The COP28 Side-event at the Japan Pavilion
on December 11, 2023 in Dubai

– *Demand response to disruptions* –

Importance of demand side solutions for the transformation towards net-zero society

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G20 Karuizawa Innovation Action Plan on Energy Transitions and Global Environment for Sustainable Growth (June 2019)

“We recognize the importance of quantitative analysis on better understanding future energy demand and supply and the role of innovation of both sides driven by digitalization, Artificial Intelligence (AI), the Internet of Things (IoT), and the sharing economy. We encourage efforts made by the global scientific community and international organizations and frameworks to further refine and develop the full spectrum of economy-wide scenarios for energy and climate models.”

Note) This is also an annex document of the G20 Osaka Leader’s declaration.

EDITS: Energy Demand changes Induced by Technological and Social innovations

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Energy Demand changes Induced by Technological and Social innovations

The EDITS project supported by Ministry of Economy, Trade, and Industry (METI), Japan

<u>The terms</u>: FY2020- (expectation: for five years and more)

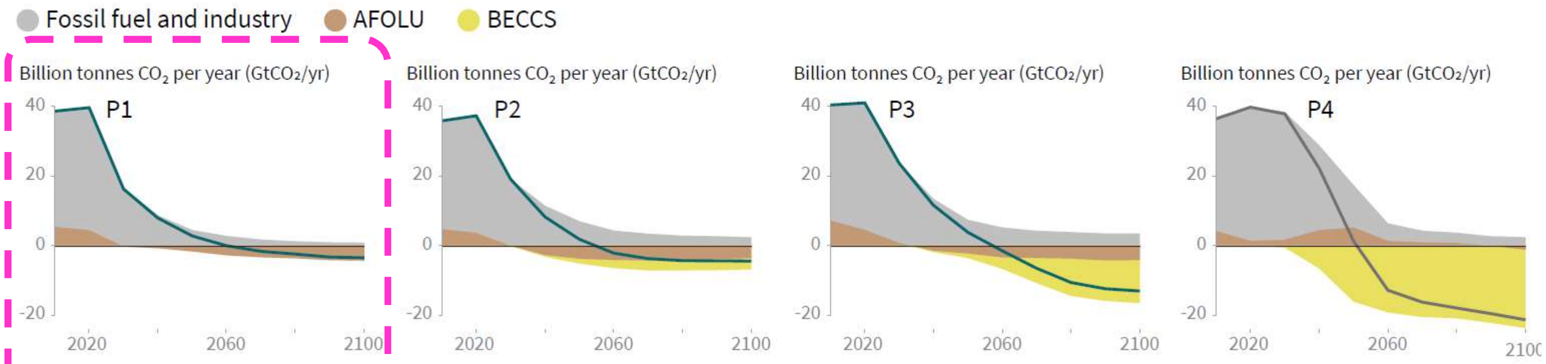
<u>Participating research institutes or researchers</u>:
IIASA, AIT, LBNL, OECD/ITF, CMCC, Central European Univ., ISCTE, Univ. of Wisconsin, UCSB, UFRJ/COPPETEC, The Korean Society of Climate Change Research, The Univ. of Tokyo, Osaka Univ., RITE, and others
Nearly 100 researchers including many IPCC lead authors are involved in.

[Objectives]

- ✓ **To create a research community with a focus on end-use, demand-side perspectives that furthers dialogue and cross-fertilization of research and policy analysis through the sharing of novel data, novel concepts, methodologies and policy analyses.**
- ✓ **To improve the state-of-art of demand modeling in environmental and climate policy analysis, via methods and model intercomparisons and assisting the transfer of conceptual and methodological improvements across disciplines, sectors, and environmental domains.**
- ✓ **To better inform policy via structured model experiments and simulations that assess potential impacts, barriers, as well as synergies and tradeoffs to other SDG objectives of demand-side policy interventions, particularly in novel fields and service provision models such as digitalization, sharing economy, or the integration of SDG and climate objectives in synergistic policy designs.**

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.

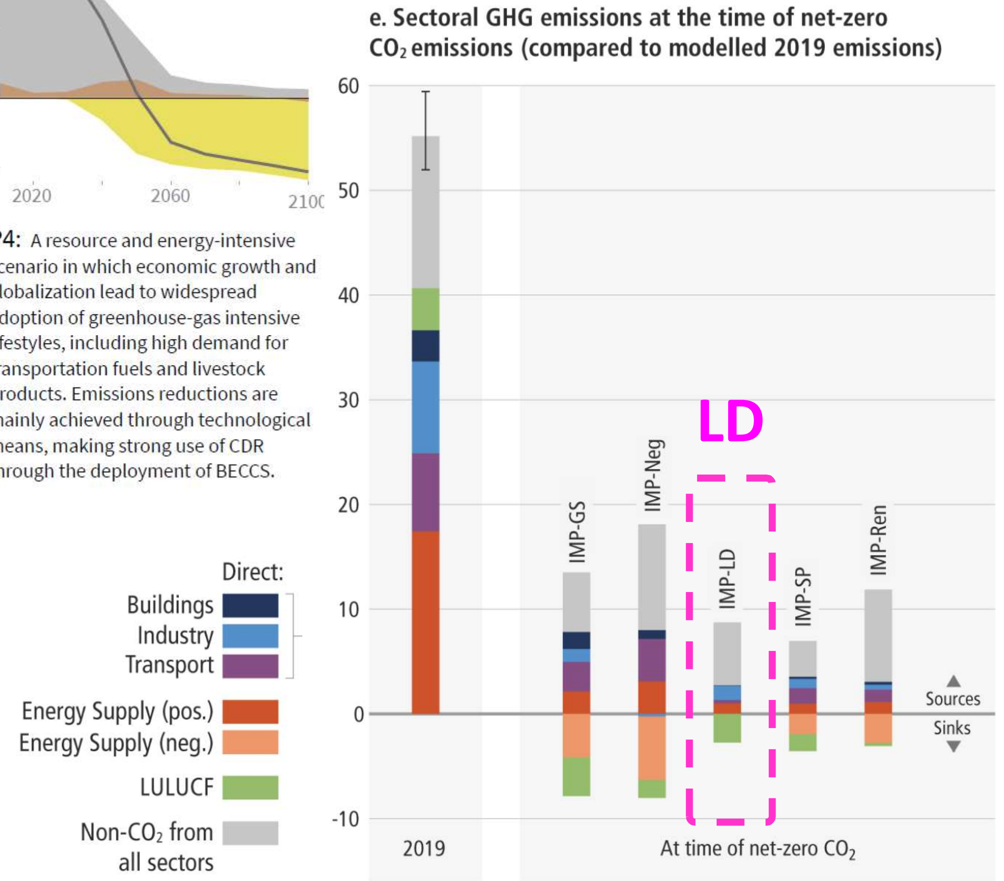
P3: A middle-of-the-road scenario in which societal as well as technological development follows historical patterns. Emissions reductions are mainly achieved by changing the way in which energy and products are produced, and to a lesser degree by reductions in demand.

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

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

IPCC 6th Assessment Report (AR6)



SDGs and a low energy demand society

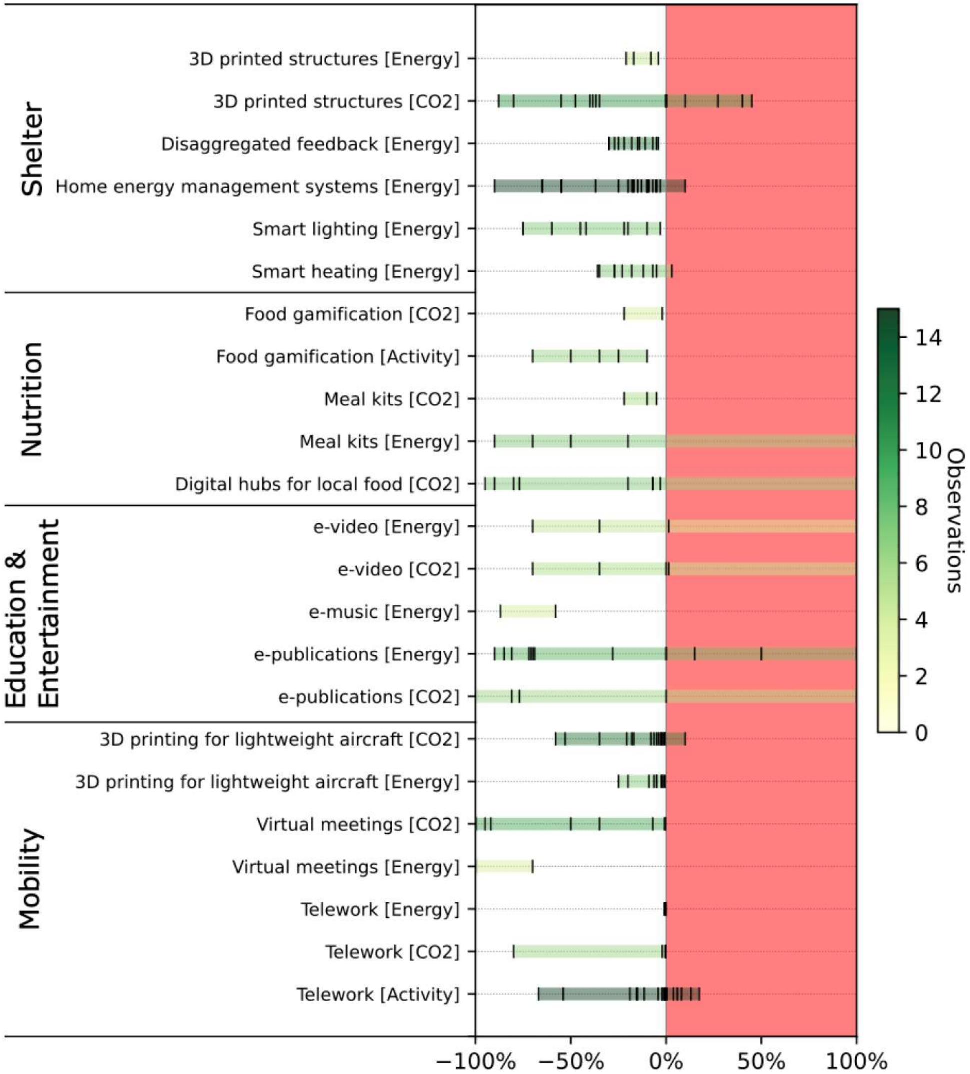
Achieving Goal 12 is well coordinated with achieving other eleven Goals

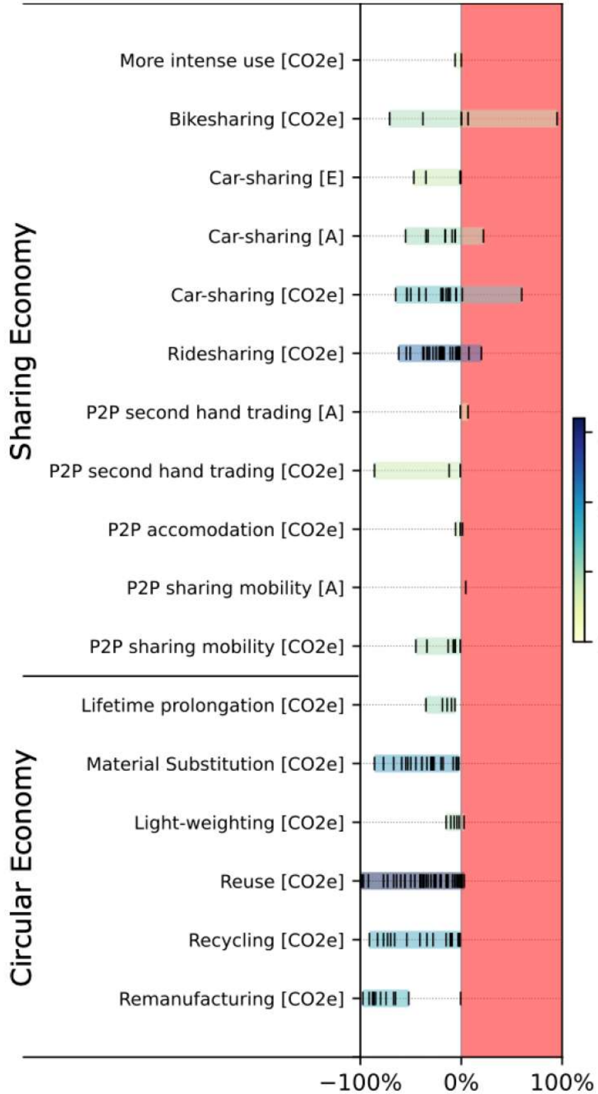
Responsible Consumption & Production:
End poverty, reduce overconsumption, minimize waste and environmental impacts

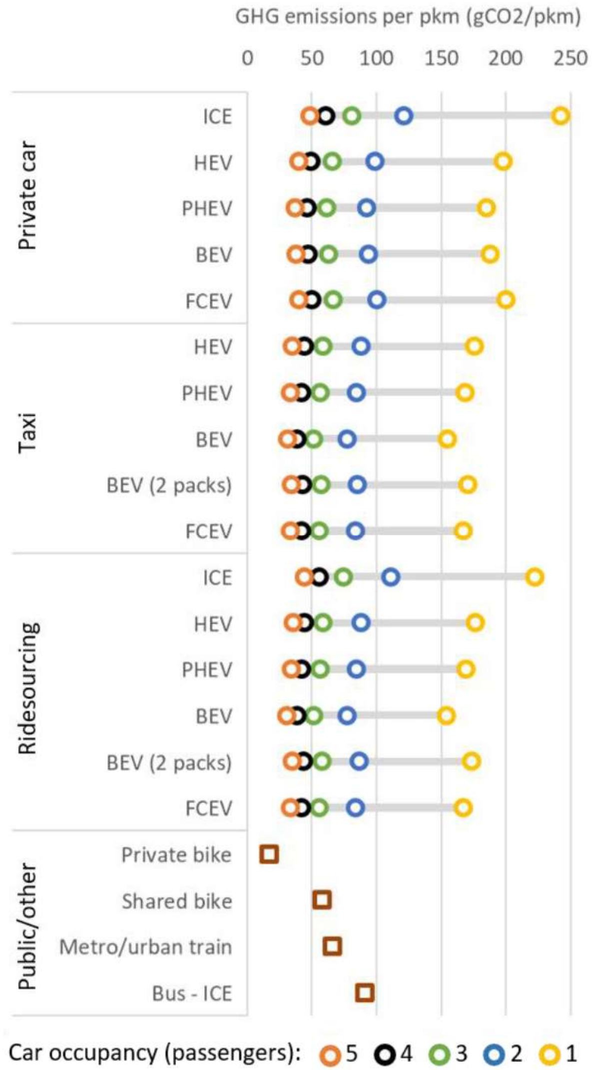
Source: IIASA, LED scenario

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.

Digitalization impacts (IPCC AR6 Ch.5)







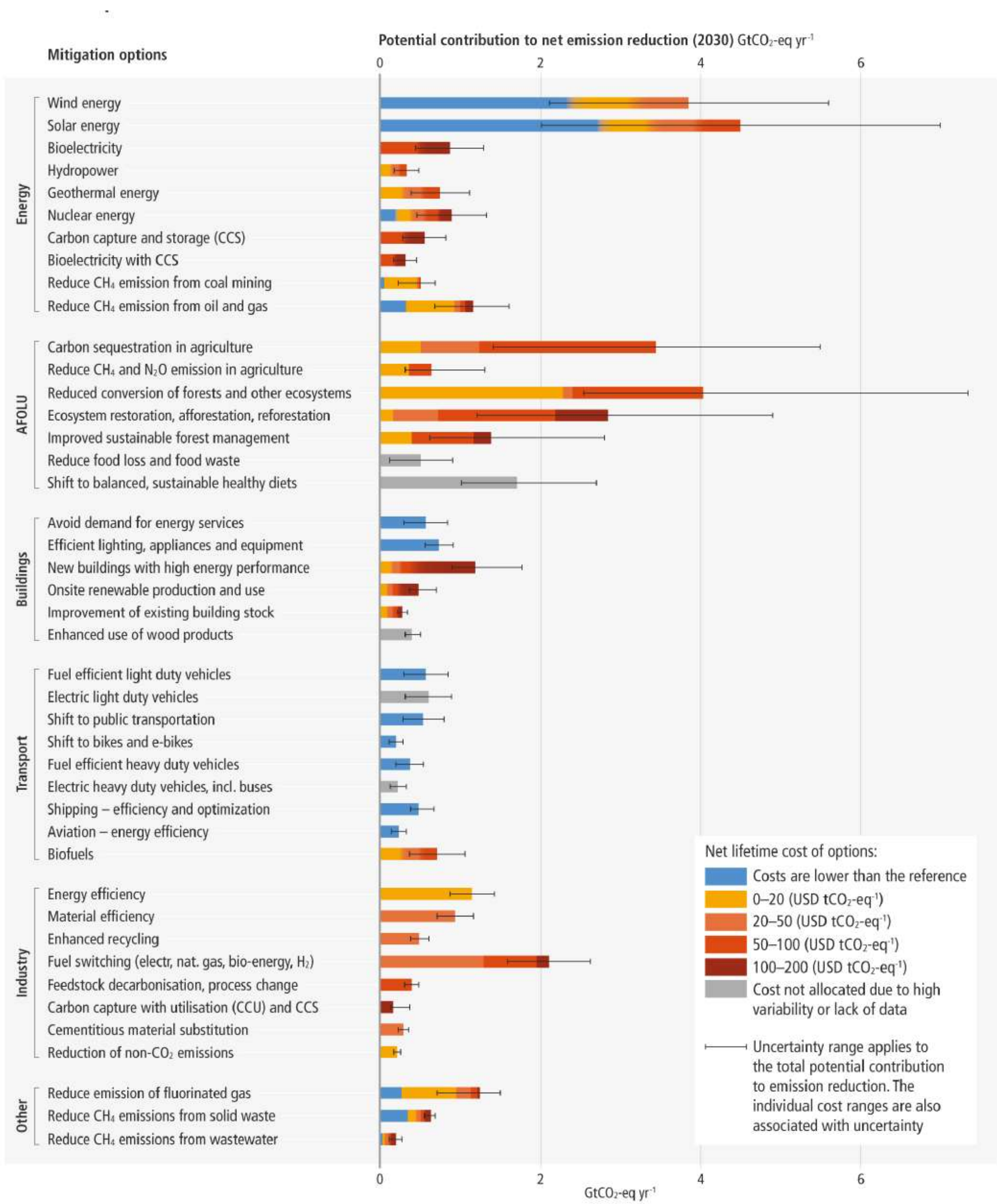
Global emission reduction costs and potentials in 2030 by sector and technology

The bottom-up studies of IPCC AR6

WG3, Fig. SPM.7

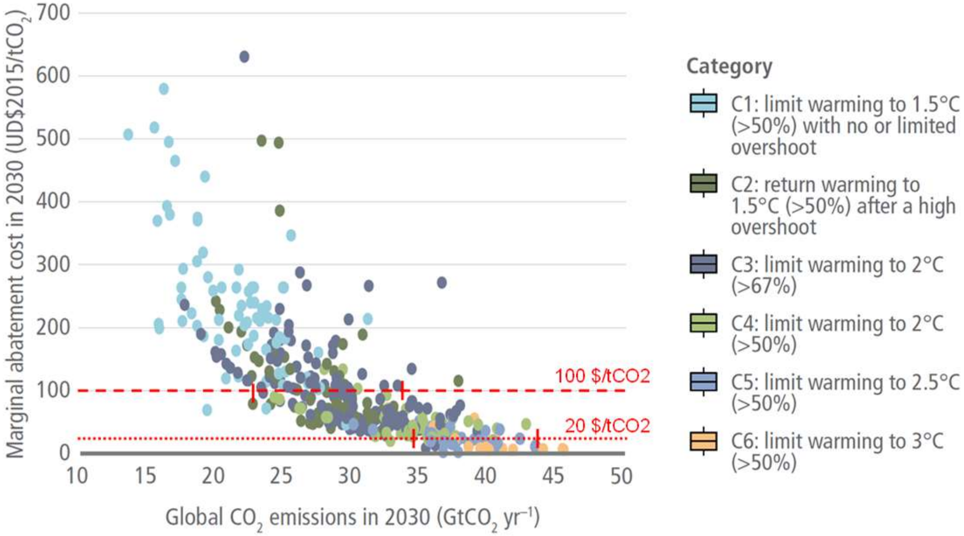
SPM C12.1
Based on a detailed sectoral assessment of mitigation options,
- ✓ It is estimated that mitigation options costing USD100 tCO2-eq-1 or less could reduce global GHG emissions by at least half of the 2019 level by 2030.
- ✓ Options costing less than USD20 tCO2-eq-1 are estimated to make up more than half of this potential.

✓ **Large amounts of emissions reduction potential with negative costs are estimated when typical discount rates, e.g., 5%/yr, are employed.**



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

IAM estimates in the IPCC AR6



		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_2eq/yr**	(49～58 GtCO_2eq/yr)
Below 100 USD/tCO_2eq	CO_2	(15.5 GtCO_2/yr)	**23～34 GtCO_2/yr**
	GHGs	**29.5 GtCO_2eq/yr** [compared to baseline：38 GtCO_2eq/yr (32～44 GtCO_2eq/yr)]	(37～48 GtCO_2eq/yr)

Note) The numbers in parentheses for CO_2 and GHG emissions are the values taken from the report and simply converted to CO_2 or GHG using the actual values of the difference in global emissions in 2019 (14 GtCO_2/yr).

✓ **There is a big difference in costs and potentials estimated by technology bottom-up studies and IAMs.**

Example of factors affecting the discount rates for investment (hidden costs)

[Technology-specific factors]

- High investment returns are required when the technology is not yet sufficiently mature (e.g., CCS) or when there are challenges in terms of social acceptance (e.g., nuclear power), due to the high risk of the technology.
- Product value depreciation: The faster the change to a new product or service, the faster the value of the product will be depreciated, and the higher the discount rate will be. If the opposite is true, the discount rate will be lower. (Energy supply such as electricity < material supply such as iron, cement, etc. (mainly energy-intensive industries) < hot water, air conditioning, etc. (the relationship with material supply is not always clear) < lighting, refrigerators, etc. < TVs, automobiles, etc.)
- If price reductions are expected in the future, it becomes rational to wait to invest, and the discount rate will be higher.

[Preferences of investors and consumers, etc.]

- Funds constraints: If another investment has a higher return, its expected rate of return is referenced.
- Hidden costs (e.g. opportunity costs)
- Consumer preference: Purchase of environmentally friendly products (e.g., early adopters), a strong perception of co-benefits (in housing, etc.)
- Discount rates are higher when the life expectancy of the residents is considered shorter than the lifetime of the house.
- Landlord-tenant problem etc. (Commercial sector)
- Bounded rationality (limitations of people's ability to process information and make decisions, etc.)

[Factors related to the trading market, investment environment, and surrounding institutions, etc.]

- Greater returns are required for climate change investments when there is greater uncertainty about energy and climate policy.
- Higher volatility in the carbon price market will demand greater returns on low-carbon and decarbonized investments.
- Under electricity liberalization, greater volatility in price indexes will demand greater returns on investments in power sources with large capital costs (low-carbon and decarbonized power sources).
- Short-term investment payback tends to be preferred under quarterly financial statements.

User cost of capital

The user cost of capital, formulated in Jorgenson's neoclassical investment theory to account for the optimizing behavior of firms, is defined as the cost that an investor must pay to obtain services from capital goods and is expressed by the following equation (partially simplified). It also corresponds to the rental price of the equipment.

$$P^K_{kjt} = (r_{kjt} + \delta_{kj} - \pi_{kt}) \cdot P^A_{kt}$$

User cost of capital (P_t^K), real market price of the capital (P_t^A), real interest rate at time t (r_t), depreciation rate (δ), cost associated with changes in the price of capital goods (capital gain or loss) (π), type of assets (k), country or economic agent (j)

The coefficient ($r_{kjt} + \delta_{kj} - \pi_{kt}$) on the real market price of the capital (P_t^A) is usually called the annualization factor.

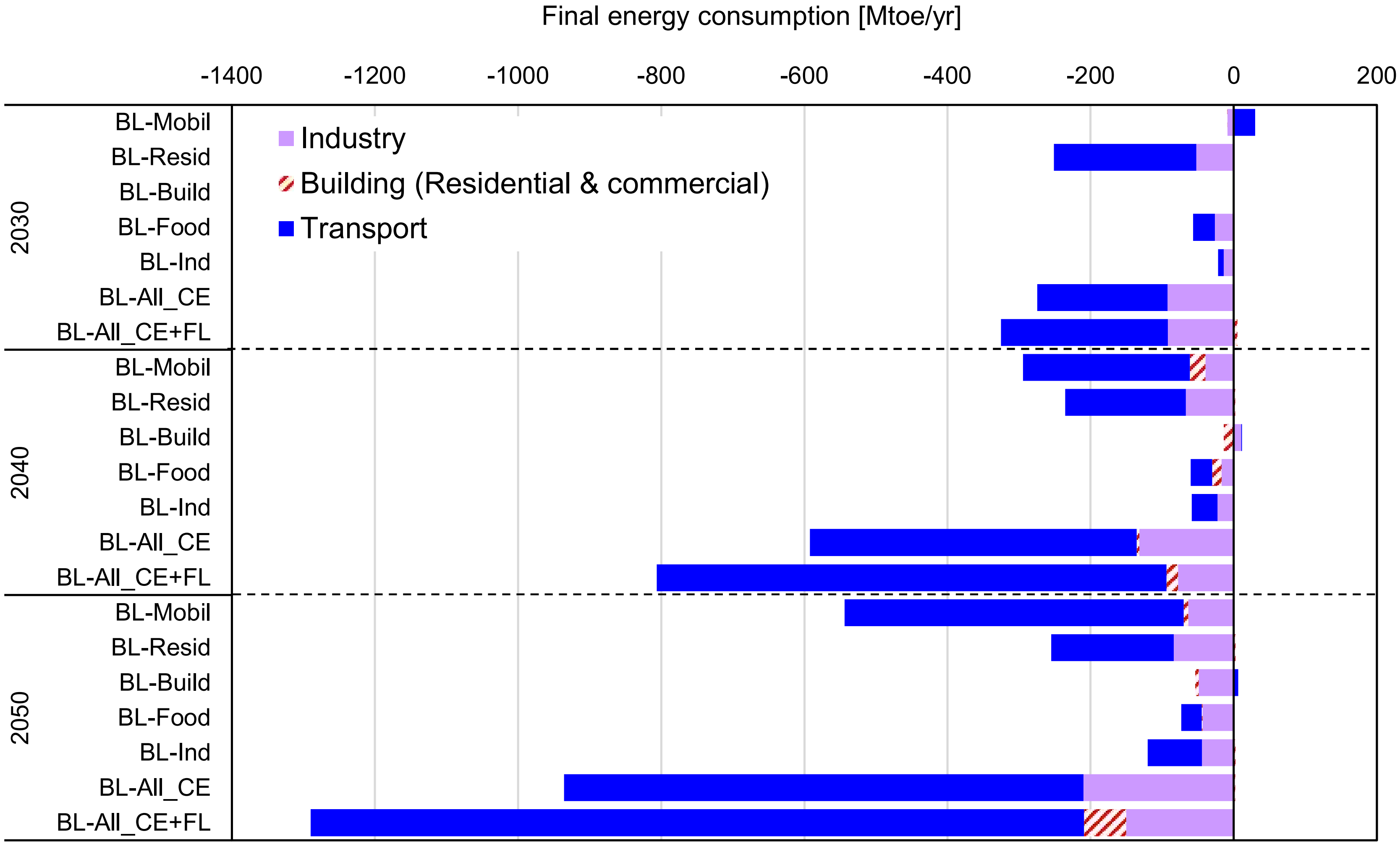
- ✓ **In a consistent manner with economic indicators, user costs of various capitals have been measured.**
- ✓ **While "implicit discount rates" explain high discount rates focusing mainly on bounded rational behaviors including heterogeneous consumers, "user cost of capital" explains high discount rates focusing mainly on rational discount rates for using capitals or on rational rental prices of capital.**
- ✓ **In the estimation of the "user cost of capital", the bounded rational factors discussed in the "implicit discount rate" are considered to be included in the values of the parameters r, δ, π, respectively.**

Scenario assumptions

	Emissions reduction	Energy demand reductions due to mainly digitalization: Transport 1)	Residential 2, 3, 4)	Building 5)	Food 6)	Industry 7)	Spill over 8)	Rapid cost red. in granular tech's, e.g., PV, Wind, EV	Demand flexibilities in electricity (EV, HP, CGS)
BL-Std	**Baseline** (non specific 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

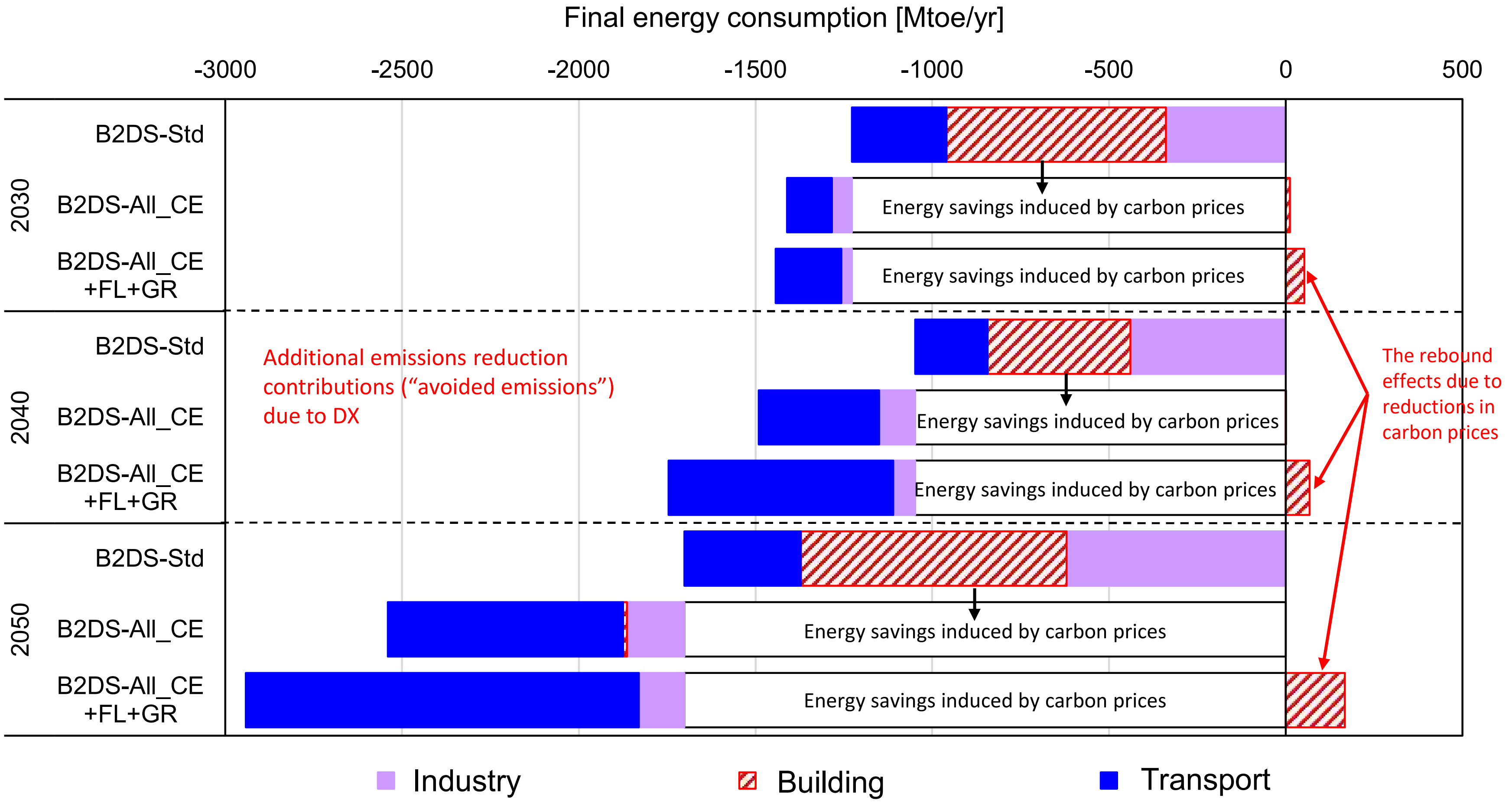


While this preliminary study assumes only limited impacts of circular/sharing economies due to digitalization mainly, significant reductions (by around 10%) in final energy consumptions are estimated.

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

Final energy consumption (preliminary)

B2DS (well below 2 °C)

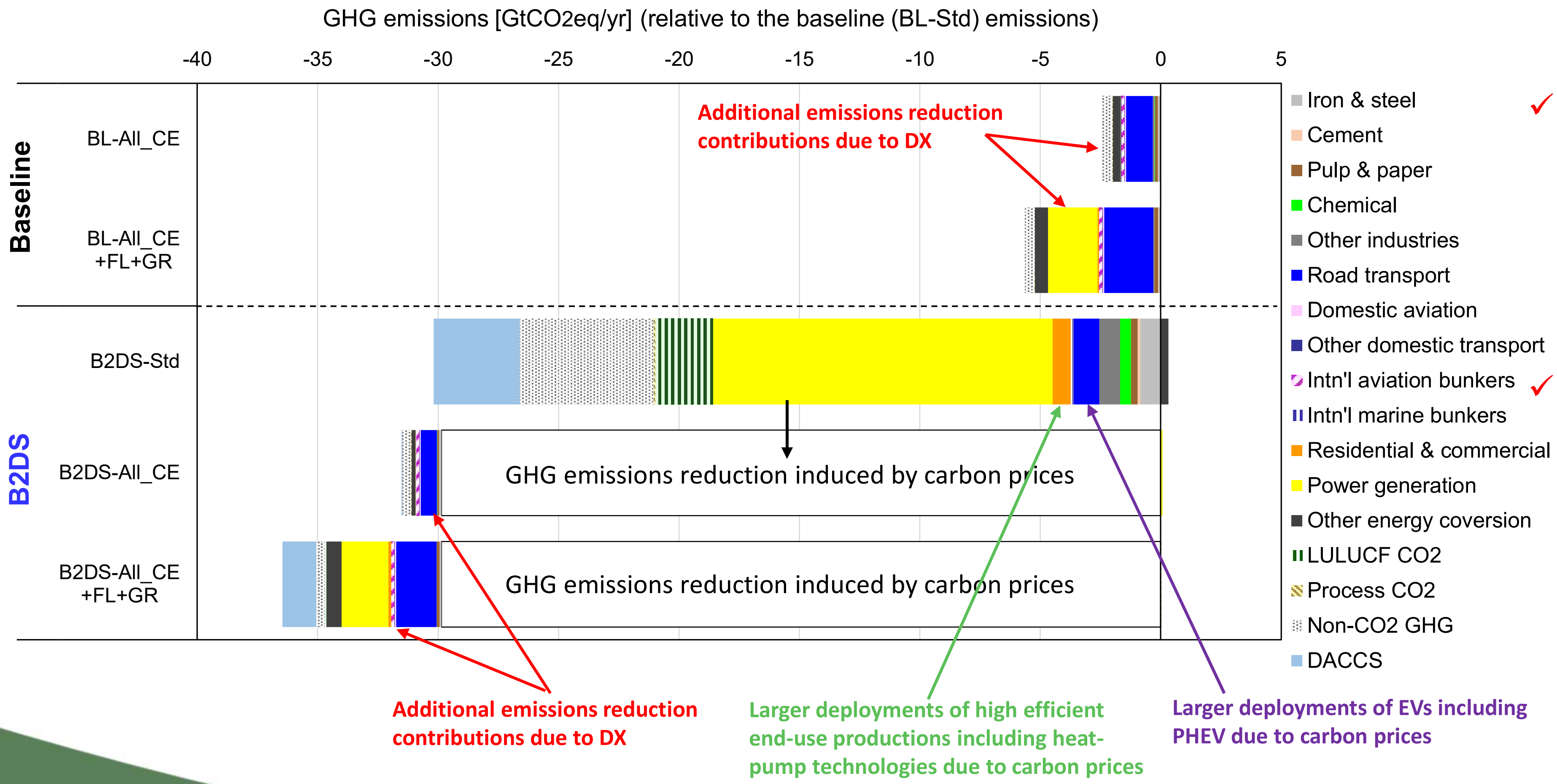


DX solutions including circular and sharing economy could induce around 6% reduction of total final energy consumption, which corresponds to a similar level of energy savings due to carbon prices for the B2DS.

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

GHG emissions reduction (preliminary)

In 2040



- ✓ Large potentials in emissions reduction in end-use sectors including products and service solutions also exist with lower costs.
- ✓ The digitalization impacts in end-use sectors on GHG emissions reduction, which will also reduce 'hidden costs,' could be also large.

Ref) Global GHG emissions in 2019: 59 GtCO2eq./yr; Baseline GHG emissions in 2050: 73 GtCO2eq/yr

IPCC AR6 Ch.5 – Knowledge Gaps

Authors: Felix Creutzig, Joyashree Roy, Arnulf Grubler, Eric Masanet, and others

1. **Better metric to measure actual human well-being**
2. **Evaluation of climate implication of the digital economy**
3. **Scenario modelling of services**
4. **Dynamic interaction between individual, social, and structural drivers of change**

These gaps should also be tackled in our EDITS project, and it is desirable for the EDITS project to contribute to the next IPCC report and other opportunities.

Topics the EDITS and this event focusing on:

- **There are large opportunities in end-use sectors to reduce GHG emissions with lower costs.**
- **In addition, many of the end-use measures will help achieve the multiple SDGs, and there are great opportunities even in a world of disruption. We should focus more on end-use measures for effective global emissions reductions.**
- **Relatively large hidden costs (large barriers of diffusions) are observed in end-use sectors in the real world, due to high depreciation rates, high expected price reductions, and bounded rationalities.**
- **Digitalization technologies could contribute to reducing the hidden costs as well as inducing circular and sharing economies. In addition, changes to lifestyle preferences for long-term cycles for products with good qualities will be one of the potential opportunities for decreasing depreciation rates etc.**
- **Better evaluations of the reduction effects of the Scope 3 emissions, particularly of the downstream, with policy supports, will be significant in order to offer the incentive in firms. The Government of Japan is supporting the scheme of "avoided emissions." Firms will have the opportunities to reduce the emissions for the products and services belonging to consumers.**
- **In order to induce the demand-side policies, visualizations of end-use measures which contribute to high well-being with high research credibility will be important.**

Thank you very much for your attention!

EDITS is an initiative coordinated by the Research Institute of Innovative Technology for the Earth (RITE) and International Institute for Applied Systems Analysis (IIASA), and funded by Ministry of Economy, Trade, and Industry (METI), Japan.

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https://iiasa.ac.at/web/home/research/researchPrograms/Energy/Research/EDITS/EDITS.html

Supplements

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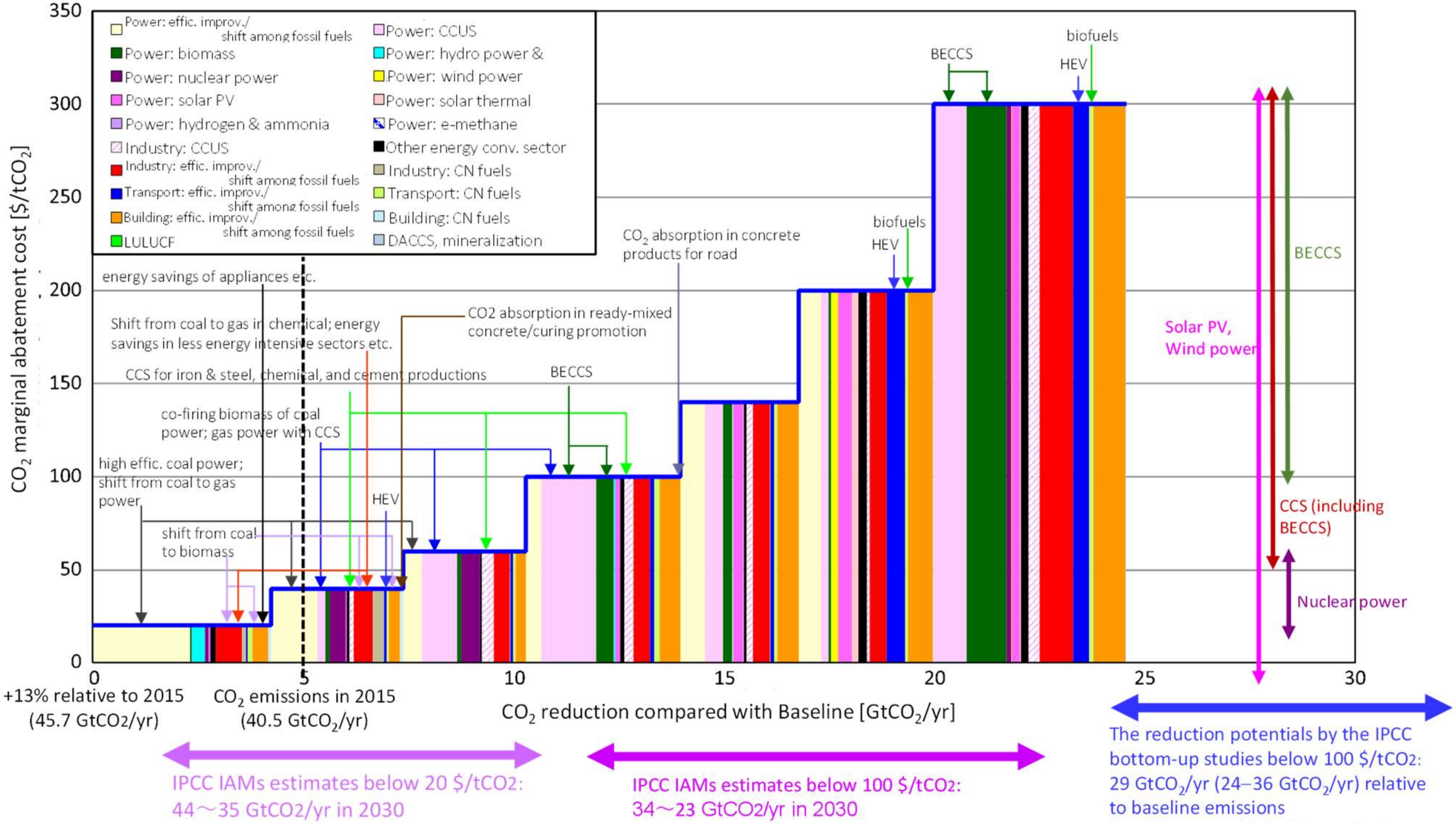
Overview of DNE21+ model

- 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.)

Global costs and potentials by sector and technology in 2030

ー Standard technology scenario & Standard discount rate ー

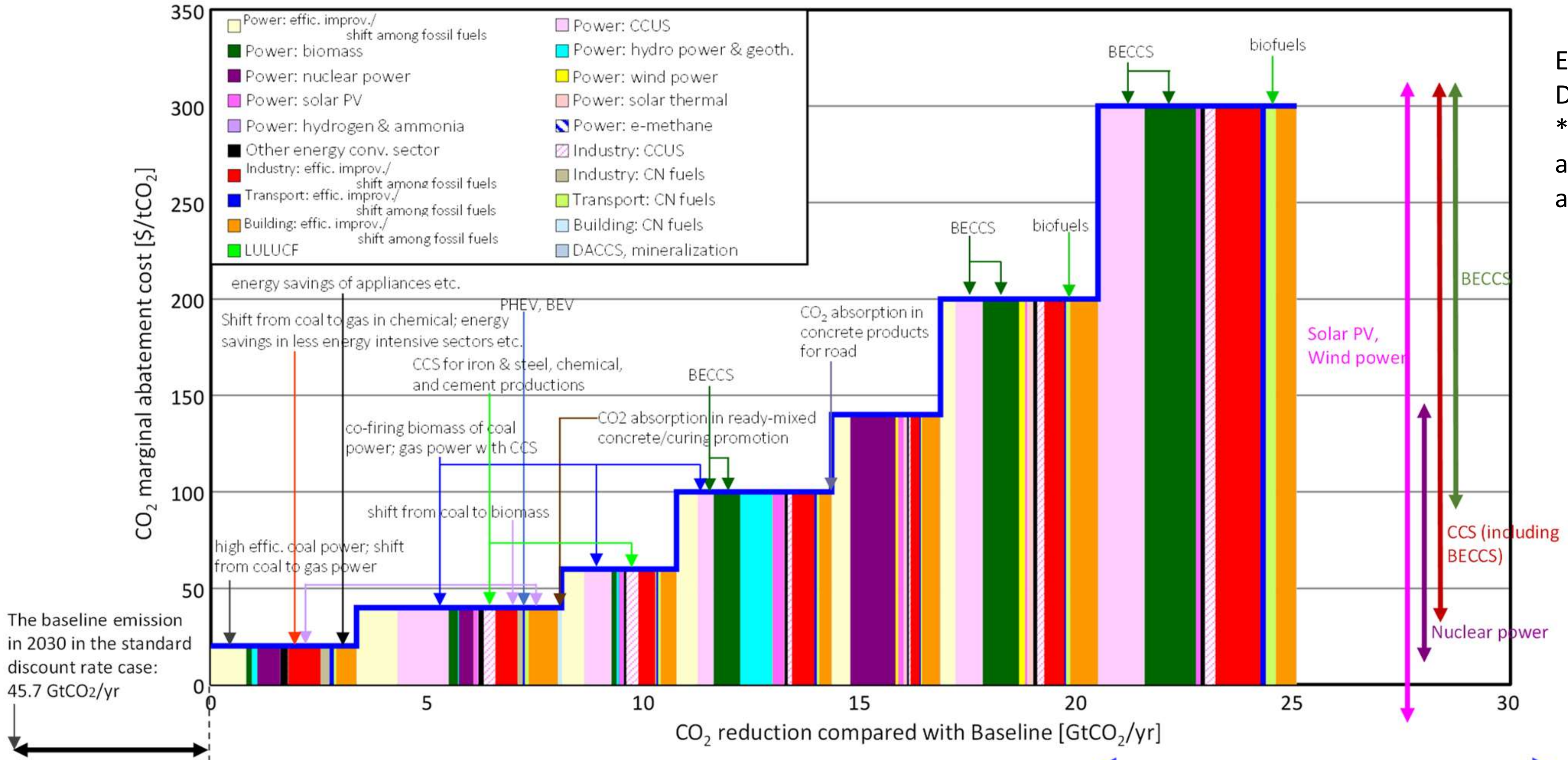


Note) The potentials in CO_2 are simply converted using the emission gap in 2019 between CO_2 and GHG (76%).

Estimates by using DNE21+ model

Global costs and potentials by sector and technology in 2030

ー Standard technology scenario & low discount rate of 5%/yr* ー



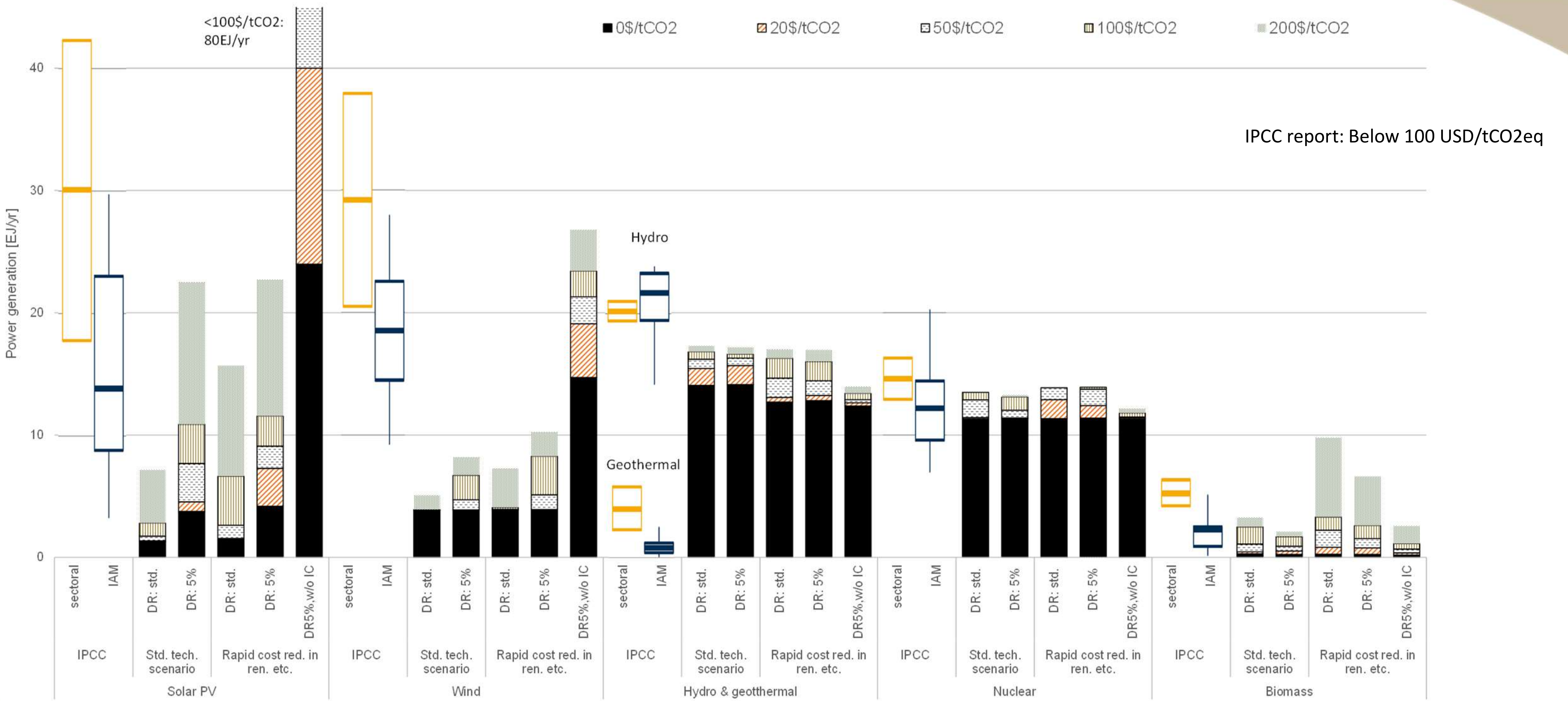
Estimated by using DNE21+ model
* 5% discount rate in all countries, sectors and technologies

The emissions reduction potentials with negative costs compared with those in the standard discount rate case: 3.8 GtCO2/yr, which include:
- hybrid vehicles
- electrification of heating in buildings

The reduction potentials by the IPCC bottom-up studies below 100 $/tCO2: 29 Gt$CO_2$/yr (24–36 Gt$CO_2$/yr) relative to baseline emissions

Note) The potentials in CO2 are simply converted using the emission gap in 2019 between CO2 and GHG (76%). The allow of the reduction potentials are shown from the baseline emission in the standard discount rate case.

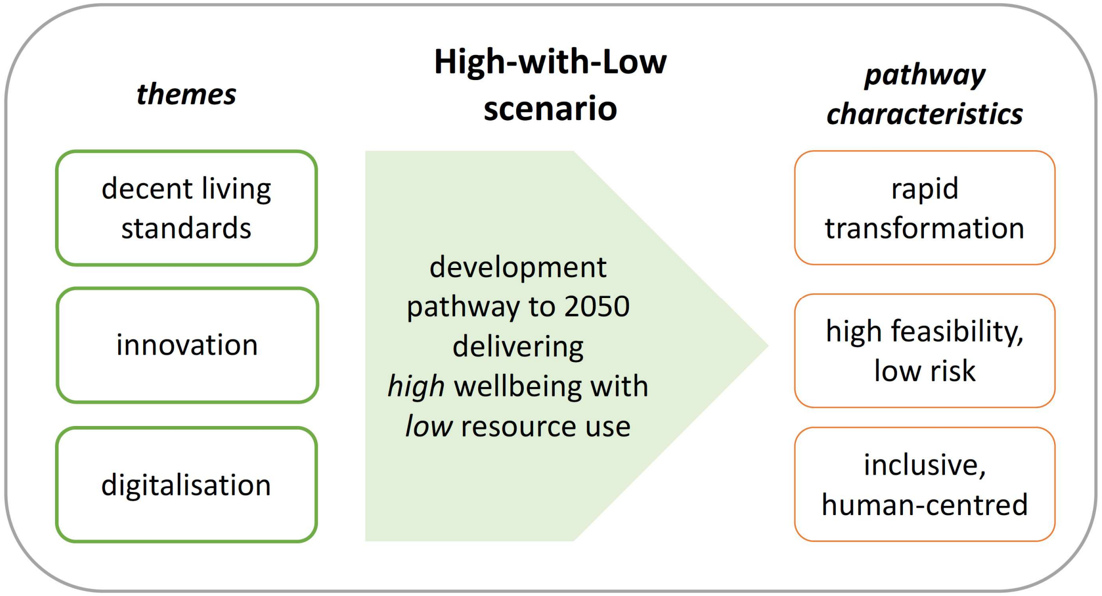
Power tech's installations in 2030: Comparison with the IPCC



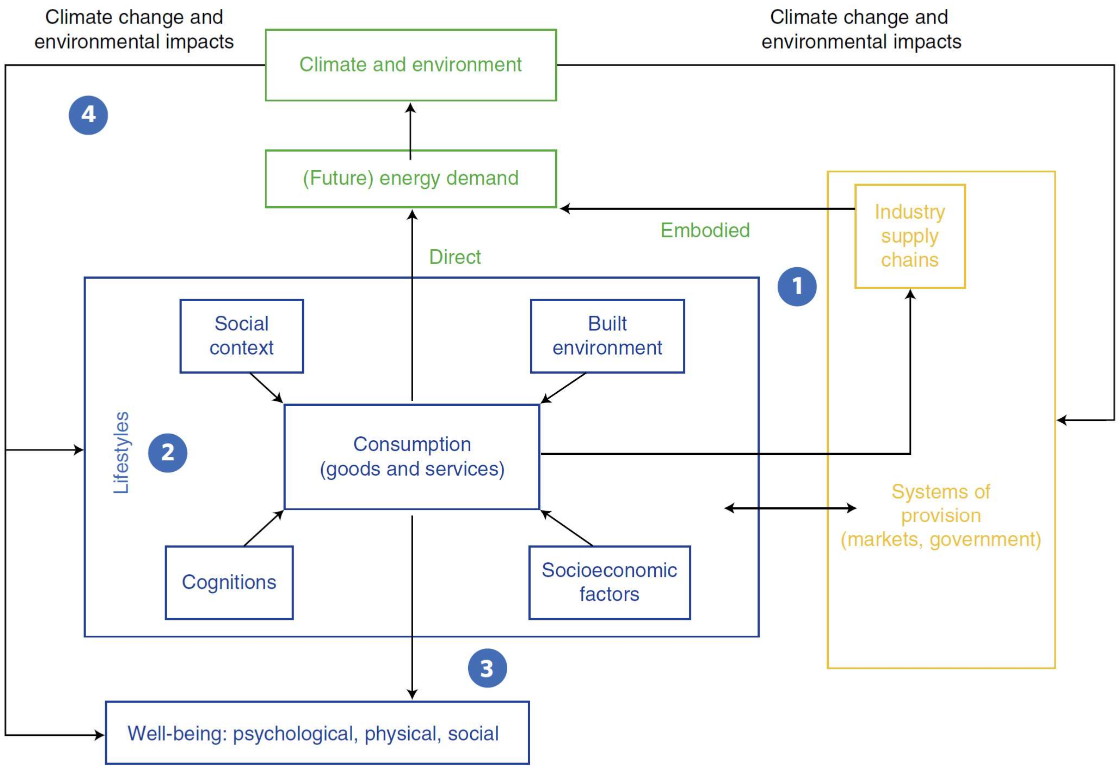
✓ **Large impacts of considerations of grid integration costs on the estimated costs and potentials of electricity generation can be observed as well as the discount rate for investments. Demand flexibilities using digitalization technologies with lower costs will be important.**

‘High-with-Low’ Narrative Scenario

high wellbeing with **low** resource use



Source: EDITS WG3 Narratives group (Arnulf Grubler, Greg Nemet, Shonali Pachauri, Charlie Wilson), The 'High-with-Low' Scenario Narrative: Key Themes, Cross-Cutting Linkages, and Implications for Modelling



Scenario assumptions

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

Changes due to digitalization	Direct impacts	Indirect impacts	Model assumptions (tentative)
1) Ride and car-sharing associated with fully autonomous cars	- Energy consumption reductions due to ride-sharing	- Reductions in consumption of basic materials, e.g., iron and steel, plastics, tire, glass, and concrete, due to reductions in number of cars associated with car-sharing - Reductions in freight shipping => 8)	- Iron and steel production: -4% compared with standard scenarios - Plastic production: -1% - Tire production (for cars): -28% - Glass production (for cars): -28% - Cement production: -1% (only for multi-storey car park)
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 iron and steel, concrete, and others *[Not yet considered]*	- Reductions in person-km travel by passenger cars, buses, and aircraft by 10%
3) E-publication etc.	- Reductions in paper consumptions due to large deployment e-publications etc.	- Potential reductions in freight services for papers. *[Not yet considered]*	- Reductions in paper/pulp by 20%
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 considered]*	- Reduction in new productions of apparels by 20%. No explicit modeling for apparels in DNE21+, and corresponding reductions in energy consumption in textile and leather sector by 20%

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	Model assumptions (tentative)
5) Longer life time of buildings due to improv. in city planning	- Potential Reddductions in cement and steel due to longer life time of buildings		- Longer lifetime of building: +40%; the related reductions in cement (-3%) and steel (-3%) productions
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 CH4 and N2O	- Reductions in freight shipping services => 8) - *Pot. red. in construction for supermarkets etc., and the resulting reductions in steel, concrete, and others [Not yet considered]* - *Pot. increases in afforestation due to increase in rooms of land area [Not yet considered]*	- Reduction in petrochemical products including ammonia by 1% - Reduction in plastics by 1% - Reduction in paper and pulp by 0.5% - Reduction in transport services by 1% and others (according to I/O analysis results) - Reduction in CH4 and N2O emissions: -493 MtCO2eq/yr in 2050
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 energy consumption reductions - *Energy efficiency improvements of cars and the energy consumption reductions [Not yet considered]*	- Red. in aluminum and steel prod. by 1% and 0.02%, respectively - Reduction in elec. consumption by 1% - Increase in energy efficiency of aircraft by about 10%
8) Red. in freight shipping services due to reductions in basic materials and products	- Energy consumption reductions in freight shipping		- Reduction in freight shipping demand by 1%

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