Research on Co-Benefits and Adverse Side Effects of Mitigation

Volker Krey
IIASA ENE Program

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Outline

• Sustainable Development Goals
• Overview of existing studies
• Knowledge gaps
• Outlook on future work
Potential Co-benefits and adverse side-effect of energy transitions

<table>
<thead>
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<th>Sectoral mitigation measures</th>
<th>Economic</th>
<th>Social</th>
<th>Environmental</th>
<th>Other objectives</th>
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<td>Energy security</td>
<td>Productivity</td>
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<td>Material efficiency</td>
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↑ co-benefit, ↓ adv. side effect

Source: von Stechow et al., 2016
<table>
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<th>Technology</th>
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Synergies across 2°C pathways and sustainable energy objectives

Trade-offs across 2°C pathways and sustainable energy objectives

Source: von Stechow et al., 2015
Air Quality Co-Benefits

**IPCC AR5 Scenario Ensemble**
Impact of Climate Policy on Air Pollutant Emissions (Global, 2005-2050)

- **Black Carbon**
  - No Climate Policy
  - Stringent Climate Policy

- **Sulfur Dioxide**
  - No Climate Policy
  - Stringent Climate Policy

Increased Pollution

Decreased Pollution

Global PM2.5 concentrations ~ 30.4 µg/m³

Source: IPCC WGIII AR5, Figure SPM.6/6.33

Source: Rao, Pachauri et al., 2013
Energy Security
Co-Benefits of Climate Policy on Energy Security

LIMITS Model Inter-Comparison
Impact of Climate Policy on Energy Security

Source: IPCC WGIII AR5, Figure 6.33
Assessment of Energy Security

For Different levels of concentration under Scenario A-I

\[ ESI = \frac{C_{oil}}{TPES} \sum_i \left( r_i \cdot S_{i,oil}^2 \right) + \frac{C_{gas}}{TPES} \sum_i \left( r_i \cdot S_{i,gas}^2 \right) \]

Share of imported oil in TPES  Political risks of region i  Dependence on region i

ESI: energy security index, TPES: total primary energy supply

Note: index based on IEA, 2007

While the energy security index of Japan decreases (less vulnerable) for CP3.0 (synergies), that of China, India increases (more vulnerable) for deeper emission reductions due to increase in imported gas shares (trade-offs).

Source: Akimoto et al., 2012
Technical potential exists.... Food and biodiversity

Global biodiversity and options to prevent biodiversity loss

Global biodiversity

Source: van Vuuren et al., 2012
Food Availability
Food availability and hunger
Food availability

Source: Havlík, Valin et al. 2015, WB
Energy Poverty
Energy Poverty in South Asia

Source: Pachauri et al. 2012, GEA
Impact of Climate Policy on Energy Access (w/o compensatory mechanisms)

Source: Cameron et al., 2016
Solid Fuel Dependence
No New Policies

Source: Cameron et al., 2016
Solid Fuel Dependence
Effect of 2°C Climate Policy

South Asia

Solid Fuel Use (% of Population)

2010  2020  2030  2040  2050

0%  10%  20%  30%  40%  50%  60%  70%  80%

2°C Climate Policy
No New Policy

0.5 mill deaths

Source: Cameron et al., 2016
Integrated Climate and Access Policies

South Asia

Solid Fuel Use (% of Population)

- 2° Climate Policy
- No New Policy
- Climate and Access

Source: Cameron et al., 2016
Water Availability
What are the Implications of Different Land Use and Bioenergy Pathways on Water Scarcity?

- Human system dynamics have a critical influence on future water scarcity.

- The percent of global population living in grids classified as water scarce in 2095 depends substantially on the role of bioenergy in future pathways.

Figures show water scarcity associated with different pathways toward roughly 4 W/m² relative to a higher-emissions reference scenario leading to forcing of roughly 8.5 W/m². Scarcity defined as annual water demand over annual water supply.

Source: Hejazi et al. 2014. Hydrology & Earth Sys. Sc. – courtesy of Jae Edmonds
Impact of Energy Sector on Water Withdrawal, Consumption, and Thermal Pollution

Source: Fricko, Parkinson et al., 2016

No climate policy
Reference
Impact of Energy Sector on Water

Withdrawal

Consumption

Thermal Pollution

Baseline

Source: Fricko, Parkinson et al., 2016
Impact of Energy Sector on Water

Alternative Technology Choices for 2C (intermediate energy demand)

Withdrawal  Consumption  Thermal Pollution

Source: Fricko, Parkinson et al., 2016
Impact of Energy Sector on Water

High Energy Demand

Withdrawal

Consumption

Thermal Pollution

Source: Fricko, Parkinson et al., 2016
Impact of Energy Sector on Water

Low Energy Demand (Efficiency)

Withdrawal

Consumption

Thermal Pollution

2 °C Energy Transformation Pathways (Cost % Ref.)

- Full mitigation portfolio (122 %)
- Limited wind/solar (133 %)
- No carbon capture and storage (143 %)
- No new nuclear (138 %)

Uncertainty Range

Range in 2100

Source: Fricko, Parkinson et al., 2016
Impact of Energy Sector on Water Efficiency + Water Adaptation Policies

Withdrawal

Consumption

Thermal Pollution

Source: Fricko, Parkinson et al., 2016
Simultaneous Assessment of Multiple Objectives
Synergies of Multiple Energy Objectives

“Single-minded” approaches for multiple challenges

Integrated Climate-Pollution-Security Policies

Added costs of ES and PH are comparatively low when CC is taken as an entry point

D. McCollum, V. Krey, K. Riahi (2011)
## Interactions!

<table>
<thead>
<tr>
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<th>Access to water</th>
<th>Access to energy</th>
<th>Clean energy</th>
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Source: van Vuuren et al. 2012
Knowledge Gaps and Future Research
Knowledge Gaps

• Improved integration: Going beyond pairs of sustainable development objectives
• Universality: Looking at national and regional context of synergies and trade-offs
• Social dimension: differential impacts on heterogeneous population groups
CD-LINKS Project

Integrated Approach:
• Climate AND Sustainable Development
• National AND Global

Multiple Objectives:
• Economic development
• Energy poverty and inequality
• Air quality and health
• Water
• Food security
• Biodiversity
• Adaptation, resilience and reduced risks
• Energy security

http://www.cd-links.org
The World in 2050 “Consortium”

- AIMES
- Brazilian Federal Agency for the Support and Evaluation of Graduate Education (CAPES)
- Centre for Integrated Studies on Climate Change and the Environment (CIRED)
- Commonwealth Scientific and Industrial Research Organization (CSIRO)
- Earth League, whole Earth system modelling initiative
  - Earth Institute, Columbia University
  - Energy Planning Program, COPPE, Federal University of Rio de Janeiro
  - Fondazione Eni Enrico Mattei (FEEM)
  - Future Earth
  - German Development Institute (DIE)
  - Global Ocean Ecosystem Dynamics (GLOBEC)
  - Indian Institute International Futures
  - Indian Institute of Technology (IIT)
  - International Energy Agency (IEA)
  - International Food Policy Research Institute (IFPRI)
  - International Monetary Fund (IMF)
  - International Institute for Applied System Analysis (IIASA)
- Intergovernmental Panel on Climate Change (IPCC)
- Joint Global Change Research Institute at Pacific Northwest National Laboratory (JGCRI/PNNL)
- Mercator Research Institute on Global Commons and Climate Change
- National Center for Atmospheric Research (NCAR)
- National Institute for Environmental Studies (NIES)
- National Renewable Energy Laboratory (NREL)
- Organisation for Economic Co-operation and Development (OECD)
- Potsdam Institute for Climate Impact Change (PIK)
- PBL - Netherlands Environmental Assessment Agency
- Research Institute of Innovative Technology for the Earth (RITE)
- Stanford University
- Stockholm Resilience Centre
- Sustainable Development Solutions Network (SDSN)
- The City University of New York (CUNY)
- Tsinghua University
- UN Population Division
- UN DESA
- UNEP-World Conservation Monitoring Centre (UNEP-WCMC)
- University of Hamburg
- World Bank
Literature

Review


Air quality and health


Energy Security

• Akimoto et al. (2012) Consistent assessments of pathways toward sustainable development and climate stabilization, Natural Resources Forum 36(4), 231-244.

Biodiversity

• van Vuuren et al. (2012) Roads from Rio+20 - Pathways to achieve global sustainability goals by 2050. PBL Netherlands Environmental Assessment Agency.

Food Availability


Energy poverty


Water


Multiple sustainable development objectives

• van Vuuren et al. (2012) Roads from Rio+20 - Pathways to achieve global sustainability goals by 2050. PBL Netherlands Environmental Assessment Agency.
Thank You!

Volker Krey
IIASA Energy Program
http://www.iiasa.ac.at
krey@iiasa.ac.at