

# Impacts of a Global Food Crisis on Carbon Offset Markets

The difficult challenge of combating hunger and climate change

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# Executive summary

Carbon offsets are one of the many markets that could be impacted by the global food crisis resulting from the Russia-Ukraine war. Increasing food prices and a greater need for domestic agriculture production could lead to small short-term increases in offset prices and major long-term changes. In addition, these changes could cause permanent, irreversible drops in offset supply, shining a light on the quandary between hunger and climate.

- Nature-based solutions, primarily from avoided deforestation and reforestation, make up 42% of cumulative offset supply since 2015 and could make up as much as 99% in 2030 and 87% in 2050, depending on how the market evolves. Offset prices are extra sensitive to any changes to nature-based solutions as a result.
- Offsets from forestry are priced based on opportunity cost, or forgone profits if that land were used for other purposes. Rising food prices and inputs for agriculture, such as fertilizer, will cause farmers to raise prices in order to maintain margins, increasing agriculture opportunity costs. If agriculture revenues increase 45%, equivalent to price rises from the 2008 food crisis, average offset prices will increase to \$16/ton in 2030 and \$73/ton in 2050, compared to \$11/ton and \$47/ton in BloombergNEF's baseline scenario.
- Increased domestic agriculture could also mean more deforestation, causing long-term changes in offset supply and small changes in price. Cutting offset supply from avoided deforestation by 25% would cause average offset prices in 2050 to reach \$51/ton, compared to a baseline scenario of \$47/ton.
- Sustainable agriculture practices, such as agroforestry, could be a silver bullet to increase food production and maintain carbon sequestration levels.

159.3 points

Record average price of UN FAO Food Price Index in March

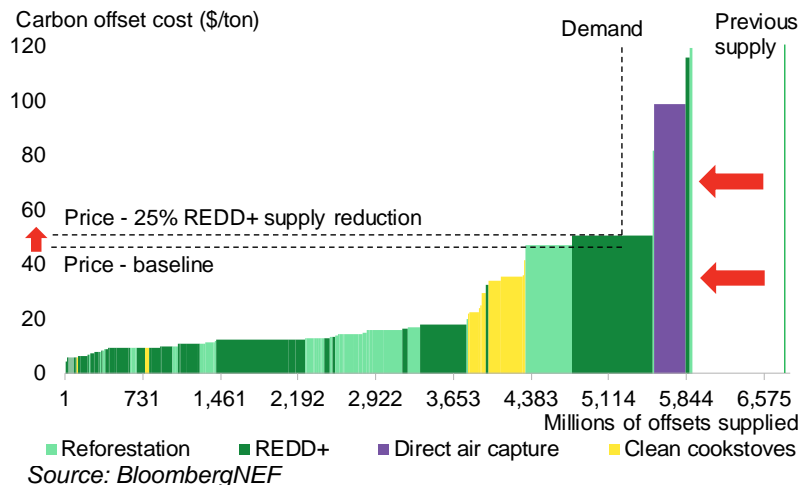
109%

Increase in average offset prices in 2050 if avoided deforestation supply is cut by 50%

93%

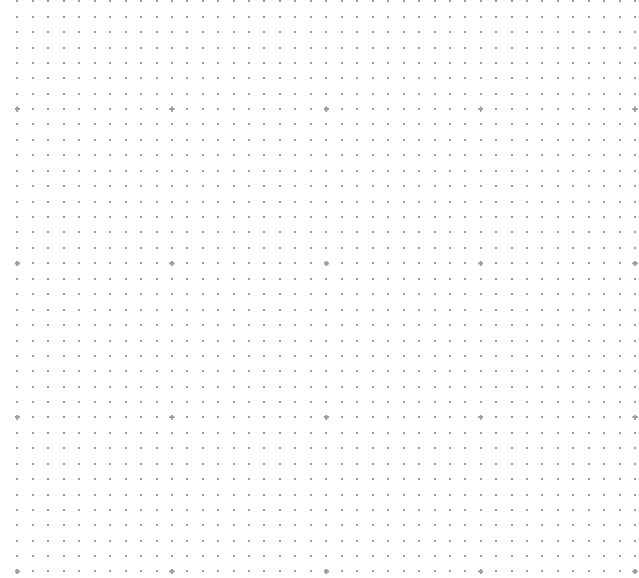
Percent of 2030 offset supply coming from nature-based solutions, based on BNEF's voluntary market scenario

## Offset supply curve in 2050, voluntary market scenario



# Introduction

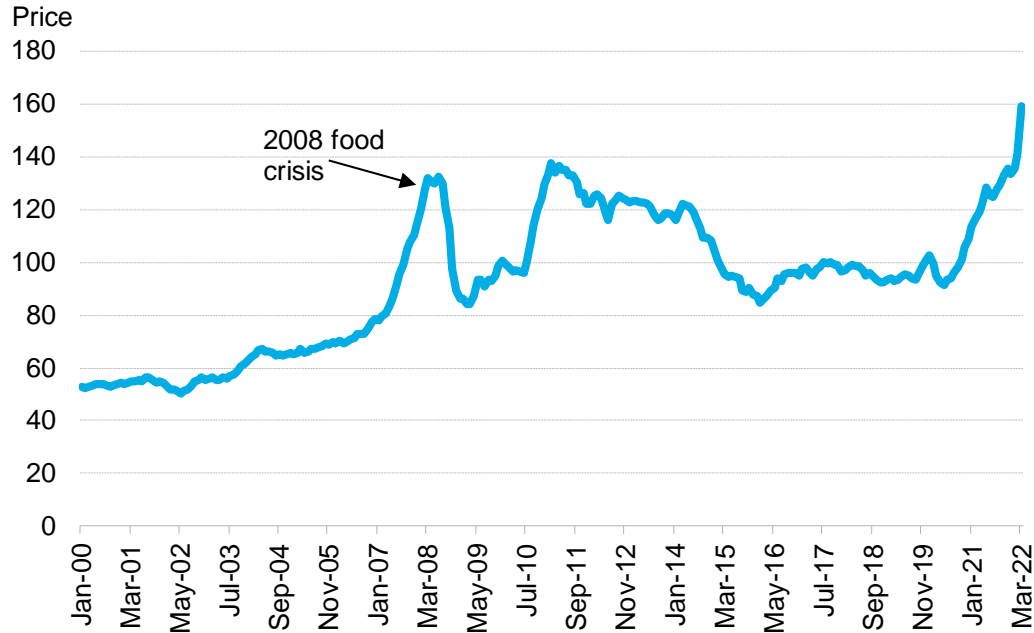
A global food crisis



# We're in a global food crisis and its impacts are wide-ranging

This content was originally presented at the Bloomberg New Economy Climate Council meeting hosted at BloombergNEF's Summit in New York. Learn more about the Climate Council [here](#).

## FAO Food Price Index



Source: BloombergNEF, Bloomberg Terminal, FAOFOODI Index, UN FAO

- The war in Ukraine has choked supply of several key food commodities, with ripple effects felt across the world. The commodity taking the biggest hit is wheat: Russia and Ukraine alone are responsible for 30% of global wheat trade, with the war causing prices to spike to record highs. It also causes other countries to ramp up their domestic supply.
- On top of this, gas prices – a key input in nitrogen-based fertilizer – have risen across the world, hitting 173 euros/MWh in Europe in early 2022. Coupled with sanctions on Russia, a key exporter of fertilizer, fertilizer prices have also reached record highs. This could result in lower yields for farmers due to added operational costs.
- These compounding factors have and will continue to drive up the price of food. The UN Food and Agriculture Organization (FAO) Food Price Index, which tracks international prices of commonly-traded food commodities, is perhaps the best indicator of how fast prices are rising. The index averaged a record 159.3 points in March 2022, up over 33% from March 2021 and 20% from 132 points at the peak of the 2008 food crisis.
- Hits to supply and increases in cost could leave tens of millions of additional people hungry, but a food crisis could also fly in the face of efforts to combat climate change.

# A food crisis could weaken the value of nature-based carbon abatement

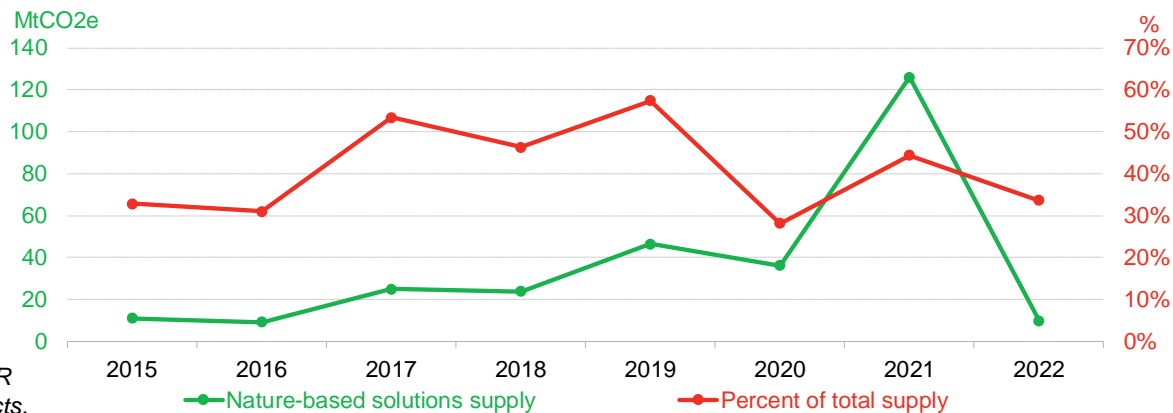
One market very vulnerable to a food crisis is carbon offsets – verified emission reduction credits that can be used by corporations to neutralize their own hard-to-abate emissions. Demand in the carbon offset market is surging as corporations set net-zero targets, most of which will require offsets in order to be achieved. Developers are ramping up supply in response, much of which comes from sectors like avoided deforestation and reforestation – broadly classified as *nature-based solutions*. Supply of nature-based solutions offsets reached a record 126 million in 2021, nearly quadrupling the 36 million issued in 2020. Some 42% of all offset supply since 2015 has come from nature-based solutions, reaching as high as 57% in 2019. Nature-based solutions are perhaps the most critical offset supply source moving forward, but the food crisis could impact them in two primary ways:

- **Lower supply:** Offset supply from avoided deforestation and reforestation depends on conserving and expanding forest. Greater strain on land for food production could mean greater deforestation, or prioritizing land for agriculture instead of expanding forests.
- **Higher prices:** Carbon offsets for nature-based solutions are generally priced based on their opportunity cost – or the potential loss/gain in revenue if that plot of land is used for something else. For forestry, the opportunity cost is typically the foregone revenue that could come from agriculture. Greater food and input costs will have farmers charging more for crops, meaning increased costs for offsets.

As offsets become a more critical part of decarbonization strategies for corporations, their goals could be directly at odds with food security.

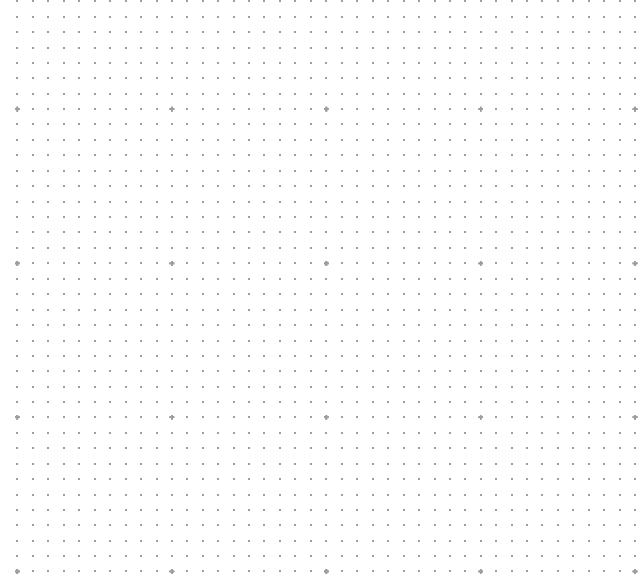
Source: BloombergNEF, VCS, Gold Standard, CAR, ACR  
Note: Chart only shows supply from verified, listed projects.

### Nature-based offset issuance and percent of total market supply



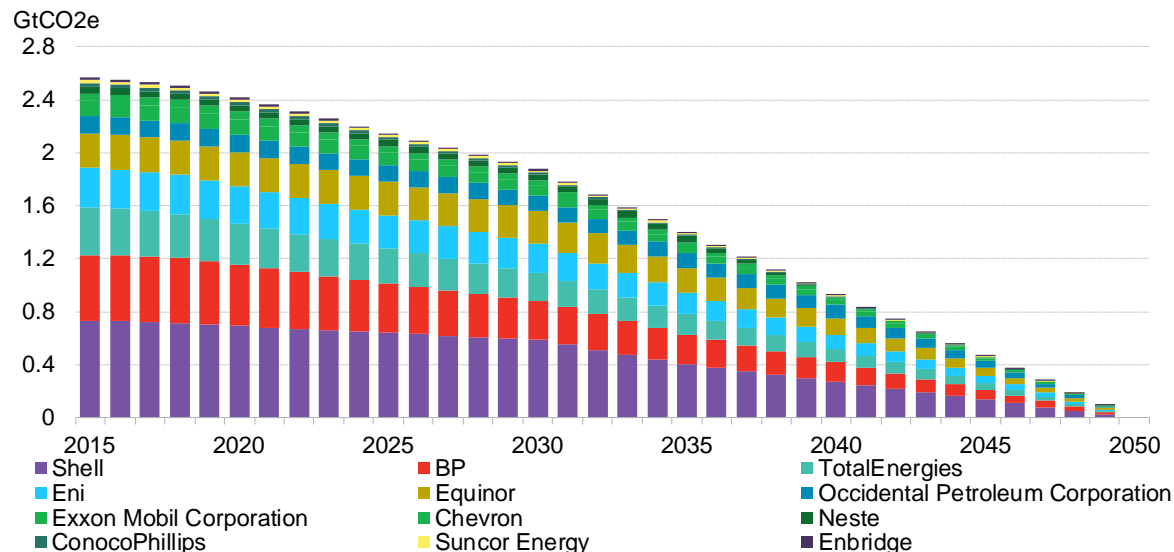
# Carbon offsets today

A Renaissance moment



# Net-zero targets call for dramatic carbon reductions

## Net-zero targets by select oil majors

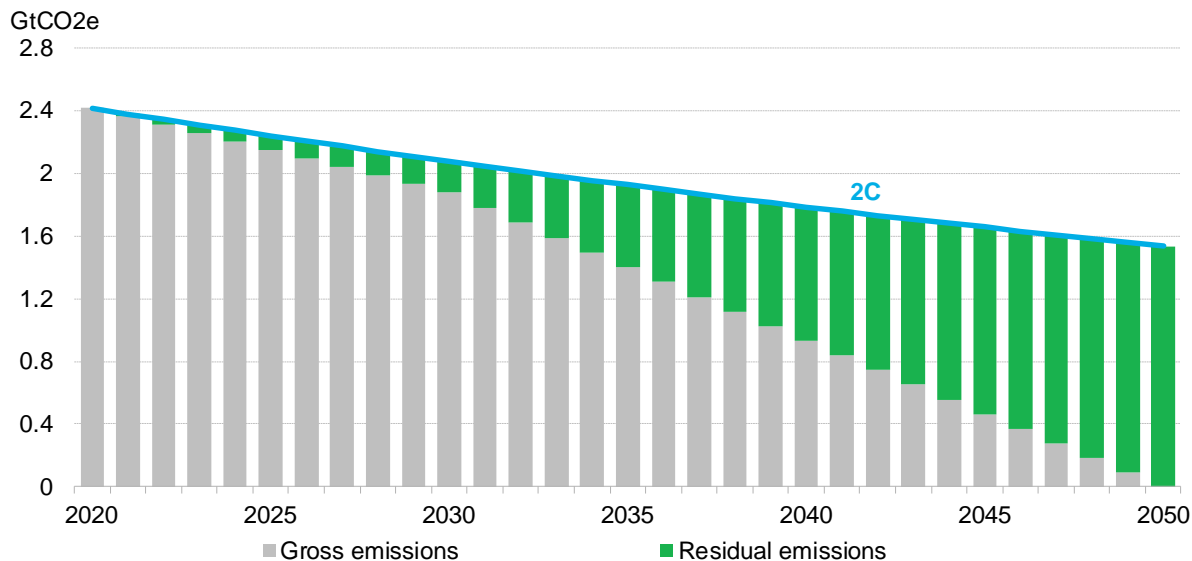


- Every day, new corporations are setting net-zero targets, pledging to fully reduce and/or offset their emissions at a level equivalent to what they emit. BNEF estimates that 123 of the 167 focus companies in the Climate Action 100+ – companies estimated to be the world’s heaviest emitting that are facing investor pressure to decarbonize – now have a net-zero target or equivalent.
- The impact of these targets is huge. The 12 largest North American and European oil majors to set net-zero goals will collectively need to reduce their emissions by 10.6 billion metric tons of carbon dioxide equivalent (GtCO<sub>2</sub>e) in 2050, from a 2015 base year. This is equivalent to 10% of global carbon emissions today.
- Every net-zero target is different. Pledges vary by factors like their target year (most often 2050), whether they have interim goals and what scope emissions are included (e.g. Scope 1 and 2 vs. Scope 3). These nuances make comparing targets across companies very difficult, let alone sectors and geographies. See our *Corporate Net-Zero Assessment Tool* for more on these nuances ([web | terminal](#)).

Source: BloombergNEF, Bloomberg Terminal, company filings Note: Chart only includes emissions covered under a net-zero target.

# Even the most aggressive abatement strategies will have residual emissions

## Residual emissions from 2C pathway for select oil majors



- Despite the lack of standardization in net-zero goals, one factor is consistent for every company: it will have *residual emissions* on the road to net zero. These are any remaining emissions a company has once it does everything it can to reduce its own *gross emissions*, or actual emissions prior to offsetting.
- Residual emissions are most often identified as the gap between a company's gross emissions trajectory and its net zero trajectory, with that gap varying significantly between sectors. For the 12 oil majors visualized on the previous slide, if they reduced their gross emissions on a well-below 2 degrees Celsius pathway – an ambitious trajectory – they would still have 459 million tons of residual emissions in 2050. If they reduced gross emissions on a 2 degrees Celsius pathway, residual emissions would total 1.5GtCO<sub>2</sub>e in 2050.
- It is easy to envision a scenario in which demand for offsets totals several billion tons in 2050, based on the sheer number of net-zero goals set.

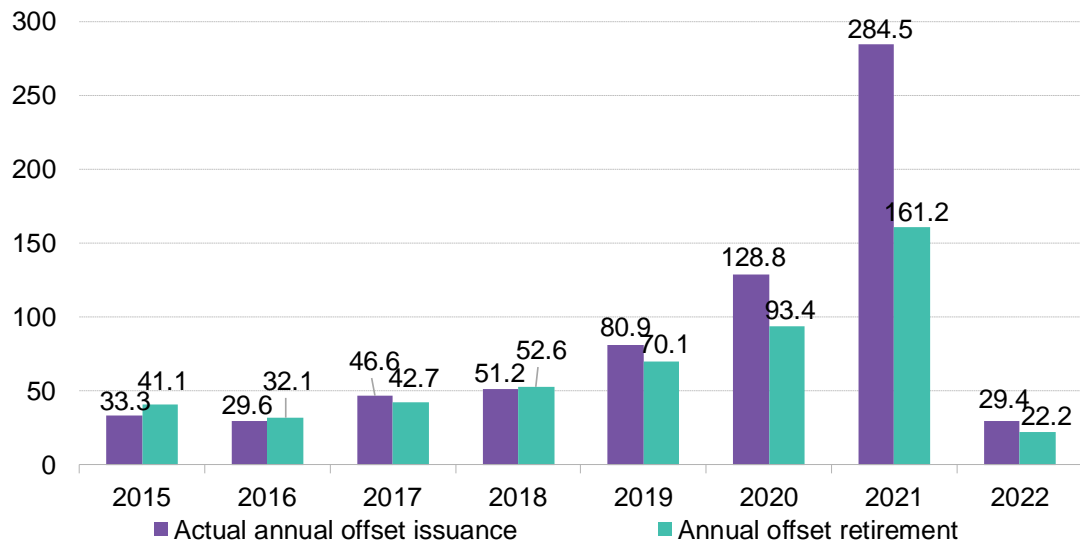
Source: BloombergNEF, Bloomberg Terminal, company filings Note: Chart only includes emissions covered under a net-zero target.



# Carbon offsets are a solution to addressing residual emissions, driving record activity

## Carbon offset issuance and retirements

Millions of offsets



- Growth in the voluntary carbon offset market, which has existed for nearly two decades, was inconsistent historically. Supply (issuances) and demand (retirements) of credits both dropped between 2015 and 2016.
- Due to the stream of net-zero targets and growing pool of residual emissions, the voluntary carbon offset market is surging, however. A record 161.2 million offsets were retired by corporations and other entities around the world in 2021.
- Developers subsequently ramped up supply, with a record 284.5 million offsets issued, or created, by projects listed on the major registries. Many of these projects had been listed on registries for many years but lay dormant with no demand signal until recently.
- The market is poised for another record year in 2022. Through February, 29.4 million offsets have been issued, with 22.2 million retired. See our *Voluntary Carbon Offset Data Viewer* for more on current supply and demand balances ([web](#) | [terminal](#)).
- As the market grows, efforts are taking place to standardize and commoditize it. This will mean some forms of supply will no longer be allowed.

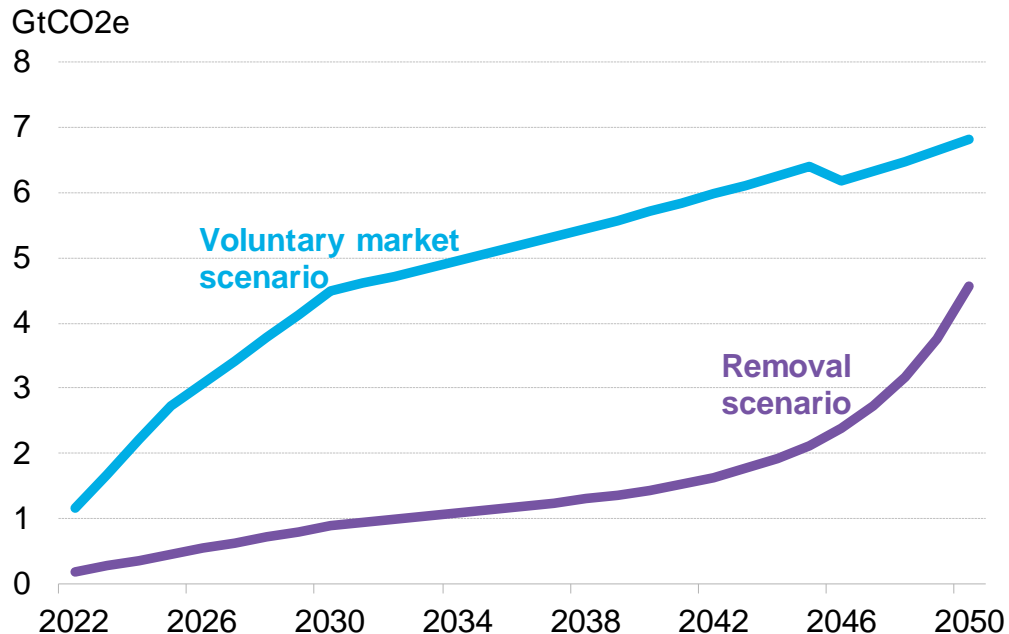
Source: BloombergNEF, Verra, Gold Standard, American Carbon Registry, Climate Action Reserve Note: Chart is subject to change as more data is made available.

# The outsized impact of nature-based solutions on carbon offsets

At odds with a food crisis

# The offset market is going to continue to grow significantly

## Forecasted carbon offset supply, by scenario



Source: BloombergNEF

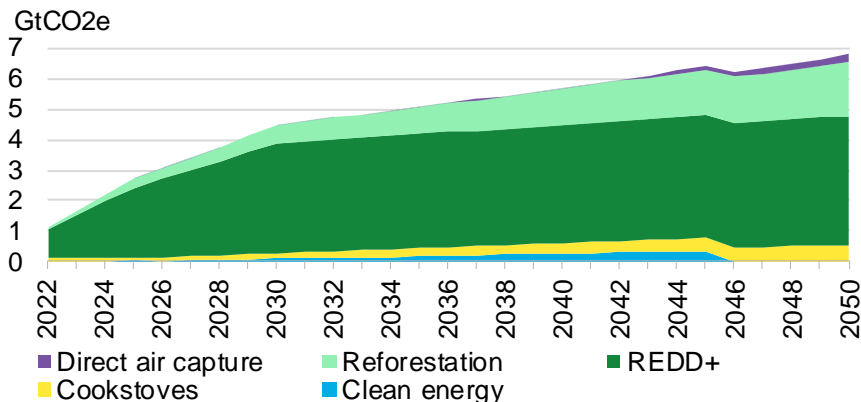
- Supply of carbon offsets is going to need to continue to grow at a significant pace to meet the growing demands of corporations, likely reaching several billion metric tons of carbon dioxide equivalent (GtCO<sub>2</sub>e) in 2050. Not all forms of supply may be allowed, however: efforts are underway to create thresholds around the quality and type of offsets. This will ensure that when companies buy offsets they're making a greater decarbonization impact.
- In its *Long-Term Carbon Offsets Outlook 2022* report, BNEF forecasts supply, demand and prices of offsets out to 2050 under various scenarios ([web](#) | [terminal](#)). Under the *voluntary market scenario*, which assumes all types of supply are permitted in the market, some 6.8 billion offsets, each equivalent to a metric ton of carbon dioxide equivalent, will be created annually by 2050.
- Under the *removal scenario*, companies can only buy carbon offsets that further remove, store or sequester carbon in order to hit their net-zero goals. This guidance was published by the Science Based Targets Initiative in October 2021 as part of its net-zero standard for companies. Sectors that avoid emissions, like clean energy, cookstoves and avoided deforestation, are excluded from this scenario. Supply ultimately reaches 2.8GtCO<sub>2</sub>e in 2050, driven more by technology-based removal.

# Nature-based solutions will have an outsized impact on offset supply

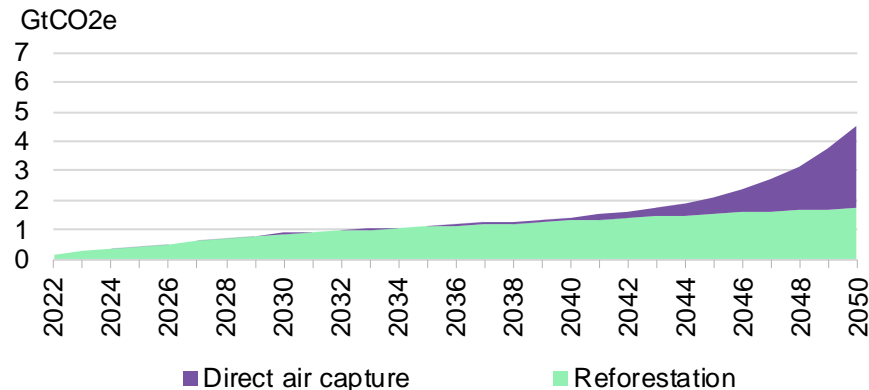
In both the voluntary market scenario and the removal scenario, the prominence of nature-based solutions in the offset supply mix is immediately noticeable. As technologies like clean energy and clean cookstoves come down in cost, the role of offsets, whose revenues are used to make technologies more competitive, will shrink. In both scenarios, clean energy offsets disappear entirely by the 2040s as it becomes cheaper to build solar and wind than fossil fuels, for example. Nature-based solutions, which have less financial additionality concerns, will be relied on even more.

Under the voluntary market scenario, BNEF forecasts that avoided deforestation (REDD+) and reforestation – the two key sources of nature-based solutions supply today – will make up 93% of the supply mix in 2030 and 87% in 2050. In the removal scenario, even with no avoided deforestation supply permitted, nature-based solutions will make up 99% of offset supply in 2030 and 39% in 2050. As a result of its dominance in the market, any changes to the cost of carbon for nature-based solutions will have major impacts on the average price of a carbon offset.

## Supply mix in voluntary market scenario



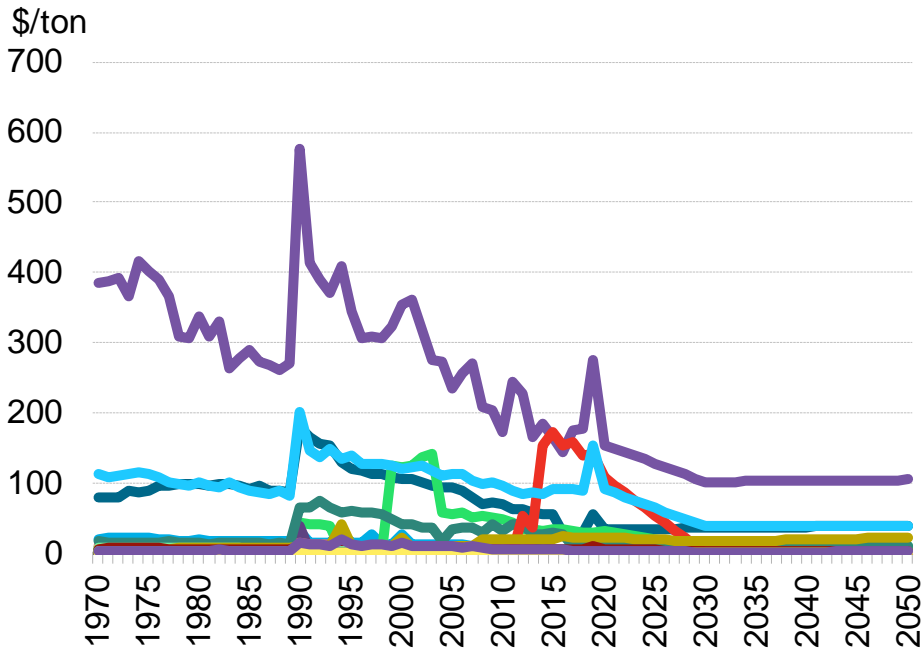
## Supply mix in removal scenario



Source: BloombergNEF Note: REDD+ is avoided deforestation.

# Offset prices for nature-based solutions are directly tied to agriculture revenues

## Agriculture revenues per ton of carbon, by country

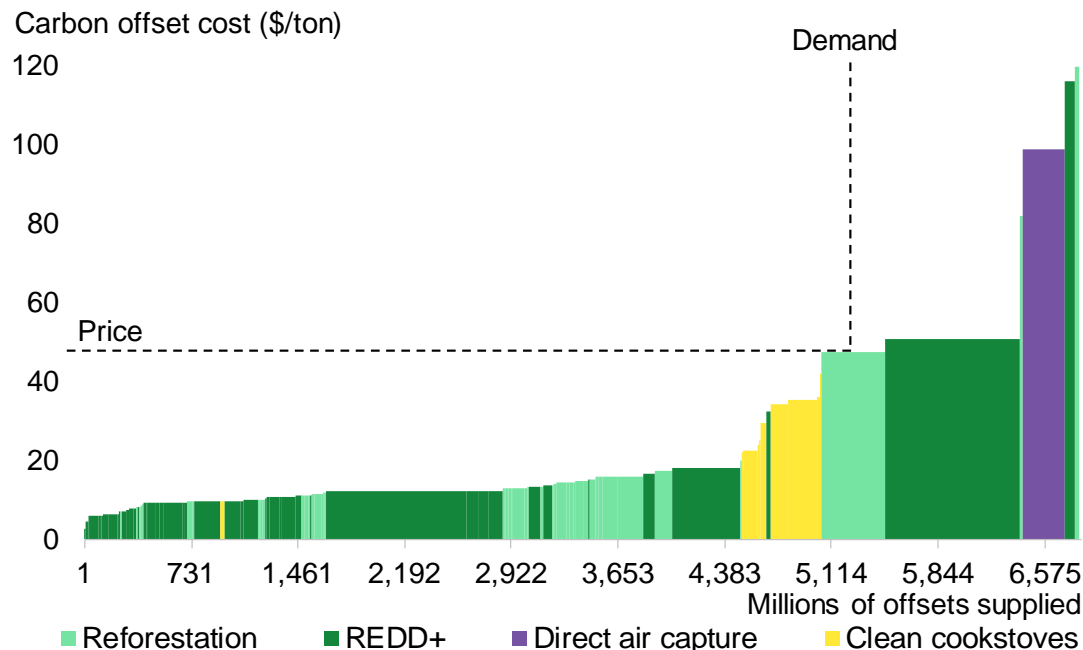


Source: BloombergNEF, UN Food and Agriculture Organization

- While many other types of carbon offsets are priced based on what is needed to bridge the gap between a clean technology and a dirty alternative (e.g. a PV plant and a coal plant), nature-based solutions are typically priced based on three main factors: *opportunity cost*, *operational cost* and *co-benefits*.
- Opportunity costs make up the biggest portion of the revenue stack. This refers to the potential loss/gain in revenue from alternative activities. By conserving or protecting a forest for example, project proponents and other stakeholders are forfeiting potential revenues that could otherwise be generated from that plot of land – namely from agriculture.
- Opportunity costs can range significantly, depending on the country's reliance on agriculture as a key export and the crops it produces. If supply of key crops is curtailed or demand for them goes up, the financial productivity of agriculture increases, which in turn increases opportunity costs and offset costs. Similarly, if key inputs for producing that crop like fertilizer increase in price, farmers will likely need to charge more to maintain margins, increasing revenue.
- Agriculture revenue can be volatile. In Australia, it was \$374 per ton of carbon in 1970 and rose to \$577/ton in 1990, before dropping to \$154/ton in 2020. Other countries have seen similar fluctuations. In general, opportunity costs remain low – of the 71 countries that are part of the UN's REDD+ program, which aims to enhance forest carbon, just 6 saw agriculture revenues greater than \$10/ton in 2020.

# The marginal price of an offset is almost always set by nature-based solutions

## Supply curve in 2050 under the voluntary market scenario



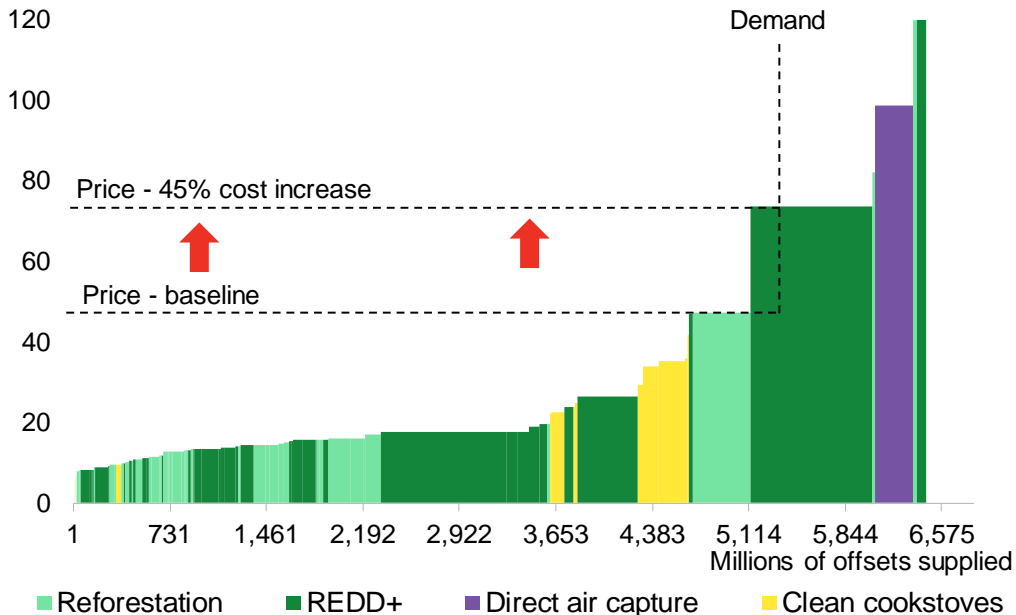
Source: BloombergNEF

- The impacts of these opportunity costs can best be visualized on a supply curve for carbon offsets. Each box on the curve is a type of carbon offset, shown by its cost (height), potential supply (width) and sector (color). Marginal prices are set by the point at which demand intersects with supply. The higher the price of offsets, the more supply there is.
- Two key factors stand out when looking at the supply curve in 2050 under BNEF's voluntary market scenario. The first is the prevalence of nature-based solutions, meaning that the marginal price setter in most years is a project in the avoided deforestation (REDD+) or reforestation sector. In 2050 under the baseline voluntary market scenario, the marginal price is set by reforestation projects in Brazil at \$47/ton, for example.
- The second factor is the disparity between cheaper and more costly offsets. Nearly two thirds of offset supply in 2050 is forecast to cost less than \$20/ton, with the remain third quickly accelerating from \$40 to \$120/ton. This means that the faster demand grows, or supply shrinks, the faster the marginal price each year increases.

# A food crisis could increase the cost of carbon

## Supply curve in 2050 under the voluntary market scenario

Carbon offset cost (\$/ton)

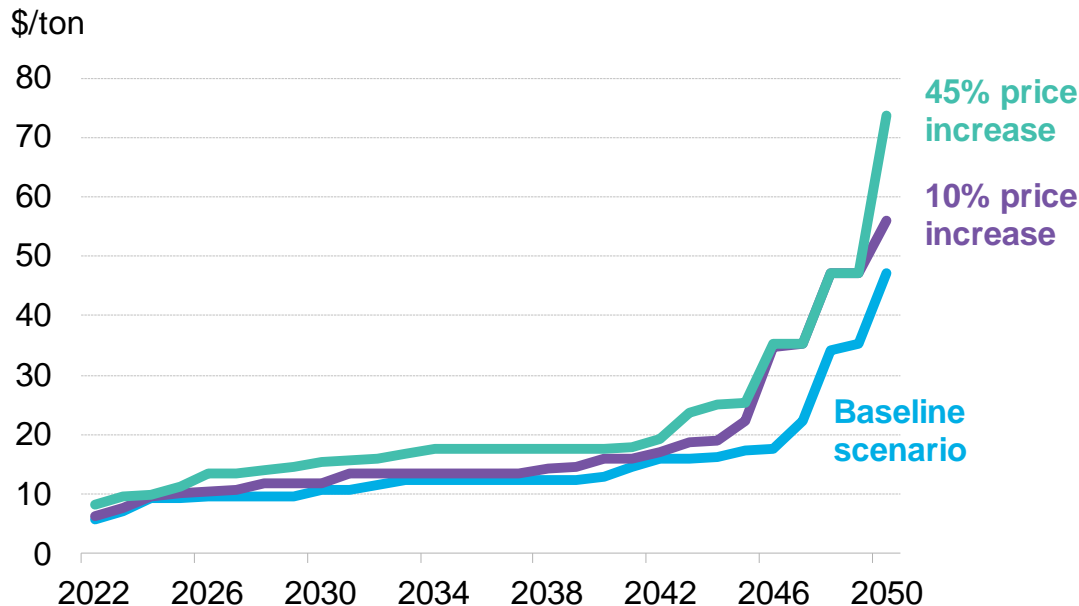


Source: BloombergNEF

- Less supply of food from key markets like Russia and Ukraine will cause demand for food from remaining key exporters to rise, in turn driving up revenues from agriculture. In addition, the war in Ukraine is also causing gas prices, a key input in fertilizer, to increase. Farmers will need to sell food at a higher price to maintain their existing margins.
- The impact is higher opportunity costs for forestry and land use, meaning offset costs go up. These are likely to be felt less in the near term when demand is only big enough to eat into the cheapest supply available – much of which is more leveled. The changes in price will be more drastic long term as demand starts to intersect with steeper parts of the supply curve.
- If we increase the cost of carbon from avoided deforestation by 45% – equivalent to the increase seen in the UN FAO Food Price Index during the 2008 food crisis – the impacts in early years are small. Average prices rise to \$16/ton in 2030, up from \$11/ton in our baseline forecast. The price increases long term are much more noticeable; the average price of a carbon offset increases from \$47/ton in our baseline scenario in 2050 to \$73/ton. The marginal price setter is avoided deforestation projects in Brazil.

# Leading to moderate offset price increases in the near and long term

## Average carbon offset prices, by scenario



- Tweaking our assumptions in our *Long-Term Carbon Offset Outlook* shows that increased costs for nature-based offsets will have smaller impact in the near term and bigger impact long term on average offset prices.
- If we increase the cost of carbon for avoided deforestation offsets by 10%, it will increase average offset prices to just \$12/ton in 2030, up from \$11/ton in our baseline voluntary market scenario. Average prices would reach \$56/ton in 2050 with a rally in prices starting in 2045 – a few years ahead of our baseline scenario.
- Increasing the cost of carbon for avoided deforestation by 45% would cause prices to increase to \$16/ton in 2030. It would then follow a similar pathway to a 10% increase scenario in the 2040s and ultimately shoot up to \$74/ton in 2050.
- While these changes are not significant enough to reshape the offset market, they are an important reminder of its sensitivity to external factors that may not seem directly relevant.

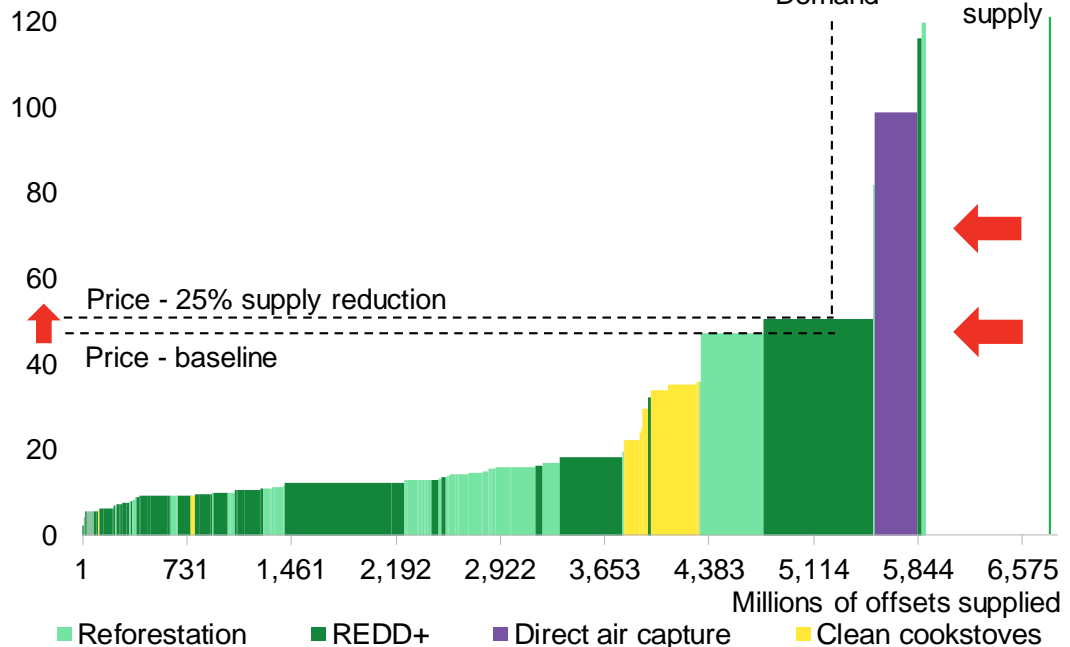
Source: BloombergNEF



# A food crisis could also shorten the supply curve

## Supply curve in 2050 under the voluntary market scenario

Carbon offset cost (\$/ton)

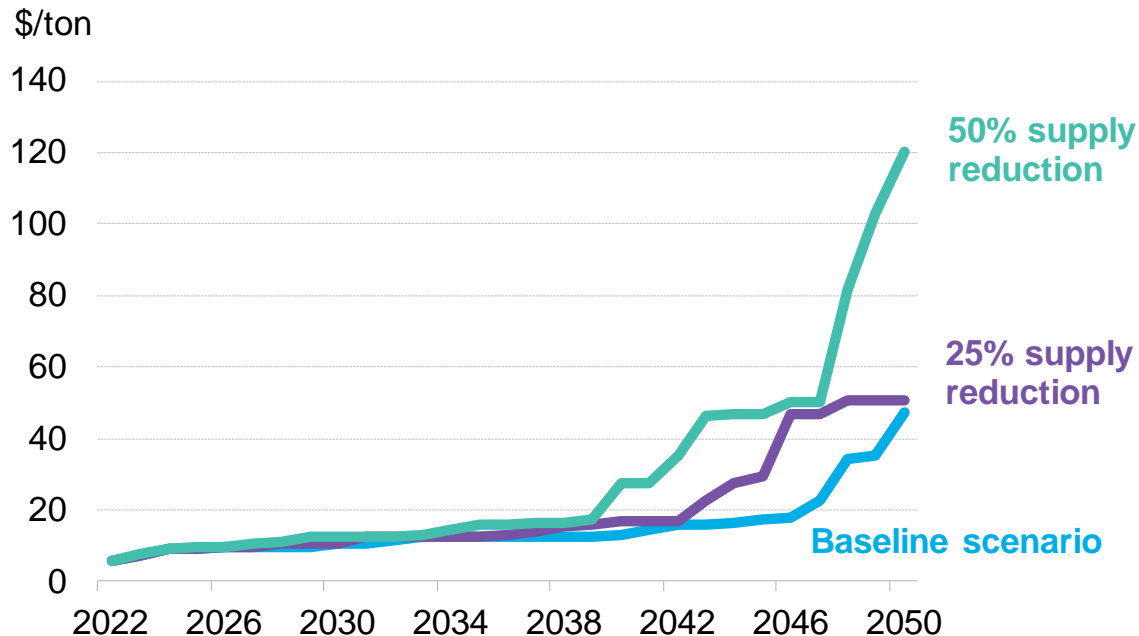


Source: BloombergNEF

- Beyond higher commodity prices, a food crisis could have impacts on supply. Should countries need to ramp up domestic food production of commodities like wheat in the absence of key exporters like Russia and Ukraine, they will require more land. This could lead to increased deforestation for agricultural use, often at the expense of forests being protected through monetizing carbon offsets.
- Deforestation also has long-term consequences. Contrary to other supply sources, where the benefits of offsets can be realized quickly or instantaneously, it can take decades for seedlings to turn into mature forests that can create offsets. Countries cutting down at-risk forests for short-term food production compromise long-term carbon sequestration and permanence. This creates a difficult dilemma between tackling food security and climate change.
- Such an outcome would shorten the offset supply curve, meaning prices of offsets are more sensitive to changes in demand. Cutting offset supply from avoided deforestation by 25% would cause average offset prices in 2050 in the voluntary market scenario to reach \$51/ton, with the marginal price set by avoided deforestation projects in Brazil. More dramatic cuts to supply would cause average prices to rise even further.

# Less supply would have little near-term effect, but significant long-term impact on pricing

## Average carbon offset prices, by scenario

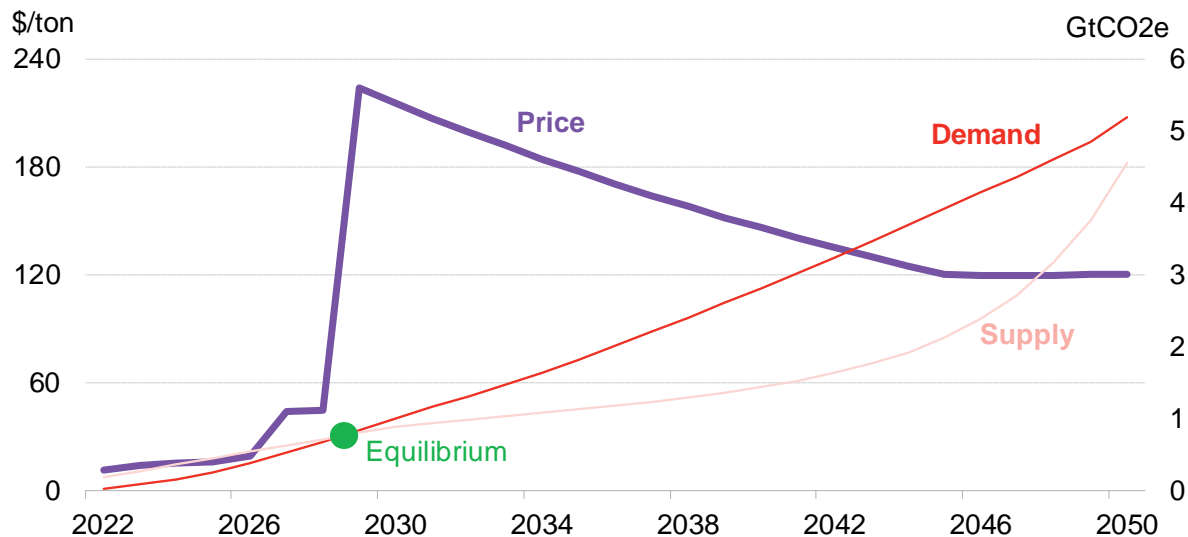


Source: BloombergNEF

- Tweaking our assumptions in our *Long-Term Carbon Offset Outlook* shows that the impacts of reduced offset supply from avoided deforestation would lead to insignificant impacts on carbon offset prices in the near term, but sizable changes long term.
- If we reduce offset supply from avoided deforestation by 25%, it will keep average offset prices at \$11/ton, the same as our baseline voluntary market scenario. Average prices would reach \$51/ton in 2050 – this is up slightly from \$47/ton in our baseline scenario, but the price rally would come sooner. In 2046, average prices are more than three times higher than our baseline scenario, at \$47/ton.
- A 50% reduction in supply would similarly have minimal short-term impact, but average prices would nearly triple to \$120/ton in 2050.
- Such changes, while illustrative, show the impact of a global food crisis on offset supply and in turn prices.

# An offset market without nature-based solutions is one that struggles to exist

## Supply, demand and prices in the removal scenario

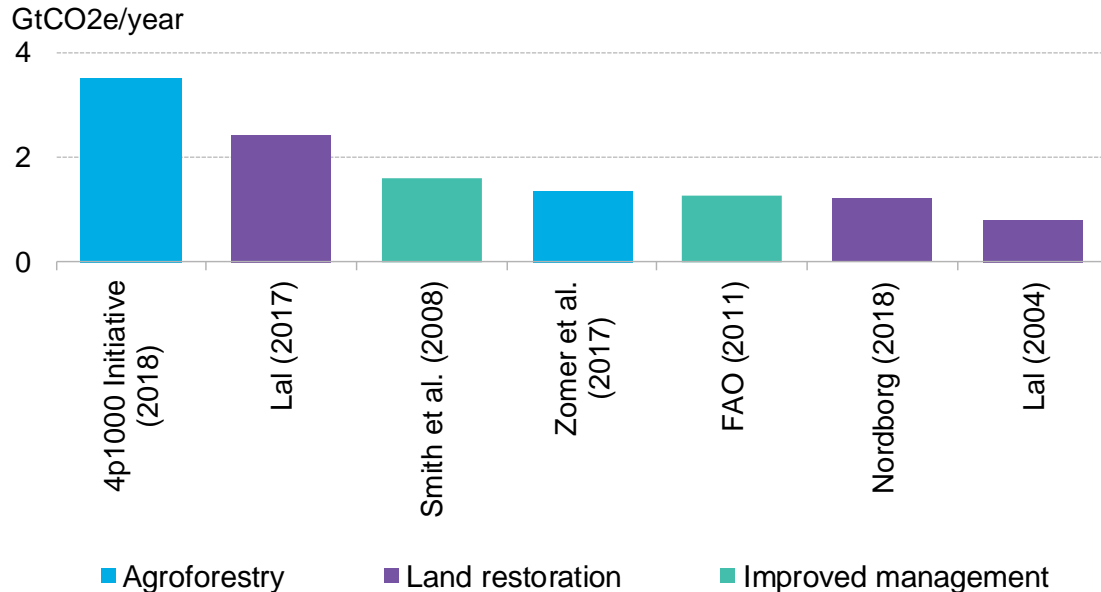


Source: BloombergNEF Note: The scenario above only considers fundamental offset demand to achieve a net-zero target. Avoidance offsets would still be permitted for companies to use outside of their own value chain.

- All nature-based solutions, including those from projects that avoid emissions (avoided deforestation) and remove them (reforestation), will be required to properly scale up the offset market. Removing nature-based offset supply from the equation means the market will likely never have enough supply to meet all demand from corporations setting net-zero goals.
- This was a key finding from the removal scenario in BNEF's *Long-Term Offsets Outlook 2022*. If companies are only allowed to use removal offsets in order to achieve their net-zero goals, the market will be undersupplied beginning in 2029, meaning the marginal price of offsets will be set by direct air capture – the most expensive supply source on the supply curve. This will cause average prices to skyrocket to over \$220/ton in 2030, pricing most companies out of the market and hurting liquidity.
- It's possible that even more significant, permanent supply shortages as a result of a global food crisis could push offset prices to unsustainably high levels, compromising the ability of corporations to use it as a decarbonization mechanism.

# Sustainable agriculture could simultaneously address hunger and climate change

## Global technical soil carbon sequestration potential across different studies



- One potential silver bullet to simultaneously address food security and climate change is to use more sustainable agriculture. Practices like regenerative agriculture, enhanced agricultural management, conservation tillage, mulching and agroforestry can maintain carbon sequestration levels while still producing food. These practices can also yield immediate offset creation, compared to reforestation projects that may take decades.
- Some of these practices can potentially create billions of carbon offsets annually. A report from the [4p1000 initiative](#) says that carbon abatement from agroforestry could be as high as 3.5GtCO<sub>2</sub>e annually. Another study from [Smith et al.](#) estimates improved management of agriculture could lead to 1.6GtCO<sub>2</sub>e of additional carbon sequestration.
- Companies like Nori are working to incentivize farmers to adopt regenerative agriculture practices through the monetization of offsets.
- See our report *Advancing Agriculture: Regenerative Farming* for more on the sequestration potential from more sustainable agriculture practices ([web](#) | [terminal](#)).

Source: BloombergNEF, various academic studies

# There are also impacts on broader energy markets and natural resources

Beyond carbon markets, food and energy are often in direct competition, meaning a global food crisis will have far-reaching impacts. Some of the impacted sectors include:

- **Clean energy development:** Utility-scale solar and wind farms require significant amount of land to generate power. Similar to avoided deforestation, this often comes at the expense of land that can be used for agriculture. It is likely some projects will get delayed or even canceled due to a lack of available land.
- **Water resources:** Agriculture production is highly dependent on water. Countries with high drought risk could face major water constraints as they try to ramp up domestic food production while still meeting rising demand from urban populations and various industrial sectors.
- **Non-food crops:** Crops used for industrial purposes or producing goods for manufacturing, such as cotton or fiber, could be de-prioritized in favor of food crops in the immediate term, causing supply to drop and prices to rise.
- **Biofuels:** Many key food crops are also used in the production of biofuels. For example, vegetable oil is a key input for biodiesel production. Corn is also a key input in ethanol. Rising food prices will cause biodiesel suppliers to ramp up prices.

## Sweden's Biggest Solar Park Blocked on Risks to Food Supply

- European Energy's planned 168MW solar site thrown into doubt
- Local county says farm land for food outweighs energy needs

By [Jesper Starn](#)

April 28, 2022, 6:47 AM EDT Updated on April 28, 2022, 7:55 AM EDT

Plans for Sweden's biggest solar park have been thrown into doubt after a local county rejected the application on grounds the land would be better used to help maintain the nation's food supply.

Privately-owned [European Energy A/S](#) had hoped to build a 168 megawatt site on pasture in Svedberga, Southern Sweden. But the Skane County Administrative Board ruled that the planned solar panels would limit the agricultural use of the land.

Source: [BloombergNEF](#)

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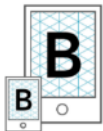
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