The COP29 side event on “Climate scenarios for this critical decade to achieve sustainable development and a resilient future” on November 19, 2024

Demand-side measures, including digital and social innovation, enabling near term action

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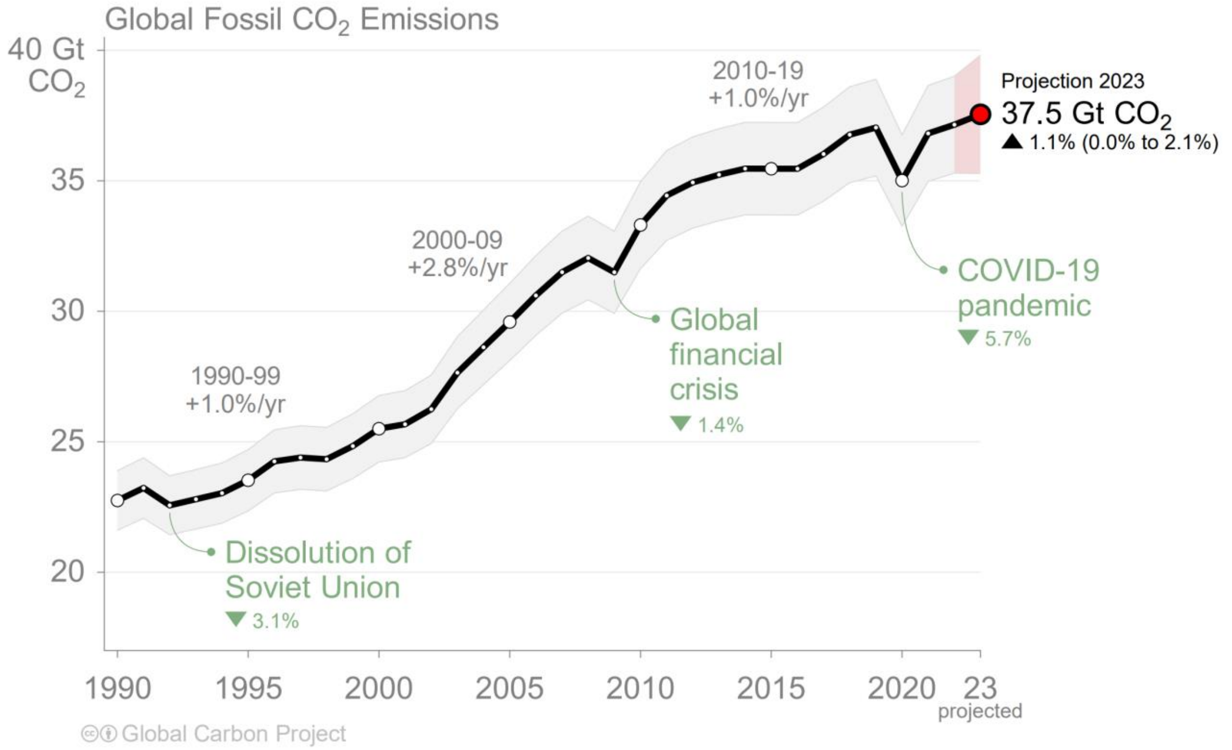
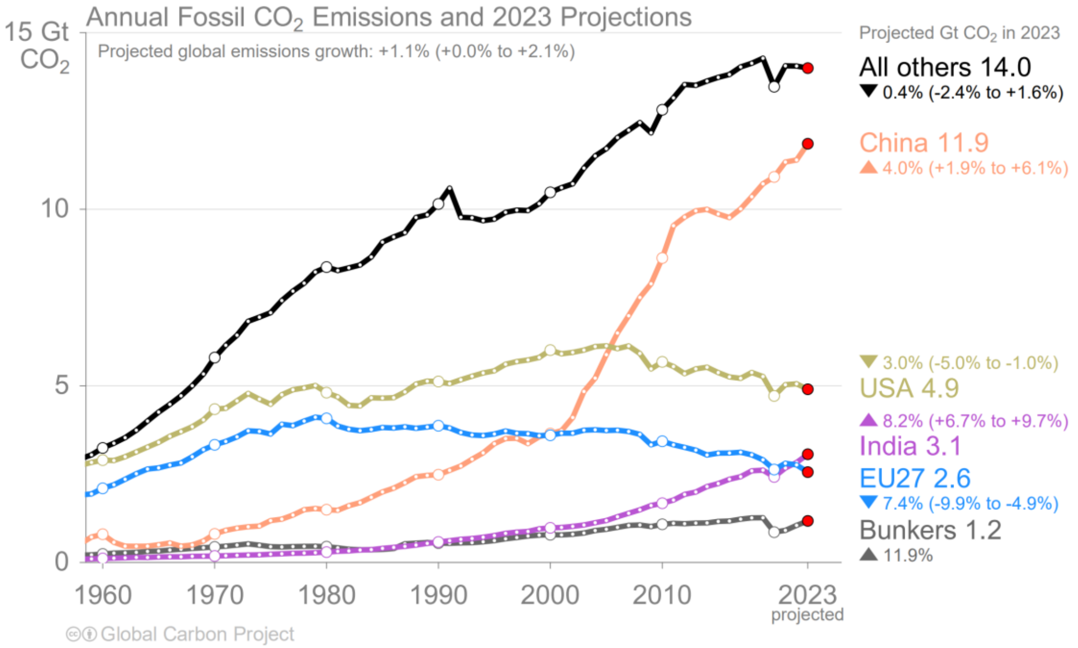
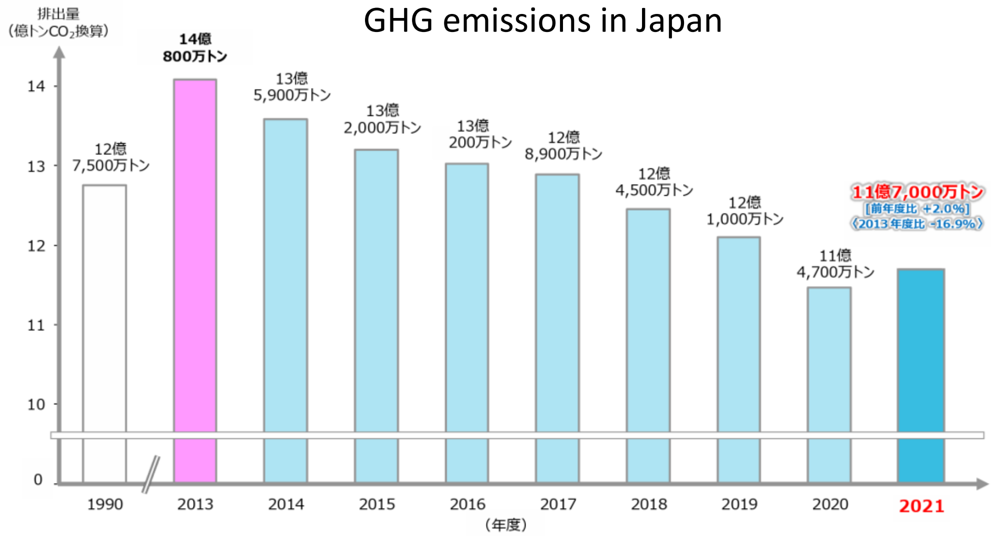
CO2 emission trajectories in the world and major countries



Source) Global Carbon Project, 2023

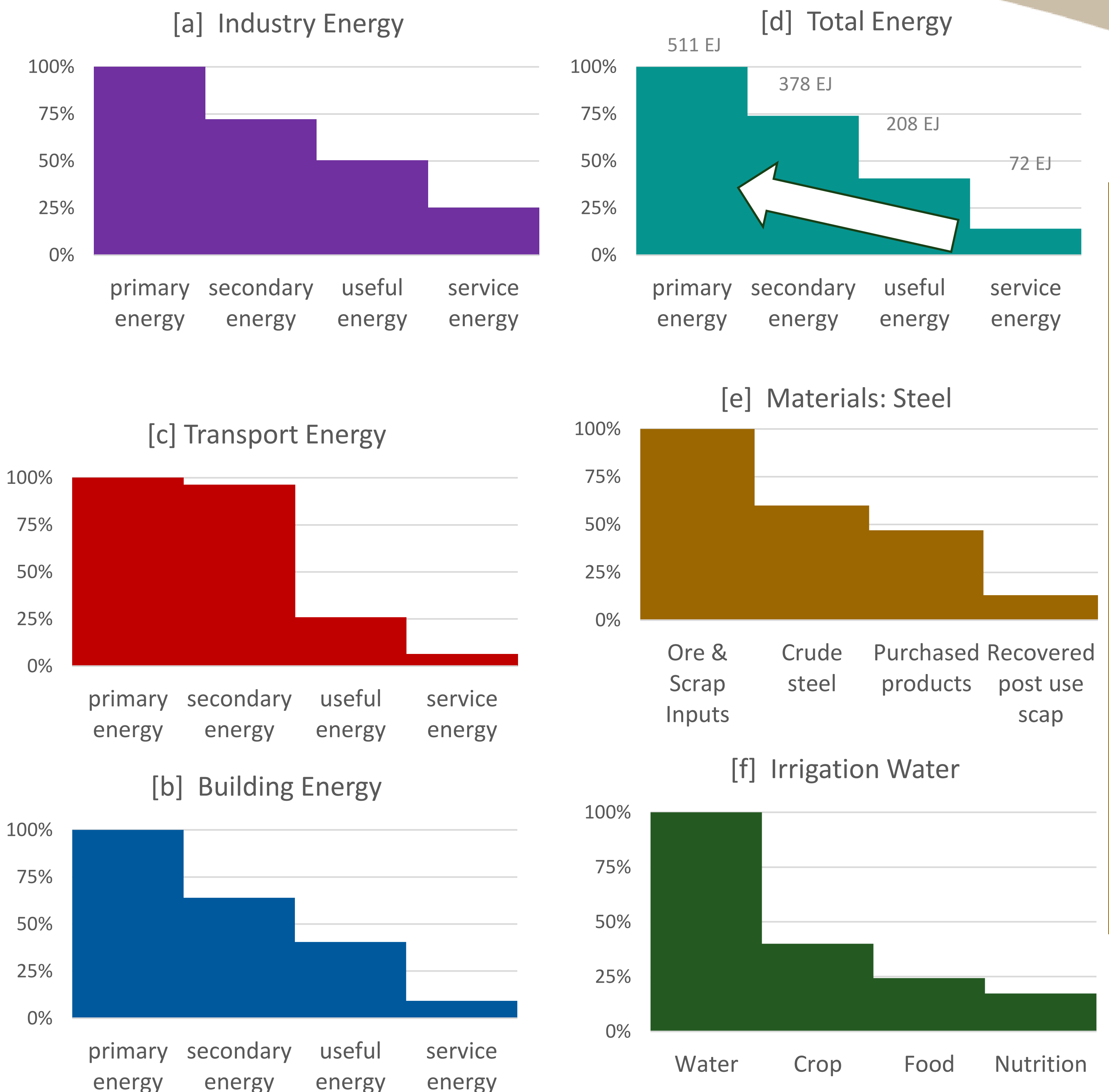




Source) The Government of Japan (Ministry of Environment), 2023

- **The coupling between the economy and CO2 emissions continues on the global level. When CO2 emissions decrease significantly, economic conditions (GDP, income) worsen.**

There is an enormous potential for services-led transformation



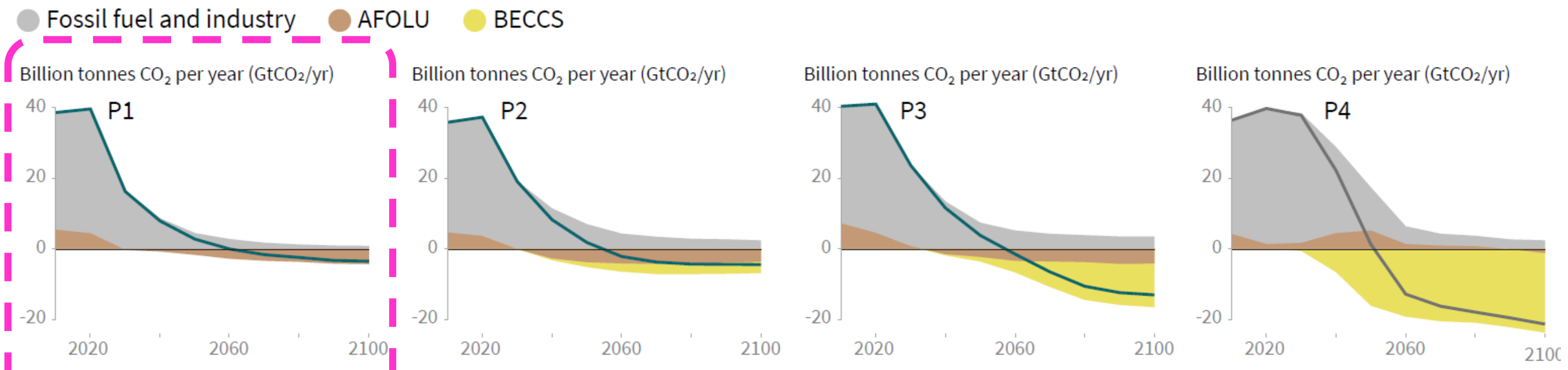
Service sectors has enormous leverage to reduce upstream energy, materials, and water use

“resource conversion cascades”

Source: Wilson, Grubler, and Zimm (2022). Energy-Services Led Transformation. In: *Routledge Handbook of Energy Transitions* (Ed: Araujo).
Data from: Grubler et al. (2018), De Stercke (2014), Nakicenovic et al. (1993), Nakicenovic (1990).

Low Energy Demand (LED) scenarios

IPCC Special Report on 1.5 C (SR15)



P1: A scenario in which social, business, and technological innovations result in lower energy demand up to 2050 while living standards rise, especially in the global South. A down-sized energy system enables rapid decarbonisation of energy supply. Afforestation is the only CDR option considered; neither fossil fuels with CCS nor BECCS are used.

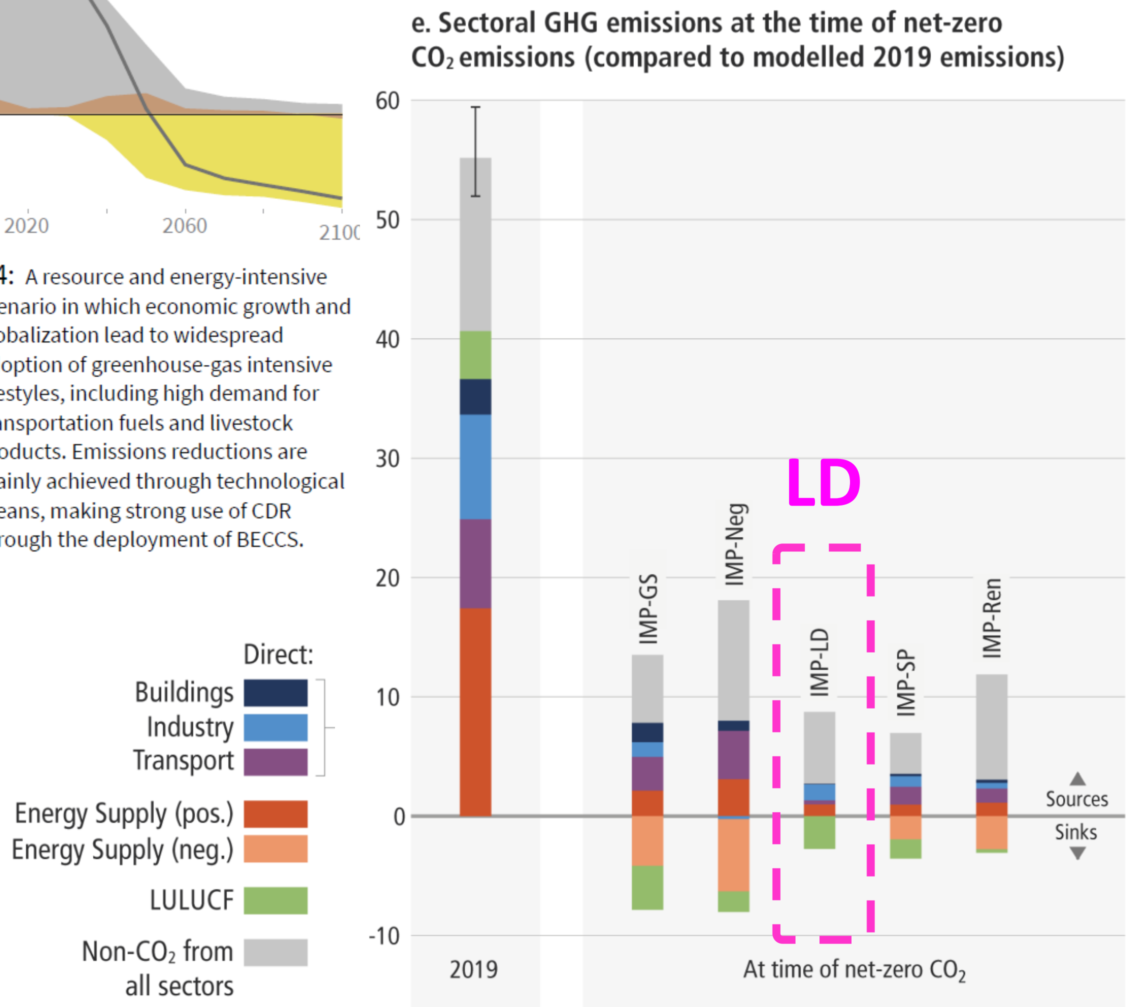
P2: A scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with limited societal acceptability for BECCS.

P3: A middle-of-the-road scenario in which societal as well as technological development follows historical patterns. Emissions reductions are mainly achieved by changing the way in which energy and products are produced, and to a lesser degree by reductions in demand.

P4: A resource and energy-intensive scenario in which economic growth and globalization lead to widespread adoption of greenhouse-gas intensive lifestyles, including high demand for transportation fuels and livestock products. Emissions reductions are mainly achieved through technological means, making strong use of CDR through the deployment of BECCS.

LED

IPCC 6[th] Assessment Report (AR6)



The IPCC reports show some scenarios of low energy demands, but more comprehensive and quantitative scenarios will be needed.

SDGs and a low energy demand society

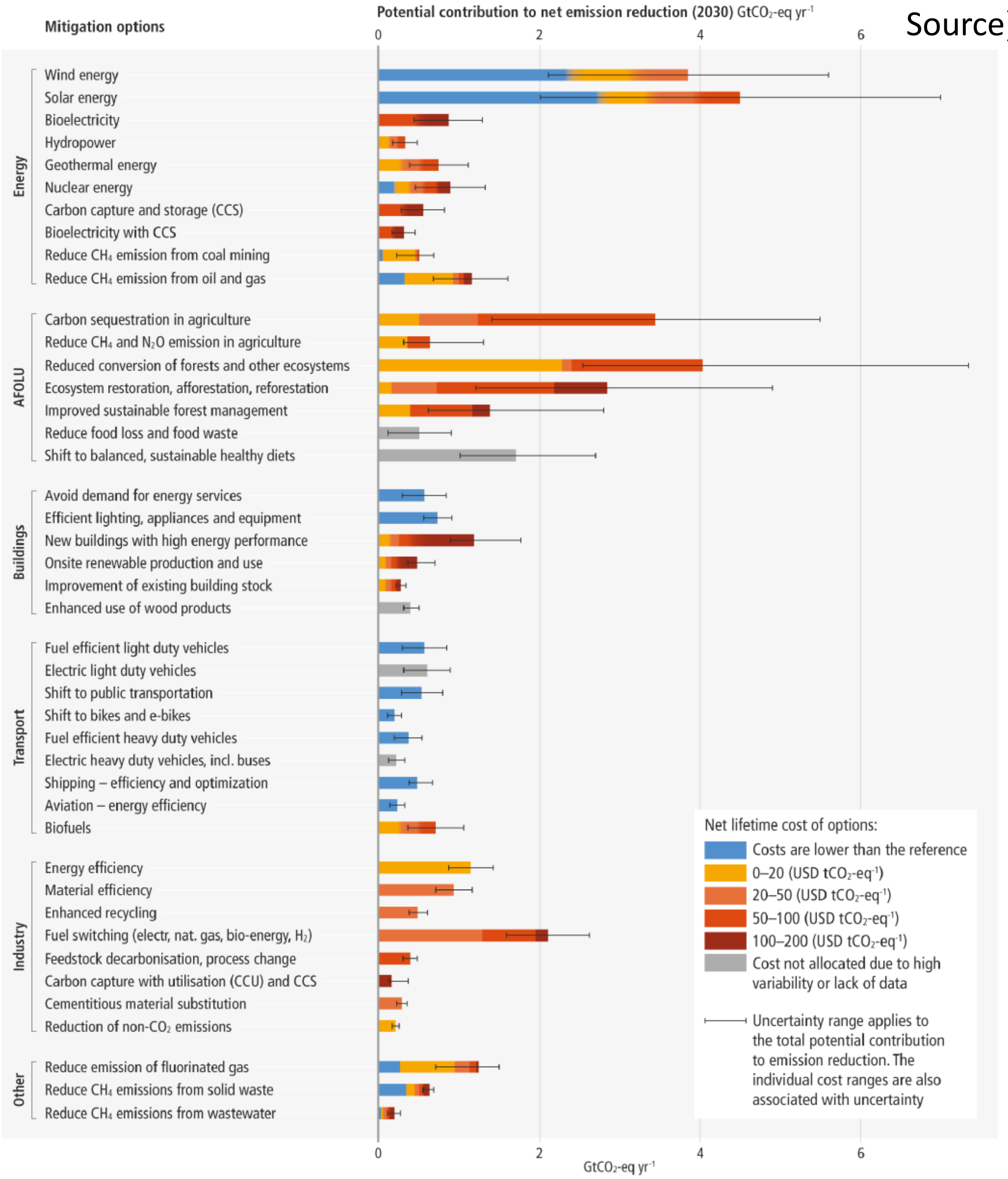
Achieving Goal 12 is well coordinated with achieving other eleven Goals

Responsible Consumption & Production:
End poverty, reduce overconsumption, minimize waste and environmental impacts

Source: IIASA, LED scenario

Deep emission reductions at affordable costs will be the key to achieving multiple SDGs, and digitalization and the related other innovations will contribute to the achievement.

Costs and potentials evaluation: 2030 global emissions –Sectoral bottom-up studies vs. IAMs–



Source) IPCC (2022)

		Bottom-up studies (IPCC Fig. SPM7)	IAMs (IPCC Fig.3.33)
Below 20 USD/tCO_2eq	CO_2	(30.3 $GtCO_2$/yr)	**35～44 $GtCO_2$/yr**
	GHGs	**44.3 $GtCO_2$eq/yr**	(49～58 $GtCO_2$eq/yr)
Below 100 USD/tCO_2eq	CO_2	(15.5 $GtCO_2$/yr)	**23～34 $GtCO_2$/yr**
	GHGs	**29.5 $GtCO_2$eq/yr** [compared to baseline：38 $GtCO_2$eq/yr (32～44 $GtCO_2$eq/yr)]	(37～48 $GtCO_2$eq/yr)

Source) K. Akimoto et al., Energy Strategy Reviews (2024)

- ✓ **There is a big difference in costs and potentials estimated by technology bottom-up studies and IAMs.**
- ✓ **Several kinds of hidden costs exist. Some of them can be reduced by DX and other demand-side measures. We should focus not only on direct costs but also hidden costs.**

Scenario assumptions

Digitalization and innovations, and induced social changes – Demand reductions (1/2)

Changes due to digitalization	Direct impacts	Indirect impacts
1) Ride and car-sharing associated with fully autonomous cars	- Energy consumption reductions due to ride-sharing	- Reductions in consumption of basic materials due to reductions in number of cars - Reductions in freight shipping => 8)
2) Virtual meeting and teleworking	- Reductions in travel service demand and the associated reductions in energy consumptions in transport sector	- Potential reductions in numbers of commercial building, and the resulting reductions in basic materials *[Not yet]*
3) E-publication etc.	- Reductions in paper consumptions due to large deployment e-publications etc.	- Potential reductions in freight services for papers. *[Not yet]*
4) Recycling and reductions in apparels due to e-commerce and other digitalization	- Reductions in energy consumptions for apparel productions	- Potential reductions in energy consumption at shopping centers etc. *[Not yet]*

Red: residential sector, **Green**: commercial sector, **Blue**: transport sector, **Purple**: industry sector , **Brown**: Non-CO2 GHGs etc.

Scenario assumptions

Digitalization and innovations, and induced social changes – Demand reductions (2/2)

Changes due to digitalization	Direct impacts	Indirect impacts
5) Longer life time of buildings due to improv. in city planning	- Potential Reductions in cement and steel due to longer life time of buildings	
6) Reductions in food losses due to better demand projection	- Reductions in nitrogen fertilizer, plastics, etc. and the resulting energy consumption reductions - Potential reductions in energy consumption at supermarkets etc. - Red. in CH_4 and N_2O	- Reductions in freight shipping services => 8) - *Pot. red. in construction for supermarkets etc., and the resulting reductions in basic materials [Not yet]* - *Pot. increases in afforestation due to increase in rooms of land area [Not yet]*
7) AM (3D-printing) for applying aircraft	- Reduction in aluminum and steel production - Reduction in electricity for productions	- Energy efficiency improvements of aircraft and the consumption reductions - *Energy efficiency improvements of cars and the consumption reductions [Not yet]*
8) Red. in freight shipping services due to reductions in basic materials and products	- Energy consumption reductions in freight shipping	

Red: residential sector, **Green**: commercial sector, **Blue**: transport sector, **Purple**: industry sector , **Brown**: Non-CO2 GHGs etc.

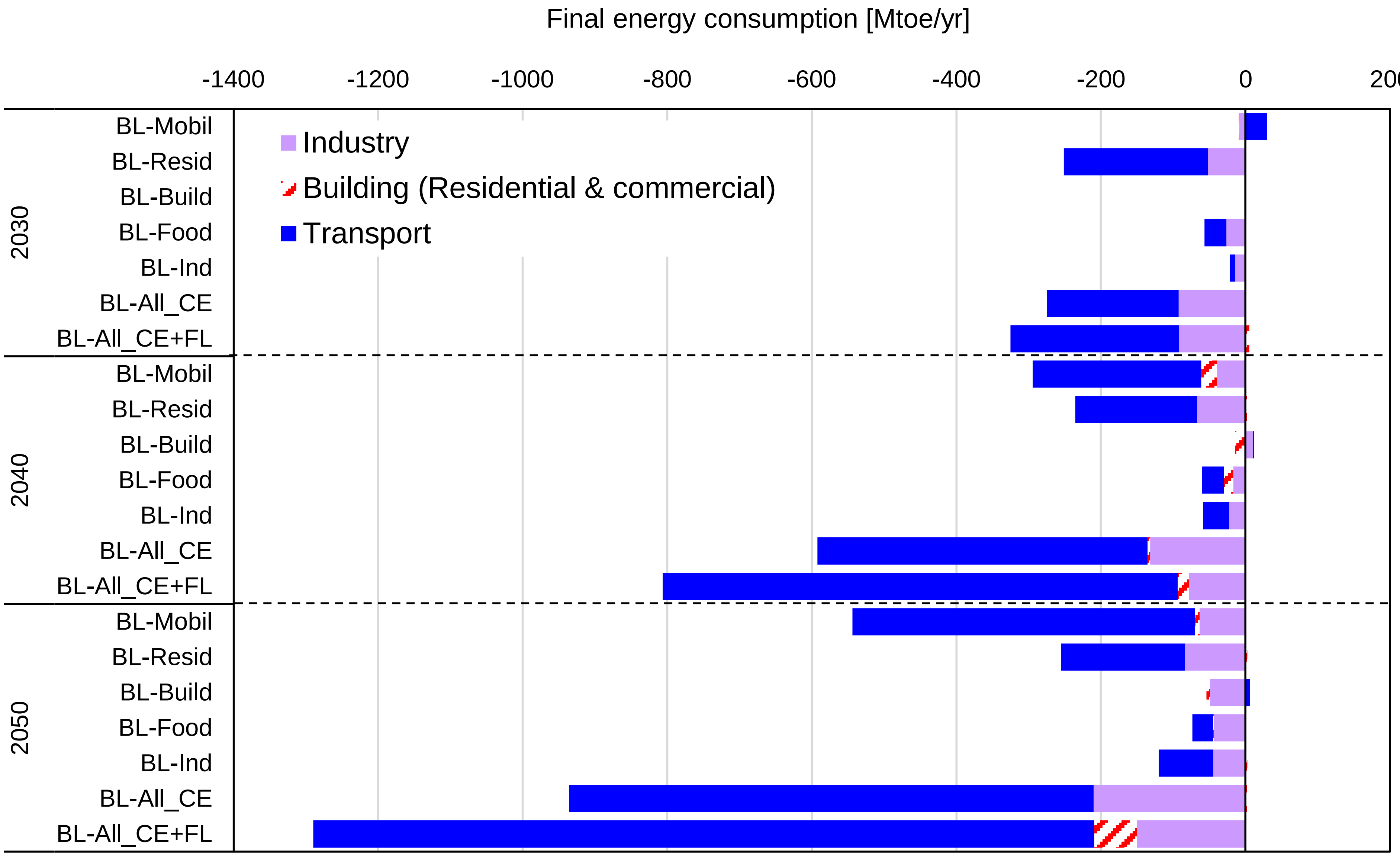
Scenario assumptions

	Emissions reduction	Energy demand reductions due to mainly digitalization						Rapid cost red. in granular tech's, e.g., PV, Wind, EV	Demand flexibilities in electricity (EV, HP, CGS)
		Transport 1)	Residential 2, 3, 4)	Building 5)	Food 6)	Industry 7)	Spill over 8)		
BL-Std	**Baseline** (without additional climate policies)	—	—	—	—	—	—	—	—
BL-Mobil		X							
BL-Resid			X						
BL-Build				X					
BL-Food					X				
BL-Ind						X			
BL-All_CE		X	X	X	X	X	X		
BL-All_CE+FL		X	X	X	X	X	X	X	X
B2DS-Std	**B2DS** (well below 2C; NDCs in 2030; CN by 2050 in G7 countries)	—	—	—	—	—	—	—	—
B2DS-Mobil		X							
B2DS-Resid			X						
B2DS-Build				X					
B2DS-Food					X				
B2DS-Ind						X			
B2DS-All_CE		X	X	X	X	X	X		
B2DS-All_CE+FL		X	X	X	X	X	X	X	X

Final energy consumption (preliminary)

Baseline (without additional climate policies); relative to the BL-Std scenario

Estimated by DNE21+ model



While this preliminary study assumes only limited impacts of circular/sharing economies due to digitalization mainly, significant reductions (by around 10%) in final energy consumptions are estimated.

Ref.) Global final energy consumption in 2019: 10 Gtoe/yr; baseline final energy consumption in 2050: 14 Gtoe/yr

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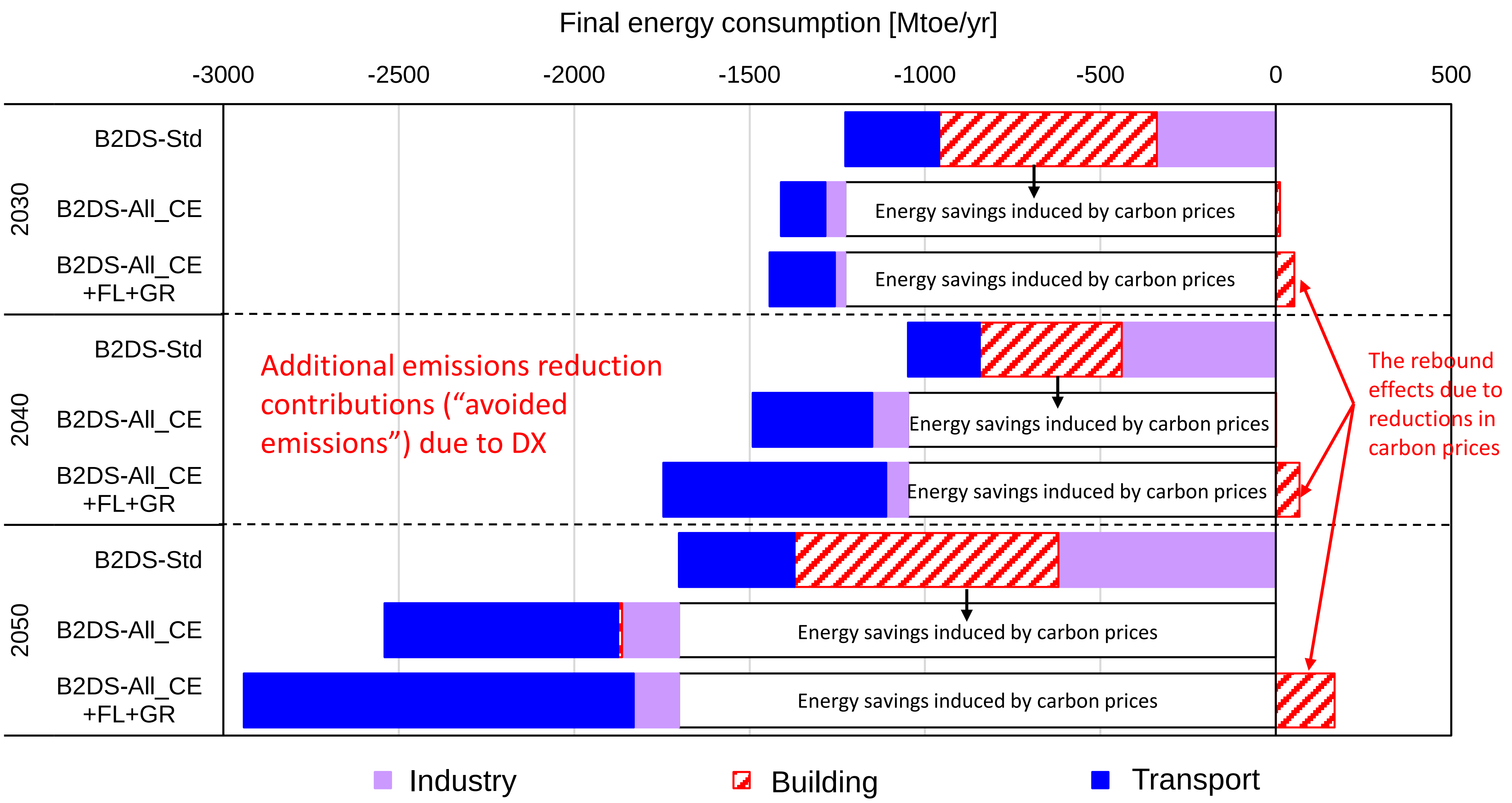
Final energy consumption (preliminary)

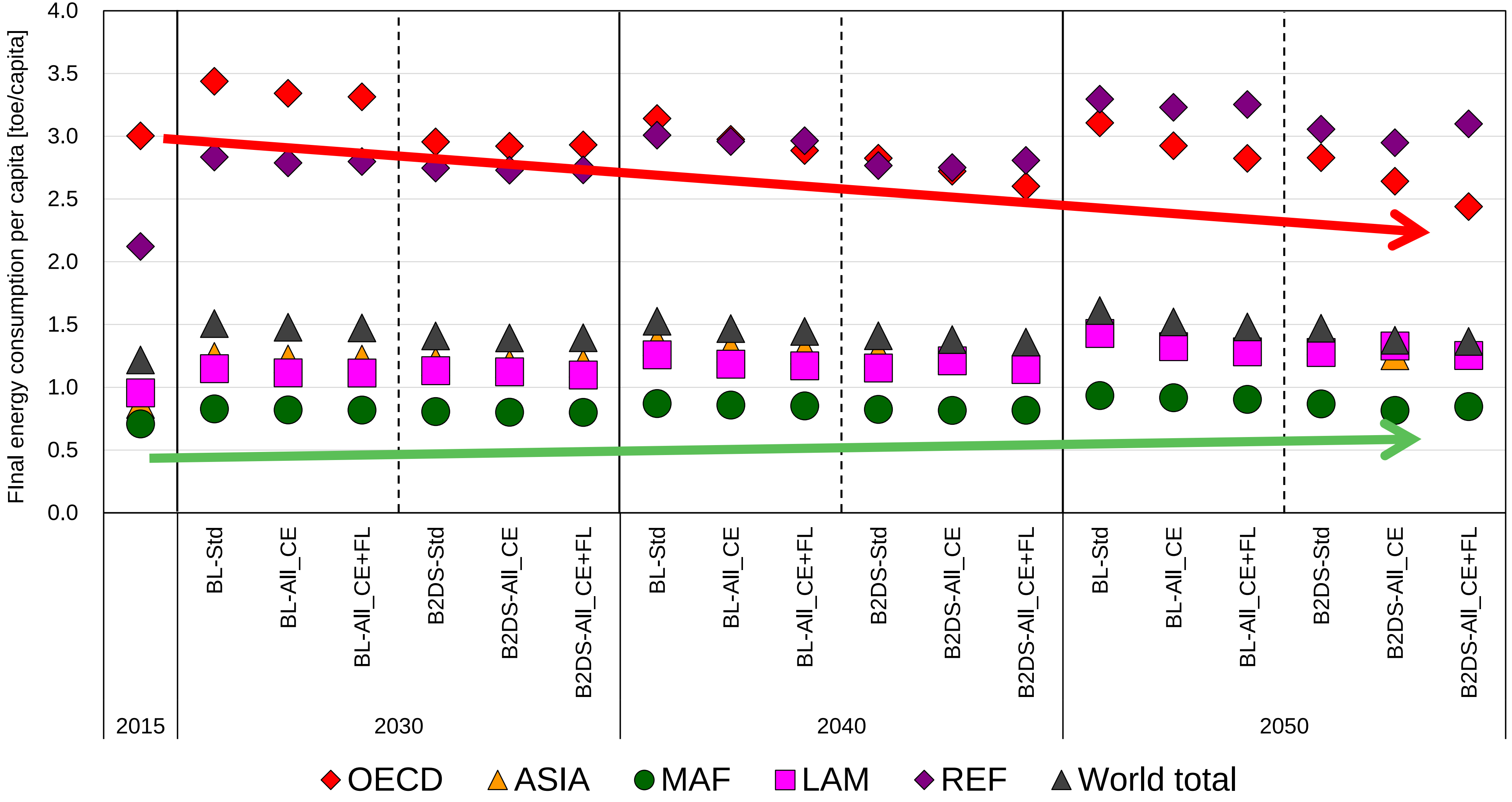
B2DS (well below 2 °C)



DX solutions including circular and sharing economy could induce around 6% reduction of total final energy consumption, which corresponds to a similar level of energy savings due to carbon prices for the B2DS.

Ref.) Global final energy consumption in 2019: 10 Gtoe/yr; baseline final energy consumption in 2050: 14 Gtoe/yr

Final energy consumption per capita by region (preliminary)



The low-demand scenarios induce smaller differences in final energy consumption across regions.

Estimated by DNE21+ model

Conclusion

Policies focusing on demand-side measures including embedded energies into products and services should be discussed more, in order to accelerate global emissions reduction and achieve multiple SDGs including equity of energy uses among countries.

- **There are near-term and cheaper costs measures in end-use sectors. We should focus not only on direct costs but also on implicit or hidden costs for deploying end-use measures. Behavior changes with DX and better institutions will reduce implicit or hidden costs.**
- **Comprehensive and quantitative analyses as well as qualitative analyses will be important for having large impacts on the IPCC and global implementation of demand-side measures with high collaboration among sectors.**
- **Integration of sectors, disciplines, and policies is a key considering differences among countries.**

Thank you very much for your attention!

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Overview of DNE21+ model

- Linear programming model (minimizing world energy system cost; with 10mil. variables and 10mil. constrained conditions)
- Evaluation period: 2000-2100
  Representative time points: 2005, 2010, 2015, 2020, 2025, 2030, 2040, 2050, 2070 and 2100
- World divided into 54 regions
  Large area countries, e.g., US and China, are further disaggregated, totaling 77 world regions.
- Interregional trade: coal, crude oil/oil products, natural gas/syn. methane, electricity, ethanol, hydrogen, CO_2 (provided that external transfer of CO_2 is not assumed in the baseline)
- Bottom-up modeling for technologies on the energy supply side (e.g., power sector) and CCUS
- For the energy demand side, bottom-up modeling conducted for the industry sector including steel, cement, paper, chemicals and aluminum, the transport sector, and a part of the residential & commercial sector, considering CGS for other industry and residential & commercial sectors.
- Bottom-up modeling for international marine bunker and aviation.
- Around 500 specific technologies are modeled, with a lifetime of equipment considered.
- Top-down modeling for others (energy saving effect is estimated using long-term price elasticity.)