International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at

science for global insight

Harnessing systems-analytical tools to develop sustainable energy scenarios for the 21st century

David McCollum

Energy Program, IIASA

Acknowledgements:

Keywan Riahi, Volker Krey, Peter Kolp, Manfred Strubegger, Joeri Rogelj, Shilpa Rao, Markus Amann, Zig Klimont, Wolfgang Schoepp, Shonali Pachauri, Arnulf Gruebler, Nebojsa Nakicenovic, Jessica Jewell, Mathis Rogner, …

IIASA Systems Analysis 2015 Conference

November 11-13, 2015 (Laxenburg, Austria)

Post-2015 Sustainable Development Goals (SDG)

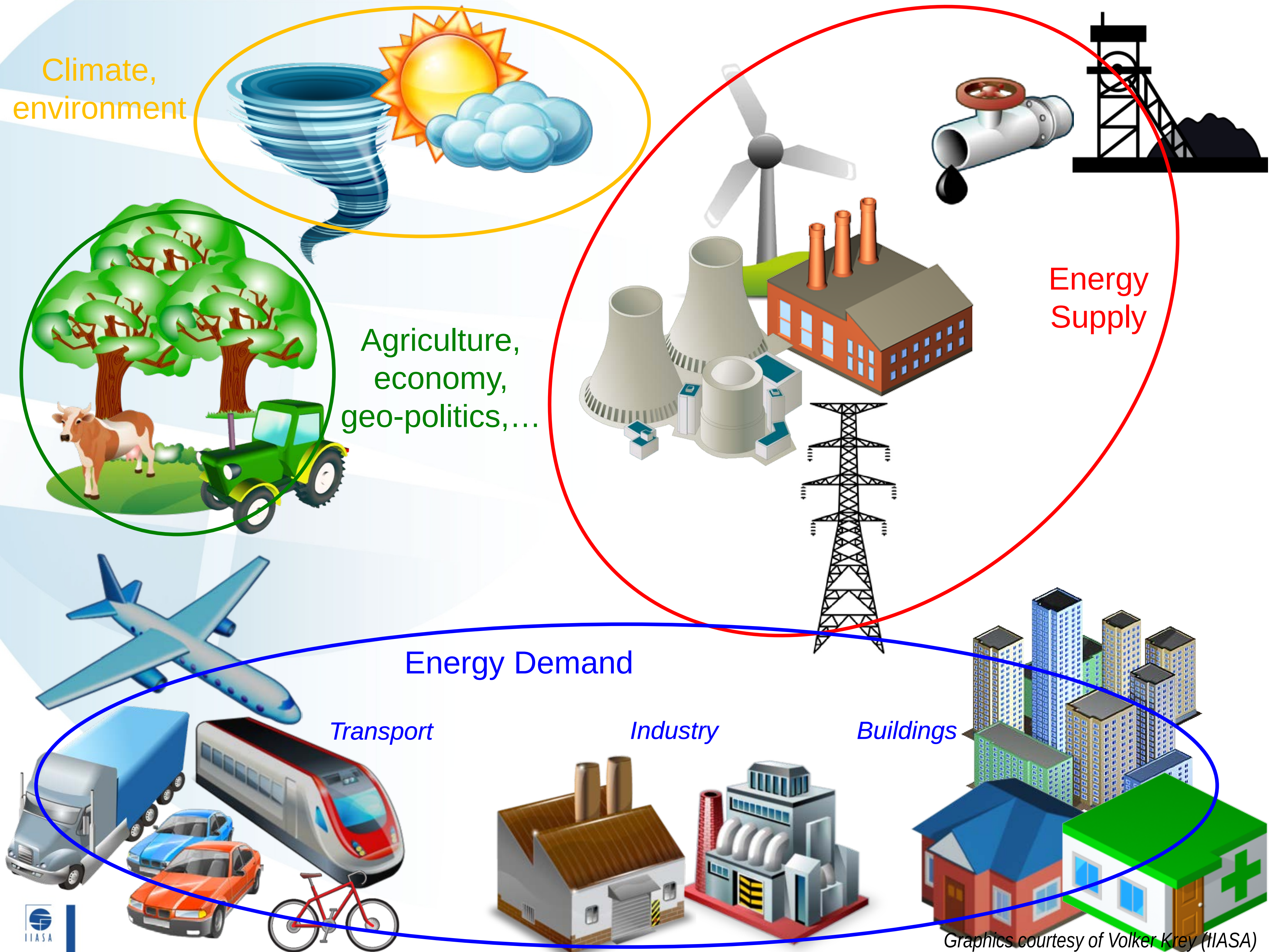
Source: https://sustainabledevelopment.un.org/

COP21: 2015 Paris Climate Conference

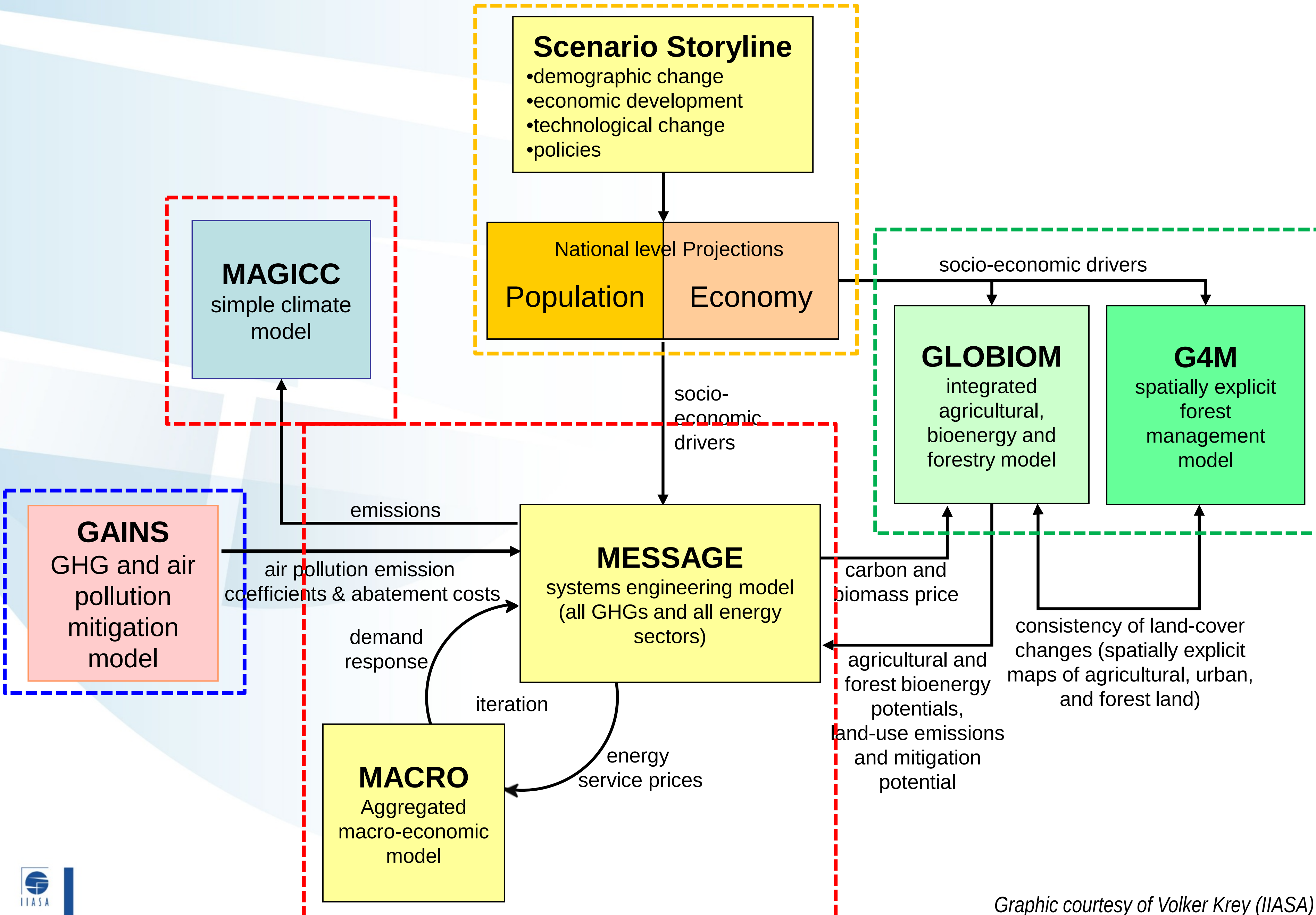
COP21 • CMP11
PARIS 2015
UN CLIMATE CHANGE CONFERENCE

Goal is to achieve a legally binding and universal agreement on climate, with the aim of keeping global warming below 2°C.

Part I: Thinking about *energy* as a *system*


Climate, environment
Agriculture, economy, geo-politics,…
Energy Supply
Energy Demand
Transport
Industry
Buildings
IIASA
Graphics courtesy of Volker Krey (IIASA)

IIASA Integrated Assessment Framework



Graphic courtesy of Volker Krey (IIASA)

‘Sustainable development’ means overcoming several energy challenges

Energy Poverty

Energy Security

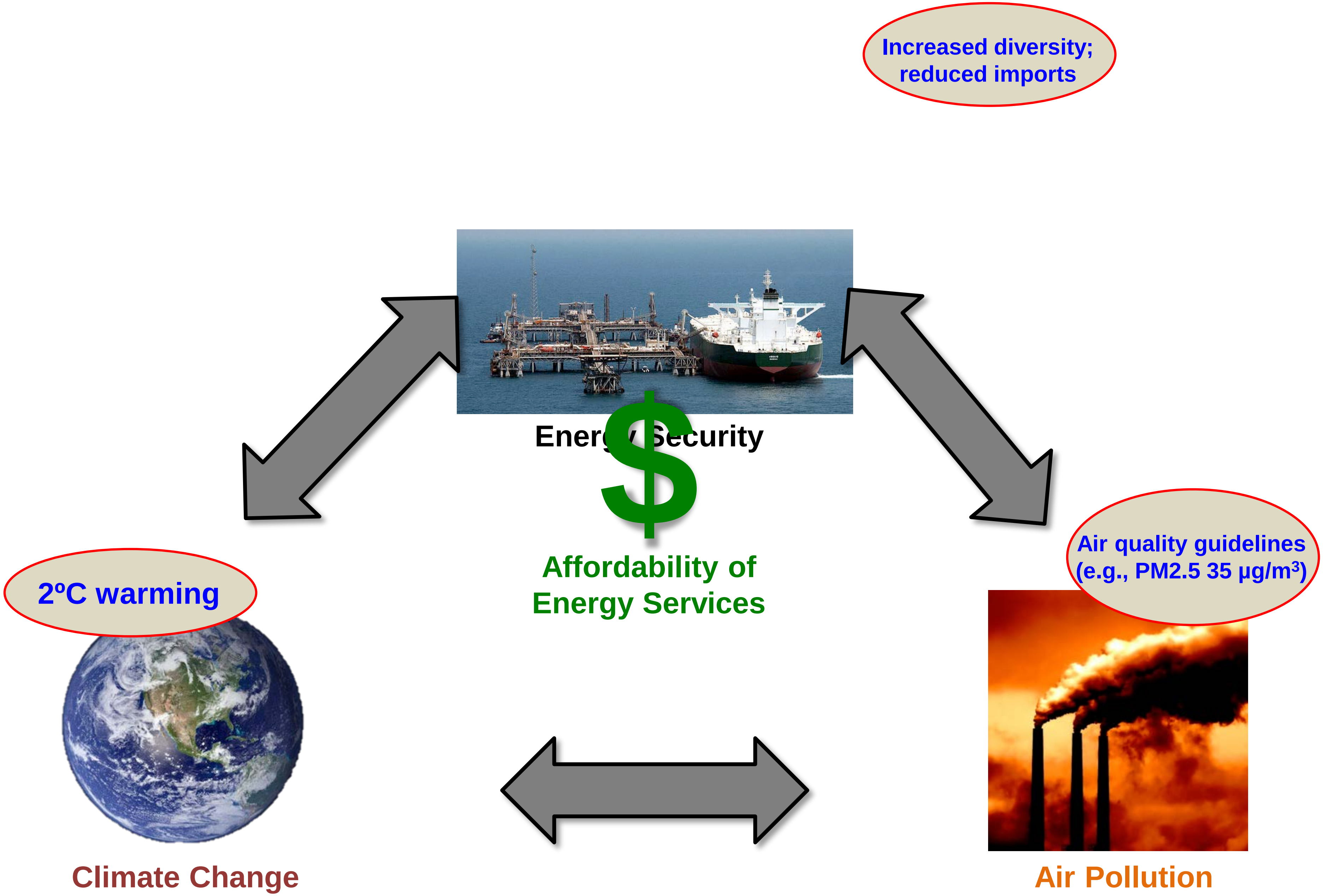
Food Security & Biodiversity

Climate Change

Water Scarcity

Air Pollution

Image sources: NASA, http://www.powernewsnetwork.com/white-house-releases-plan-to-cut-oil-imports-by-13-by-2025/1798/, http://wheresmyamerica.wordpress.com/2007/08/26/i-cant-see-my-america/, http://www.americanprogress.org/issues/green/report/2009/05/14/6142/energy-poverty-101/, http://today.uconn.edu/blog/2010/12/reclaiming-water-a-green-leap-forward/, http://te.wikipedia.org/wiki/%E0%B0%A6%E0%B0%B8%E0%B1%8D%E0%B0%A4%E0%B1%8D%E0%B0%B0%E0%B0%82:Forest_Osaka_Japan.jpg


Increased diversity; reduced imports
Energy Security
$
Affordability of Energy Services
2ºC warming
Climate Change
Air quality guidelines (e.g., PM2.5 35 μg/m^3)
Air Pollution

Modeled policies of varying stringency

Global warming

> 4°C
⋮
3°C
⋮
2°C
⋮
1.5°C

39 levels

Energy imports and diversity

Increasing stringency

Business-as-usual

Weak effort

Moderate effort

Stringent effort

4 levels

Air pollution framework (PM, SO_2, NO_x, BC, …)

Increasing stringency

No further improvement

Current legislation

Stringent legislation

Maximum feasible reduction

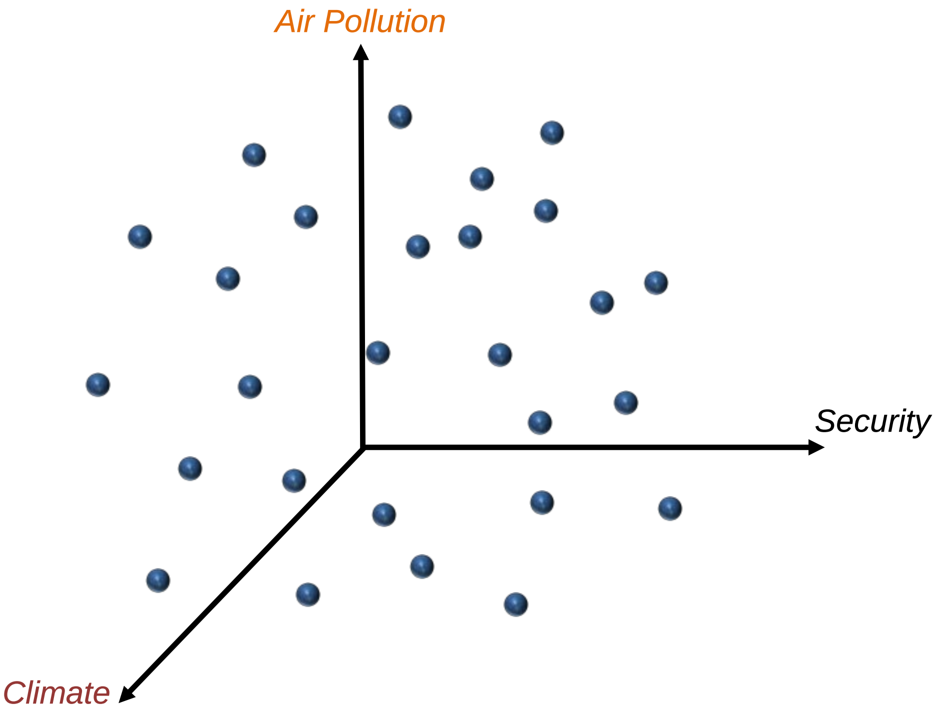
4 levels

A large scenario ensemble was generated

Climate Change

Energy Security

Air Pollution



>600 unique scenarios spanning the feasible scenario space (energy-climate-pollution-security futures)

Ref: McCollum, D., V. Krey, K. Riahi et al., "Climate policies can help resolve energy security and air pollution challenges." *Climatic Change* (2013).

Synergies of *energy efficiency and decarbonization* accrue in multiple dimensions

1. **Co-benefits for air pollution and human health**

   → improved air quality

   (22-32 million fewer disability-adjusted life years globally in 2030)

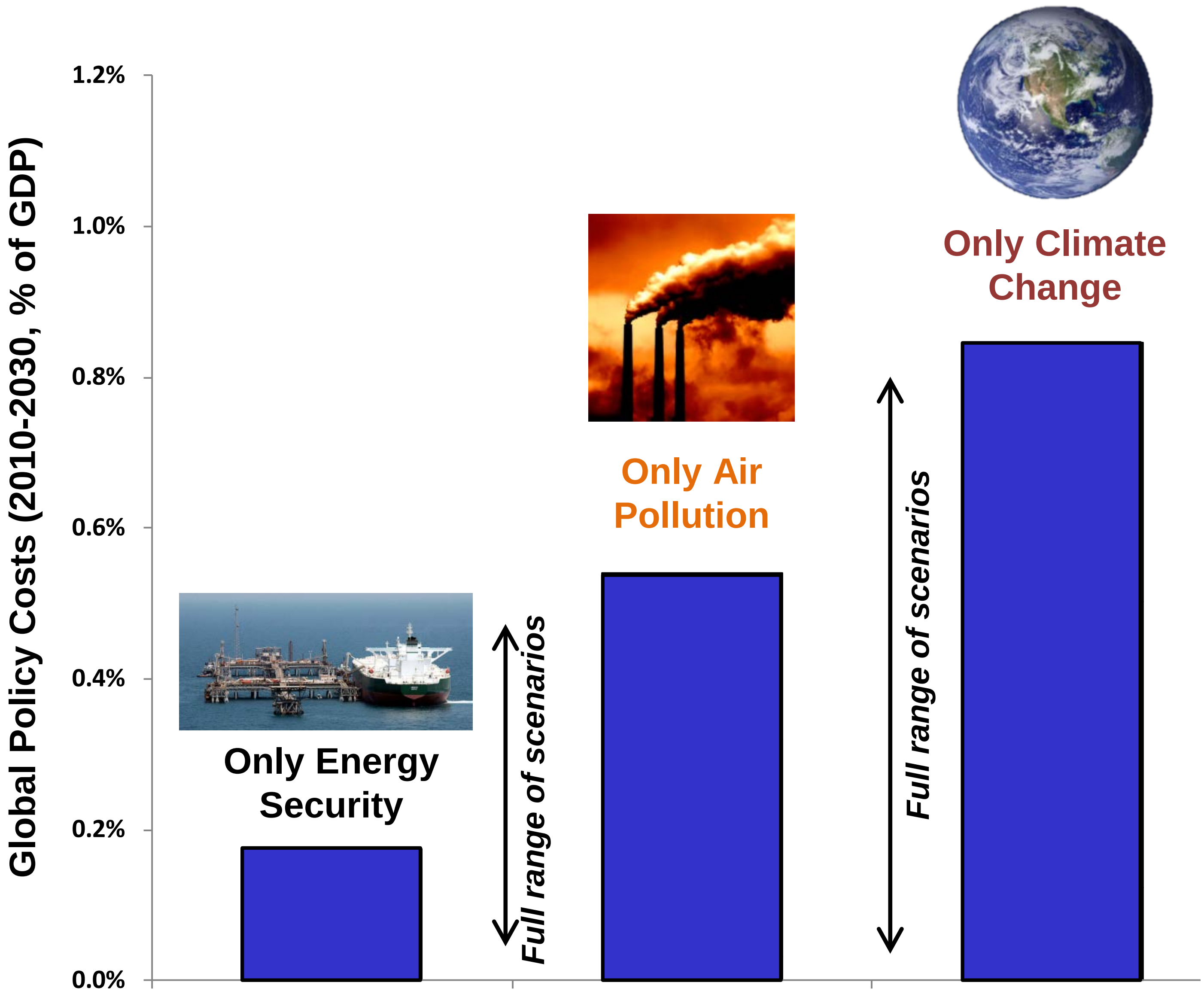
2. **Synergies for improved energy security**

   → more dependable, resilient, and diversified energy portfolios

3. **Cost savings and spillovers**

   → up to $600 billion/yr globally in reduced pollution control and energy security expenditures by 2030 (0.1-0.7% of world GDP)

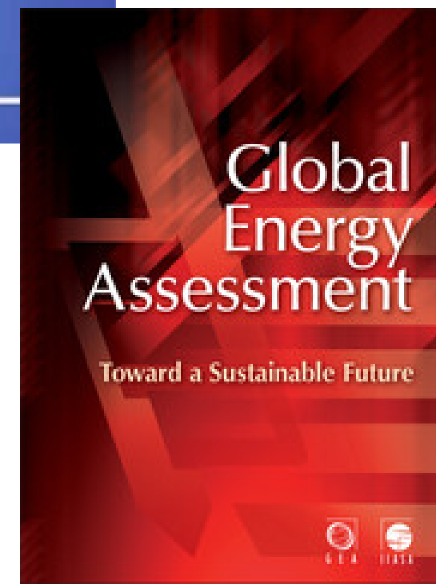
An integrated approach saves >$5 trillion (~0.5% of GDP)



Ref: McCollum, D., V. Krey, K. Riahi et al., "Climate policies can help resolve energy security and air pollution challenges." *Climatic Change* (2013).

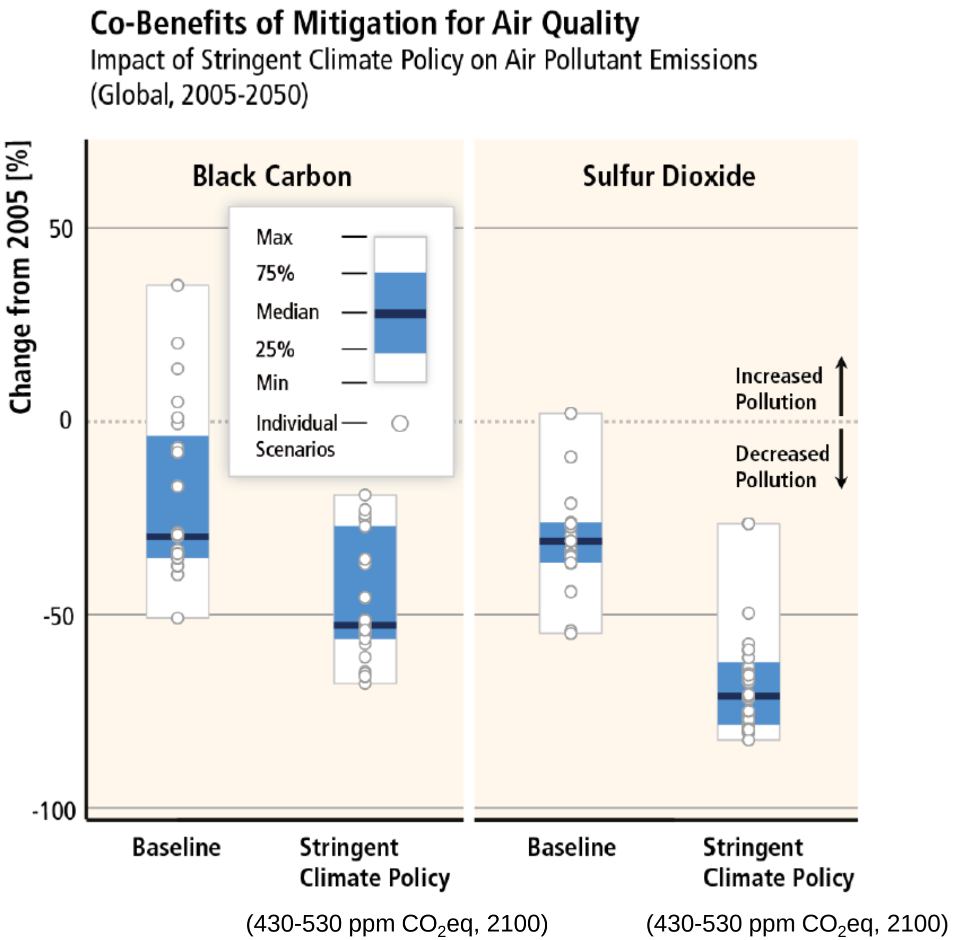
GEA Launch @ RIO+20, June 2012

Kandeh Yumkella, DG UNIDO, referred to the GEA report as the "energy bible".



Josè Goldemberg, Yong Ha Kim, H.E. Nguyen Thien, L. Gomez-Echeverri, Pavel Kabat, Hasan Mahmud, Kuntoro Mangkusubroto

Low-carbon scenarios show reduced costs for achieving air quality and energy security objectives, with significant co-benefits for human health, ecosystems, and energy resource sufficiency and resilience.



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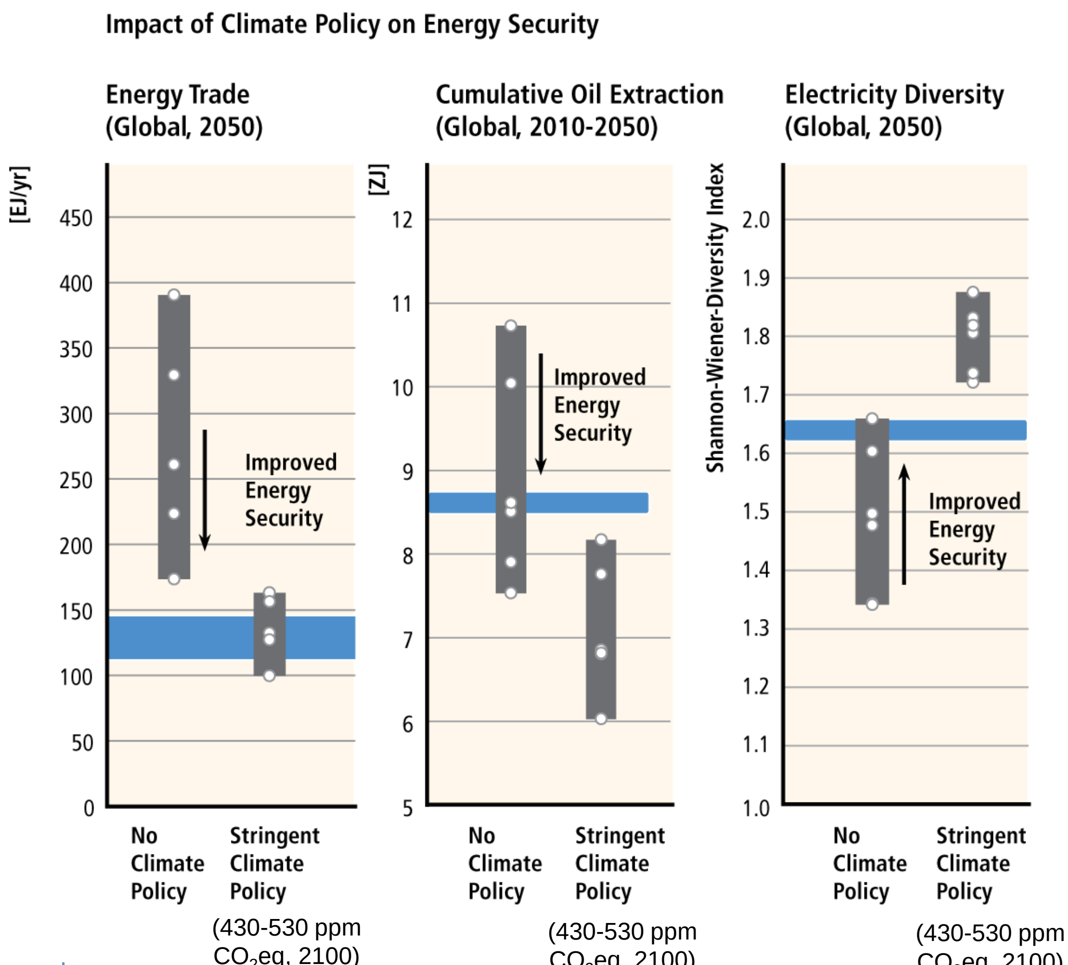
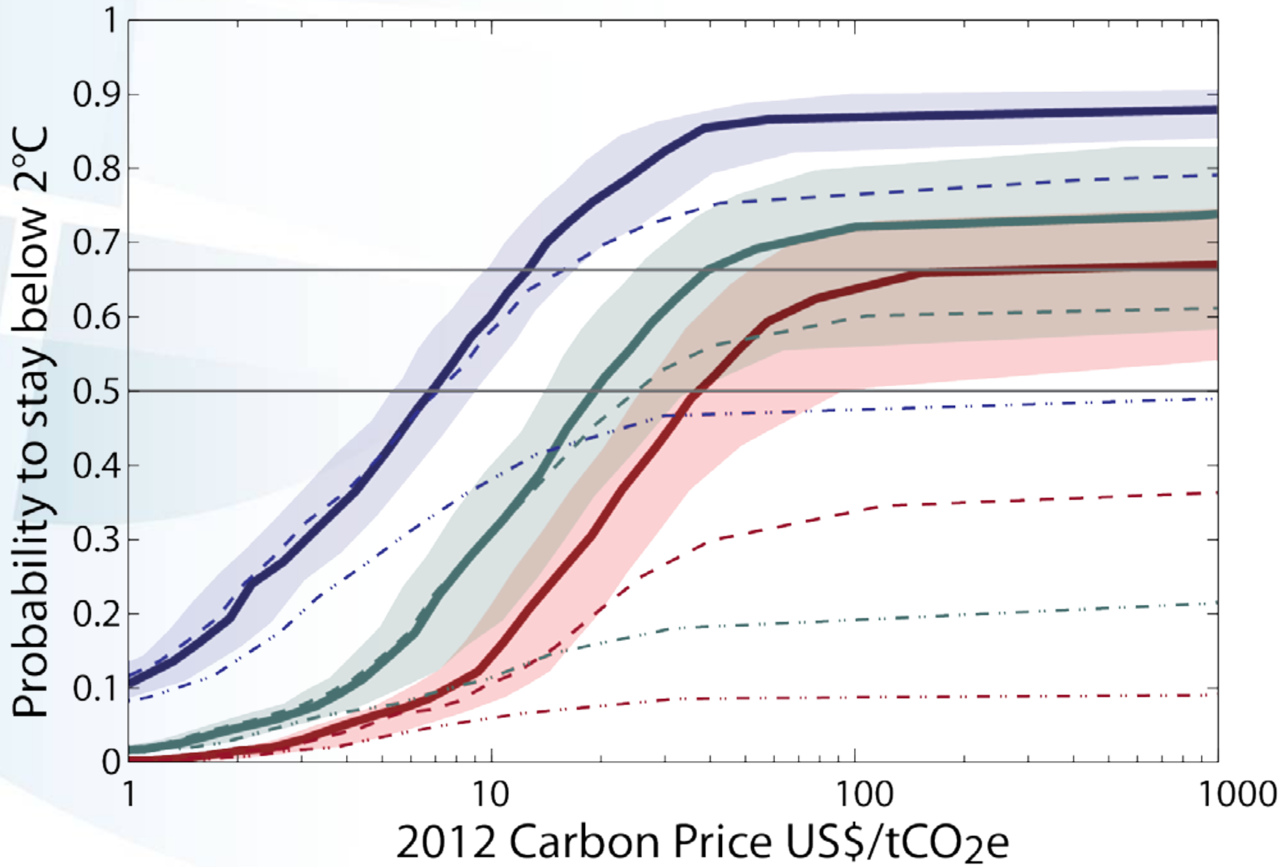
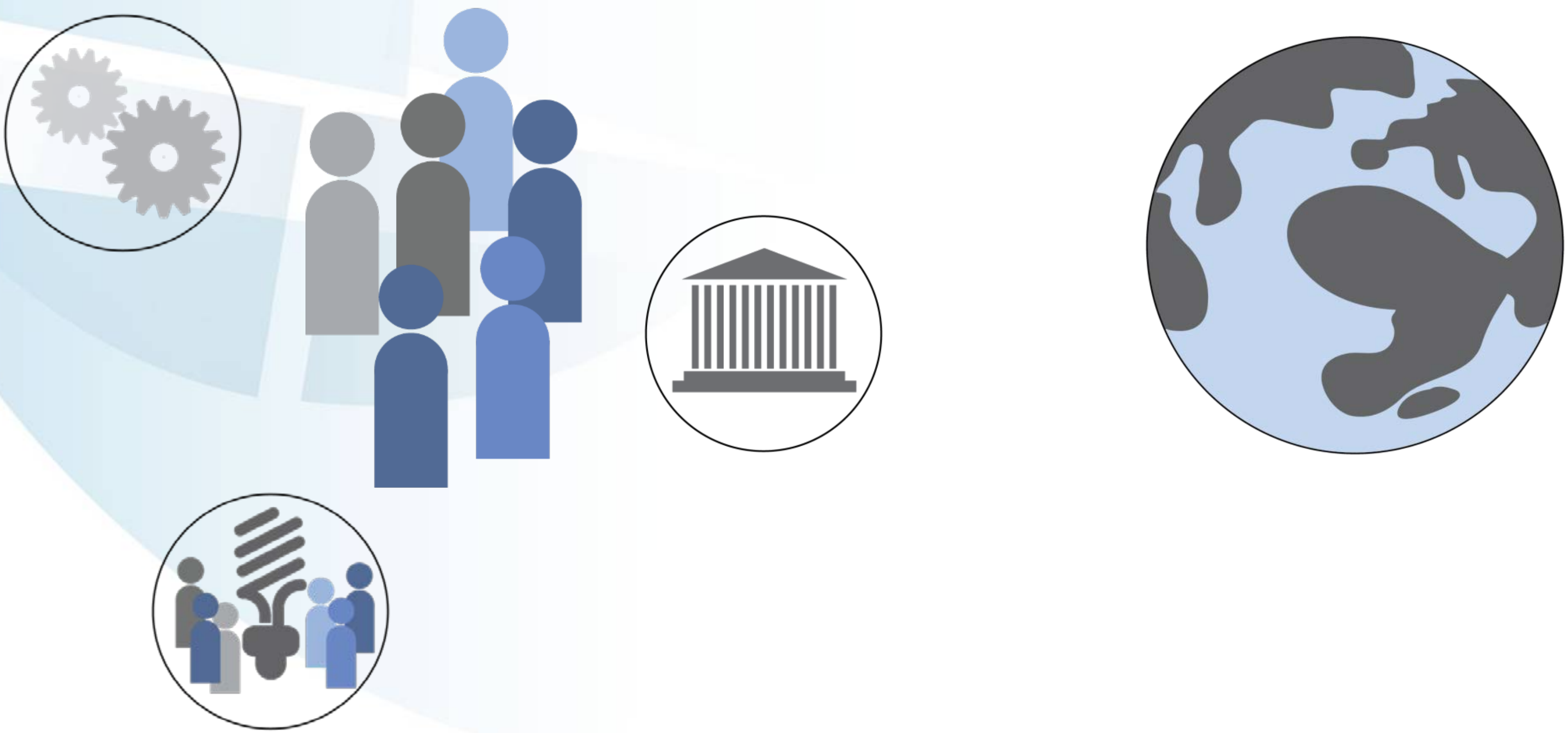


Part II: Integrating uncertainties for climate change mitigation



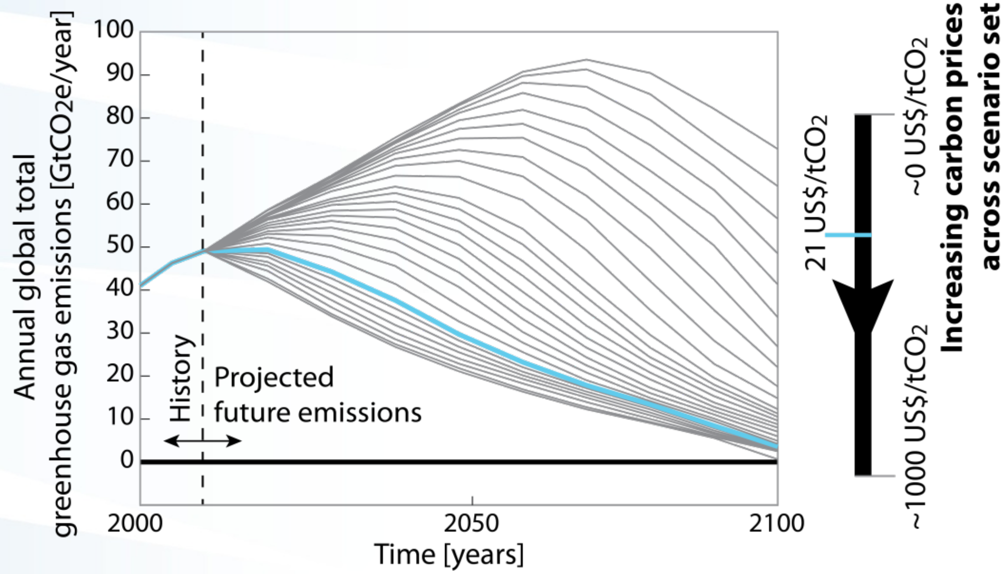
Acknowledgements: Joeri Rogelj

Integrating uncertainties for climate change mitigation

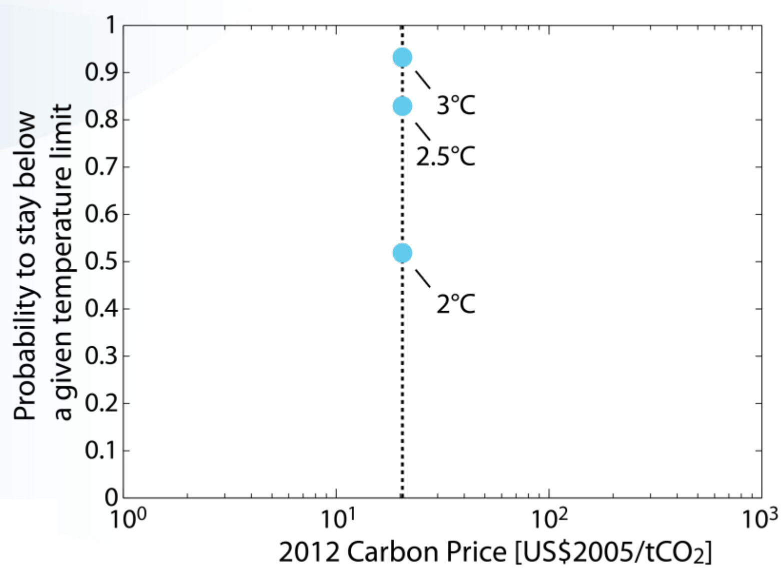


Methodology: developing cost-risk distributions for climate protection

MESSAGE



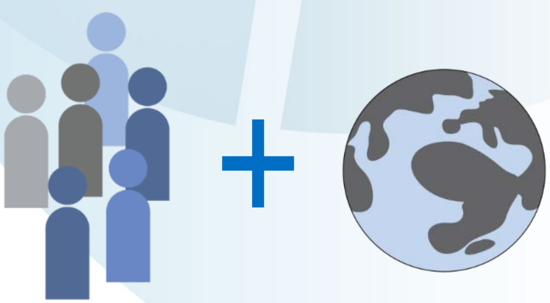
MAGICC

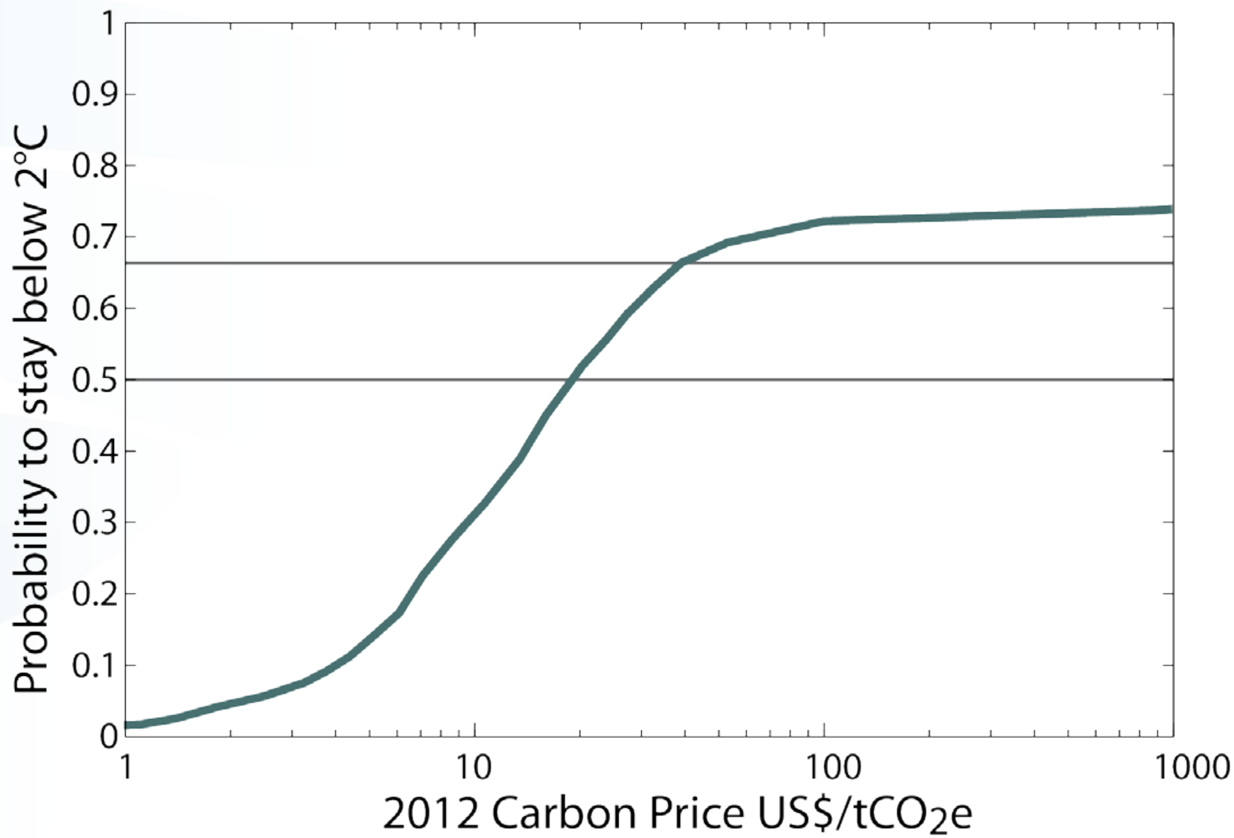


Graphics courtesy of Joeri Rogelj

Cost-risk framework for summarizing the importance of socio-political, technological, and geophysical uncertainties

2ºC





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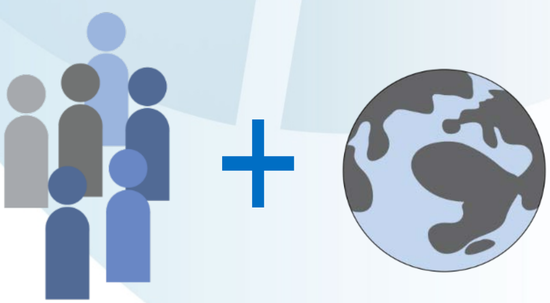
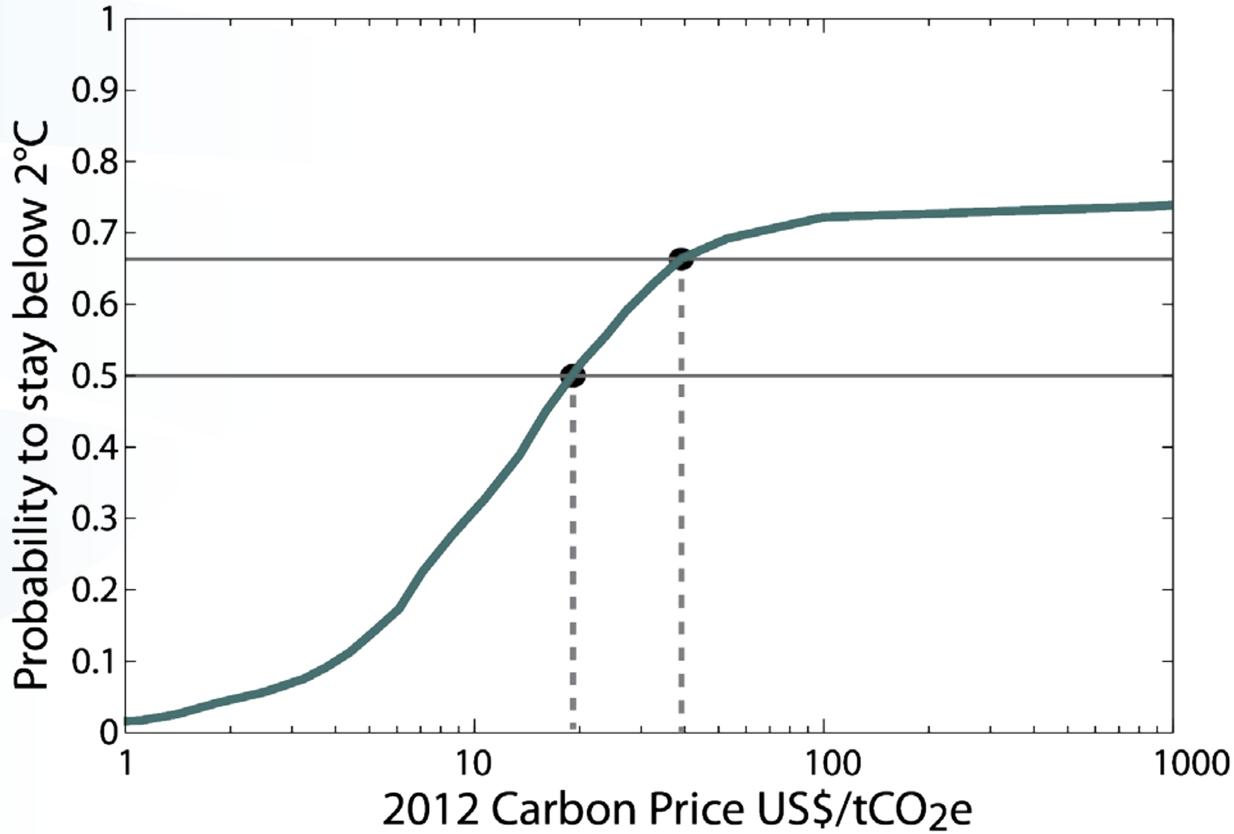


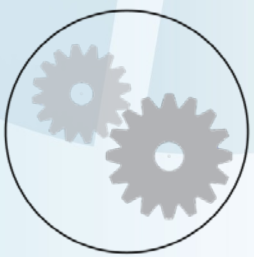


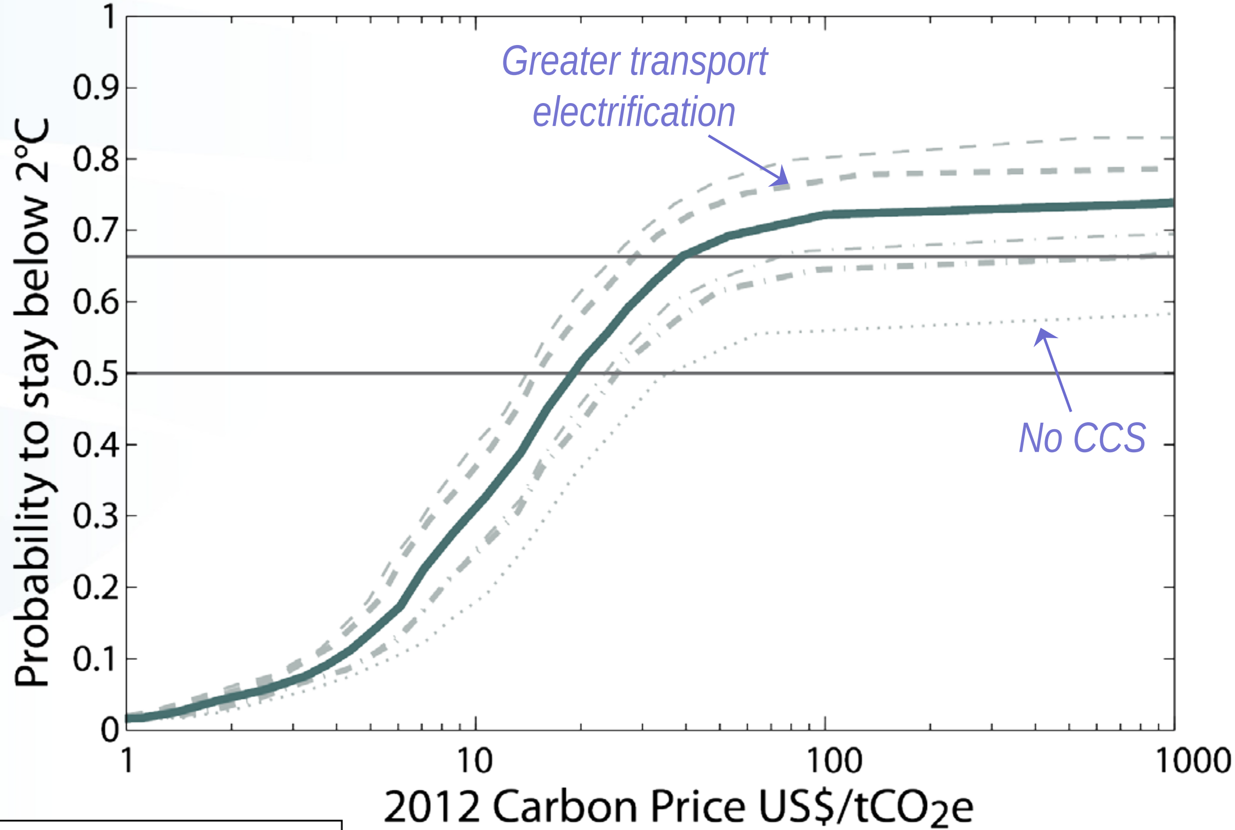
Ref: Rogelj J., D.L. McCollum, A. Reisinger, M. Meinshausen, K. Riahi, "Probabilistic cost estimates for climate change mitigation." *Nature* (2013) .

Technological uncertainties are ***large***

Cost-risk distribution

2ºC





Legend
- Reference full technology portfolio
- Advanced long-term non-CO_2 mitigation
- Advanced transportation
- No new nuclear
- Limited land-based mitigation measures
- No CCS

Cases based on:
Global Energy Assessment (Riahi et al. 2012)
Reisinger et al. (2012), Beach et al. (2008), Van Vuuren et al. (2006)

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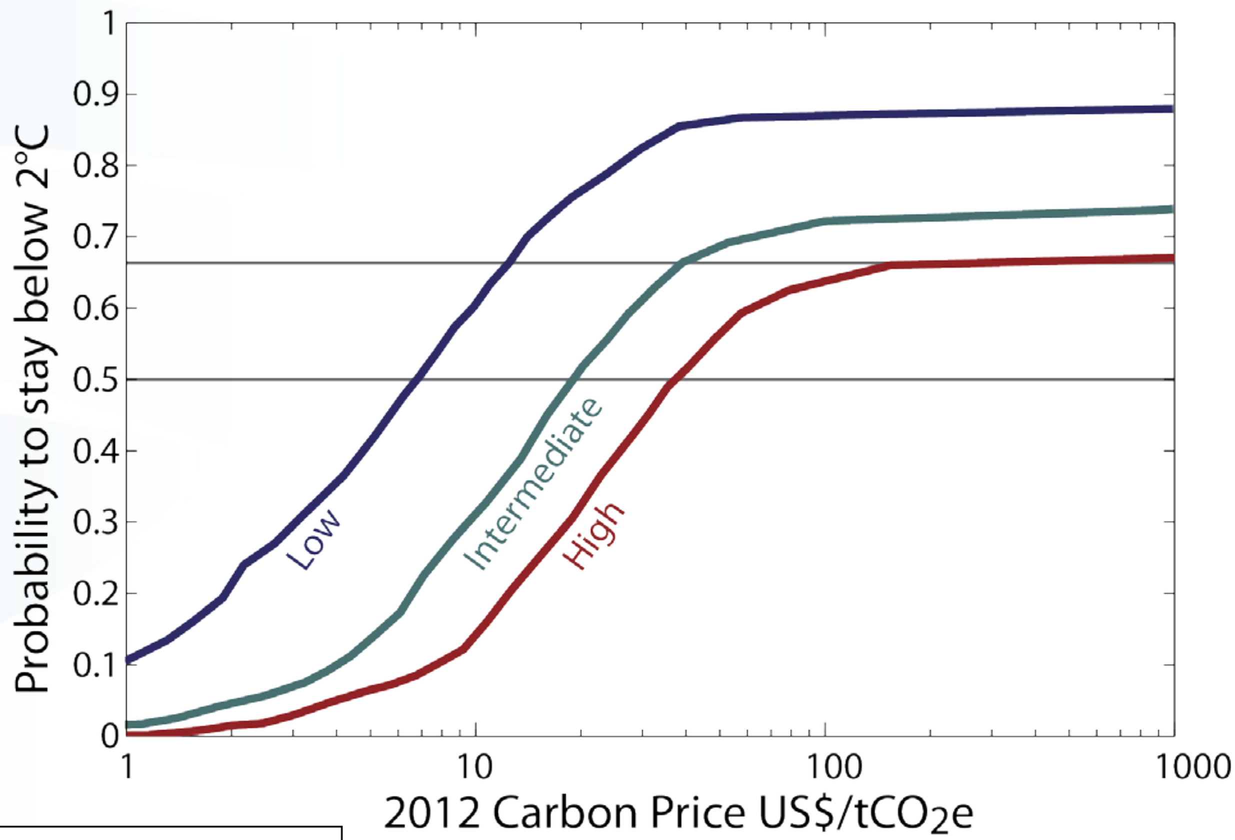
Ref: Rogelj J., D.L. McCollum, A. Reisinger, M. Meinshausen, K. Riahi, "Probabilistic cost estimates for climate change mitigation." *Nature* (2013) .

Social (energy demand) uncertainties are *larger*

Cost-risk distribution

2ºC



Legend
- Reference full technology portfolio
- Advanced long-term non-CO_2 mitigation
- Advanced transportation
- No new nuclear
- Limited land-based mitigation measures
- No CCS

Intermediate future energy demand
Low future energy demand
High future energy demand

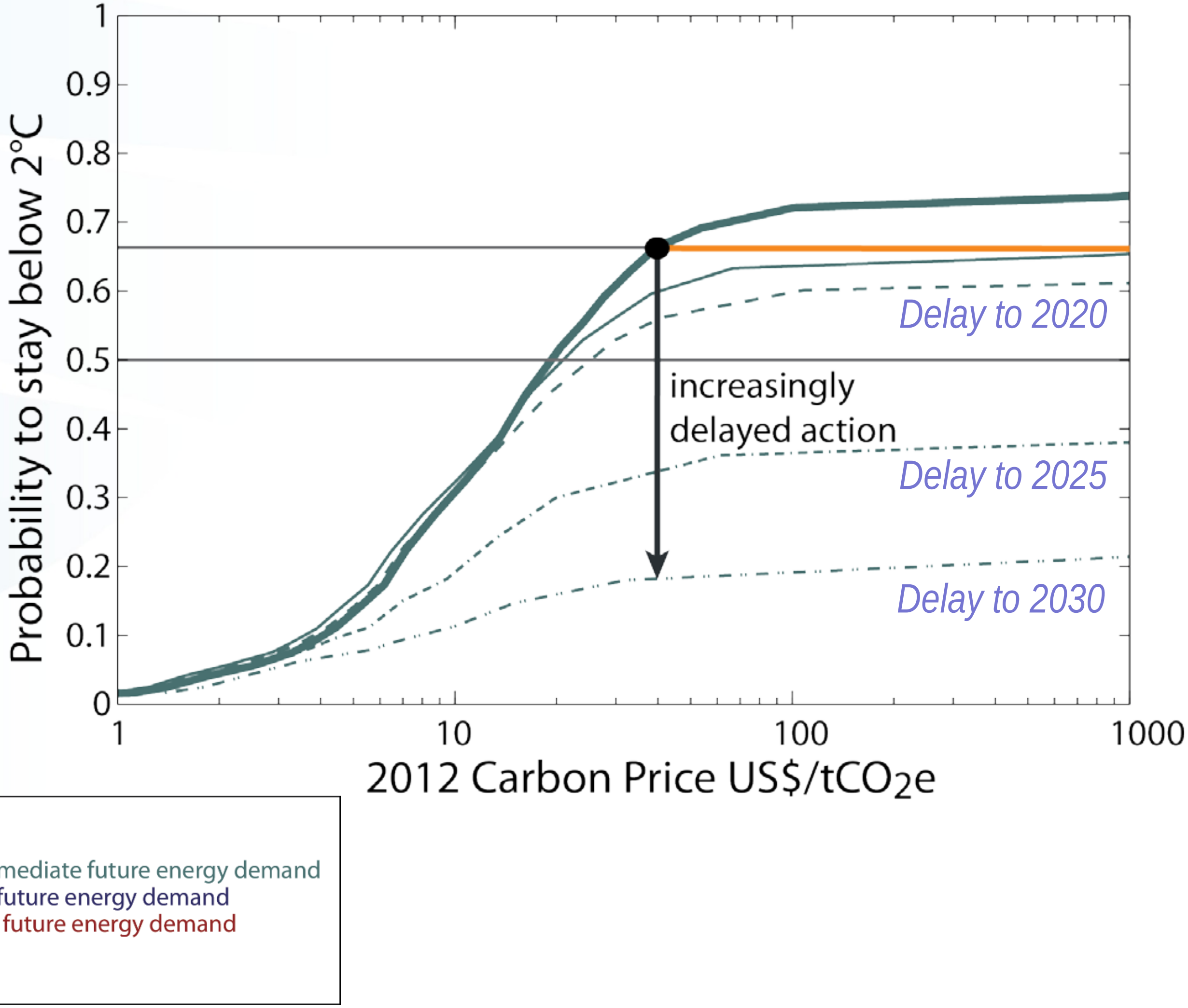
Cases based on:
Global Energy Assessment (Riahi et al. 2012)

Ref: Rogelj J., D.L. McCollum, A. Reisinger, M. Meinshausen, K. Riahi, "Probabilistic cost estimates for climate change mitigation." *Nature* (2013) .

Political (delayed action) uncertainties are *largest*

Cost-risk distribution

2ºC



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Systems analysis provides a lens through which complex interlinkages can be explored

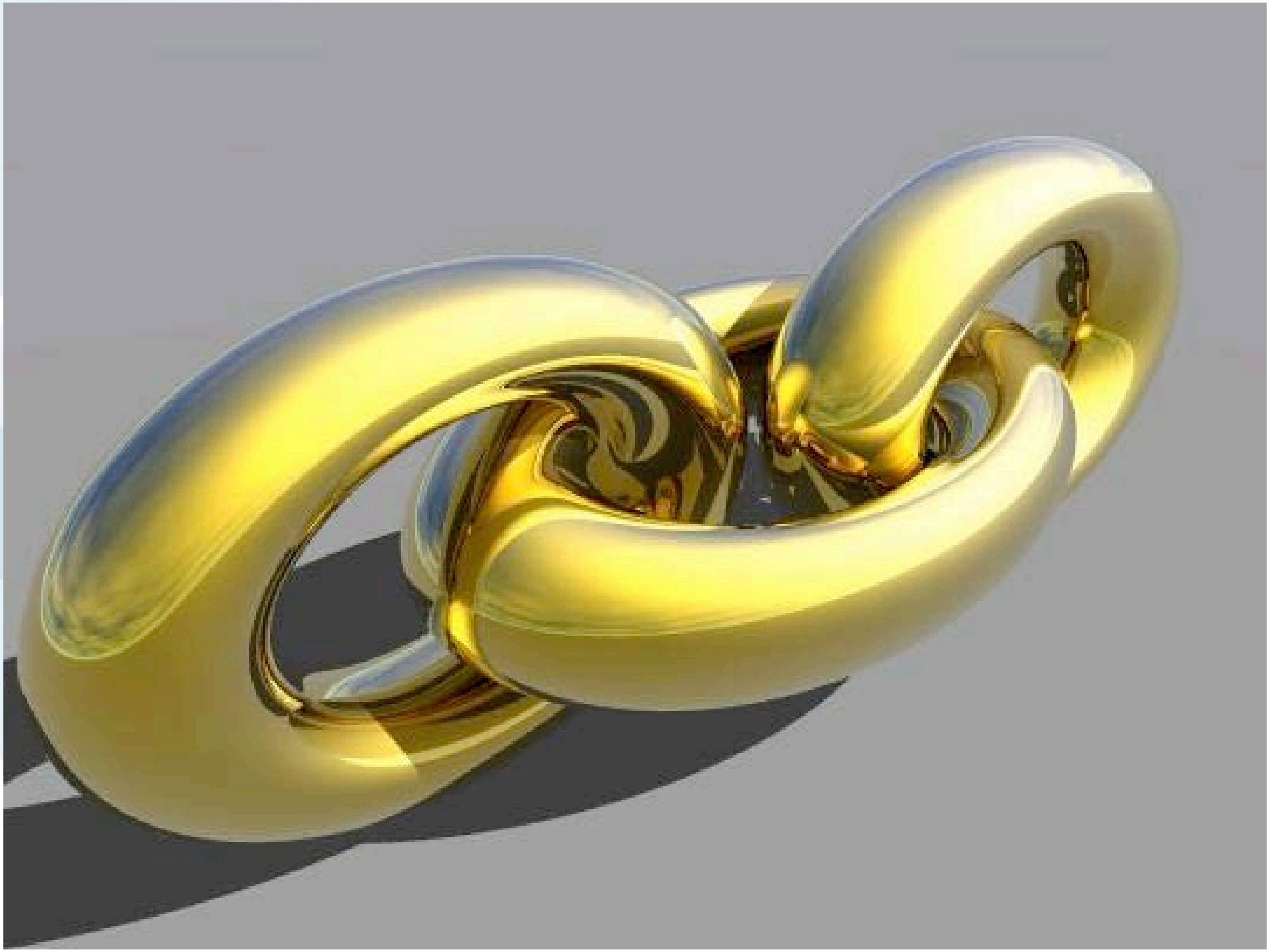

Image sources: http://www.irunoninsulin.com/?attachment_id=1887

Questions?
Comments?

Contact: David McCollum (mccollum@iiasa.ac.at)