

Carbon Offsets

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1. Introduction

I have been trying to make my posts shorter recently. One way of doing this is to reference previous posts (via links), and limit any repetition. I've written (at least) a couple of prior posts on subjects close to that covered in this one. These are:

- (1) Part 2 of the series "The Path to Net-Zero"
<https://www.energycentral.com/c/cp/path-net-zero-%E2%80%93-part-2>
- (2) NUTS
<https://www.energycentral.com/c/cp/nuts>

In section 3.12 of the first post I cover California's Cap and Trade system. In that, we review offsets (offset credits), which are an important part of this program.

In Section 3 of the second post we briefly look at an important source of offsets (forests) and explore the differences between woody biomass (for energy production) and carbon capture by permanently preserved forests.

In this paper we will explore carbon offsets much more deeply.

2. Carbon Offsets

It is generally agreed that a carbon offset (or offset credit) is a reduction in emissions of carbon dioxide or other greenhouse gases made in order to compensate for emissions made elsewhere.¹ It is also generally agreed that an offset credit represents a greenhouse gas (GHG) reduction or GHG removal enhancement of one metric ton of CO₂e (CO₂ equivalent). The last statement is from the California Cap and Trade Program (CCTP), but it seems to be in agreement with other systems.

The above seems simple enough, but like most things, the devil is in the details. Adding some more of these details (again from CCTP), an offset credit must represent a GHG emission reduction or GHG removal enhancement project that is real, additional, quantifiable, permanent, verifiable, and enforceable. The credits are assigned on a project basis. GHG removal (from the atmosphere or emission source) might use forestation, sequestration, destruction (of the GHG) or conversion of a strong GHG (typically methane) to a weaker one (typically CO₂). Entities regulated under CCTP can use offsets to cover up to 8% of their compliance obligations.

The subsections below will define types of offsets and give examples of projects of each type. This is in lieu of going into gory details about offsets.

2.1. Forestation or Reforestation

A long-lived tree is the perfect carbon-capture and sequestration (CCS) machine. It builds itself out of water, CO₂, and nutrients from the soil. It is powered by solar energy.

¹ Wikipedia article on "Carbon offset", https://en.wikipedia.org/wiki/Carbon_offset

Perhaps the only better CCS machine is a forest that is managed to maximize the carbon stored in the trees and soil.

Given the above there is no doubt that that a forestation project is "... *real, additional, quantifiable, permanent...*" which only leaves "...*verifiable, and enforceable.*" The CCTP identifies two types of forestation project compliance offset protocols:

- U.S. Forest Projects Compliance Offset Protocol²
- Urban Forest Projects Compliance Offset Protocol³

The specific project that really got my attention was the project described below, and more thoroughly by the article referenced at the end of this paragraph. This was certified under the first bullet's protocol above. This is a project created by an agreement where BP Alaska developed two carbon credit offset projects with Alaska Native corporations Ahtna and Sealaska. The Native corporations have agreed to maintain the forests they manage for at least 100 years.⁴

The world-wide market for forest-related offsets has three to four categories:

- Avoided deforestation is the protection of existing forests.
- Reforestation is the process of restoring forests on land that was once forested.
- Afforestation is the process of creating forests on land that was previously not forested, typically for longer than a generation.
- Soil management projects attempt to preserve or increase the amount of carbon sequestered in soil.

Note that the last category may or may not be related to forests.

2.2. Livestock Projects

Livestock projects, specific to the CCTP "Livestock Projects Compliance Offset Protocol"⁵ involves treating livestock manure to convert all methane evolved from this manure to biogas and burn this gas, thus converting the methane to CO₂. It's the "burning" part that is interesting. The protocol allows the following three types of burning: "...*on-site, transported for off-site use (e.g. through gas distribution or transmission pipeline), or used to power vehicles.*" Transmission through a gas distribution or transmission pipeline requires conversion to biomethane. "*Biomethane is produced by purification of biogas to a composition that meets the specifications of a pipeline transmission system. In other words it's not significantly different in composition than any*

² See California Air Resources Board, " Compliance Offset Protocol U.S. Forest Offset Projects", https://www.arb.ca.gov/cc/capandtrade/protocols/usforest/usforestprojects_2014.htm

³ See California Air Resources Board, " Compliance Offset Protocol, Urban Forest Projects", <https://www.arb.ca.gov/regact/2010/capandtrade10/copurbanforestfin.pdf>

⁴ Elizabeth Harball, Alaska's Energy Desk, Capital Community Broadcasting, Inc., "Native corporations maintaining Alaska forests find a carbon credit buyer: oil company BP", January 18, 2019, <https://www.ktoo.org/2019/01/18/native-corporations-maintaining-alaska-forests-find-a-carbon-credit-buyer-oil-company-bp/>

⁵ California Air Resources Board, " Compliance Offset Protocol Livestock Projects", <https://www.arb.ca.gov/cc/capandtrade/protocols/livestock/livestock.htm>

other 'natural gas'." This text is from an earlier post linked below, Section 2.2. Refer to this for additional information.

<https://www.energycentral.com/c/pip/alternatives-alternative-energy>

Also note that the process used to convert manure to biogas (digestion) is mentioned in section 2.1 of the above-linked paper. This process, per the offset protocol, is "*anaerobic manure treatment*".

Specific Project: The Climate Trust Capital's Fund I will invest \$862,000 in a covered lagoon digester that will destroy methane and produce carbon offsets under the above described protocol. The investment is based on the anticipated 10-year value of carbon credits from a livestock digester project located at West-Star North Dairy, a 1,500-acre farm in California's San Joaquin Valley. Project partner, California Bioenergy LLC (CalBio) has built three other dairy digester projects, including the state's largest, with many more scheduled for development. This project investment started generating carbon offsets in January 2018 with initial cash flow from the sale of these offsets in 2019.⁶

The West-Star North digester will treat the manure by installing CalBio's patented dairy digester design—excavating two new lagoons in the process—and then covering the lagoons with a flexible, high-density polyethylene cover. Captured methane will be stored and then combusted in a high-efficiency generator that delivers renewable electricity to Pacific Gas and Electric. In addition, the digester will be double lined and enhance ground-water protection. Effluent from the digester will be used to irrigate fields and will also be part of a USDA drip irrigation study.

2.3. Ozone Depleting Substances

Ozone Depleting Substances (ODS) are a shorthand for CFCs and HCFCs, which are in-turn a shorthand for chlorofluorocarbons and hydrofluorocarbons. Don't worry, I'll stick to ODS. As their abbreviation might suggest, they tend to migrate into the upper atmosphere, decompose yielding monoatomic chlorine, which tends to destroy the ozone layer. Thus since 1987 the Montreal Protocol called for drastic reductions in the production of CFCs.

CFC's are some of the strongest greenhouse gasses, with a Global Warming Potential (GWP) in the range of hundreds to thousands of times stronger than CO₂.⁷ Also ODS have a very long lifetime (over 100 years) in the atmosphere. Thus there are two good reasons to destroy as much ODS that we reasonably can before it escapes to the atmosphere.

So how and where can we do this? Per the: "*Ozone Depleting Substance Compliance Offset Protocol*", the following are approved sources for removing and destroying the ODS.⁸

⁶ AGDAILY, "The Climate Trust invests in first livestock digester project", Sep 21, 2017, <https://www.agdaily.com/news/climate-trusts-invests-digester/>

⁷ U.S. EPA, "Understanding Global Warming Potentials", <https://www.epa.gov/ghgemissions/understanding-global-warming-potentials>

⁸ CARB, "Ozone Depleting Substance Compliance Offset Protocol", 2014, <https://www.arb.ca.gov/regact/2014/capandtrade14/ctodsprotocol.pdf>

- Refrigerants from industrial, commercial or residential equipment, systems, and appliances or stockpiles;
- ODS blowing agents extracted and concentrated from appliance foams; or
- Intact foam sourced from building insulation

Specific Project: That old refrigerator you had out in the garage cooling your beer on the Fourth of July? It could be leaking ODS – and probably should be taken out of commission. In fact, many ancient refrigerators using the gas are being dismantled, with the help of the above protocol.⁹

These old refrigerators often end up at Appliance Recycling Centers of America's (ARCA) Compton, California facility. The Compton facility is the base of the company's appliance recycling and energy efficiency contracts with major utilities such as Southern California Edison, for which the facility has recycled more than one million refrigerators over 21 years, as well as Los Angeles Department of Water and Power and San Diego Gas and Electric. When customers of these utilities call to take advantage of recycling or appliance exchange incentive programs offered by the utilities, ARCA staff travel to their homes to retrieve these old appliances and transport them to Compton.



Where old refrigerators go to die

ARCA's Compton facility specifically is responsible for the creation of about 25,000 carbon offsets per year, said Derek Six, Chief Executive Officer of project developer Environmental Credit Corp (ECC), which works with materials sourced from ARCA to generate carbon offsets. R-12 from appliances stripped in Compton is shipped to Philadelphia, Pennsylvania where it is aggregated with R-12 (a.k.a. CFC-12) from other ARCA recycling facilities across the United States, he said. The materials are then cleaned, tested, and weighed before being sent for destruction at an ARB-approved destruction facility in Bowling Green, Ohio.

⁹ Gloria Gonzalez, Ecosystem Marketplace, " From Icebox To Offset: Destroying Ozone Depleting Substances, With The Help Of The Carbon Markets", July 13, 2015, <http://www.ecosystemmarketplace.com/articles/icebox-offset-destroying-ozone-depleting-substances-help-carbon-markets/>

2.4. Mine Methane Capture

Many mines have fugitive methane emissions. That is, methane emissions that occur in the mine and as a result of the mining operation. These are potentially lethal to miners and also represent a fire and/or explosion risk. Historically, the method for dealing with these were with ventilation systems, but these vented the methane to the atmosphere. Instead, mine methane capture projects capture and convert methane from selected (U.S. coal and trona) mines to CO₂. The protocol description for this is referenced at the end of this paragraph.¹⁰

I found a very good presentation from CARB and the EPA on this protocol and related projects which I will use in the information below. This is referenced and linked at the end of this paragraph.¹¹

The purpose of the mine methane capture protocol is to quantify GHG emission reductions associated with the capture and conversion of methane that would otherwise be vented into the atmosphere as a result of mining operations at:

- Active underground coal and trona mines
- Active surface coal and trona mines
- Abandoned underground coal mines

There are four eligible project activity-sources:

- Active underground mine ventilation air methane
- Active underground mine methane drainage
- Active surface mine methane drainage
- Abandoned underground mine methane recovery

Methane drainage refers to using boreholes and pipes to drain methane from coal seams ahead of mining operations.

Offset Project Operator must have the legal authority to implement the project and be either:

- Mine operator
- Entity that owns or leases the equipment used to capture or destroy mine methane

Early action volunteer offset credits (see next section) could be switched to CARB compliance offset credits if the projects achieved verified greenhouse gas emission reductions between January 1, 2005 and December 31, 2014. CARB has approved three Early Action Offset Programs and Offset Project Registries:

¹⁰ California Air Resources Board, "Compliance Offset Protocol, Mine Methane Capture Projects", 2014, <https://www.arb.ca.gov/regact/2013/capandtrade13/ctmmcprotocol.pdf>

¹¹ Jessica Bede, CARB, " Compliance Offset Protocol Mine Methane Capture Projects", 2014, https://www.epa.gov/sites/production/files/2016-03/documents/2014uscmm_bede.pdf

American Carbon Registry (ACR)
<http://americancarbonregistry.org>

Climate Action Reserve (The Reserve)
<http://www.climateactionreserve.org>

Verified Carbon Standard (VCS)
<http://www.v-c-s.org>

The project that I identified (described below) was an early action offset project that was certified under VCS. It is unknown whether the project operator converted the volunteer offsets to CARB compliance offsets.

The project identified was methane capture and use project at the North Antelope Rochelle Coal Mine Complex near Gillette, Wyoming. The Project consists of the collection and injection of the methane into a natural gas transmission pipeline. This methane would have otherwise been released into the atmosphere.¹²

2.5. Rice Cultivation

Rice paddies are one of the largest man-made sources of methane, and rice is the world's second-most produced staple crop. Rice is also a major crop for California, which produces more than 2 million tons of rice, making it the second largest rice growing state in the nation, thus the most recent CARB Compliance Offset Protocol for Rice Cultivation Projects was developed.¹³

Together, higher carbon dioxide concentrations and warmer temperatures predicted for the end of this century could double the amount of methane emitted per kilo of rice produced. Because global demand for rice will increase further with a growing world population, without additional measures the total methane emissions from rice agriculture will strongly increase.¹⁴

Several options are available to reduce methane emissions from rice agriculture. For instance, management practices such as mid-season drainage and using alternative fertilizers have been shown to reduce methane emissions from rice paddies. By switching to more heat-tolerant rice cultivars and by adjusting sowing dates, yield declines due to temperature increases can largely be prevented, reducing the effect of warming on methane emissions per yield.

Three activities are specified by the above offset protocol:

- **Dry Seeding Activities:** This protocol applies to rice cultivation projects that sow seeds into a dry or moist, but not flooded, seedbed by drilling or broadcasting seeds onto rice fields, resulting in the reduction of methane that would otherwise be released into the atmosphere if the seeds were wet-seeded.

¹² First Environment, Inc., "Verification Report for the Coal Mine Methane Capture and Use Project at The North Antelope Rochelle Coal Mine Complex" (Note: enter the title of this report into your search engine of choice, and it should provide a link to the download.)

¹³ CARB, "Compliance Offset Protocol, Rice Cultivation Projects", 2015,
<https://www.arb.ca.gov/cc/capandtrade/protocols/rice/riceprotocol2015.pdf>

¹⁴ Sylvia Wright, UC Davis, "Rice agriculture accelerates greenhouse gas emissions", 2012,
<https://www.ucdavis.edu/news/rice-agriculture-accelerates-greenhouse-gas-emissions>

- **Early Drainage in Preparation for Harvest Activities:** This protocol applies to rice cultivation projects that drain or dry standing water, while the soil is still saturated, from rice fields earlier during the rice growing season in preparation for harvest, resulting in the reduction of methane that would otherwise be released into the atmosphere if the rice fields were drained or dried on the customary date.
- **Alternate Wetting and Drying Activities:** This protocol applies to rice cultivation projects that cyclically wet and dry the rice fields during the growing season to reduce methane emissions that would otherwise be released into the atmosphere if the project employed continuous flooding.

The rice cultivation project used for this paper was the initial demonstration project that provided the justification for this compliance offset protocol: *Demonstrating GHG Emission Reductions in California and Mid-south Rice Production Conservation Innovation Grant (CIG)*. This demonstration took place from 2011-2015. CIG partners used the results from a previous Conservation Innovation Grant and efforts by the Environmental Defense Fund (EDF) and Winrock International to establish the feasibility for greenhouse gas (GHG) emissions-reducing practice implementation in the California and Mid-south rice-growing regions.¹⁵

As of the writing of the above referenced report, the California carbon credit project with four California producers representing 5,389 acres and the potential for 5,445 tons of carbon credits between 2012 and 2016 is undergoing the final stages of verification.

From the referenced analysis, it is believed that there is a potential for reductions in methane emissions from changing rice cultivation practices in California and the Mid-south. It is clear that rice farmers, and eventually other crop farmers have great potential to reduce GHG emissions and create carbon offsets.

2.6. Offset Verification Program

CARB accredits Offset Verification Verifiers (individuals), and Offset Verification Bodies (companies). Lists of these (Excel spreadsheets) are linked from the web page linked below, along with information on each individual or company.

<https://www.arb.ca.gov/cc/capandtrade/offsets/verification/verification.htm>

3. Voluntary Market

Before the California Cap and Trade Program (with its offset credits) started, there were other cap and trade programs (most notably in Europe), and also a set of voluntary offset protocols. The subscribers to voluntary protocols were typically large corporations that wished to demonstrate to their customers and other supporters that they were doing everything reasonably possible to mitigate climate change.

These markets were supported by a set of voluntary offset project registries and verification firms. Three of these are listed in subsection 2.4 above (after the seventh paragraph). These efforts served as a training-ground for developing a robust set of project criteria and verification standards. In addition to the registries listed in section

¹⁵ "Final Report, Demonstrating GHG Emission Reductions in California and Midsouth Rice Production", July 31, 2015, https://www.edf.org/sites/default/files/report_usda-cig-emission-reductions.pdf

2.4, the following are a few more registries and offset project consultants (in no particular order):

NativeEnergy

<https://nativeenergy.com/>

Green-e

<https://www.green-e.org/>

International Carbon Bank and Exchange

<http://www.icbe.com/0.asp>