Carbon Direct Commentary: Release of the Voluntary Registry Offsets Database

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Whether you're a corporate sustainability lead trying to affordably neutralize your organisation's emissions or a vacationer buying a plane ticket and questioning whether to check an "offsetting" box, a key area of friction for carbon offset buyers is the sheer breadth and variety of the credit supply. How can one make sense of the vast supply and diversity of carbon credit types to make an informed purchase decision?

A key gap to date has been the lack of a centralized database capturing the observable universe of carbon credits. In April 2021 the Berkeley Carbon Trading Project with support from Carbon Direct released a database[1] covering all known voluntary carbon projects. This database spans the four major voluntary offset project registries and represents over *one billion tonnes* of purported carbon dioxide avoidance, reduction, and removal. The breadth of the *potential* carbon benefits represented in the database is stunning. For context, cars made by Tesla, the world's largest electric vehicle company, have saved only 4 *million* tons of carbon dioxide to date.

This powerful tool arrives at an opportune time; the voluntary carbon market (VCM) is at a crossroads. Retrospective studies of carbon offset programs have substantiated fears that many credits are not delivering the climate benefits they claim to provide.[2] For example, one analysis found that 85 percent of projects developed under the Clean Development Mechanism, the first generation carbon offset market, had a "low likelihood" of being additional with dubious climate benefits.[3] This has led to growing media and public scrutiny

[1] Barbara Haya, Micah Elias, Ivy So. (2021, April). Voluntary Registry Offsets Database, Berkeley Carbon Trading Project, Center for Environmental Public Policy, University of California, Berkeley. Retrieved from: https://gspp.berkeley.edu/faculty-and-impact/centers/cepp/projects/berkeley-carbon-trading-project/offsets-database

[2] University of California-Berkeley. Berkeley Carbon Trading Project. Accessed April 11, 2021 from: https://gspp.berkeley.edu/faculty-and-impact/centers/cepp/projects/berkeley-carbon-trading-project

[3] Cames, M., Harthan, R.O., Fussler, J., Lazarus, M., Lee, C.M., Erickson, P., & Spalding-Fecher, R. (2016). How additional is the Clean Development Mechanism. Oko-Institut e.V. Accessed April 11, 2021 from: https://ec.europa.eu/clima/sites/clima/files/ets/docs/clean_dev_mechanism_en.pdf

of the VCM[4,5,6] and an increasing subset of buyers who are wary of the reputational fallout of buying "hot air". Even savvy buyers express frustration with how difficult it can be to find high-quality carbon credits.[7,8]

In partnership with the authors of the Voluntary Registry Offsets Database, Carbon Direct took an early look at what the data can tell us about the state of offsetting.

The database at a glance

The Voluntary Registry Offsets Database contains all of the carbon offset projects globally listed on the four major VCM registries: American Carbon Registry (ACR), Climate Action Reserve (CAR), Gold Standard (GS), and Verra (VCS)[9]. This database covers 1.1 billion tonnes of CO_2 that is purported to have been avoided, reduced, or removed by over 5,000 individual carbon projects. The vast majority of projects are hosted on the VCS (40 percent) and GS (39 percent) registries; of the remaining 21% of projects listed under the CAR and ACR registries, slightly over half are also projects that can be used to meet California cap-and-trade requirements under the Air Resources Board (ARB), and the remainder are voluntary-only projects.

In terms of the number of carbon offset credits issued to date, VCS also leads with nearly 57 percent of the total credits across all registries. North America is the leading geography from which credits are issued, followed by South Asia and South America. The three leading host countries for offset credit projects are the United States (n = 1,099), India (n = 977), and China (n = 647) (see Figure 1).[10]

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[4] Elgin, B. (2020). These Trees Are Not What They Seem. Bloomberg Green. Accessed April 11, 2021 from: https://www.bloomberg.com/features/2020-nature-conservancy-carbon-offsets-trees/

[5] Song, L., 2019. An (Even More) Inconvenient Truth: Why Carbon Credits For Forest Preservation May Be Worse Than Nothing [WWW Document]. ProPublica. URL https://features.propublica.org/brazil-carbon-offsets/inconvenient-truth-carbon-credits-dont-work-deforestation-redd-acre-cambodia/ (accessed 12.24.20).

[6] Elgin, B. & Mider, Z. (2020). The Real Trees Delivering Fake Corporate Climate Progress. Bloomberg Green. Accessed April 11, 2021 from: https://www.bloomberg.com/news/features/2020-12-17/the-real-trees-delivering-fake-climate-progress-for-corporate-america

[7] Zelikova, J. (2021). In Search of Carbon Removal Offsets. Medium. Accessed April 11, 2021 from: https://carbon180.medium.com/in-search-of-carbon-removal-offsets-42abf71b3ccc

[8] Klein, J. In the quest for carbon offsets, (almost) anything goes. GreenBiz. Accessed April 11, 2021 from: https://www.greenbiz.com/article/quest-carbon-offsets-almost-anything-goes

[9] Note: The database includes California offset projects that are eligible for use towards meeting the state's cap-and-trade program requirements, but do not include Clean Development Mechanism credits that are not listed on these voluntary registries.

[10] Note: Data in the above two paragraphs is all available in visual form in the 'Charts' tab of the Voluntary Registry Offsets Database, including Figure 1 which we reproduce below.

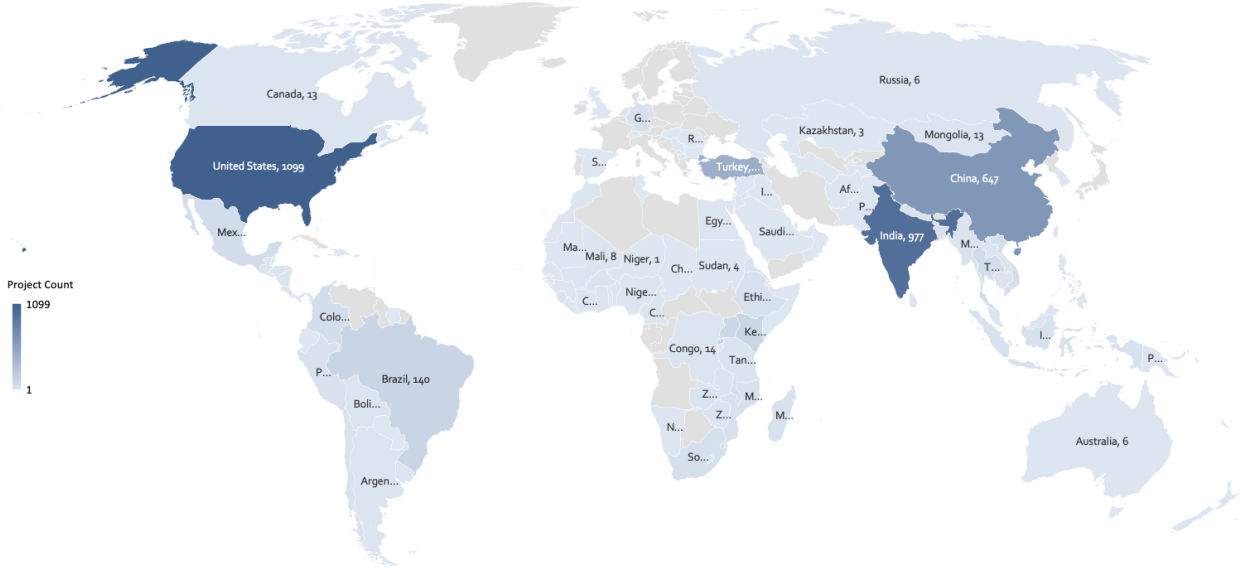

Figure 1 - Offset credit projects by country of origin.

The authors of the database hope to promote transparency and provide a powerful tool to empower others to analyse and understand the range of carbon credits in the market. This resource tries to define the "observable universe" of carbon offsets as comprehensively and openly as possible, and could form the foundation for work to reform and improve oversight of the VCM. Importantly, this database provides for macro-level analyses using variables such as offset credit type, age of the credits, and geographic location but does not allow for more granular analyses to assess credit quality according to principles for high-quality carbon removal and is not, in isolation, a guide to carbon credit procurement.

1 - Breaking down credits by type

Forestry and renewable energy, two project types with deep quality issues, continue to dominate and are growing

Nearly three-fourths of the total credits issued to date came from ‘Forestry and Land Use’ (46 percent) and ‘Renewable Energy’ (28 percent) (Figure 2a).

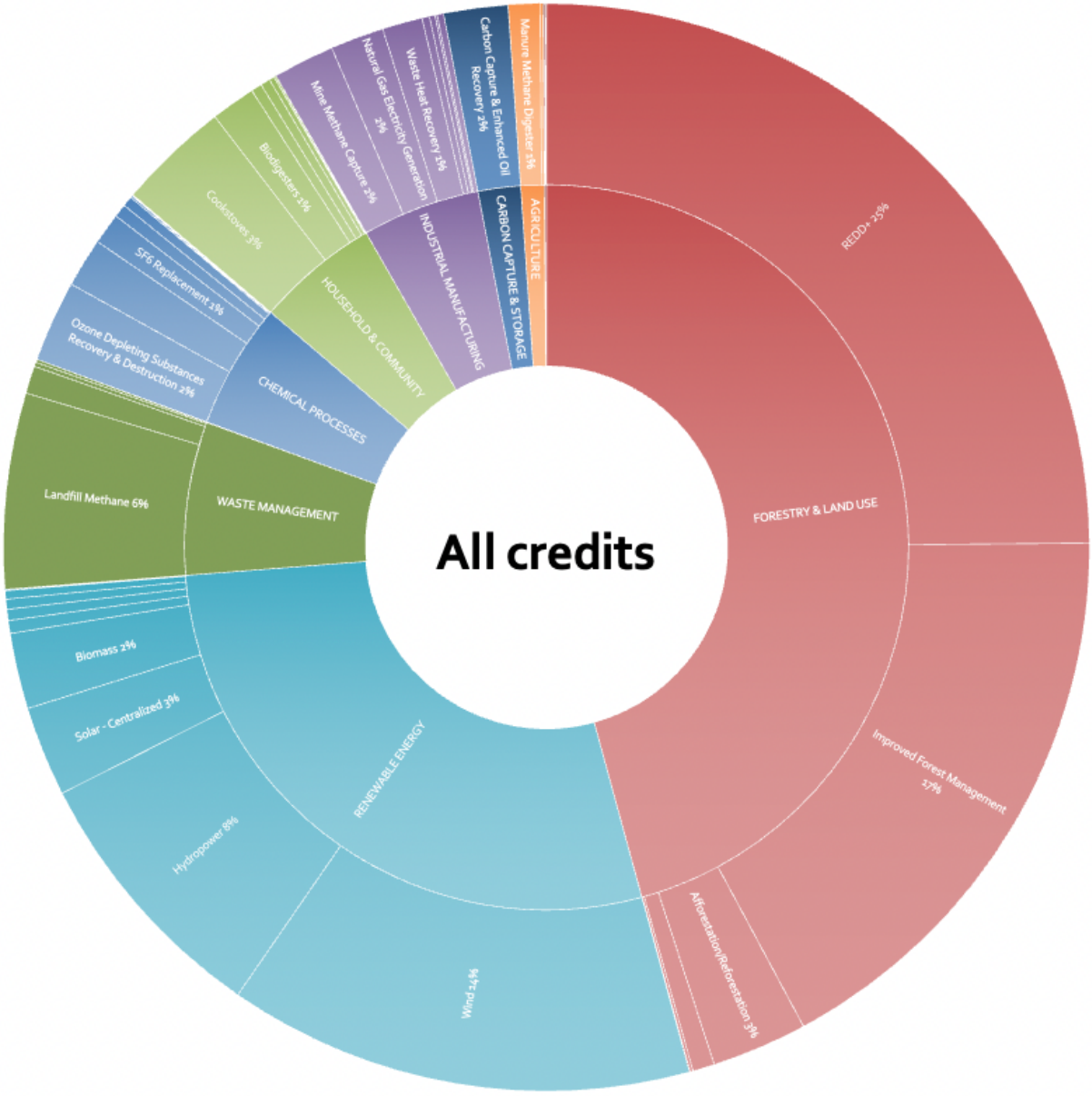

Figure 2a - Breakdown of all credits generated for reductions/removals achieved in the years 1996-2020 by project type.

We wanted to understand how the prevalence of these project types had shifted over time. Around 50% of all credits issued to-date were generated over the last six years (2015-2020). Figure 2b shows the breakdown for only these most recent six years of credits.[11] Some project types from the industrial manufacturing and transportation categories have all but

[11] We chose this 6-year window to reflect the fact that credits are purchased and retired an average 4.5 years after they are generated, so a retrospective 6-year window provides a picture of what buyers on the market today are likely to select from. See Section 3 below for this "time-to-retirement" analysis.

disappeared. Forest-based mitigation, including improved forest management (IFM) and avoided deforestation (project-based REDD+), have exploded in prevalence. Figure 3a shows the percentage prevalence of project type categories over time, highlighting the relative decline among many groups of project types as a proportion of credits generated, except for forestry & land use and renewable energy which have increased in both absolute and relative terms. Figure 3b shows these same trends on an absolute basis. Renewable energy credits appeared to be declining as a share of all credits generated in the early 2010s, but may be rebounding. This is a surprising finding given that the largest registry, VCS, has limited these projects exclusively to least-developed countries citing additionality concerns.[12] The database shows VCS projects from these newly excluded project types still generating credits or going through validation, perhaps having been grandfathered in.

[12] Verified Carbon Standard. (2019). VCS Standard v4. Accessed April 19, 2021 from: https://verra.org/wp-content/uploads/2020/03/VCS-Standard-v4.0_Updated.pdf

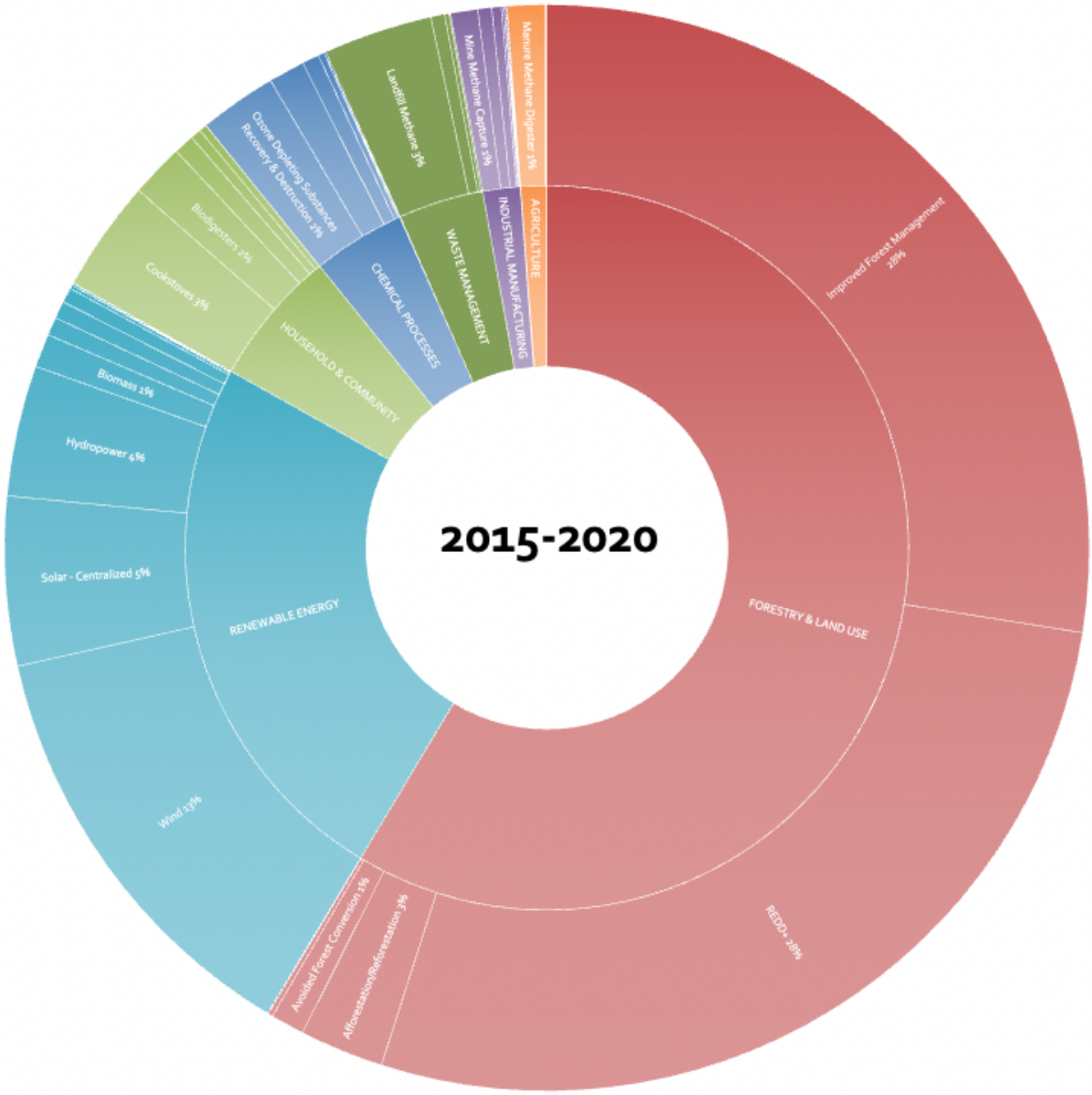

Figure 2b - Breakdown of all credits generated for reductions that occured in 2015-2020 by project type.

While this database cannot shed light on the legitimacy of the individual credits it summarizes, it does provide a snapshot of what buyers see when they approach the voluntary offset registries. Renewable energy and forest-based offsets, which have generated close to three-quarters of offset credits generated to date with increasing shares of credits in the most recent years, both have well-documented quality challenges.

Renewable energy carbon credits continue to come almost exclusively from utility-scale wind, solar, and hydro projects. These three forms of energy are already cost-competitive

with fossil fuels in at least two-thirds of countries.[13] While their efficacy in producing affordable clean electricity is unparalleled, when used to generate carbon credits in today's economic environment they have been shown to have high rates of non-additional projects.[14] We would expect and hope that renewable energy credits, to the extent they remain in use at all, would shift away from wind, solar, and hydro and toward exclusively earlier stage, higher-cost renewable energy technologies where revenue from carbon credits is key to the financial viability of the project and the the risk of non-additionality is therefore low.

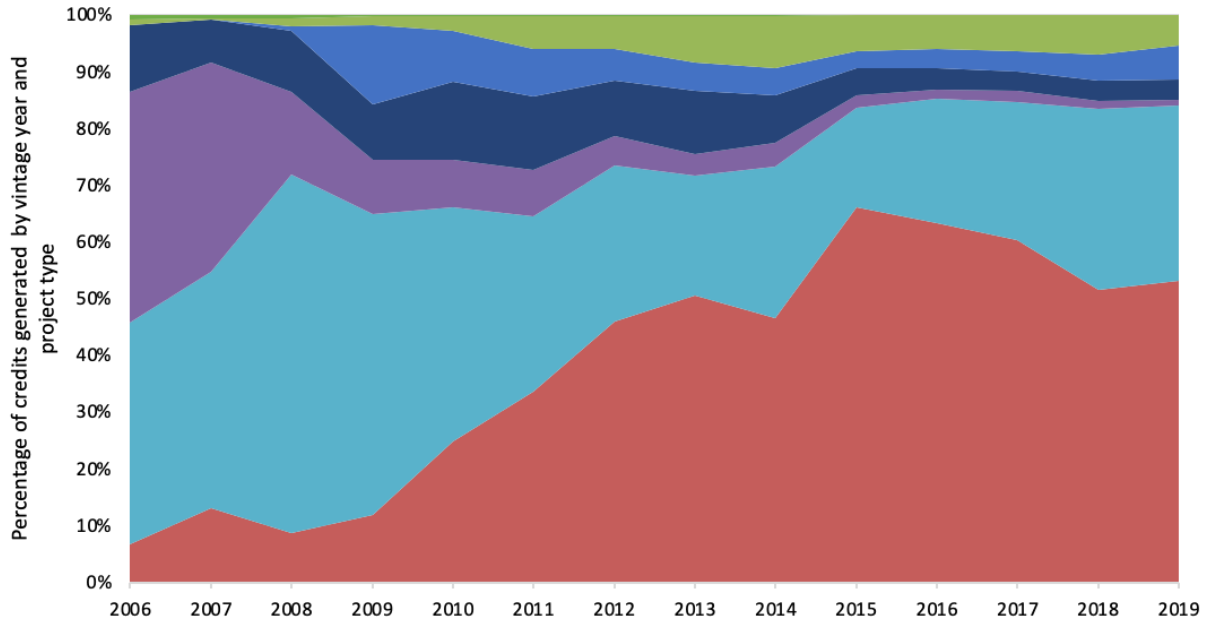

Figure 3a - Trends in project type over time, relative basis.

[13] Reback, S., 2019. Solar, Wind Provide Cheapest Power for Two-Thirds of Globe. Bloomberg.
[14] Warnecke, C., Schneider, L., Day, T., La Hoz Theuer, S., Fearnehough, H., 2019. Robust eligibility criteria essential for new global scheme to offset aviation emissions. Nature Climate Change 9, 218–221. https://doi.org/10.1038/s41558-019-0415-y; He, G., & Morse, R. (2014). Addressing Carbon Offsetters' Paradox: Lessons from Chinese Wind CDM. Energy Policy, 63, 1051–1055. https://doi.org/10.1016/j.enpol.2013.09.021; Haya, Barbara. (2010). Carbon Offsetting: An Efficient Way to Reduce Emissions or to Avoid Reducing Emissions? An Investigation and Analysis of Offsetting Design and Practice in India and China [PhD, University of California, Berkeley]. https://escholarship.org/content/qt7jk7v95t/qt7jk7v95t.pdf.

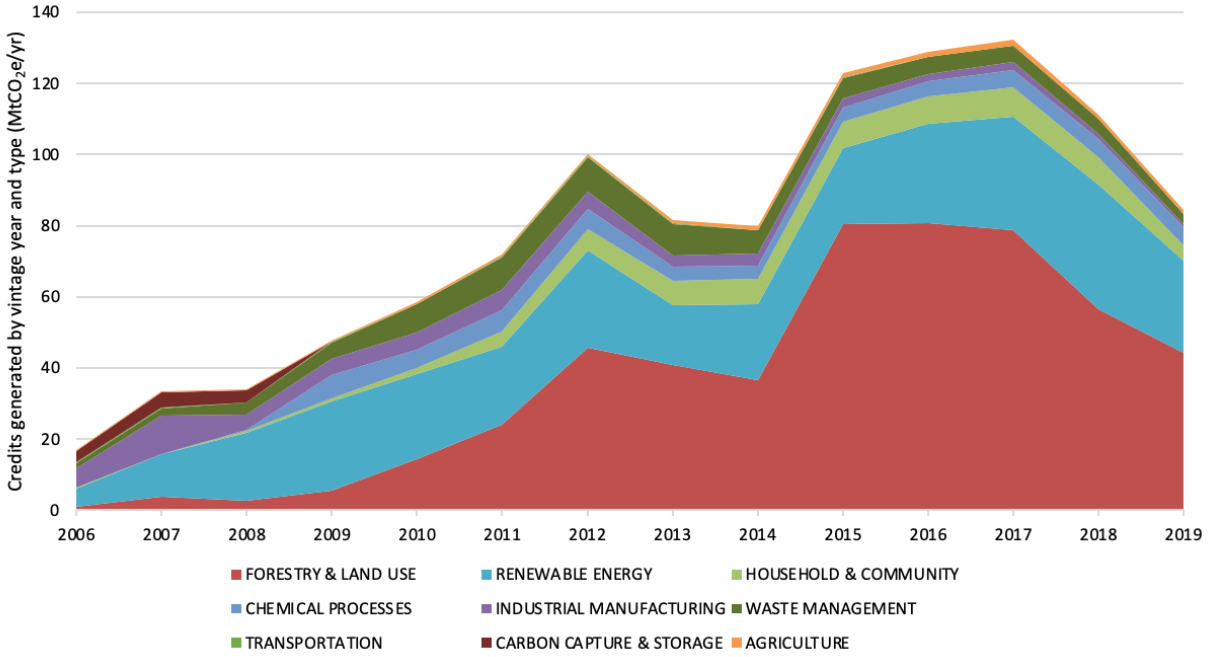

Figure 3b - Trends in project type over time, absolute basis.

Over-crediting has also been well-documented for IFM and REDD+ offset projects. Project developers have in many cases used baselines which exaggerate the emissions that would occur without the project. This allows credits to be generated beyond the change in forest management (harvest volumes) and deforestation that can reasonably be attributed to carbon finance.[15] Indirect carbon leakage has also been a challenge for forest offset projects. Such leakage occurs when, for example, a forest project reduces harvesting without reducing demand for timber products, thus displacing timber harvesting to other forests. It can also occur when an avoided deforestation project simply shifts the drivers of deforestation to other forests. Both forms of leakage are well documented, and are also very difficult to accurately trace and measure.[16] California's forest protocol, which generates the majority of credits from improved forest management, has been shown to systematically and

[15] West, T. A. P., Börner, J., Sills, E. O., & Kontoleon, A. (2020). Overstated carbon emission reductions from voluntary REDD+ projects in the Brazilian Amazon. *Proceedings of the National Academy of Sciences*, *117*(39), 24188. https://doi.org/10.1073/pnas.2004334117; Ben Elgin. (2020, December 9). These Trees Are Not What They Seem: How the Nature Conservancy, the world's biggest environmental group, became a dealer of meaningless carbon offsets. *Bloomberg Green*. https://www.bloomberg.com/features/2020-nature-conservancy-carbon-offsets-trees/

[16] Ingalls, M. L., Meyfroidt, P., To, P. X., Kenney-Lazar, M., & Epprecht, M. (2018). The transboundary displacement of deforestation under REDD+: Problematic intersections between the trade of forest-risk commodities and land grabbing in the Mekong region. *Global Environmental Change, 50*, 255-267.

substantially over-credit because of a failure to adequately account for leakage.[17] Over-crediting has also been documented by a range of other offset project types.[18] The permanence of the claimed carbon benefit is also a key consideration. For forest and other nature-based carbon project types particularly, there is a risk of physical reversal of carbon due to direct human intervention (e.g. forest conversion for agriculture) or due to the indirect effects of anthropogenic climate change (e.g. increased incidence of fire, drought, pests, and disease). Buffer pools are established to insure against such losses, but whether these buffer pools are large enough to address the increasing incidence of wildfire due to climate change, for example, is an active area of investigation. These projects can provide valuable non-carbon benefits including preserving and restoring sensitive ecosystems and providing havens for biodiversity, and there is ample reason to deploy them on these bases alone. However, focusing exclusively on their carbon benefit, concerns over additionality, leakage, and permanence remain insufficiently addressed if the credits are to be used to make net zero claims.

Both for renewable energy and forest-based carbon credits, improvements to the underlying protocols used to generate credits could reduce some of the additionality, leakage, and permanence concerns. However this snapshot of the VCM as it exists today suggests a prevalence of credits which are likely to represent less mitigation than they claim. Project developers and registry managers in the VCM must find ways to rapidly scale up higher-integrity project types while reforming existing ones.

2 - Disentangling mitigation and storage type

Removals are ambiguous and scarce, low-risk storage is non-existent

Another way of breaking down the universe of carbon credits is according to the type of mitigation they provide (avoidance/reduction vs. removal) and the way in which the carbon is stored (higher risk vs. lower risk). Starting in late 2020, in response to the increasing prevalence of “net zero” commitments by companies, several initiatives began proposing guardrails or principles for “net zero aligned offsetting”, highlighting how buyers can incorporate offsetting into their decarbonization plan and still credibly claim to have achieved net zero. The Science Based Targets Initiative’s recently proposed changes (final version

[17] Haya, B. (2019). The California Air Resources Board’s U.S. Forest offset protocol underestimates leakage. Goldman School of Public Policy Working Paper. University of California, Berkeley. https://gspp.berkeley.edu/faculty-and-impact/working-papers/policy-brief-arbas-us-forest-projects-offset-protocol-underestimates-leaka

[18] Cames, M., Harthan, R.O., Fussler, J., Lazarus, M., Lee, C.M., Erickson, P., & Spalding-Fecher, R. (2016). How additional is the Clean Development Mechanism. Oko-Institut e.V. Accessed April 11, 2021 from: https://ec.europa.eu/clima/sites/clima/files/ets/docs/clean_dev_mechanism_en.pdf; Heilmayr, R., Echeverría, C., & Lambin, E. F. (2020). Impacts of Chilean forest subsidies on forest cover, carbon and biodiversity. *Nature Sustainability*, *3*(9), 701–709. https://doi.org/10.1038/s41893-020-0547-0.

forthcoming), the Climate Champions' Race to Zero Criteria (final version forthcoming), and the Oxford Principles for Net Zero Aligned Carbon Offsetting[19] vary on some details but agree clearly on two major points: eventually all offsets purchased in service of claiming "net zero" must be *removals only* and must exclusively constitute *long-lived carbon storage*. This is in keeping with the Intergovernmental Panel on Climate Change (IPCC) definition of net zero as requiring a balance of sources (emissions) with sinks (removals), and the need to ensure that CO_2 stays out of the atmosphere in perpetuity in order to halt warming. There is not yet agreement on the required speed of transition toward removals and permanent carbon storage, but there is agreement on this end destination for net zero aligned offsetting specifically.

In parallel with the growing consensus around the importance of removals and storage with very low reversal risk in governance, environmental NGOs, and academic circles, high-ambition companies have independently begun focusing their offset procurement on removals (e.g., Microsoft, Shopify). These include pioneering commitments to achieve "net negative emissions" on a cumulative basis; in other words, to remove all future and historical emissions attributable to the company.

Given the importance of removals and storage with lower reversal risk, we wanted to understand whether the VCM contains even remotely enough credits of either type to meet what we expect will be rapidly growing demand for them. We split up project types according to the Oxford Taxonomy:

- **Type of mitigation** - Does the carbon credit constitute avoided/reduced emissions, carbon removal, or a mix of both?
- **Type of storage** - Does the carbon credit employ lower-risk storage (likely to persist for centuries or millennia, for example storage in deep sediments, geological formations, and mineral forms), or higher-risk storage (likely to persist for decades or less, for example in some vegetation or soils)? Alternatively, does the credit not involve the apparent storage of any carbon, such as instances where renewable energy displaces fossil fuels or emissions like methane or nitrous oxide are destroyed?

Critically, all of these forms of storage provide value, and nature-based solutions have the capability of offering affordable and de-risked storage through the careful application of legal and governance frameworks to ensure that any reversals are remediated with commensurate storage.

[19] Allen, M., Axelsson, K., Caldecott, B., Hale, T., Hepburn, C., Hickey, C., Mitchell-Larson, E., Malhi, Y., Otto, F., Seddon, N., Smith, S., 2020. The Oxford Principles for Net Zero Aligned Carbon Offsetting. University of Oxford, Oxford, UK.

Figure 4 shows our findings. There are vanishingly few pure carbon removal options today, and virtually all of them are from reforestation. Because IFM and avoided deforestation projects involve both avoided emissions and removals, we classify them as “mixed”. Clearer disambiguation of removals and reductions in these project types would be the easiest short-term option for identifying more offset credits representing pure removals. A preliminary analysis of IFM projects in the database show that on average 82% of mitigation is achieved in the first year of the project, around 90% of which represents avoided emissions, therefore roughly three fourths of all IFM credits are avoided emissions with the rest representing removals.

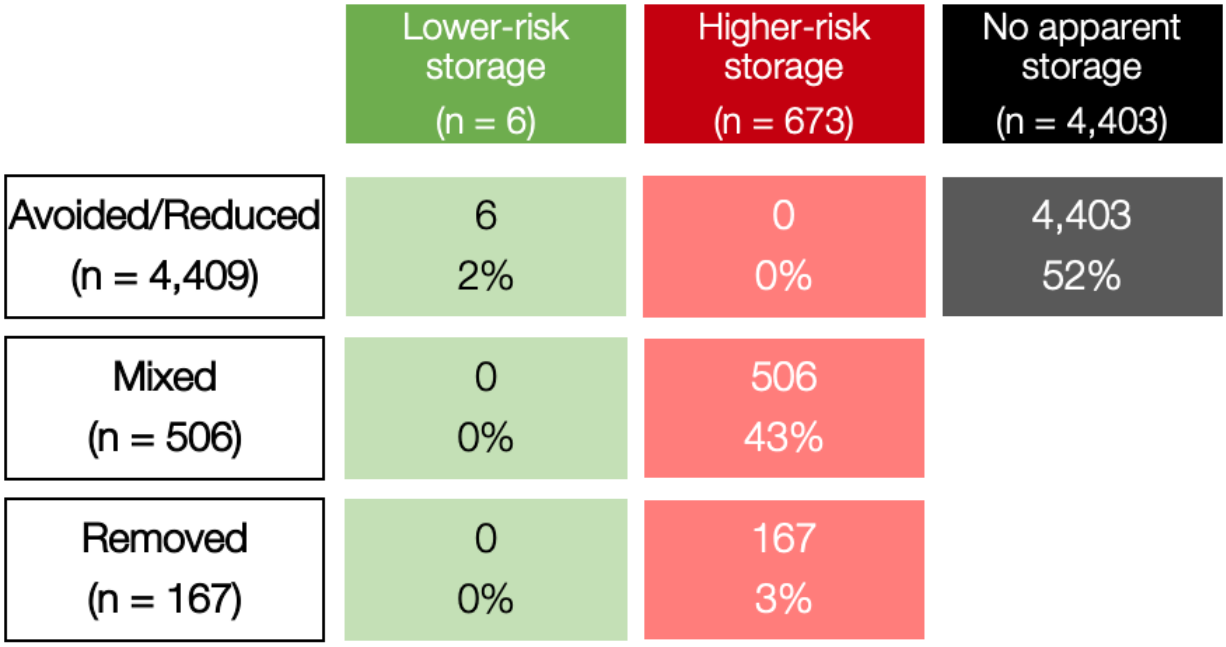

Figure 4 - Breakdown of all carbon credits generated to date according to the Oxford Taxonomy. We followed a similar approach to CarbonPlan’s recent analysis of the Microsoft procurement process, drawing on the taxonomy proposed in the Oxford Principles.

There are virtually no credits in the database that unambiguously offer “lower risk”, highly permanent storage. The only projects that involve permanent geological storage of CO_2 are enhanced oil recovery projects, which come with their own lifecycle accounting issues and are unlikely to be acceptable to many buyers due to the close association with the production of additional fossil fuels. We’d like buyers to have more options to complement higher-risk storage, including pure-play mineralization, enhanced weathering, and permanent storage of removed CO_2 (e.g., direct air capture with saline aquifer storage, some forms of biomass carbon removal and storage, etc.). These other techniques capable of delivering century- or millenia-scale storage are in many cases still nascent and high cost. The registries need to rapidly apply and adapt protocols (the methodologies they use to approve

credits) to onboard these project types and make them available to early-adopters, and project developers will need to partner with buyers to get early projects off the ground and begin bringing costs down.

Carbon credits with "no apparent storage" of carbon still comprise 41% of credits generated in the 2015-2020 window (down from 52% of all credits generated to date). These include both destruction of non-CO_2 pollutants (e.g., methane, SF_6) where there is no need to store carbon, and avoided emissions of fossil fuels (e.g., renewable energy projects) where the carbon is essentially "stored" as an uncombusted fossil fuel. Although in both cases the avoided emissions are considered "permanent" in most offsetting regimes, in the latter case it must be noted that the emissions may not be permanently avoided, and instead deferred into the future. There is no specific physical pool of carbon to monitor and observe, as with avoided deforestation or geological storage, where the preserved carbon stock is clear and unambiguous.

The future of avoided emission and emission reduction carbon credits in net zero strategies is uncertain, though it seems likely they will play a significant role during the transition toward permanent removals. To the extent such credits can fund real mitigation, with sufficient reform they could become a powerful tool to drive decarbonization. There is concern that too rapid a shift to removals risks pulling funding from important projects, though our position is that funds must be urgently shifted from insufficiently validated mitigation toward real projects. We expect avoided/reduced emission offsets to ultimately support new corporate claims based around the concept of "climate contribution", rather than being used to explicitly neutralize specific emissions. In other words, companies may draw a distinction between offsets they are using to support a net zero strategy (for which carbon benefits must be highly certain), and additional credits they buy for the purpose of supporting a mix of benefits, including to the climate, ecosystem restoration, and other outcomes linked with the Sustainable Development Goals.

3 - Tracking the surplus of old credits

Credits take on average four-and-a-half years from generation to retirement, but some linger unsold for much longer

Finally, we wanted to understand how the VCM treats older credits. More than half (55%) of all credits generated to date have not yet been retired and are still outstanding. This includes credits that have not yet been sold, some because they are part of buffer pools used as insurance in case mitigation is less than claimed and others because they simply never found a willing buyer. It also includes credits that *were* sold but have not yet been retired. This may include credits held by speculators who intend (or intended) to sell them at a later date, or held by companies planning to use them to address future emissions.

Also of note is the lag between when the mitigating activity represented by a carbon credit takes place (the "vintage"), and the date when the credit is finally retired by a buyer. This takes an average of 4.5 years, suggesting a combination of lag time between the mitigation and the official issuance of the credit, lag between issuance and final sale, and lag due to buyers deferring retirement for their own internal reasons.

Finally, we looked for patterns in the outstanding buckets of credits from each vintage year (Figure 5). Excluding the early 2000s which saw low volumes, it appears that over the long term most vintage years see ~70-80% of their credits retired, with 20-30% remaining outstanding even after the 4.5-year lag time. The high percentage of credits generated recently (over the last five years) that are still outstanding (not yet retired) is likely to go down as more credits are sold, but older vintages are likely to retain a pool of outstanding credits, much of which are locked up in insurance buffer pools.

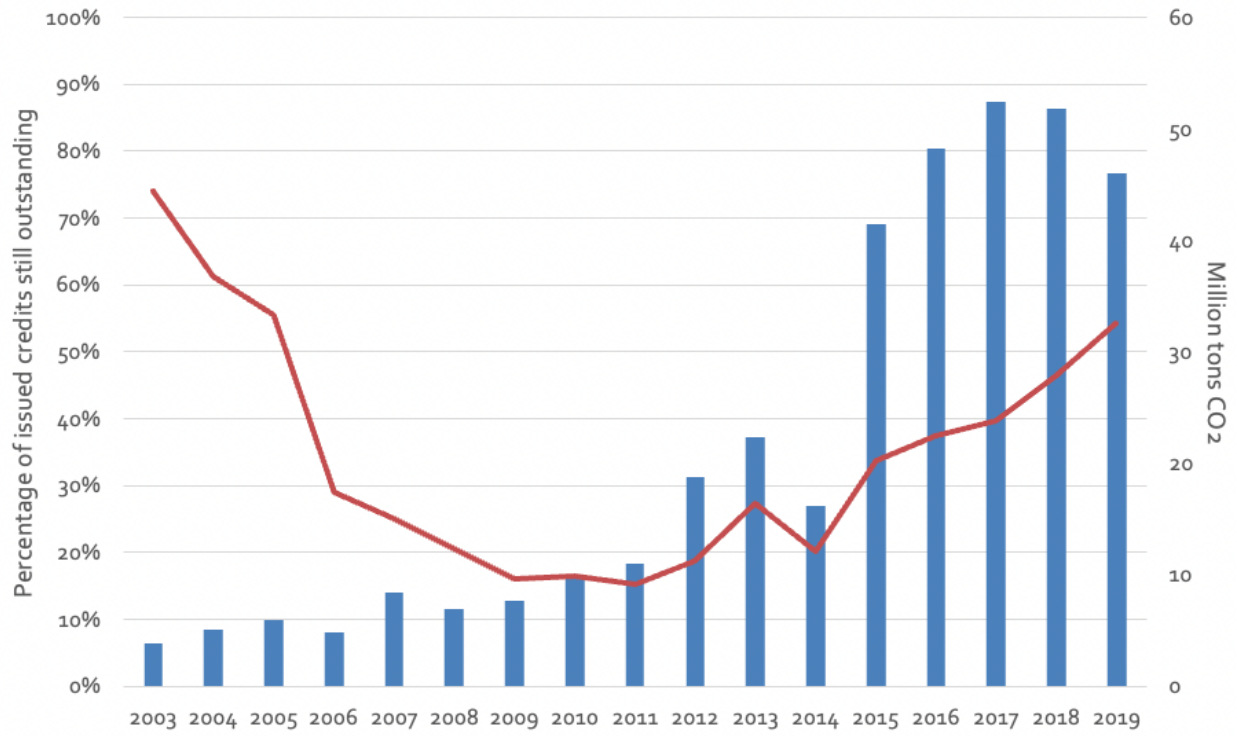

Figure 5 - Outstanding (not-yet-retired) credits from each vintage year are shown with blue bars. Percentage of credits issued in each year that are still outstanding are shown as percentages (red line).

Future of the Voluntary Carbon Market

The VCM is growing, driven in part by a flurry of corporate activity pursuing climate commitments in the coming decades. In 2019, the VCM was responsible for nearly

two-thirds of total carbon offset credits issued (outpacing compliance markets),[20] and the total volume of transacted carbon offset credits eclipsed 100 million metric tonnes of CO_2e.[21] Some initiatives have made it their goal to scale up the VCM by a factor of 15 over the current decade to satisfy the projected demand surge for carbon offset credits.[22]

However, there remains an urgent need to address the vast majority of low-quality carbon offset credits, which should precede efforts of rapid scale-up to help ensure maximum climate benefits from credit purchases. Failure to do so risks eroding public confidence in the VCM and undermine its ability to deliver effective climate benefits. A commitment to scientifically rigorous standards[23,24] across the VCM is therefore paramount; sound science remains the best defense available to carbon offset credit purchasers. Voluntary payments for high-quality carbon offset credits, including a dedicated focus on carbon removal (as opposed to avoided/reduced emissions) and longer duration carbon storage, can help steer the VCM toward climate outcomes aligned with net zero global emissions.

The authors would like to acknowledge the Berkeley Carbon Trading Project team at the UC Berkeley Goldman School of Public Policy's Environmental Center for their review and contribution in the drafting of this white paper.

[20] Vivid Economics. (2020). An investor guide to negative emissions technologies and the importance of land use. Accessed December 20, 2020 from: https://www.unpri.org/download?ac=11980

[21] Forest Trends' Ecosystem Marketplace. The Only Constant is Change. State of the Voluntary Carbon Markets 2020, Second Installment Featuring Core Carbon & Additional Attributes Offset Prices, Volumes and Insights. Washington DC: Forest Trends Association, December 2020.

[22] Forest Trends' Ecosystem Marketplace. The Only Constant is Change. State of the Voluntary Carbon Markets 2020, Second Installment Featuring Core Carbon & Additional Attributes Offset Prices, Volumes and Insights. Washington DC: Forest Trends Association, December 2020.

[23] Carbon Direct. (2020). 5 Principles for High-Quality Carbon Removal from Nature-Based Climate Solutions. Accessed April 11, 2021 from: https://carbon-direct.com/wp-content/uploads/2021/03/CD-Principles-for-Carbon-Removal.docx.pdf

[24] Allen, M., Axelsson, K., Caldecott, B., Hale, T., Hepburn, C., Hickey, C., Mitchell-Larson, E., Malhi, Y., Otto, F., Seddon, N., & Smith, S. (2020). The Oxford Principles for Net Zero Aligned Carbon Offsetting. University of Oxford. Accessed April 11, 2021 from: https://www.smithschool.ox.ac.uk/publications/reports/Oxford-Offsetting-Principles-2020.pdf