Global Trade Analysis Project

Global Fossil-fuel Subsidy Reform and Paris Agreement

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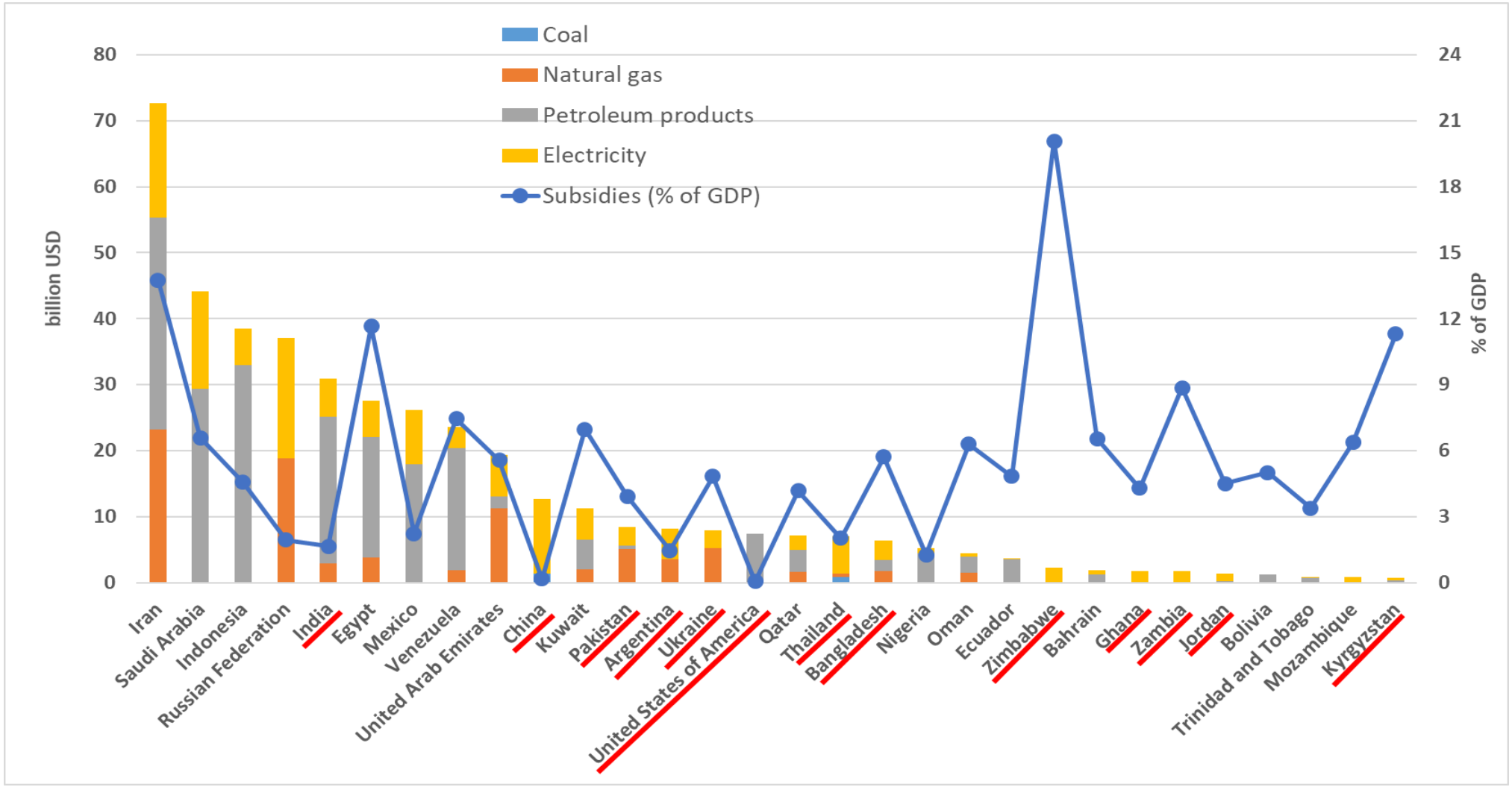
Outline

1. Motivation
2. Energy subsidies and nationally determined contributions (NDCs)
3. Methodology and baseline development
4. Scenarios and results
5. Concluding remarks

1. Motivation

- **Fossil-fuel subsidies globally are estimated to be around $500 billion (in 2014) – 0.6% of global GDP.**
  - For many countries they can represent between 2 and 10 percent of GDP and for a handful even between 10 and 20 percent.
- **Despite recent downward trend (mainly due to falling energy prices), still have a high potential to be used as an environmental policy instrument**.
  - Studies show that global GHG emissions reduction following energy subsidies elimination is on average between 4% and 10% (Magne et al. (2014), Burniax and Chateau (2014), IEA (2015) and IMF (2015))**.** More recent estimates (Jewel et al., 2018) report much lower reduction (between 1 and 4%).
- **Energy subsidies reform is explicitly included into the NDCs of 13 countries though concrete contribution to emissions reduction is often missing (Terton et al., 2015).**
- **Energy subsidies are not represented in most global modelling databases, including GTAP (it currently explicitly captures $22 billion fossil-fuel subsidies).**

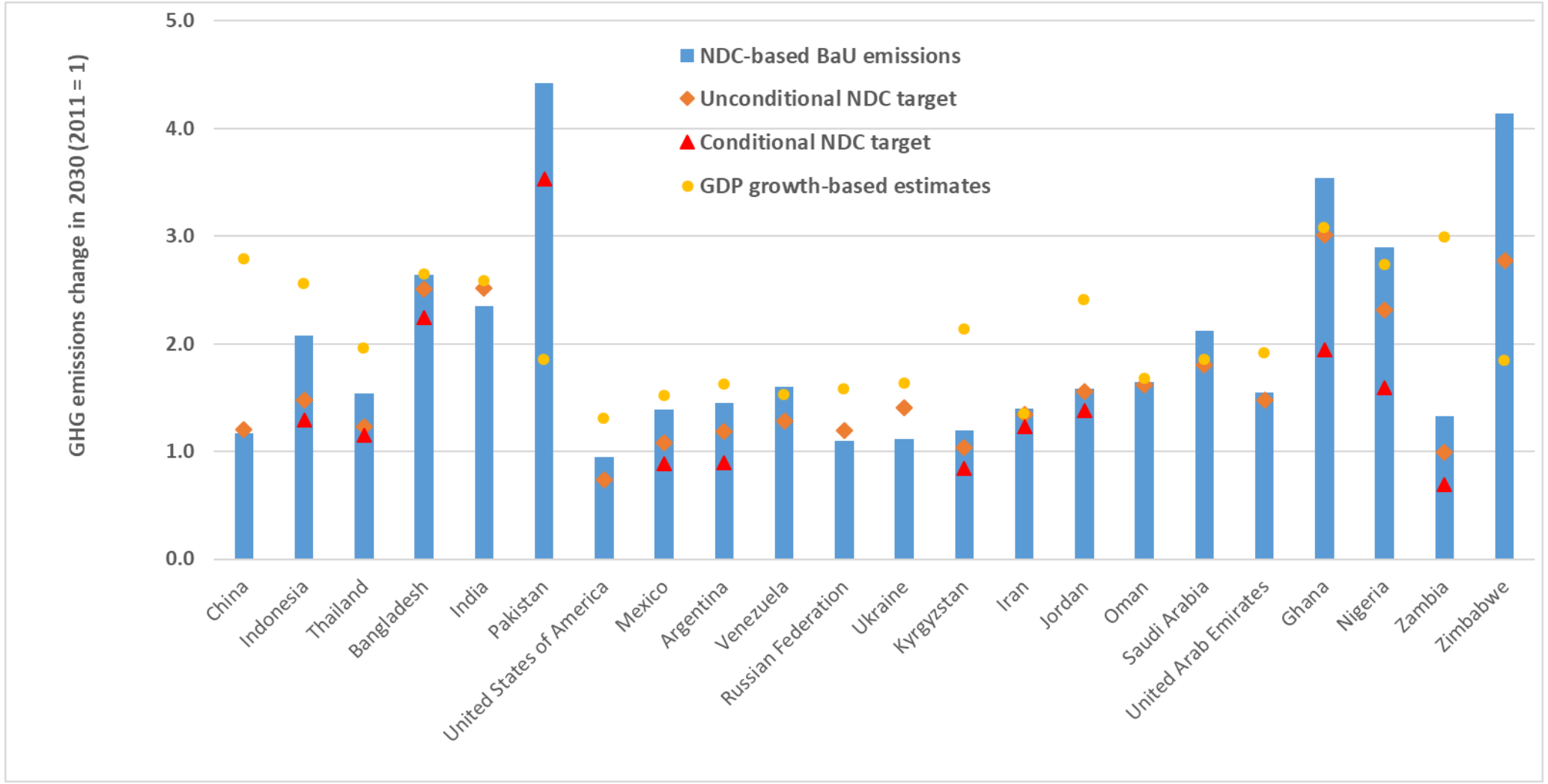
2.1. Regional distribution of energy subsidies



Magnitude of the fossil-fuel consumption subsidies in selected countries

Notes: Regions underlined red are net energy importers.
Source: Estimated by authors based on IMF (2015), Coady et al (2015), Aguiar et al (2016).

2.2. BaU emissions and NDC targets



Baseline emissions, unconditional and conditional reduction targets associated with NDC contributions in 2030, (2011=1).

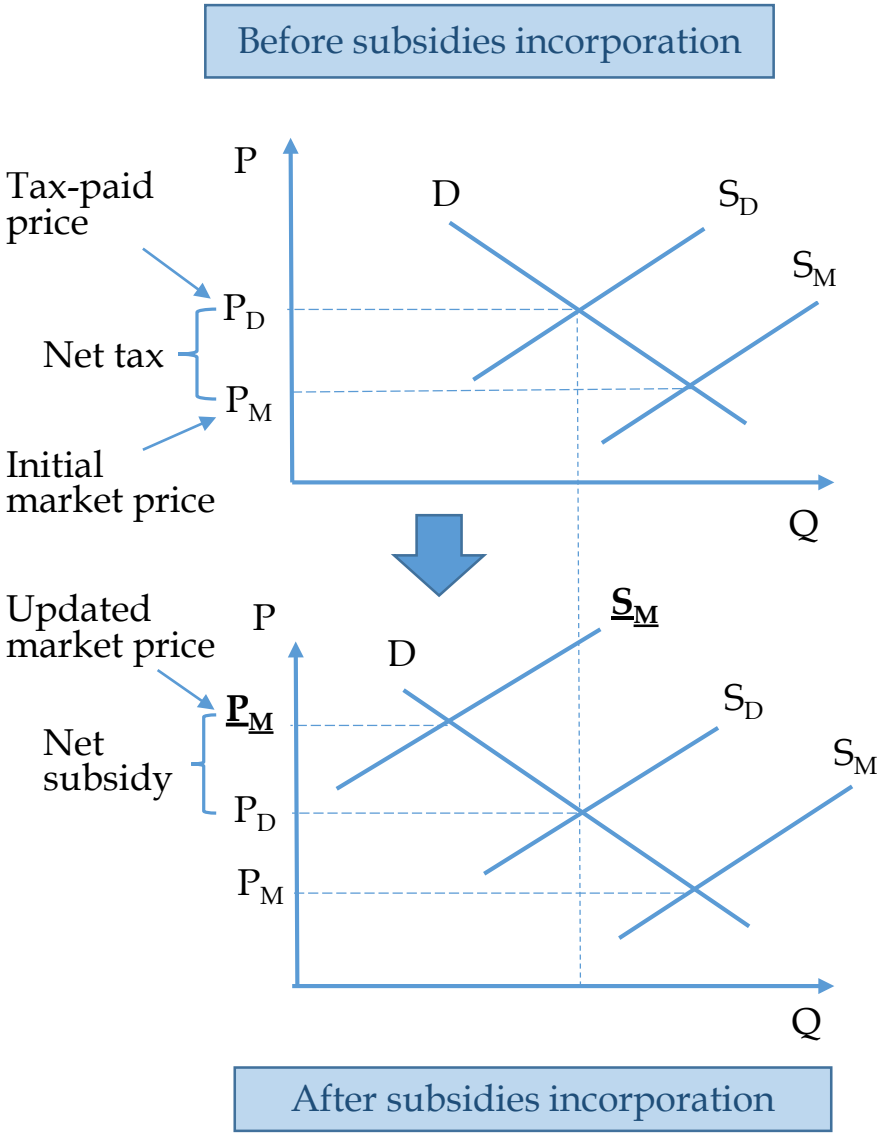
Source: Estimated by authors based on UNFCCC (2018b), CAT (2017), CW (2018), WB (2018), US EPA (2018), Chepeliev et al (2018).

3.1. Modelling framework – input data

- **GTAP-Power 9.2 Data Base with** ***included energy subsidies*** **(67 sectors, 141 regions)** (Chepeliev et al., 2018)
- **Aggregated to 42 regions and 24 sectors**
- **Additional extentions:**
  - *Emissions of non-CO_2 greenhouse gases* (N_2O, CH_4, F-gases).
  - *Air pollution database* (10 types – BC, CO, NH_3, NMVB, NMVF, NO_x, OC, PM10, PM2.5, SO_2).
  - Shared Socioeconomic Pathways (SPP) database (GDP and population) – “middle of the road” SSP2 scenario.
  - Oil price scenarios (IEA, 2017; WB, 2018).

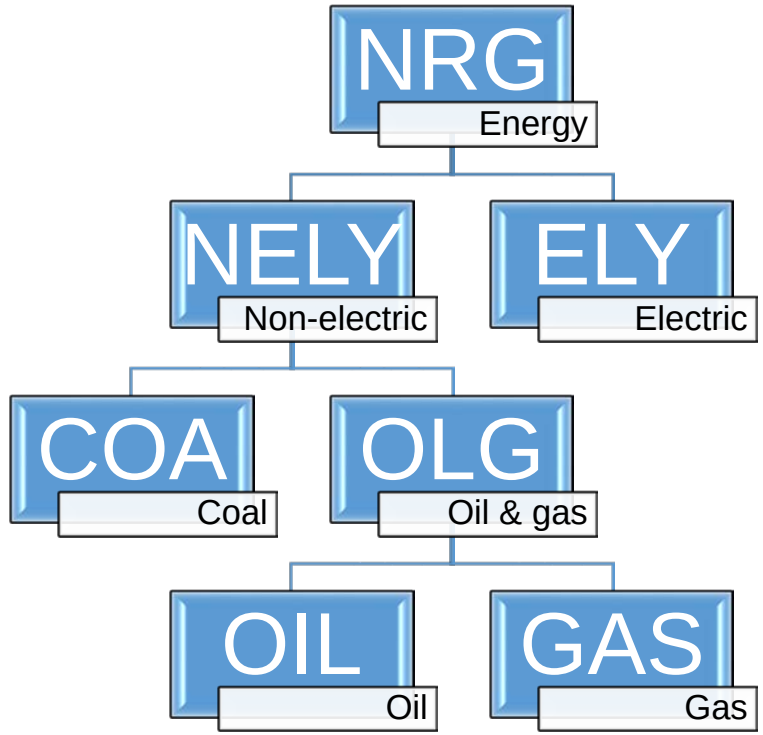
3.2. Including fossil-fuel consumption subsidies in GTAP

(1) Input data preprocessing	• ***Data:*** fossil-fuel supply costs, consumer prices and consumption (IMF, 2015): 188 countries, 6 energy commodities. • Elimination of discrepancies, conversion to uniform units.
(2) Subsidy estimates	• ***Data:*** GTAP-based energy volumes, prices, IMF-based subsidy values and volumes • subsidy estimates and mapping to GTAP regions
(3) Domestic energy prices and taxes update	• ***Data:*** GTAP-based energy quantities, IMF-based subsidy values. • Coal, petroleum products, natural gas and electricity subsidy rates estimates (per unit consumed), commodity tax rates and price updates.
(4) Data Base build	• Updated GTAP 9.2 Data Base distribution with incorporated pre-tax fossil-fuel consumption subsidies



3.3. Modelling framework – ENVISAGE

- **Global recursive-dynamic CGE model** (van der Mensbrugghe, 2018)
  - 2011-2100 (2011-2030 for this study)
- **Calibrated to GTAP-Power v9.2** (2011 base year)
- **Nested energy demand:**
  - energy preferences are agent-specific; substitution elasticities are vintage specific; autonomous energy efficiency improvement
- **Preference shift parameters**
  - Change the preference for one set of commodities in a demand system relative to other commodities, but without changing the aggregate cost
- **Dynamics:**
  - exogenous labor growth; capital growth a function of savings; exogenous land, energy and trade productivity
- **Current mapping:** 42 regions and 24 sectors

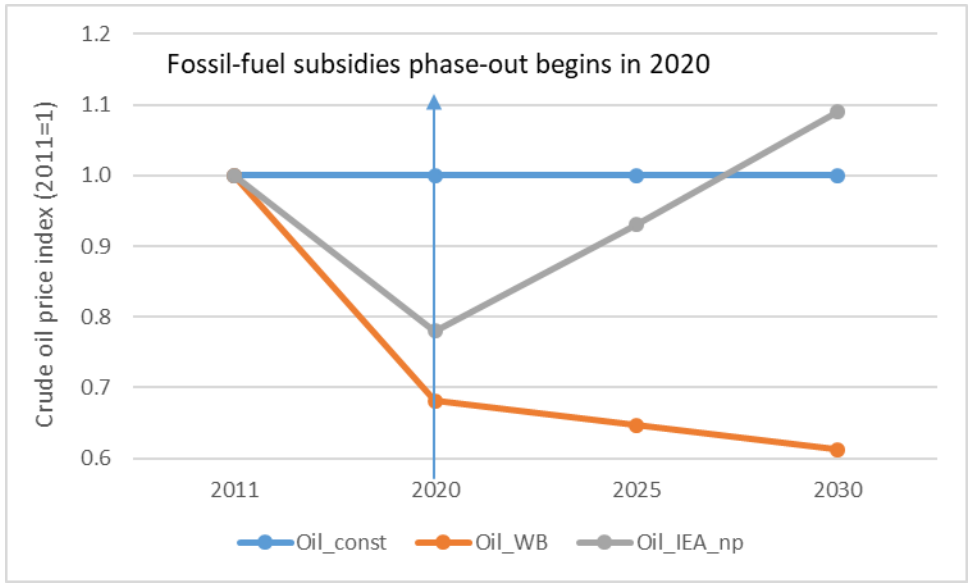


3.4. BaU path development: assumptions (1)

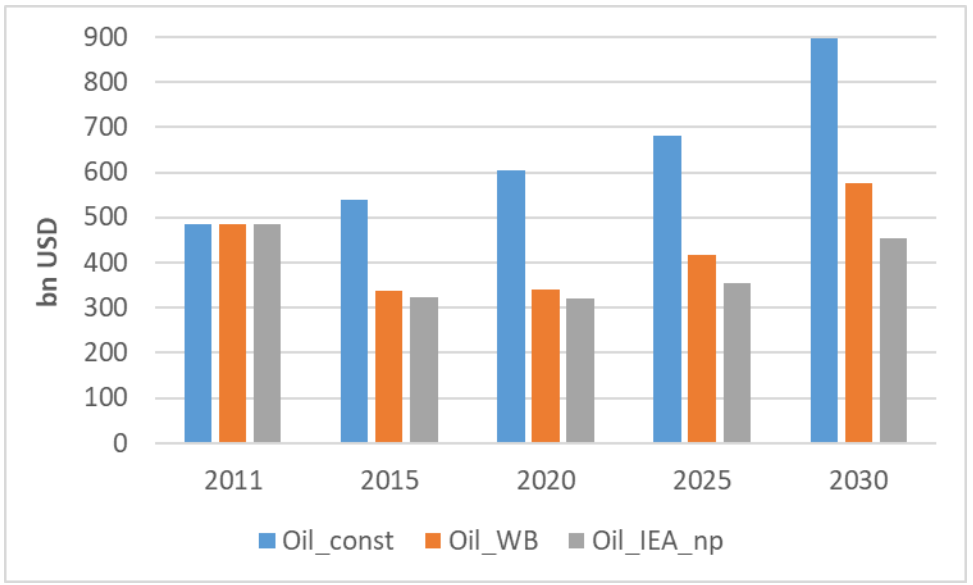
- **Macroeconomic and demographic assumptions – SSP2.**
- **Renewables costs reduction by 2030:**
  - 10% for wind, 20% for solar and other renewables.
- **Non-price related changes in preferences towards renewables**
  - Target for renewable electricity as a share of total electricity demand (implement 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)**
  - 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.
- **Improvements in international transport costs**
  - Costs decline by 1% per annum.

3.5. BaU path development: assumptions (2)

- **Oil price and energy subsidy scenarios:**
  - **“Oil_const” scenario**. Oil price is fixed at the 2011 level w.r.t. to the manufactures unit value (MUV) index. Subsidies are calibrated using 2011 data.
  - **“Oil_IEA_np” scenario**. Oil prices follow “New Policies” scenario of the World Energy Outlook (IEA, 2017). Subsidies are calibrated using 2011 and 2015.
  - **“Oil_WB” scenario**. Oil prices follow World Bank commodity price forecasts (WB, 2018). Subsidies are calibrated using 2011 and 2015.

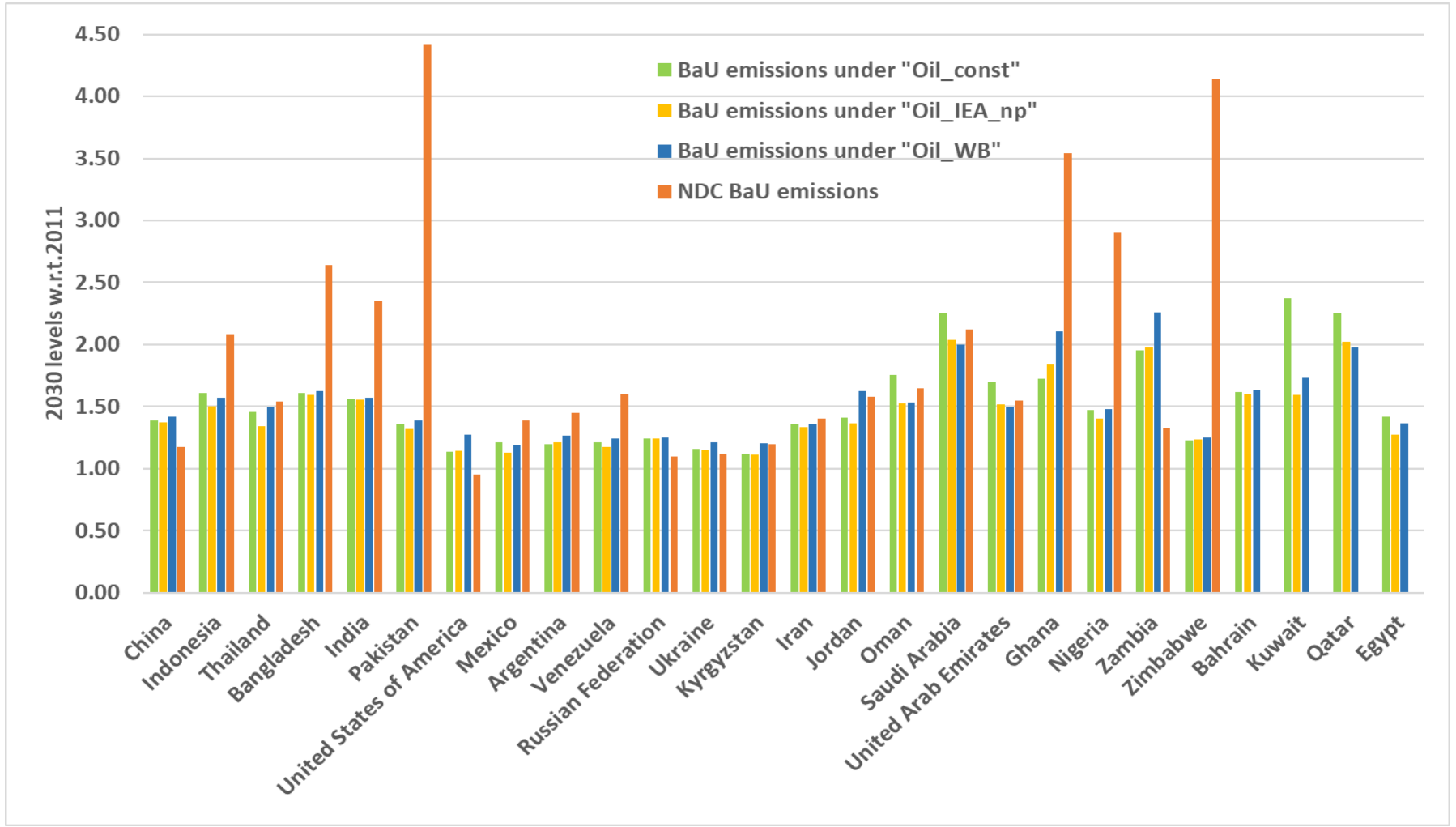


Crude oil price assumptions under different baseline scenarios (2011=1)



Fossil-fuel subsidy values under different baseline scenarios

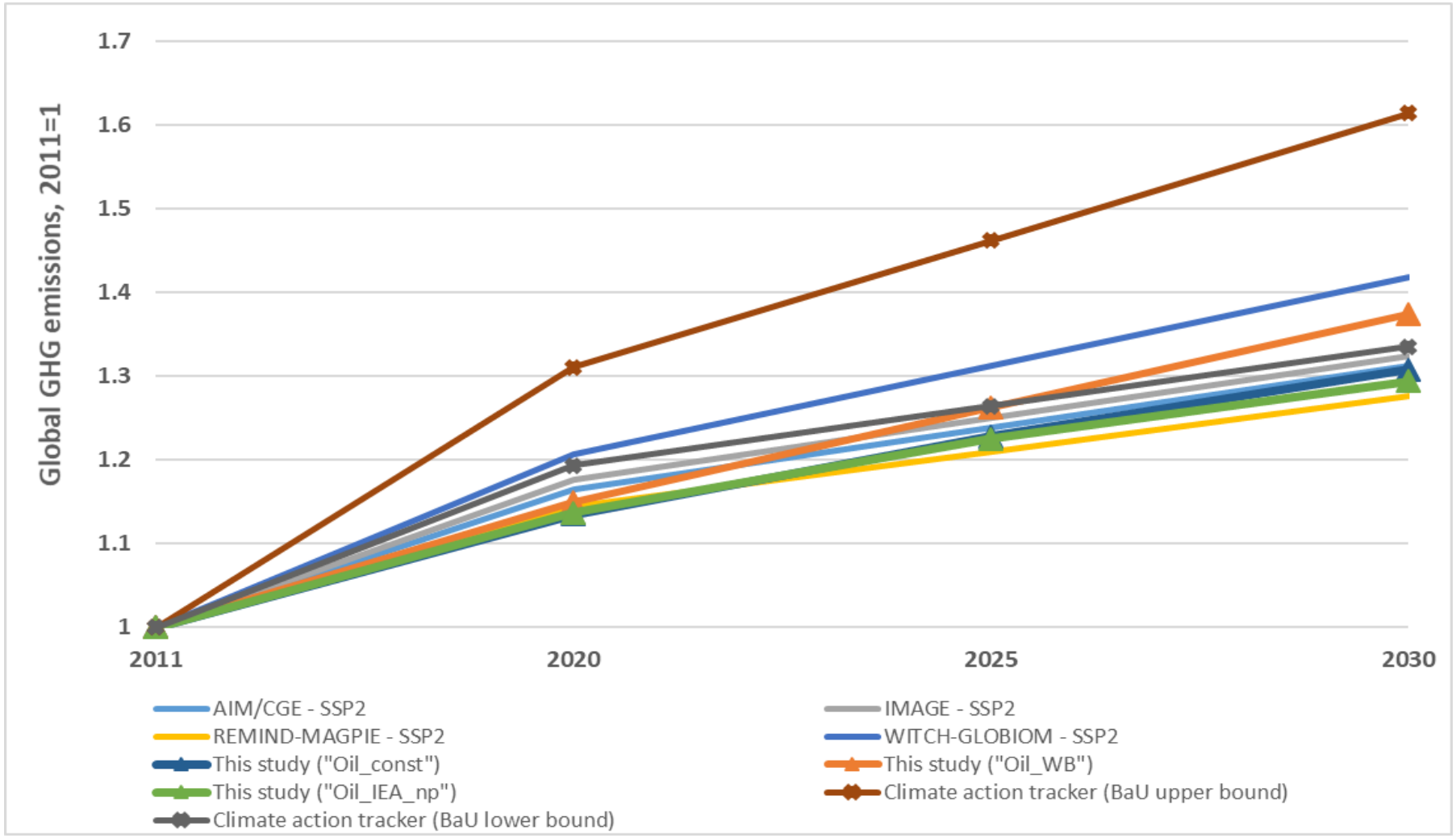
3.6. BaU GHG emissions and NDC targets



Notes: 2030 emission levels are expressed in terms of 2011 levels. 2011 emissions levels are assumed to equal "1". Non-binding NDC targets are not represented.

Source: Estimated by authors based on UNFCCC (2018b), CAT (2017), CW (2018), WB (2018), US EPA (2018), Chepeliev et al (2018).

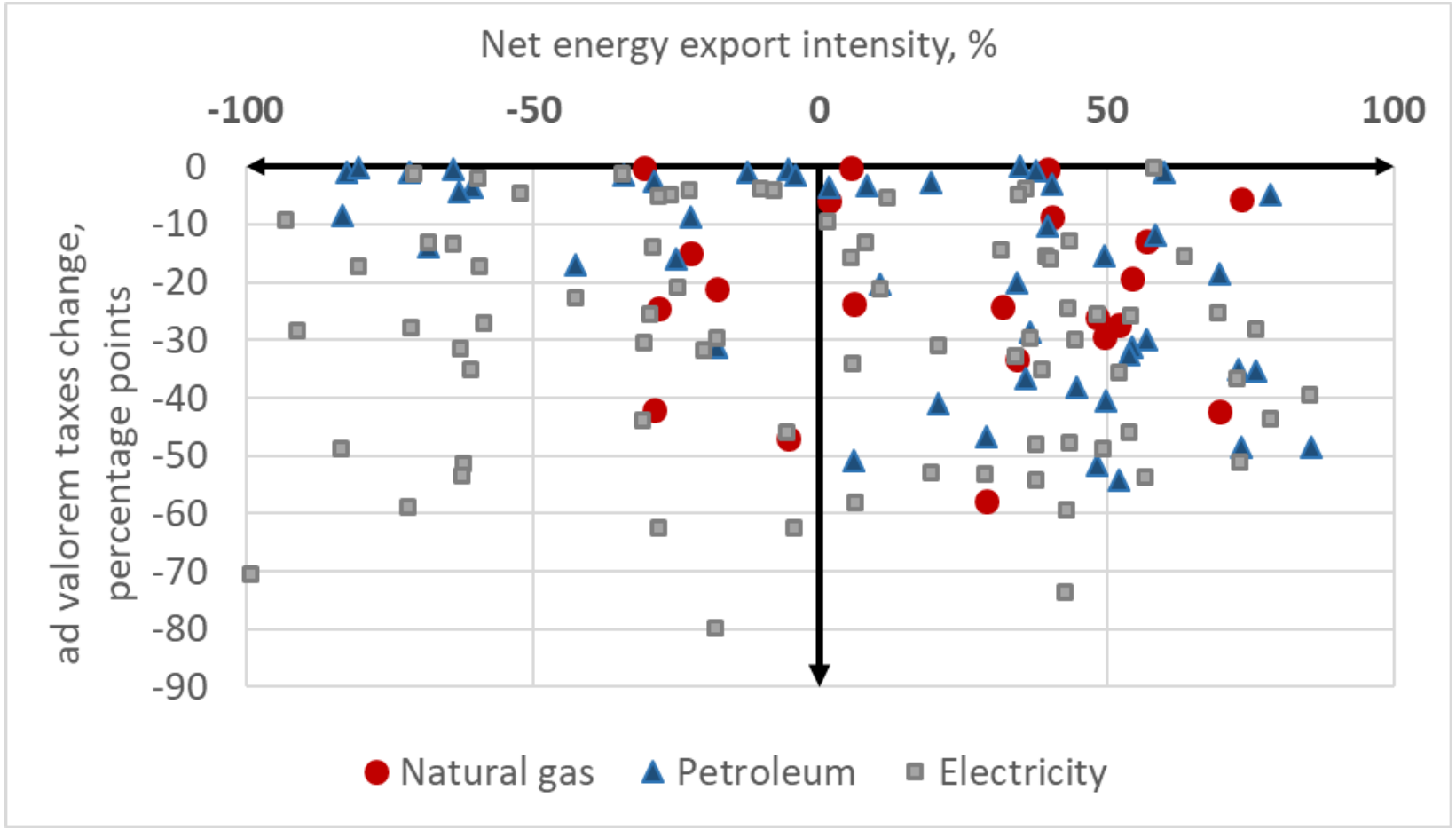
3.7. Baseline GHG emissions



Comparison of baseline GHG emission scenarios (2011=1)

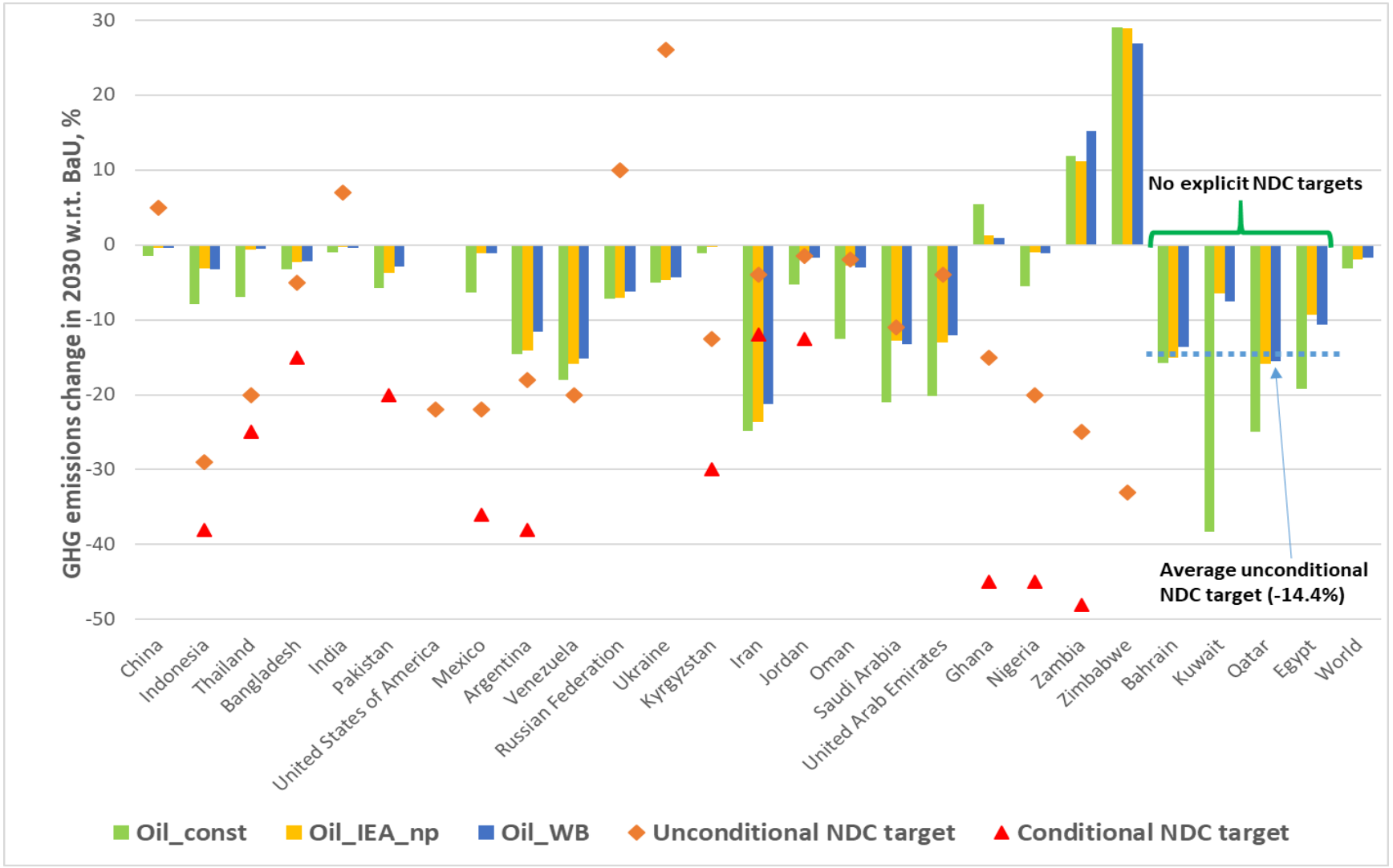
4.1. Energy subsidy elimination scenarios

Elimination of energy subsidies through energy commodity taxes increase. 2020-2025 elimination timeframe.



Weighted average energy consumption ad valorem tax rate changes in 2011, percentage points ("Oil_const" scenario)

4.2. NDC targets and energy subsidies elimination



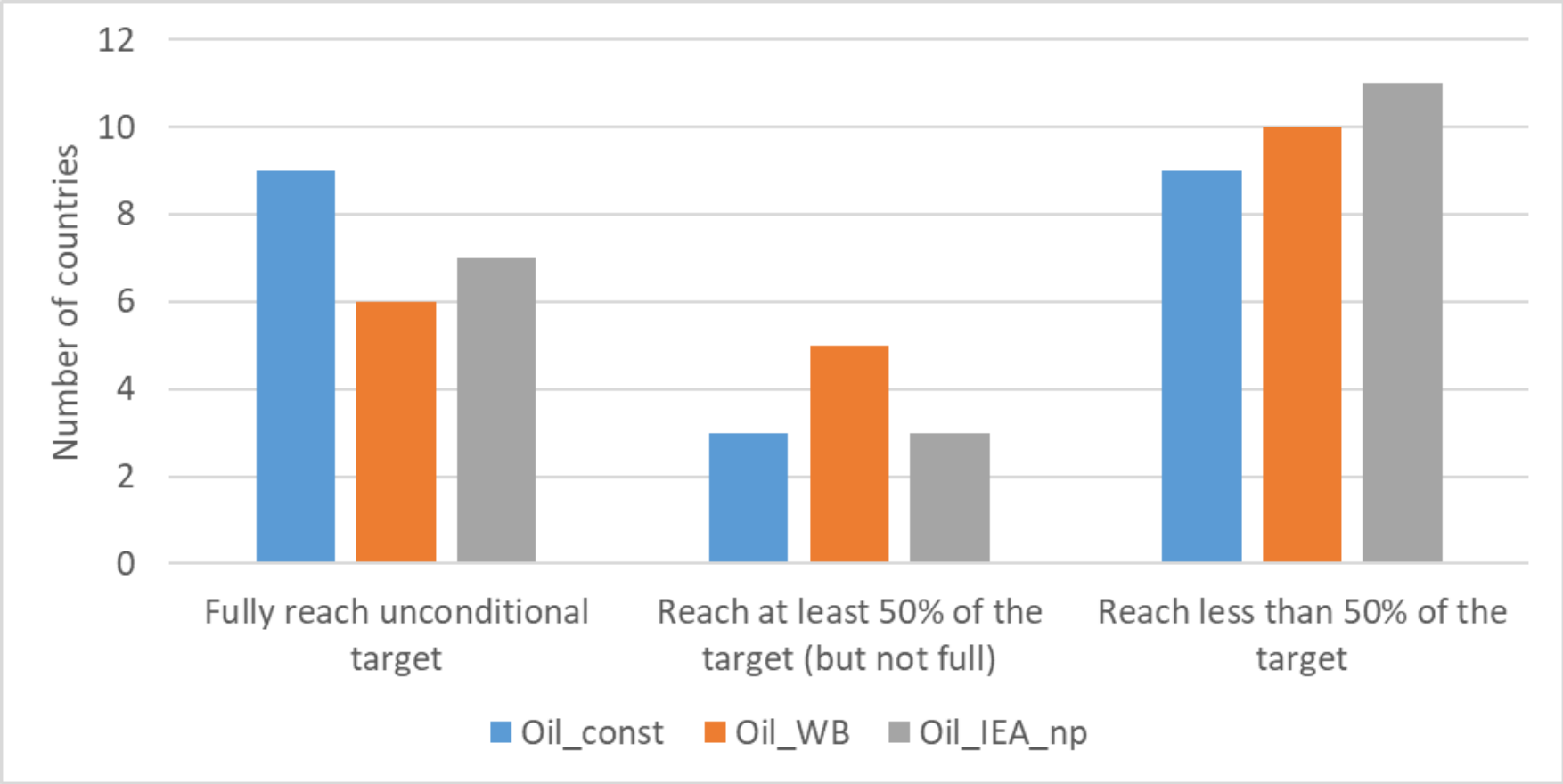
GHG emissions changes following fossil-fuel consumption subsidies elimination under different oil prices scenarios (w.r.t. BaU in 2030)

Global GHG emissions fall by 1.8-3.2%

6-9 countries fully reach unconditional NDC target

10-12 countries fulfill at least 50% of the target

4.3. Fulfillment of the NDC targets by countries



Number of countries that reach certain level of the NDC emissions reduction targets in 2030 (only countries with non-binding targets are reported)

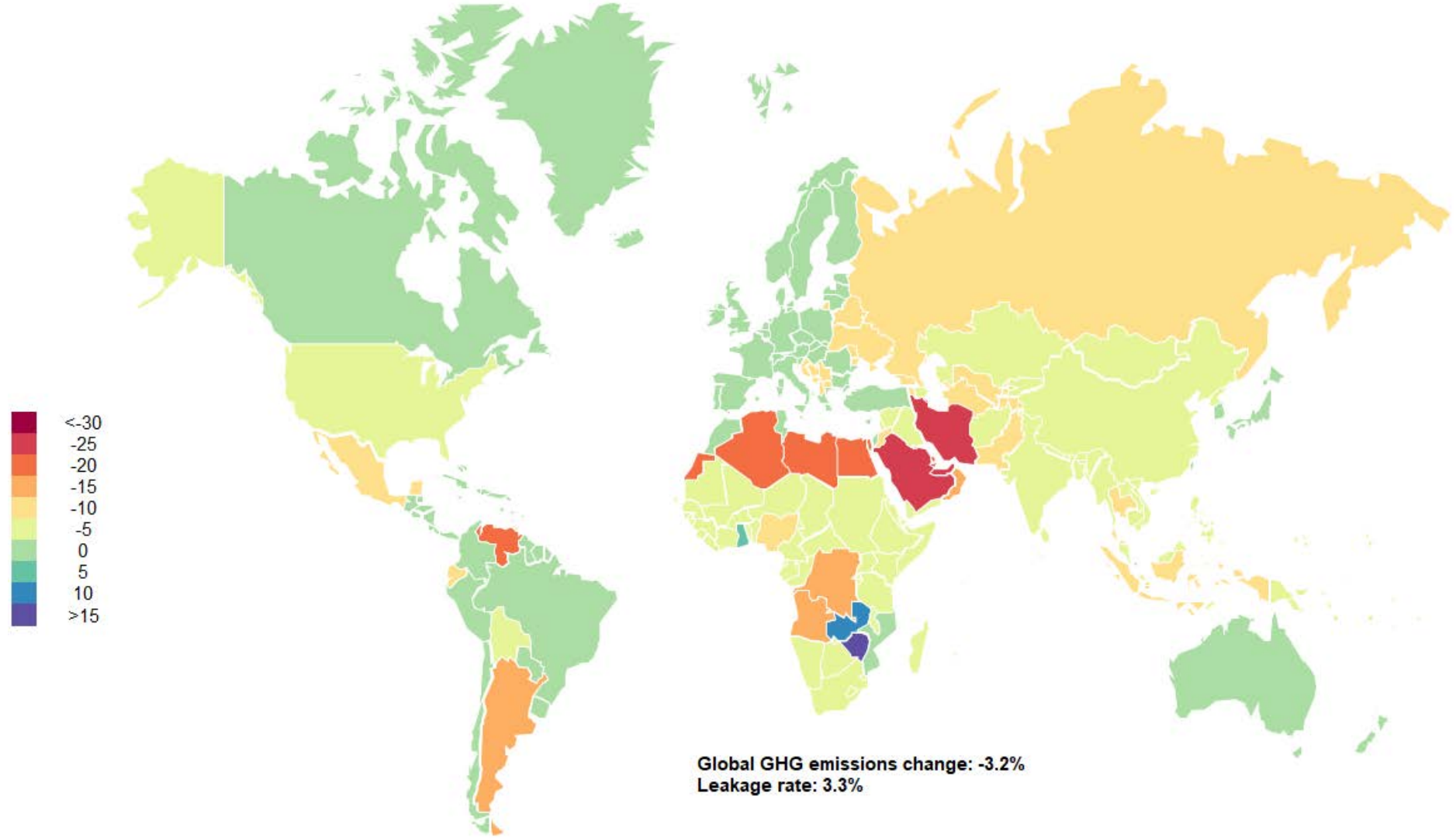
4.4. Some explanatory factors

- Subsidies phase out starts in 2020 (oil prices pass the lowest point in 2016).
- Higher energy demand under lower oil price scenarios (“Oil_IEA_np” and “Oil_WB”) – partial compensation in terms of subsidy values.
- Electricity subsidies are not significantly impacted by the global oil price changes (costs also depend on other factors).

Less variation in global GHG emissions reduction than in Jewell et al. (2018): ***1.8%-3.2%*** vs ***1%-4%***

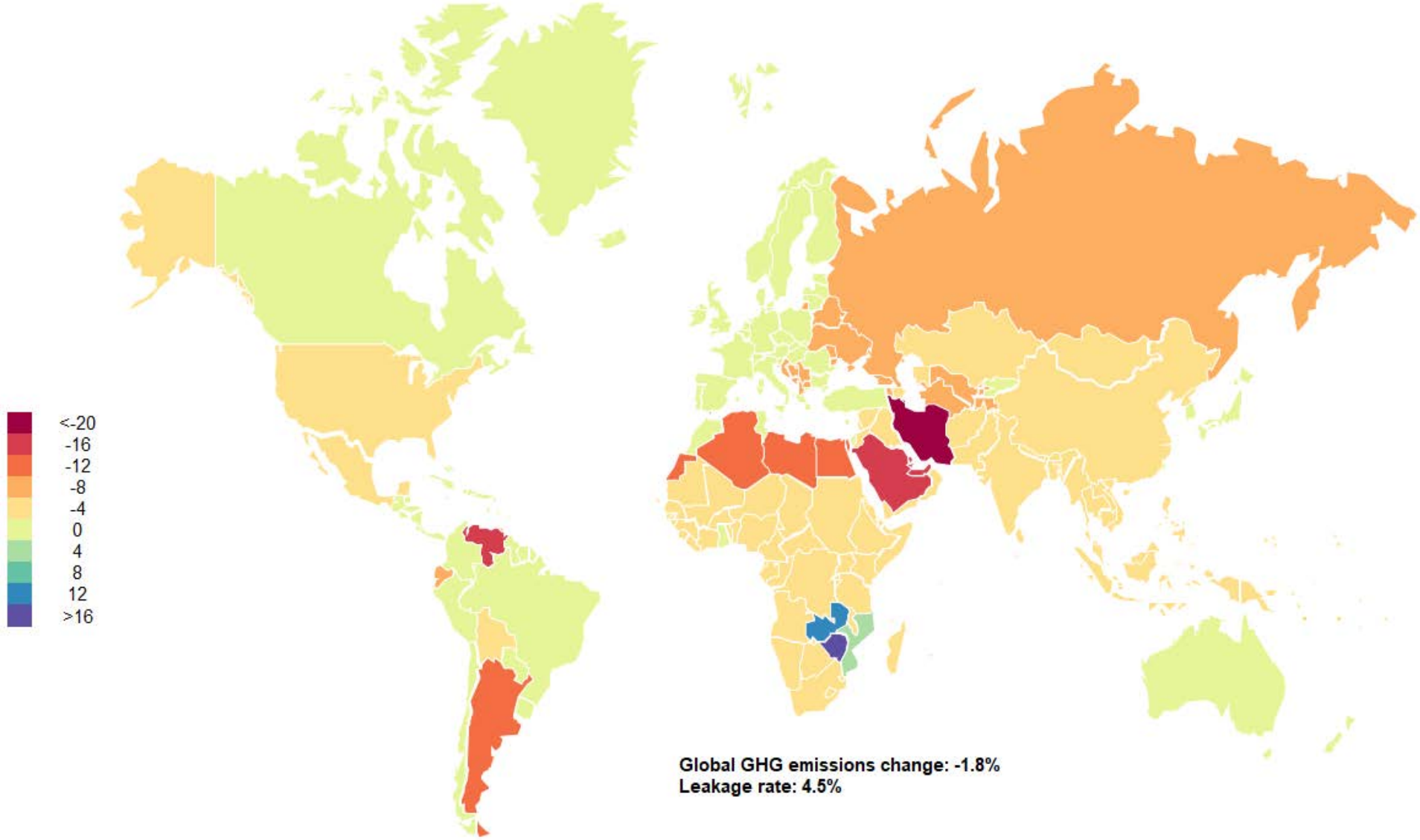
Lower GHG emissions reduction than in most previous studies: Magne et al. (2014), Burniax and Chateau (2014), IEA (2015) and IMF (2015) report ***4%-10%***

4.5. GHG emissions change under “Oil_const” scenario



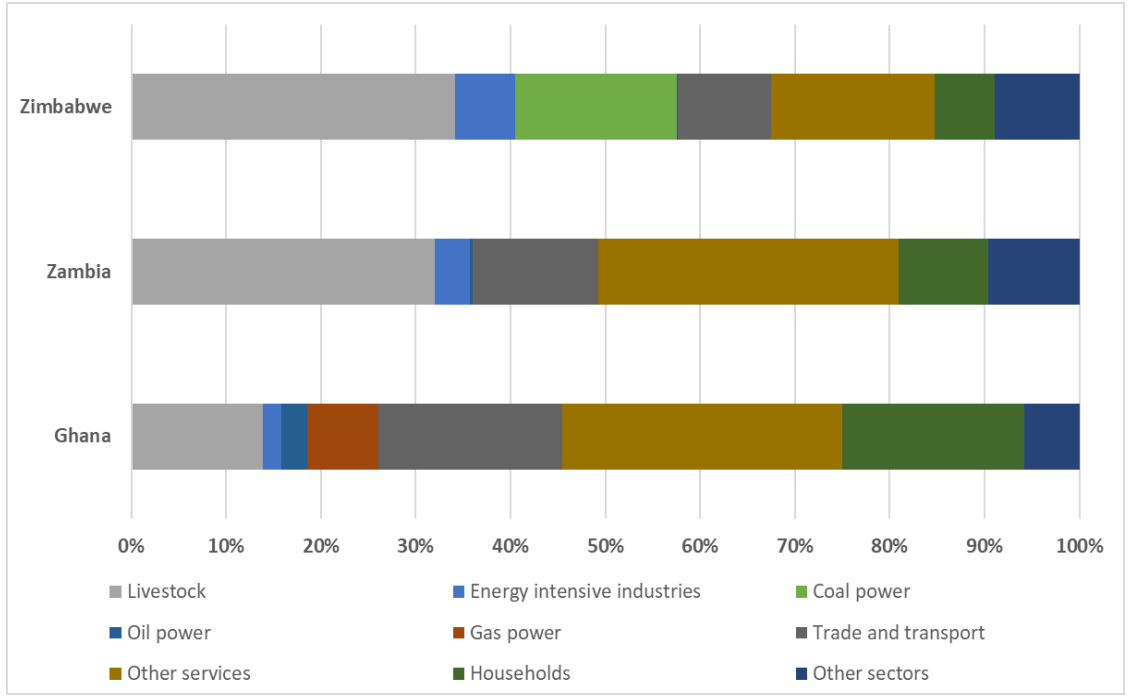
Change in GHG emissions by regions w.r.t. BaU scenario in 2030 following fossil-fuel consumption subsidies elimination, %

4.6. GHG emissions change under “Oil_WB” scenario

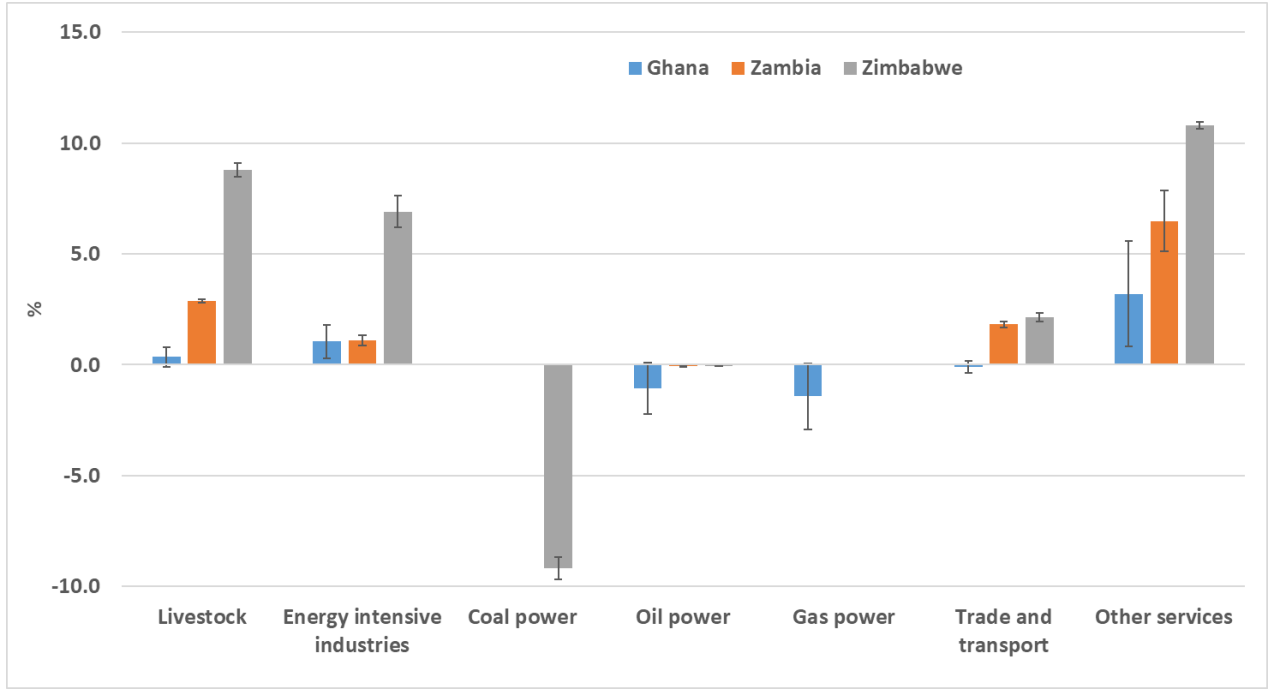


Change in GHG emissions by regions w.r.t. BaU scenario in 2030 following fossil-fuel consumption subsidies elimination, %

4.7. GHG emissions sectoral leakages (1)



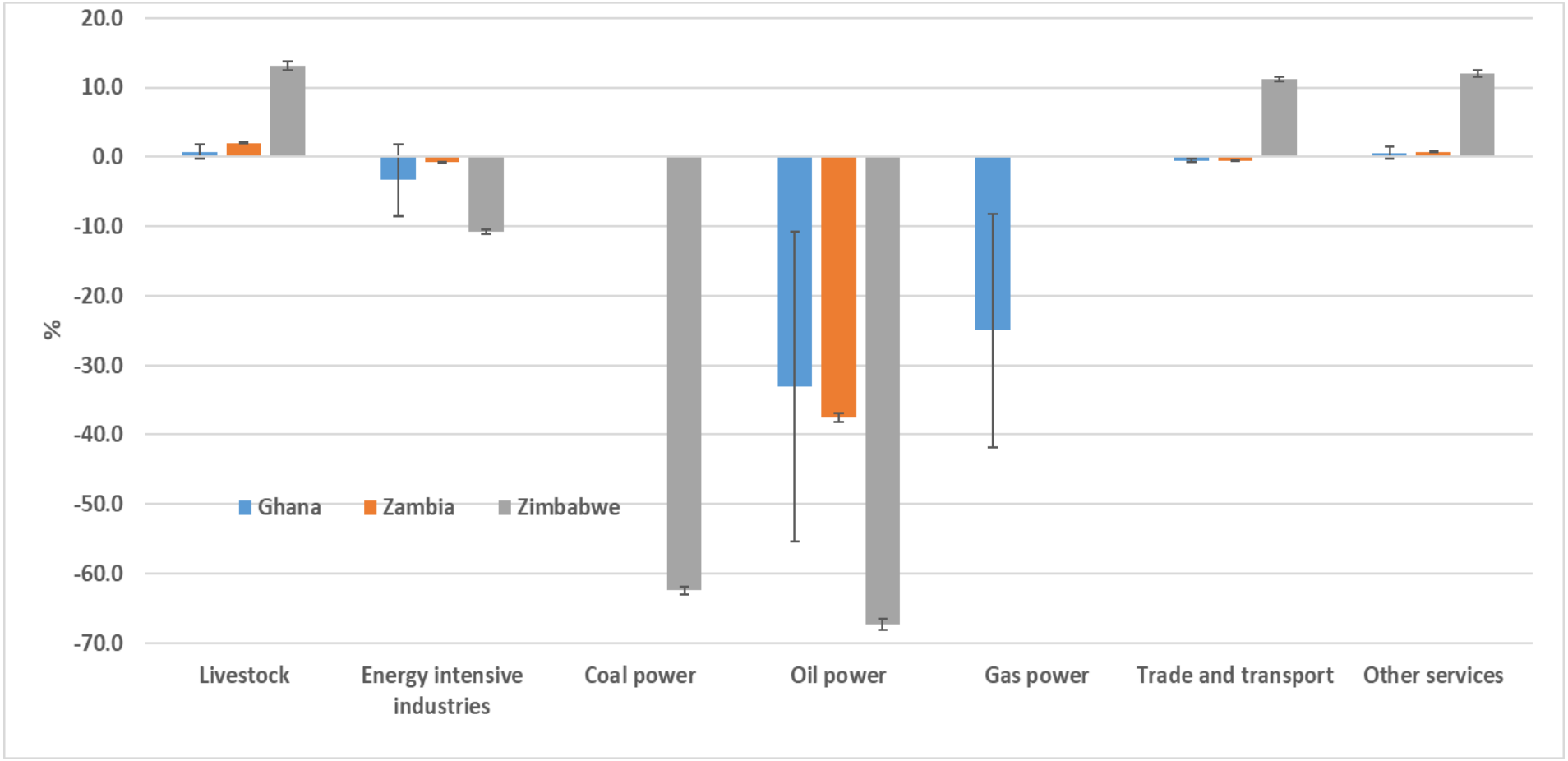
Sectoral distribution of the GHG emissions in selected countries, 2011 (%)



GHG emissions changes for selected countries and sectors w.r.t. to BaU in 2030, % of the total emissions change

Notes: Column bars (right chart) report simple average changes over three oil price scenarios; error bars report standard deviations from the simple average.

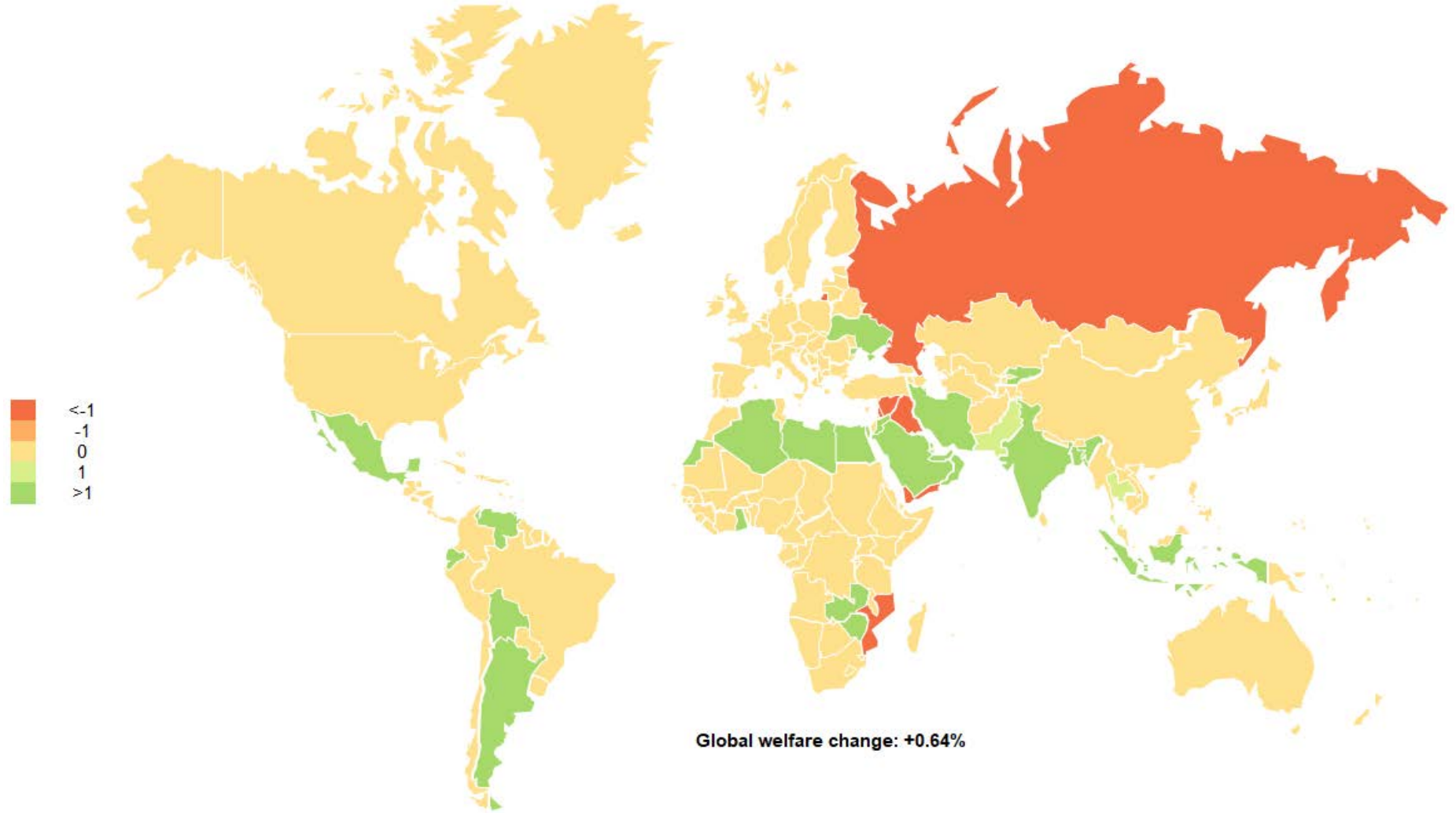
4.8. GHG emissions sectoral leakages (2)



Output changes for selected countries and sectors w.r.t. BaU in 2030, %

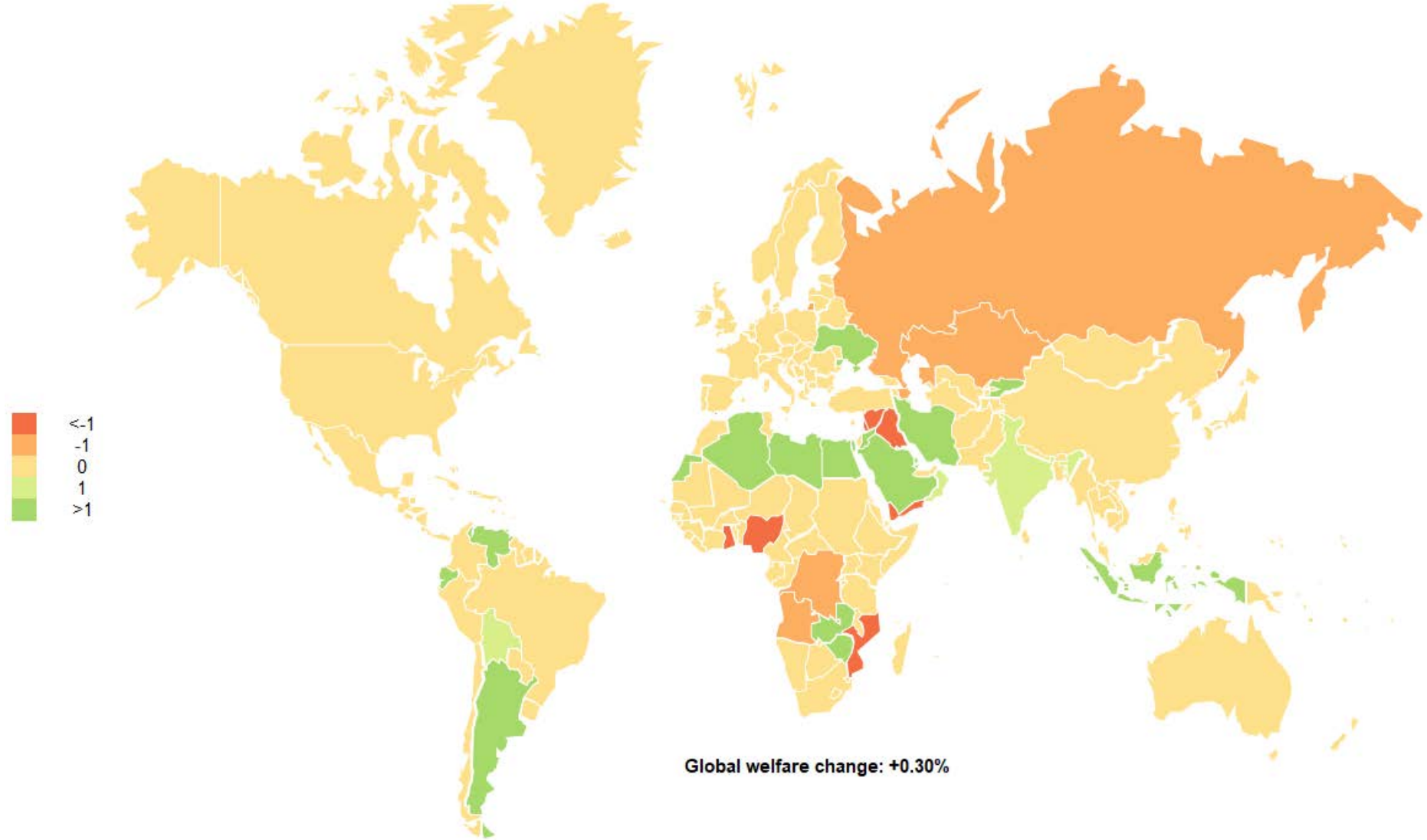
Notes: Column bars (right chart) report simple average changes over three oil price scenarios; error bars report standard deviations from the simple average.

4.9. Change in welfare under “Oil_const” scenario



Welfare changes under “Oil_const” price scenario in 2030, %

4.10. Change in welfare under “Oil_WB” scenario



Welfare changes under “Oil_WB” price scenario in 2030, %

5. Conclusions

- **Energy subsidies – large distortive impacts, continue to be supported in many countries.**
- **Energy subsidies are mentioned in 13 NDC contributions (but no numerical assessment).**
- **Subsidies elimination – global GHG emissions reduction by 1.8-3.2%.**
- **Positive global welfare implications (0.3%-0.6%).**
- **Regional (e.g. EU, USA, XHY) and sectoral (e.g. ZMB, GHA) leakages.**
- **Addressing domestic price distortions – efficient way in fulfilling NDC commitments (10-12 (out of 21) countries reach at least 50% of the NDC target).**

Global Trade Analysis Project

Questions/Comments?

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Sectoral mapping for policy experiment

Sector code	Sector description	GTAP-Power sector
Crp	Crops	pdr wht gro v_f osd c_b pfb ocr
Lvs	Livestock	ctl oap rmk wol frs fsh
Coa	Coal	coa
Oil	Oil	oil
Gas	Gas	gas gdt
omn	Minerals nec	omn
Pfd	Processed food	cmt omt vol mil pcr sgr ofd b_t
xma	Other manufacturing	tex wap lea lum ppp mvh otn ele ome omf
p_c	Petroleum and coal products	p_c
chm	Chemical, rubber, plastic products	crp
ke5	Energy intensive industries	nmm i_s nfm fmp
Etd	Electricity transmission	TnD
Nuc	Nuclear power	NuclearBL
Clp	Coal-fired power	CoalBL
Gsp	Gas-fired power in base load	GasBL GasP
wnd	Wind power	WindBL
Hyd	Hydro power	HydroBL HydroP
Olp	Oil-fired power	OilBL OilP
Xel	Other power	OtherBL
Sol	Solar power	SolarP
Wtr	Water	wtr
Cns	Construction	cns
Ttp	Transportation	trd otp wtp atp
Xsv	Other services	cmn ofi isr obs ros osg dwe