A Tool for Scenario Analysis: An IPCC perspective

Christophe Cassen (cassen@entre-cired.fr), Toshihiko Matsui (masui@nies.go.jp)
Julien Lefevre (Lefevre@centre-cired.fr), Antoine Teixeira (teixeira@centre-cired.fr), Franck Lecocq (lecocq@centre-cired.fr)

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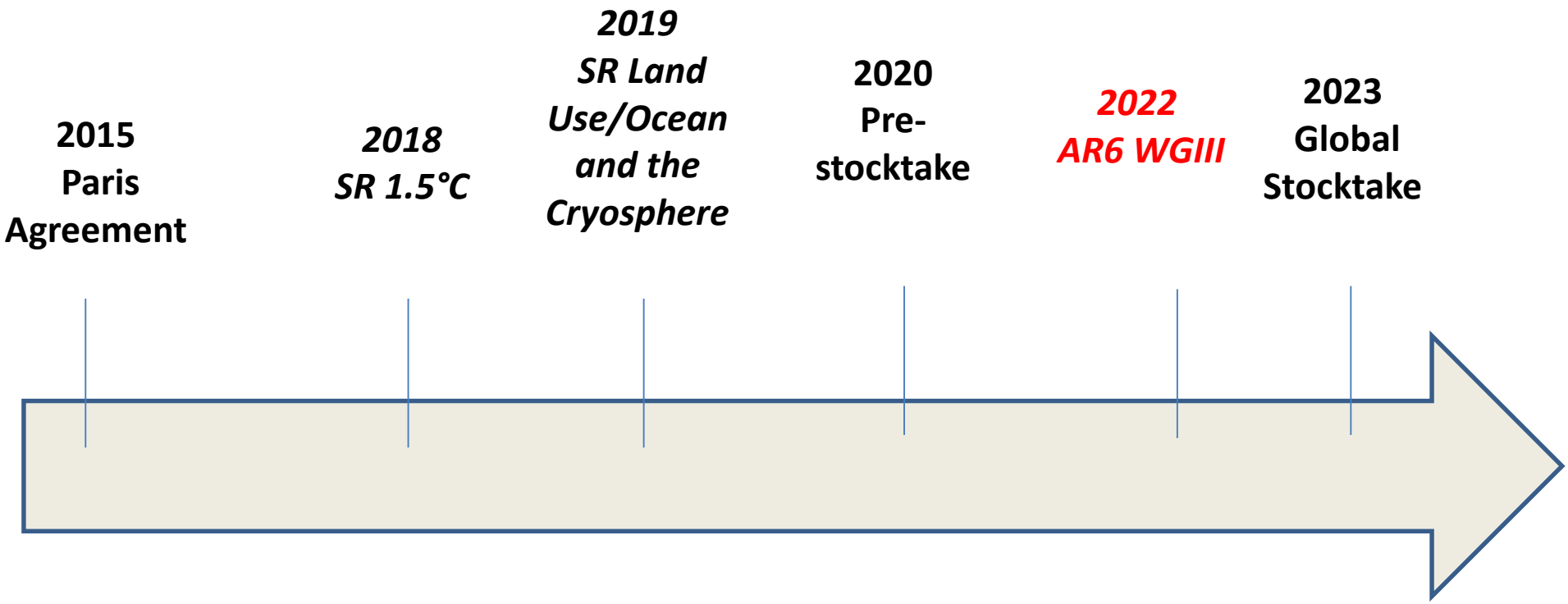
The IPCC process in the context of Post Paris Agreement



- NDCs, Long term GHG dev strategies as cornerstones of the climate action after Paris
- Increasing needs for modeling evaluations of national low carbon strategies
- New issues at stakes for modelers: development of carbon neutrality, finance, development styles…

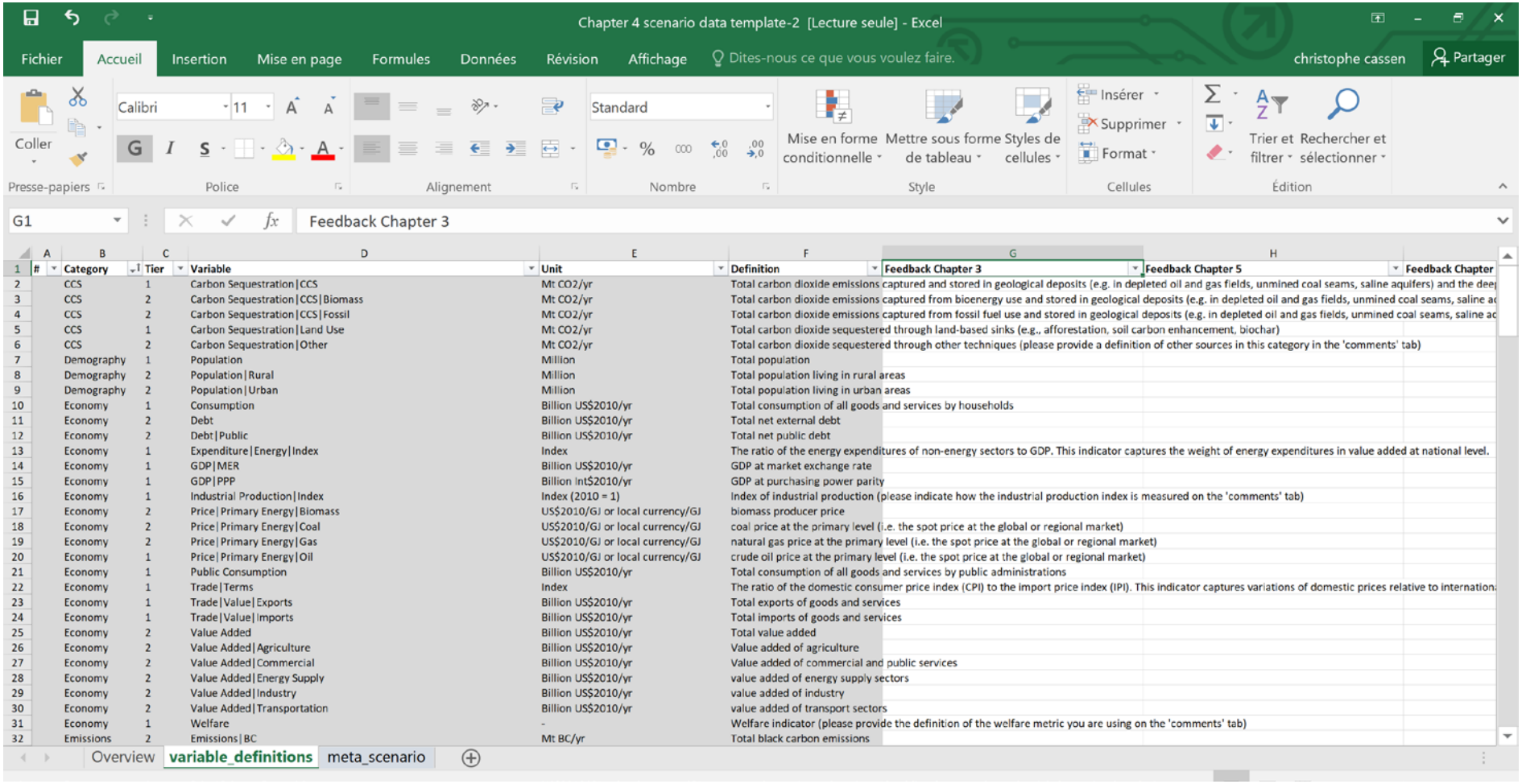
Outline of the IPCC AR6 (WGIII)

- Chap 1: Introduction and Framing
- Chap 2: Emissions trends and drivers
- Chap 3: Mitigation pathways compatible with long-term goals (CLA: Riahi (IIASA)/Schaefer (UFRJ))
- Chap 4: Mitigation and development pathways in the near-to mid-term (CLA: Winkler (ERC)/Lecocq (CIRED))
- Chap 5: Demand, services and social aspects of mitigation
- Chap 6: Energy Systems
- Chap 7: Agriculture, Forestry, and Other Land Uses (AFOLU)
- Chap 8: Urban systems and other settlements
- Chap 9: Buildings
- Chap 10: Transport
- Chap 11: Industry
- Chap 12: Cross Sectoral Perspectives
- Chap 13: National and sub-national policies and institutions
- Chap 14: International cooperation
- Chap 15: Investment and Finance
- Chap 16: Innovation, technology development and transfer
- Chap 17: Accelerating the transition in the context of sustainable development

Scenario data templates in AR6 WGIII (chapters 3 and 4)

- Take stock of national and global scenarios **published** in peer reviewed literature in specific databases (not obvious for national scenarios!)
- Enable comparisons btw scenarios and evaluation of the impacts on emission trends (e.g 2030), key **economic, energy and technological** parameters: GDP, employment, final and primary energy, investment...
- Open call for scenarios
  - Chapter 3: 31st October 2019 (first deadline of submission)
  - Chapter 4: starting end of October 2019

Chapter 4 scenario provisional data template rationale



#	Category	Tier	Variable	Unit	Definition	Feedback Chapter 3	Feedback Chapter 5	Feedback Chapter
2	CCS	1	Carbon Sequestration|CCS	Mt CO2/yr	Total carbon dioxide emissions captured and stored in geological deposits (e.g. in depleted oil and gas fields, unmined coal seams, saline aquifers) and the dee			
3	CCS	2	Carbon Sequestration|CCS|Biomass	Mt CO2/yr	Total carbon dioxide emissions captured from bioenergy use and stored in geological deposits (e.g. in depleted oil and gas fields, unmined coal seams, saline a			
4	CCS	2	Carbon Sequestration|CCS|Fossil	Mt CO2/yr	Total carbon dioxide emissions captured from fossil fuel use and stored in geological deposits (e.g. in depleted oil and gas fields, unmined coal seams, saline a			
5	CCS	1	Carbon Sequestration|Land Use	Mt CO2/yr	Total carbon dioxide sequestered through land-based sinks (e.g., afforestation, soil carbon enhancement, biochar)			
6	CCS	2	Carbon Sequestration|Other	Mt CO2/yr	Total carbon dioxide sequestered through other techniques (please provide a definition of other sources in this category in the 'comments' tab)			
7	Demography	1	Population	Million	Total population			
8	Demography	2	Population|Rural	Million	Total population living in rural areas			
9	Demography	2	Population|Urban	Million	Total population living in urban areas			
10	Economy	1	Consumption	Billion US$2010/yr	Total consumption of all goods and services by households			
11	Economy	2	Debt	Billion US$2010/yr	Total net external debt			
12	Economy	2	Debt|Public	Billion US$2010/yr	Total net public debt			
13	Economy	1	Expenditure|Energy|Index	Index	The ratio of the energy expenditures of non-energy sectors to GDP. This indicator captures the weight of energy expenditures in value added at national level.			
14	Economy	1	GDP|MER	Billion US$2010/yr	GDP at market exchange rate			
15	Economy	1	GDP|PPP	Billion Int$2010/yr	GDP at purchasing power parity			
16	Economy	1	Industrial Production|Index	Index (2010 = 1)	Index of industrial production (please indicate how the industrial production index is measured on the 'comments' tab)			
17	Economy	2	Price|Primary Energy|Biomass	US$2010/GJ or local currency/GJ	biomass producer price			
18	Economy	2	Price|Primary Energy|Coal	US$2010/GJ or local currency/GJ	coal price at the primary level (i.e. the spot price at the global or regional market)			
19	Economy	2	Price|Primary Energy|Gas	US$2010/GJ or local currency/GJ	natural gas price at the primary level (i.e. the spot price at the global or regional market)			
20	Economy	1	Price|Primary Energy|Oil	US$2010/GJ or local currency/GJ	crude oil price at the primary level (i.e. the spot price at the global or regional market)			
21	Economy	1	Public Consumption	Billion US$2010/yr	Total consumption of all goods and services by public administrations			
22	Economy	1	Trade|Terms	Index	The ratio of the domestic consumer price index (CPI) to the import price index (IPI). This indicator captures variations of domestic prices relative to internation			
23	Economy	1	Trade|Value|Exports	Billion US$2010/yr	Total exports of goods and services			
24	Economy	1	Trade|Value|Imports	Billion US$2010/yr	Total imports of goods and services			
25	Economy	2	Value Added	Billion US$2010/yr	Total value added			
26	Economy	2	Value Added|Agriculture	Billion US$2010/yr	Value added of agriculture			
27	Economy	2	Value Added|Commercial	Billion US$2010/yr	Value added of commercial and public services			
28	Economy	2	Value Added|Energy Supply	Billion US$2010/yr	value added of energy supply sectors			
29	Economy	2	Value Added|Industry	Billion US$2010/yr	value added of industry			
30	Economy	2	Value Added|Transportation	Billion US$2010/yr	value added of transport sectors			
31	Economy	1	Welfare	-	Welfare indicator (please provide the definition of the welfare metric you are using on the 'comments' tab)			
32	Emissions	2	Emissions|BC	Mt BC/yr	Total black carbon emissions			

A preliminary application: Japan and French low carbon scenarios

JAPAN: The Long-term Strategy under the Paris Agreement (Cabinet decision, June 11, 2019)

- http://www.env.go.jp/press/802.pdf
  - 80% reduction of GHG in 2050
  - Accomplishment of decarbonized society (anthropogenic GHG emissions equal absorption) as early as possible in the 2nd half of 21st century.
- This is not a practical roadmap but a vision.
  - Visions of each sector
  - Cross-sectoral measures
    - Innovation: technology; economic and social systems; lifestyle
    - Green finance
    - International application and cooperation
- Because there is no information on the numerical roadpmap in the present long-term strategy, AIM/CGE [Japan] preliminarily assesses 80% reduction of GHG emissions in 2050 and more severe target (95% reduction in 2050).

Outlines of Japan's Long-term Strategy under the Paris Agreement (Cabinet decision, June 11, 2019)

Provisional Translation

Chapter 1: Basic Concepts

- **Proclaiming a "decarbonized society" as the ultimate goal and aiming to accomplish it ambitiously as early as possible in the second half of this century**, while boldly taking measures towards the reduction of GHGs emissions by 80% by 2050
  * an unconventional vision of an "ideal future model" * contributing to the achievement of the long-term goals of the Paris Agreement, including efforts to limit the temperature increase to 1.5℃
- **Realizing "a virtuous cycle of environment and growth"** towards the vision with business-led disruptive innovation, Swift implementation of actions from now, contributing to the world, **Action Towards a bright Society with Hope for the Future**

[Factors: Achievement of SDGs; "Co-innovation", Society 5.0; the "Circulating and Ecological Economy"; and leading country in solving problems]

Chapter 2: The Vision of Each Sector and the Direction of Measures

Section 1: Measures for Emissions Reductions

1.Energy: For energy transition/decarbonization, pursuing every option

- Utilizing renewable energy as the major power source
- Reducing CO_2 emissions from the thermal power in line with the long-term goals of the Paris Agreement
- Promoting CCS&CCU/Carbon Recycling
- Realizing a "Hydrogen Society"/battery/nuclear/energy efficiency

2.Industry: Decarbonized manufacturing

- Use of CO_2-free hydrogen (e.g. a challenge towards "zero-carbon steel")
- Feedstock change (e.g. CCU including artificial photosynthesis and biomass utilization)
- Achieving drastic energy efficiency, and complete transition from fluorocarbons in mid-long term

3.Transport: the challenge of "Well-to-Wheel Zero Emission"

- Achieving the highest level of environmental performance of Japanese vehicles supplied worldwide by 2050
- Road/transport systems using big data and IoT

4.Community and Living: Achieving carbon neutral, resilient and comfortable communities and living by 2050/ creating the "Circulating and Ecological Economy"

- Capable communities and corporations to achieve carbon neutrality even before 2050
- Shift to carbon neutral living (encouraging technology development and dissemination to achieve net Zero Energy Buildings, equivalency in stock average of housing and office buildings/ shift of lifestyles)
- Carbon-neutral community building (urban city building, farming/forestry/fishing villages building, and development of distributed energy systems)

Section 2: Measures for Carbon Sinks

Chapter 3: Cross-sectoral Measures for Achieving a Virtuous Cycle of Environment and Growth

Section 1: Promotion of Innovation

- Promoting innovation for practical application and wide usage of cross-sectoral decarbonization technologies leading to drastic reduction of GHG, achieving cost that allows commercialization for social application

(1) Progressive Environment Innovation Strategy

- Setting clear goals such as costs, maximizing investment of public and private resources, discovering and creating technological seeds in and outside Japan, setting issues from demands, strengthening support that leads to commercialization
- Challenging R&D, and enhancing alliances among R&D institutes with facilitation of international joint R&D activities [Research and Development 20 for clean energy technologies(RD20)]
- Target setting and visualizing challenges for the practical use
  - Realizing hydrogen cost equivalent to existing energy: e.g. lowering manufacturing cost of CO_2-free hydrogen to 1/10
  - CCU/carbon recycled products to be provided with costs equivalent to existing products, nuclear power(such as Reactor, Fusion)

(2) Innovation in Economic and Social Systems/lifestyle

Section 2: Promotion of Green Finance

- Appropriately "visualizing" corporate efforts in innovation etc. and mobilizing finance for innovation by financial institutions

(1) Mobilizing green finance through TCFD※ disclosures and dialogues ※Task Force on Climate-related Financial Disclosures

- Industry: improving TCFD Guidance & Scenario Analysis Guide / Financial sector: Formulating a guidance on green investment
- Facilitating dialogue between industry and financial sector (TCFD Consortium)
- Promoting discussion and share the above initiatives with the world (TCFD Summit)

(2) Promoting initiatives to expand ESG finance

- Initiatives for ESG finance (Support to the issuance of green bonds, encouraging local ESG finance), development of ESG Dialogue Platform, enhancing ESG finance literacy, ESG Finance High-Level Panel

Section 3: Business-led Promotion of International Application, and International Cooperation

- Promoting competitive technologies and products with high environmental performance/ promoting co-innovation benefiting participants from both countries

(1) Promoting international application of decarbonization technologies together with policy/institutional development and international rule-making

- Promoting international application of decarbonization technologies and reductions of GHG emissions through development of business environment by improving business environment including working for institutional development in partner countries leading international rule-making cooperating in building policy and institutional framework in partner countries and by international rule-making (e.g. establishing public and private-sector initiatives in ASEAN, and developing appropriate international frameworks for utilizing market-based mechanisms)

(2) Strengthening Development and Investment of infrastructure that contributes to CO_2 emission reductions

- Development and investment of energy and city/transport infrastructure that contributes to CO_2 emission reductions in line with the long-term goals of the Paris Agreement (e.g. renewable energy such as offshore wind power and geothermal power, hydrogen, CCS&CCU/Carbon Recycling, smart cities)

(3) Creating platforms for global scale decarbonized society building

- Supporting partner countries in the formulation of NDCs and mitigation measures, enhancing transparency in the overall supply chains

Chapter 4: Other Measures

- Human Resource Development
- Just transition
- Government-led initiatives
- Integrating climate change adaptation with development of a resilient society
- Carbon Pricing (Expert/technical level discussions)

Chapter 5: Review and Implementation of the Long Term Strategy

- **Review:** Re-examining policies and measures flexibly every about 6 years with reference to situations, and improving the Long-term strategy if necessary
- **Implementation:** Analysing relevant factors responding to future changes in the situations / collaborating and having dialogues with stakeholders including the youth

Features of AIM/CGE [Japan]

- National computable general equilibrium model with recursive dynamics
- Base year: 2005
  - GDP, population and GDP per capita in 2050 are assumed to be 1.3 times, 0.8 times and 1.6 times, respectively, compared to 2005 level.
- 40 sectors (power sector has more sub-sectors) and 43 commodities; each sector/sub-sector has different technology sets
  - tec0: conventional technology set
  - tec1: technology set to achieve NDC in 2030
  - tec2: technology set to achieve 80% reduction of GHG in 2050
  - tec3: tec2 + CCS in energy intensive industries and thermal power sectors
  - tec4: technology set to achieve electrification
  - In order to install efficient technologies, additional investment is needed. AIM/Enduse [Japan] provides information of energy efficient technologies.
- Household sector has 5 categories by homeowner's age (-29; 30-39; 40-49; 50-59; 60-), and energy efficiency improvement in household is also assumed the spread of efficient equipment stock.
- Scenario: Reference case, 80% reduction case and 95% reduction case
  - It is assumed that retirement of less efficient technologies will be forced in GHG reduction cases.

Simulation results of AIM/CGE [Japan] Economy

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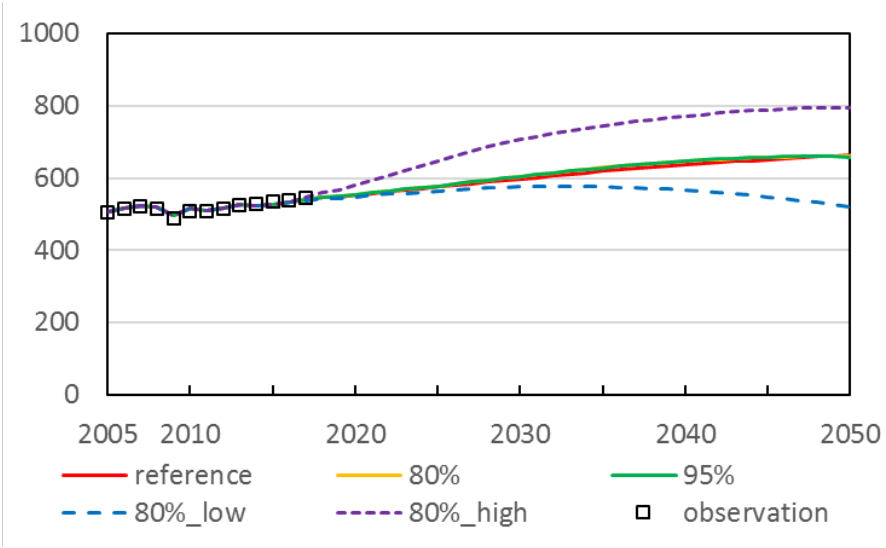
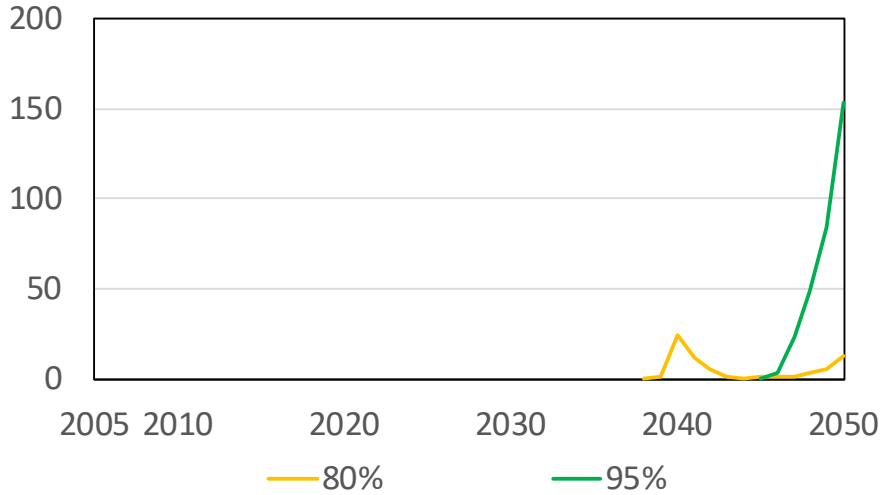
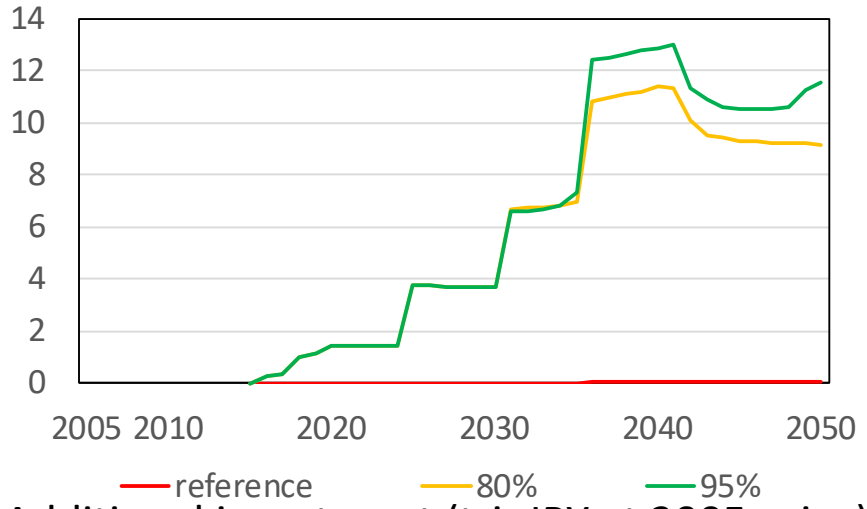


GDP (tri. JPY at 2005 price)



GHG price (1000 JPY / tCO2 eq)

Early retirement of conventional technology will increase investment and promote productivity. As a results, severed GDP losses in mitigation cases are not observed. If forced retirement of less efficient technologies is not assumed, GHG price will be much expensive.



Additional investment (tri. JPY at 2005 price)

Simulation results of AIM/CGE [Japan]
Production by technologies

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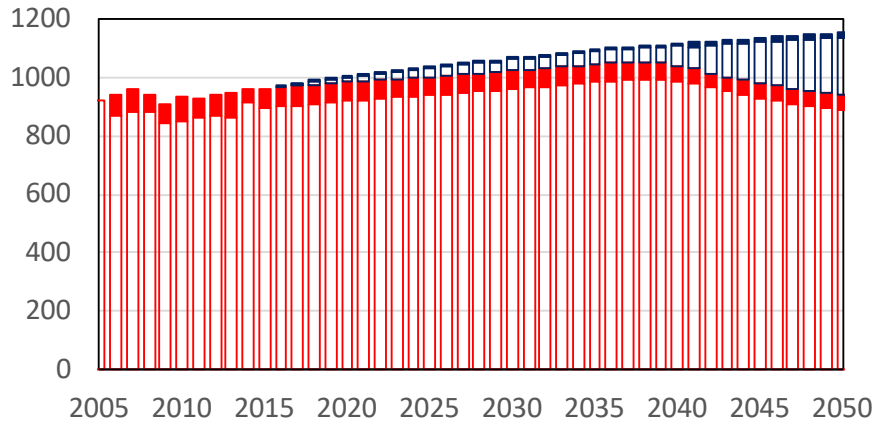
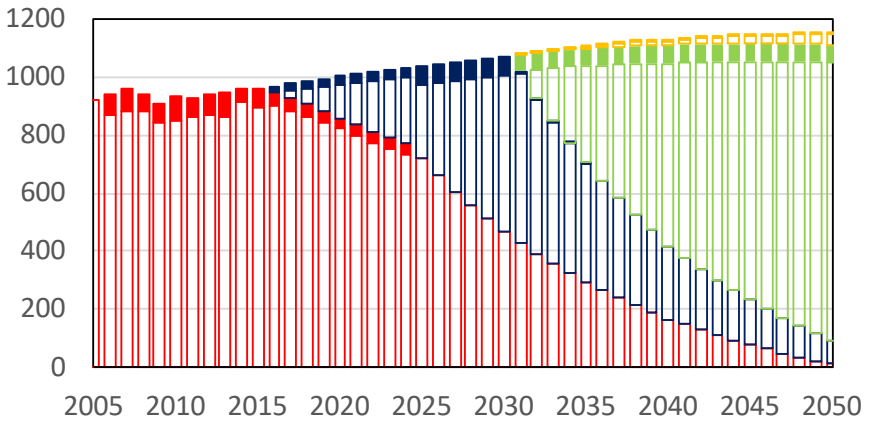
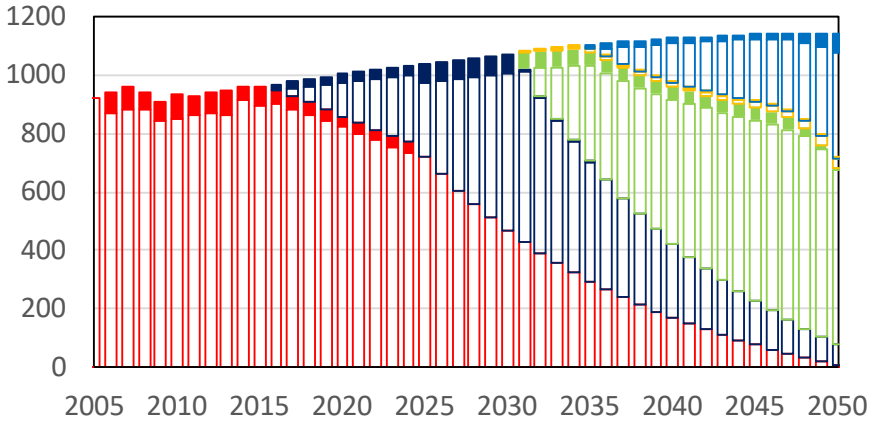


Reference case



80% reduction case



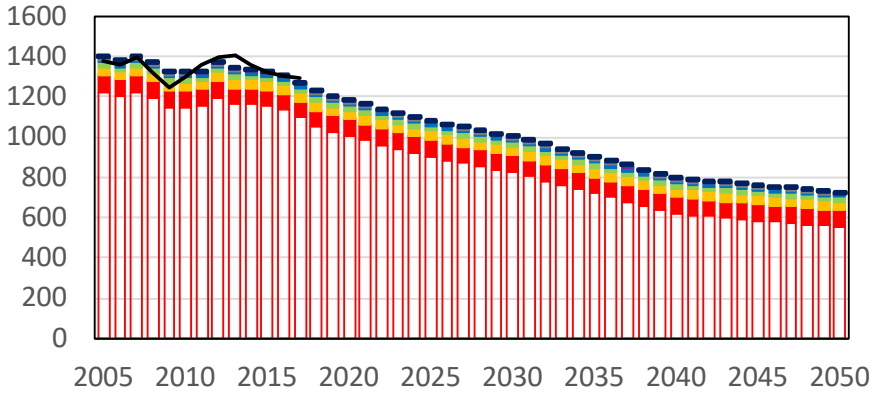
95% reduction case

tec0_stock tec0_new tec1_stock tec1_new tec2_stock
tec2_new tec3_stock tec3_new tec4_stock tec4_new

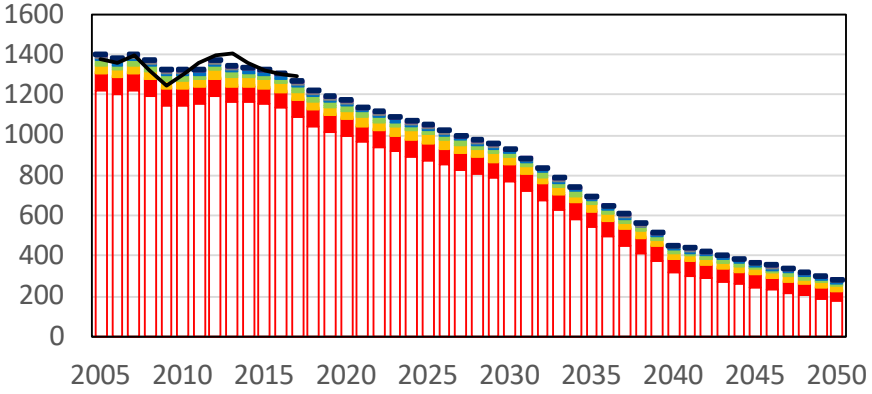
Since depreciation rate is assumed to be 5% per year, stock with conventional technology will remain in 2050.
In mitigation cases, more rapid diffusion of efficient technologies will be needed to achieve the GHG reduction target.

Simulation results of AIM/CGE [Japan]
GHG emissions

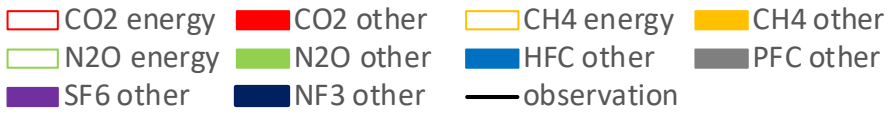
Do not quote because of preliminary results

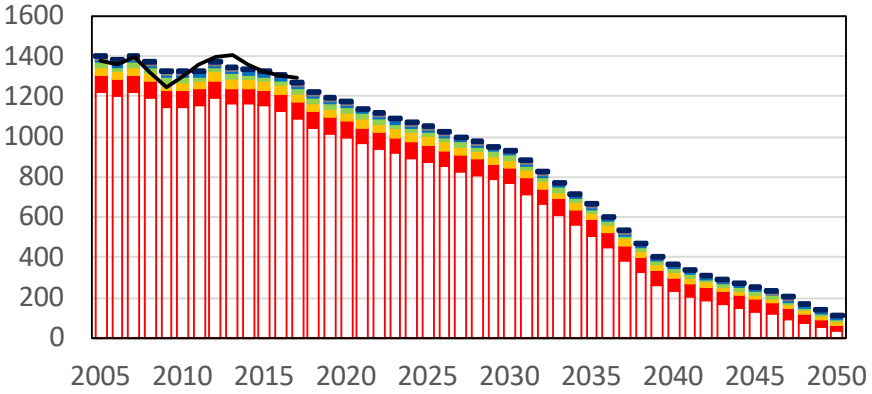


Reference case



80% reduction case





95% reduction case

In reference case, GHG emissions will also decrease because of increase of renewable energies.

Because of forced retirement of less efficient technologies, GHG emissions in 2030 will be less than those of NDC.

Simulation results of AIM/CGE [Japan]
Electricity supply by technologies

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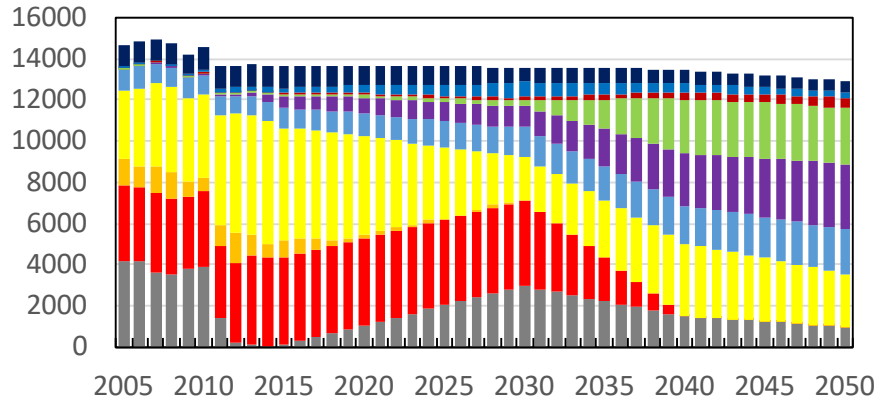
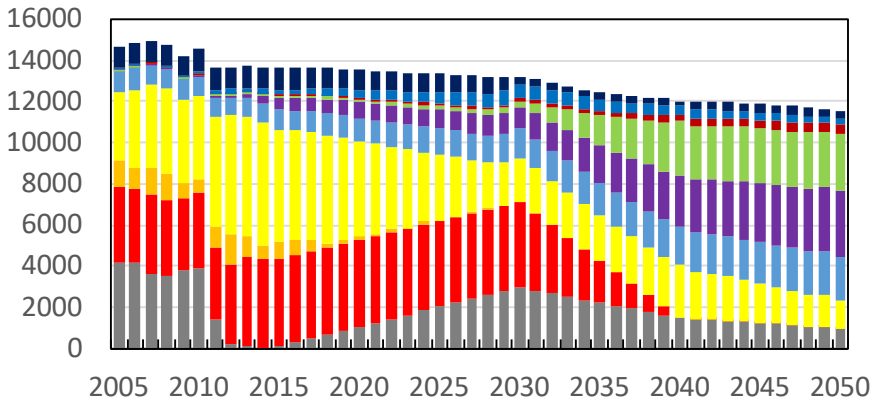
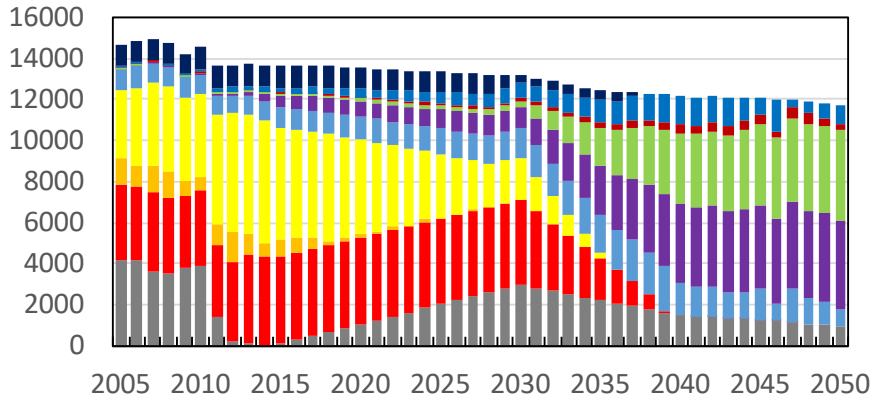


Reference case



80% reduction case



95% reduction case

Increase of renewable energies is common assumption among the cases.
In 95% reduction case, all electricity will be supplied from low carbon technologies after 2040. Because of electrification, electricity supply in 95% reduction case will be more than that in 80% reduction case.

The (2nd) French National Low carbon strategy

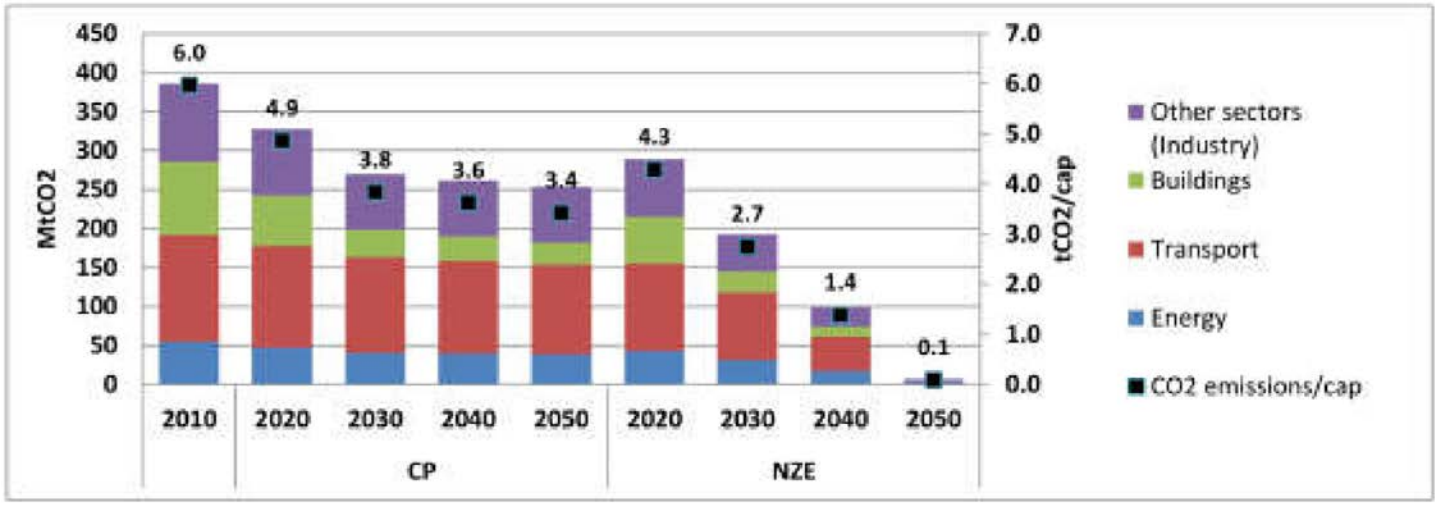
- Commissioned and supervised by the French government

(https://www.ecologique-solidaire.gouv.fr/strategie-nationale-bas-carbone-snbc)

- **Prospective exercise** at national level to design political and technical actions to reach a given GHG emissions reduction target by 2050
  - 2015 climate legislation (LTECV): toward "Factor 4"
  - 2017 climate plan: toward **net zero GHG emissions**
- Gives **strategic orientations** and recommendations and defined carbon budgets, both at national and sectorial level, for next climate legislation design
- Compared 2 illustrative scenarios
  - **Current policies scenario (AME) to net-zero emissions scenario (AMS)**
  - Built in a consultative process with main stakeholders (working groups)

	Current Policies (CP) scenario	Net-zero Emissions (NZE) scenario
Macroeconomic drivers Trend GDP growth World energy prices	1.4%/yr (2010-2030) – 1.8%/yr (2030-2050) IEA RTS 2030-2050: Oil (USD/bbl): 111 - 137 Gas (USD/MBtu): 10.3 – 12.6	Id IEA 2DS 2030-2050: Oil (USD/bbl): 85 - 72 Gas (USD/MBtu): 9.4 – 10.5
Buildings	*New buildings* Thermal regulations and energy standards (< 50kWhPE/m²/yr) *Retrofitting of existing buildings* Tax credit (30% of investment) and zero-interest loan	*New buildings* More stringent thermal regulations and energy standards: energy consumption ceiling (+ GHG criteria) per use to reach 20 kWhFE/m²/yr in 2050 *Retrofitting of existing buildings* Stronger incentives 700.000 retrofitted dwellings/yr and full low-energy buildings by 2050 GES criteria included
Transport	+35% p.km/t.km in 2050 No significant modal shift New vehicle standards (LDV and trucks) - Ex: ICE cars: 4,7l/100km beyond 2030 Slow electrification of LDV fleet, little incorporation of low-carbon fuels (biogas, biofuels) Fiscal incentives (bonus-malus, premiums, etc.)	+30% p.km/t.km in 2050 Modal shift: 4% from cars to collective transport and bike New vehicle standards (LDV and trucks) - Ex: ICE cars: 2l/100 km in 2050 Massive electrification of LDV fleet, mixed electric/biogas/biofuel fleet for trucks and buses; penetration of bio jet-fuel Increased occupation rate (+15% in 2050) of cars Stronger fiscal incentive
Industry	Incentives for electrification of processes EU-ETS	Maximum energy efficiency 80% electrification target, rest bioenergy Circular economy, bio-sourced materials EU-ETS
Energy	Current support to REN extended	Zero carbon energy system in 2050: zero carbon electricity and heat + bioenergy Strong support to REN
Carbon tax policy Carbon price Recycling	100€/tCO2 from 2030 to 2050 Decrease of payroll taxes (PT)	225€/tCO2 (2030), 400€/tCO2 (2040), 600€/tCO2 (2050) Hybrid recycling (HB): Lump sum to households + energy cost offset of productive sectors

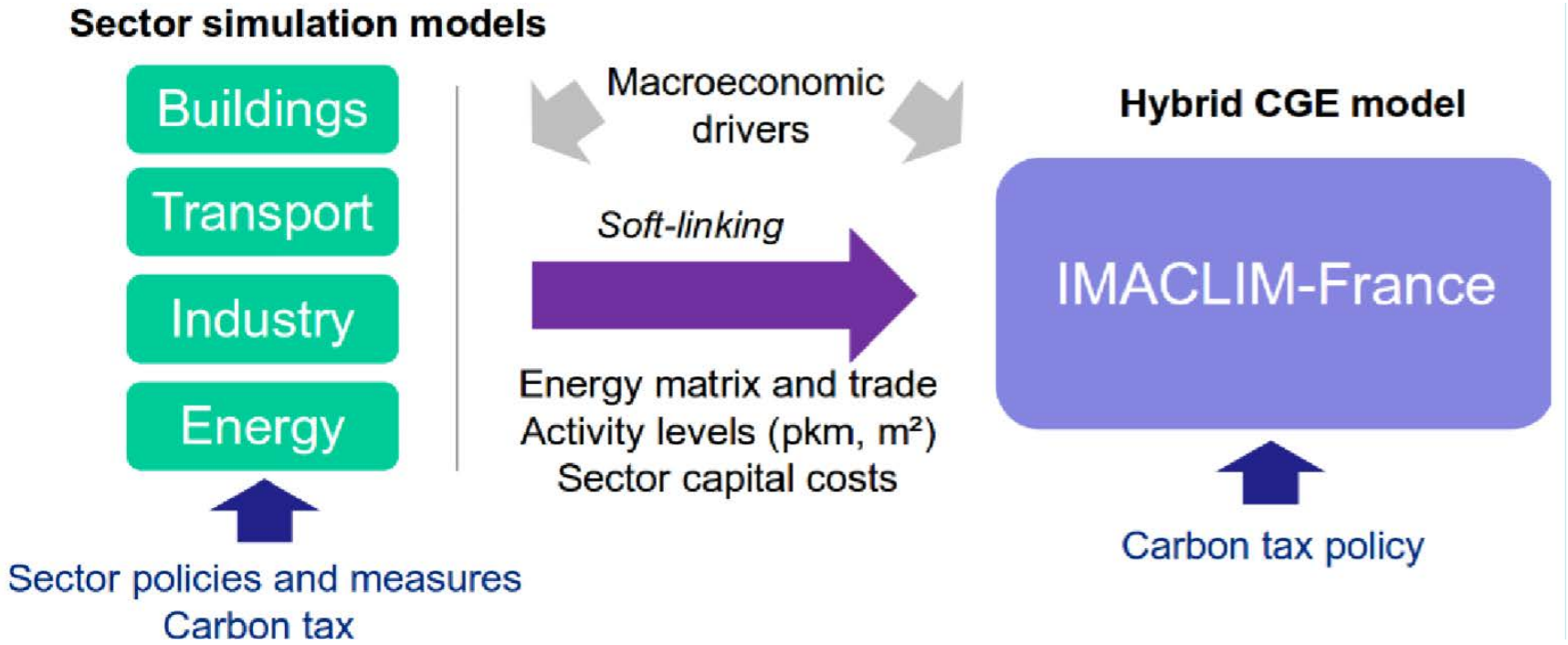
CO2 emission pathways



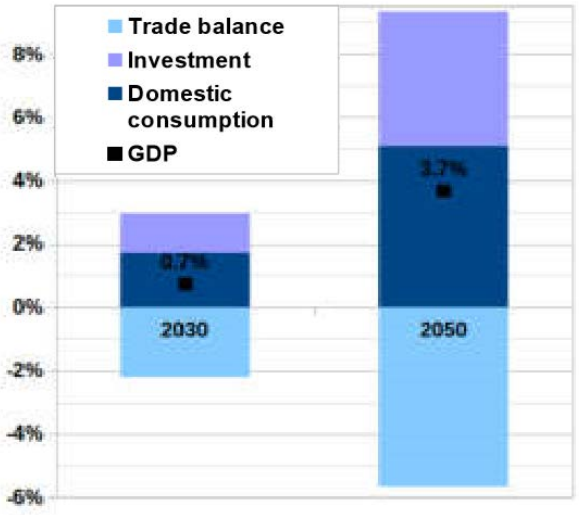
Source: CIRED

Evaluation of the (2nd) French National Low carbon strategy : a focus on macroeconomic dimensions

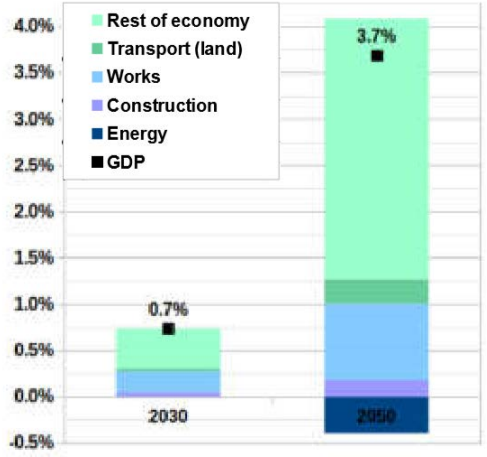
The modeling approach



Macroeconomic and social implications

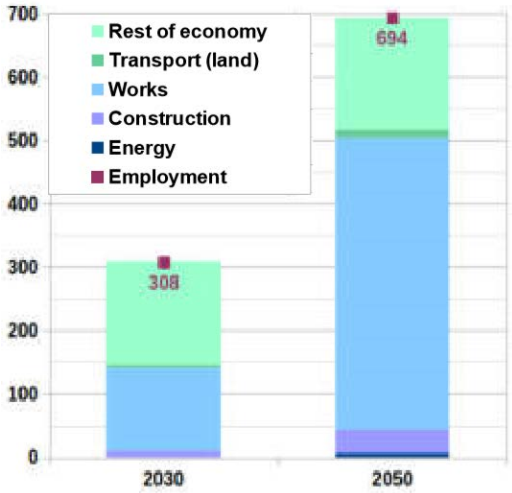


Decomposition of relative GDP variations in NZE compared to CP in 2030 and 2050



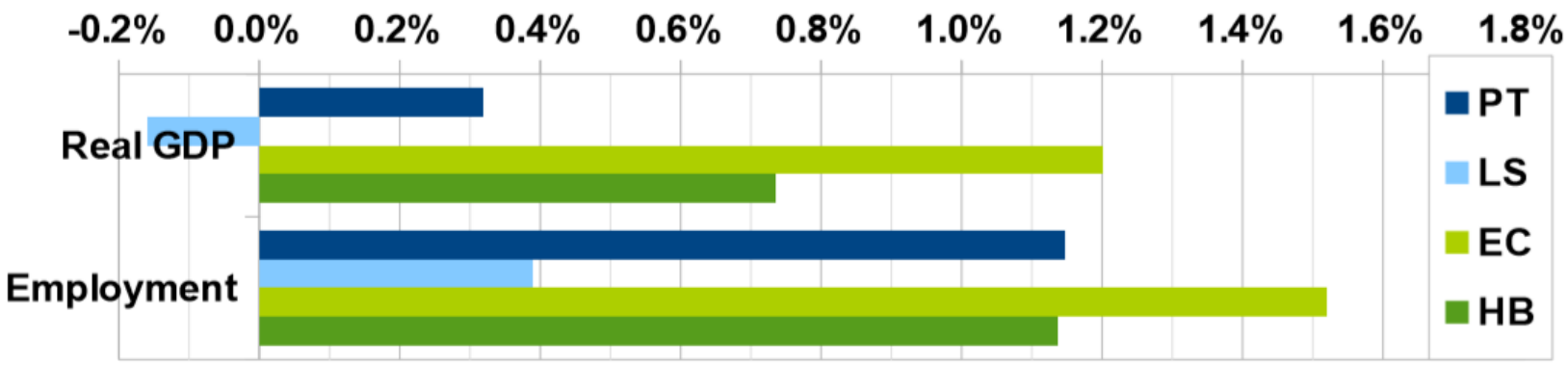
Sector contributions to relative GDP variation in NZE compared to CP in 2030 and 2050

- Macroeconomic dividend in the NZE scenario, enhanced in the long run
- Virtuous cycle through investment stimulus, energy efficiency gains and cancelation of fossil fuel imports/more than offset mitigation costs in the long run
- Ripple effect of sectors (building, work, transport) on the rest of the economy
- 700000 additional jobs in 2050 (70% in the construction sector



Variation of employment in NZE compared to CP in 2030 and 2050

Recycling modalities of a carbon tax



Relative variations of GDP and employment in 2030 in NZE compared to CP according to the recycling scheme of carbon tax revenues in NZE

PT: reduction of payroll taxes LS: lump sum transfer to households EC: redistribution of revenues to productive sectors according to their energy costs; HB: reference hybrid recycling scheme

Source: CIRED

Conclusion and next steps

- A dedicated data template of national scenarios in AR6 IPCC
  - How gathering non published scenarios? Which linkages to other IPCC chapters?
- A tool useful to :
  - Aggregate results for key parameters (emissions, GDP etc.)
  - Compare drivers, P&M among countries
  - Identify gaps (eg. emissions at the global level) and enabling conditions to raise ambition
  - Help modelers in their day to day work to check data and foster collaboration btw teams
- Challenges underlying French and Japanese scenarios exercises
  - Carbon neutrality (official target in France)
  - Vision (Japan) vs Strategy with policy and short term measures (France)
  - Deep technological transformations and structural change
    - Sensitive technologies: REN vs nuclear, CCS, hydrogen
    - Further evaluation: lifestyle, circular economy, urban transformations and land use changes
  - Common focus on macroeconomic implications (GDP, employment, investments)
    - Optimistic mobilization of investments
    - Impact of international trade?
  - Management of the transition (winners and losers, types of employment, stranded assets) ?

Merci!