Support financial actors in climate risk assessment

Enerdata-CIRED joint solutions in macro economy-energy scenario modelling

Summary

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What is at stake?

Climate scenario analysis, an essential starting point in the race to Net Zero by 2050

- The **world is at a critical juncture** where climate pathways could move from a successful transition to **net-zero GHG emissions by 2050** to a dooming path to a hot house.
- **Financial actors** are concerned by climate-related risks as **economic transmission channels** could increase their **financial risks**.
- Mark Carney's « Tragedy of Horizons » marked the **wake-up call** on climate importance on financial stability.
- Race to Net Zero by 2050 is now launched and in the face of such uncertainty, **climate scenario analysis** is a **vital tool** for financial actors to **prepare and adapt for a range of future pathways.**
- **Regulation is fortunately moving fast**, notably in the European Union with significant development of ESG-Climate disclosure standards and risk management frameworks for corporates and financial institutions, **including scenario analysis**.
- **Climate scenario analysis are very complex exercises** that requires the progress, transparency and alignment on data and methodologies of all stakeholders from regulators, financial institutions, data providers, scenario modellers and corporates.

We, **Enerdata and CIRED**, as **renowned scenario modellers** offer **unique complementarity** to support the financial actors in better assessing their climate-related financial risk exposure

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Our understanding of financial actors' needs in climate scenario analysis

▪ Climate-related stakes:

Transition risks & opportunities	Physical risks	Litigation risks

▪ Your needs:

Strategic Planning	Risk Management		Compliance & Transparency
Define the Group's mid to long term strategic objectives *aligned with a transitionning world*	***Pilot the risk*** *of all financial contracts in order to:*		***Comply to climate-related regulations*** *and maintain open dialogue with stakeholders via* ***transparent disclosures***
	Assess the unexpected	***Assess the expected***	

▪ Support methodologies & tools:

Portfolio Alignment methodologies	Climate Stress-testing exercices	GHG-adjusted pricing and valuation	Sustainability & integrated reports
Often based on energy-climate scenarios (e.g. IEA), with a **macro-energy prism**	Based on **NGFS** scenarios	Any scenarios related to climate transition & physical risks	Today, regulation does not require a specific Integrated Assessment Model (IAM) provided methodology is made available and detailed.

We, Enerdata and CIRED, propose coupled cutting-edge macro energy-climate and macroeconomic modelling to go deeper in sectoral and geographical granularity, with scenarios outputs that will feed in your in-house prospective capabilities

Who we are

Enerdata &

Enerdata - Since 1991, we have proven a renowned expertise in energy-climate scenario modelling services

- **Independent energy research & consulting company since 1991**
- Expert in analysis and **forecasting of global energy & climate issues**
- **In-house** and globally recognized **sectoral databases** and **forecasting models**

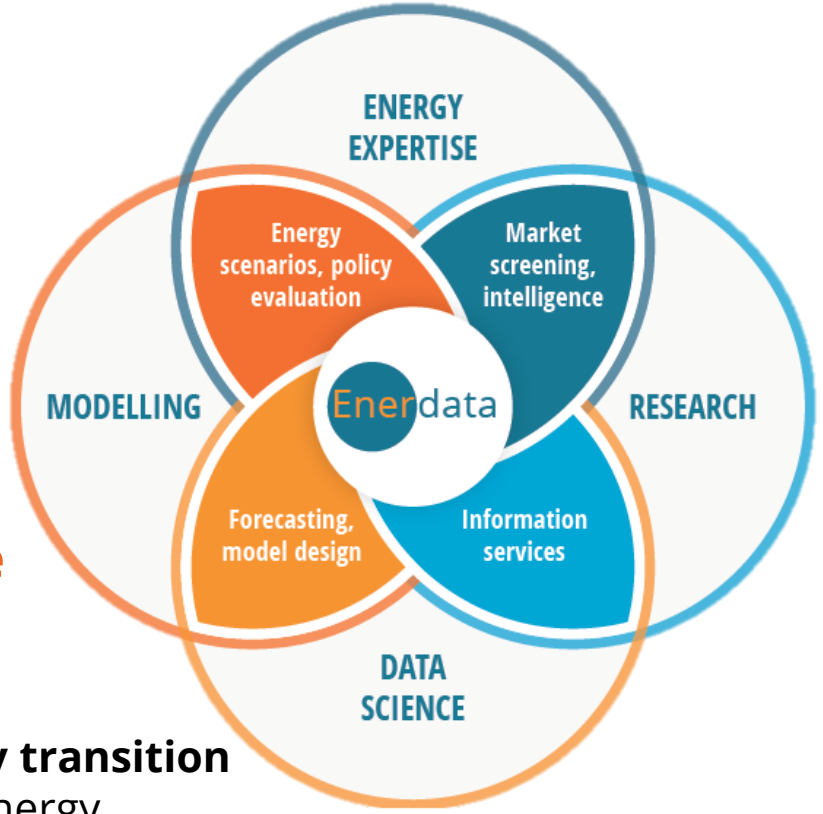
50+
committed Consultants and Experts

- **Headquartered in the Grenoble (French Alps) research cluster**; a subsidiary in **Singapore**
- **Global reach**: Clients and projects in Europe, Asia, Americas, Middle East, Africa
- **Connected** with **leading public institutions, financial and corporate actors, academia and NGOs**

Enerdata - We leverage our fields of expertise on energy & climate (E-C) from research, data science and modelling

Modelling

- Creation of E-C scenarios, **climate alignment trajectories**
- Identification of alignment pathways by sector and by country



Market intelligence

- Business intelligence, **energy market watch**
- Tracking of E-C policies worldwide

Expert in energy-climate issues

- Knowledge of **market drivers**
- **Expertise covering all energy transition** pillars: mix decarbonization, energy efficiency, sufficiency
- **Large coverage: all energies, all sectors and 150+ countries**

Data science

- Gathering, consolidating and analyzing **energy data**
- **Market forecasts: supply, demand and prices**

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CIRED – A public research institution investigating 'ecodevelopment' pathways since 1973

- A public institution gathering means from **CNRS, ENPC, CIRAD, EHESS and AgroParistech:** close-to 100 personnel (inc. PhD students) at Jardin Tropical de Paris… and growing
- In **response to the ZEG** (zero economic growth) imperative : investigating the conditions of reconciliation of economic growth and environmental protection
- Pursuing **economic modelling** as means to
  - Frame **growth** outlooks and their environmental consequences
  - Bring into consistency **the economist's and the engineer's views** on the future of Consumptions, Techniques and Localisations
  - **Assess public policy** propositions from the short to the long term

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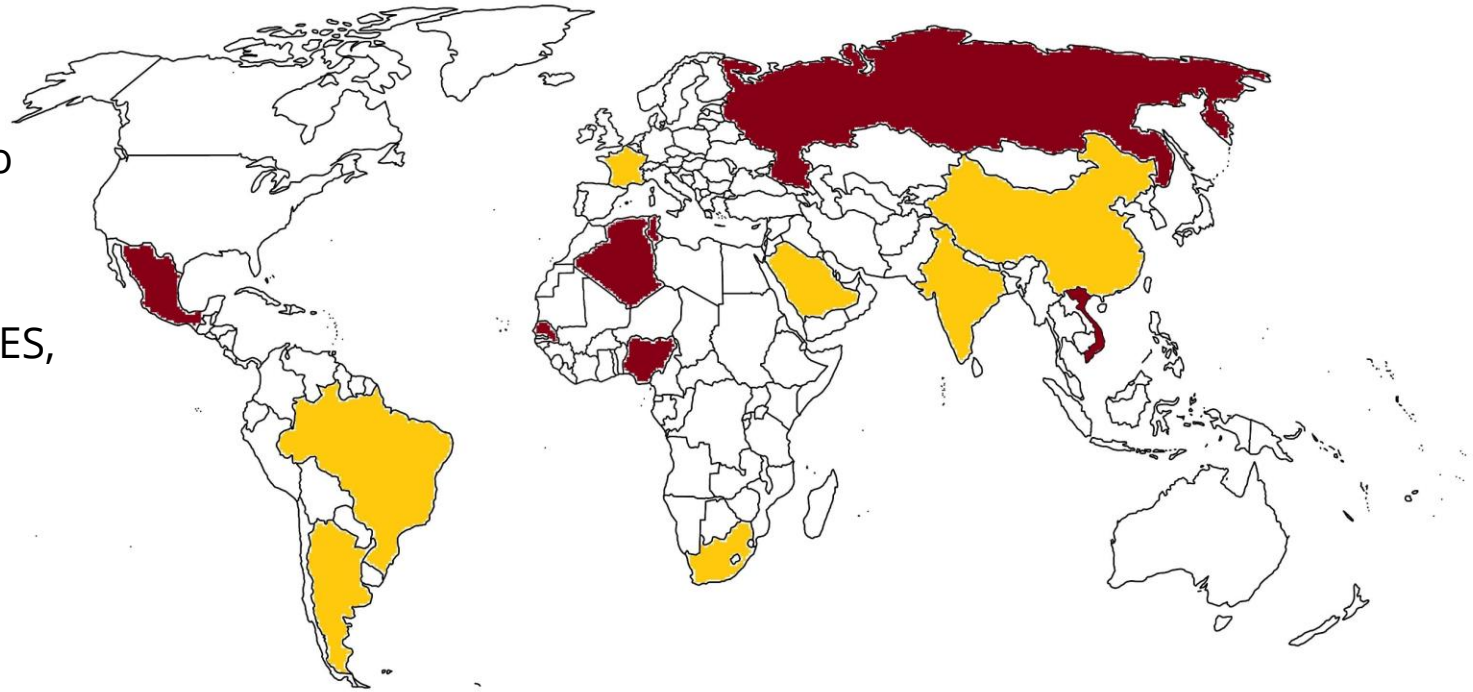
CIRED – The IMACLIM modelling solution

- **Hybrid modelling** to reconcile the economist's and the engineer's views
  - **Calibrated on hybrid data** bringing into consistency national accounting and energy balance statistics
  - **Coupled to energy modelling**, e.g. POLES, to properly picture energy systems dynamics
- Implementing **country-specific, transition focused macroeconomics** based on exploration with a 2-sector 'KLEM' precursor
- Developed by a **growing global community of users** from 13 research institutions in France and major emerging countries including the **BRICS**



Functional IMACLIM (ARG, BRA, CHN, IND, FRA, SAU, ZAF)

Work-in-progress (NGA, TUN, ALG, MEX, SEN, RUS, VNM)

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Our solutions

Global Economics and Energy Model (GEEMO)

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In a nutshell, GEEMO gives you the most of Enerdata and CIRED's know-hows in energy/economy modelling

- **Macro-economics variables:**
  - Gross Domestic Product (GDP)
  - Sectoral gross value-added, K & L costs
  - Sectoral turnover
  - Sectoral investments
  - Consumption by sector
  - Export & Import by sector
  - Earnings
  - Purchasing power
  - Real effective exchange rate
  - Consume/GDP/Investment/Import price indexes, etc.

- **Macro-energy variables:**
  - Primary consumption per fuel per sector
  - Final demand per fuel per sector
  - Activity per sector (e.g. steel production)
  - Investment
  - Energy bills
  - Absolute GHG emissions
  - Unit consumption
  - Energy and GHG intensities, etc.

Your needs:

- Extend the range of scenario outputs **from macro-economics to macro-energy and climate variables** that will help you assess the potential impacts of transition journey on your financial assets
- **Assess GHG emission abatement costs** for a wide range of technologies
- Have **sectoral** and **geographical granularity** in macro-scenario outputs to deepen the climate-related forecasting analytics
- Have access to **robust** and **regularly updated empirical economy-energy data**

Our solutions:

- Couple **CIRED's IMACLIM model** with **Enerdata's POLES model** to produce **extended economy-energy scenario variables**
- Leverage on **Enerdata's sectoral Marginal Abatement Cost Curves (MACCs)** to conduct thorough **CO_2-linked sensitivity analysis** and help you **prioritize technologies** to invest/divest in.
- Cover **20+** economic sectors and subsectors, **50+** countries including G20 countries
- Make available **user-friendly web interfaces** to consult **economy-energy databases with possibility to extract raw data** for your own computations.

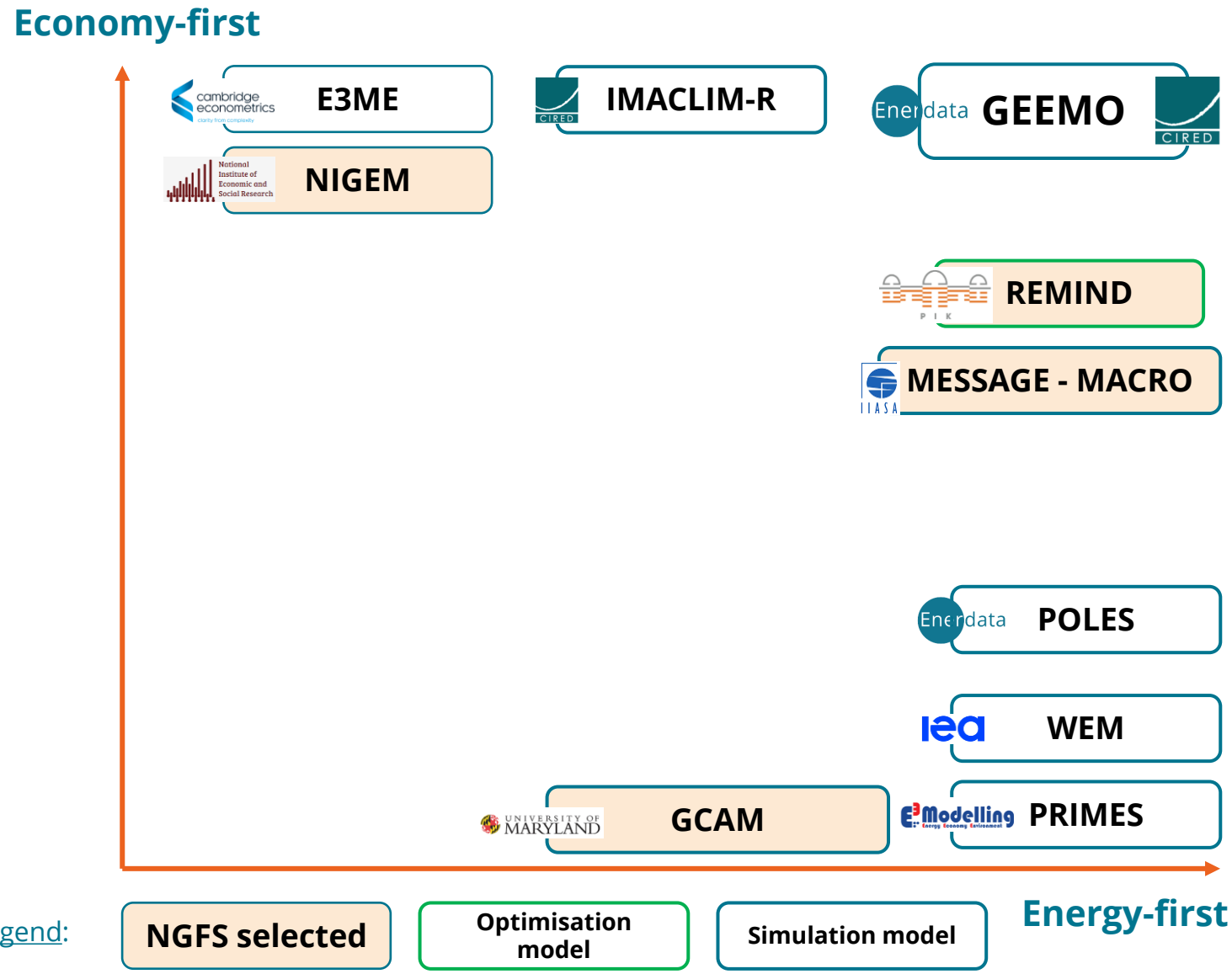
Enerdata & CIRED

GEEMO belongs to the tier-1 macro economy-energy scenario providers

- **IMACLIM-R Model:**
  - A hybrid general equilibrium model of world economy covering 2001-2100 through recursive iteration of annual static equilibria and dynamic modules.

- **POLES-Enerdata Model:**
  - A world energy-climate partial equilibrium simulation model until 2050 with complete modelling from upstream production to final user demand and GHG emissions.

- **Enerdata x CIRED's GEEMO Model:**
  - Combines POLES's description of energy systems and IMACLIM's macroeconomics with extended sectoral granularity



Strengths of the Enerdata-CIRED partnership and GEEMO model

- CIRED and Enerdata maintain a long-standing cooperation based on a set of common shared values from expertise, independence to societal commitment

- From this prospect, GEEMO has been developed to help financial actors to progress on transition risk assessment thanks to:

✓ Sectoral and geographical granularity
✓ Coupling of macro-economics and energy models
✓ Academically vetted capabilities and references in the economy-energy modelling field
✓ Suitable scenarios for climate stress-testing exercices
✓ Custom-scenarios modelling services or on-the-shelve scenario products
✓ Access to robust and up-to-date asset-level databases on key energy-intensive sectors

Our credentials

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Enerdata - We assist public and private actors on various energy-climate issues

(2021)

Price forecasts & E-C outlook

Energy price forecasts and prospective energy-climate analysis **for a large institutional investor**

(2019)

Carbon neutrality pathway

Setting up of the roadmap enabling the SNCF Group to achieve carbon neutrality by 2050

(2019)

PPA Price Estimate

Modelling of renewable PPA prices and of renewable technologies production costs in Europe to 2050

(2021)

Transport Scenarios

Calculation of energy demands and GHG emissions at 2030 and 2050 for the Transportation sector

(2021)

Residential Scenarios

Study of the levers and issues of the low-carbon transition of the residential sector in the medium and long terms

MINISTÈRE DE LA TRANSITION ÉCOLOGIQUE

(2018)

UE Package E-C 2030

Modelling of different prospective energy-climate scenarios for the European Union by 2050

Department for Business, Energy & Industrial Strategy

(Since 2009)

Providing E-C data

Providing to BEIS E-C data from 1990 to 2050 and marginal abatement cost curves (i.e. "MACC") based on the WEO of the IEA

(2018)

ZEN 2050 Project

Assistance for the construction of a Net Zero Emissions scenario for France by 2050

(2021)

PER 2050 Project

Assistance for the design of prospective scenarios designed to offer visions of a sustainable energy and climate future

ROYAUME DU MAROC
Ministère de l'Energie, des Mines et du Développement Durable

(2020)

Vision Morocco 2050

Assistance to the elaboration of the National Low Greenhouse Gas Development Strategy (LT-LEDS) of Morocco

CIRED – Participates to world leading climate policy forums thanks to funding of recognized private and public institutions

WORLD-CLASS ACADEMIC POSITION…

- Prominent role in **WG3 of IPCC** since 1995
  AR6: **Lead author** of Ch4 on national transition pathways, **CLA** of Ch3 on global long-term pathways, **Review Editor** of Ch15 on climate finance
- Member of the Scientific Steering Committee of the **Integrated Assessment Modeling Consortium**
- Member of the **Low-Carbon Society Research Network** and Stanford's **Energy Modelling Forum**
- Animating the **IMACLIM international modelling community**
- Coordinating a **MSc modelling course** and a **Summer School** of Economic Modelling of Environment and Climate issues

…RECOGNIZED BY PUBLIC & PRIVATE FUNDING

- Having provided **expertise** to The World Bank, the IDB, the IEA, the UNEP, the UNDP, the French MTE and ADEME
- Modelling activities **funded** by
  - The European Union and EuropeAid
  - The CNRS: the IMACLIM network recognized and funded as 'IRN' over 2020-2024
  - The Agence Française de Développement
  - ADEME, EDF, GRTgaz, RTE, Schneider Electric and TotalEnergies through the Chair *Prospective Modeling for Sustainable Development*

Annexes

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Overview of IMACLIM, a dynamic hybrid CGE model

INPUTS

Growth drivers
Labour force
and labour productivity

Hybrid national accounting data
Cost structure of productions/Market structure of goods and services

Energy & climate policies
Carbon pricing, subsidies, efficiency, etc.

Behavioural parameters
Saving and investment behaviours, Trade, consumption and incorme elasticities

INTERNATIONAL TRADE

Trade-offs between domestic and imported varieties of 66 goods and services

National economic systems (62)

PRODUCTIONS (66 goods and services)

Cost structure of energy supplies inc. rents on primary energies, energy intensities of non-energyv supplies taken from energy system model (POLES). Labour and capital intensities of non-energy supplies resulting from endogenous cost minimisation.

CONSUMPTIONS

Households' energy consumptions taken from energy system model (POLES). Other consumption choices resulting from price and income elasticities. Public consumption choices with constant structure.

INVESTMENT AND SAVING

Country-specific investment and savings markets depending on financial constraint, from neoclassical to Johansen to post-Keynesian closure.

PRIMARY FACTOR MARKETS

Modelling of imperfect labour (unemployment) and capital (idle capacities) markets.

OUTPUTS

Prices, exports and imports of 66 g&s

Trade balance

GDP, sectoral VA, sectoral turnovers

K and L costs / Earnings

Sectoral cons., purchasing power of households

National savings, sectoral investments

Price indexes

Unemployment, capacity utilisation

Overview of POLES-Enerdata, a multi-issue energy model

INPUTS

Resources

Oil, gas, coal, biomass, uranium, hydro, wind, solar

Macroeconomic assumptions

GDP, populations, etc.

Energy & climate policies

Carbon pricing, subsidies, efficiency, etc.

Technologies

Costs, efficiency, etc.

International energy markets

Oil	Gas	Coal	Biomass
1 market 88 producers	14 import markets 88 producers	15 import markets 81 producers	1 market 66 producers

National energy systems (66)

ENERGY SUPPLY

- Domestic production
- Import / Export
- Trade routes

PRIMARY ENERGY DEMAND

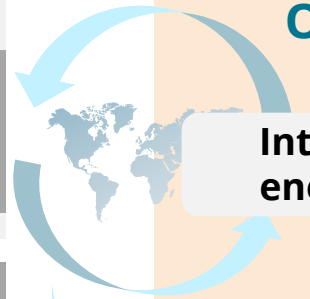
- Fossil fuels
- Nuclear
- Hydro
- Biomass & wastes
- Other RES

ENERGY TRANSFORMATION

- Power sector
  - Investments/capacity planning
  - Electricity generation
- Refineries (incl. Synfuels)

FINAL ENERGY DEMAND

- Industry
- Transport
- Buildings
- Agriculture



OUTPUTS

International energy prices

Energy consumptions

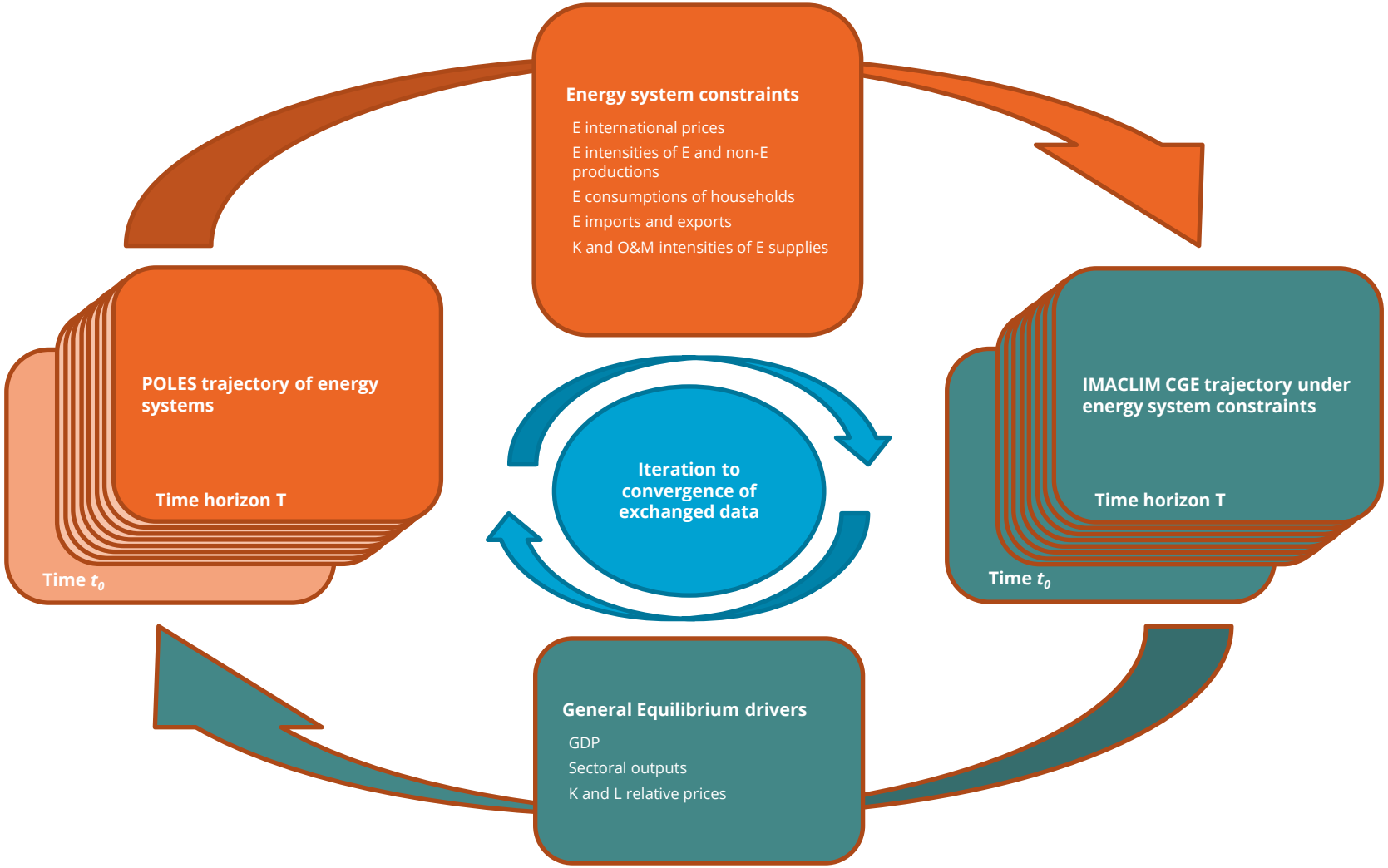
Energy productions

Energy end-user prices

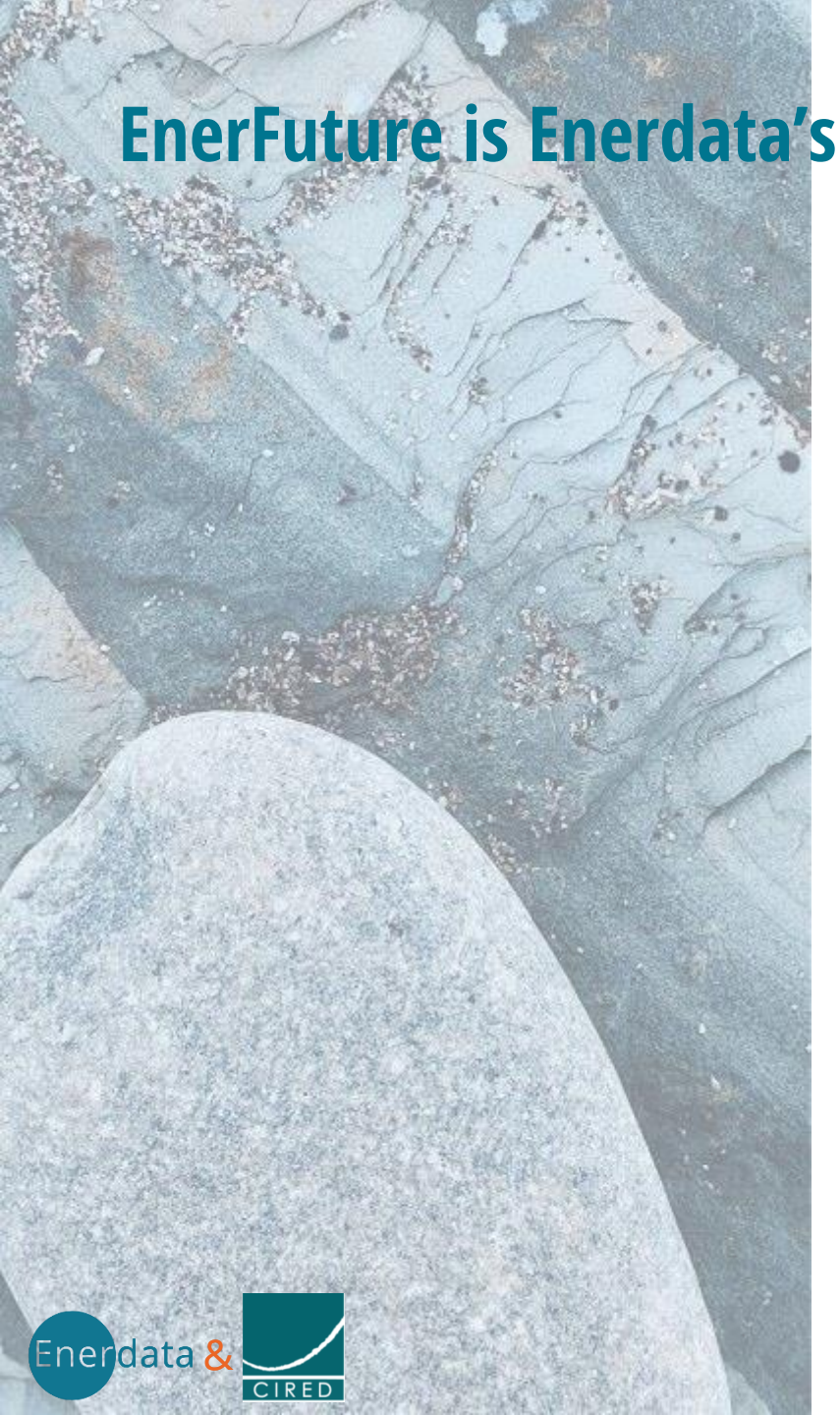
Energy investments

GHG emissions

Overview of IMACLIM-POLES coupling



EnerFuture is Enerdata's own set of 3 scenarios, updated every year



EnerBase

Climate and energy policies

- Efforts to mitigate GHG emissions limited to historical trends
- Policies lacking climate ambition, not compatible with NDC targets

Energy demand

- Limited improvements in energy efficiency
- High demand growth in developing countries, and moderate in OECD

Energy supply and prices

- Fossil fuels remain dominant
- Moderate development of renewables
- Fuel prices increase (driven by rising demand and geopolitical context)

The EnerBase emission trajectory could lead to a temperature increase between 5°C and 6°C.

EnerBlue

Climate and energy policies

- Reinforced GHG emissions mitigation efforts
- Climate policies in line with NDC objectives.

Energy demand

- Demand growth controlled through energy efficiency
- Energy demand increasing in developing countries, and stable in OECD

Energy supply and prices

- Progressive diversification towards renewables
- Fossil fuel share on a decreasing trend
- Slowly increasing international fuel prices

The EnerBlue emission trajectory could lead to a temperature increase between 3°C and 4°C.

EnerGreen

Climate and energy policies

- Strong efforts towards GHG emissions mitigation
- Ambitious climate policies, with NDC objectives revised upwards

Energy demand

- Regular updates of energy efficiency targets
- Global stabilization of energy demand, with significant decrease in OECD

Energy supply and prices

- Complete phase-out of fossil fuel subsidies
- Strong development of renewables
- Significant carbon taxations balance stable fuel prices

The EnerGreen scenario explores a world in which temperature increase is limited to 2°C.

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About Enerdata

Enerdata is an energy intelligence and consulting company established in 1991.
Our experts will help you tackle key energy and climate issues and make sound strategic and business decisions.
We provide research, solutions, consulting and training to key energy players worldwide.

About CIRED

The Centre international de recherche sur l'environnement et le development (CIRED) is an interdisciplinary research laboratory at large economic dominant created in 1973 by Ignacy Sachs, on the basis of a core group that came together in 1971 as the Development Strategy Research Group.

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