

The Need for Negative Emissions and Direct Capture from Air

Klaus S. Lackner

February 2015

Carbon dioxide once emitted to the atmosphere moves readily between ocean, atmosphere and biosphere, but it remains in the combined reservoir for many thousand years. Roughly half of the carbon dioxide will be in the atmosphere for centuries. This matters, because carbon dioxide is a potent greenhouse gas and its steady accumulation poses ever-larger risks of harmful climate change. Stopping the rise in carbon dioxide concentration at any level demands a long-term transition to a net zero carbon economy. Net zero may not be enough; the last IPCC report suggests that the world has waited too long before curtailing emissions, and that staying away from dangerous climate conditions now requires net negative emissions for a large part of this century. This calls for technologies that can remove carbon dioxide from air and a storage capacity for spent fossil carbon that is sufficient to safely and permanently dispose past emissions. The low concentration of carbon dioxide in air makes it difficult to transfer existing gas separation technology from industrial applications to air capture. Capture by biomass is feasible but ultimately limited by available land. I will discuss why novel direct air capture technologies have the potential for affordable implementations. Our own approach uses humidity changes to allow sorption of carbon dioxide on a sorbent in the dry state and release in the wet state. The process is fast, reversible and efficient in terms of cost and energy. A wind driven, passive capture device collecting one ton of carbon dioxide per day could fit into a standard shipping container. Even when using coal energy for its operation, it would produce negative emissions. Scaling up to operation comparable to current emissions is challenging but well within the capacity of human industrial infrastructures.