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Supplementary Material

Supplementary Text 1: Approach to determining the minimum level of ambition aligned with limiting warming to 1.5°C

Overview of scenarios

Scenarios limiting warming to 1.5C depict a wide range of energy system transitions that reflect various assumptions and contingencies. Because the sum of all emissions and removals must conserve a single budget, sectoral pathways are deeply interdependent. For example, in scenarios where non-electric fuel use-related emissions are reduced more slowly, the power and AFOLU sectors compensate by actively removing a greater amount of CO2 from the atmosphere. Alternatively, in scenarios where all sectors rapidly reduce their gross emissions in the near-term, CO2 removal (CDR) is almost entirely avoided.[1]

In most scenarios, CDR is deployed by the power sector through the application of bioenergy carbon capture and storage (BECCS) and/or by the land sector through afforestation/reforestation (AR). Regardless of how CDR is deployed, its purpose is to compensate for residual gross emissions. By comparison to scenarios where all sectors rapidly decarbonize according to their own least discounted cost path of action, which avoid reliance on CDR to mitigate warming, scenarios that rely on CDR depict a vastly different allocation of the mitigation burden. Assessments have concluded that the inclusion of CDR in scenarios also defers near-term ambition (Minx, et al. 2018, Chang 2020, Strefler, et al. 2018, Holz, et al. 2018, van Vuuren and al. 2018).

[1] Carbon dioxide removal (CDR) comprises “anthropogenic activities removing CO2 from the atmosphere and durably storing it in geological, terrestrial, or ocean reservoirs, or in products. It includes existing and potential anthropogenic enhancement of biological or geochemical sinks and direct air capture and storage, but excludes natural CO2 uptake not directly caused by human activities (Masson-Delmotte, et al. 2018)”

There is widespread agreement in the scientific community that it is risky to rely on the future deployment of CDR to limit warming. Notably, the authors of SR15 specify that "most CDR technologies remain largely unproven to date and raise substantial concerns about adverse side-effects on environmental and social sustainability (Rogelj, et al. 2018)."

SBTi pathway requirements

The identification of sector-specific pathways that are compatible with the mission of the SBTi must be carefully considered, in part to ensure that scenarios do not externalize the mitigation burden from one sector to another (Science Based Targets initiative 2017). Since the release of the IPCC's Special Report on Global Warming of 1.5C (SR15), the SBTi has conducted a sizable volume of research in consultation with the Scientific Advisory Group to inform updates to existing target-setting approaches and, more recently, to explore Paris-aligned energy system transitions and intersectoral dependencies (Chang 2020, Science Based Targets initiative 2019). It is evident that many scenarios rely on BECCS and AR-related CDR exceeding sustainable limits and that the inclusion of BECCS results in externalizing the mitigation burden from other sectors of the energy system to the power sector. Moreover, scenarios that reduce near-term ambition due to assumed availability of future carbon dioxide removal are not aligned with the SBTi's decision to base minimum ambition on scenarios that are plausible, consistent, responsible, and objective relative to the desired goal of limiting warming to 1.5C or well-below 2C. Accordingly, the initiative concludes that sector pathways should be derived from scenarios that exclude CDR from the energy system and that rely on land-use related emissions and removals not exceeding best available, bottom-up estimates of what the land system can achieve. The only scenario conservatively fulfilling these criteria in the SR15 Scenario Database that also contains a satisfactory degree of sectoral and technological resolution is the Low Energy Demand (P1) scenario (Supplementary Text 2).[2] All other 1.5C low/no overshoot scenarios in SR15 that do not exceed power sector emissions in P1 by more than 15% in 2030 onward are considered valid for target-setting purposes by the SBTi. These scenarios may include CDR at rates that are higher than conservative filter thresholds, but its effect is not to compensate for a slower power sector decarbonization by comparison to P1.

The P1 scenario depicts a 1.5C-aligned future that achieves sustainable development goals for a middle-of-the-road projection of population growth. Success is achieved by means of the rapid

[2] As scenario development continues to evolve and improve, the SBTi will also continue to assess the quantitative parameters determining valid scenarios and to contribute thought leadership to the assessment and production of new scenarios that are fit-for-purpose

electrification of many energy services and improved energy efficiency of end-use sectors, as well as through a transition from emitting to renewable power generation. Power sector pathways in P1 are very similar to those of the archetype scenario P3; a critical difference between P1 and P3 is that emissions attributable to fossil energy are reduced faster in P1 than in P3, while P3 relies more on CDR to rectify overshoot later in the century, with the power sector ultimately becoming a sustained net CO2 sink around 2050. A full description of the LED experiment and MESSAGE-GLOBIOM model may be found in Grubler et al., (2018).

High-resolution data for the P1 scenario can be acquired from both the SR15 scenario database, jointly hosted by the Integrated Assessment Modeling Consortium and IIASA at https://data.ene.iiasa.ac.at/iamc-1.5c-explorer, and the LED database, jointly hosted by IIASA Energy and Transitions to New Technologies Programs at https://db1.ene.iiasa.ac.at/LEDDB.

Supplementary Text 2: Scenarios fulfilling pathway requirements

The following conditions were used to determine 1.5C-aligned scenarios considered valid by the SBTi for SBT-setting purposes.

Exclude carbon dioxide removal from the energy system

Carbon dioxide removal in the energy system almost exclusively consists of bioenergy with carbon capture and storage (BECCS) in integrated assessment models.[3] In most IAMs, BECCS is applied primarily or entirely to power generation, although it may also be applied to industrial non-electric fuel combustion and hydrogen fuel production.

In this approach, scenarios with more than 100 GT CO2 cumulatively sequestered by BECCS between 2016 and 2100 are removed. This condition should not be interpreted as implying that no CDR will occur in the energy system, but rather that the pace of action that is consistent with limiting warming to 1.5C over the next 5-15 years should not be determined based on scenarios that assumed high deployment of CDR later in the century (Supplementary Text 1).

Land-use emissions

Scenarios' temperature classifications in the SR15 database are calculated based on all global emissions, including non-CO2 GHGs and land-use sector emissions. It is important to confirm that scenarios classified as 1.5C low/no-overshoot do not rely on land-sector transformations not estimated to be feasible to limit warming to the specified level.

A comprehensive review of top-down and bottom-up modeling approaches suggests that a highly ambitious land-sector pathway aligned with limiting warming to 1.5C would achieve net-zero emissions by 2040 and a net carbon sink of approximately 3 Gt CO2e/year by 2050 (Roe, et al. 2019).

Results

Out of all 53 1.5C low/no overshoot scenarios in the SR15 database, only 8 rely on under 100 GT CO2 of cumulative BECCS between 2016 and 2100. Of those 8 scenarios, only 2 include non-CO2 AFOLU emissions (N2O and CH4) that are needed to fully assess the land sector transformation. One of those scenarios – the archetype P1 (MESSAGEix-GLOBIOM 1.0 - LowEnergyDemand) – does not rely on land-use transformations that are more ambitious than

[3] A small number of models also include direct air capture

those specified above, while the other one relies on the land sector achieving net-zero emissions around 2036 and sequestering 4.6 Gt CO2e/year in 2050.

Out of the other six scenarios without non-CO2 AFOLU emissions data, two of them rely on achieving net-zero land-use related CO2 emissions by 2022, which is likely infeasible. The other four were all generated by the C-ROADS model, and while at least two of those scenarios may depict land-use transformations that are consistent with requirements described above, the C-ROADS model itself is highly simplified, and its scenarios are missing the data that would be needed to estimate power-related and primary energy subsector emissions or activity pathways. Additional details on each of the eight scenarios are included in Table 1.

After this filtering process was conducted, all other 1.5C low/no overshoot scenarios in SR15 that do not exceed emissions in P1 by more than 15% 2030 onward are considered valid for target-setting purposes by the SBTi. 20 scenarios meet these criteria.

Table 1: SR15 scenario assessment results

Model-Scenario	Year of net-zero AFOLU CO2 emissions	Year of net-zero AFOLU GHG emissions	AFOLU CO2 emissions in 2050	AFOLU GHG emissions in 2050	Inc
C-ROADS-5.005-Ratchet-1.5-limCDR	2029		-5118.22		-
C-ROADS-5.005-Ratchet-1.5-limCDR-noOS	2025		-9665.93		-
C-ROADS-5.005-Ratchet-1.5-noCDR	2029		-3520.53		-
C-ROADS-5.005-Ratchet-1.5-noCDR-noOS	2026		-4158.76		-
IMAGE 3.0.1-IMA15-TOT	2028	2036	-4607.50041	-1228.63	-
MESSAGEix-GLOBIOM 1.0-LowEnergyDemand	2030	2088	-769.364011	4034.031	1
POLES EMF33-EMF33_WB2C_nobeccs	2022		-1643.51648		-
POLES EMF33-EMF33_WB2C_none	2022		-2142.37915		-

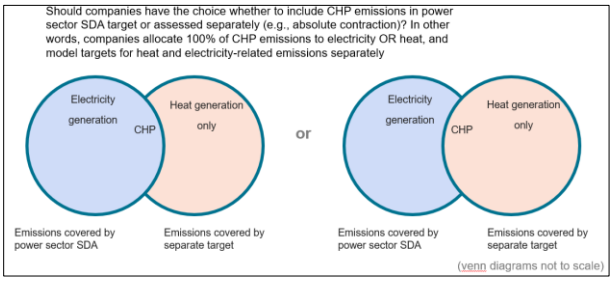
Supplementary Material 3: Overview of stakeholder consultation process and feedback

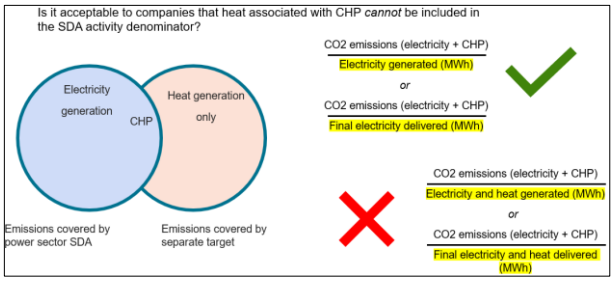
On March 23, CDP presented a consultative webinar to stakeholders in the Power Sector to solicit feedback on the newly developed 1.5C-aligned power sector pathway, as well updates to the sector-specific method application requirements and guidance. CDP requested feedback on the following areas to inform the SBTi's forthcoming update that will enable companies to set 1.5C-aligned targets with minimal changes to the existing SDA methodology, as well as the release of abbreviated guidance:

1. Feedback on inventory and target boundary accounting guidance;

	Generation	Generation and T&D	T&D only
Electricity	SDA required for scope 1: $\frac{\text{CO2 emissions (electricity + CHP)}}{\text{Electricity generated (MWh)}}$ *or* $\frac{\text{CO2 emissions (electricity + CHP)}}{\text{Final electricity delivered (MWh)}}$		SDA for scope 3 using same pathways
Electricity and CHP			

2. Feedback on guidance for companies whose operations includes CHP;





3. Feedback on regional and country-specific pathways;
4. Feedback on other topics.

Stakeholders had until April 3 to share feedback. CDP received written responses from 8 registrants – 5 European electric utilities, 1 Asian electric utility, 1 consultancy, and 1 sustainable business initiative – from a pool of 83 webinar registrants (60 attendees) provided with the opportunity to share comments.

Summary of feedback

- Respondents consistently upheld that “tCO2e per kWh of electricity generated” is the most appropriate intensity metric for companies involved with electricity production because it directly targets the primary source of emissions and it is the existing industry reporting standard;
- Some respondents mentioned that “tCO2e per kWh of electricity delivered” could be preferable to T&D companies, while others stated that such a pathway is not appropriate because T&D companies frequently do not have control of the intensity of electricity delivered to end users;
- Respondents strongly urged the SBTi to provide an option for companies to set targets with a numerator including CO2 emissions from electricity and CHP with a denominator including the sum of electricity and heat generation. They cite existing reporting frameworks and guidance provided by the GHG Protocol that supports calculating the intensity of a CHP plant based on total emissions divided by total output; perceived penalization of CHP if heat is not allowed to be included in the denominator of a target; and burdensome complexity as reasons for allowing these targets;
- Respondents generally support the pathway applicability framework for regional and country-specific pathways, with one respondent voicing that it depends on the assumptions underlying differentiated pathways and another specifying that “combined” pathways for countries operation in more than one regional are needed.