Challenges for sustainable energy and interactions with other sustainability goals

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28 September 2016
Energy and Climate Change
“Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels”

*The Long-Term Temperature Goal*

*Paris Agreement Article 2*
Paris climate ambition

“Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels”

The Long-Term Temperature Goal, Paris Agreement Article 2

“In order to achieve the long-term temperature goal set out in Article 2, Parties aim to reach global peaking of greenhouse gas emissions as soon as possible [...], and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century”

Paris Agreement Article 4
Emissions implications

How much remains for 1.5°C and 2°C?

For 2°C
- >66% (is this "well below")
  - About 1000 GtCO₂ after 2011 (IPCC AR5 SYR)
  - 590–1240 GtCO₂ after 2015 (post-AR5 literature)

For 1.5°C
- 550 GtCO₂ after 2011 (IPCC AR5 SYR)
- 650 GtCO₂ since 2010-2020 average (CMIP5, present-day adjusted)

Context:
- Current annual emissions ~40 GtCO₂/yr
- Until 2011: about 1900 GtCO₂ emitted

Figure: IPCC AR5 WGI SPM.10
Scenario implications

*Internal consistency Paris Agreement*

- medium chance (50-66%) of limiting warming <2°C in 2100
- likely chance (>66%) of limiting warming <2°C in 2100
- >50% chance of returning warming to below 1.5°C in 2100

range of INDC estimates for 2030

Source: IPCC AR5 Scenario Database; Rogelj et al. 2015
Global Primary Energy
Industrial Revolution until Today

Source: Riahi et al. (2012)
Global Primary Energy

Supply focus – high Nuclear

Source: Riahi et al. (2012)
Global Primary Energy

Efficiency focus – no CCS, no Nuclear

Source: Riahi et al. (2012)
Global Primary Energy

Efficiency focus – no CCS, no Nuclear

Source: Riahi et al. (2012)
Global Primary Energy

Efficiency focus – limited Bioenergy and variable Renewables

Source: Riahi et al. (2012)
Water Use in the Energy Sector
Impact of Energy Sector on Water

Withdrawal

Consumption

Thermal Pollution

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

Withdrawal

Consumption

Thermal Pollution

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

No climate policy

Reference

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
- GEA–Efficiency
- GEA–Mix
- GEA–Supply

Range in 2100
- GEA–Efficiency
- GEA–Mix
- GEA–Supply

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
Equity and Energy Poverty
Final Energy – Regional Distribution

Source: Global Energy Assessment – Grubler et al. (2012)
Global Lorenz Distributions

Cumulative Population

Cumulative Consumption
Global Lorenz Distributions

Wealth per capita 2014: 2000
Global Lorenz Distributions

Cumulative Population

Cumulative Share

GDP (MER) per capita

2000

2013
Global Lorenz Distributions

GDP (PPP) per capita, 2000

GDP (PPP) per capita, 2013
Global Lorenz Distributions

Electricity per capita 2010
Energy Poverty in South Asia

1.3 billion

0.6 billion

Source: Global Energy Assessment, IIASA
Useful Energy for Cooking per HH

South Asia

Data: NSSO, 2007

Rural HH (by income)

Urban HH (by income)

LPG
Kerosene
Solid Fuel

GJ/UE/hh

R1 R2 R3 R4 U1 U2 U3 U4

Data: NSSO, 2007
Solid Fuel Dependence
No New Policies

South Asia

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

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

Source: Cameron et al., 2016
Air Quality and Health Co-Benefits of Climate Policy
Air Quality and Health Co-Benefits

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

Global PM2.5 concentrations ~30.4 µg/m³

Source: IPCC WGIII AR5, Figure SPM.6/6.33
Air Quality and Health Co-Benefits

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

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

Energy Trade (Global, 2050)
Cumulative Oil Extraction (Global, 2010-2050)
Electricity Diversity (Global, 2050)

[Graphs showing energy security levels under different climate policies]

Source: IPCC WGIII AR5, Figure 6.33
Energy Independence vs. Climate Policy

Increasing energy independence

Increasing climate protection

Difference in annual GHG emissions compared to the Baseline (%)

Difference in annual global energy trade compared to the Baseline (%)

Source: Jewell et al., 2016
Food Security, Climate Impacts and Mitigation
Food availability and hunger

Source: Hasegawa et al. 2015
Holistic Strategies (and more Research) needed
Synergies of Multiple Energy Objectives

D. McCollum, V. Krey, K. Riahi (2011)

“Single-minded” approaches for multiple challenges

Total Global Policy Costs (2010-2030)

- CC – Climate Change
- PH – Pollution & Health
- ES – Energy Security

Synergies of Multiple Energy Objectives

Integrated Climate-Pollution-Security Policies

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

Climate Change

Water

Energy poverty

Air quality and health

Energy Security
• Jewell et al. (2016) Comparison and interactions between the long-term pursuit of energy independence and climate policies. Nature Energy 1:16073

Food Security

Multiple sustainable development objectives
Thank You!

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