



# GLOBAL IQ

IMPACT QUANTIFICATION OF GLOBAL CHANGES

## The Global IQ scenarios Europe in a changing world

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Brussels, 17 June 2014



EUROPEAN COMMISSION  
European Research Area



FONDAZIONE ENI  
ENRICO MATTEI

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*This research project has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under the grant agreement n° 266992 (Global IQ)*

# Overview

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- Part I
  - Modeling work in Global-IQ
  - The scenario architecture
- Part II
  - The Global-IQ Reference scenario
- Part III
  - The challenges of climate policy



# Modelling work in Global-IQ

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- 5 research centers
- 7 models, enhanced during the project
- 6 macro challenges
- 11 subtopics
- 7 reference scenarios
- 67 scenarios with full adaptation
- 106 scenarios with limited adaptation



# The Global-IQ scenarios

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- A total of 173 scenarios publicly available
  - Hundreds of variables
  - Macro-region and national scale
  - Time scale up to 2100
- User-friendly
  - Excel format
  - Same template for easy comparison
- Nested in the shared socio-economic pathways (SSP) literature
  - Reference scenario modelled on SSP2 “middle-of-the-road”



# Challenges in the Reference scenario

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- Six broad areas:
  - Population and economic growth
  - Competitiveness and trade
  - Energy and energy security
  - Feeding a growing population
  - Environment
  - Climate change



# Challenges to the Reference

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- Alternative assumptions on:
  - Trade regimes
  - Global fossil resources and energy markets
  - Climate change mitigation policy
  - Environmental policy
  - Lifestyles
  - Demographics and migration
- Sensitivity analysis
- Mitigation scenarios: directed by policy choices



# Adaptation

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- Private adaptation
  - Autonomous, market driven
- Public adaptation
  - Needs coordination policies
- Models cannot endogenously determine public adaptation
- Focus on private adaptation
- Role of public institutions:
  - Facilitate change of individuals and firms
  - Information
  - Promote alternative lifestyles, preferences



# The cost of not adapting

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- Set of scenarios with limited market adaptation
  - Technologies
  - Factor substitution
  - Trade
- Value of adaptation





# The Global IQ scenarios

Macro challenge	Subtopics	Full adaptation	Limited adaptation
Reference	---	7	21
Climate change impacts	Agriculture	8	23
	Long-term impacts and cost-benefit analysis	12	6
	Economy-wide impacts	3	12
	Trade	2	2
Climate change mitigation	Representative concentration pathways	12	27
Competitiveness and trade	Trade policy	2	1
Energy	Non-conventional resources	8	6
Environment	Biodiversity	3	3
	Lifestyle changes	1	---
	Local pollutants	1	1
Population and migration	Population growth and distribution	8	4
<b>Total</b>		<b>67</b>	<b>106</b>

## PART II

# The Global-IQ Reference Scenario

# The Reference scenario

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- Exogenous drivers from SSP2
  - Medium population growth related to medium educational investments
  - Medium economic growth, slow convergence
- Models endogenously generate patterns of:
  - Energy demand
  - Trade patterns
  - Land use
  - Pollution
  - GHG emissions
  - ...



# Population

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- Global population increases from 6.8 billion to 9.2 billion in 2050.
- Europe's population is stable, with Eastern Europe losing about 10% of the population.
- Africa, the Middle East, South Asia and India, will be home to about 80% (two billion people) of global incremental population 2010-2050.



# Economic growth

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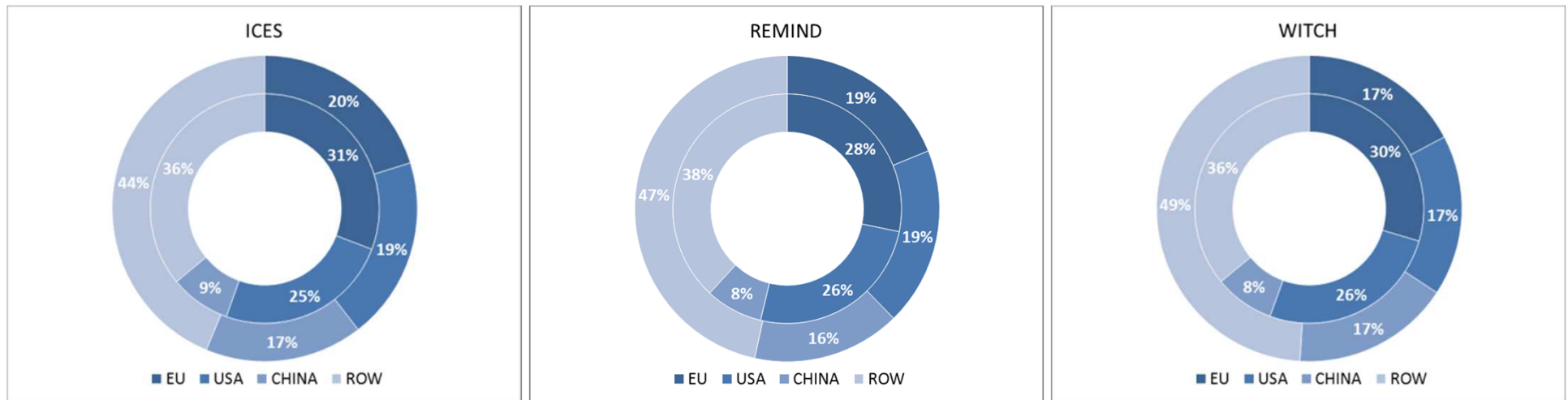
- Global economic activity triples from 2010 to 2050.
- Global growth rate per year from 2 to 3%.
- European countries grow slower than the global average.
- The USA grows slightly faster than Europe.
- The fastest growing region is Sub-Saharan Africa, followed by India.



# Economic growth

- Europe and the USA still command high (but declining) shares of total global production in 2050.

Share of global GDP, 2010 and 2050

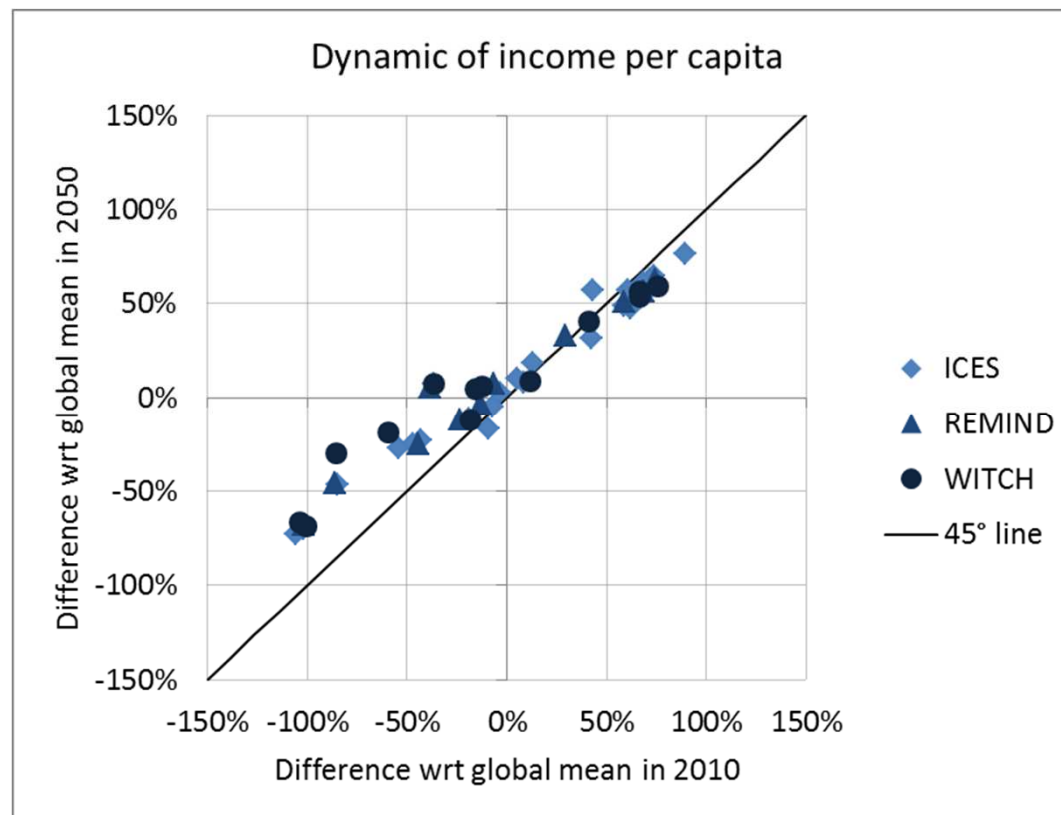


Notes: inner circle, 2010; outer circle, 2050.



# Income inequality

- Global inequality declines, but substantial income differences remain in 2050.



# Competitiveness and Trade

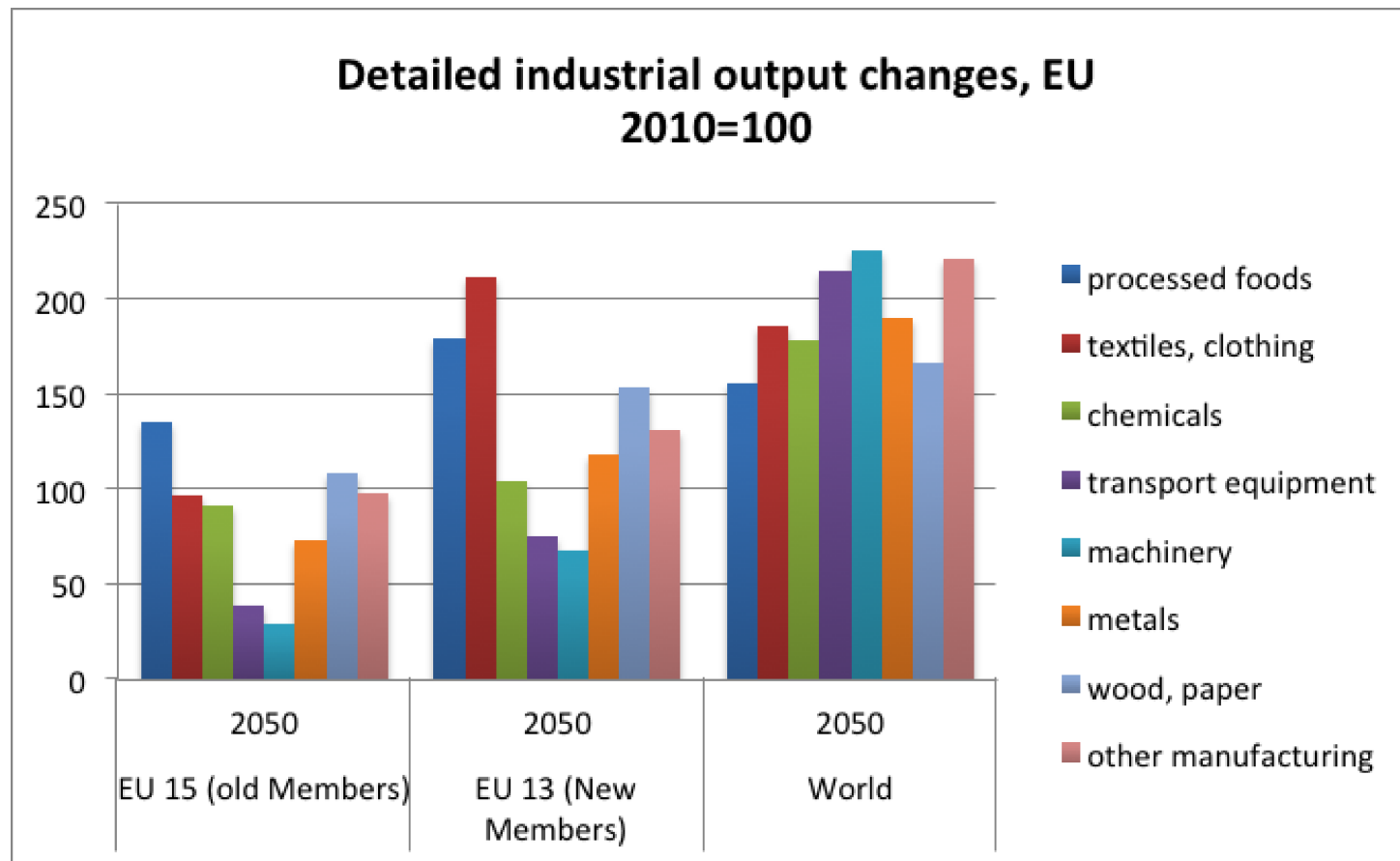
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- Increasing challenges to competitiveness of EU
  - EU concentrates in services
  - Political drivers for protectionism may increase
  - EU13 and EU15 follow different paths: Industry moves East.
- Migration provides an adaption channel (population growth) and challenges (OECD labor markets)
  - Relocation of labor to high wage countries
  - Pressure on OECD workers, but rising overall wage trends
- Continued education/skills upgrading in emerging markets
  - Narrows wage gaps with North
  - Trade transmits higher income demand to the EU
  - EU workers benefit from more higher-skill emerging market work force

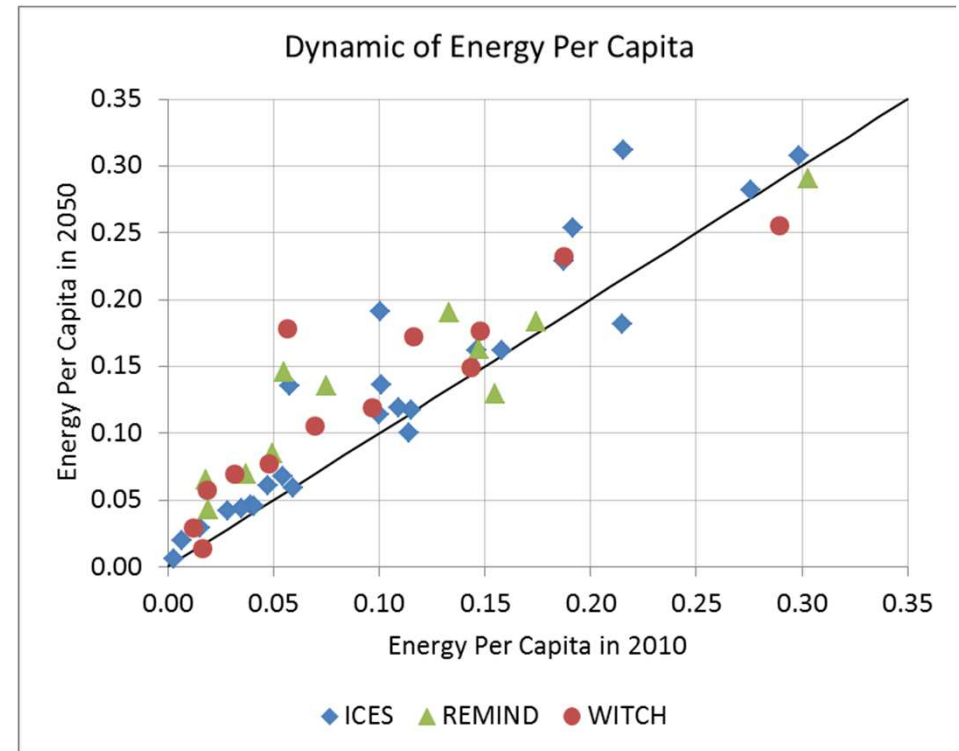
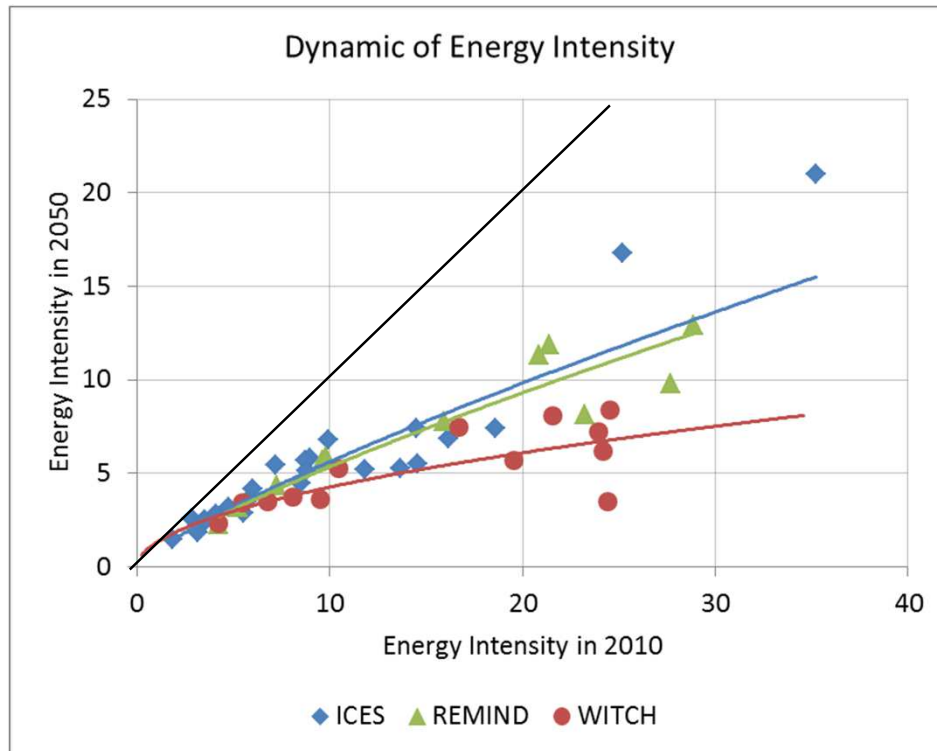




# EU Competitiveness



# Dynamics of energy demand



- Higher energy efficiency...
- But higher energy demand



# Energy

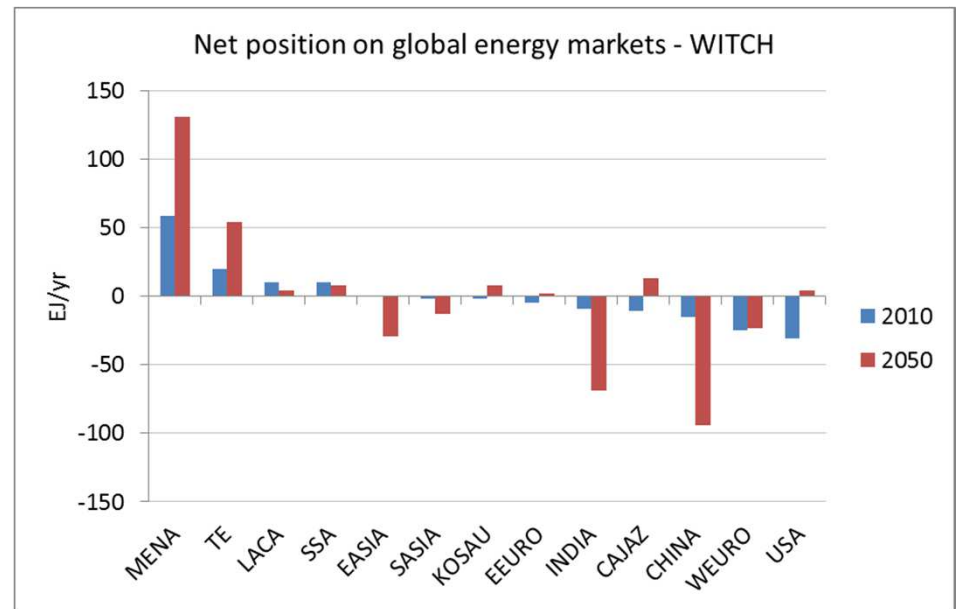
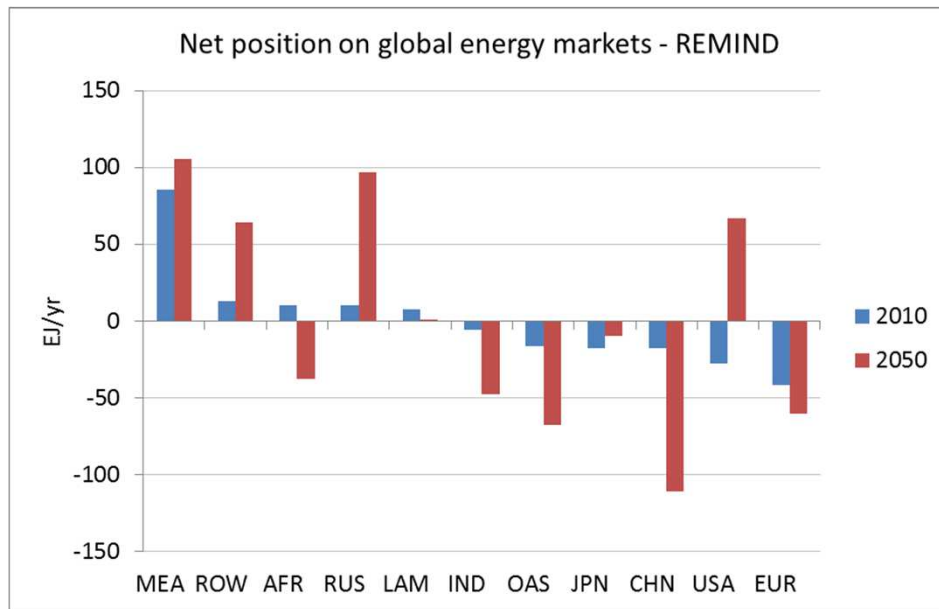
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- Final and primary energy demand increase by 80% from 2010 to 2050.
- In Europe final energy demand is almost flat from 2010 to 2050.
- Without additional policies, fossil fuels dominate the global and European energy systems in 2050:
  - 70-80% of electricity generation;
  - more than 80% of primary energy is from oil, coal and gas.
- Europe has a substantial energy deficit
  - together with China, Europe is the dominant energy resources importing region until 2050.



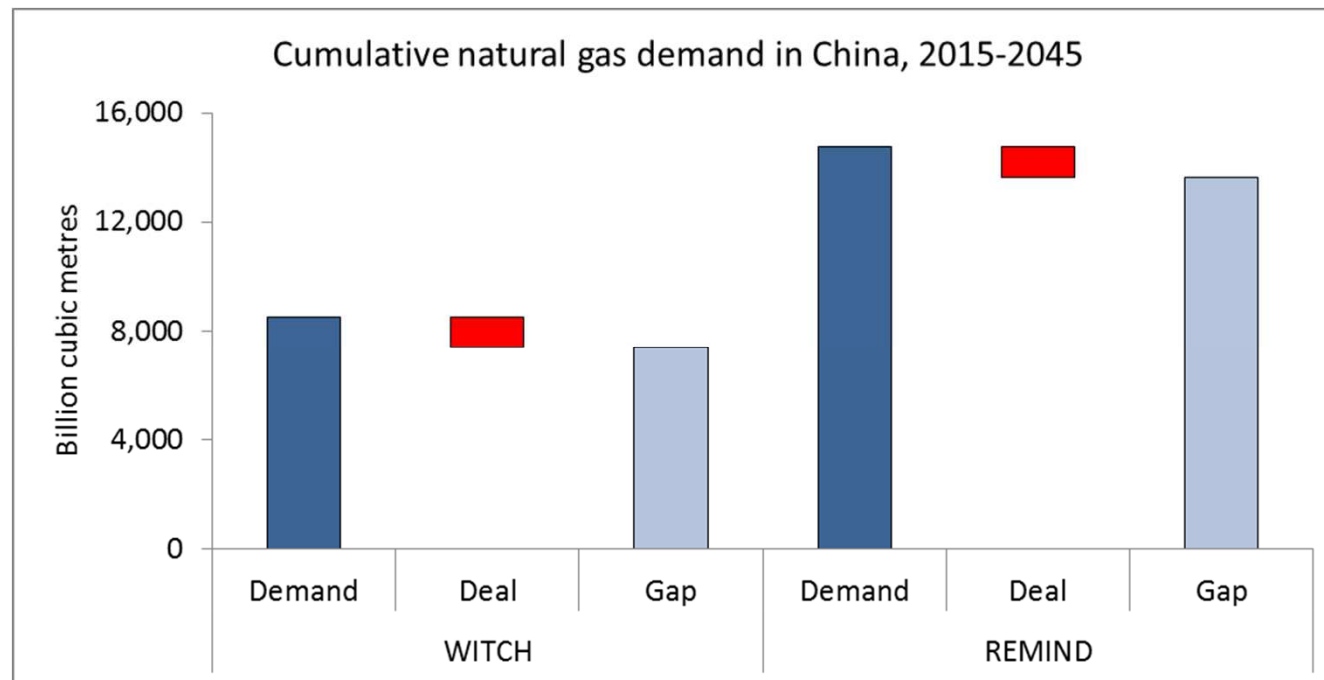
# Global energy markets

- Europe will have to compete with emerging economies to secure energy supply



# The China-Russia natural gas deal

- 30 years, 38 bn cubic metres of gas each year
- Total of 1,140 bn cubic metres
- Estimated \$400bn value



Deal covers  
only 8-13 %  
of cumulative  
natural gas  
demand



# Europe's Energy Security

theguardian

Search

## Russia cuts off gas supply to Ukraine as deadline passes

Ukraine and Russia fail to agree compromise deal over gas prices and unpaid bills but EC hopes accord can still be reached

Associated Press

theguardian.com, Monday 16 June 2014 08.40 BST



A gas worker in western Ukraine: Gazprom said Ukraine was obliged to ensure gas reached its European customers. Photograph: Gleb Garanich/Reuters

## Gazprom demande à l'Ukraine de prépayer ses livraisons de gaz

Le Monde.fr avec AFP et Reuters | 16.06.2014 à 01h15 • Mis à jour le 16.06.2014 à 09h49



Les Russes et les Ukrainiens ont jusqu'à lundi matin pour trouver un compromis. | AFP/ALEXANDER ZOBIN



# Europe's Energy Security

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- DESERTEC-like projects are the answer?
  - About 20% of EU electricity from MENA in 2050
- Massetti and Ricci (2013):
  - Potentially expensive and premature
  - Technical, political and institutional challenge



The views expressed are personal and are not necessarily endorsed by the European Union, by other project partners nor by the Institutions I am affiliated to.



# Agriculture

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- Demand for agricultural products increases by 50% (global) and 18% (EU) from 2010 to 2050.
- Relatively stable or even slightly decreasing prices.
- Share of Europe in global supply either declining or stable.
- Europe remains a net importer of agricultural goods.
- Agricultural trade deficit may increase.





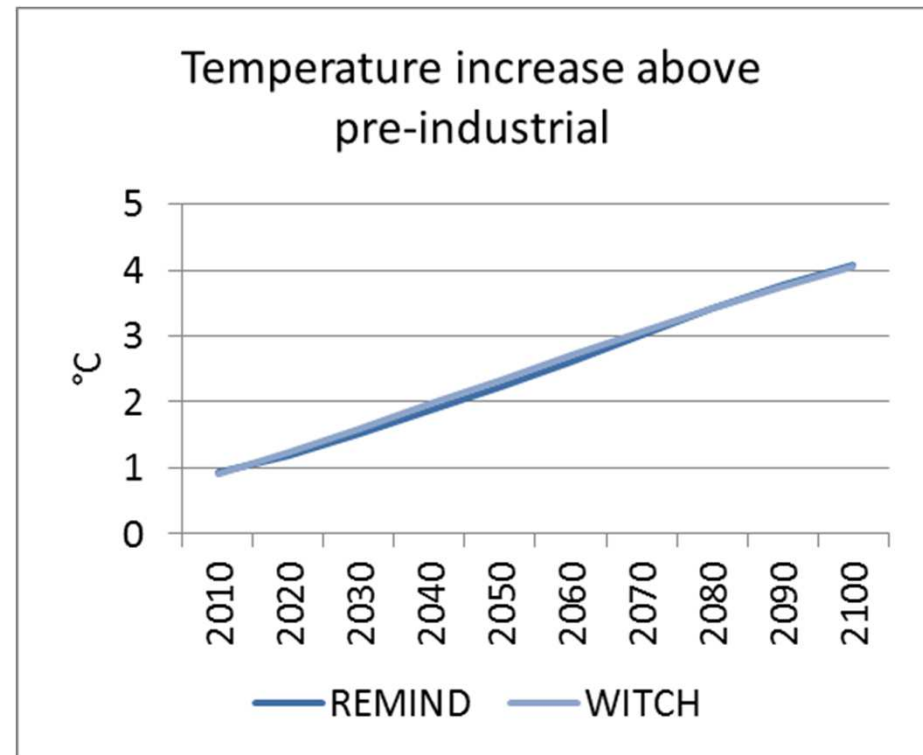
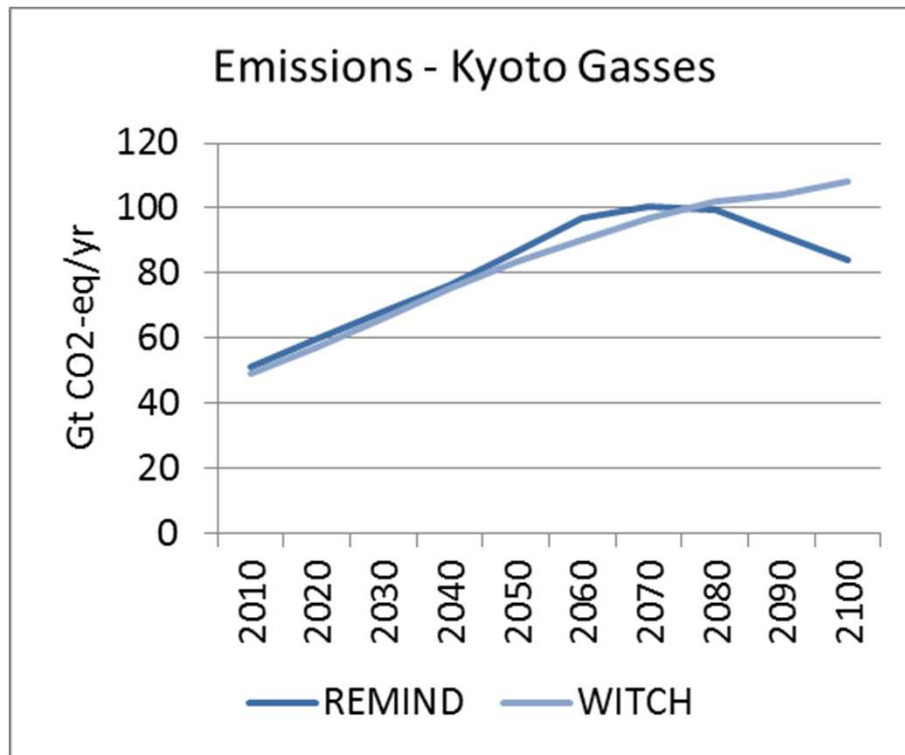
# Global food production

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- Global cropland +11 to +15%, mainly in Latin America and Africa.
- Global irrigated area changes from -26% to 26% in 2050 compared to 2010.
- Cumulative GHG emissions from AFOLU: 312 to 437 GtCO<sub>2</sub>eq in 2050
  - Methane >50%



# GHG emission pathways

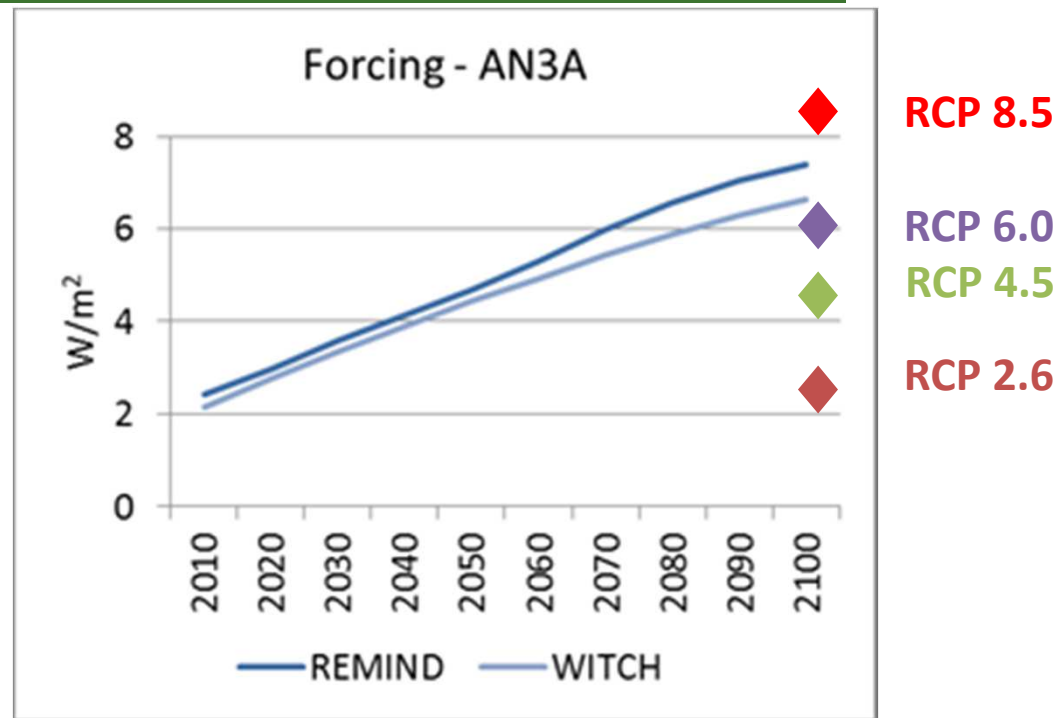


## PART III

# Challenges from Climate Policy

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# Global-IQ emissions compared to RCPs

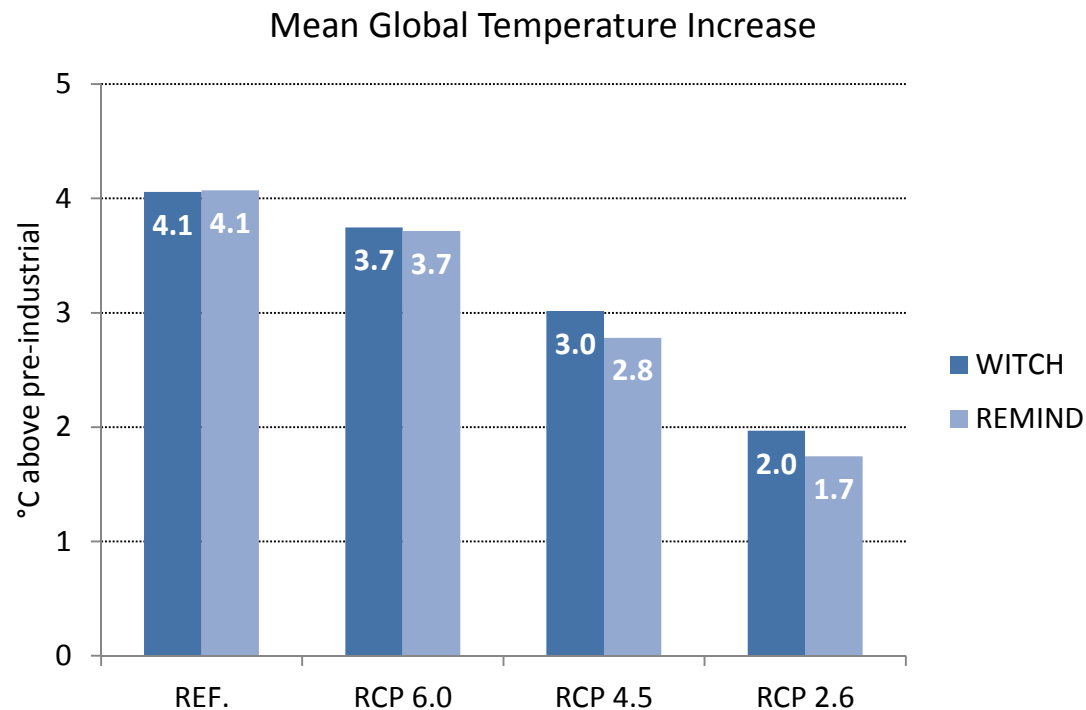


- Reference scenario close to RCP 6.0:
  - WITCH: 6.7  $\text{W/m}^2$ ; REMIND: 7.4  $\text{W/m}^2$
- RCP 8.5 is a pessimistic emission scenario



# Temperature in the RCP scenarios

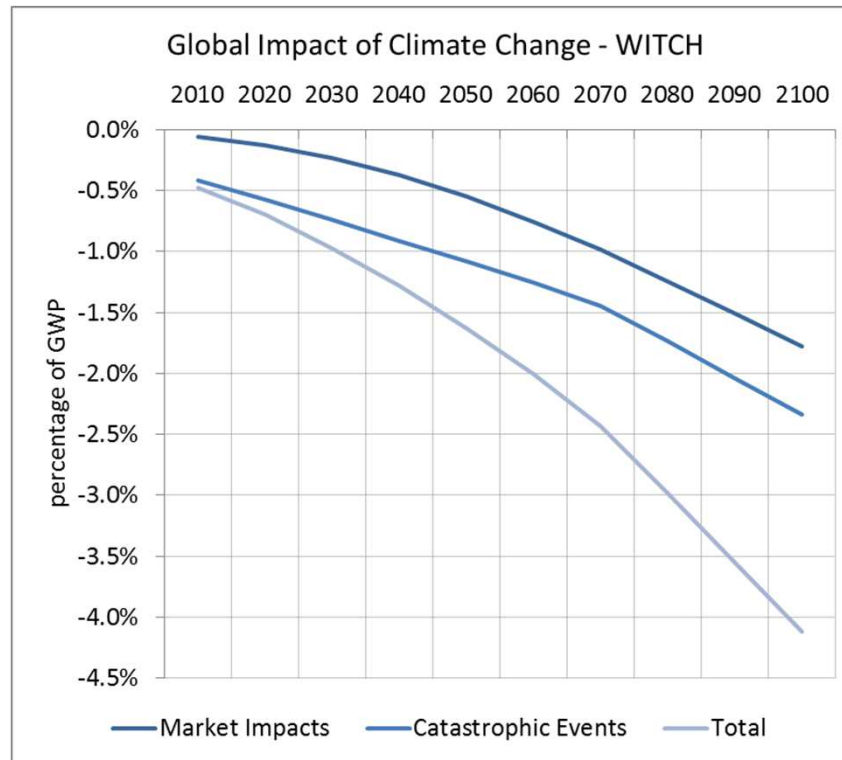
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- Only the RCP 2.6 trajectory goes below the 2°C limit



# Global impacts on the economy

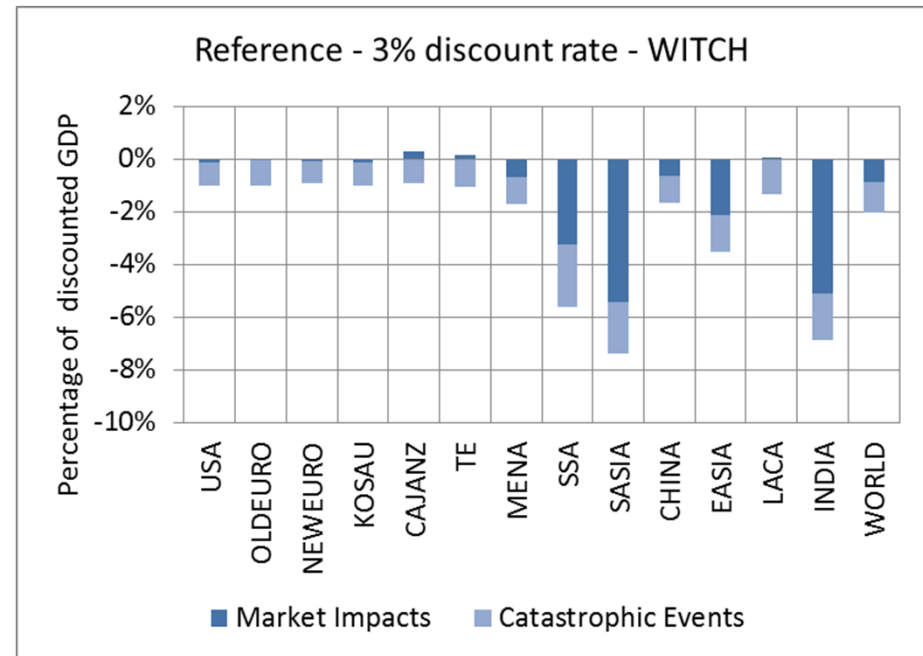
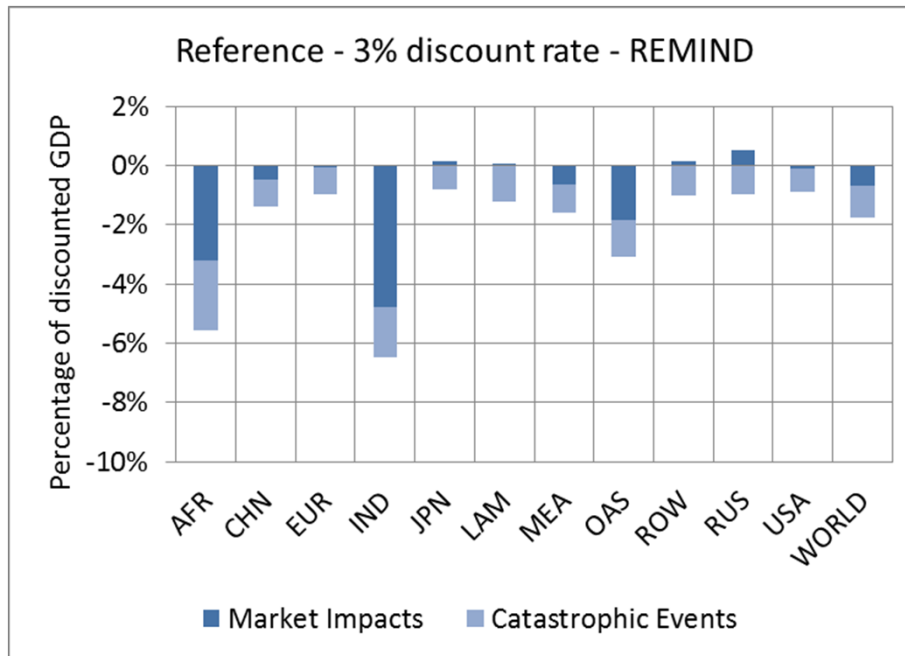


Similar impacts  
for REMIND

- Reference scenario, with full adaptation
- Damage functions obtained from the model ICES
- In line with the literature and IPCC WGII survey



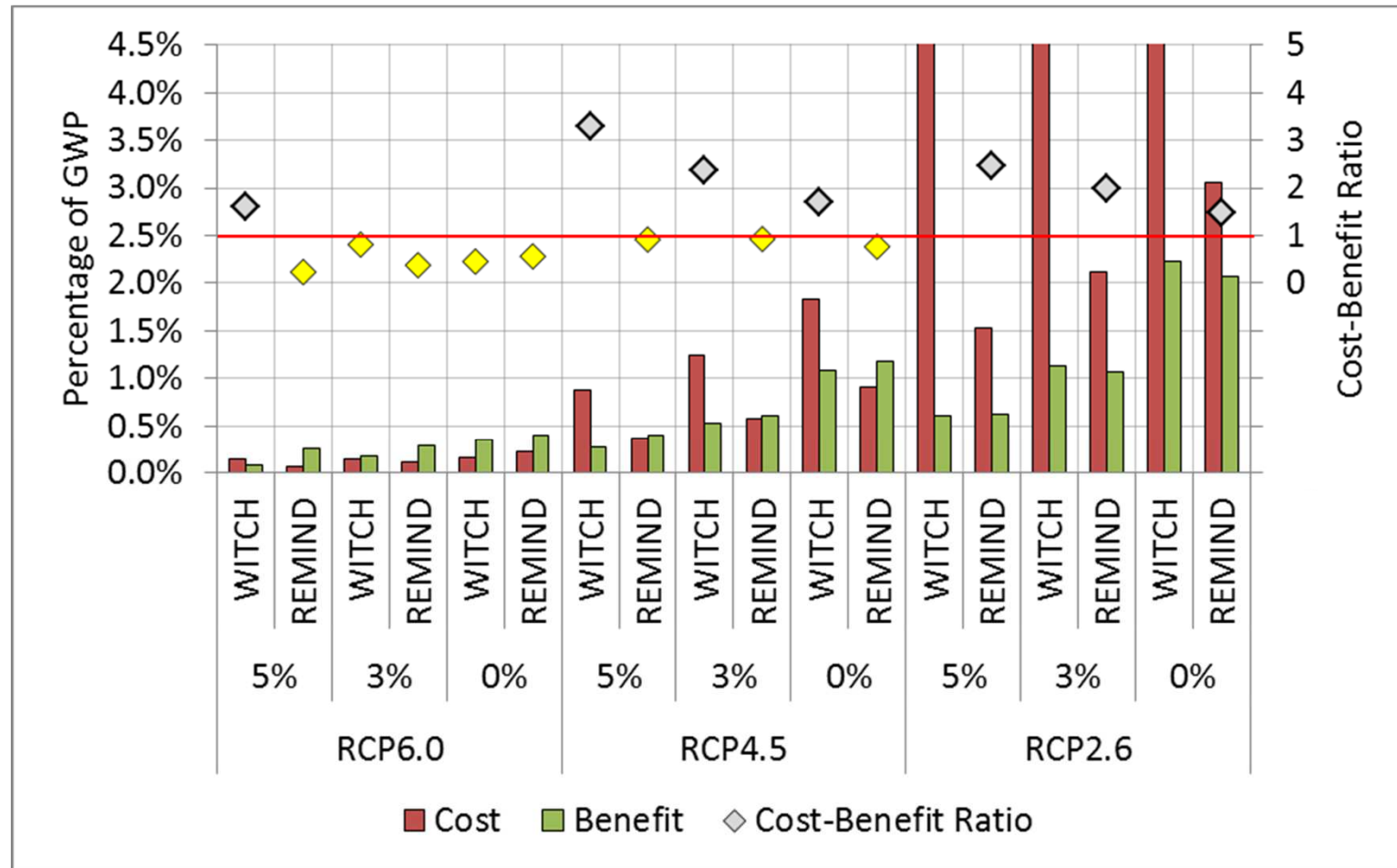
# Regional impacts on the economy



- Large regional disparities



# Comparison of costs and benefits



- Full adaptation scenarios

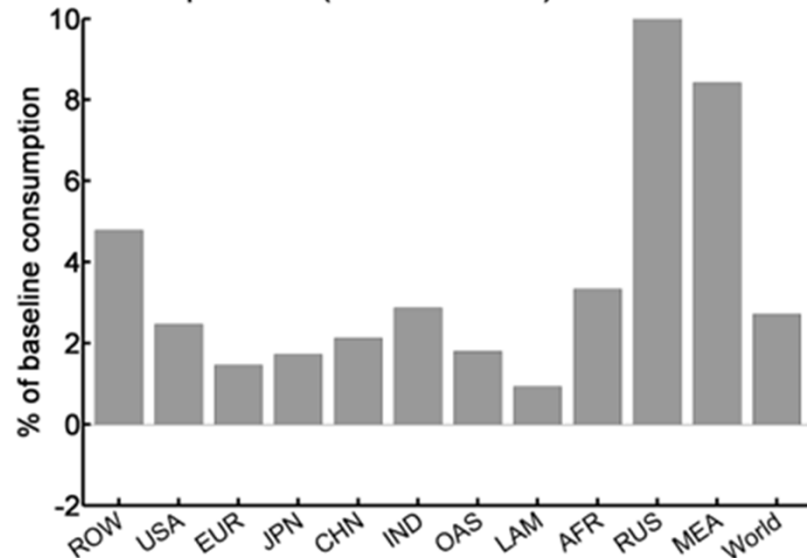




# Regional mitigation costs

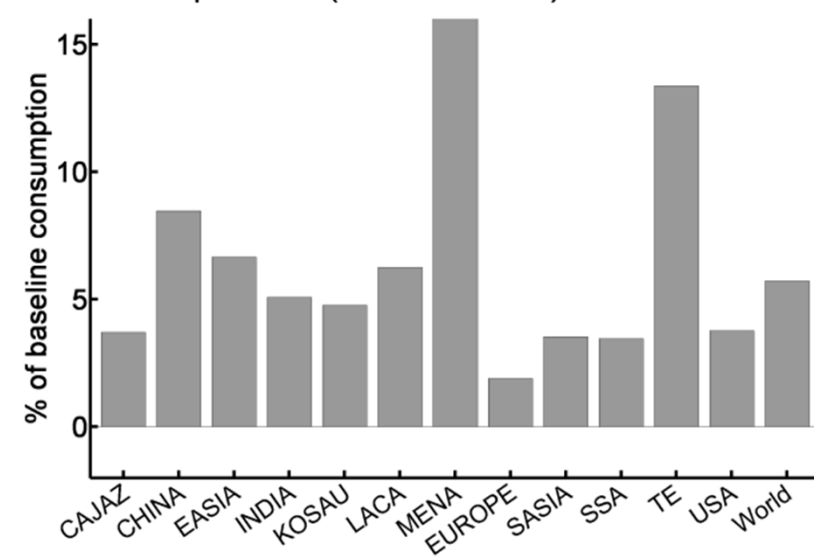
REMIND

Cum Consumption Loss(3%discount rate) -- RCP-2.6 -- 2005-2100



WITCH

Cum Consumption Loss(3%discount rate) -- RCP-2.6 -- 2005-2100



- Large regional disparities



# Summary

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- The RCP 2.6 target does not pass our heuristic cost-benefit assessment
- Mixed results for the RCP 4.5 target
- The RCP 6.0 target passes the cost-benefit test
- The RCP 8.5 scenario seems quite pessimistic

*“Politically meaningful” emissions pathways are between RCP 4.5 (possibly 3.7) and RCP 6.0?*



# Fossil fuels exporting regions

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- Climate mitigation policy is a net loss because it depreciates the endowment of fossil resources
- Oil exporting regions adversely hit
- Middle East, North Africa severely hit while facing multiple challenges:
  - Growing population
  - Growing economies but slow convergence
  - Economies based on fossil fuels



# Challenges for Europe

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- Middle East, Northern Africa and Transition Economies may block transition to low-carbon economy
  - Example: long-term supply of oil at low price
- These issues are very sensitive and (thus) little investigated.
- Necessary to foster cooperation across the Mediterranean and the Middle East.



# Conclusions

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- Europe faces multi-faceted challenges in a “business-as-usual” scenario
- Market adaptation is important and must be facilitated
- Climate mitigation policy is a global challenge
- The 2°C target does not seem cost-efficient
- The relevant
- Challenge to convince fossil fuels exporters





# GLOBAL IQ

IMPACT QUANTIFICATION OF GLOBAL CHANGES

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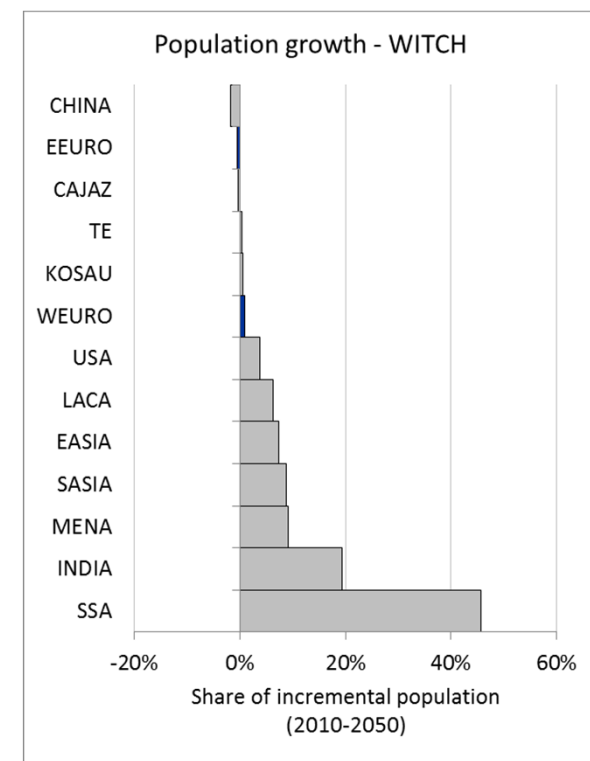
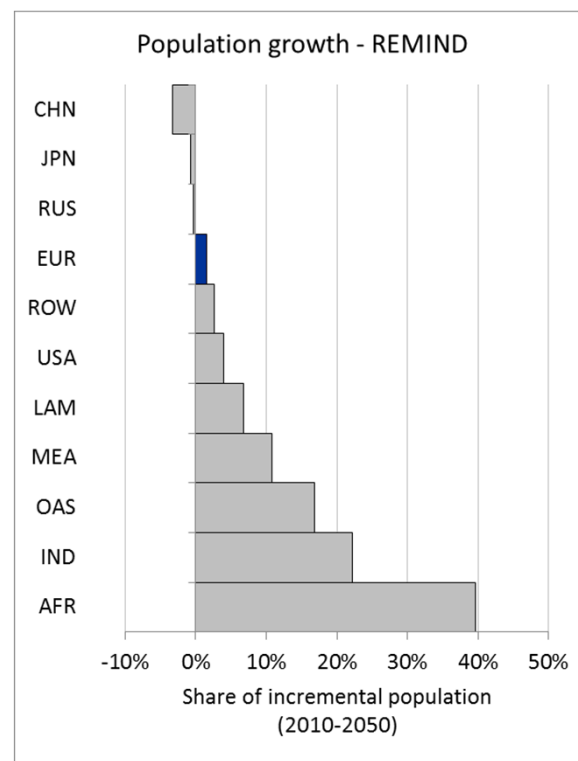
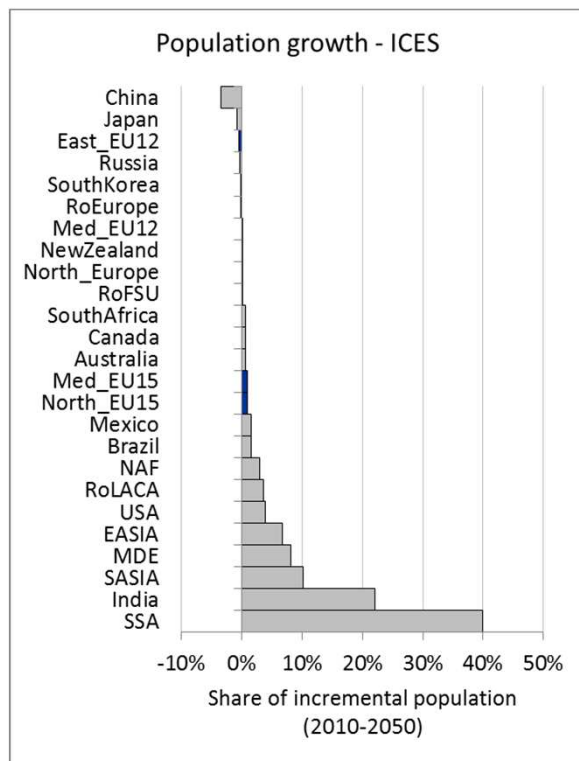
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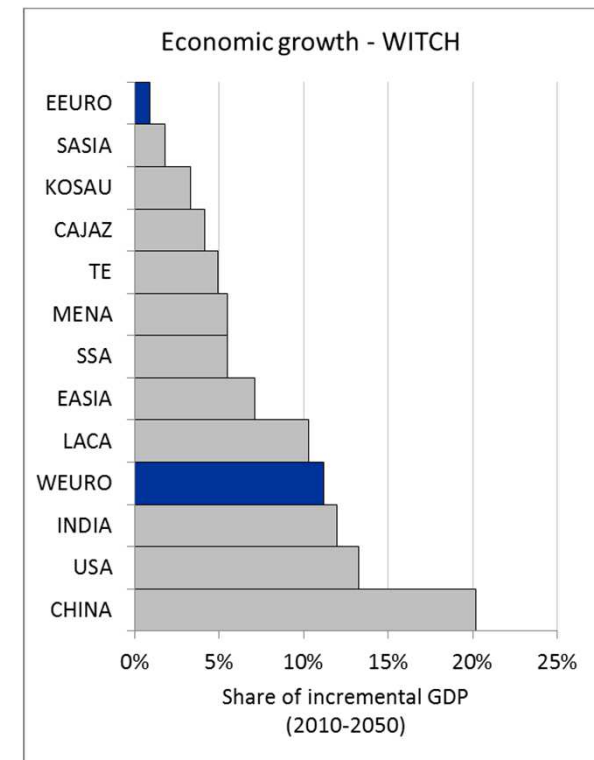
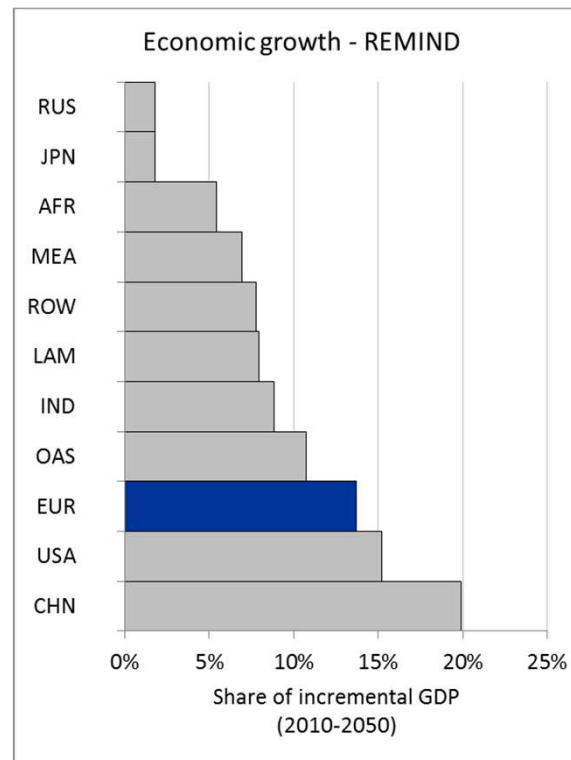
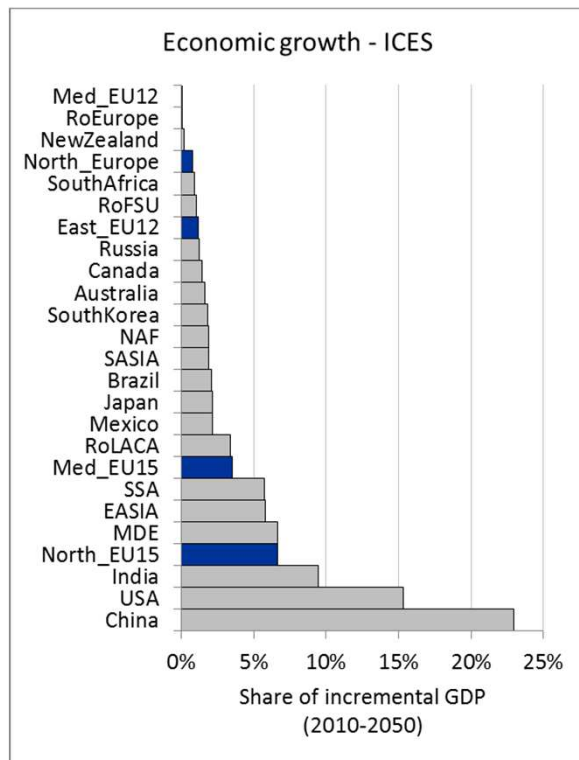
# Population

## Share of global incremental population 2010-2050



# Economic growth

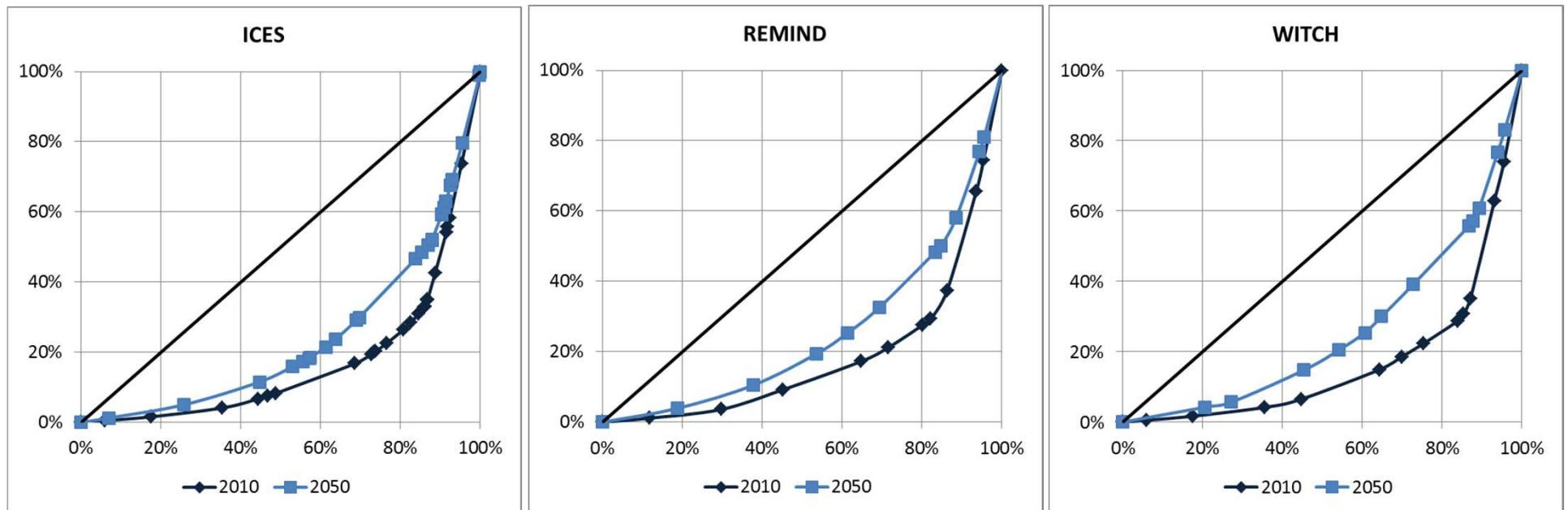
## Share of global incremental GDP 2010-2050





# Income inequality

Lorenz curves of income per capita, 2010 and 2050

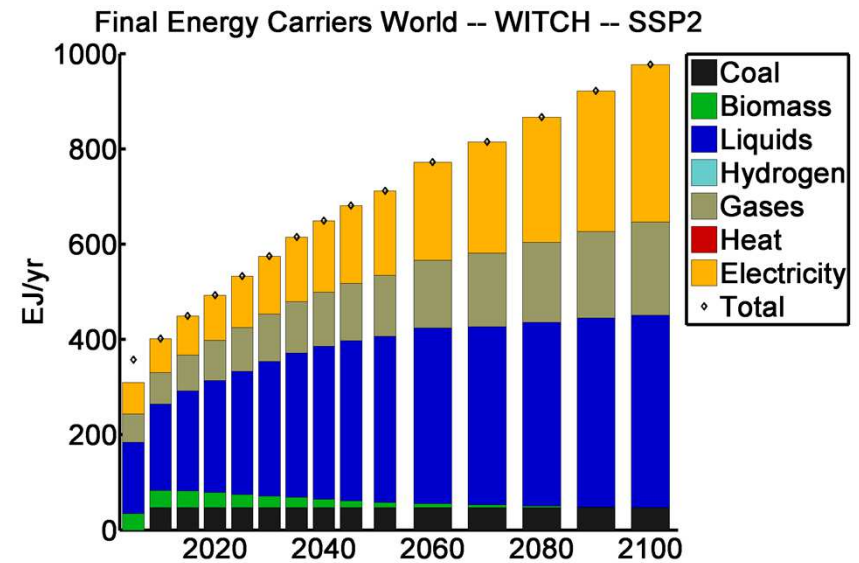
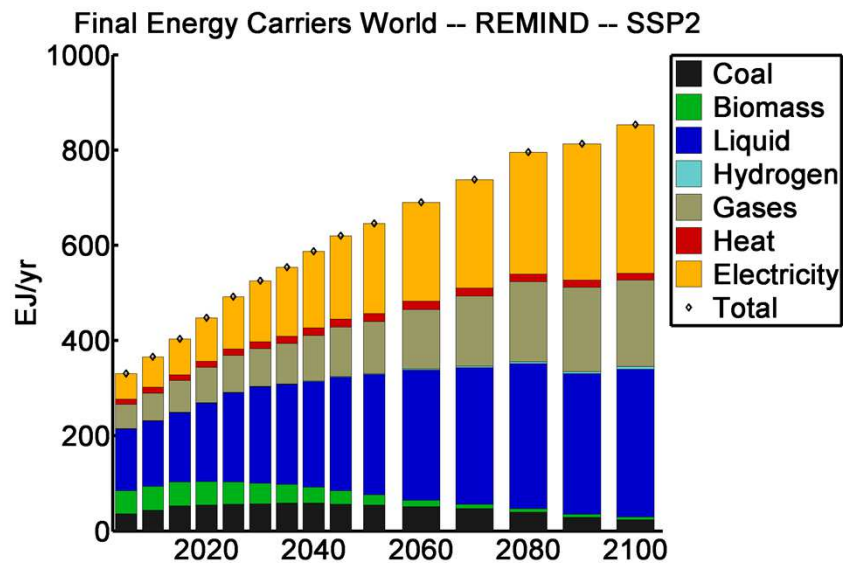


The Gini index:

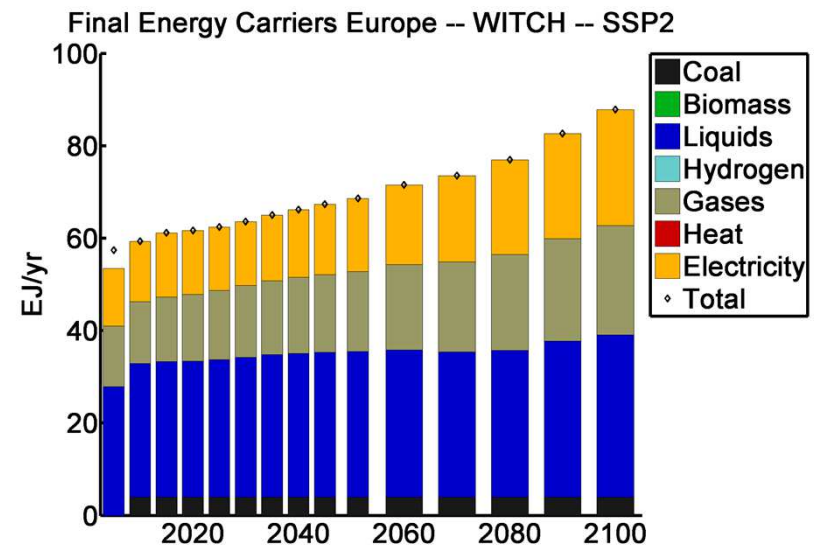
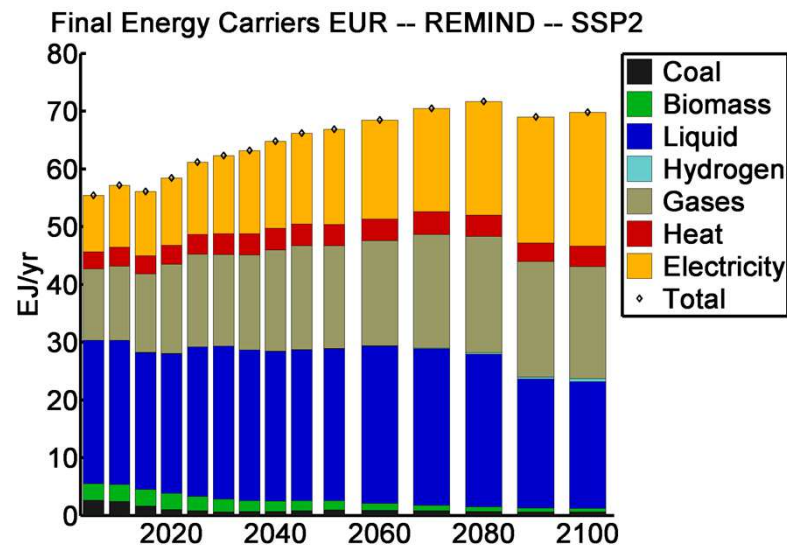
- 2010: 0.66 (ICES), 0.631 (REMIND), 0.66 (WITCH)
- 2050: 0.531 (ICES), 0.491 (REMIND), 0.476 (WITCH)



# Final energy carriers - World

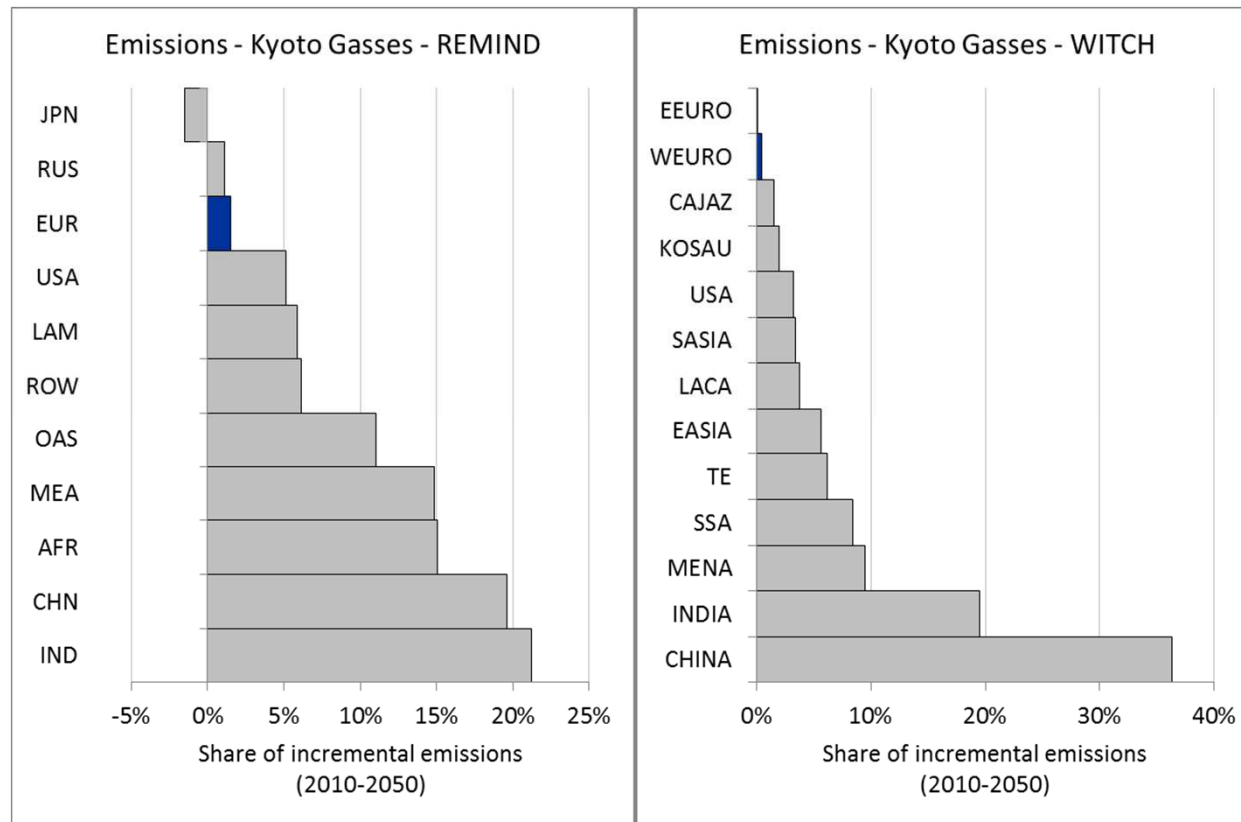


# Final energy carrier - Europe

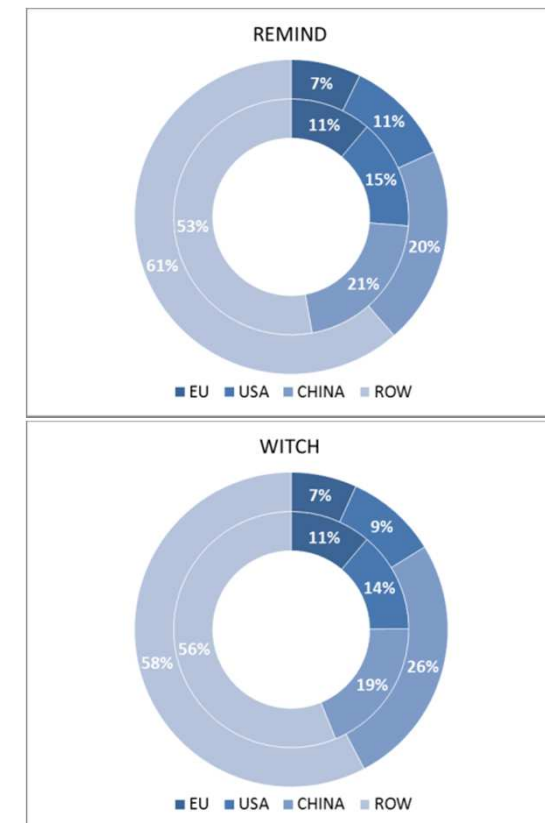


# Incremental GHG emissions

Share of incremental global GHG emissions  
2010-2050

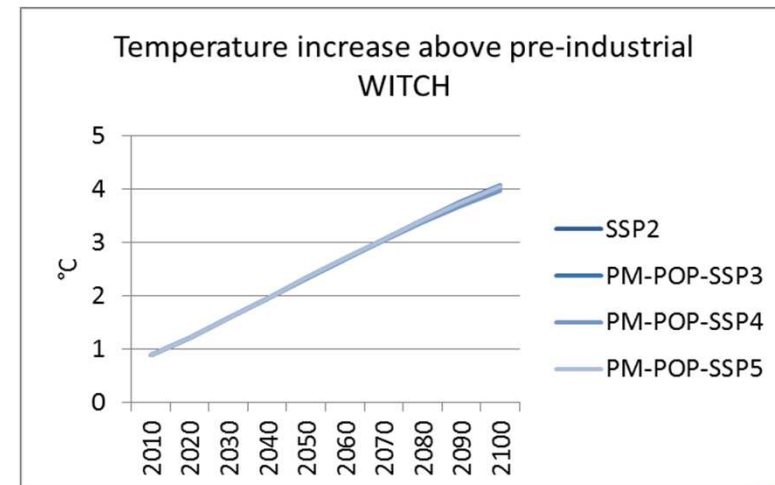
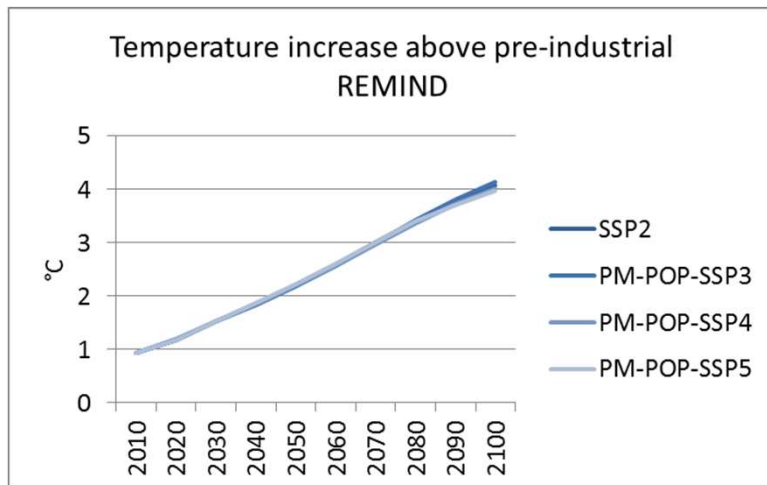
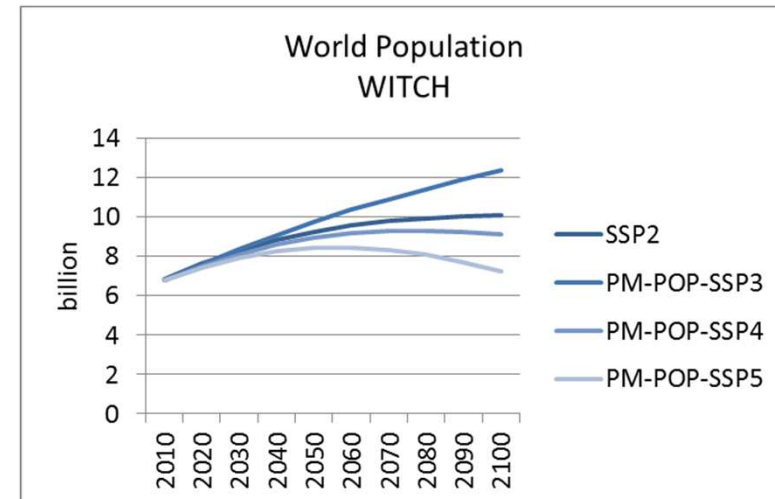
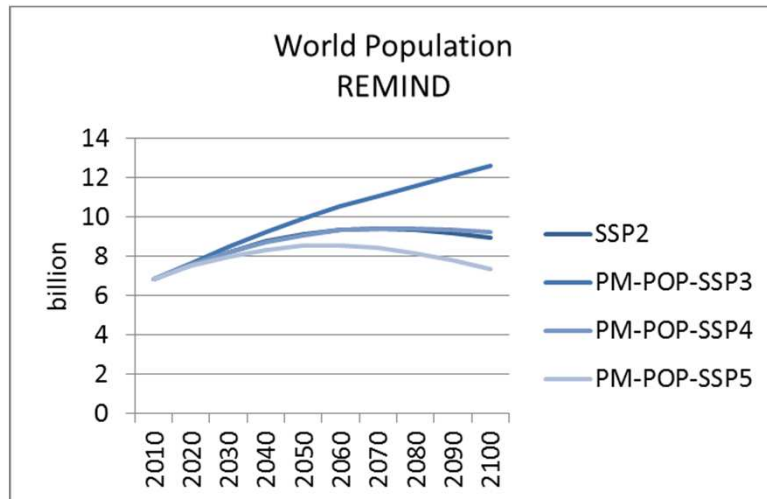


Share of global  
GHG emissions  
in 2010 and 2050



Notes: inner circle, 2010; outer circle, 2050.

# Emissions and population



# Economic impact of climate change

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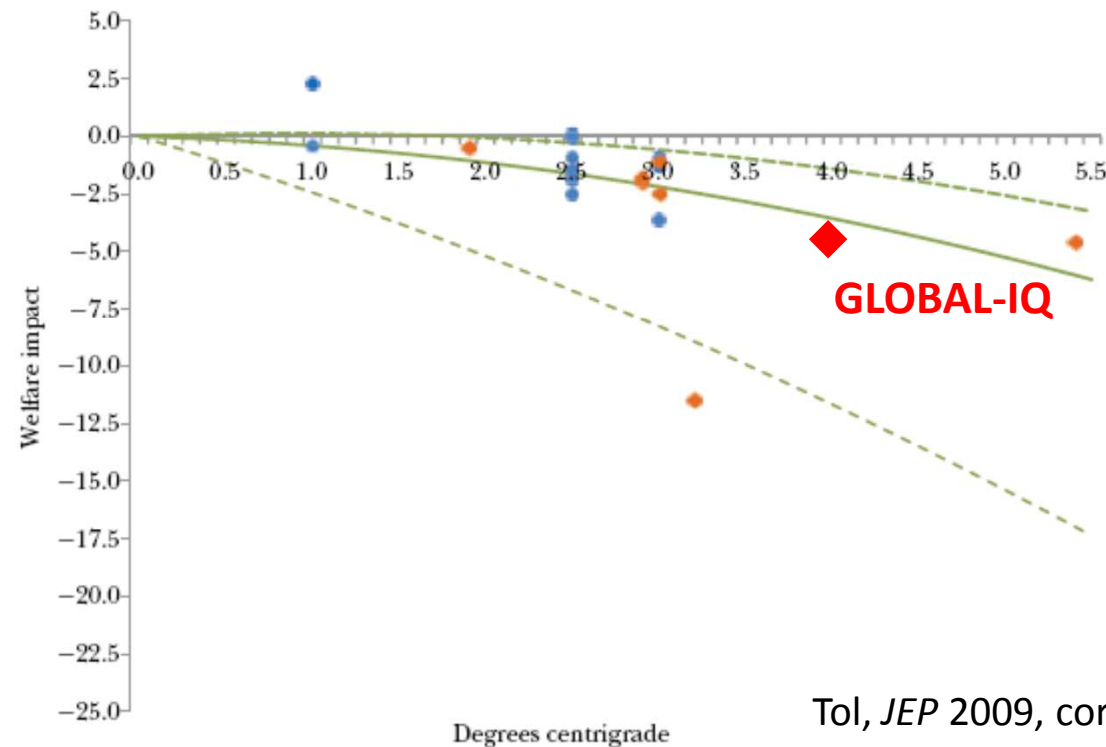
- Relationship between global temperature and regional economic losses (damage function)
- Derived using the ICES model
  1. Impacts estimates from the literature
  2. Economy-wide impacts with market flexibility
  3. Market impacts
  4. Catastrophic events
- Applied ex-post to the scenarios
- Repeated with limited market adaptation



# Comparison with the literature

Figure 2

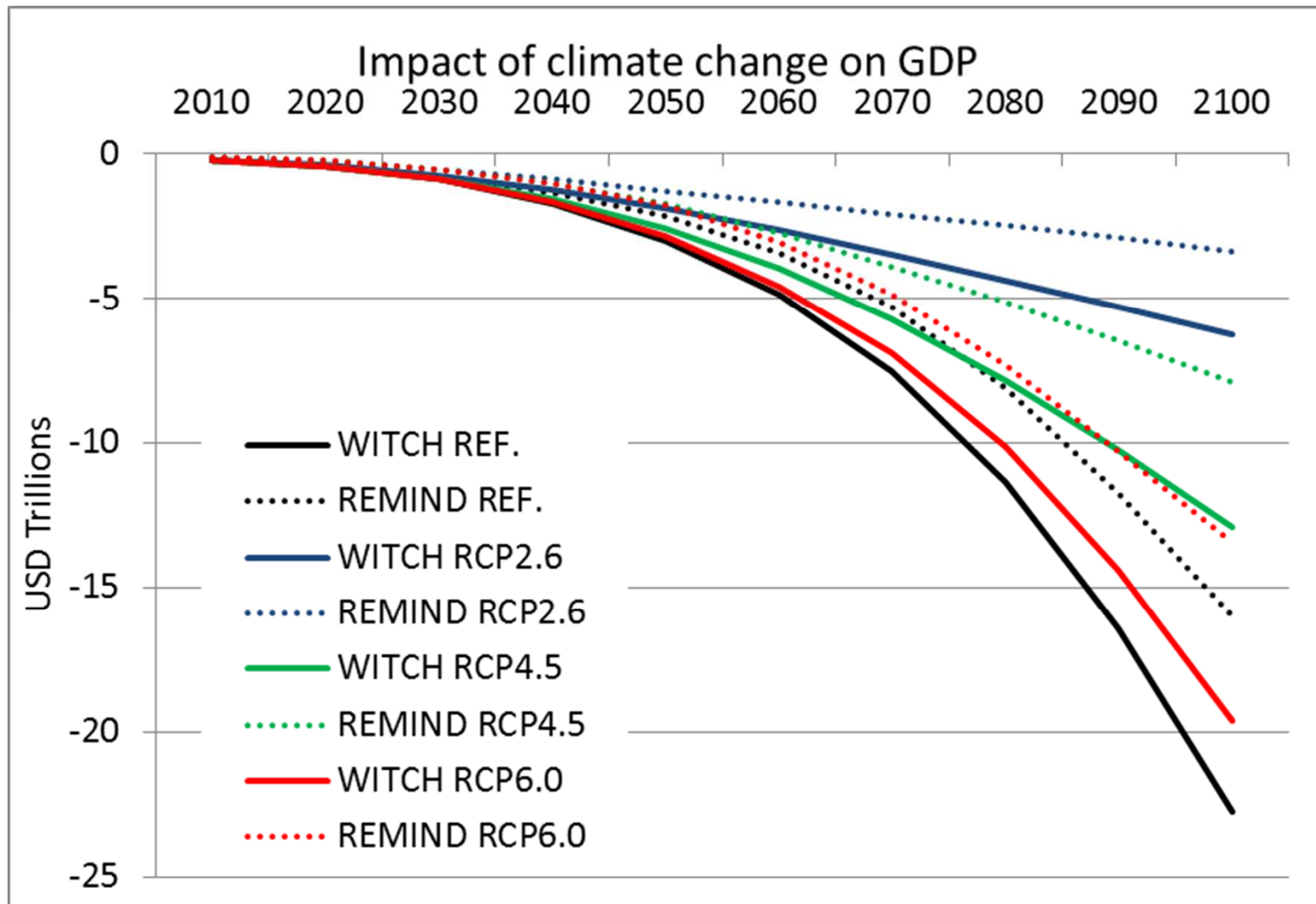
Twenty-One Estimates of the Global Economic Impact of Climate Change



- In line with the literature and IPCC WGII survey

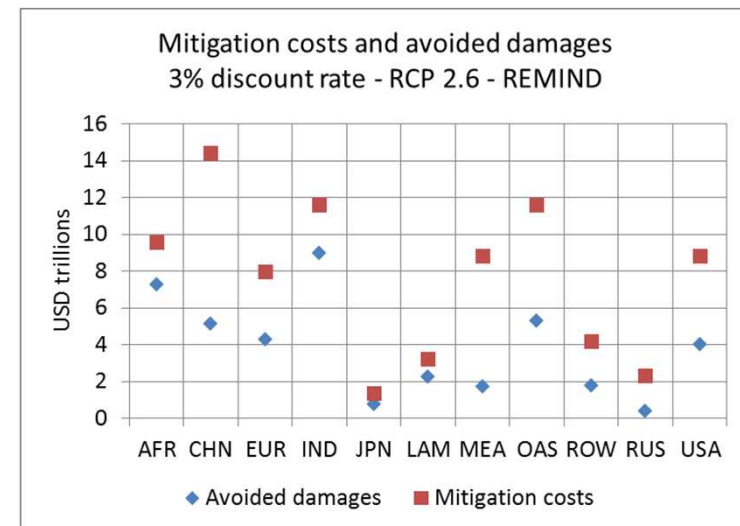
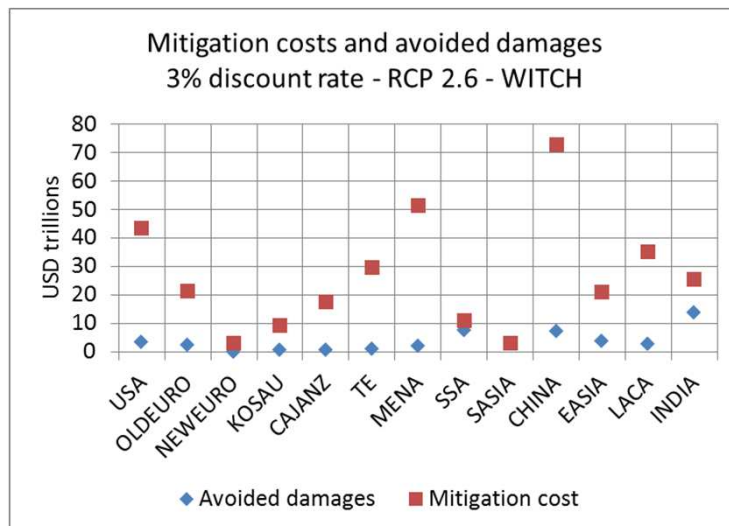
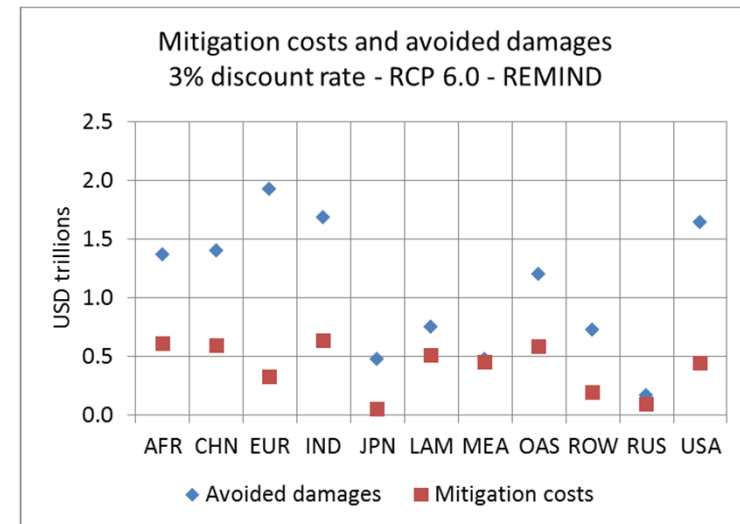
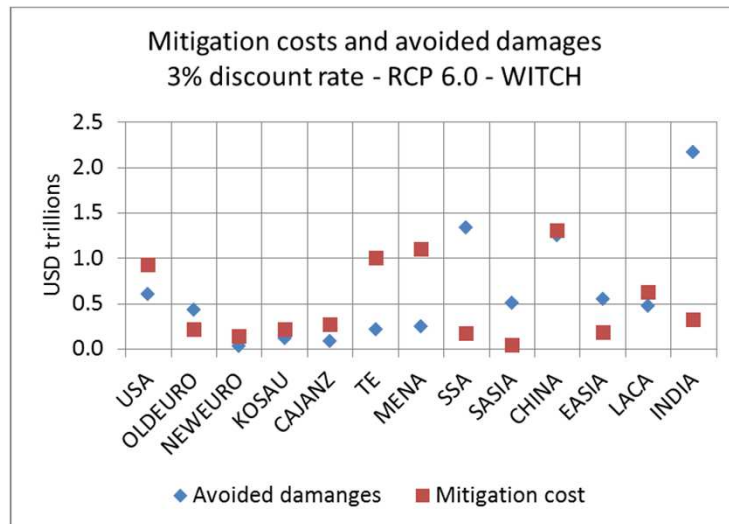


# Global residual damages

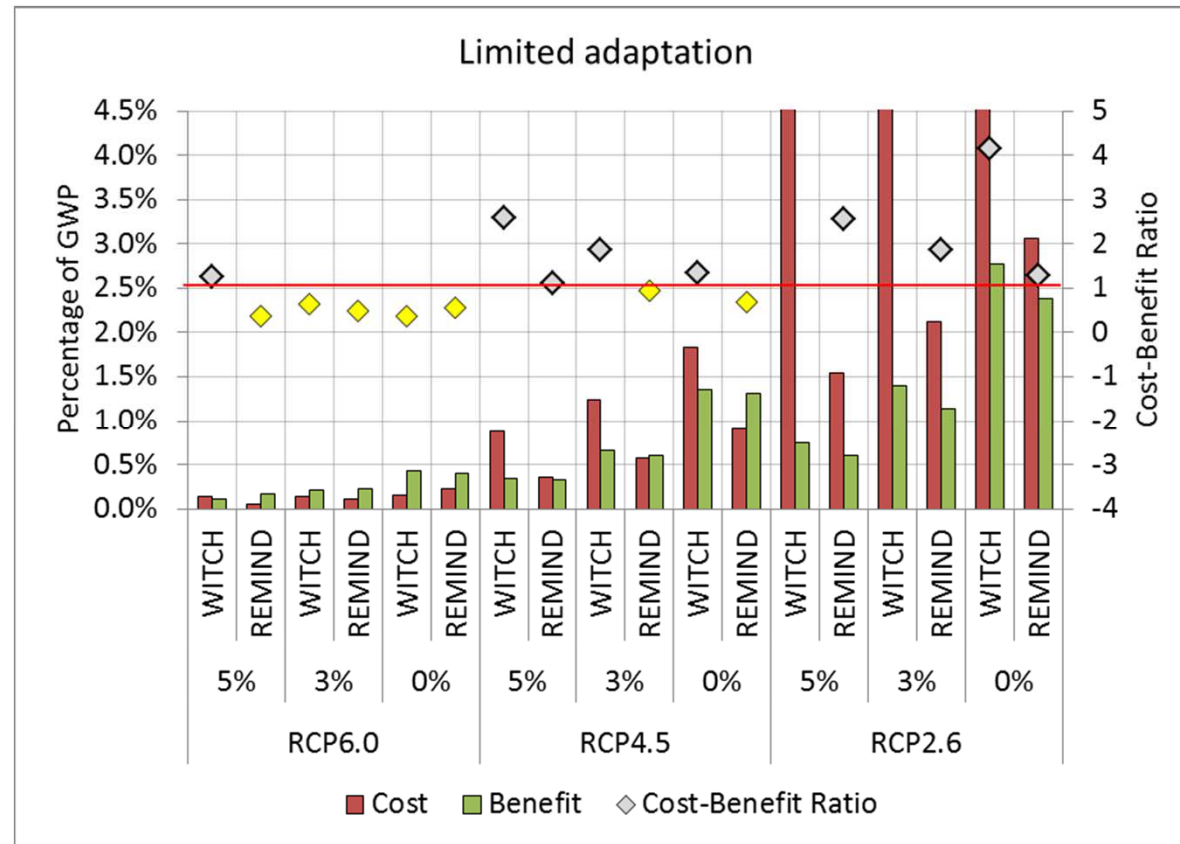





# Regional costs and benefits

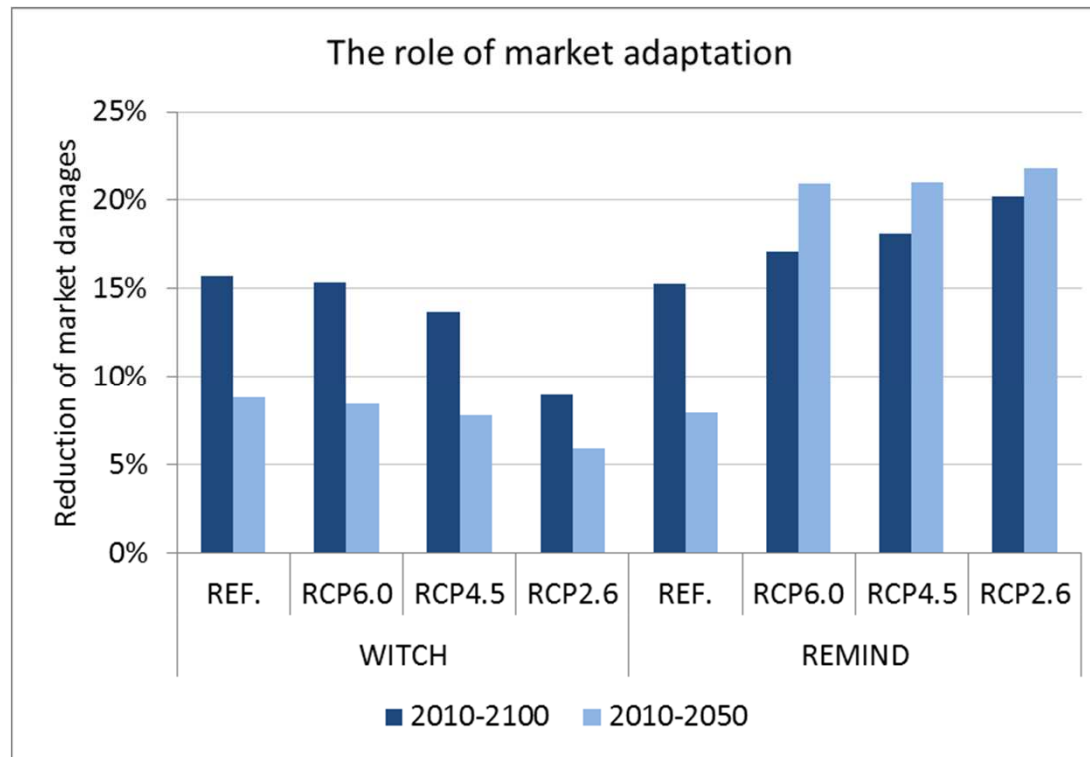


# Costs and benefits without adaptation



- Partial adaptation increases impacts but does not substantially change the cost-benefit exercise 

# The value of market adaptation



- Reduced labor and factor mobility and reduced trade openness.
- Partial adaptation increases impacts but does not substantially change the cost-benefit exercise.

