Global Trade Analysis Project

Crafting the Baseline: Deep Decarbonization Case

Presented by
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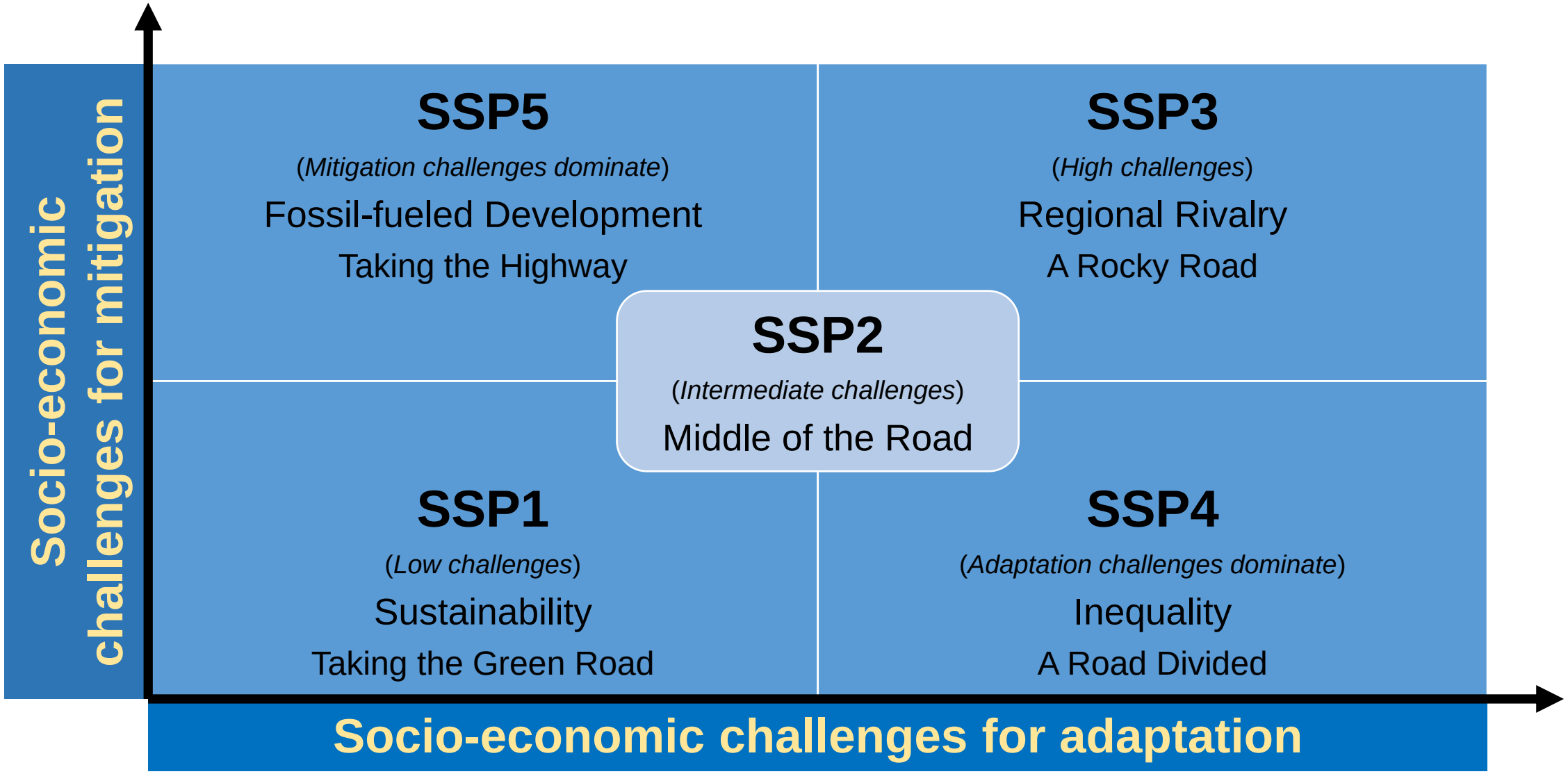
Dynamics

- **Labor/population**
  - UN Population Division
  - IIASA/Shared Socio-economic Pathways (SSPs)
  - Labor growth = growth of working age population (15-64), constant LFPR
- **Capital growth a function of savings**
  - $K_t=(1-\delta)K_{t-1} + I_{t-1}$ $I=S^h+S^g+S^f$
- **Productivity**
  - Labor productivity, differentiated across activities
  - Land productivity, calibrated to external assumptions
  - Energy efficiency, calibrated to external assumptions
  - Trade and transport margins efficiency improvement

Shared socio-economic pathways

- **Evolution of the economics of climate change community**
  - Since 2007, Integrated Assessment Modeling Consortium (IAMC)
  - Coordinates international research on climate change
  - Provides key contributions to IPCC Assessment Reports
  - Though mostly driven by economic, energy and bio-physical modelers, also encompasses ESM and IAV communities
- **Shared socio-economic pathways (SSPs) to replace SRES**
  - Parallel process (RCPs and SSPs)
  - Now in integration phase
- **Key drivers available since 2013**
  - Demographics, education, GDP and urbanization

Two-axes: adaptation & mitigation challenges



Source: O'Neill et al. 2015

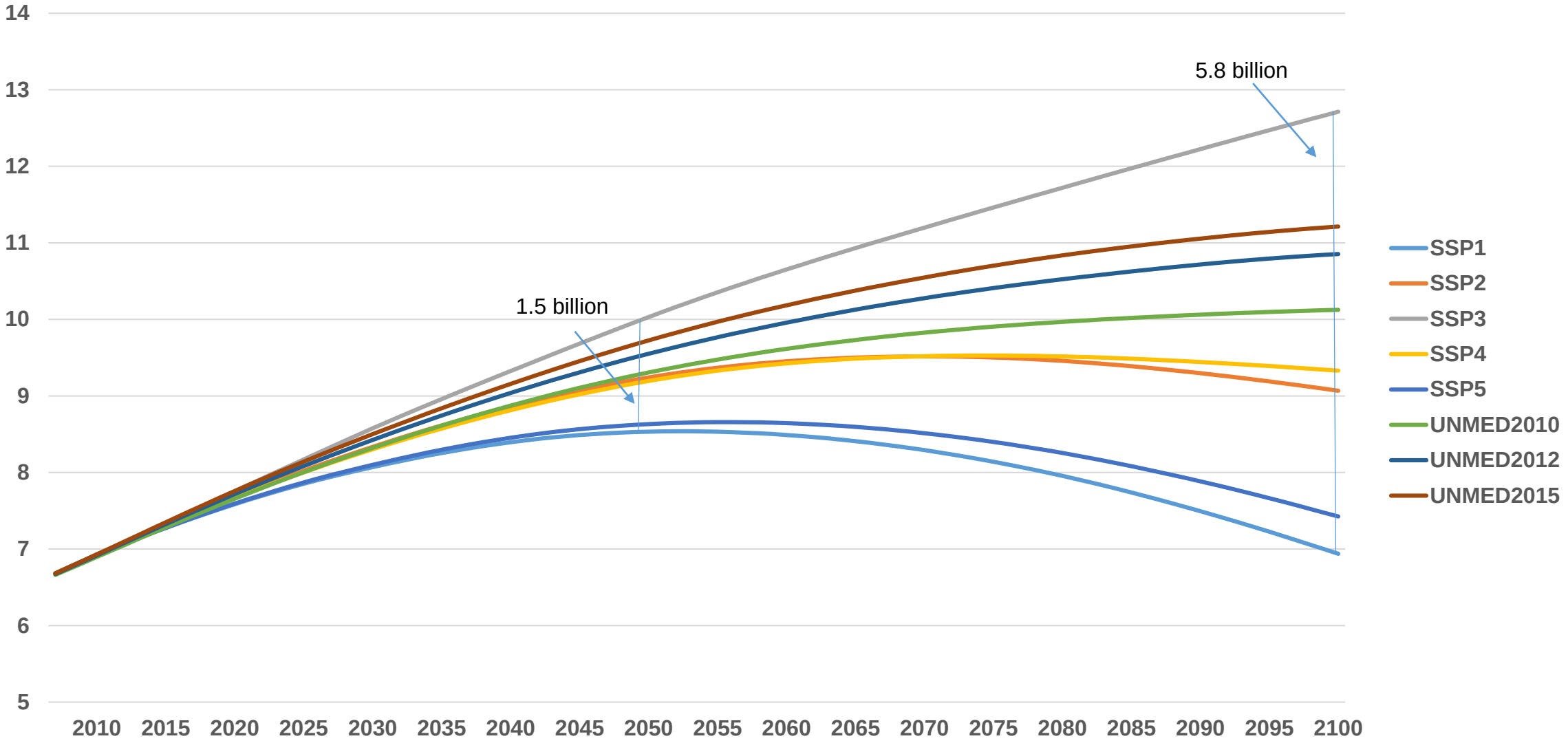
Climate and SSP scenarios

	SSP1 "Sustainability"	SSP2 "Middle of the Road"	SSP3 "Fragmentation"	SSP4 "Inequality"	SSP5 "Conventional development"
RCP 8.5					"No CC policy"
RCP 6.0	"No CC policy"	"No CC policy"	"No CC policy"	"No CC policy"	
RCP 4.5			"w mitigation"		
RCP 2.6	"w mitigation"	"w mitigation"	Infeasible?	"w mitigation"	"w mitigation"
RCP 2.0					

Quantification

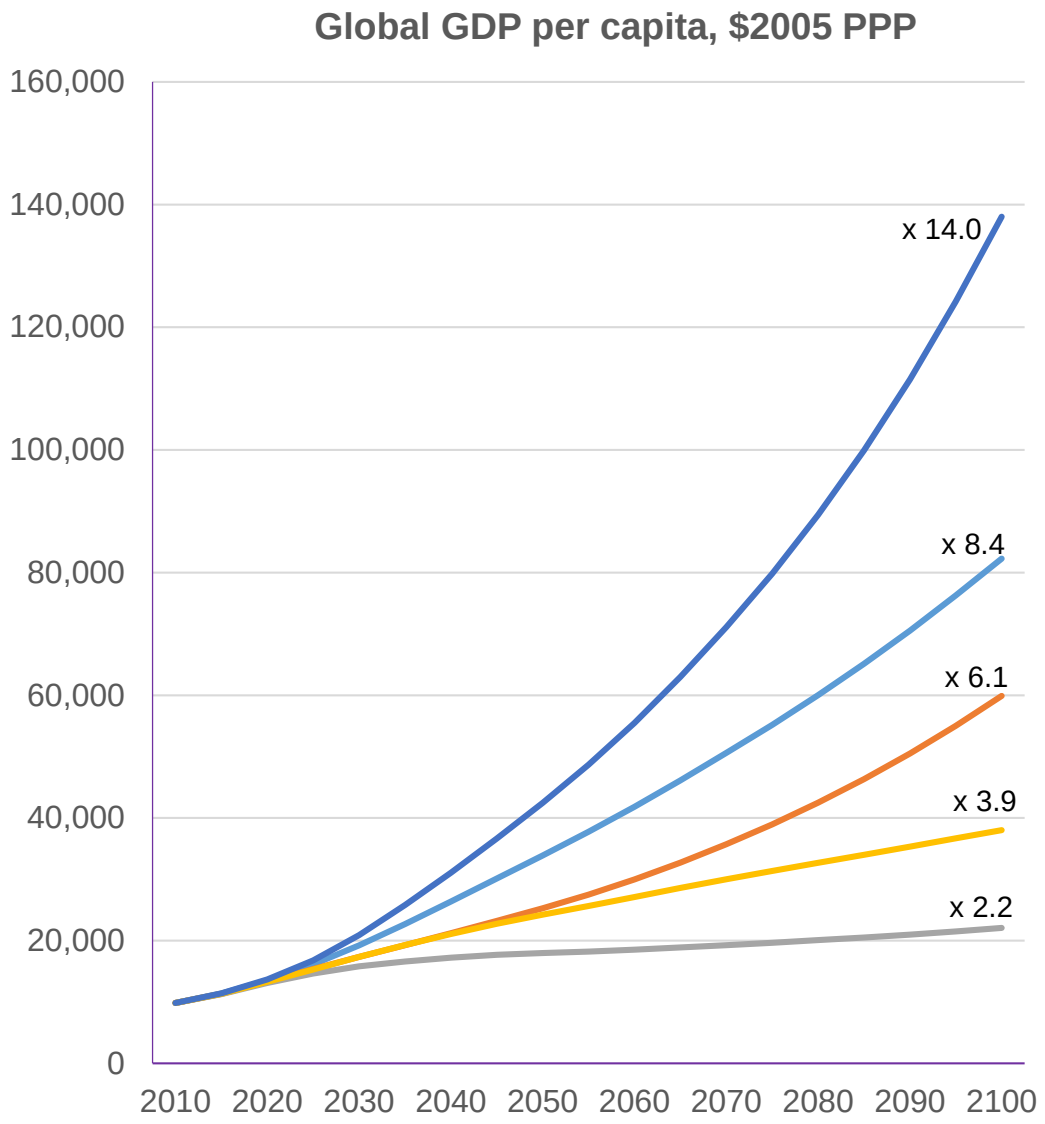
- **Time framework—2010-2100**
- **Population—source IIASA**
  - Age (5-year cohorts), gender, education (four levels—none, primary, secondary, tertiary)
- **GDP**
  - 3 sources—IIASA, OECD, PIK
  - All harmonized to same (IIASA) demographic scenarios
  - IIASA and OECD country-level
- **Urbanization—source NCAR**

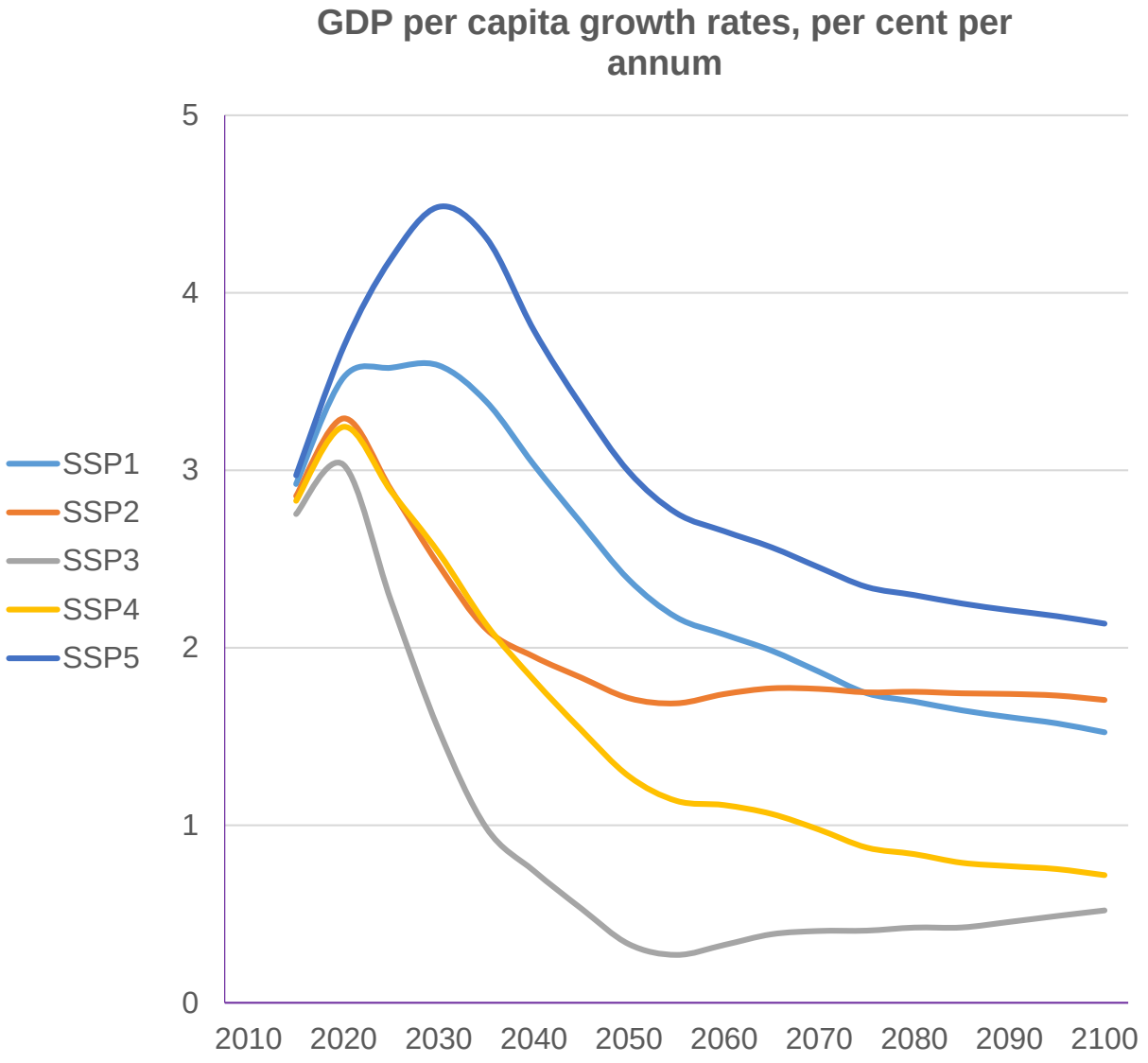
Global population, billion



Source: IIASA 2013, UN Population Division (2010, 2012, 2015).

Lower growth in second half of the century



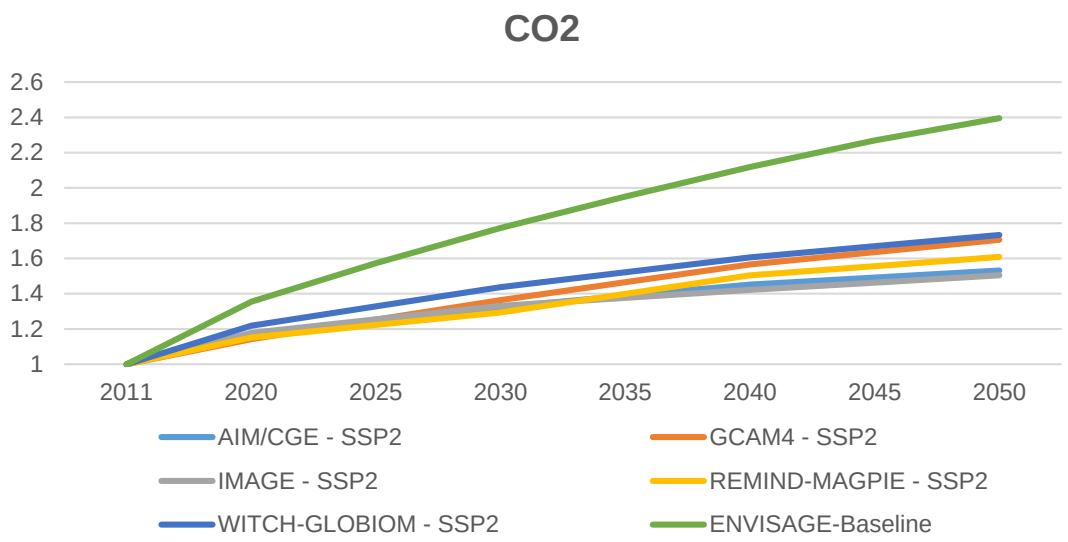


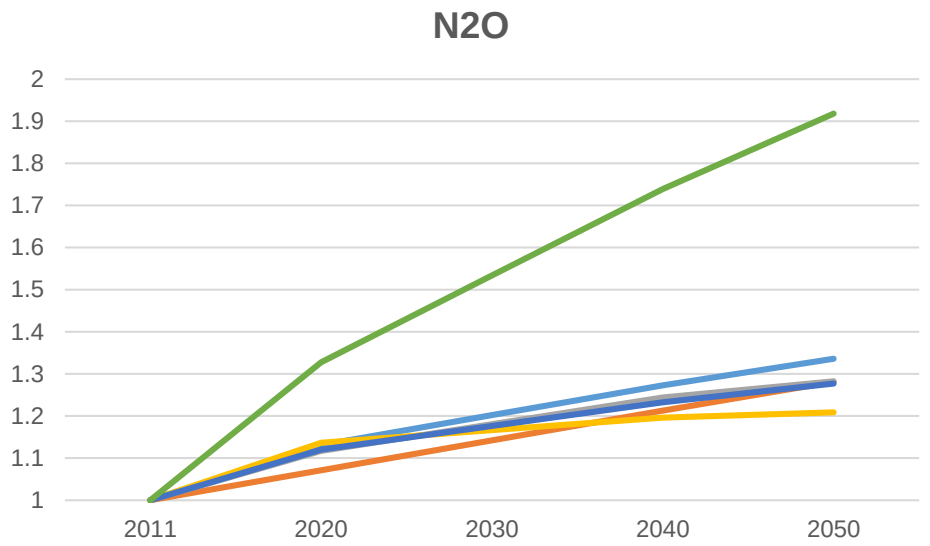
Source: IIASA/OECD 2013.

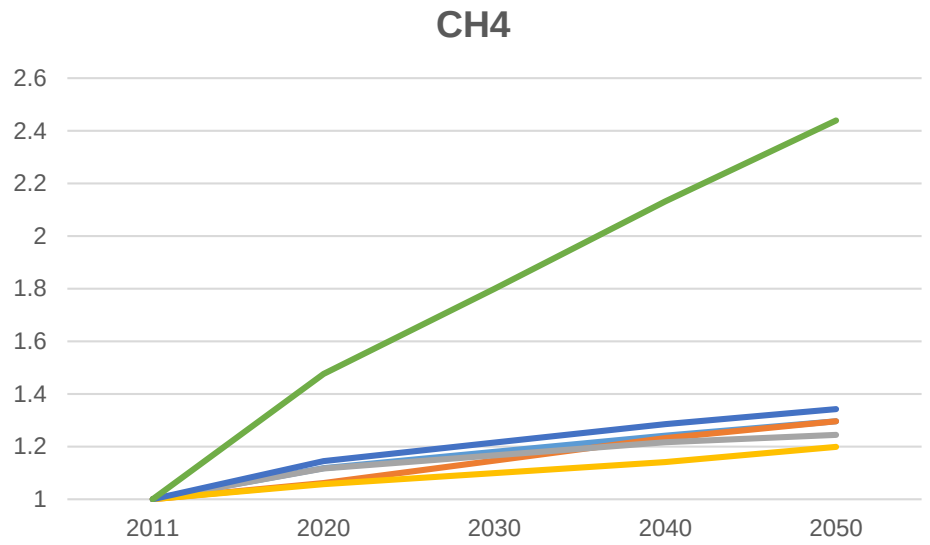
Crafting the Baseline: Basic Assumptions

- **Macroeconomic and demographic assumptions – SSP2.**
- **Autonomous energy efficiency improvement (AEEI parameter)**
  - Energy efficiency improvement 1% per annum (lower/capped for specific technologies, e.g. coal power generation).
- **Improvements in international transport costs**
  - Costs decline by 1% per annum.

Crafting the Baseline: First Implementation

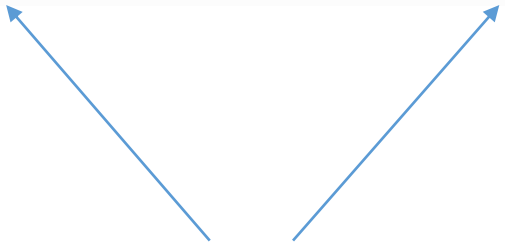






Identifying Key Drivers of Differences: Kaya Identity

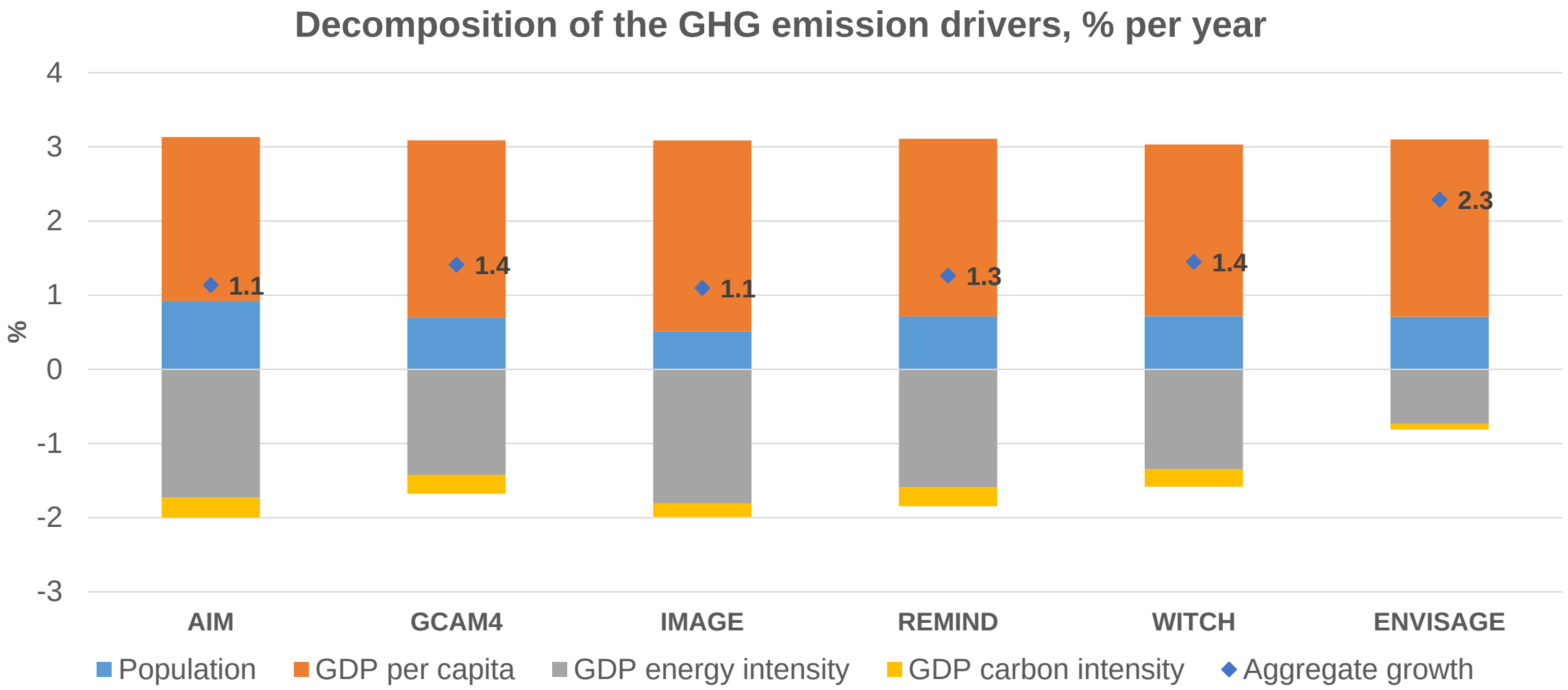
$$\mathrm{CO_2} = \mathrm{Population} \times \frac{\mathrm{GDP}}{\mathrm{Population}} \times \frac{\mathrm{Energy}}{\mathrm{GDP}} \times \frac{\mathrm{CO_2}}{\mathrm{Energy}}.$$



SSP-based

Implicit assumptions

Kaya Identity: Model Comparisons



Crafting the Baseline: Additional Assumptions

- **Renewables costs reduction by 2030**
  - 10% for wind, 20% for solar and other renewables.
- **Non-price related changes in preferences towards renewables**
  - Target for renewable electricity as a share of total electricity demand (implement the twist assuming no change in prices).
- **Target increase in electricity share for agents**
  - 30% increase for transportation sector, 10% for other sectors.
- **Autonomous energy efficiency improvement (AEEI parameter)**
  - Differentiated by countries and over time.

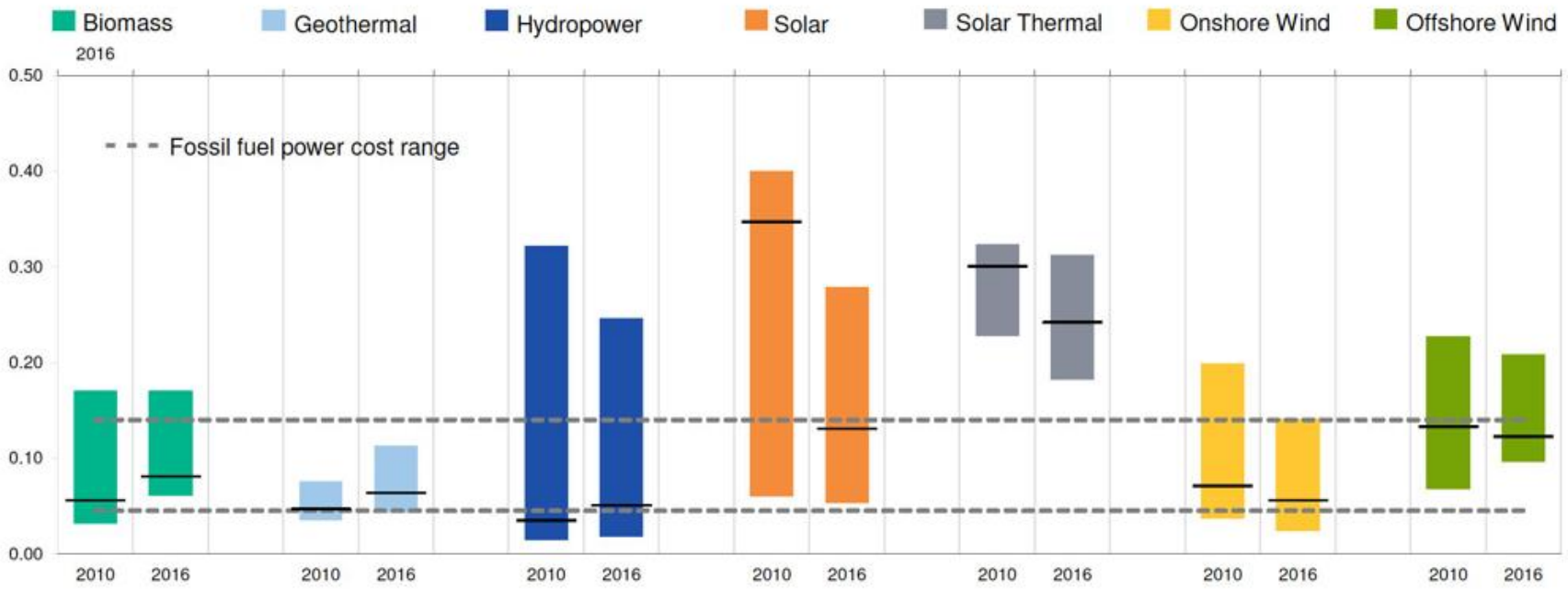
Crafting the Baseline: Cost of Renewables

Implementation	Specific assumptions
Hyperbola specification with a cost asymptote. The curve is calibrated to three parameters – the asymptote (relative to current costs), a targeted reduction and the year the target is reached.	Wind – the asymptote is 80% of today's price and the costs are dropping by 10% between 2011 and 2030. Solar and other renewables – the asymptote is 60% and the costs are dropping by 20% between 2011 and 2030.

Exhibit 3

The cost of renewable energy technologies has become competitive with fossil fuels

Levelised cost of electricity from renewable energy, 2016 USD per kWh



Note: The bars represent the min-max range in LCOE, and the black lines are the average. All costs are in 2016 USD. Weighted Average Cost of Capital is 7.5% for OECD and China and 10% for Rest of World. Preliminary data for 2016.

Source: IRENA's Renewable Cost Database

Crafting the Baseline: Preferences Change

Preference 'twist' parameters change the preference for one set of commodities in a demand system relative to other commodities, but without changing the aggregate cost.

Non-price related changes in ***preferences towards renewables***

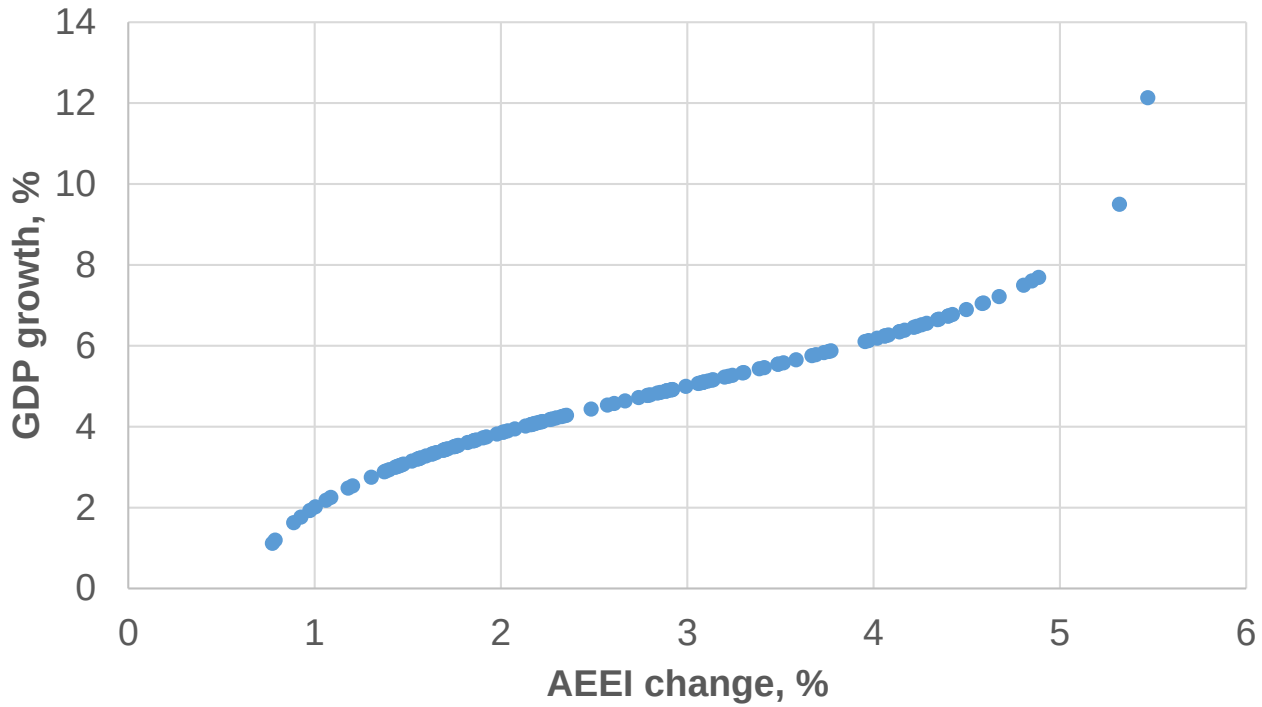
Aggregate region/country	Target renewable share
China	25
Indonesia	15
Thailand	15
Bangladesh	na
India	12
Pakistan	na
United States of America	20
Mexico	15
Argentina	10
Bolivia	15
Ecuador	10
Venezuela (Bolivarian Republic of)	na

Target ***increase in electricity share*** *for agents (trend towards electrification following IEA (2017a))*

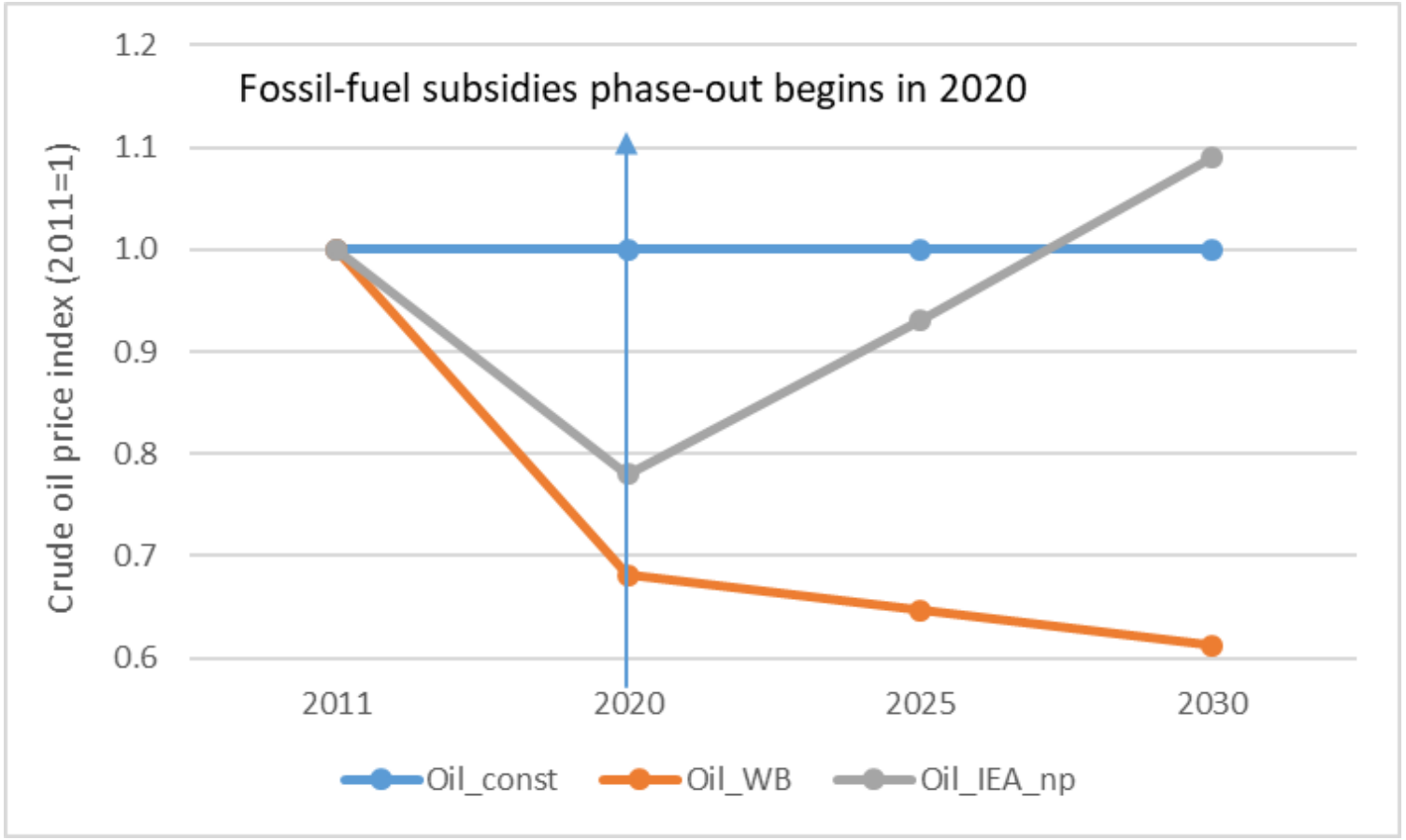
Assume 30% increase in electricity share in transportation sector for all regions by 2030. Assume 10% increase in electricity share for all non-energy industries.

Crafting the Baseline: Efficiency Changes

- **Autonomous energy efficiency improvement (AEEI parameter)**
  - Power function with defined elasticities to establish the link between GDP growth and AEEI values and use lower (0.5%) and upper (5.5%) bounds to cap AEEI levels. Fixed values for coal, oil.



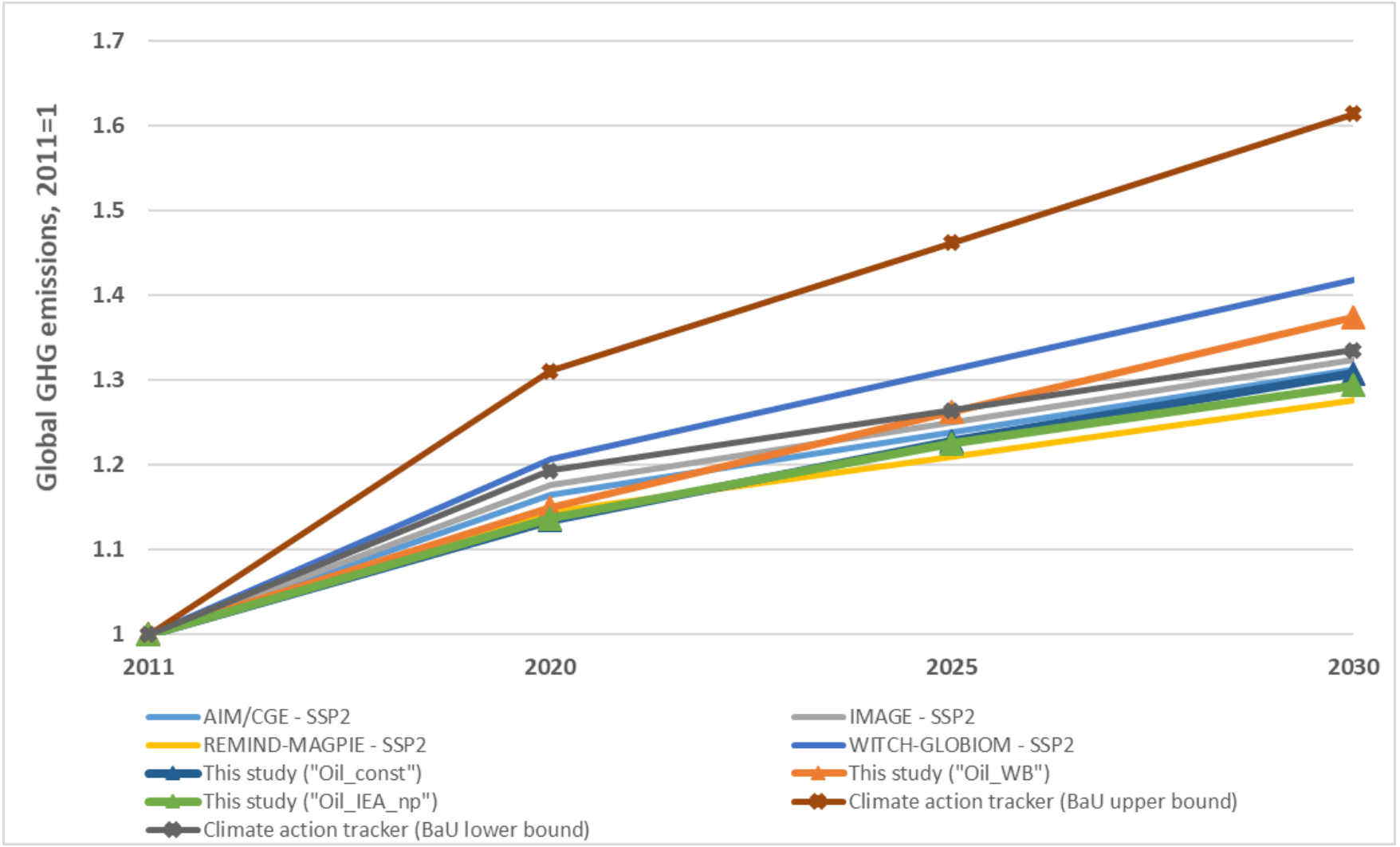
Crafting the Baseline: Targeting Oil Prices



Source: WB (2018), IEA (2017a).

Notes: "Oil_const" corresponds to the scenario with fixed international crude oil prices w.r.t. to the manufactures unit value (MUV) index at the 2011 level; under "Oil_WB" scenario oil prices follow the World Bank commodity price forecasts; "Oil_IEA_np" corresponds to the International Energy Agency "New Policies" scenario.

Crafting the Baseline: Getting Closer…

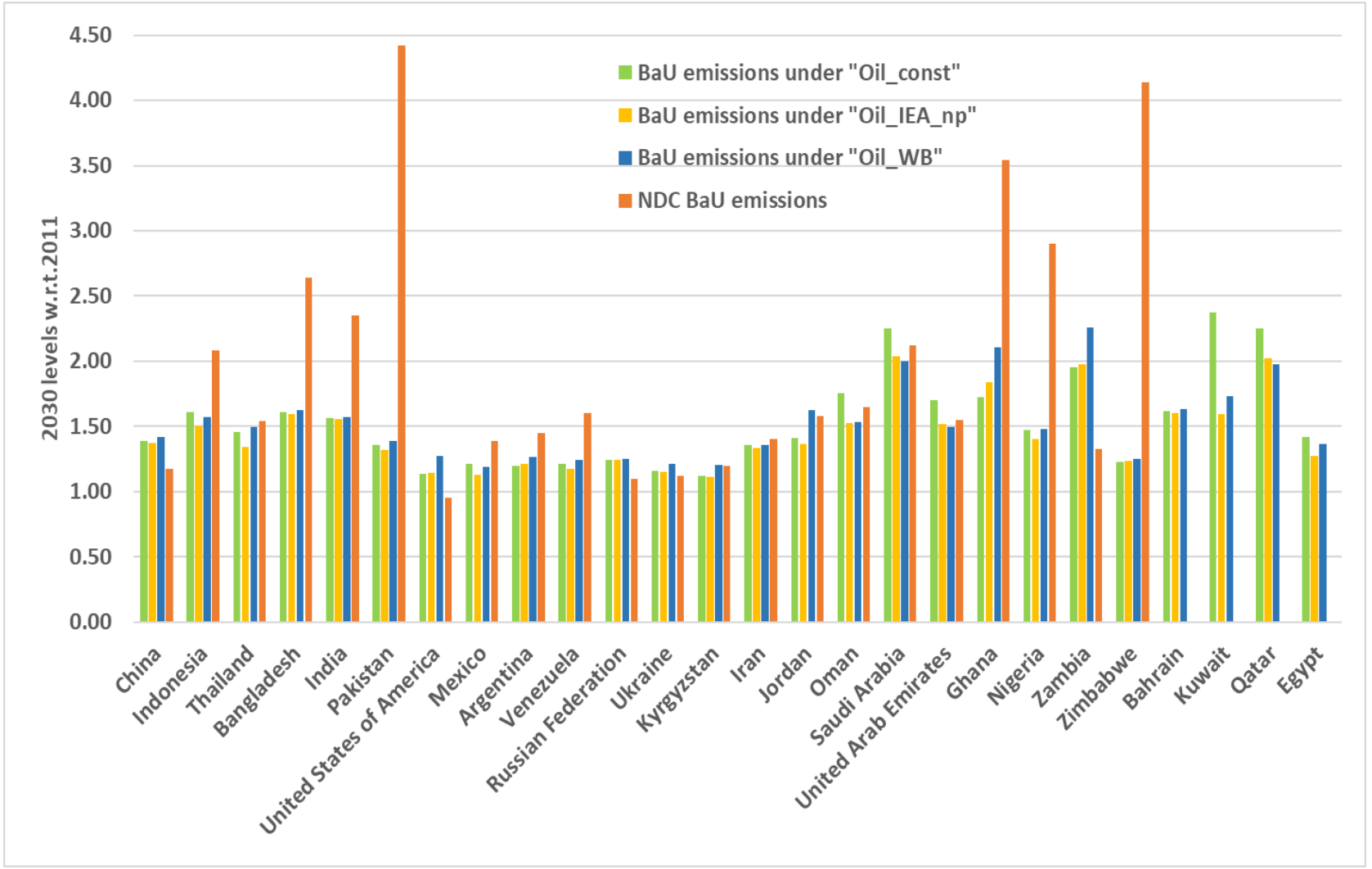


Source: IIASA (2016), CAT (2018), authors' estimates.

Crafting the Baseline: Getting Closer…

Fossil-fuel subsidy values under different baseline scenarios

Crafting the Baseline: Is it close enough?



2030 BaU GHG emissions and NDC targets, 2011=1

Crafting the Baseline: Specific Country Cases

Verification of the BaU GHG emissions for selected countries

Country	NDC-based BaU GHG emissions annual growth rates, % (2012-2030)	Predicted annual GDP growth rates, %	
		IMF (2018); 2012-2023 average growth rate	OECD (IIASA, 2016); 2012-2030 average growth rate
Pakistan	8.1	4.6	4.4
Ghana	6.9	5.8	6.9
Zimbabwe	7.8	4.4	3.9

Notes: In case of GDP forecasts by OECD, we use the SSP2 scenario from the Share Socioeconomic Pathways (SSP) database (IIASA, 2016). SSP2 scenario represents "middle of the road" pathway with intermediate socio-economic challenges for mitigation and adaptation.

Source: Estimated by authors based on IMF (2018), IIASA (2016), UNFCCC (2018b).

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