Reversing Climate Change within a Generation – The Pivotal Role of Algae

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Our pursuit of a better life, enabled by the discovery of fire, agriculture, and fossil fuels, gave us modern civilization. It also gave us climate change. We can reverse climate change and improve the quality of life on earth using proven technologies and practices – all of which can be brought to scale by 2040 – that *reduce* CO_2 emissions to zero and *remove* CO_2 from the atmosphere.

All demand for electricity in 2040 can be satisfied by renewables. Renewable electricity is already cheaper and more energy efficient than fossil fuels – that's why it's winning in the marketplace. By 2030, most energy storage systems will deliver energy at $0.05-$0.10/kWh, which is competitive with fossil fuels. That solves the grid continuity problem. Emissions fall to near zero.

By 2040 microalgae could provide all the biofuels we need – *plus* all the animal feed protein, and all of the world's vegetable oil. Microalgae are grown on barren land. Without freshwater. No herbicides, no pesticides, no agricultural wastewater. No deforestation required. We would need just 7% the Sahara Desert. We need liquid transport fuels for aircraft, ships and trucks. This challenge is *not* solved by conventional bioenergy crops. The deforestation needed to make cropland for biofuels will release much more CO_2 than fossil fuels. Instead, by using microalgae, the 2.8 million km^2 of cropland now used to produce biofuels, animal feed and vegetable oil - 18% of total cropland - becomes reforested. The reforestation will *remove* >8 billion tonnes (GT) CO_2 per year.

By converting to renewable heat sources - solar for water and space heating, heat pumps for residential heating, advanced stoves for cooking, biogas and hydrogen for both residential and industrial use – we trim CO_2 emissions more than 80%. Anaerobic digestion of macroalgae, mass-cultured on <1 million km^2 of barren land, can supply all the methane needed for industrial use.

Surprisingly, the total emissions from agriculture and forestry could actually be negative. Meaning that instead of an *input* of 10 GT CO_2 to the atmosphere we'll be *removing* it at the rate of 4 GT per year. This is due to the effect of reforestation of cropland, abandoned for algae production to replace animal feed, vegetable oil and biofuels.

By 2040, the emissions from landfills, wastewater, cement production, and refrigerants will decrease by 70% - all due to technologies and practices that are already cutting our emissions. Overall, by 2040, we will have decreased our emissions to just 5% of what they were in 2010.

The best technology for removing CO_2 from the air is called a forest. By 2040, reforestation, together with direct air capture, biochar, and microalgae production can remove up to 23 GT of CO_2 per year. That would get us back to pre-Industrial Revolution levels of atmospheric CO_2 within less than 100 years.

Algae play a pivotal role. Algal transport fuels enable us to reduce CO_2 emissions by 13 GT per year. Algal biomethane for heat enables another 5 GT. Global energy investment in 2017 was $1.7 trillion, or 2.3% of global GDP. Only $20 billion was invested in renewable transport and heat. It's time we turn the tables. *Algae alone could reduce global GHG emissions by 40%.* That seems worth the investment of $1 trillion per year for the next 20 years.

What can you do? Take Personal, Community, Business or Regional Actions. The consequences of your actions are immediate – act now!