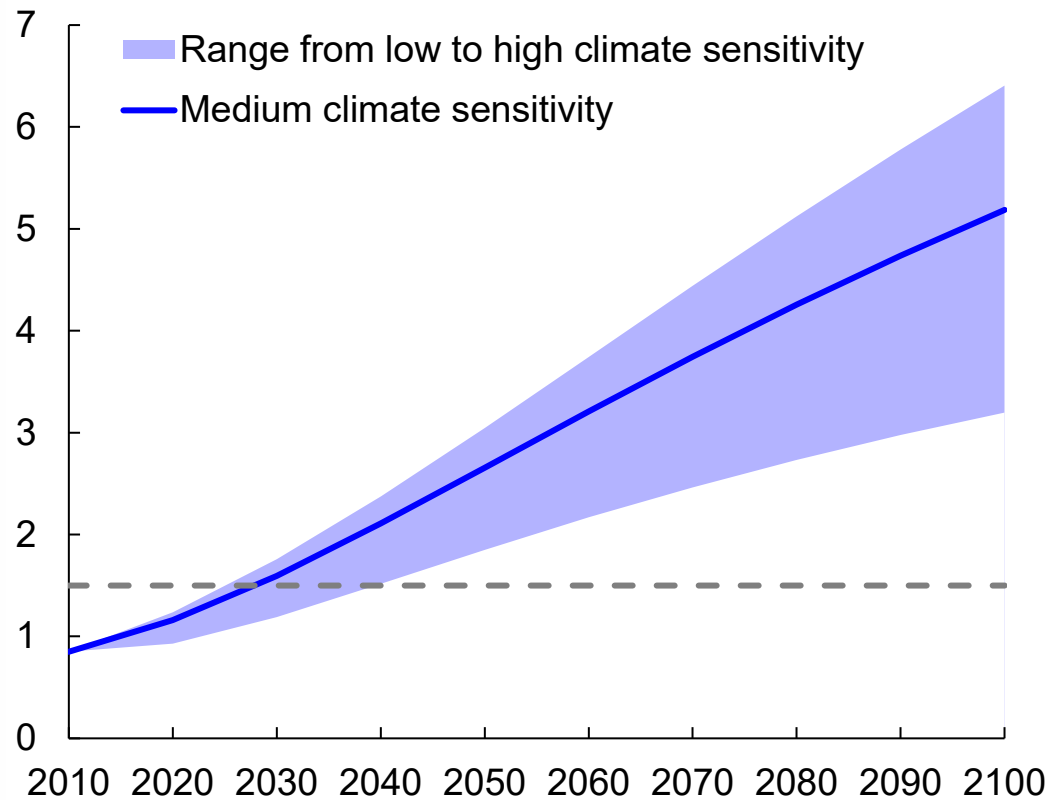# Mitigating Climate Change: Growth- and Distribution-Friendly Strategies
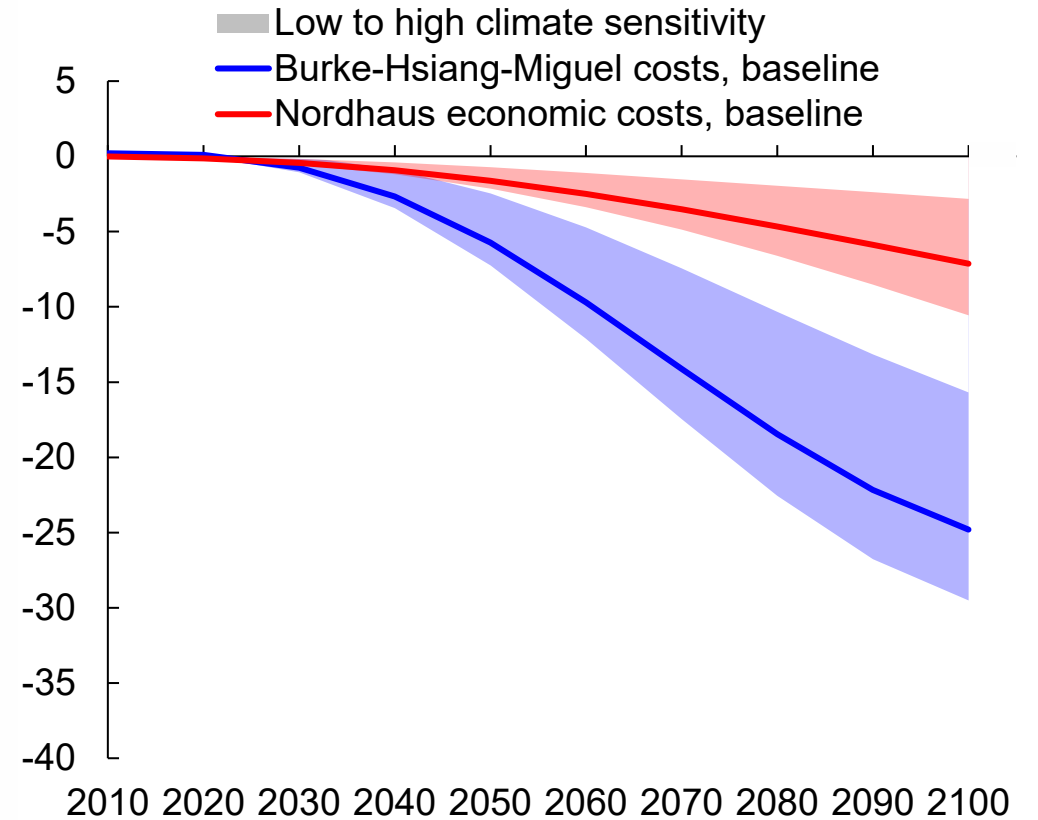
October 2020 WEO Chapter 3

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A rapidly closing window

Temperature under "Business-as-Usual"
(Degrees Celsius above preindustrial average)

- Range from low to high climate sensitivity
- Medium climate sensitivity

Output Losses from Climate Change
(Percent)

- Low to high climate sensitivity
- Burke-Hsiang-Miguel costs, baseline
- Nordhaus economic costs, baseline

Source: Burke, Hsiang, and Miguel 2015; Nordhaus 2010; and IMF staff calculations.

Opportunity to green the recovery

Urgent to act on climate: emissions are on course to raise temperature by 3-6C by 2100. The window for limiting warming to 1.5-2C (net zero emissions in 2050) is closing rapidly.

Opportunity to "green" the recovery: *Recovery stimulus* can be designed to boost green and resilient public infrastructure; policies can ensure composition of recovery in capital spending is consistent with decarbonization by providing *correct price signals* or other financial incentives.

Questions:
- How can we reach net zero carbon emissions by 2050 in a **growth, employment and distribution friendly** way?

- Can well-designed and sequenced mitigation policies **help with the economic repair** from the Covid-19 crisis?

Main takeaways

- NZE by 2050 feasible and would boost incomes in the long run and avoid catastrophic risk.

- An initial green investment push combined with steadily rising carbon prices would deliver the needed emissions reductions at reasonable output effects (initial boost to global GDP and employment followed by moderate output losses in the medium run).

- Development of new green technologies (including through R&D support) reduces transitional output costs substantially.

- Large cross-country differences in output effects, with most oil producers and countries with fast population and economic growth bearing larger costs in the medium run. But these need to be weighted against avoided damages from climate change and co-benefits.

- Carbon-revenue recycling can compensate poor households and support job transitions.

The low-carbon transition has started

Environmental Policy Stringency index (EPS) increased over time

- It contributed to **30 percent** of the increase in global **clean energy innovation**
- It explains about **55 percent** of the increase in the share of renewables in **electricity generation**
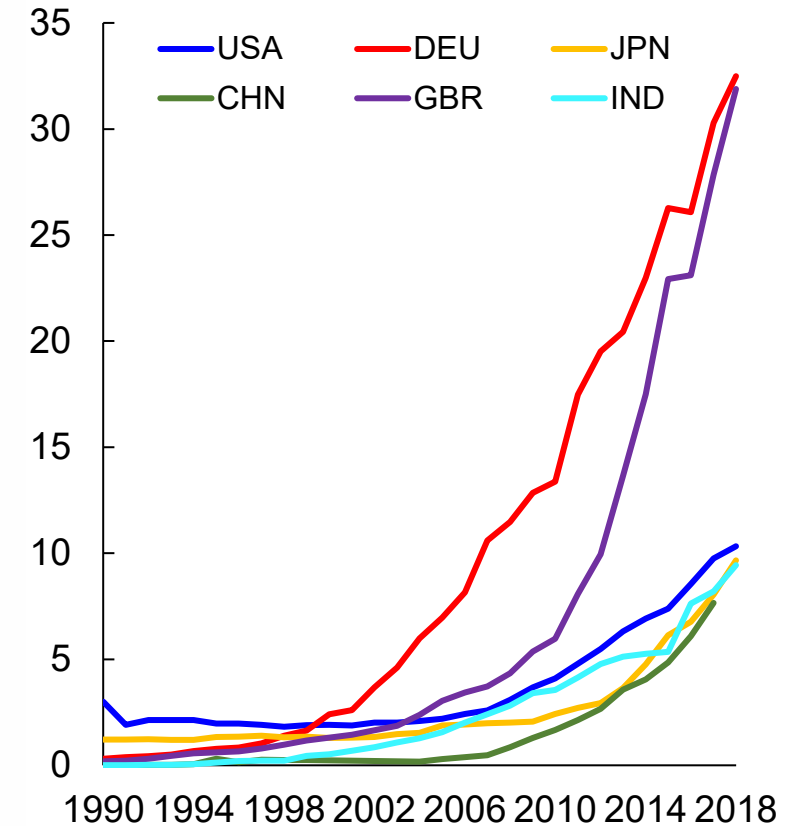
Clean Innovation, Electricity Generation, and Policies
(Index; percent on right scale)
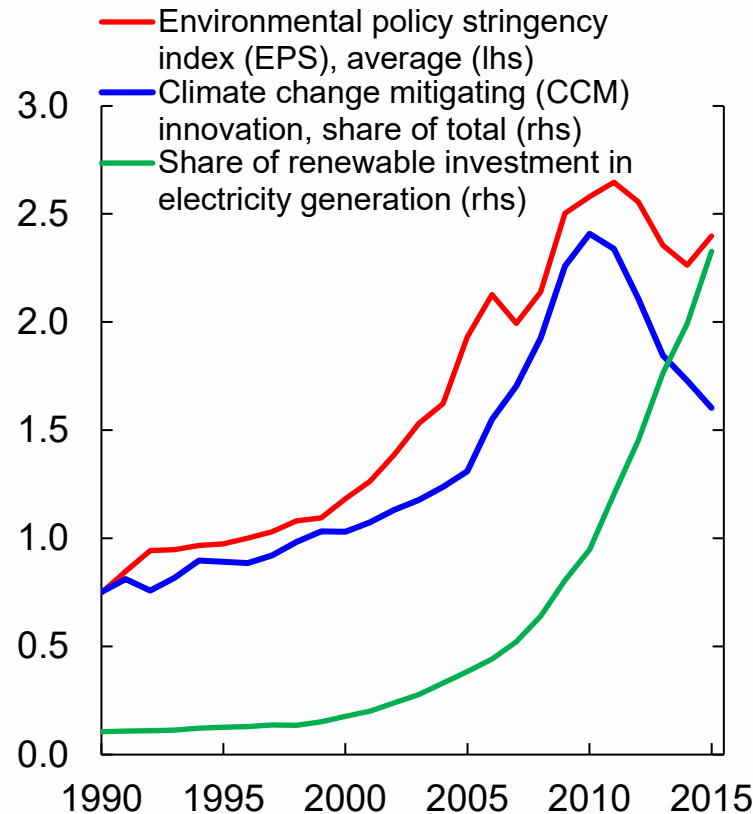
Electricity Share of Solar, Wind and Biomass
(percent)

Sources: IEA; OECD; PATSTAT; and IMF staff calculations.

# Environmental policies lead to job reallocations

Concern that climate policies will lead to job losses in carbon-intensive activities

- coal mining, shale oil and gas production

- carbon-intensive manufacturing

- transport

Econometrics suggests that policies have succeeded in **reallocating jobs** from high- to low-carbon sectors

However, job transitions can still involve **costs** for the workers affected

Effect on Employment, by Sector and Emission Intensity
(Percent)
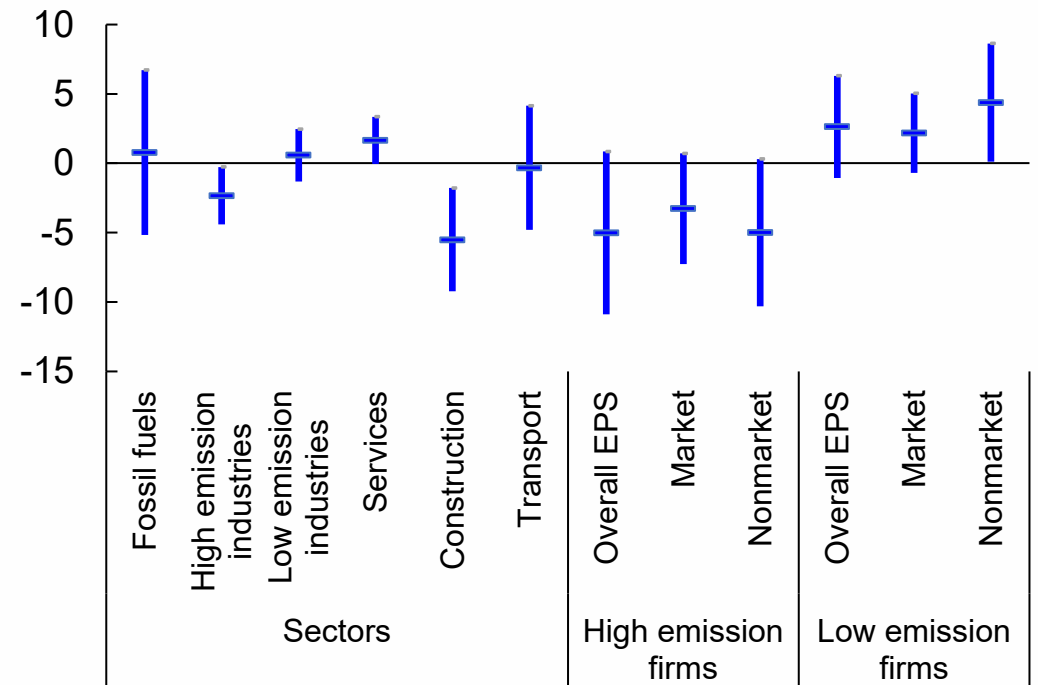
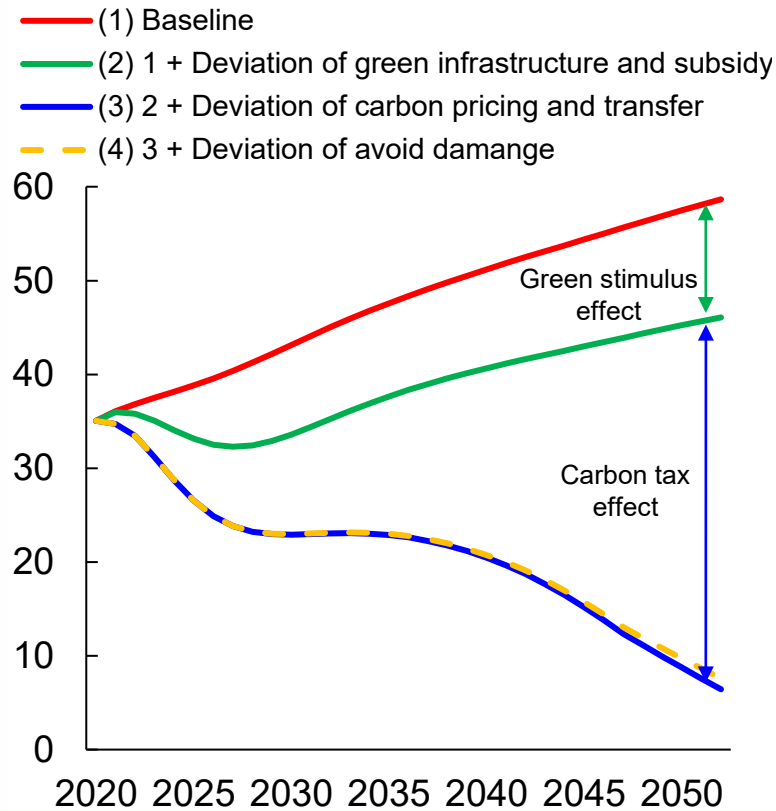Source: Worldscope database; and IMF Staff calculations.
Note: This shows the effect of tightening policies by one standard deviation on employment. The dot (line) shows point estimate (90 percent confidence internal).

How to get to net zero emissions by mid-century?

- **Objective** Reaching net zero emissions by mid-century in a growth, employment, and distribution-friendly way.

- **Policy** Comprehensive macro package
  1. *Green supply policies:* subsidy on renewables production + 10-year green public investment program
  2. *Carbon pricing:* gradual (low starting levels, high growth rate). Between $40 and $150 a ton of CO_2 in 2050
  3. *Compensatory transfers to households:* ¼ of carbon tax revenues to protect the purchasing power of poor households
  4. *Supportive macro policies*: fiscal easing that requires debt financing for the first decade and occurs amid low-for-long interest rates (given low-inflation context)

- **Models** *G-cubed* global macro model with sectoral detail (McKibbin and Wilcoxen 1999, 2013; Liu and others 2020) and a stylized *Integrated assessment model* (Hassler, Krusell and Olovsson 2020) with possibility of endogenous technological change.
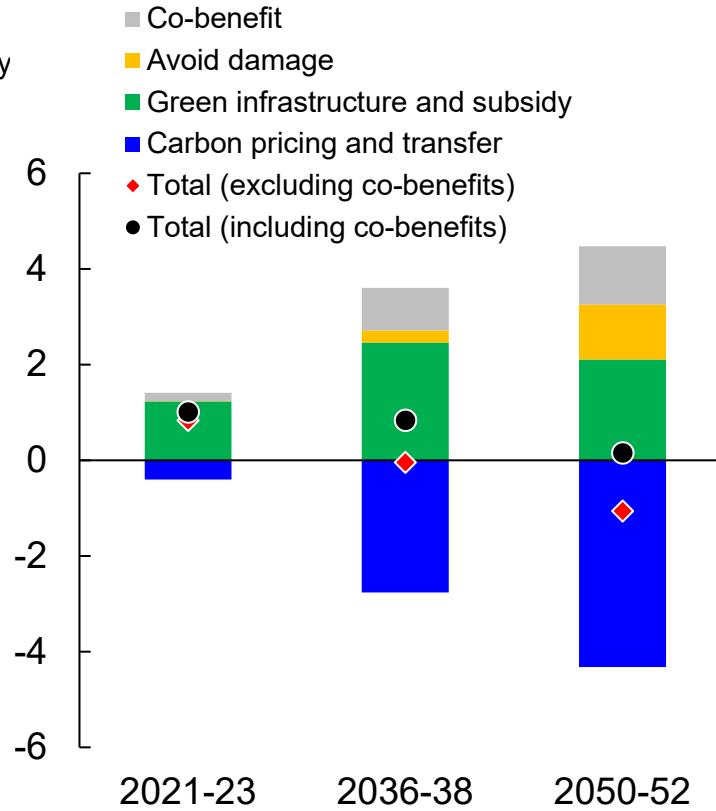
Policy package: CO2 emissions and real GDP

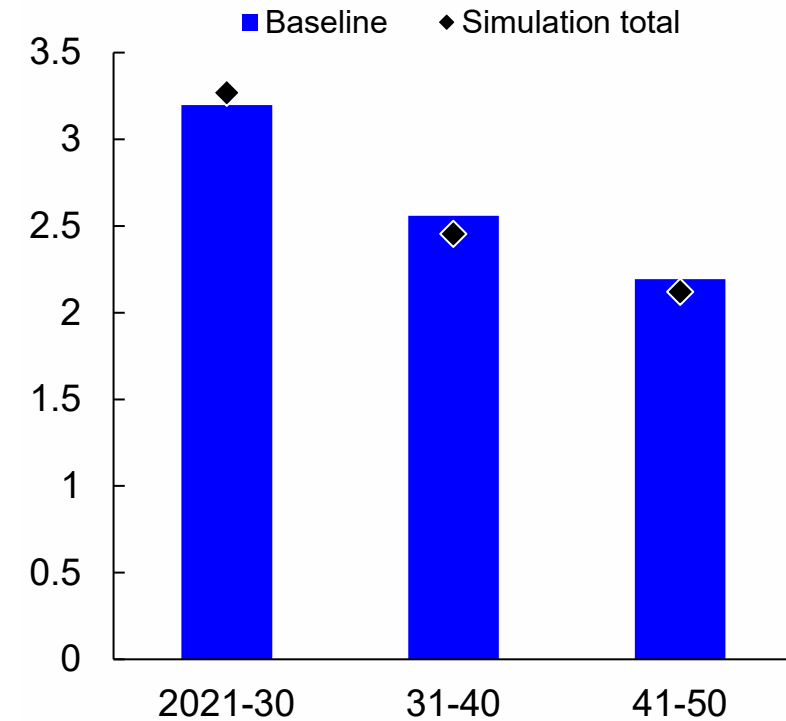**Global CO2 Emissions**
(Gigatons of CO2)

- (1) Baseline
- (2) 1 + Deviation of green infrastructure and subsidy
- (3) 2 + Deviation of carbon pricing and transfer
- (4) 3 + Deviation of avoid damange

Green stimulus effect

Carbon tax effect

Impacts on Global Real GDP
(Deviation from baseline, percent)

- Co-benefit
- Avoid damage
- Green infrastructure and subsidy
- Carbon pricing and transfer
- Total (excluding co-benefits)
- Total (including co-benefits)

2021-23   2036-38   2050-52

Annual Global Real GDP growth
(percent change)

- Baseline   ◆ Simulation total

2021-30   31-40   41-50

Source: IMF staff calculations.

Policy package: employment effects

Global Employment, by Sector
(Contribution to deviation of total employment from baseline, percent)

Legend:
- Renewables
- Services
- Coal
- Transportation
- Other low-carbon
- Gas
- Construction
- Net effect
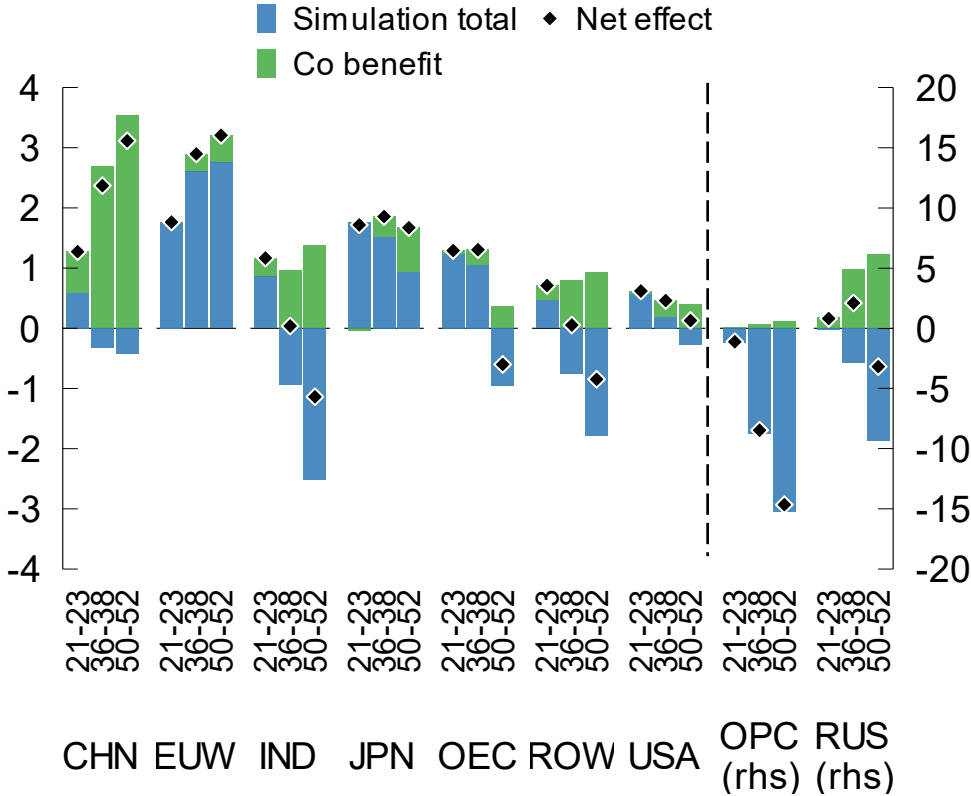- Agriculture, forestry and other mining
- Oil and petroleum
- Manufacturing
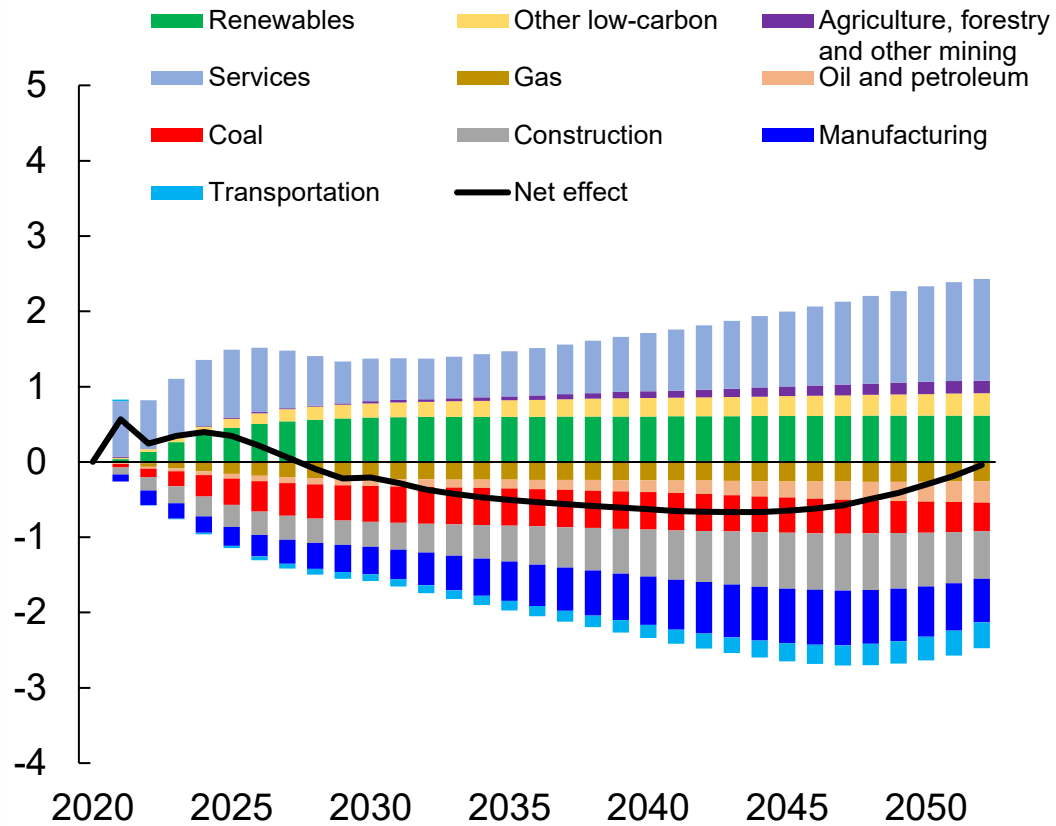
Job Multipliers
(Job-years per gigawatt hour; levelized over lifetime of utility)

Categories: Energy efficiency, Solar PV, Hydro (small), Geothermal, Solar thermal, Biomass, Wind, Municipal waste, Storage, Hydro (large), Nuclear, Coal, Natural gas
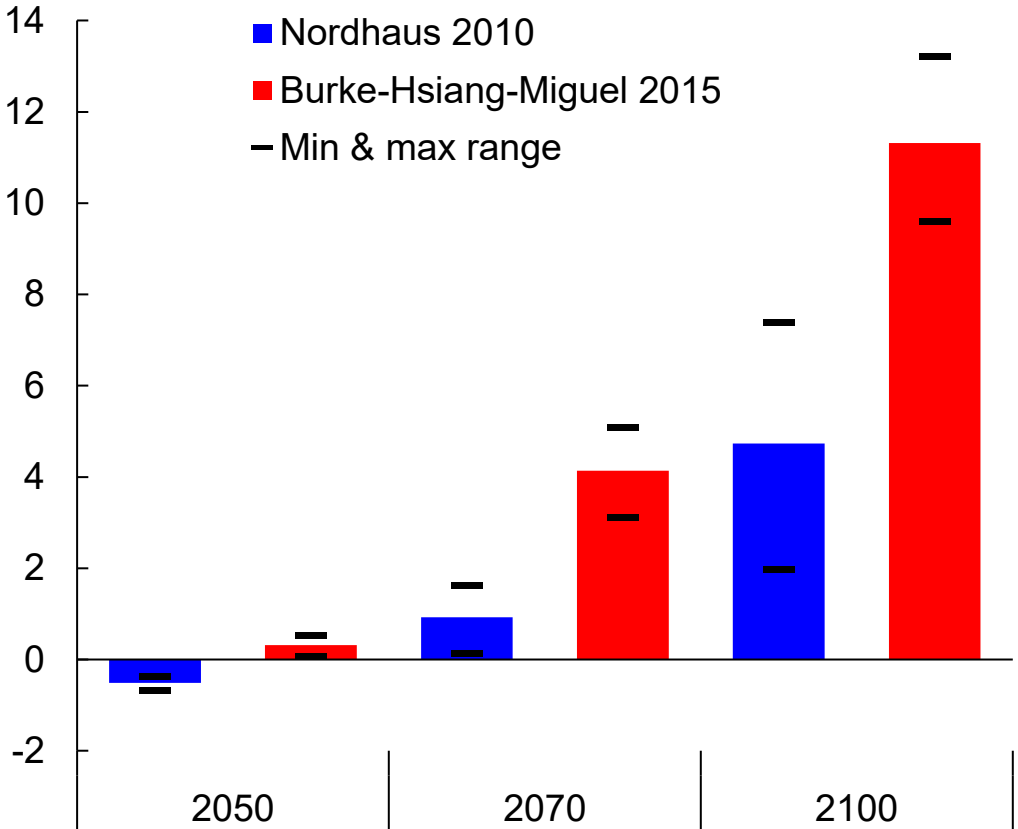
Source: IMF staff calculations.
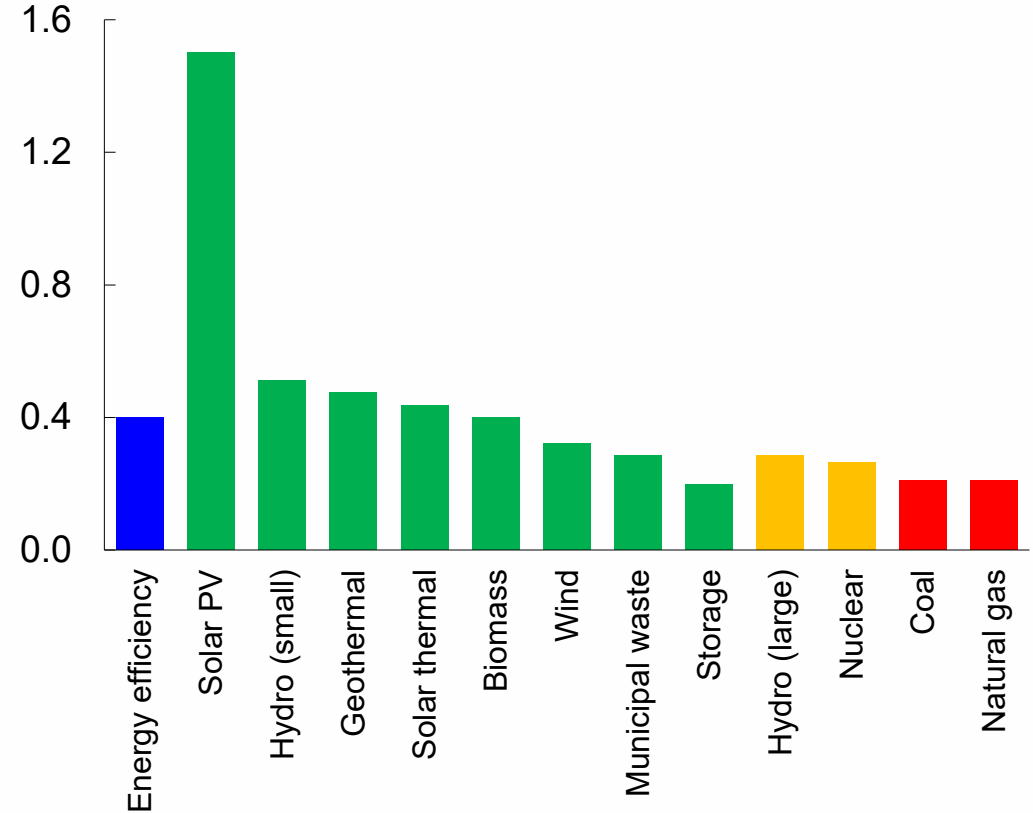
Policy package: medium- to long-term output gains

Real GDP and Co-benefits, Three-Year Average *(Percent deviation from baseline)*

Legend: Simulation total ◆ Net effect, Co benefit

X-axis groups (21-23, 36-38, 50-52 for each): CHN EUW IND JPN OEC ROW USA | OPC (rhs) RUS (rhs)

Medium- to Long-Term Output Gains *(Percent of baseline GDP)*

Legend:
- Nordhaus 2010
- Burke-Hsiang-Miguel 2015
- Min & max range

X-axis: 2050, 2070, 2100
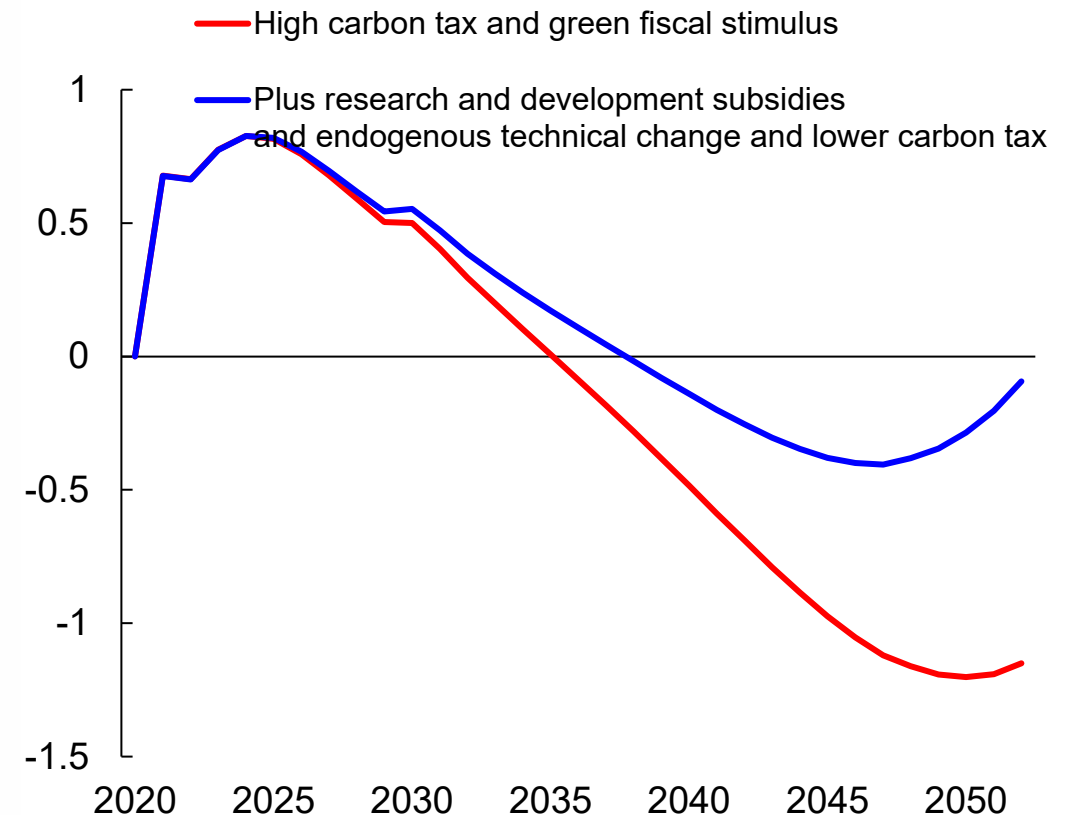
Role of green technological progress

- Development of technologies will be a key enabler of the transition and **reduces transitional costs**.

- There is a case to complement carbon pricing with **R&D subsidies** early on.

- A good **example** of the role of technologies is the **electricity sector:** low-carbon technologies already exist and are economically competitive.

- Important questions of **technology transfers**

Global Output Relative to Baseline, With and Without Technology Response
*(Percent deviation)*

High carbon tax and green fiscal stimulus

Plus research and development subsidies and endogenous technical change and lower carbon tax

Source: IMF staff calculations.

How to build inclusion?

Low-income households are more impacted in many countries:

- They spend a relatively larger share of their income on energy-intensive goods

- They tend to be employed in low-skill occupations in carbon-intensive sectors

**Public Opinion in Support of Environmental Protection** *(Percent)*
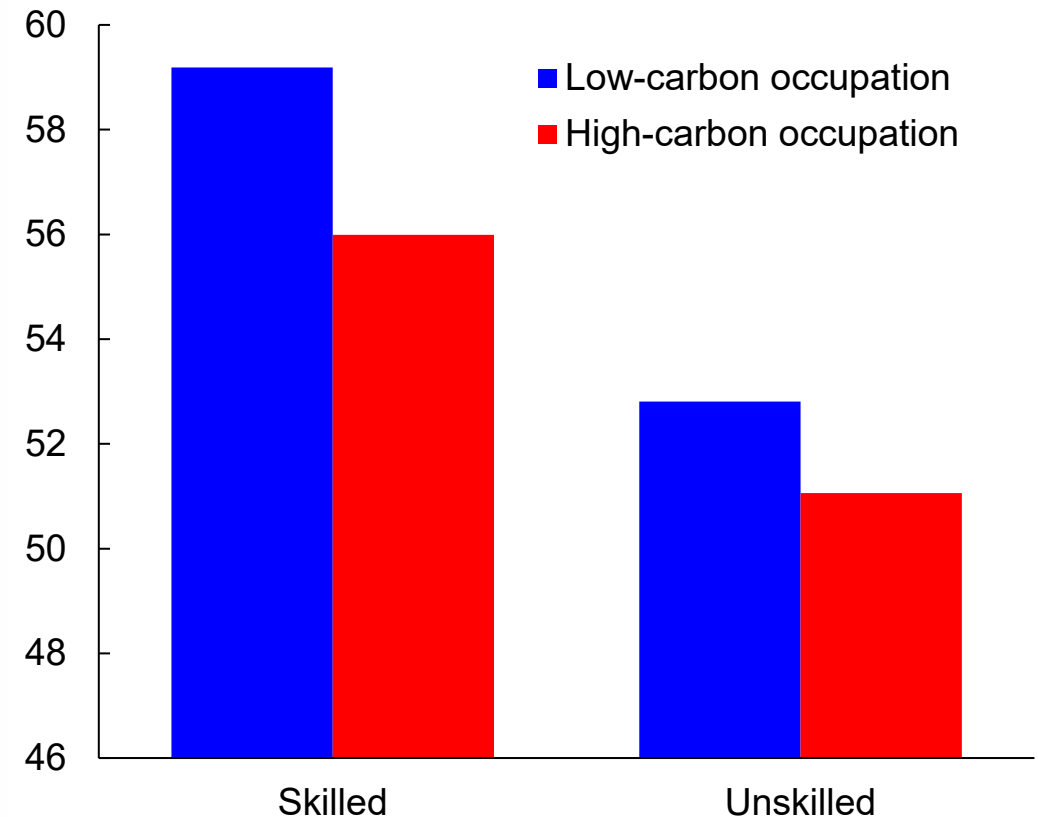
Source: European Values Study (2017); World Values Survey, wave 7 (2017–20); and IMF staff calculations.

Distributional impact of a carbon tax

**Impact of a 50 USD Carbon Tax
under different recycling options for revenues**

Consumption of Bottom Two Quintiles
(Percent deviation from baseline)

Legend:
- Low-energy government spending
- Universal transfers
- Targeted to bottom two quintiles
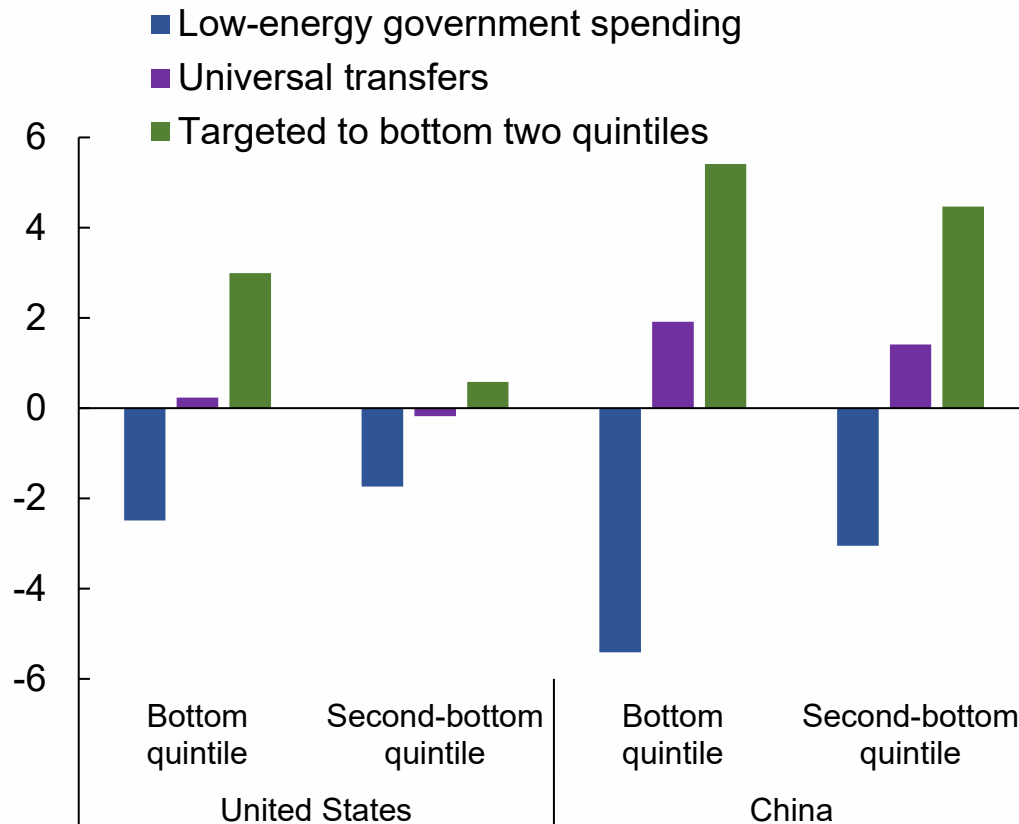
Source: IMF staff calculations.

Policies to protect low-income households:

- Redistributing about 1/6 to 1/4 of the carbon revenues in targeted transfers to protect consumption of bottom quintile

- Increasing government spending on low-carbon sectors to support job transitions

Conclusions

- Net zero emissions by 2050
  - Feasible objective that would boost incomes in the long run and avoid catastrophic risk.
  - But the window is rapidly closing.

- An initial green investment push combined with steadily rising carbon prices would deliver the needed emission reductions at reasonable transitional output effects.
  - A green fiscal stimulus would support output and employment in the recovery from the Covid-19 crisis, and help lower the costs of adjusting to higher carbon prices.
  - Carbon pricing is critical to mitigation because higher carbon prices discriminate better and incentivize energy efficiency in addition to reallocating resources from high- to low-carbon activities.

- A fair transition requires compensating lower-income households for higher carbon prices and supporting job transitions to low-carbon sectors.