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COVER NOTE

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To:	Ms Thérèse BLANCHET, Secretary-General of the Council of the European Union
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Subject:	COMMISSION STAFF WORKING DOCUMENT IMPACT ASSESSMENT REPORT Part 5 Accompanying the document COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Securing our future Europe's 2040 climate target and path to climate neutrality by 2050 building a sustainable, just and prosperous society

Delegations will find attached document SWD(2024) 63 final - part 5 of 5.

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EUROPEAN
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Strasbourg, 6.2.2024
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PART 5/5

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT REPORT

Part 5

Accompanying the document

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Securing our future
Europe's 2040 climate target and path to climate neutrality by 2050 building a sustainable, just and prosperous society

{COM(2024) 63 final} - {SEC(2024) 64 final} - {SWD(2024) 64 final}

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Annex 14: GHG budget

This Annex looks at an indicative "GHG budget" for the EU with the geographical scope of 1st February 2021 ("EU27"). This "budget" is defined according to the emission scope of the European Climate Law and consistently with the proposed 2040 climate target.

1 EU COMMITMENT TO THE PARIS AGREEMENT

The Paris Agreement aims at limiting "the increase in the global average temperature to well below 2°C above pre-industrial levels" and pursue efforts "to limit the temperature increase to 1.5°C above pre-industrial levels." In recent decisions taken in the UNFCCC, Parties have reinforced the need to deliver emissions reductions in line with the IPCC recommendations, in order to keep the 1.5°C within reach.

Under the Paris Agreement, Parties have agreed to prepare, communicate and maintain successive nationally determined contributions and pursue domestic measures, with the aim of achieving the objectives of such contributions. Article 4.3 states that each Party's successive nationally determined contribution will represent a progression beyond the Party's then current nationally determined contribution and reflect its highest possible ambition, reflecting its common but differentiated responsibilities and respective capabilities, in the light of different national circumstances. Article 4.4 of the Paris Agreement states that developed countries should continue taking the lead by undertaking economy-wide absolute emission reduction targets and developing countries should continue enhancing their efforts and are encouraged to move towards economy-wide targets over time. The Paris Agreement also requests all Parties to strive to formulate and communicate long-term low greenhouse gas emissions development strategies. The European Union has committed to the goals of the Paris Agreement and has been faithful to its provisions:

- In 2020, the EU committed to climate neutrality by 2050 in its long-term strategy to the UNFCCC and submitted an ambitious Nationally Determined Contribution with a 2030 climate target of at least 55% reduction of net emissions of greenhouse gases as compared to 1990. The 2030 and the 2050 targets are mutually supportive, are enshrined in the EU Climate Law and are legally binding. Setting these targets, the EU has set itself on a path of domestic GHG mitigation aiming at limiting the temperature increase to 1.5°C above pre-industrial levels, in line with the most ambitious interpretation of the Paris Agreement and reinforcing the EU's commitment towards its implementation.
- According to the Climate Law, the EU will undertake a review of its progress towards climate neutrality target every five years, in line with the global stocktake exercise under the Paris Agreement.
- The EU has substantially exceeded its 2020 targets, and, in 2022, the EU greenhouse emissions reduced to 32.5% below 1990 levels, while global emissions have risen by over 50% worldwide. During that period, the EU and its Member States' emissions reductions outpaced those of any other major developed or developing economy.
- Currently, the EU contributes 7% to global emissions and cannot solve the climate crisis on its own: international cooperation remains at the heart of the EU's

contribution to global climate action and the EU will continue to call on the countries with the largest share of emissions to commit to the highest possible ambition.

Internationally, the EU has been fully engaged as a positive actor to support the mitigation of GHG emissions globally in line with the Paris Agreement, aiming at keeping 1.5°C in reach. On a per capita basis, EU emissions are also among the lowest of any major high-income economy and lower than several emerging economies. The EU research and innovation and industrial policies have for decades incentivised and supported the development of innovative, state-of-the-art low carbon technologies and corresponding markets. For instance, between early 2000 and 2015, the EU has consistently deployed the largest share of the solar and wind energy capacity installed worldwide, reaching a 74% share at the beginning of the 2000s for wind and around 2010 for solar. In this way, the EU contributed to driving global learning and reducing costs for these two technologies that benefitted all countries: world average wind and solar Levelised Cost of Electricity (LCOE) reduced drastically in this period by around 50% ([1]) and 80% ([2]) respectively. More than two decades of experience in designing, agreeing and implementing climate and energy policies, have provided a wealth of lessons, that the EU has been sharing for more than a decade through multilateral initiatives and bilateral policy dialogues and projects. Thereby, it continues to contribute to the creation of global value chains that, through technology dissemination and cost decrease, now drive the required transformations towards zero carbon economies and societies.

The EU and its MS are collectively the largest contributor to international public climate finance. Since the launch of the "USD 100 billion by 2020 goal" in 2009 the EU and its 27 Member States have been strongly committed to helping achieve it. In 2022, the European Union and its 27 member states contributed EUR 28.5 billion in climate finance from public sources and mobilised an additional amount of EUR 11.9 billion of private finance, including more than €12 billion per year for climate adaptation or actions combining adaptation and mitigation. Thanks to this contribution and to a significant increase in international climate finance in 2023, OECD Secretary General stated that the 100 billion USD will likely have been reached in 2022 based on preliminary data ([3]).

The EU will continue to stand by its commitment to deliver its fair share of the USD 100 billion USD mobilisation goal and the doubling of adaptation finance by 2025, making support for adaptation a priority of its global action. In 2024, the EU will also push for an agreement in 2024 on the New Collective Quantified Goal for climate finance under the Paris agreement including leveraging an increasing private sector contribution to global climate finance and reform of Multilateral Development Banks.

([1]) Data extrapolated from Ourworldindata.org for the period 2008-2018. Original data source from IRENA (2022), Renewable Power Generation Costs in 2021, International Renewable Energy Agency, Abu Dhabi.

([2]) European Commission, Directorate-General for Energy, Rademaekers, K., Smith, M., Gorenstein Dedecca, J. et al., *Energy costs, taxes and the impact of government interventions on investments – Final report, summary*, Publications Office, 2020, **https://data.europa.eu/doi/10.2833/827631**

([3]) OECD, 2023. Climate Finance Provided and Mobilised by Developed Countries in 2013-2021: Aggregate trends and opportunities for scaling up adaptation and mobilised private finance, OECD Publishing

The EU aims to target and tailor support where it is needed the most, with a prime focus on most vulnerable countries, small island developing states and fragile countries. While developed countries shall continue to take the lead, moving the needle on climate finance should compel the EU to reach the largest possible donor base and go beyond the developed/developing countries split.

2 THE GHG BUDGET IN THE EUROPEAN CLIMATE LAW

Article 4(4) of the EU Climate Law mandates the Commission, when making the proposal for the Union 2040 climate target, 'to publish in a separate report the projected indicative Union greenhouse gas budget for the 2030-2050 period", taking into account the advice of the European Scientific Advisory Board on Climate Change (ESABCC). This GHG budget approach was an innovation for the EU introduced by the Climate Law, aiming to increase the transparency and accountability of climate policies. It also makes it easier to compare action at EU level with international efforts and the global emissions budget. The Climate Law also defines the indicative Union GHG budget as "the indicative total volume of net greenhouse gas emissions (expressed as CO2 equivalent and providing separate information on emissions and removals) that are expected to be emitted in that period without putting at risk the Union's commitments under the Paris Agreement'.

The 2030-2050 GHG budget is expressed in tonnes of CO2 equivalent (tCO2-eq) and covers all GHGs ([4]) under the scope of the European Climate Law ([5]) from 2030 (included) to 2050 (included). It combines a "carbon" budget (cumulative CO2 emissions) with cumulative emissions of non-CO2 GHGs ([6]) and including the contribution of carbon removals.

The notion of "emissions budget" refers to the carbon budget at global level that is defined in the IPCC AR6 as the maximum quantity of CO2 emissions that can be released to the atmosphere over that period while keeping global warming below a given level of temperature. Non-CO2 GHG emissions are not typically expressed as budget.

The differentiation between the role of CO2 and non-CO2 in the definition of the budget relates to the dominant contribution of CO2 to global surface temperature increase: most warming to date has been caused by CO2, which has the most permanent impact on the climate system ([7]). The IPCC indicates that the maximum temperature reached is determined with high confidence by cumulative net global anthropogenic CO2 emissions up to the time of

([4]) See part 2 of Annex V to Regulation (EU) 2018/1999

([5]) The scope is the same as the ones for the Union 2040 climate target and is defined as all Union-wide GHG emissions regulated in Union law, which include: domestic EU emissions, international intra-EU aviation, international intra-EU maritime, and 50% of international extra-EU maritime under the MRV.

([6]) Non-CO2 GHG emissions are converted into "CO2 equivalent" using the global warming potential for a 100-year time horizon from the IPCC Fifth Assessment Report ("AR5").

([7]) Jenkins, S., Cain, M., Friedlingstein, P., Gillett, N., Walsh, T., & Allen, M. R. (2021). Quantifying non-CO2 contributions to remaining carbon budgets. npj climate and atmospheric science, 4(1), 47.

net zero CO2 emissions and with medium confidence by the level of non-CO2 radiative forcing in the decades prior to the time that maximum temperatures are reached ([8]).

3 THE REMAINING GLOBAL CARBON BUDGET

The IPCC AR6 report reaffirms with high confidence that there is a near-linear relationship between cumulative anthropogenic CO2 emissions and the global warming they cause, estimating a global surface temperature increase of 0.45°C per each 1000 GtCO2 of cumulative CO2 emissions, and highlighting that limiting global temperature increase to a specific level, for example as defined in the Paris Agreement would imply limiting cumulative CO2 emissions to a set carbon budget ([9]).

The IPCC AR6 ([10]) estimates that from the beginning of 2020, the remaining global carbon budget is 500 GtCO2 for limiting global warming to 1.5°C with 50% likelihood, 850 GtCO2 for limiting global warming to 1.7°C with 50% likelihood, and 1150 GtCO2 for limiting global warming to 2°C with 67% likelihood (see Table 1**Error! Reference source not found.**).

([8]) IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3-24. https://doi.org/10.1017/9781009157940.001.

([9]) IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 3−32, doi:10.1017/9781009157896.001. Figure SPM.10

([10]) Canadell, J.G., P.M.S. Monteiro, M.H. Costa, L. Cotrim da Cunha, P.M. Cox, A.V. Eliseev, S. Henson, M. Ishii, S. Jaccard, C. Koven, A. Lohila, P.K. Patra, S. Piao, J. Rogelj, S. Syampungani, S. Zaehle, and K. Zickfeld, 2021: Global Carbon and other Biogeochemical Cycles and Feedbacks. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 673–816, doi:10.1017/9781009157896.007

Table 1: IPCC estimates of the global carbon budget.

Table SPM.2 | Estimates of historical carbon dioxide (CO_2) emissions and remaining carbon budgets. Estimated remaining carbon budgets are calculated from the beginning of 2020 and extend until global net zero CO_2 emissions are reached. They refer to CO_2 emissions, while accounting for the global warming effect of non-CO_2 emissions. Global warming in this table refers to human-induced global surface temperature increase, which excludes the impact of natural variability on global temperatures in individual years.
{Table 3.1, 5.5.1, 5.5.2, Box 5.2, Table 5.1, Table 5.7, Table 5.8, Table TS.3}

Global Warming Between 1850–1900 and 2010–2019 (°C)		Historical Cumulative CO_2 Emissions from 1850 to 2019 ($GtCO_2$)					
1.07 (0.8–1.3; likely range)		2390 (± 240; likely range)					
Approximate global warming relative to 1850–1900 until temperature limit (°C)[a]	Additional global warming relative to 2010–2019 until temperature limit (°C)	Estimated remaining carbon budgets from the beginning of 2020 ($GtCO_2$) *Likelihood of limiting global warming to temperature limit*[b]					Variations in reductions in non-CO_2 emissions[c]
		17%	*33%*	*50%*	*67%*	*83%*	
1.5	0.43	900	650	500	400	300	Higher or lower reductions in accompanying non-CO_2 emissions can increase or decrease the values on the left by 220 $GtCO_2$ or more
1.7	0.63	1450	1050	850	700	550	
2.0	0.93	2300	1700	1350	1150	900	

[a] Values at each 0.1°C increment of warming are available in Tables TS.3 and 5.8.

[b] This likelihood is based on the uncertainty in transient climate response to cumulative CO_2 emissions (TCRE) and additional Earth system feedbacks and provides the probability that global warming will not exceed the temperature levels provided in the two left columns. Uncertainties related to historical warming (±550 $GtCO_2$) and non-CO_2 forcing and response (±220 $GtCO_2$) are partially addressed by the assessed uncertainty in TCRE, but uncertainties in recent emissions since 2015 (±20 $GtCO_2$) and the climate response after net zero CO_2 emissions are reached (±420 $GtCO_2$) are separate.

[c] Remaining carbon budget estimates consider the warming from non-CO_2 drivers as implied by the scenarios assessed in SR1.5. The Working Group III Contribution to AR6 will assess mitigation of non-CO_2 emissions.

Source: IPCC (2021). AR6. WG1, summary for policy makers, Table SPM.2

More recent estimates ([11]) assess that these remaining carbon budgets have decreased, to 250 GtCO2 as of beginning of 2023 for a 1.5°C global warming threshold (with a 50% likelihood), to 600 GtCO2 for 1.7°C and 1150 GtCO2 for 2°C (with a 50% likelihood) – see Table 2.

([11]) Forster, P. M., Smith, C. J., Walsh, T., Lamb, W. F., Lamboll, R., Hauser, M., Ribes, A., Rosen, D., Gillett, N., Palmer, M. D., Rogelj, J., von Schuckmann, K., Seneviratne, S. I., Trewin, B., Zhang, X., Allen, M., Andrew, R., Birt, A., Borger, A., Boyer, T., Broersma, J. A., Cheng, L., Dentener, F., Friedlingstein, P., Gutiérrez, J. M., Gütschow, J., Hall, B., Ishii, M., Jenkins, S., Lan, X., Lee, J.-Y., Morice, C., Kadow, C., Kennedy, J., Killick, R., Minx, J. C., Naik, V., Peters, G. P., Pirani, A., Pongratz, J., Schleussner, C.-F., Szopa, S., Thorne, P., Rohde, R., Rojas Corradi, M., Schumacher, D., Vose, R., Zickfeld, K., Masson-Delmotte, V., and Zhai, P.: Indicators of Global Climate Change 2022: annual update of large-scale indicators of the state of the climate system and human influence, Earth Syst. Sci. Data, 15, 2295–2327, https://doi.org/10.5194/essd-15-2295-2023, 2023. Table 7.

Table 2: Updated estimates of the remaining carbon budget

Historical cumulative CO_2 emissions (1850–2019) AR6 WGI Table SPM.2	2390 (±240; *likely* (66 %–100 % probability) range)					
Remaining carbon budgets Case/update	Base year	Estimated remaining carbon budgets from the beginning of base year ($GtCO_2$)				
Likelihood of limiting global warming to temperature limit.		17 %	33 %	50 %	67 %	83 %
1.5 °C from AR6 WGI	2020	900	650	500	400	300
+ AR6 emulator update	2020	750	500	400	300	200
+ as above with AR6 scenario update	2020	750	500	400	300	200
+ as above with warming update (2013–2022) (best estimate)	**2023**	**500**	**300**	**250**	**150**	**100**
1.7 °C from AR6 WGI	2020	1450	1050	850	700	550
+ AR6 emulator update	2020	1250	900	700	600	450
+ as above with AR6 scenario update	2020	1300	950	750	600	500
+ as above with warming update (2013–2022) (best estimate)	**2023**	**1100**	**800**	**600**	**500**	**350**
2 °C from AR6 WGI	2020	2300	1700	1350	1150	900
+ AR6 emulator update	2020	2050	1500	1200	1000	800
+ as above with AR6 scenario update	2020	2200	1650	1300	1100	900
+ as above with warming update (2013–2022) (best estimate)	**2023**	**2000**	**1450**	**1150**	**950**	**800**

Source: Forster et al., See also (7)

Comparing these carbon budgets with current annual global CO2 emissions shows that a significant global reduction of CO2 emissions within this critical decade is imperative to keep the 1.5 °C in reach. The EDGAR report 2023 ([12]) estimates that the global CO2 emissions in 2022 amounted to around 38.5 GtCO2([13]), more than 15% of the remaining global CO2 budget as of 2023.

([12]) Crippa, M., Guizzardi, D., Pagani, F., Banja, M., Muntean, M., Schaaf E., Becker, W., Monforti-Ferrario, F., Quadrelli, R., Risquez Martin, A., Taghavi-Moharamli, P., Köykkä, J., Grassi, G., Rossi, S., Brandao De Melo, J., Oom, D., Branco, A., San-Miguel, J., Vignati, E., GHG emissions of all world countries, Publications Office of the European Union, Luxembourg, 2023, doi:10.2760/953322, JRC134504. The choice of the database is motivated by the limited available data in the UNFCC Inventory, which for the year 2021 reports only CO2 emissions (including LULUCF) from 43 countries.

([13]) representing about 71.6% of the global GHG emissions estimated at 53.8 GtCO2-eq in 2022

4 INDICATIVE EUROPEAN UNION NET GHG BUDGET FOR THE 2030-2050 PERIOD

4.1 GHG budget estimates

4.1.1 Advice by the ESABCC

In its advice for the determination of an EU-wide 2040 climate target and a greenhouse gas budget for 2030–2050 ([14]), the ESABCC indicates a feasible domestic EU ([15]) net GHG budget for 2030-2050 of 13-16 GtCO2-eq and recommends a range of 11-14 GtCO2eq. These values assume a global warming limited to 1.5°C by the end of the century with no or limited overshoot with at least 50% chance.

The range presented by the ESABCC is calculated from existing modelled scenarios that are selected as described briefly below. The report proceeds with a multiple-step filtering process excluding many scenarios for the EU on "high feasibility concern" grounds (related to the role of CCUS, bioenergy, LULUCF net removals), and eventually selects seven scenarios ([16]). These seven scenarios are all compatible with the Paris Agreement, and more specifically with the long-term temperature goal of limiting global average temperature to 1.5°C. They serve to build the analysed range for the GHG budget within environmental risk levels (7 scenarios, 11-16 GtCO2-eq), the analysed range within environmental risk levels and the technological deployment challenge (5 scenarios, 13-16 GtCO2-eq), and the recommended range (6 scenarios, 11-14 GtCO2-eq). The recommended range discards the scenario showing 2040 reductions lower than 90% compared to 1990 and includes two scenarios showing very ambitious 2040 reduction levels overcoming one or more of the technological deployment challenges defined by the report ([17]).

In terms of GHG profile, the six scenarios building the recommended range all show net negative GHGs in 2050 ([18]), implying a stronger effort than what is required under the Climate Law, which states that the European Union shall reduce emissions to net zero by 2050 and shall aim to achieve negative emission thereafter.

([14]) European Scientific Advisory Board on Climate Change. 2023. Scientific advice for the determination of an EU-wide 2040 climate target and a greenhouse gas budget for 2030–2050. URL: https://climate-advisory-board.europa.eu/reports-and-publications/scientific-advice-for-the-determination-of-an-eu-wide-2040

([15]) The scope of the recommended GHG Budget by the ESABCC is "intra-EU", i.e. domestic as per the inventories and including intra-EU aviation and intra-EU maritime transport. It does not consider 50% of international extra-EU maritime under the MRV, which are included in the scope of the EU Climate Law. The difference in terms of cumulative emissions over 2030-2050 between the ESABCC "intra-EU" scope and EU Climate Law scope is estimated at around 0.5 GtCO2-eq.

([16]) See the "European Climate Advisory Board Scenario Explorer", for details on the different scenarios: https://data.ece.iiasa.ac.at/eu-climate-advisory-board.

([17]) The technological deployment challenges are defined as total installed capacity in 2030 of PV (900 GW), wind (630 GW) and hydrogen (50 GW).

([18]) The scenarios reach net GHGs in 2045 ranging from +141 MtCO2-eq to -63 MtCO2-eq, and are all net negative in 2050 from -46 to -176 MtCO2-eq. Excluding the scenario meeting 88% in 2040 that has not been retained by the ESABCC in its recommended ranges for a 2040 target and the GHG budget, 2045 net emissions reach +73 to -63 MtCO2-eq in 2045 (reductions between -98% and -101% compared to 1990) and -94 to -176 MtCO2-eq in 2050 (-102% to -104%).

The above discussed numbers thus represent the most ambitious approach that can be taken by the EU.

4.1.2 Other estimates

A report by PBL ([19]) provides an analysis of GHG budgets for major emitting countries to achieve the Paris Agreement temperature goals. It looks at the global cumulative GHG emissions over 2030-2050 ([20]) of scenarios in the IPCC AR6 database for different climate categories([21]):

- C1: limit warming to 1.5°C with no or limited overshoot and with a probability higher than 50%,
- C1a: subcategory of C1 including only scenarios reaching global net-zero greenhouse emissions in the second half of this century,
- C2: return warming to 1.5°C with a probability higher than 50% after a high overshoot
- C3: limit warming to 2°C with a probability higher than 67%.

The distribution of these global carbon budgets to regional carbon budgets (Table 3) focuses on five major economies (China, India, EU, United State and Japan). The analysis gives for the EU a 2030-2050 GHG budget of 15 GtCO2-eq (ranging 7-24) for climate category C1, 17 GtCO2-eq (12-25) for category C1a, 23 GtCO2-eq (15-36) for category C2, and 26 GtCO2-eq (18-40) for category C3.

([19]) Hooijschuur, E, den Elzen, M.G.J., Dafnomilis, I. and van Vuuren, D.P. (2023), Analysis of cost-effective reduction pathways for major emitting countries to achieve the Paris Agreement climate goal, The Hague: PBL Netherlands Environmental Assessment Agency.

([20]) Including the year 2030, but excluding the year 2050.

([21]) Riahi, K., R. Schaeffer, J. Arango, K. Calvin, C. Guivarch, T. Hasegawa, K. Jiang, E. Kriegler, R. Matthews, G.P. Peters, A. Rao, S. Robertson, A.M. Sebbit, J. Steinberger, M. Tavoni, D.P. van Vuuren, 2022: Mitigation pathways compatible with long-term goals. In IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.005. Table 3.2. Limited overshoot refers to exceeding 1.5°C global warming by up to about 0.1°C, high overshoot by 0.1°C-0.3°C, in both cases for up to several decades.

Table 3: GHG budget for 2030-2050 per climate category and per country or region.

			China	EU-27	India	Japan	US	World
Total cumulative net GHGs 2030-2050*	**C1**	Median	67	15	34	5	22	308
		Range	56-85	7-24	15-39	3-7	10-36	171-355
	C1a	Median	72	17	35	5	23	316
		Range	57-84	12-25	26-40	3-7	14-38	238-363
	C2	Median	98	23	39	7	41	414
		Range	77-116	15-36	27-50	5-12	23-61	311-492
	C3	Median	110	26	49	9	48	505
		Range	90-140	18-40	32-64	6-14	31-72	398-611

*Note: *Includes the year 2030 and excludes the year 2050.*

Source: Hooijschuur et al. (2023).

Other recent estimates for EU CO2 and GHG budgets are reported:

- The German Advisory Council on the Environment calculates a *CO2* budget for the period 2022-2050 of 23.1 for 1.5°C with 50% probability and 39.5 GtCO2 for 1.75°C with 67% probability ([22]).
- Agora Energiewende suggests a domestic ([23]) EU GHG budget of 14.3 GtCO2-eq for the period 2030-2050 to achieve net-zero emissions by 2050 ([24]).

4.2 Cumulative 2030-2050 GHG emissions associated to target options

The Impact Assessment looks at a broad range of options for the 2040 GHG emission reduction target, ranging from below 75% up to 95% in comparison with 1990 emission levels. The analysis focuses on three target levels:

- Option 1: a reduction of consistent with a linear trajectory between 2030 and climate neutrality by 2050,
- Option 2: a reduction of at least 85% up to 90%,
- Option 3: a reduction of at least 90% up to 95%.

For each target option, the "GHG budget" is calculated as the cumulative net GHG emissions of 2030-2050, assuming net GHG emissions reaching zero in 2050 and linear trajectories of net GHGs between 2030 and 2040, and between 2040 and 2050. The EU-wide net domestic GHG emissions cut by 2030 is estimated at 57% compared to 1990 under the Fit-for-55 legislation as adopted.

([22]) German Advisory Council on the Environment (2022). A justified ceiling to Germany's CO_2 emissions: Questions and answers on its CO_2 budget. German Advisory Council on the Environment. The upper limit for CO2 for domestic budget in the period 2022-2050 is defined as of 23.1 GtCO2.

([23]) The difference in scope between the indicative budget (European Climate Law scope) and a domestic budget (excuding emissions for international aviation and maritime transport) is quantified to around 1.2 GtCO2-eq.

([24]) Graf, A., et al. (2023). Breaking free from fossil gas. A new path to a climate-neutral Europe. Agora Energiewende.

The resulting GHG budget ranges from above 23 GtCO2-eq for a 2040 reduction lower than 75%, 21 GtCO2-eq for target option 1, up to 18 GtCO2-eq for option 2 and up to 16 GtCO2-eq for option 3.

Table 4: EU GHG budget over 2030-2050 associated to each target option.

GHG reductions in 2040 compared to 1990	Below 75%	Target option 1 (linear 2040, 78%)	Target option 2 (85-90%)	Target option 3 (90-95%)
Corresponding GHG budget over 2030-2050 (GtCO2-eq)	More than 23	21	Up to 18	Up to 16

4.3 Cumulative 2030-2050 GHG emissions associated to the proposed EU 2040 climate target

Consistently with the EU 2030 climate target of at least 55% reduction of net GHGs and its associated policy framework, with climate neutrality in 2050 and with the proposed 2040 target of -90%, the resulting indicative "GHG budget" for the EU over the 2030-2050 period is estimated at 16 GtCO2-eq.

The scope of the indicative GHG budget is consistent with the European Climate Law: it includes domestic EU emissions, international intra-EU aviation, international intra-EU maritime, and 50% of international extra-EU maritime under the MRV. It is calculated considering linear reductions in the 2030-2040 decade to achieve -90% and in the 2040-2050 decade to achieve net-zero in 2050.

The indicative GHG budget consists of cumulative gross GHG emissions of around 21-24 GtCO2-eq, and of cumulative net removals of around 5-8 GtCO2-eq over the 2030-2050 period, depending on the contribution of LULUCF net removals and industrial carbon removals. The carbon budget (including the contribution of the LULUCF net removals and of industrial carbon removals) and the cumulative non-CO2 emissions represent each about half of the indicative GHG budget.

It falls within the range analysed by the ESABCC from feasible scenarios compatible with a 1.5°C global warming ([25]) and is in the middle of the range of AR6 scenarios analysed by PBL between climate category C1 and C1a, both compatible with the same global warming level.

This indicative 2030-2050 GHG budget is fully compatible with the Paris Agreement long term temperature goals of well below 2°C and pursuing effort to limit it to 1.5°C, and thus does not put at risk the EU's commitment to contribute to achieving the Paris Agreement.

([25]) The difference in scope between the indicative budget (European Climate Law scope) and the ESABCC budget (intra-EU emissions) is quantified to around 0.5 GtCO2-eq

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