CIRCLE

Costs of Inaction and Resource scarcity: Consequences for Long-term Economic growth

From cost of control to cost of inaction: Overview of the CIRCLE project

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BETTER POLICIES FOR BETTER LIVES

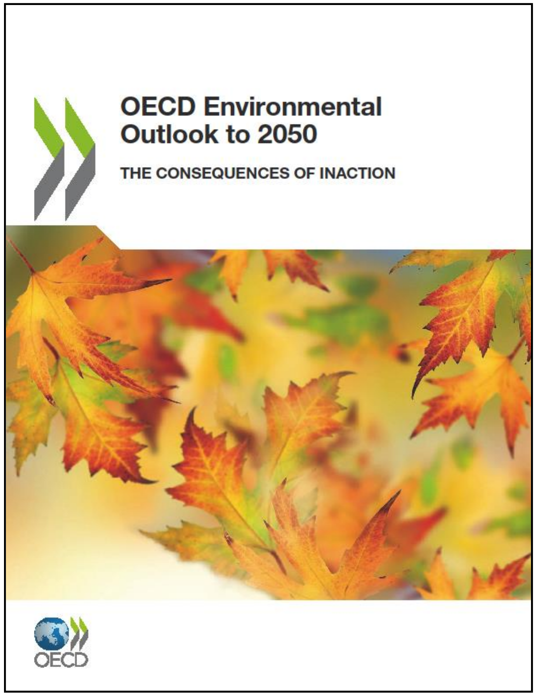
OUTLINES

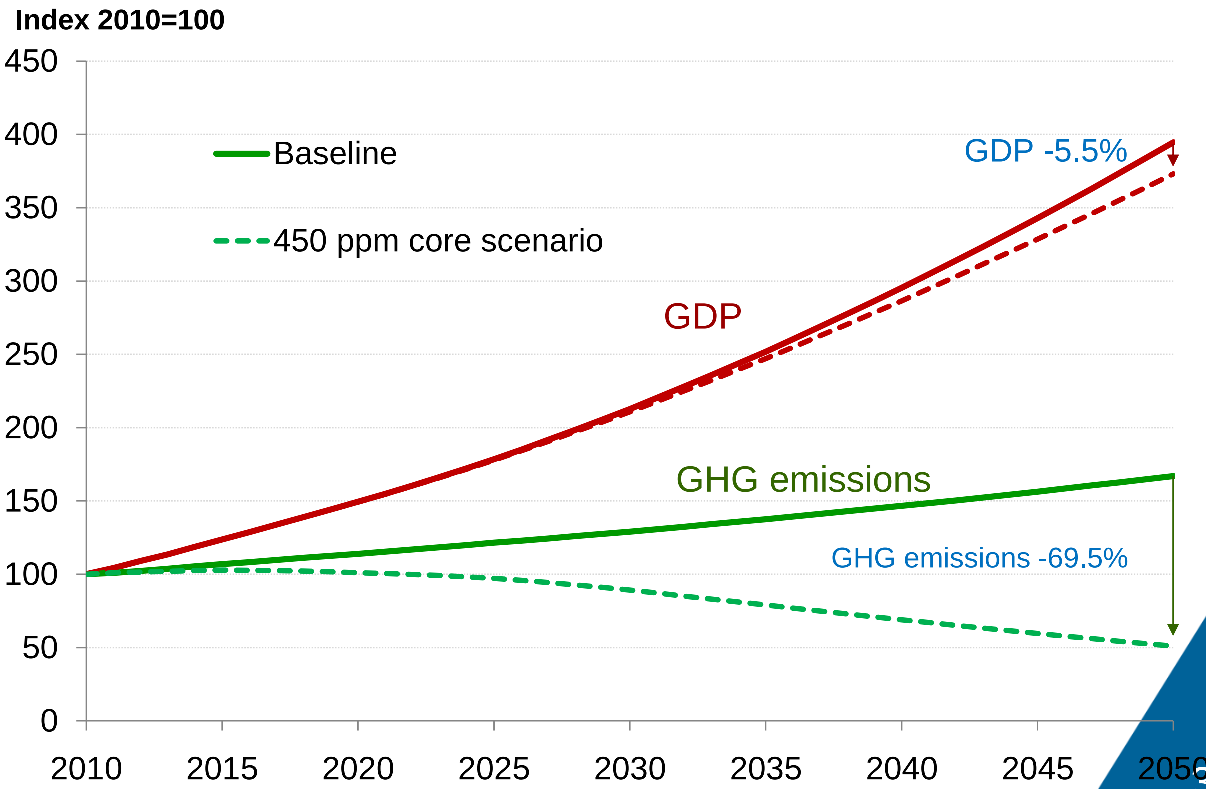
1	Introduction to CIRCLE
2	Economic consequences of Climate Change
3	Economic cost of air pollution
4	Elements on water scarcity for power generation
5	Discussion

Environmental outlook to 2050

-Regional & sectoral GHG mitigation costs: impact on GDP, sectoral value added, real income

-Assessment with Computable General Equilibrium model (CGE) allows to account wide rage of reallocation mechanisms, input substitution, sectoral reallocation, change in international trade…



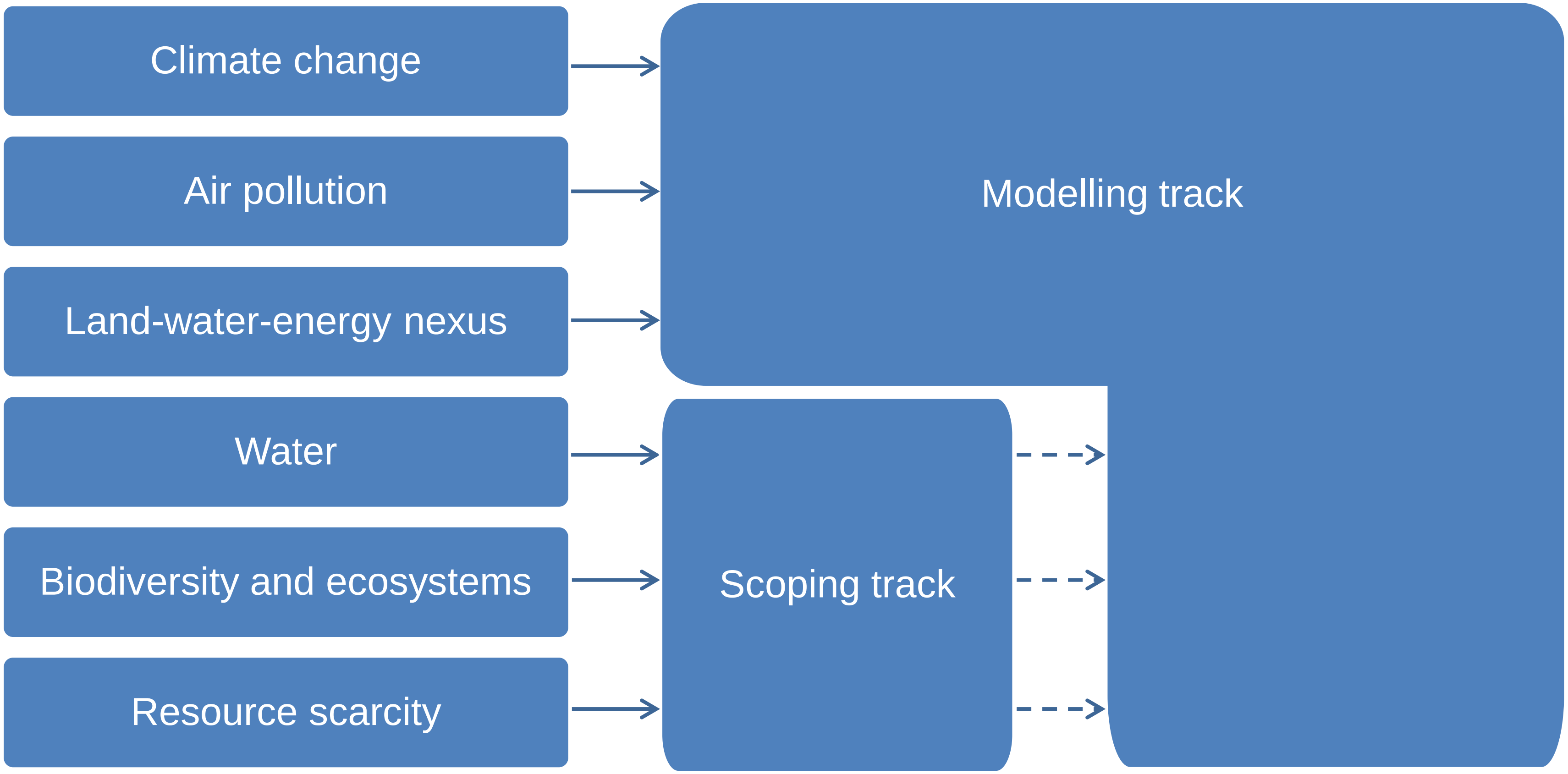


CIRCLE project

- **CIRCLE project** : **C**osts of **I**naction and **R**esource scarcity: **C**onsequences for **L**ong-term **E**conomic growth

- Aims to include the **feedback of environnemental damages on economic growth**
  - Regional and sectorial costs of inaction assess with CGE, based on collaboration with several expert groups
  - Use GDP as key indicator of economic growth
  - Qualitative assessment to complete the picture
  - Wide collection of damages are considered: climate change, land and water scarcity, air pollution

CIRCLE project themes and tracks



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Introduction

- Aim: assess the economic consequences of climate change
- Until 2060, multi-sector, multi-region General Equilibrium production function approach: climate change affects drivers of growth
- After 2060, stylised Integrated Assessment Model approach
- Collaboration with several expert groups, incl. FEEM, CERE, NIES

Selected impacts of climate change

Included in the modelling

- Agriculture: yield changes for 8 crop sectors, and fisheries
- Coastal zones: capital and land losses due to sea level rise
- Health: diseases and labour productivity losses from heat stress
- Energy demand
- Tourism demand
- Capital damages from hurricanes

Stand-alone analysis

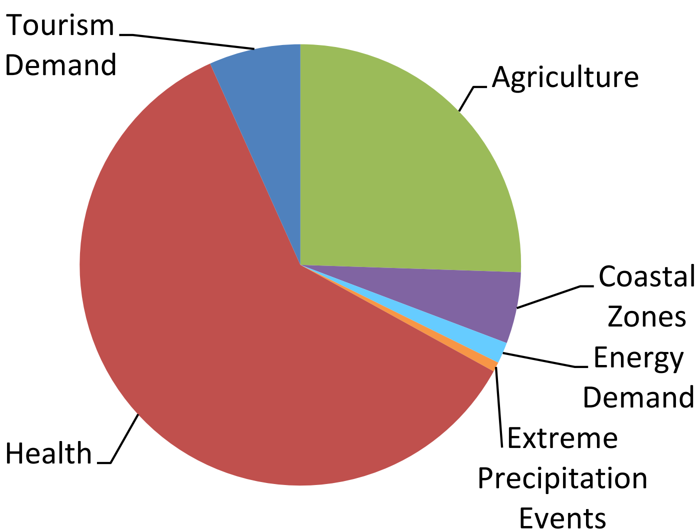
- Fatalities from heatwaves
- Urban damages from river floods
- Ecosystems: biodiversity (crude approximation)

Still not quantified

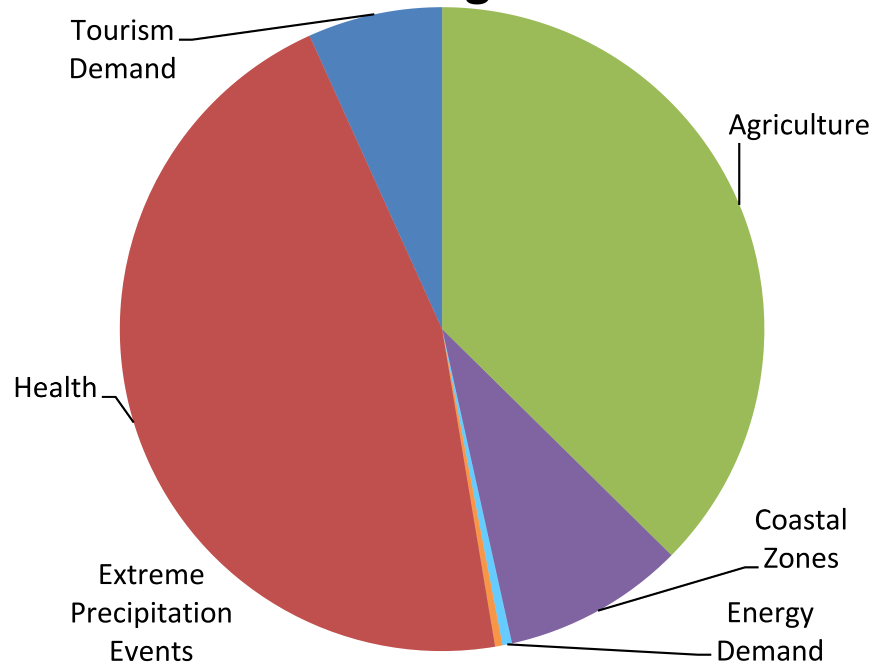
- Large-scale disruptive events, …

Global importance of different impacts

Global damages 2035



Global damages 2060



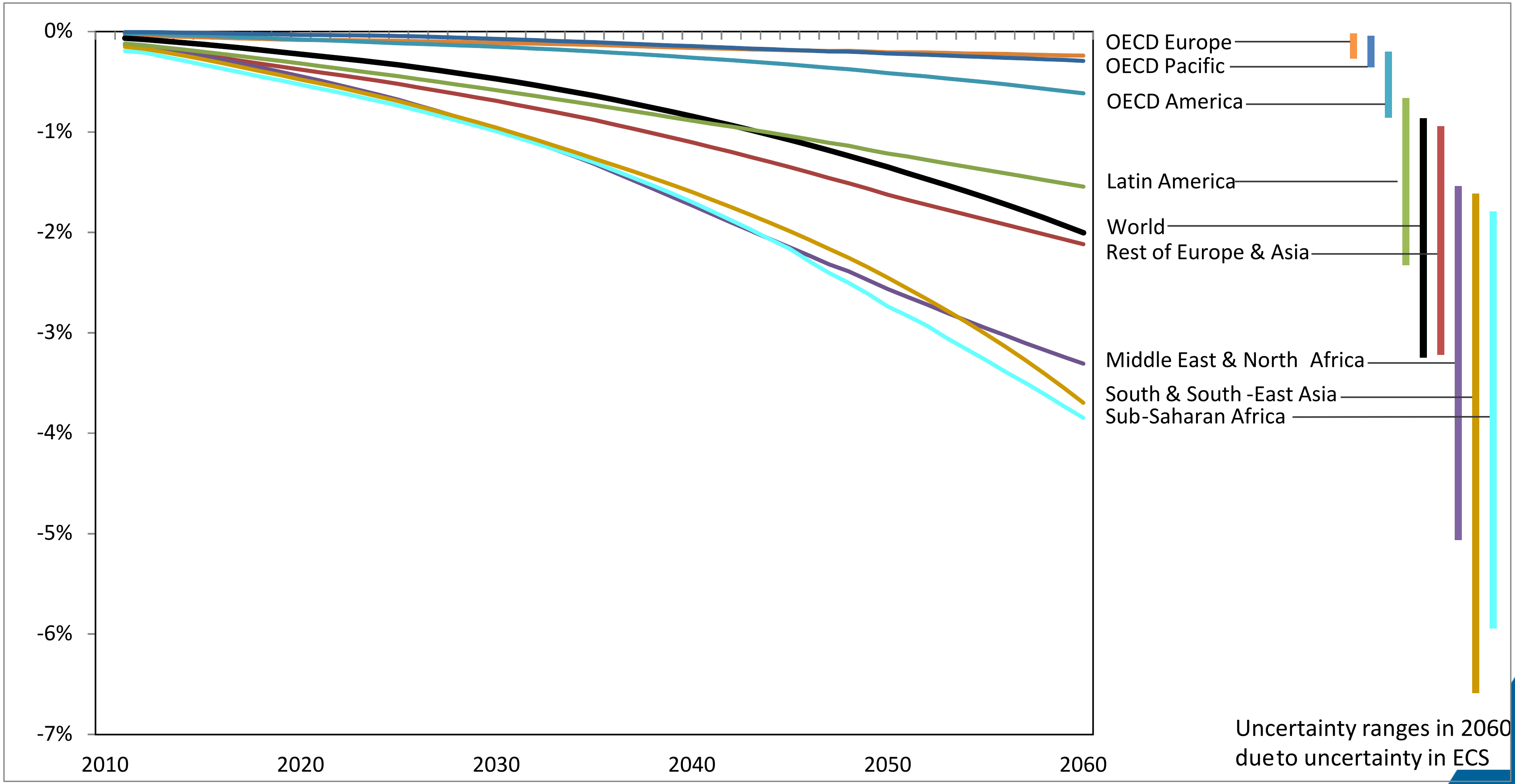
Global GDP loss:

0.3-1.0%

1.0-3.3%

Source: ENV-Linkages calculations

Regional cost of selected climate impacts



Source: ENV-Linkages calculations

Main messages (I)

1. Almost all regions significant negative market and non-market impacts, plus downside risks
   – Global GDP cost 1.0-3.3% by 2060, 2-10% by 2100
   – Largest losses in Africa and Asia
   – Largest losses from health and agricultural impacts
   – Largest losses to capital and labour
   – Costs increase more than proportionately with temperature
2. Losses spread across economies
   – All sectors and regions are indirectly affected
3. Consequences are unavoidable and enduring
   – Emissions commit the world to long-lasting impacts

Main messages (II)

4. Ambitious adaptation and mitigation can reduce future impacts and limit risks
   - Ambitious policies can reduce macroeconomic costs by 2100 from 2-10% to 1-3%
   - Adaptation is important to ensure consequences of climate change remain limited
   - Ambitious global mitigation can help avoid half of the economic consequences and limit downside risks
   - Distribution of policy costs and benefits across regions and sectors will not be proportional (but both imply a shift towards more services)

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Local air pollution in CIRCLE: methodology

1. **Projections Of Air Pollutant Emissions**

↓

2. **Concentrations Of Air Pollutants**

↓

3. **Impacts on Human Health**
   (Hospital admissions, sick days, premature deaths…)

↓

4. VALUATION

Market Impacts
- *health expenditures*
- *labour productivity*

Non-Market Impacts
- *value of lives lost, using VSL*
- *costs of pain and suffering*

5. Macroeconomic Impacts Of Air Pollution

(In ENV-Linkages)

5. Welfare Impacts Of Air Pollution

(Separately)

OUTLINES

Water for Energy

Power generation

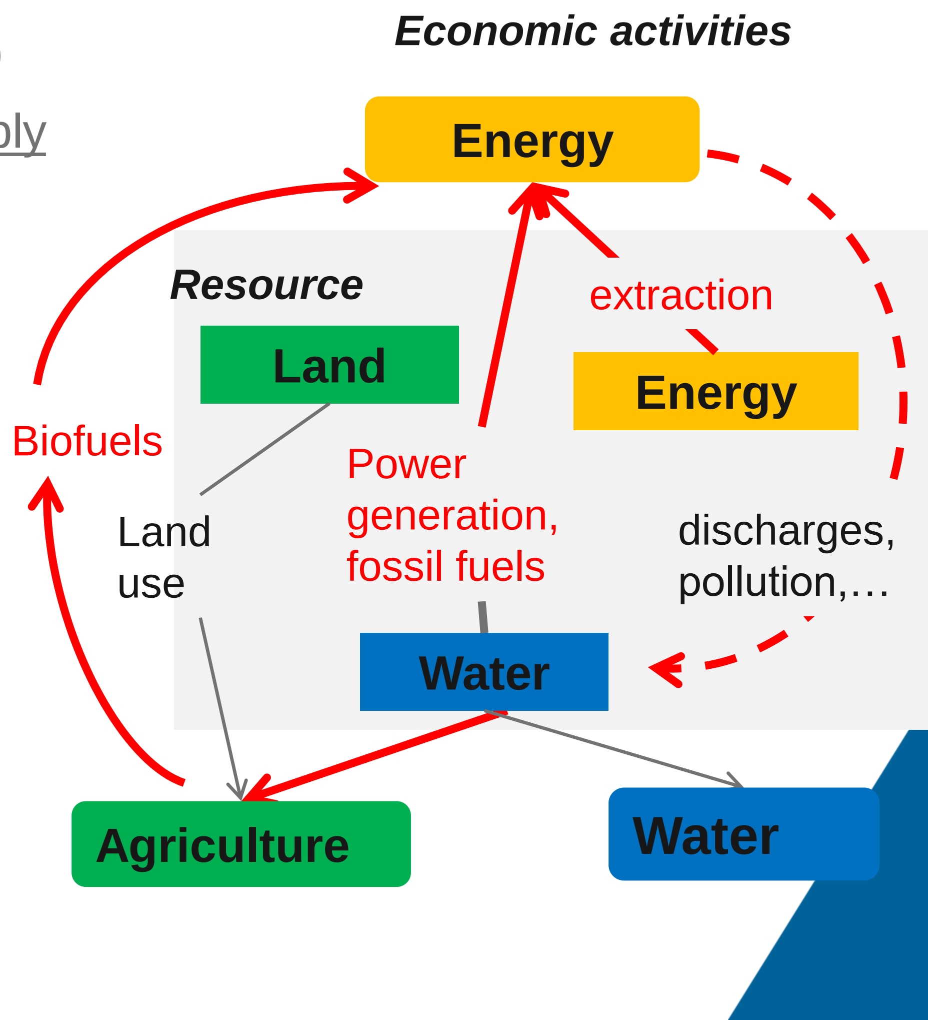
- Hydroelectric & thermoelectric (TE) plants
- Mostly water withdrawal (not consumption)
- <u>Limited power trade & need for stable supply</u>

Fossil fuels

- Cons. & withdrawal for extraction & processing
- Fossil resources available become more water intensive (e.g. shale oil & gas)
- International trade (->virtual water trade)

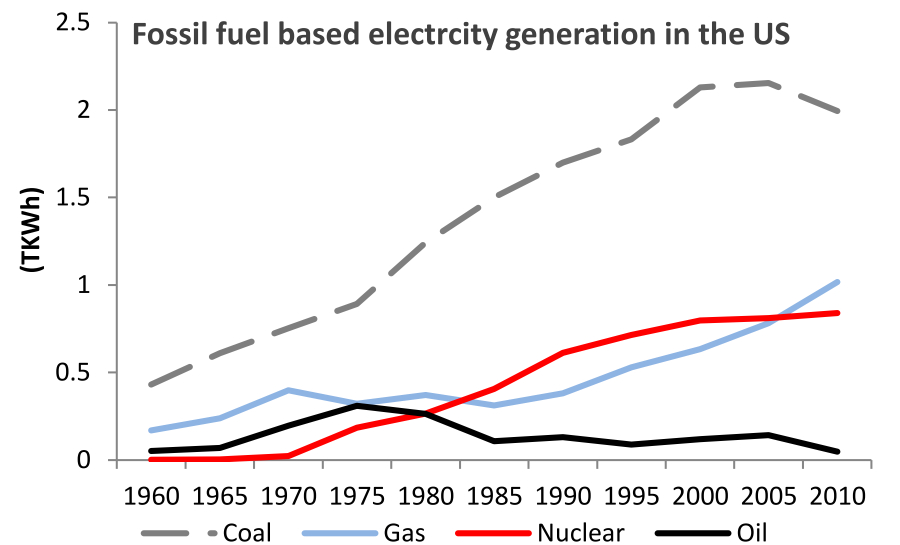
Biofuels

- Water consumption, dep. types of crops
- Role of energy & env. policies
- International trade (->virtual water trade)

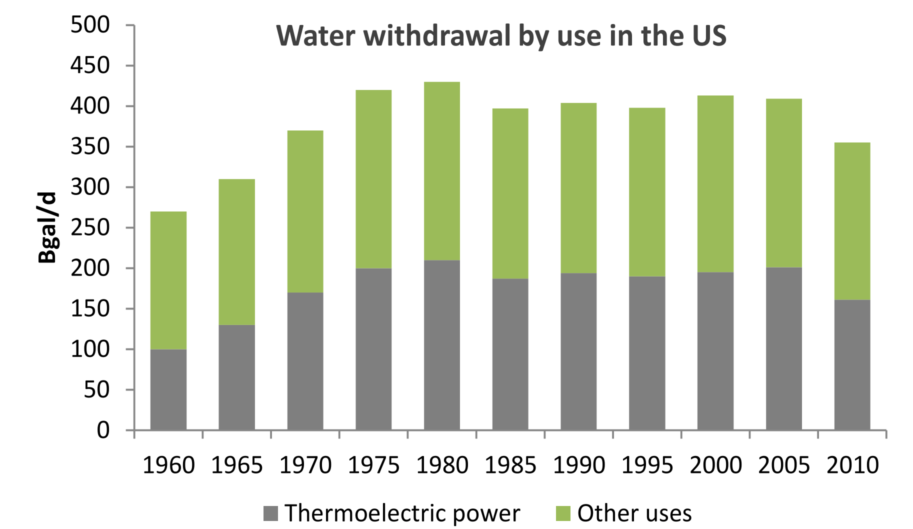


Megatrends	Power demand	Power supply & transportation
Socioeconomic drivers		
Population & GDP IT technologies	(+) quantity & quality of supply	
Climate change		
T° increase Change in rainfall Seasonal variations Extreme events Uncertainty	(+) cooling (-/+) pumping in agric) (-/+) annual load (-/+) peak load	(-) hydro, (-) TE (-/+) capacities (-) hydro, (-) TE capacities (+/-) seasonal H & (+ ?) grid security
Environmental policies		
Energy conservation Renewable (wind, sol...) Efficiency standards Local air protection	(-) quantity	(+) hydro, (-) TE dependence (-) dependence on TE (+) PG in less populated areas
Water policies		
TE plant cooling system standards		(-) TE dependence on water

Country level: ways to generate electricity with less water, example in the US



source: IEA extended energy balances 2014



source: USGS Water Use Data for the Nation

Reduced water withdrawal from thermoelectric generation:

-Cooling technologies: phase out of once-through systems

-Plant efficiency

But stress at the sub-national level

-South West US (DOE, 2012)

-No disruption but power provided to final consumers at a higher cost

Competition with other activities: urban demand, shale oil and gas,…

How to assess macroeconomic costs of water scarcity through power generation?

Cost for the power sector?

- PG technologies and water intakes
- Interconnections
- Response to water scarcity
- Uncertainty

>Need for detailed power generation model

Cost for the whole economy?

- Production function approach?
- Cost of disruption (with VOLL)?
- Cost for reducing the risk of disruption?
- Opportunity cost of reduced future access?

>How to get these notions in ENV-Linkages?

Assessment at the global level? Water demand for energy (Davies et al; 2013, Kyle et al., 2012) but no macroeconomic cost

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THANK YOU!

For more information:

www.oecd.org/environment/CIRCLE.htm

www.oecd.org/environment/modelling

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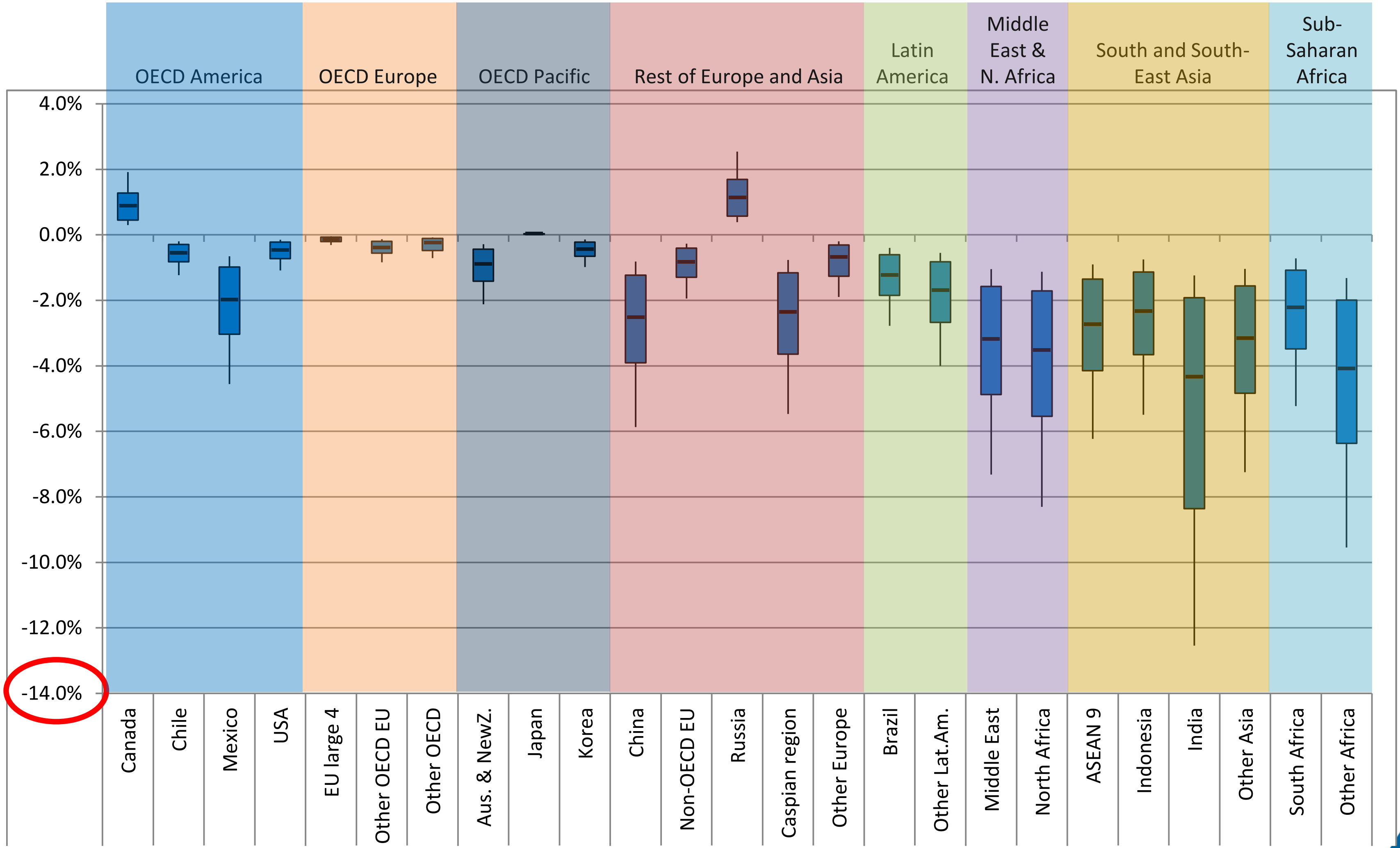
APPENDIX

Methodology for climate damages

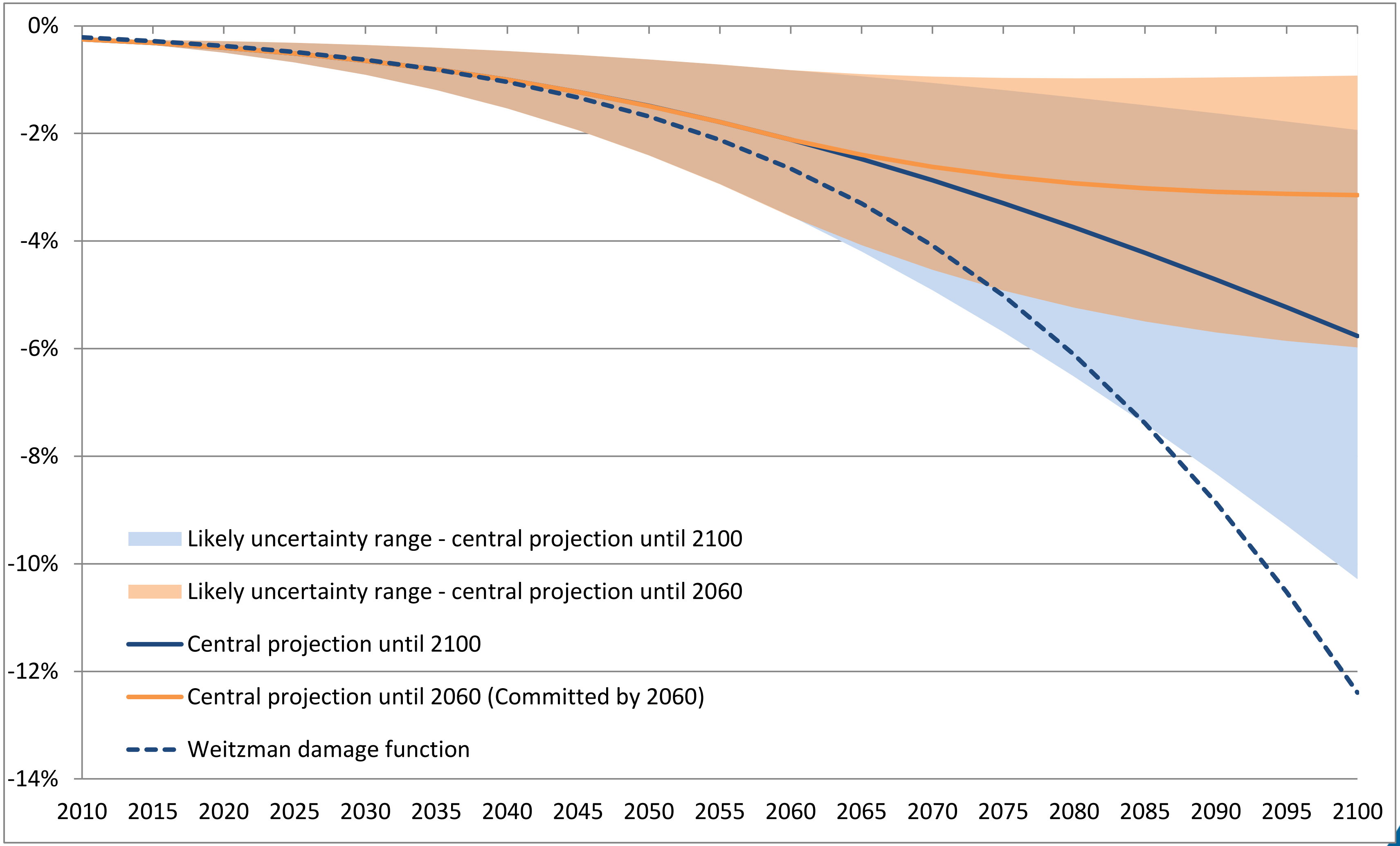
- Collaboration with existing impact studies
  - Methodology largely based on the FEEM ICES model
  - Data for a subset of damages from sectoral EU projects, obtained with help of FEEM
  - Additional data from range of collaborators, incl. NIES, VU University Amsterdam, IIASA, IPTS-JRC
  - Data consistency on damages is ensured by choosing damages corresponding to an appropriate temperature pathway (no simple damage functions relating everything to global ΔT)
- Damages calculated in ENV-Linkages model to 2060
  - Autonomous adaptation takes place via sectoral adjustments and international trade
- Stylised calculations with AD-DICE to 2100
  - Baseline and damages to 2060 harmonised with ENV-Linkages

Regional results and uncertainty from climate sensitivity – year 2060



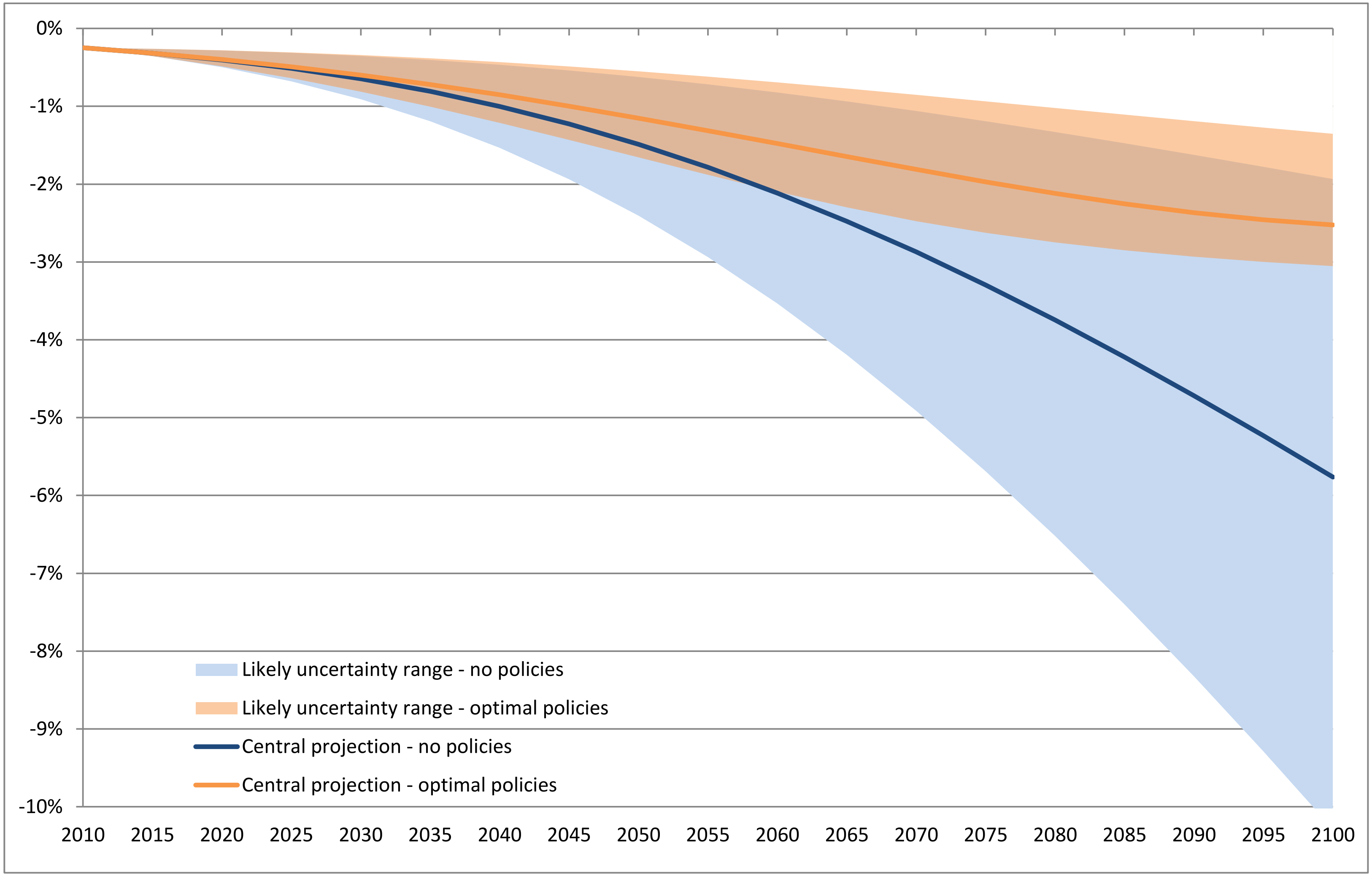
Source: ENV-Linkages calculations

Long-term damages



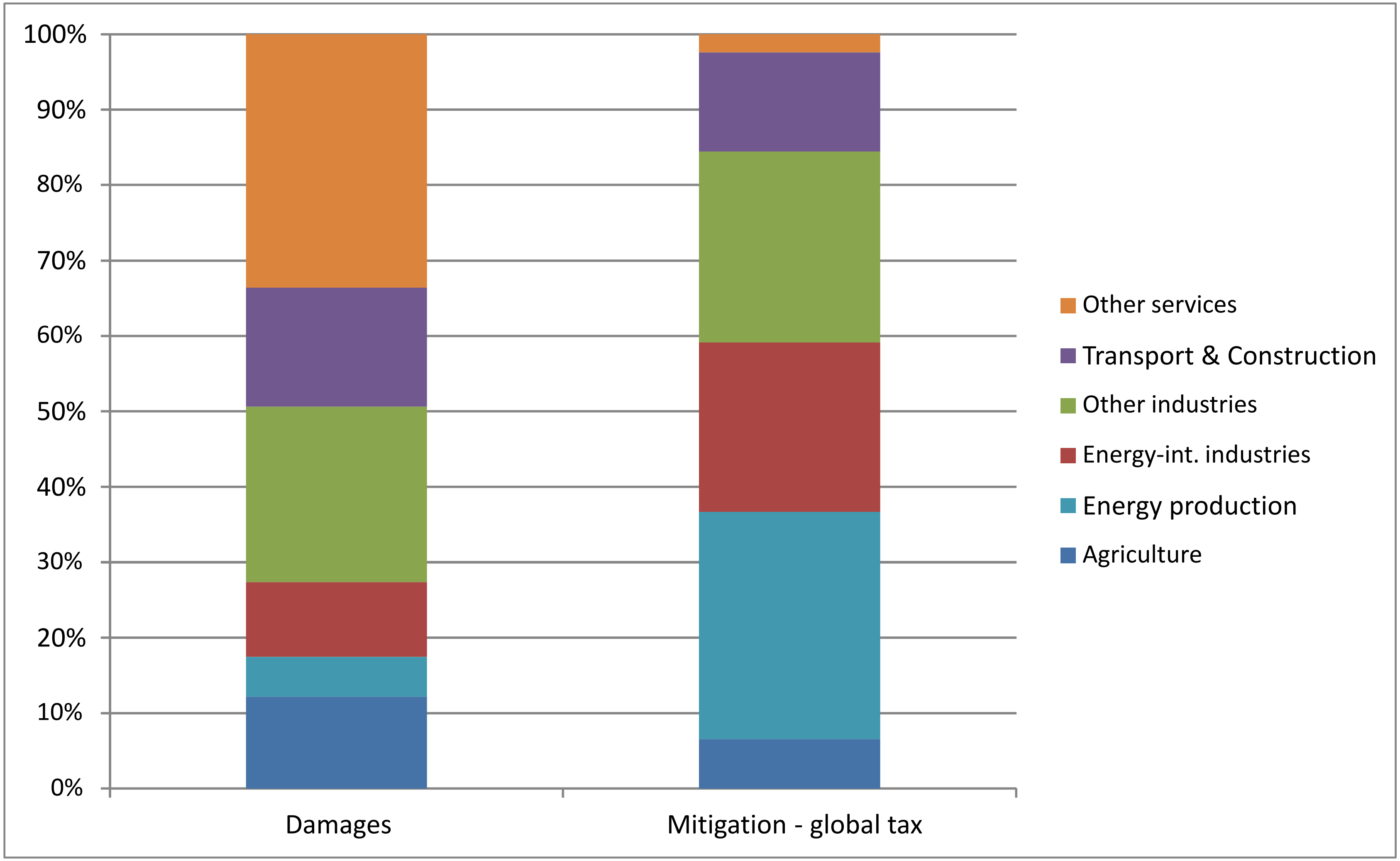
Source: AD-DICE calculations

Damages with policy controls



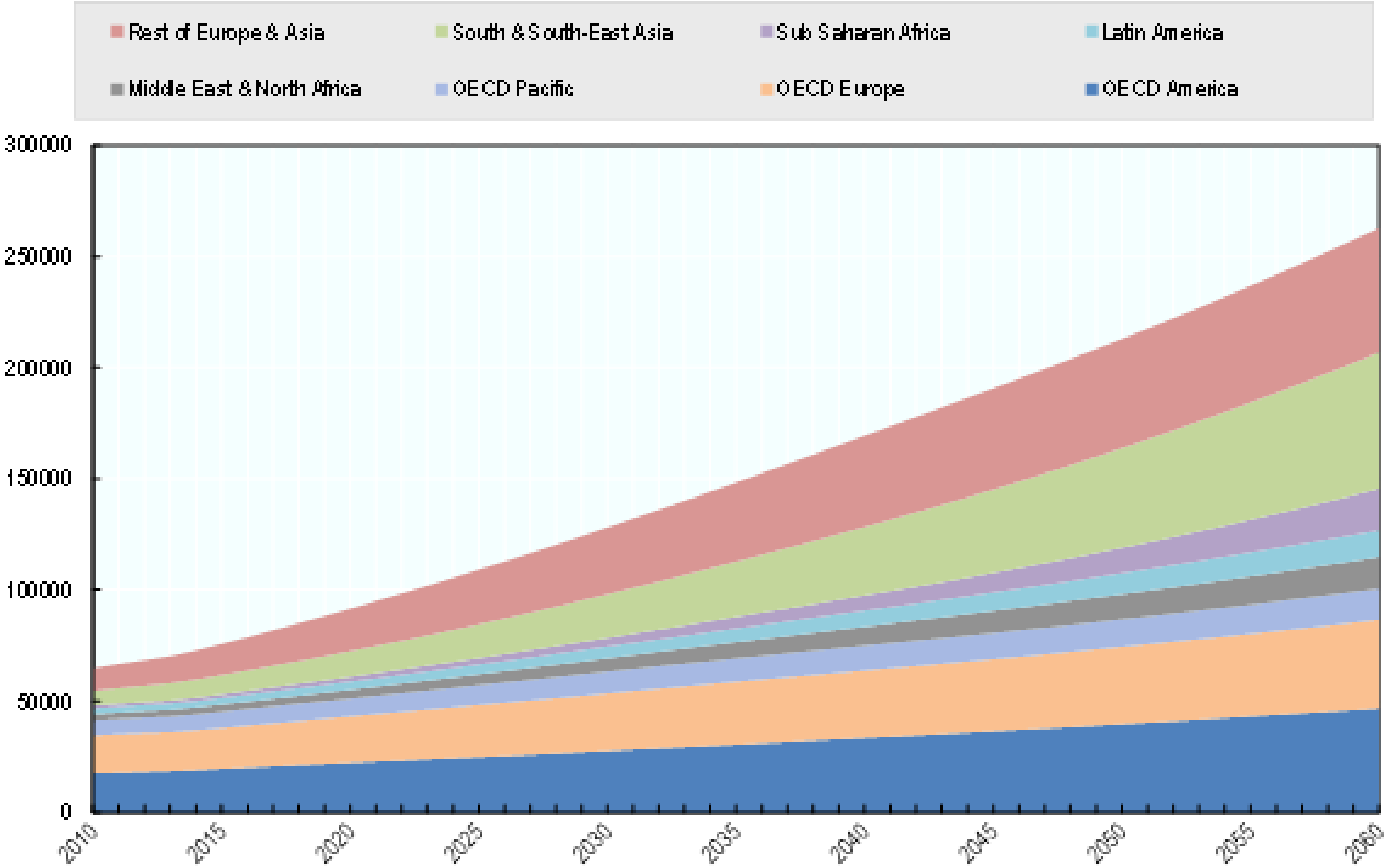
Source: Preliminary AD-DICE calculations

Sectoral damages and mitigation costs



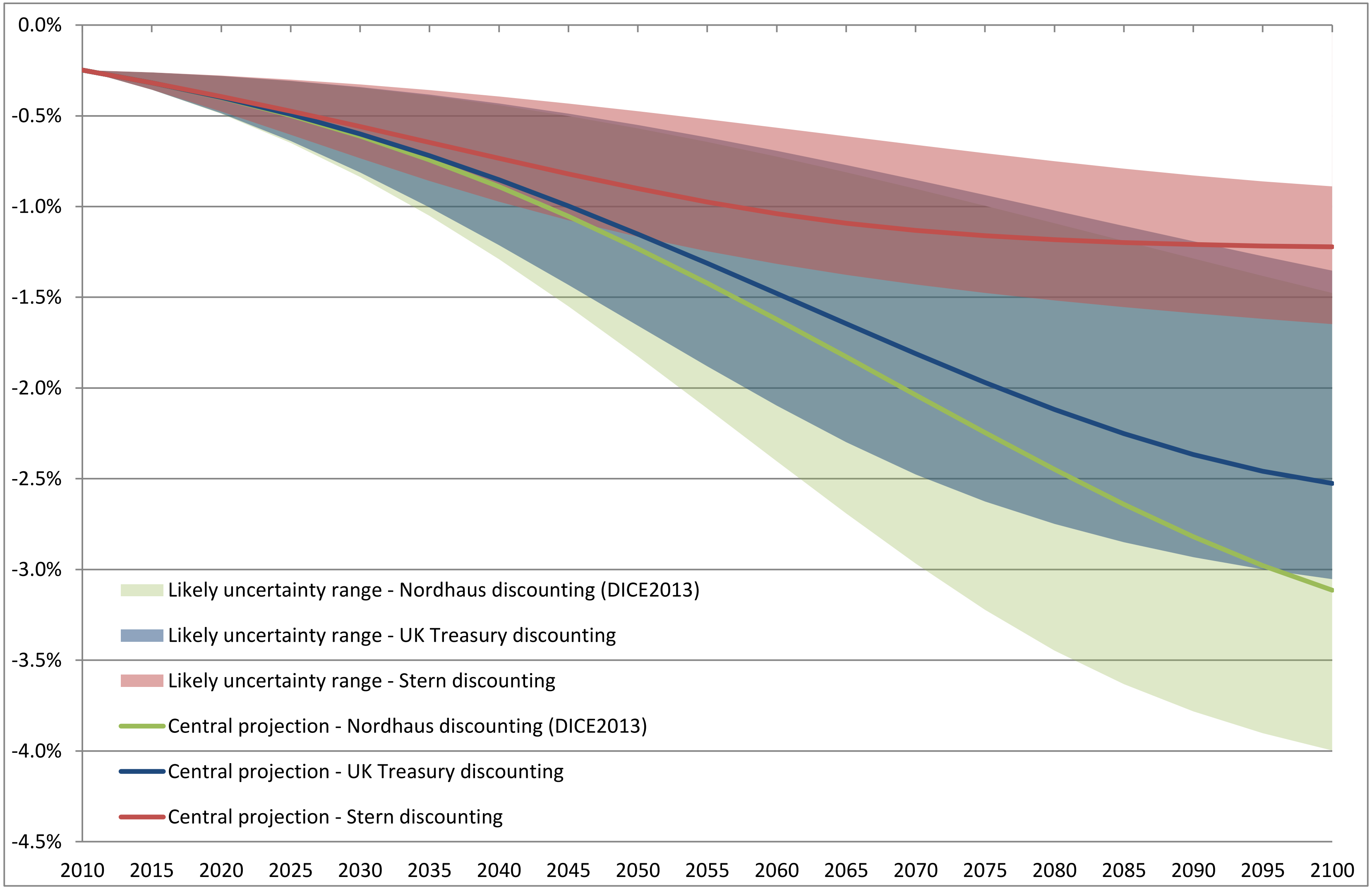
Source: ENV-Linkages calculations

No-damage baseline GDP projection



Source: ENV-Linkages calculations

Global damages under optimal mitigation – alternative discounting rules



Source: AD-DICE calculations

Howe local circumstances matter: Hotspots and bottlenecks

Europe France (IEA, 2012); Central Europe **(**Rübbelke and Vögele, 2011)

Australia: increased water withdrawal for power generation in water stressed areas (Smart and Aspinall, 2009)

China: Power generation in regions with water scarcity, adoption of dry cooling + (shale resources in water scarce areas) (IEA, 2012)

India: seasonal variations drought and heat waves create high demand and low supply (IEA, 2012; Bhattacharya and Mitra, 2013)

Sub Saharan Africa: uncertainty on water flows increases the cost of developing that hydro capacities (Cervigni et al 2015)