Part 2

The economic challenge of redirecting investment towards low-carbon and climate-resilient capital

09/01/2018

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2. Under the Paris agreement, countries are to undertake a massive economic shift, notably towards low-carbon and climate resilient infrastructures

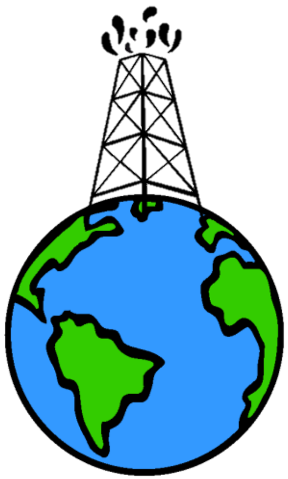
→ Why is this a challenge and what tools can be deployed to make it happen ?

Outline

Intro: Let's imagine three worlds…

1. How NDCs and 2°C compatible pathways raise a strong economic challenge
2. Building the right incentives to overcome a project initiator's dilemma
3. A framework to understand how to finance a low-carbon, climate-resilient economy

Let’s imagine three worlds



A

World « up to 1990 »
Fossil fuel based economy
No climate change
No climate impacts

A

B

World we live in now
Fossil-fuel based economy
Runaway climate change
Important climate impacts

B

C

2°C world
Climate-neutral economy
Stabilized climate change
Limited climate impacts

C

Let’s imagine three worlds

« According to traditional economic analysis, which of these three world is globally the wealthiest (in global GDP), in the long run (21st century) ? »

World A No climate change	World B Runaway climate change, strong impacts	World C Stabilized climate change, limited impacts
X	X	X

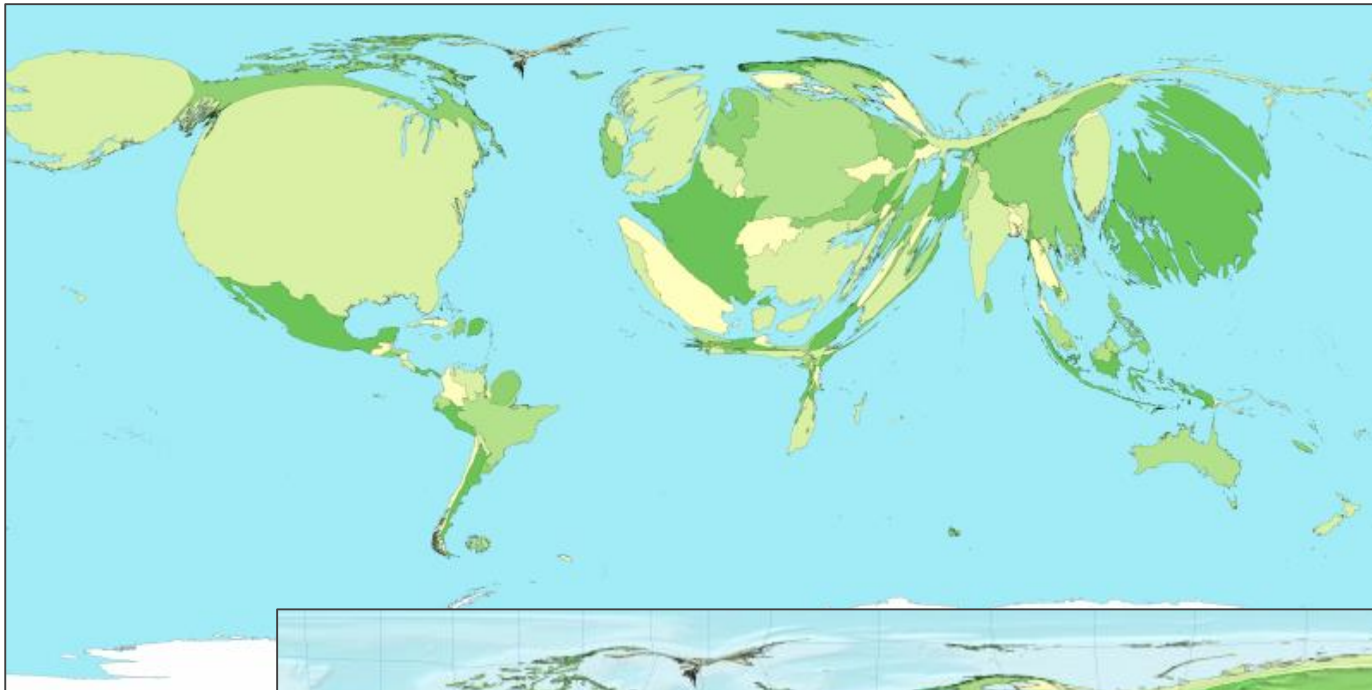
A **B** **C**

Comparing the cost of action and the cost of inaction (a.k.a. the Stern review)

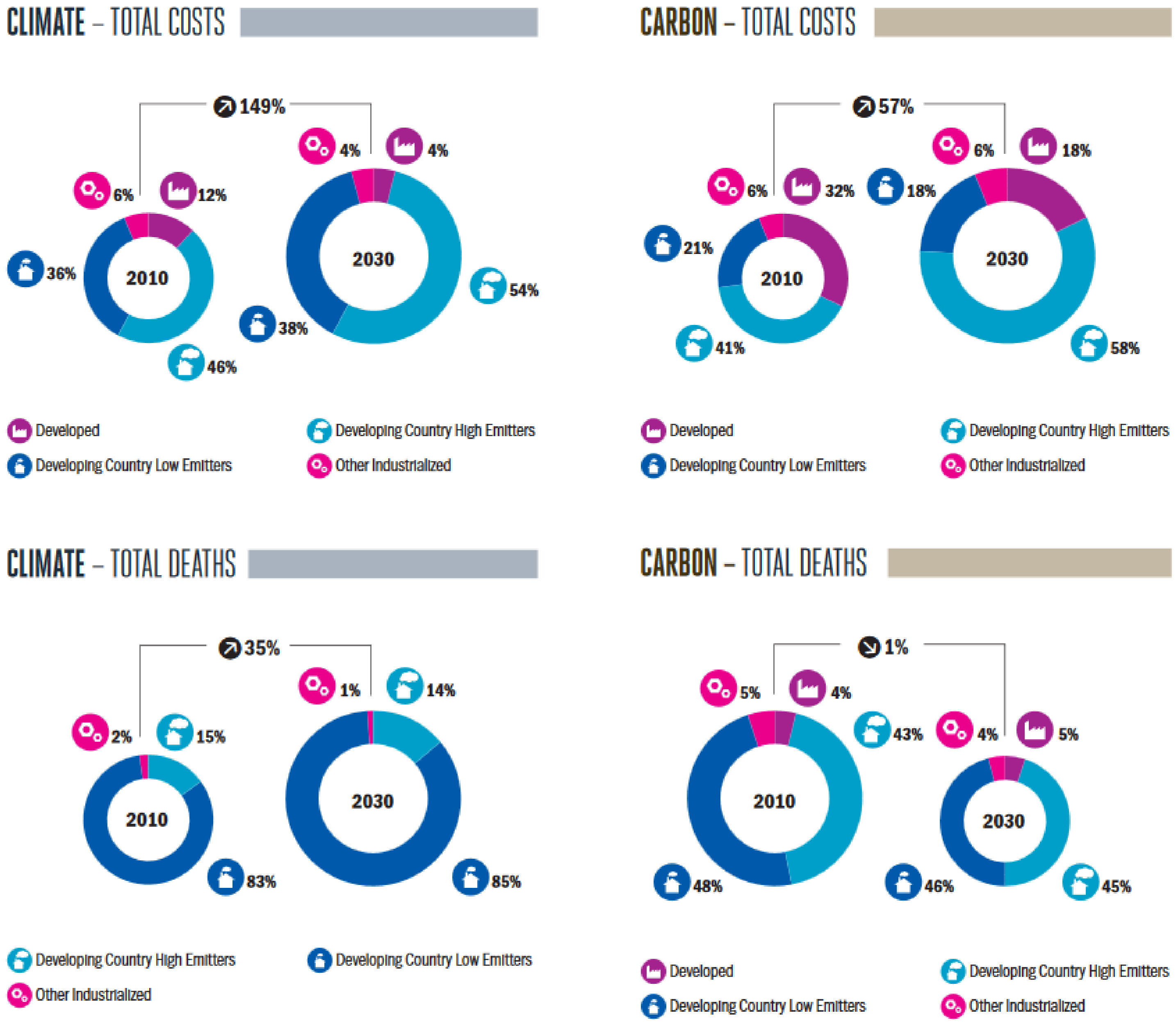
- Costs of inaction: here and now
  - 400,000 deaths per year directly from climate change
    - See Climate Vulnerability Monitor
  - 7 million pre-mature deaths from air pollution
    - not climate change, but linked to the use of fossil fuels
  - Losses of 1.6% of global GDP
  - (All compared to a world with no climate change & no fossil fuel)
- Costs of inaction: growing in the future
  - 3.2% of global GDP in 2030
  - 5-20% of global GDP in 2100
  - (Compared to a world with no climate change and with fossil fuel)
- Staying within +2°C
  - Additional costs are estimated to be ~1% of global GDP annually

Sources: WHO (2016), Climate Vulnerability Monitor (2015), World Bank (2015), IPCC (2014), Stern Review (2006)

Global GDP



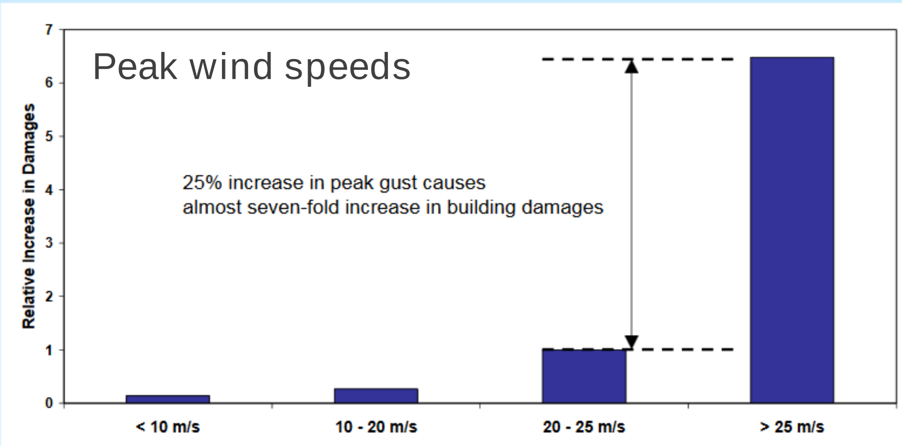
Global population



Source: [Climate Vulnerability Monitor](#)(2015)

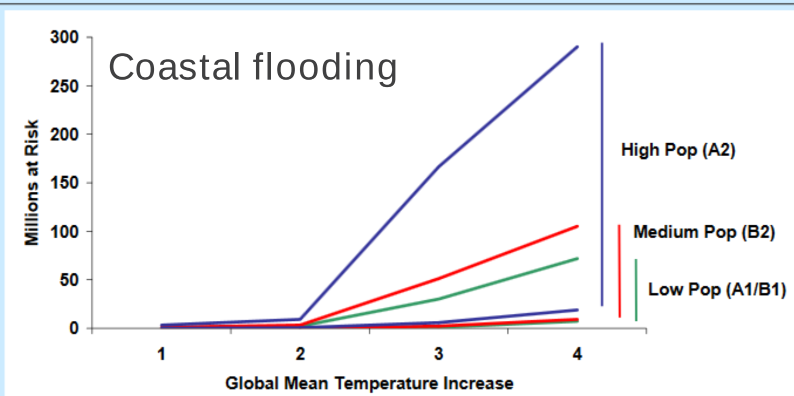
Costs of inaction grow disproprotionately faster than global temperature increase, concludes Stern in 2007

Figure 3.10 Damage costs increase disproportionately for small increases in peak wind speed



Source: IAG (2005)

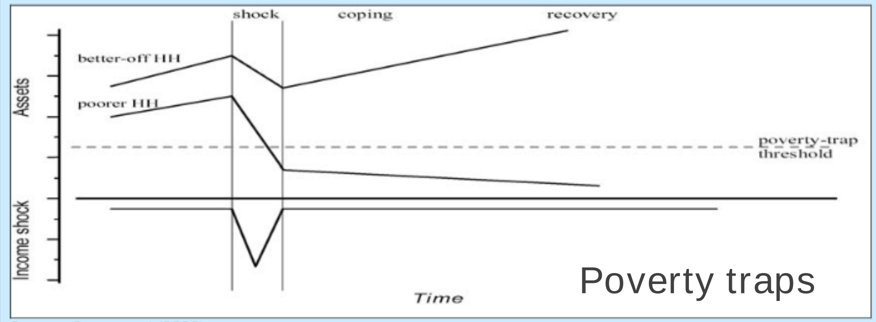
Figure 3.9 Additional millions at risk from coastal flooding



Source: Warren *et al.* (2006) analysing data from Nicholls (2004), Nicholls and Tol (2006) and Nicholls and Lowe (2006)

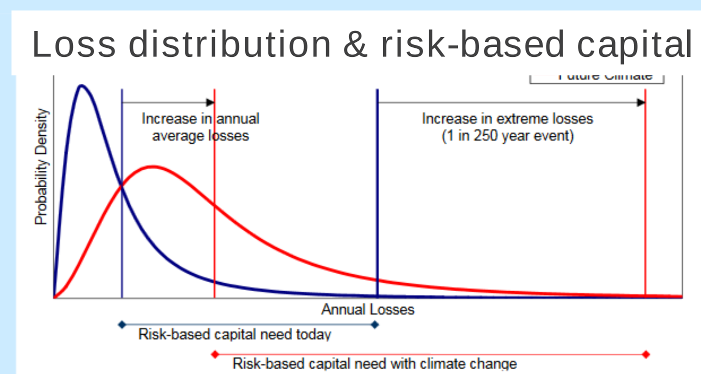
Figure 4.4 Impact of a climate shock on asset trajectory and income levels

This diagram illustrates: a) the period of shock itself (e.g. hurricanes or drought), b) the coping period in which households deal with the immediate losses created by the shock, and c) the recovery period where a household will try to rebuild the assets they have lost as a result of the climate shock or through the coping strategy they adopted.



Source: Carter et al (2005)

Climate change is likely to lead to a shift in the distribution of losses towards higher values, with a greater effect at the tail.[47] Average annual losses (or expected losses) will increase by a smaller amount than the extreme losses (here shown as a 1 in 250 year event), with the result that the amount of capital that insurers are required to hold to deal with extremes increases.

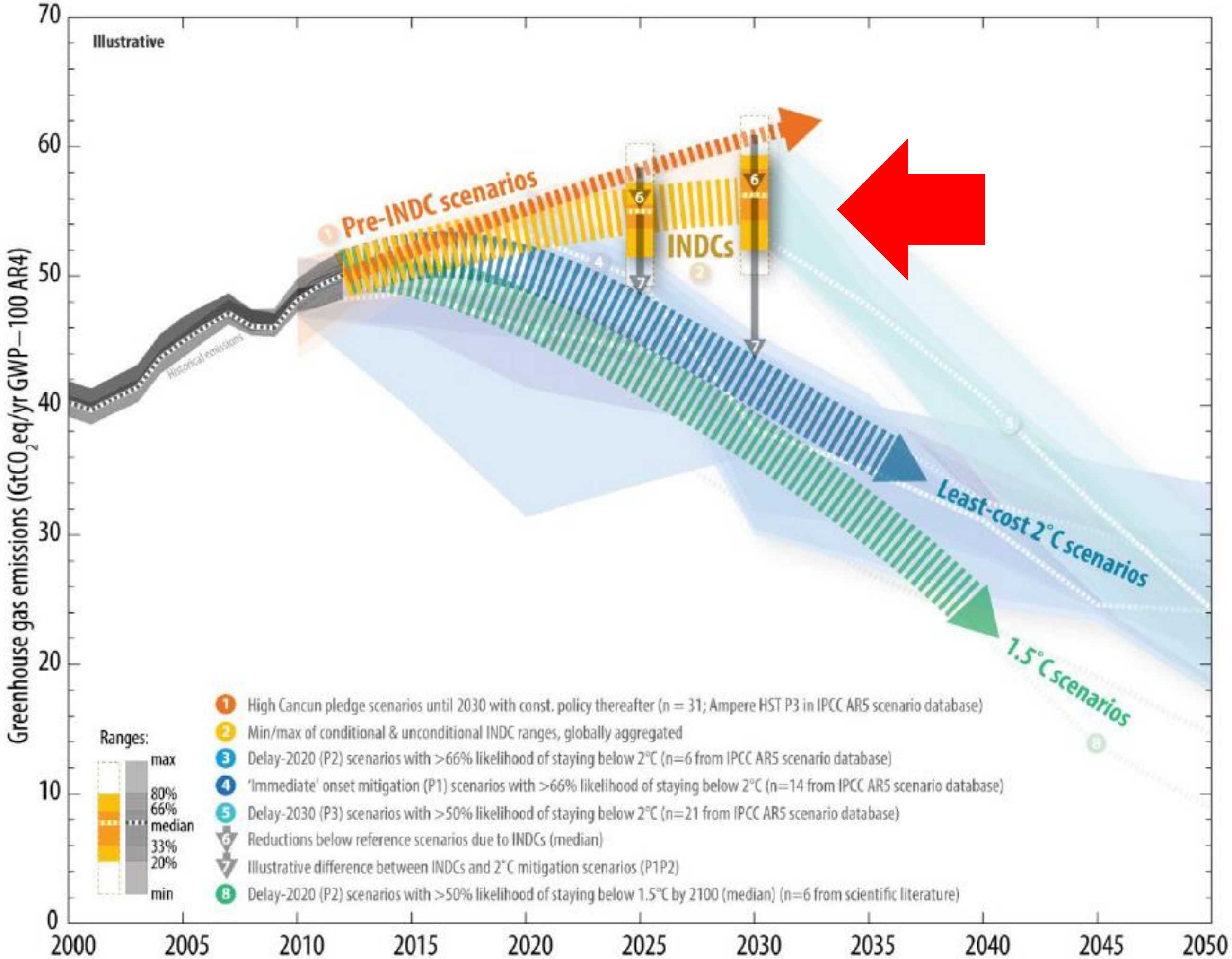


If storm intensity increases by 6%, as predicted by several climate models for a doubling of carbon dioxide or a 3°C rise in temperature, this could increase insurers' capital requirements by over 90% for US hurricanes and 80% for Japanese typhoons – an additional $76 billion in today's prices.

Source: Association of British Insurers (2005a)

From Paris agreement's NDCs to the broader investment challenge

Even if correctly implemented, Paris agreement pledges (NDCs) still fall short of shifting emissions towards 2°C

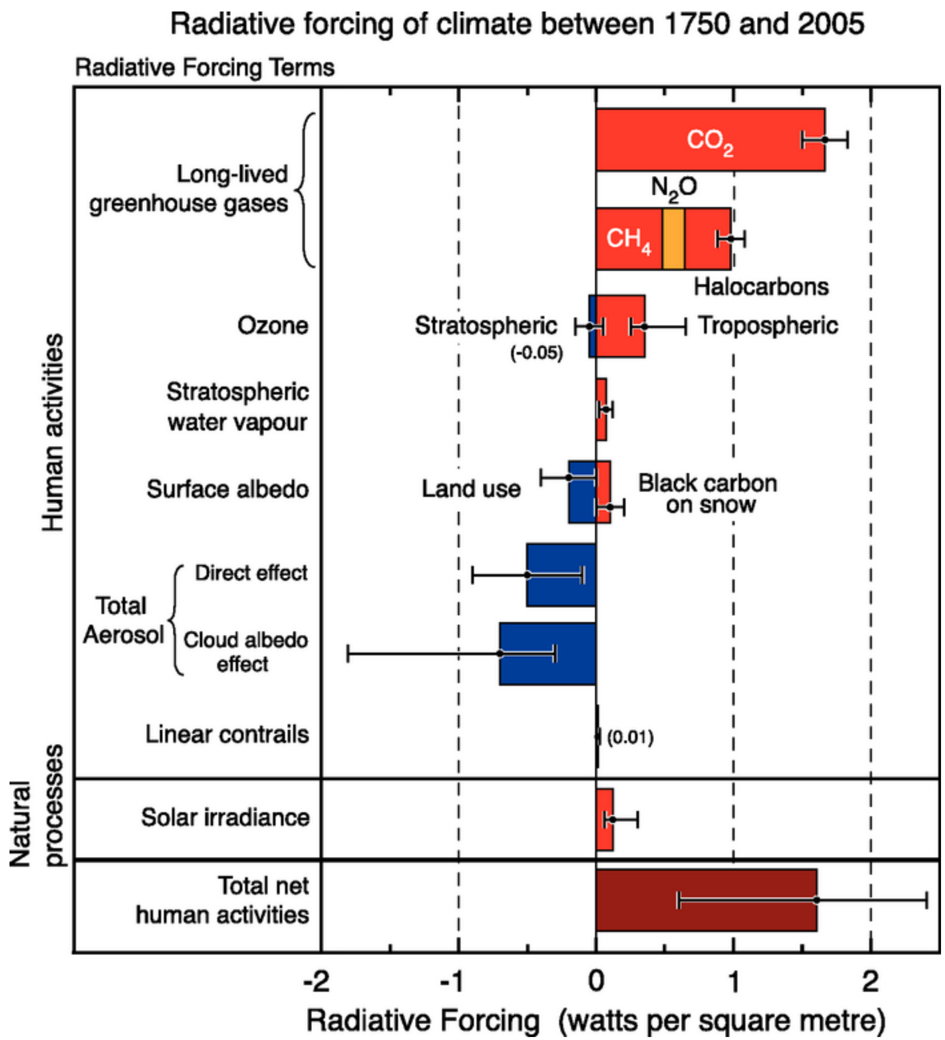


Sources: Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report scenario database, 1.5 °C scenarios from scientific literature (see footnote 18), IPCC historical emission database and intended nationally determined contribution quantification.

Abbreviations: AR4 = Fourth Assessment Report of the Intergovernmental Panel on Climate Change, GWP = global warming potential, INDC = intended nationally determined contribution, IPCC AR5 = Fifth Assessment Report of the Intergovernmental Panel on Climate Change, n = number of scenarios, yr = year.

Reminder : current radiative forcing is mainly (but not solely) due to the combustion of fossil fuels

- Radiative forcing
  - Changes in radiation balance
  - External factors, both positive and negative forcing
- Different factors
  - Anthropogenic
    - Energy/industrial processes: GHG emissions (long lived & short lived/aerosols)
    - Non energy processes: Albedo due to land use change
  - Natural
    - Change in solar radiation
- Global positive radiative forcing from human activities (warming)
  - Linked with global warming potential
  - Importance of non energy related forcing: land use

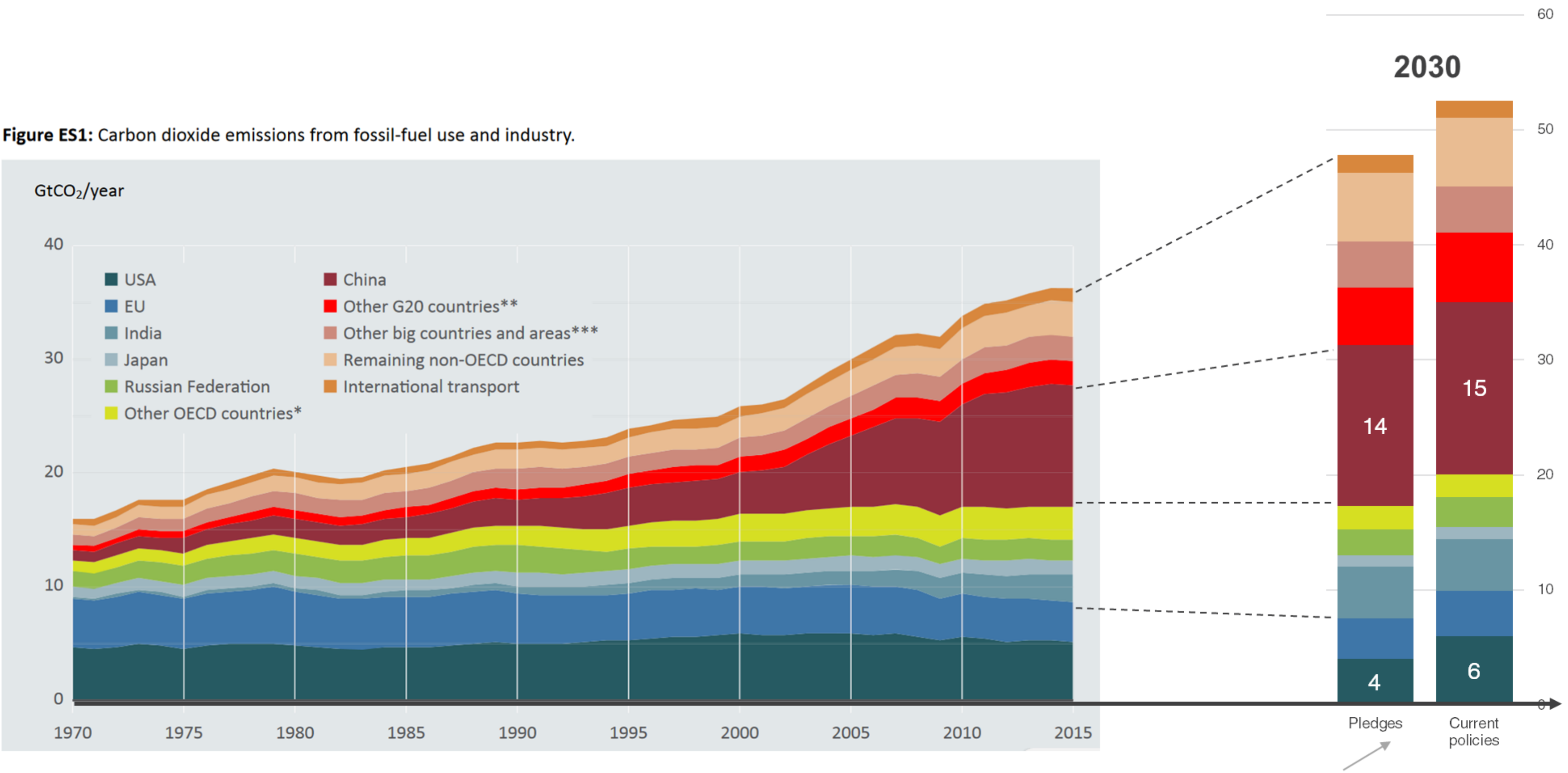


Reminder : current radiative forcing is mainly (but not solely) due to the combustion of fossil fuels

Source	Anthropogenic												Natural
Category	Emissions of green-house gases (GHGs) 2010 data World Bank / The Shift Project												Ex: Solar variance
GHG	CO_2		CH_4			N_2O			F-gases				
System 1. Energy 2. Agriculture and forestry 3. Other industry and waste	Fossil fuel combustion	Changes in land-use	Agriculture & animals	Waste management	Fossil fuel distribution leaks	Fossil fuels combustion	Industrial processes	Use of fertilizers	Industrial processes	Short Lived pollutants	Aerosols	Change in albedo due to land-use change	
Agriculture	0,7	5,0	3,1					1,9		✖		✖	
Industry (incl. Power)	12,3				2,8	0,3	0,1		1,0				
Building & Waste	8,2			1,3			0,4			✖		✖	
Transport	5,9									✖			
Total (MtCO2eq)	27,2	5,0	3,1	1,3	2,8	0,3	0,5	1,9	1,0				
Total (W/m²) IPCC	+1,68		+0,97			+0,17			+0,18	+0,18	-0,82	-0,15	0,05

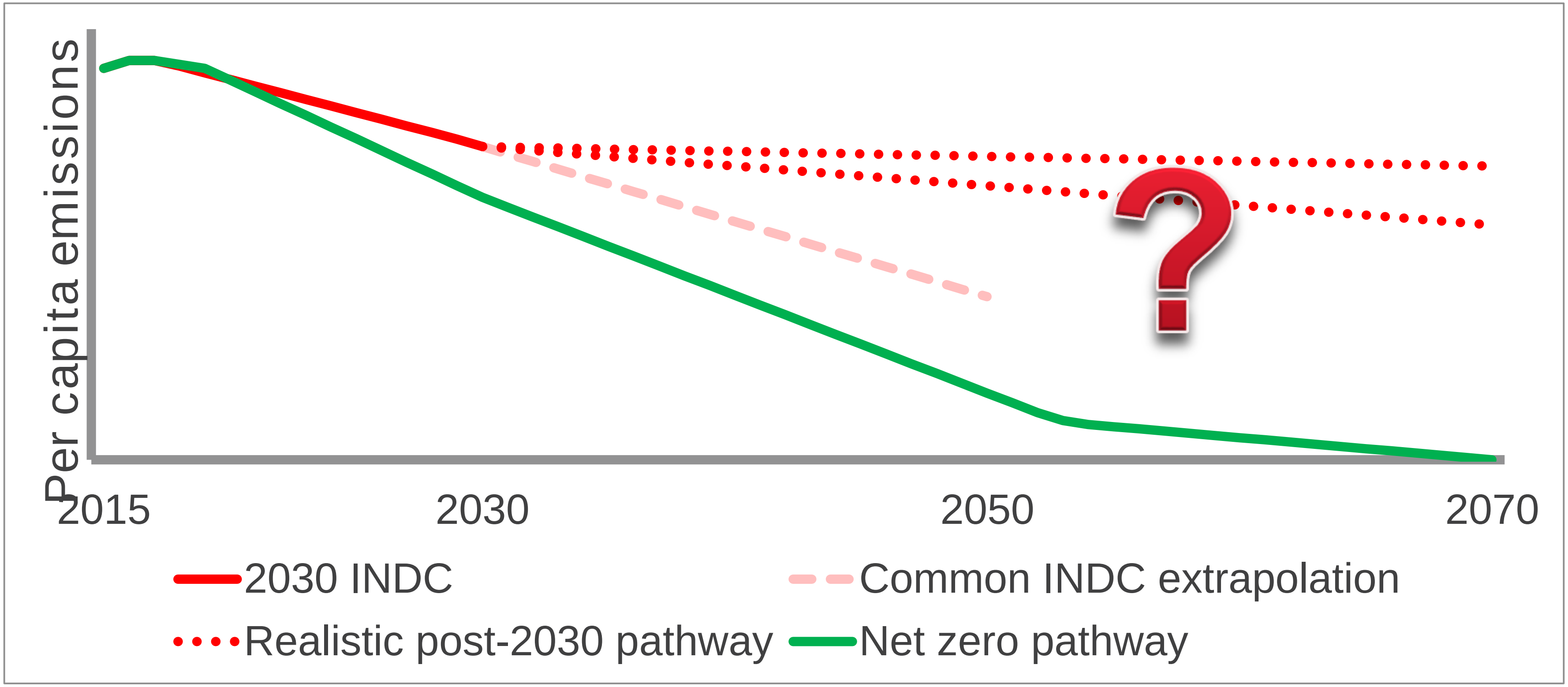
Current pledges (NDCs) and policies likely result in an increasing of annual emissions between now and 2030

Figure ES1: Carbon dioxide emissions from fossil-fuel use and industry.

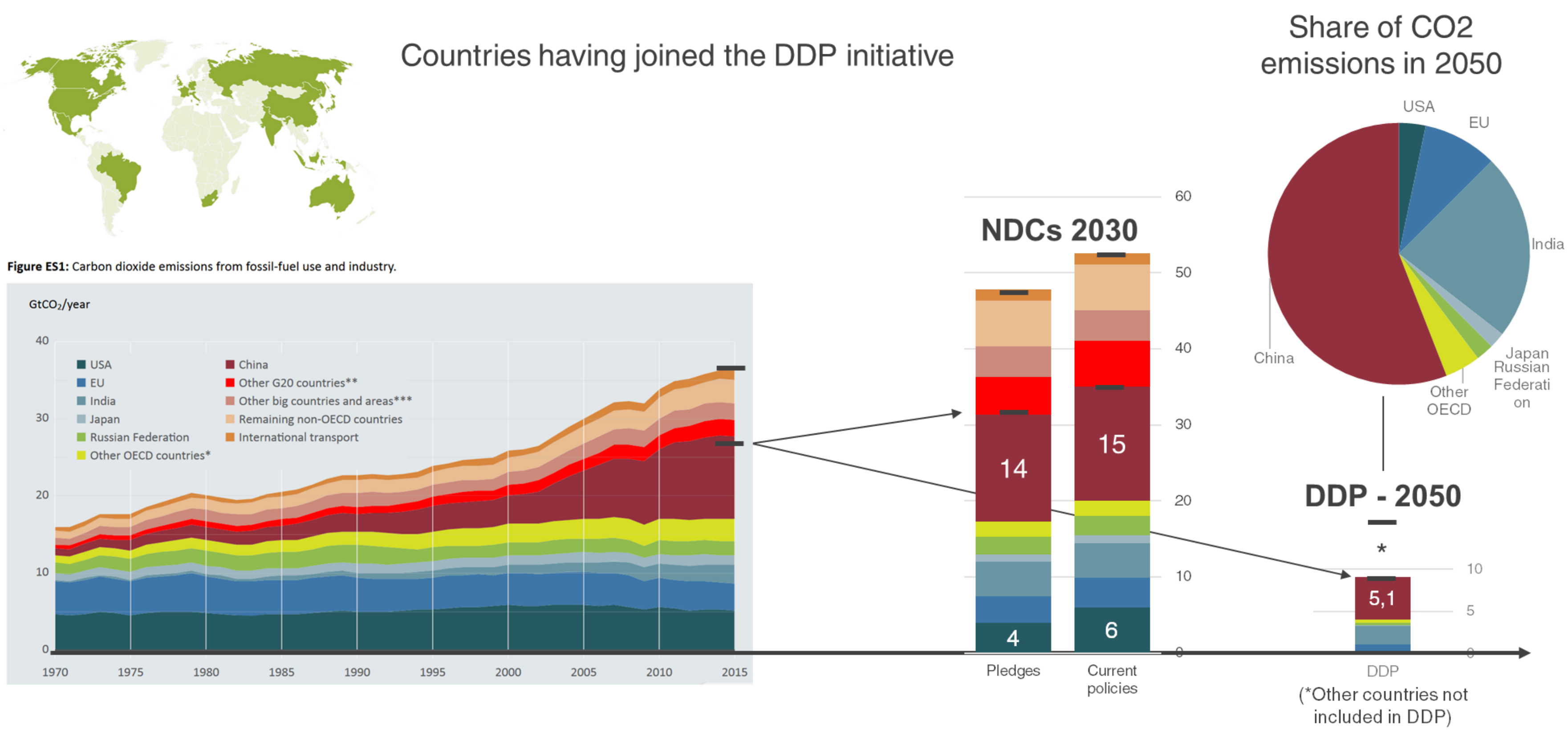


H. Hainaut, 2030 bars built from UNEP Gap report data

Are NDCs projections realistic when compared to a long-term, net-zero emissions pathway?



By 2050, major emitters should aim at a much stronger reduction of their annual emissions



Data from Deep Decarbonization Pathways Project (IDDRI)

Reminder 1
million, billion, trillion

x1000 x1000

10^6
Million
(mega)

10^9
Billion
(giga)

French:
Un milliard

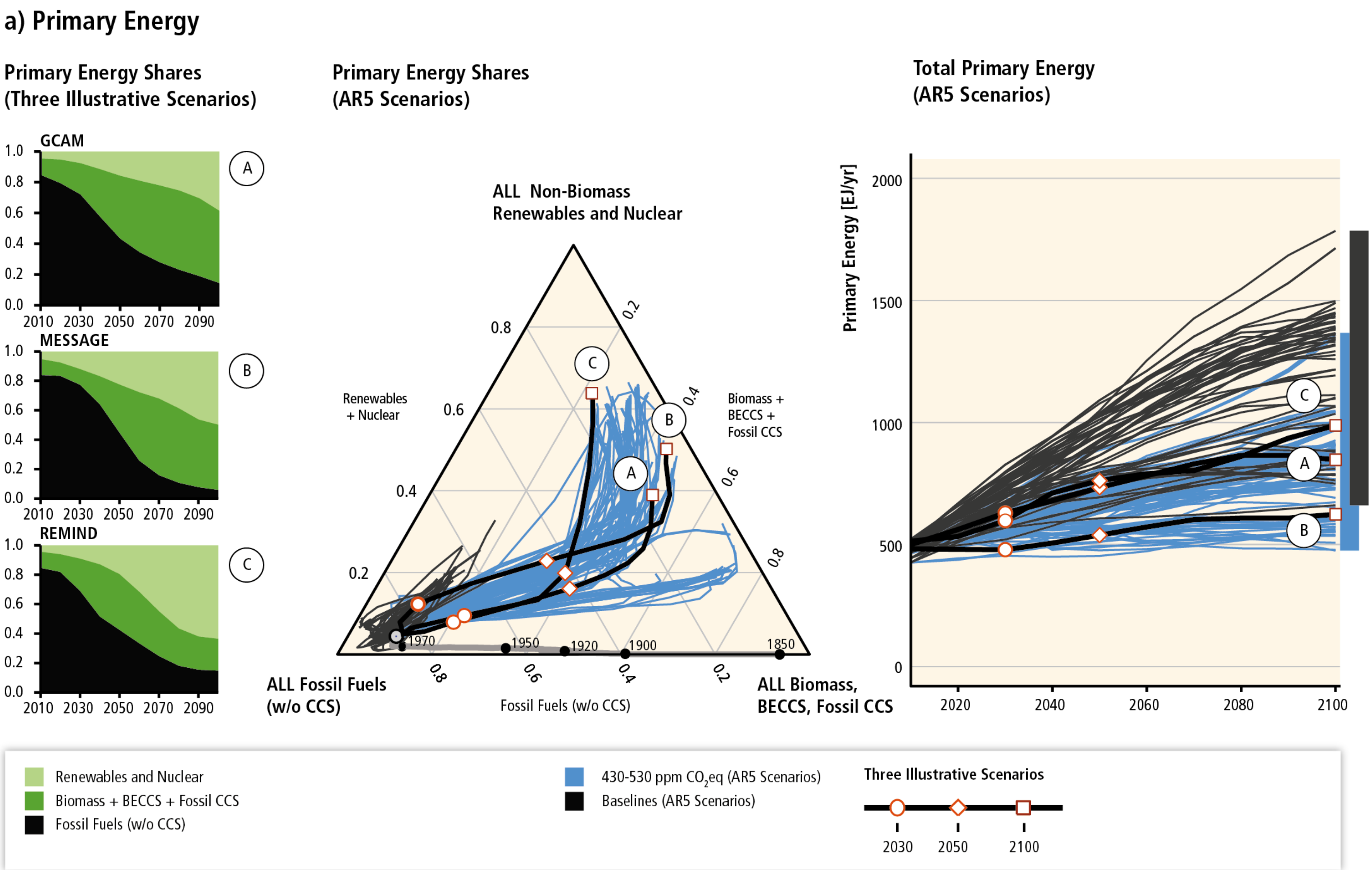
10^{12}
Trillion
(tera)

French:
Un billion

Total world GDP in 2015 = ~74 $ trillion (World Bank Data)

Of which ~47 $ trillion in high income (roughly OECD) countries

Reminder 2
different pathways can lead to the same objective

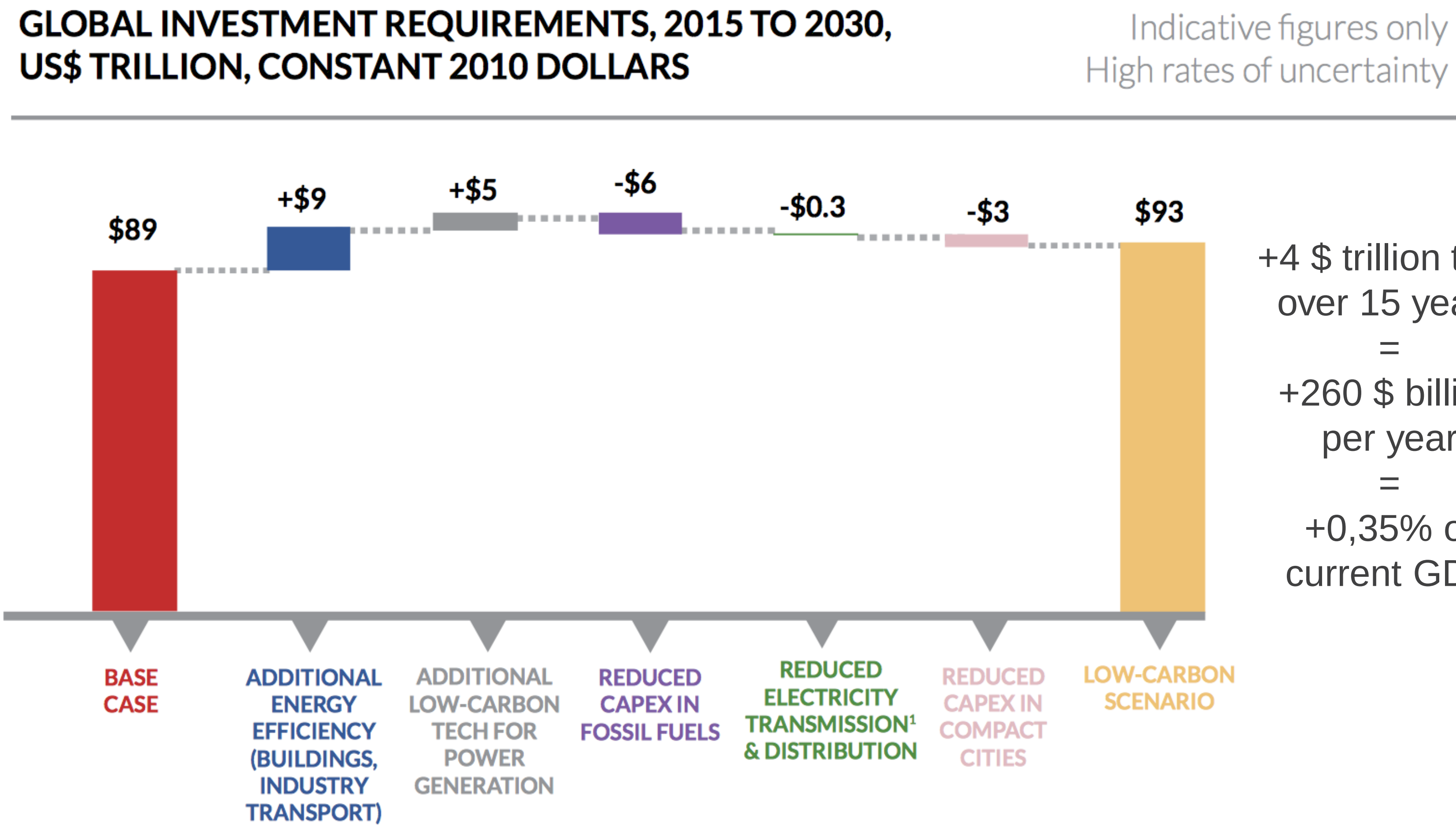


Sources: IPPC AR5 Working Group 3, Chapter 7

Reminder 2
and why is so?

- Models and projections typically are typically guided by a form of "least-costly option" taking into account constraints and opportunities.
- Constraints such as:
  - The remaining lifetime of existing infrastructure
  - The growing population and purchasing power of households
    - (and what exactly they are willing to buy)
  - The sheer acceptability of technologies such as nuclear, carbon capture
    - (reflected in the wide disagreement over their costs)
  - Reaching an exogenous climate objective (backcasting)
- Opportunities such as:
  - The rate at which the cost of renewable energy may decline
  - The potential for actual energy efficiency, taking into account a rebound effect
  - The market response to the introduction of carbon price(s)
  - The exogenous introduction of disruptive technologies
- Models also vary in their ability to represent complex drivers
  - Markets, policies, sectors, regions, behaviours

How much for a low-carbon economy? The New Climate Economy approach



+4 $ trillion total over 15 years
=
+260 $ billion per year
=
+0,35% of current GDP

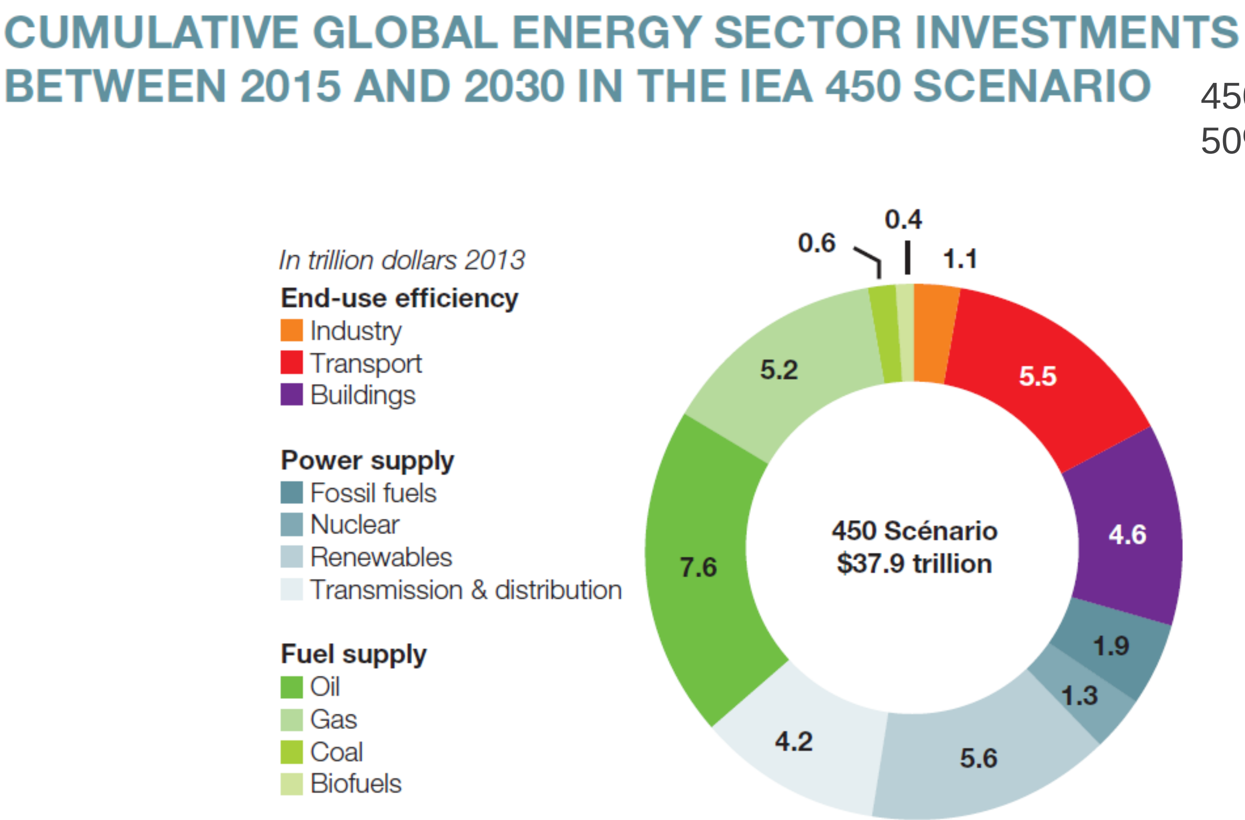
Sources: Canfin Grandjean Report, from New Climate Economy (2015)

The New Climate Economy approach
A structural transformation of the global economy

- $90 trillions needed in infrastructure between 2015 and 2030
  - To boost economic and social development
  - Equivalent to 1 year of global GDP in 15 years – or 1/15th each year
- $4 trillion additional investments for a low carbon scenario
  - Increase in:
    - Energy efficiency : buildings, transports, industry
    - Renewable energy generation
  - Decrease in:
    - Fossil fuels infrastructure
    - Transmission and distribution
    - Transport infrastructure in more compact cities
  - Infrastructure capital spend is 1% lower in low-carbon scenario
- Most of the shift from B.A.U. is to redirect investments
  - Redirect existing capital and financial flows towards low-carbon projects

From: H. Hainaut and C. Cristofari, *"Business As Unusual", Sciences*-Po, Spring Semester 2016

How much for a low-carbon economy? The IEA's approach



450ppm = stable climate
50% chance of <+2°C warming

Note: $37,9 trillion is only the energy sector

NCE (previous slide) also includes baseline transport infrastructure

Source: *International Energy Agency, June 2015*

The IEA's approach in WEO 450ppm : Shift from fossil fuels to efficiency and renewables

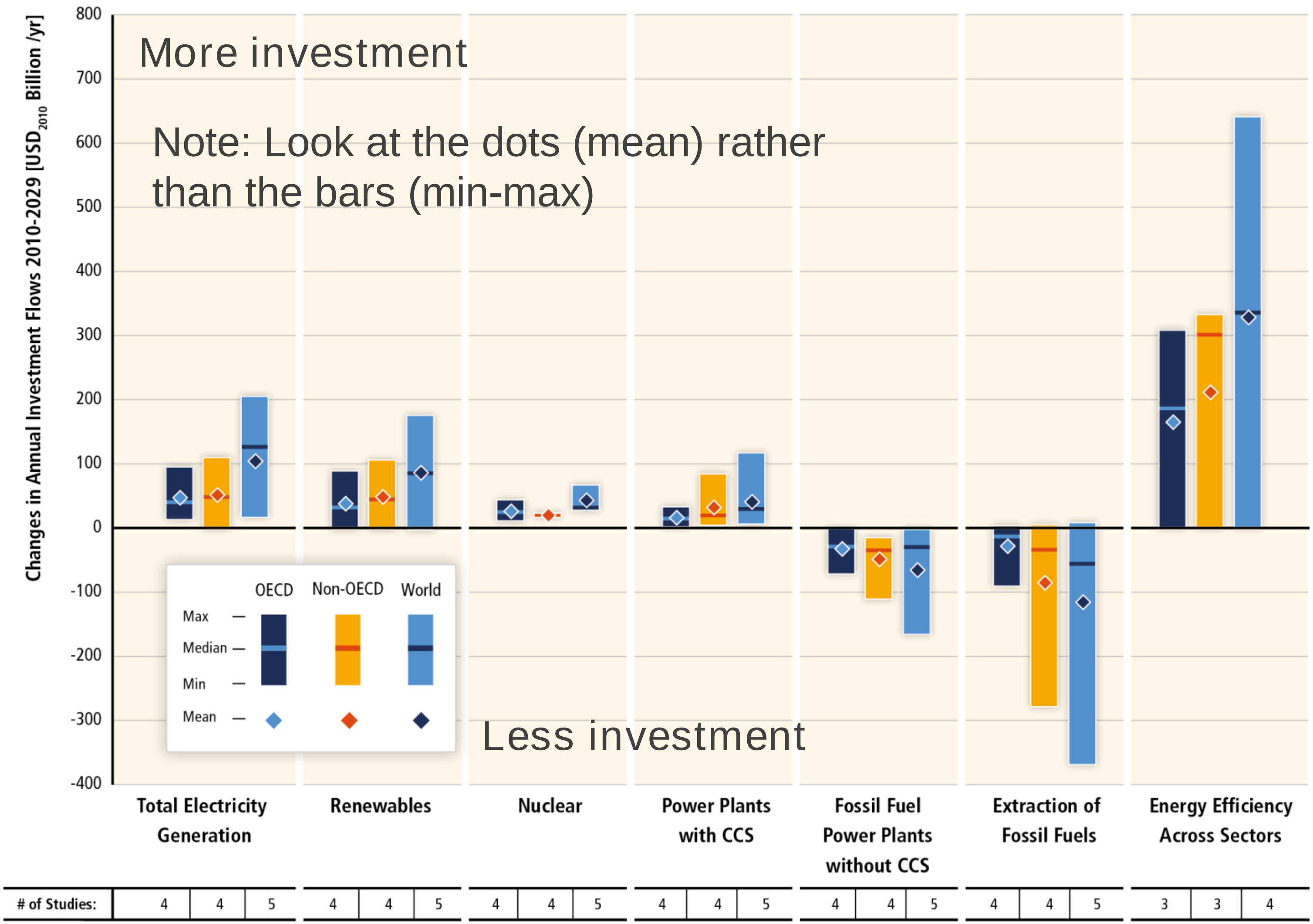
Cumulative global energy investment by type and scenario, 2016-2040

USD trillion per year	Historical 2011-2015*	Current policies	New policies including NDCs	450 ppm scenario 50% chance <+2°C
Fossil fuels	1,1	1,3 ↗	1,0 →	0,7 ↘ -30%
Renewables	0,3	0,2 →	0,3 →	0,5 ↗ +60%
Networks	0,2	0,3 →	0,3 →	0,3 →
Other (nuclear, CCS)	0,01	0,05 ↗ x5	0,05 ↗ x5	0,1 ↗ x10
Total supply	1,6	2,0	1,7	1,6
Energy efficiency**	0,2	0,6 ↗ x3	0,9 ↗ x4,5	1,4 ↗ x7
Total investment	1,8	2,6	2,6	3,0

Sources: World Energy Outlook 2016

* The methodology for energy efficiency investment derives from a baseline of efficiency levels in different end-use sectors in 2014, the annual figure for energy efficiency in this column is the figure only for 2015. ** Includes nuclear and CCS.

The IPCC's review of 4-5 existing studies: Major shift in both OECD and non-OECD countries



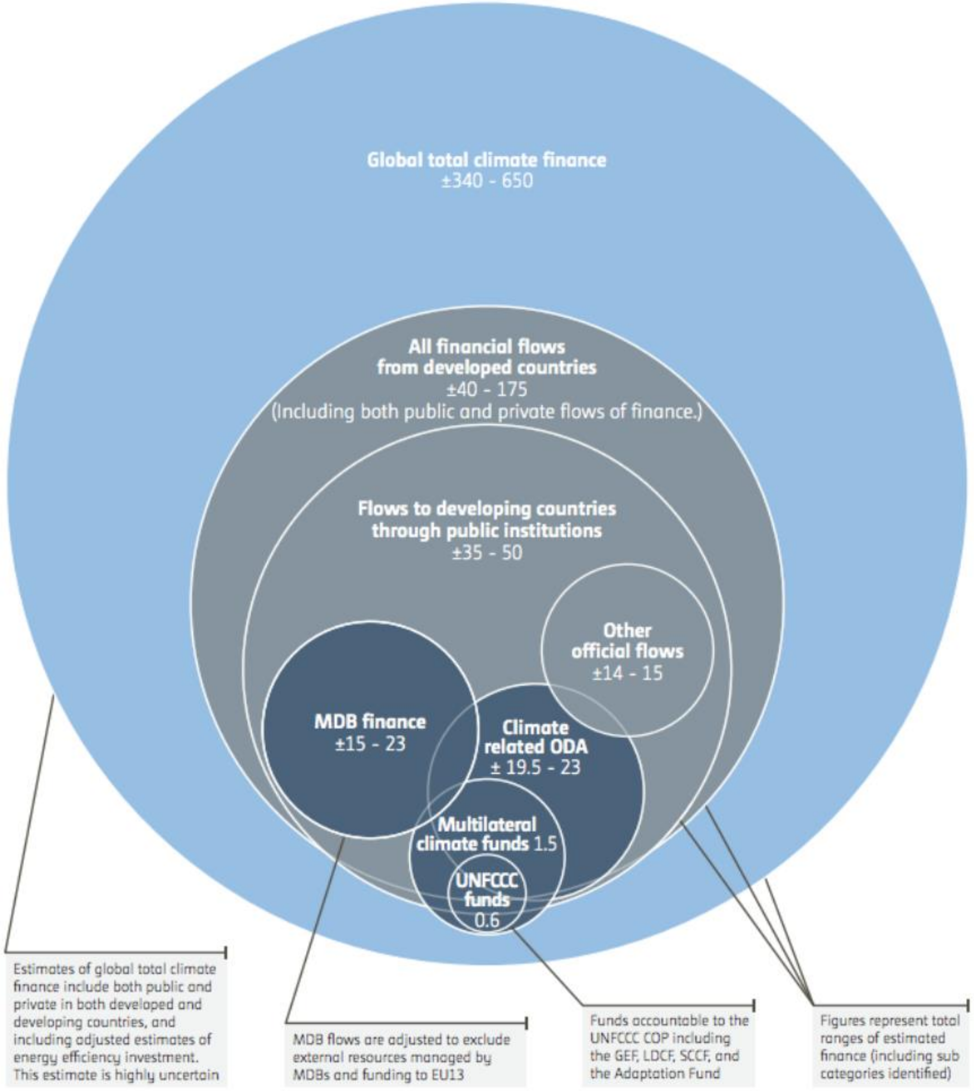
Sources: IPCC AR5 Working Group 3, Chapter 16

Kind reminder : be aware of the counting biaises !

- We often count and discuss:
  - Investment in the energy sector over transport, agriculture, land-use
  - Material capital
  - Spending on mitigating climate change
- We often forget to account for:
  - Innovation, research & development spending
  - Education and training
  - Spending on adaptation

Climate finance in 2015 : a few hundred billions
Limited flows from developed to developing countries

- Climate finance estimated between $340 and $650bn
  - Public and private sources
  - Inside and outside the UNFCCC obligations
- Private sector provides most of financial flows
  - Only $35-50bn public
  - 92% of total flows are private
- Limited finance from North to South countries
  - About 20% of all flows
  - Significant margin of uncertainty



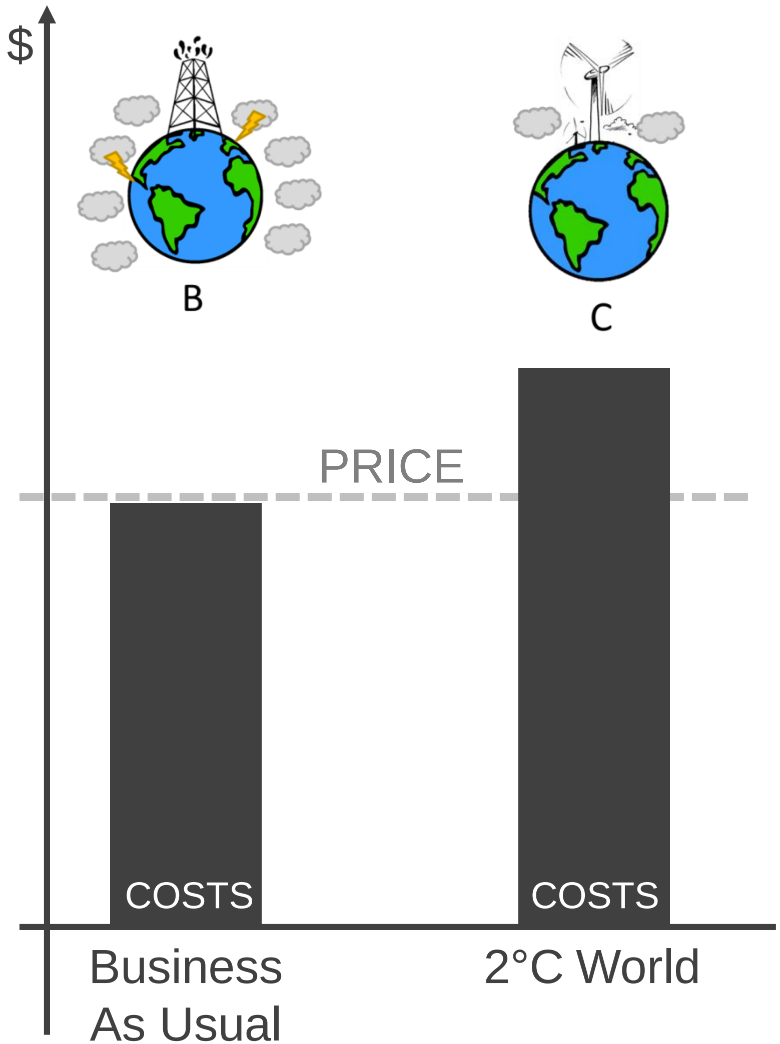
Standing Commitee on Finance, UNFCCC, 20

Warning : always look at the background of climate investment, costs or finance figures

- Geography
  - Which countries are covered?
  - What's the regional or country breakdown?
  - Are we talking figures within or between countries?
- Sectors
  - Energy sector only? CO2-only?
  - Is transport infrastructure included?
  - What about agriculture?
  - Reporting only investment on current climate projects?
- Institutions
  - Public only? State only?
- Timeframe
  - Current picture
  - Trends over recent years
  - Cumulative figure from now to 2030
  - Snapshot of the future (ex: in 2050)
- Accounting
  - Investment only or overall spending
  - Total GDP estimates
  - Comparison to baseline

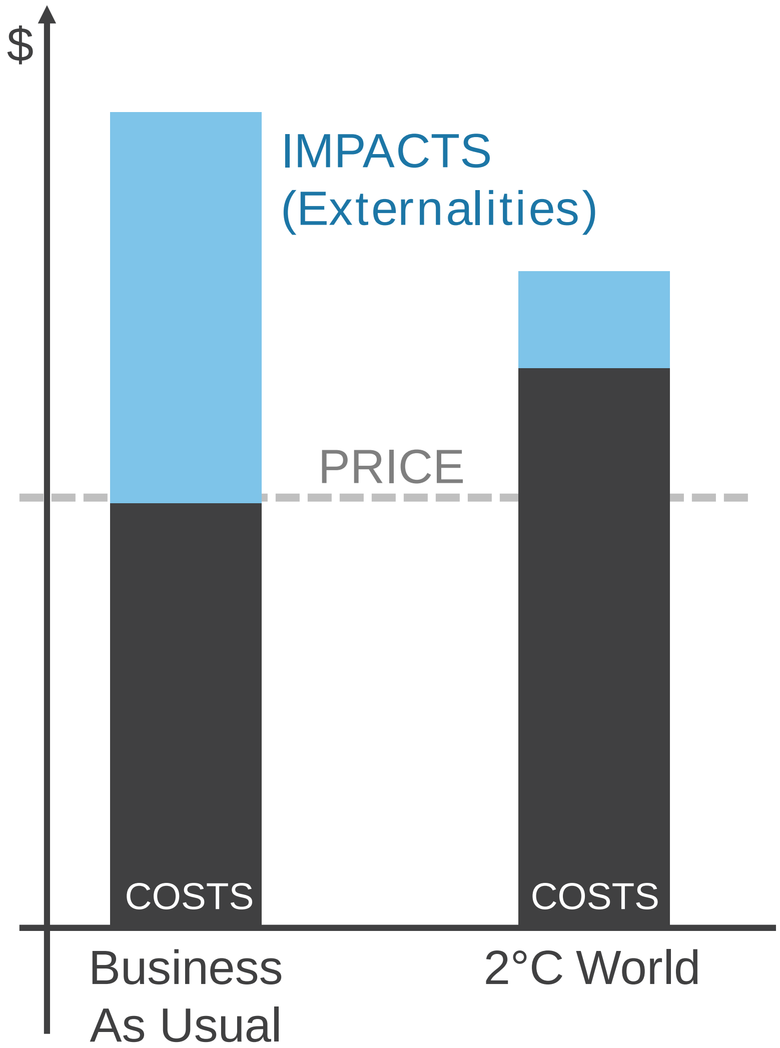
A project initiator's dilemma

A project initiator's dilemma



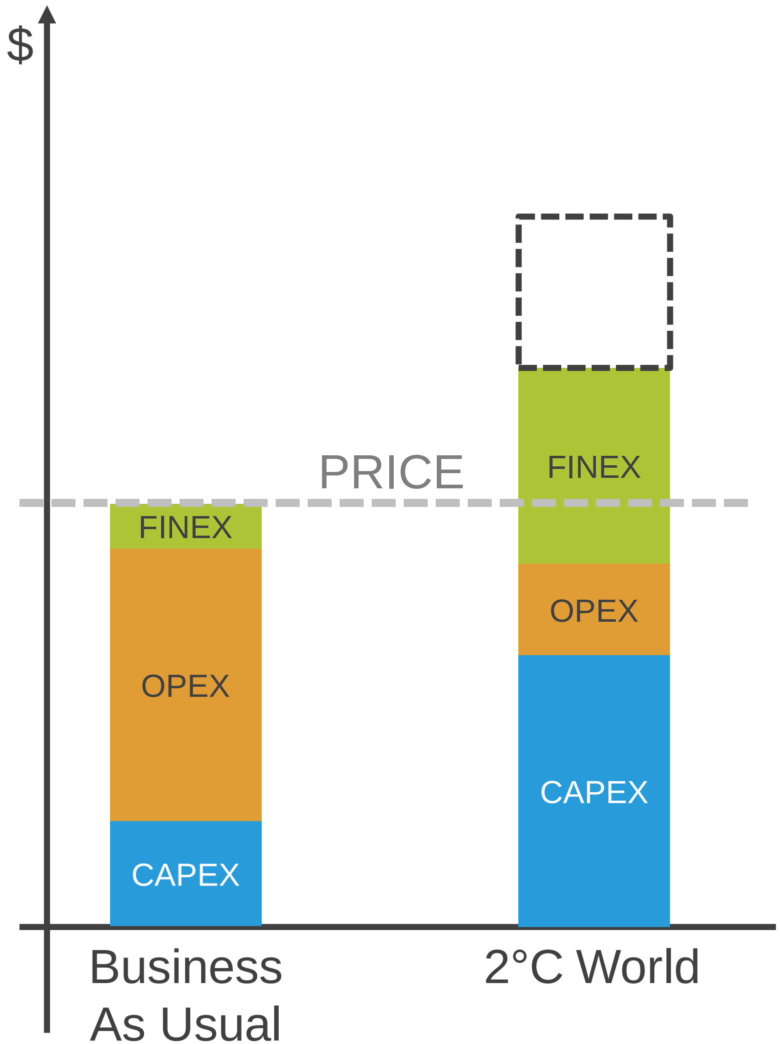
- Project initiators
  - Households
  - Companies providing goods and services
  - Utilities (providing energy, including electricity)
- What's the challenge?
  - For the project initiator, costs of a « 2°C compatible » solution are typically higher than « fossil » business as usual.
- So what?
  - In the absence of incentives, redirection won't occur

Why would we want to make project initiators pay more ?



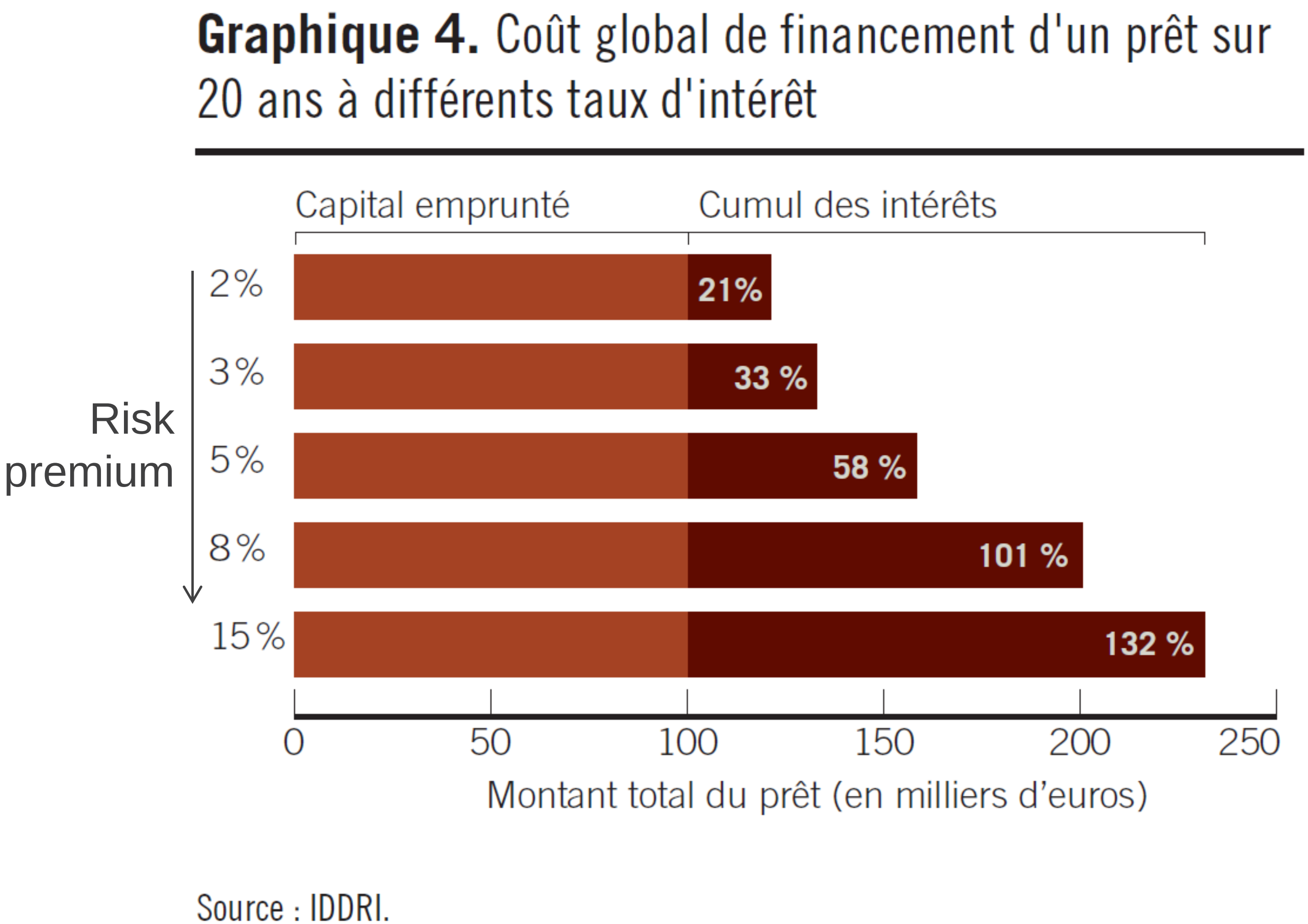
- In a business as usual world
  - Strong impacts are generated
  - They act as a negative externality
  - They are not priced
- In a 2°C world
  - Impacts are expected to be limited
  - Collective costs in a 2°C world are lower than in a BAU
    - (We are richer)

Why exactly are climate investment expensive ?

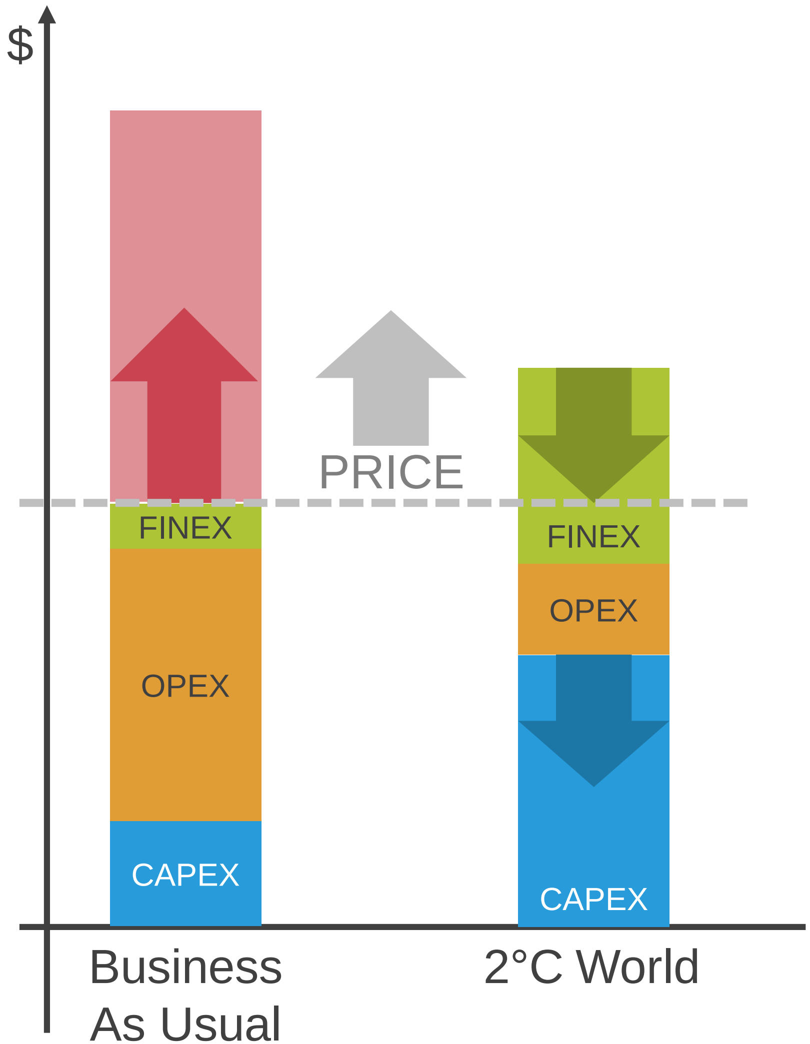


- In comparison with a typical BAU project
  - Upfront capital costs (CAPEX) are higher
  - Operation costs (OPEX, most notably fuel costs) are lower, because of energy efficiency or access to free renewable sources
  - Financial costs (FINEX) are higher as well, because of
    - Longer immobilization of capital
    - Risk premiums
- Some "invisible" costs
  - Access to information, to markets
  - Time allocated to decision-making
- Discounting rates

How risk premium can burden a project's total cost



Changing the terms of the dilemma



- Put a price on externalities
  - Carbon pricing
- Reduce capital costs
  - Technology development and deployment, scale economies
  - Innovation, productivity gains
  - Direct subsidies
- Reduce financial costs
  - De-risk projects
  - Provide adequate financial supply to new stream of projects
- Increase price to secure a tangible return

A framework to understand public intervention to finance a low-carbon, climate resilient economy

Financing the energy transition: some hard but helpful truths

- There is no « painless » financial instrument
  - Different instruments imply different burden-sharing (and opportunity sharing) between economic actors
  - Beyond economic optimization, many choices require some form of political alliance
- Households ultimately finance everything
  - Through different channels: taxes, savings, energy consumption, etc.
- There is no « one size fits all » instrument
  - Different sectors face different investment obstacles
  - Different countries have different approaches to financing their economies
- Public intervention is (almost) always required
  - State-funded subsidies are definitely not

What we mean by « financing the energy transition » Two sides of the same coin

	Provide affordable funds to low-carbon climate-resilient projects (construction)	Securing profits and returns for low-carbon climate-resilient projects (operation)
What for ?	To pay for the upfront capital cost of low-carbon projects and technologies	To pay for the operational expenses and constitute returns on capital invested
Issue for private investor ?	• Higher upfront capital costs • Overall low and late return on investment • Risky returns deter private investment	• Revenues are captured by competition from cheap fossil fuel technologies • Energy efficiency is unprofitable at low energy prices
Public intervention	• Subsidies for upfront capital costs • Concessional debt for low-interest rate / long-term borrowing • Risk management tools such as guarantees • Direct public investment where private funds won't go	• Additional revenues for projects with LCCR characteristics through fiscal incentives • Captive markets through norms • Raising the cost of fossil fuel alternatives through carbon price

Financial obstacles to low-carbon investment vary from sector to sector

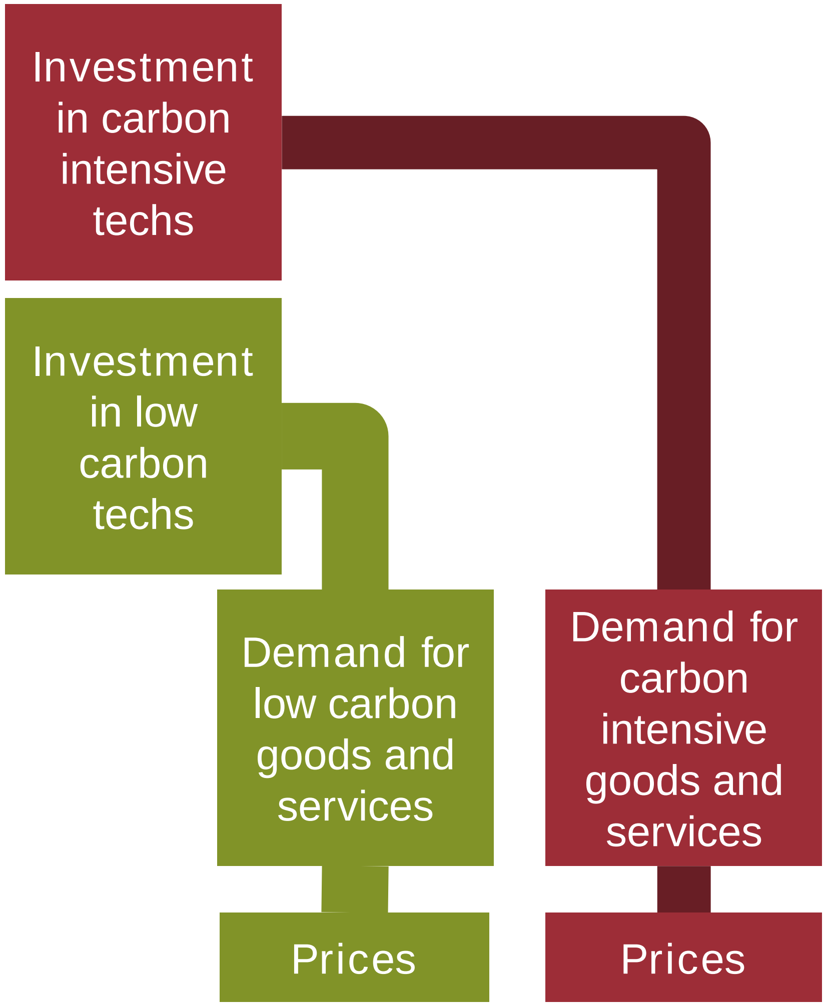
Building sector	Transport sector	Power sector
• Very long lifetime of current investments and high risk of lock-in • Ageing population of house owners, with decreasing incentives to invest • Strong practical constraints (vacancies) • Lack of predictable returns on energy efficiency projects • Lack of access to third-party financing (high reliance on own funds for works)	• What is the economic model for low-carbon transport in the long term? • How to create investment in low-carbon vehicles when there is no charge infrastructure (and vice-versa) • Very long capital immobilization, low returns on investment • Rapid change in the ownership structure of transport technologies	• Short-term electricity markets alone don't provide enough signal for long-term low-carbon investment • High cost of capital for low-carbon project because of policy/admin risks • Current big players (utilities) are accumulating financial difficulties and have to managed ageing infrastructure • Rapid change in the ownership structure of power generation capacities
In common: Capital intensive projects / Uncertainties over economic model / Bad or delayed market signals / Imperfect or irrational decision making process		

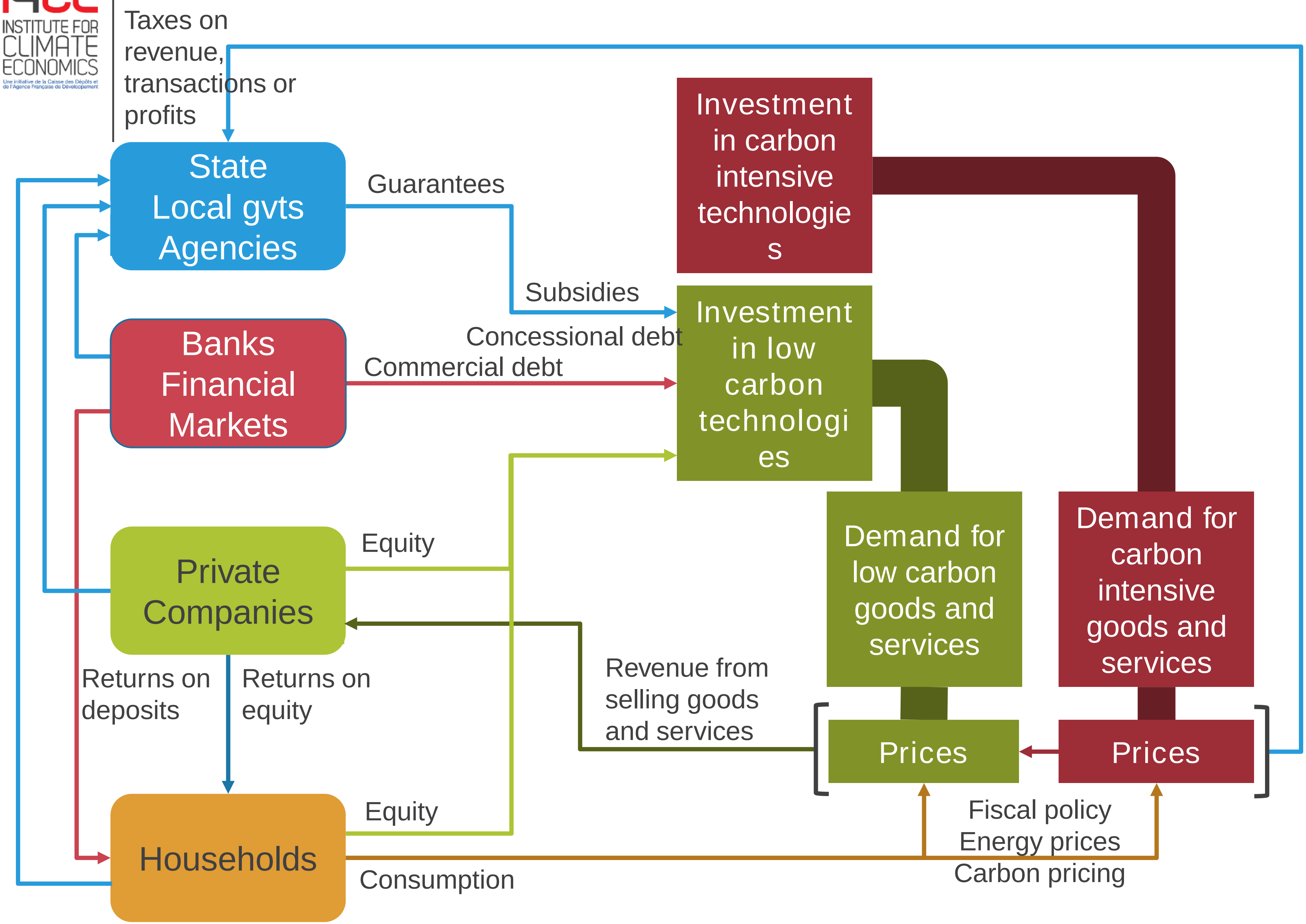
State
Local gvts
Agencies

Banks
Financial
Markets

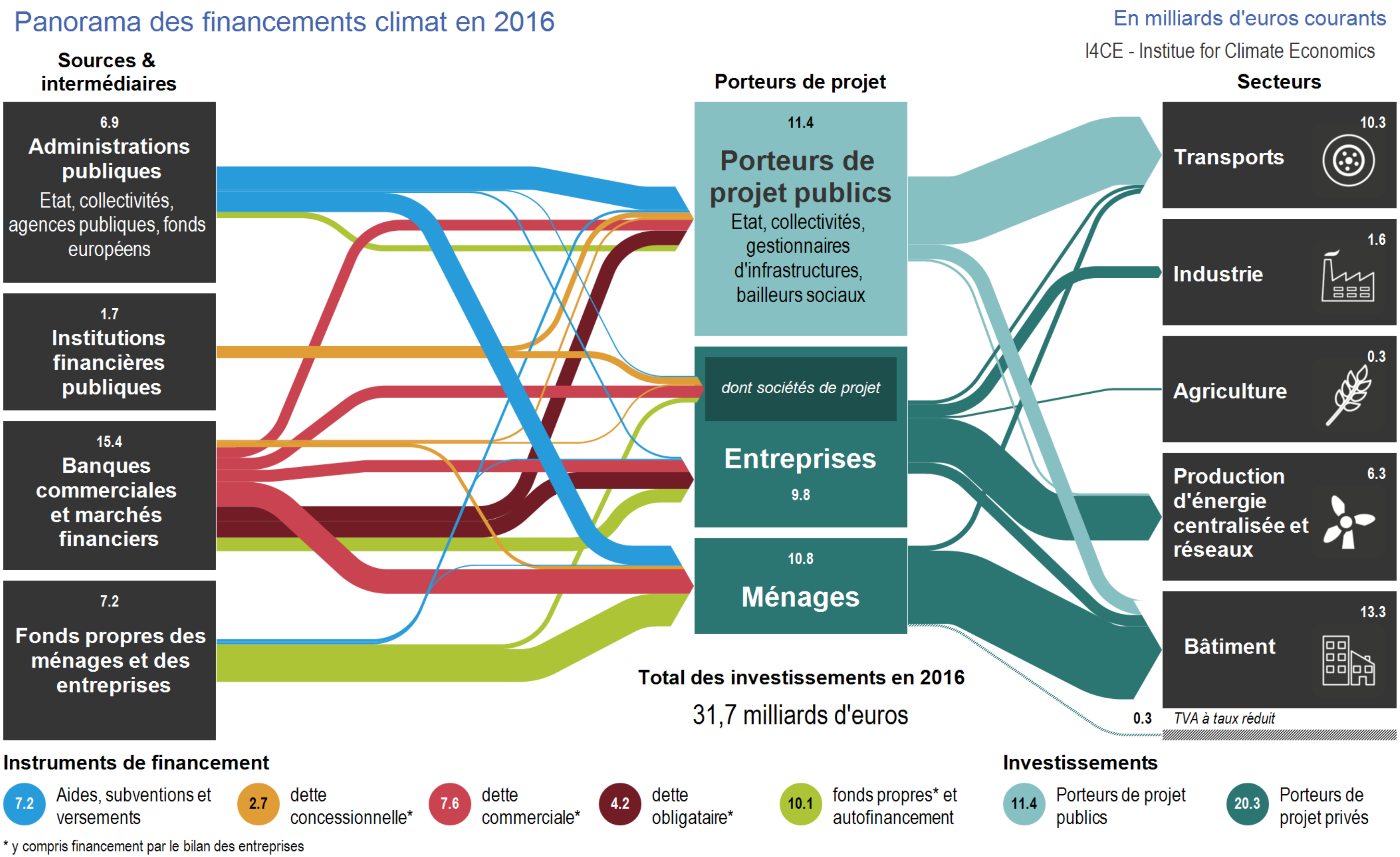
Private
Companies

Households




Taxes on revenue, transactions or profits
State
Local gvts
Agencies
Guarantees
Subsidies
Concessional debt
Commercial debt
Banks
Financial
Markets
Investment in carbon intensive technologies
Investment in low carbon technologies
Equity
Private Companies
Returns on deposits
Returns on equity
Revenue from selling goods and services
Demand for low carbon goods and services
Demand for carbon intensive goods and services
Prices
Prices
Equity
Households
Consumption
Fiscal policy
Energy prices
Carbon pricing

I4CE research work : Landscape of climate finance in France in 2016



Public instruments and interventions can target different obstacles for project developers

Economic Instruments		Non-economic instruments
Project Economic Model Instruments that make LCCR projects profitable or accessible to project initiators	**Financial Value Chain** Mobilizing capital sources to finance investment in LCCR projects	Knowledge Communication Technology
• Carbon pricing tools: taxes and markets • Energy efficiency demand • Renewable energy supporting tools • Sectorial energy efficiency standards	• Concessional debt targeted towards low-carbon projects • Direct subsidies for energy efficiency in households • Green bonds attracting institutional investors • Recycling of carbon revenues	• Improve communication between financing institutions • Demonstrate technical feasibility of innovative processes (R&D) • Knowledge sharing or improving over key transition topics

LCCR= Low carbon, climate resilient : includes mitigation and adaptation

Instruments : project economic model

Project Economic Model

Instruments that make LCCR projects profitable or accessible to project initiators

- Carbon pricing
  - Eg: Carbon taxes and emission trading systems (markets)
- Energy efficiency demand support
  - Eg: White certificates
- Renewable energy generation support
  - Feed-in tariffs, feed-in premia, auctions
- Sectorial energy efficiency standards
  - Building standards, vehicle emissions standards
- Payment for ecosystemic services
  - Agriculture, forestry

Instruments : financial value chain

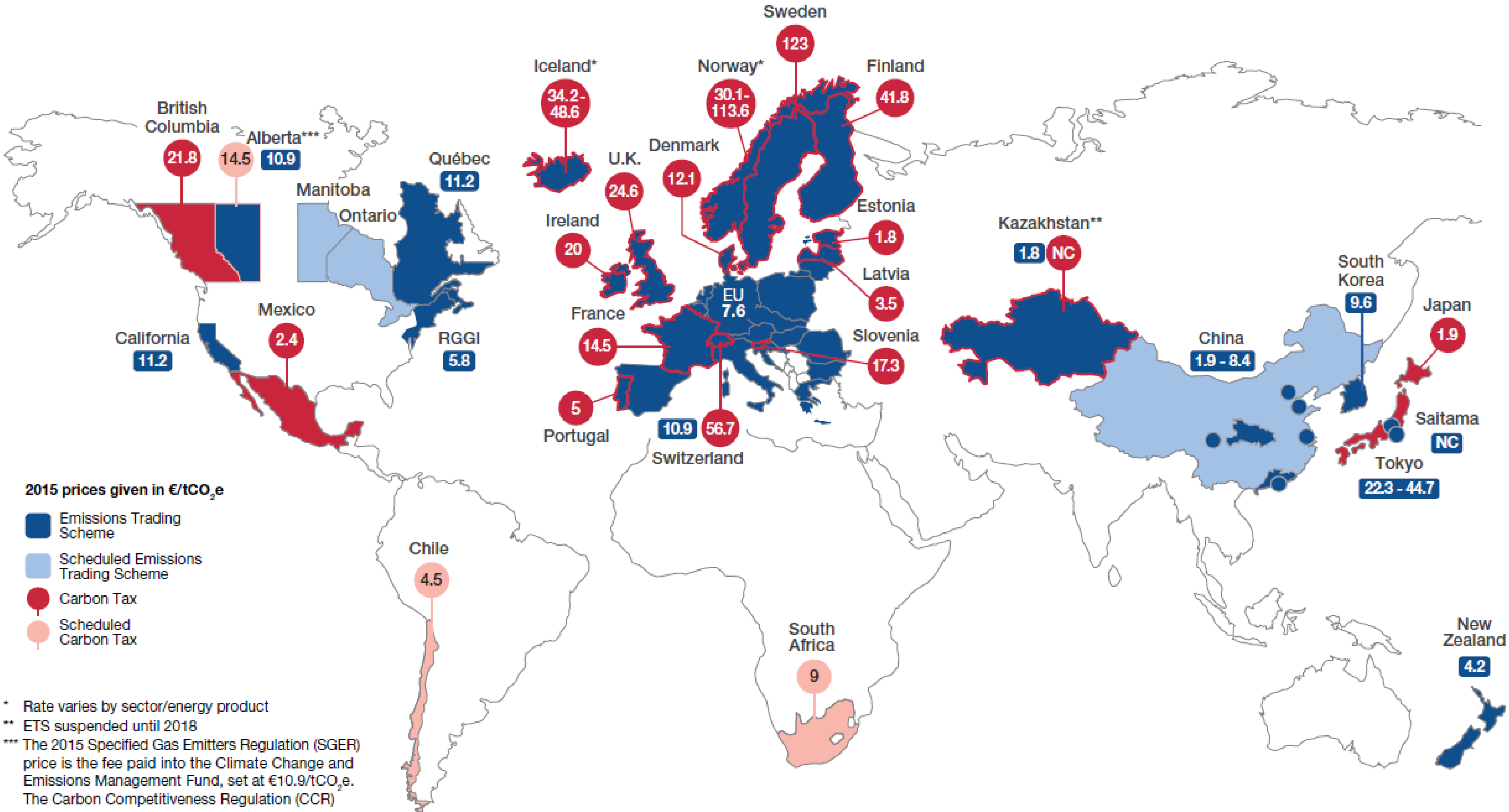
Financial Value Chain

Mobilizing capital sources to finance investment in LCCR projects

- Mobilizing capital sources
  - Recycling / earmarking of carbon revenues
- Support investment in LCCR projects
  - Concessional debt towards renewable energy generation projects
  - Direct subsidies to households for energy efficiency or renewable energy investments
- Combine instruments and intermediaries
  - Public-private partnerships on sustainable infrastructure
  - Guarantees on debt in energy efficiency projects
  - Third party financing of public building's energy efficiency

Public-driven finance for a low-carbon economy

Carbon pricing world map (2016)



* Rate varies by sector/energy product

** ETS suspended until 2018

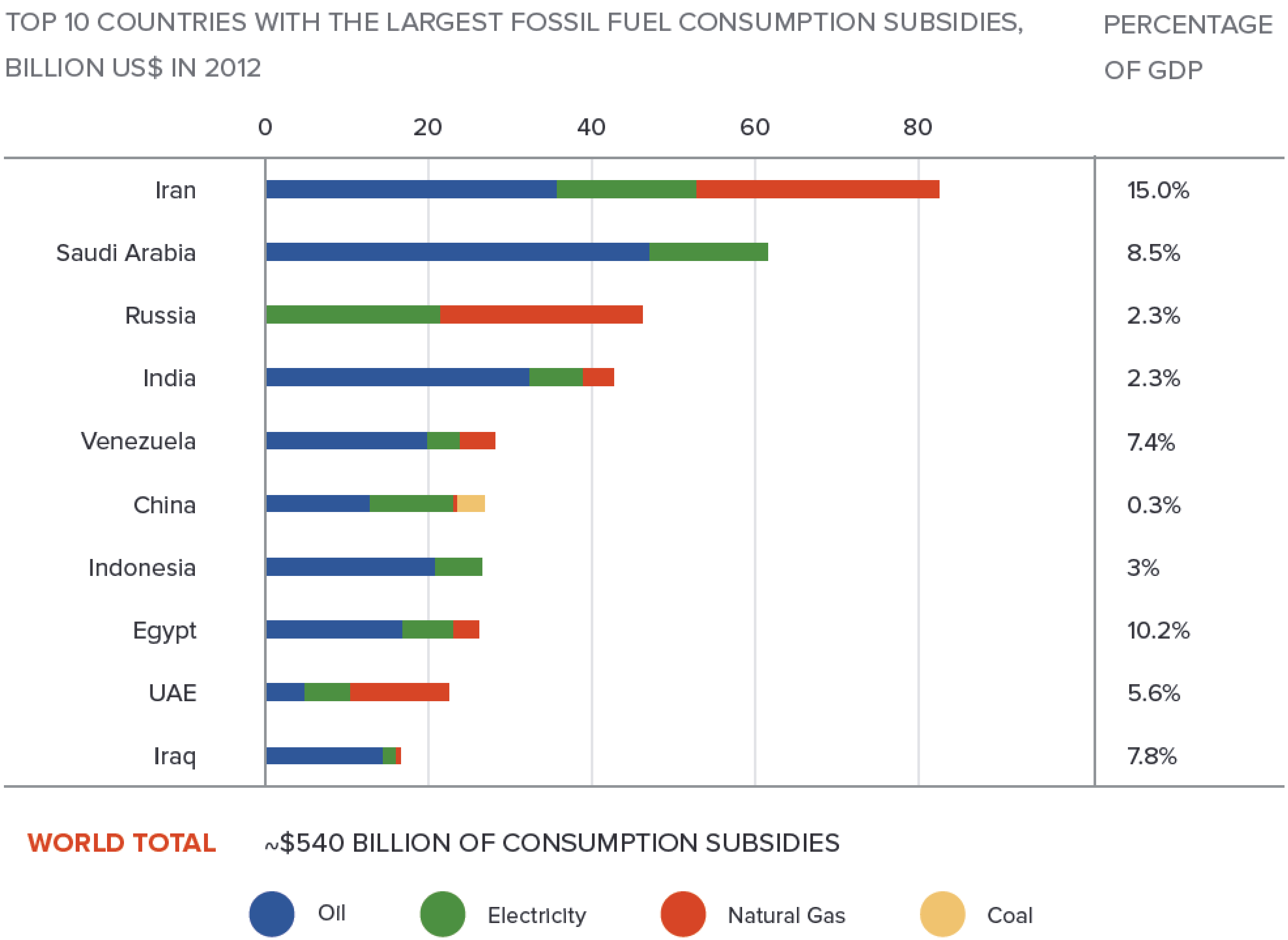
*** The 2015 Specified Gas Emitters Regulation (SGER) price is the fee paid into the Climate Change and Emissions Management Fund, set at €10.9/tCO_2e. The Carbon Competitiveness Regulation (CCR) will replace the SGER in 2018, at which point, an economy-wide carbon price of €21.8/tCO_2e will be set

China ETS pilots: Beijing, Chongqing, Guangdong, Hubei, Shanghai, Shenzhen and Tianjin

RGGI: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, Vermont

Source: I4CE (2016)

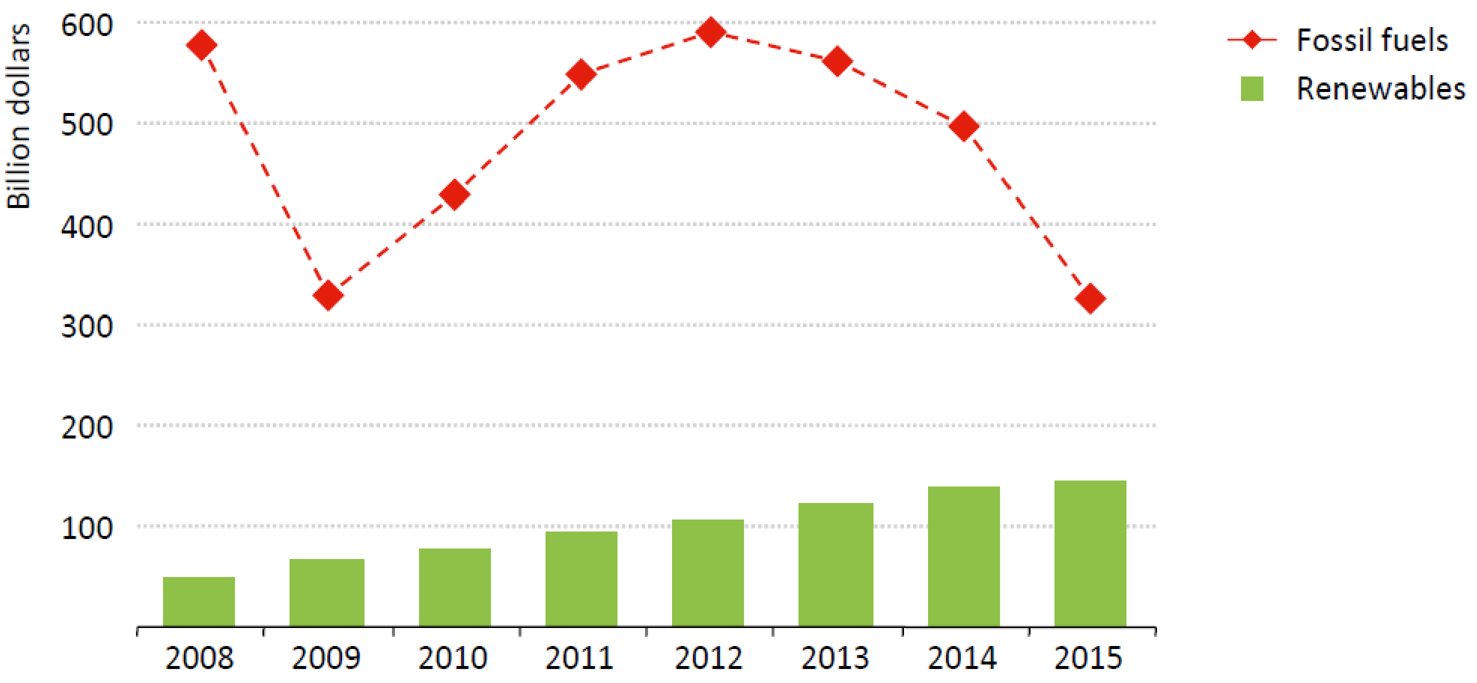
Fossil fuel subsidies: A negative carbon price?



Source: New Climate Economy Report (2015)

Fossil fuel subsidies: A negative carbon price?

Figure 2.21 ▻ **Estimates for global fossil-fuel consumption subsidies and subsidies for renewables**



The drop in fossil-fuel prices and in the value of subsidies has raised prospects for reform; the fall in technology costs has boosted the effectiveness of subsidies for renewables

Key messages from part II

- Shifting towards low-carbon and climate-resilient development pathways poses a formidable economic challenge
- While profitable in the long run and at the collective level, low-carbon investment is hindered at the project level through multiple market and non-market obstalces
- Financing the shift requires changing the terms of the dilemma as well as creating opportunities for projects to raise affordable capital
  - No painless financial instruments
  - All flows link back to households
  - No unique economic tool – national and sectoral circumstances vary
  - Some form of public intervention always required