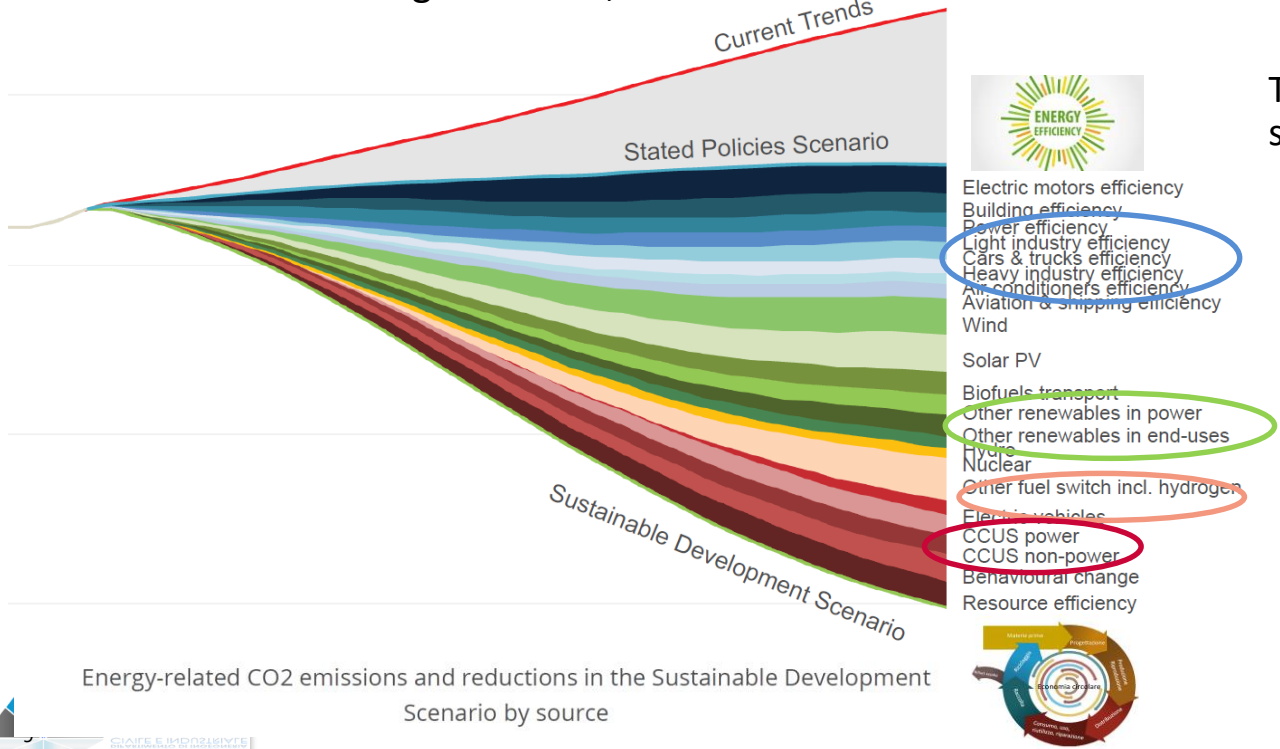
Each Party's Intended Nationally Determined Contribution (INDC) submitted for the Paris Agreement will formally become an NDC when each Party ratifies the Agreement. This publication uses the term NDC to refer to both cases (INDC and NDC)

DICI
DIPARTIMENTO DI INGEGNERIA CIVILE E INDUSTRIALE

IN SUPREMÆ DIGNITATIS 1343

Technologies and Research Topics

The Department of Civil and Industrial Engineering of Pisa University is involved in several projects concerning carbon reduction, the Climate Change and access to energy, in collaboration with Public and Private organisations, and international networks.



Energy-related CO2 emissions and reductions in the Sustainable Development Scenario by source

The research topics at DICI can be summarized as:

- **Managing emissions from industrial production;**
- **Reducing emissions from power generation: natural gas and renewables;**
- **Carbon capture, use and sequestration**

Topic #1: Natural gas and hydrogen /syngas for the transition to a decarbonized fuel

- *Motivation*
  - *Energy efficiency*
  - *Improve NG utilization*
  - *Utilization of alternative fuels (NG/H_2 mixtures, biogas/bio-methane) in industrial and domestic applications*
- *How?*
  - *Advanced simulations for optimization (pollutants, CO_2, efficiency)*
  - *Pilot and bench test of burners and componenets*
- *Partners (some)*

People:
- Prof. Chiara Galletti
- Prof. Leonardo Tognotti
- Dr. Federica Barontini

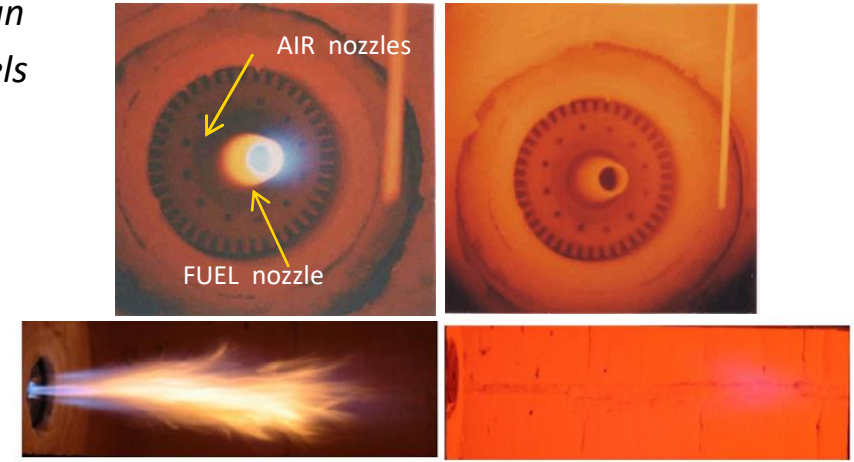
Green Power

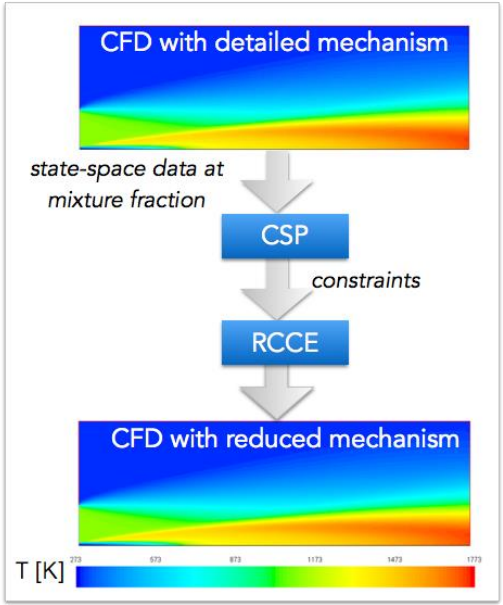
IFRF

Topic #1: Natural gas and hydrogen /syngas for the transition to a decarbonized fuel

NOVEL COMBUSTION TECHNOLOGIES (flameless or MILD combustion)

- *development of numerical models*
- *improve burner design*
- *use of alternative fuels*





- *Collaborations*

Topic #2: Reducing emissions from energy generation: Biomass & Biofuels

- *Motivation:*
  - *Near-zero emissions options for energy generation at local and medium scale are represented by renewables. While these technologies continue to be developed, additional technical breakthroughs will be needed to achieve cost-effective deployment at the scale needed to transform the energy system.*
  - *The main objectives were to **demonstrate the feasibility and availability** of technologies for local, small scale, distributed generation*

- *How:*
  - *Biomass combustion, in collaboration with DESTEC -Department of Energy, Systems, Territory and Construction –*
  - *Biomass gasification and anaerobic digestion have been the main topics of research of DICI in the last decade, including biofuel production - biomethane, torrefied biomass, etc.*





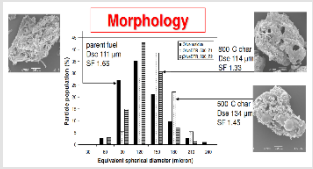
People:
- Prof. Leonardo Tognotti
- Prof. Cristiano Nicolella
- Prof. Chiara Galletti
- Dr. Federica Barontini

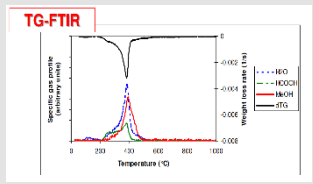
Topic #2: Biomass Combustion/Gasification/Anaerobic Digestion

Joint modelling and experimental investigations

Lab-scale

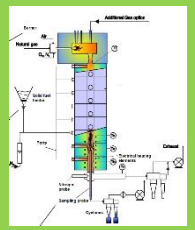
- Fuel fingerprinting
- TG-FTIR, tar analysis
- Kinetics from TGA and DTR

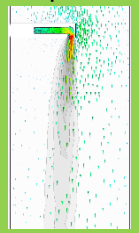




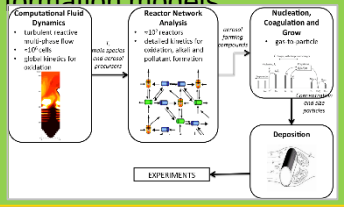
Pilot-scale

- High temperature and heating rate test
- Kinetics from CFD qualification procedures



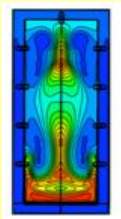


- Aerosol formation models

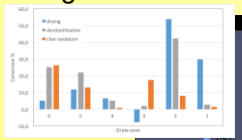


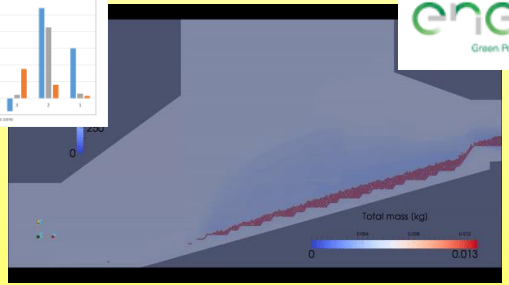
Semi- & industrial scales

- Gasification: downdraft reactor
- Pyrolysis: fixed-bed reactor with tar sampling
- Combustion: fixed-bed boilers

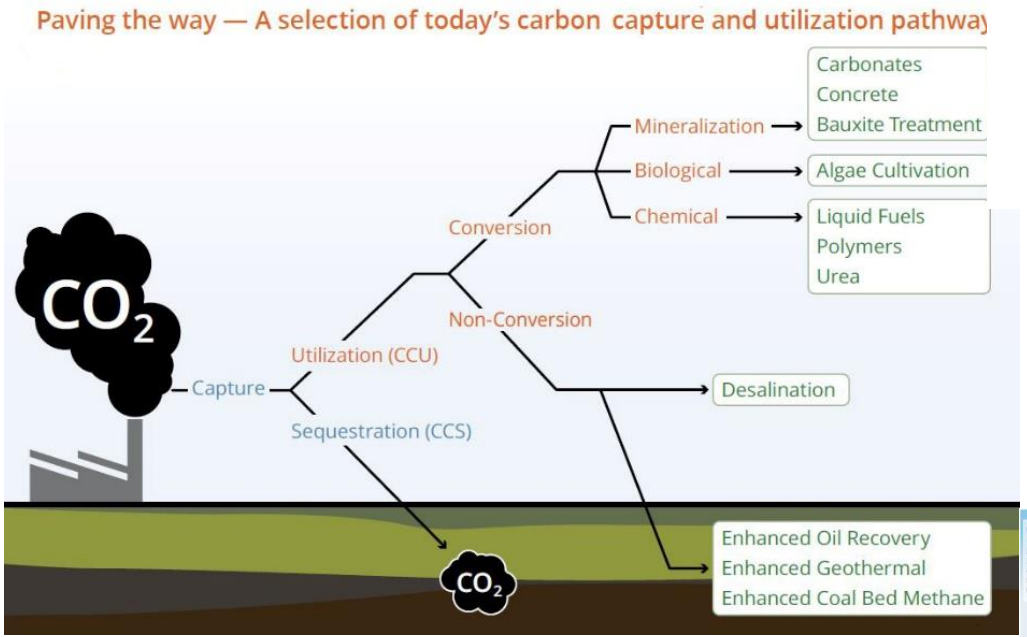


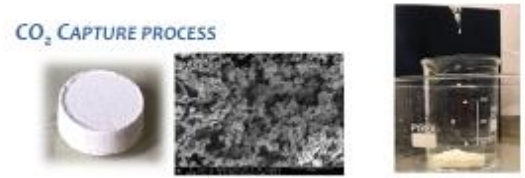
- Combustion: CFD-XDEM models for moving grate boilers

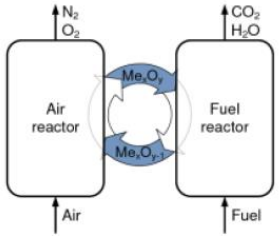


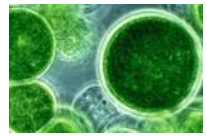


Topic #3: *the future: CO2 capture and use*

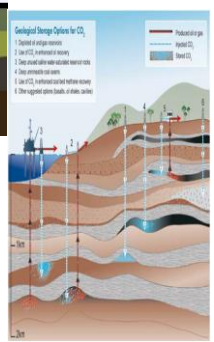


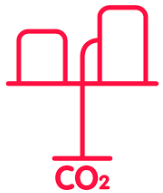






Algae





Our roadmap for decarbonization

TARGETS @ 2025

- UPS UNITARY DIRECT EMISSIONS - 43% vs 2014
- ZERO ROUTINE GAS FLARING
- FUGITIVE EMISSIONS | MtCH4 - 80% vs 2014

TARGETS @ 2030

NET ZERO EMISSIONS

TOOLS

Increased efficiency

Forestry projects

Growing share of gas

Zero carbon sources

Circular approach

CCUS

Flaring down

NEW TECHNOLOGIES

GHG targets referred to Scope 1 emissions

Images for illustrative purposes ONLY .

Thank you for your attention

- *All the technologies*
- *Taken from University of Sheffield*