# Feasibility of Greenhouse Gas Emissions Offsets at Petroleum Release Sites

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**Background/Objectives.** Recent advances in petroleum site characterization have identified natural source zone depletion (NSZD) as an ongoing process that can assist in achieving risk reduction for human and ecological receptors. This source depletion tends to occur as some combination of subsurface hydrocarbon volatilization, methanogenesis, and oxidation to carbon dioxide. The resulting carbon dioxide (and in some cases, methane) emissions at ground surface serve as one indicator of remedial progress. However, they are also an indication of greenhouse gas (GHG) emissions to the atmosphere. This presentation will make a case for offsetting these GHG emissions with renewable energy generation on the contaminated site's footprint.

**Approach/Activities.** Remediation and GHG offset of an example petroleum release site is considered. The example site is a 30 m by 30 m footprint and light non-aqueous phase liquid (LNAPL) smear zone thickness of 0.8 m. The estimated long-term GHG emissions from the contaminant is based on a mass estimate of hydrocarbons in place and the ratio of long-term $CH_4$ to $CO_2$ emissions due to biodegradation of hydrocarbons. This comprises the projected lifetime GHG footprint of the pollutant. Renewable energy is estimated using solar energy by a photovoltaic (PV) system and life cycle emissions offsets for this technology. The feasibility for offsets is scaled to the footprint of the example site and the cost is estimated.

**Results/Lessons Learned.** Estimated LNAPL in the formation for this example site is 110,000 liters, with a corresponding GHG emissions of 290 metric tons $CO_2$ equivalent. Remediation is capable of decreasing the emissions to approximately 260 metric tons $CO_2$ equivalent by converting a small $CH_4$ emissions to $CO_2$ emissions via passive bioventing. The PV system is capable of achieving a life cycle offset of 350 g $CO_2$ eq / kWh versus natural gas as the baseline grid energy source. Individual PV panels are 270 watts operating at 300 kWh/year for 25 years. These values correspond to a required 99 solar panels, comprising 162 $m^2$ or 20% of the site footprint. This indicates that the renewable energy offset is feasible and allows for the rest of the facility to be used for remediation purposes and later redevelopment. The estimated cost of the system is approximately $85,000 baseline and $60,000 with low-end value for tax credit. This cost is considerably less than that typical for remediation of a site with these characteristics and suggests an opportunity for cost savings if the renewable energy offset is tied to decreased late-stage site remediation.