Book Ten Technologies to Save the Planet

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Recommendation

The geographical characteristics of an area dictate which renewable energy sources will work best. Because renewable energy is inherently, though predictably, intermittent, governments will need to build supplementary systems. Basically, no single technology will answer all of the world's needs. However, a "portfolio" of technologies should do the trick. Businessman and climate change expert Chris Goodall describes 10 technologies in intricate detail, from the well-known to the obscure, and explains clearly which will work where, and why. Each technology has the potential to reduce the world's annual carbon dioxide output by 10%. Although quite technical, *BooksInShort* recommends this book to businesspeople, plant managers, home owners and others who value social responsibility and sustainability.

Take-Aways

- Renewable energy will mitigate climate change, as prices continue to drop and global understanding of today's unsustainable energy situation grows.
- Until the price of alternative fuels becomes competitive with petroleum, governments must encourage innovation, rapid adoption and reduction of carbon emissions.
- Developed countries will need to spend 5% more annually on energy for the next ten years to halt climate change.
- Different climates require different portfolios of renewable technologies.
- Wind, solar and wave energy will gain prominence as their technologies improve.
- Better insulated, more airtight homes will lower emissions and save on heating bills.
- Transition to electric-powered cars is inevitable.
- Industries will use carbon capture and storage (CCS) technology, which traps carbon emissions underground, only when governments give them an incentive to do so.
- Simple technologies such as burning wood to create charcoal hold promise for sequestering carbon and slowing forest destruction.
- Improving land usage will help the world meet its fuel and food needs.

Summary

Light at the End of the Tunnel

Although the prospect of slowing global warming sometimes seems hopeless, the world in fact has the ability to build low-carbon economies with lower energy prices. However, renewable technologies are in their infancies and will require lots of capitalization to fulfill their potential. Until the price of alternative fuels becomes competitive with petroleum, governments must encourage innovation, rapid adoption and reduction of carbon emissions. Halting climate change would require developed countries to spend an additional 5% annually on energy for about the next decade. However, there is no one-size-fits-all solution. Each country has different energy needs. Countries should mix-and-match from the following 10 technologies to mitigate their individual carbon footprints:

1. “Capturing the Wind”

Despite price spikes in 2006-2007 for turbine materials and a temporary inability to fulfill an overwhelming worldwide demand, wind power looks set to deliver decreasing costs in the near future. It already attracts plenty of investment and turns a profit. It is approaching cost competitiveness with traditional energy generation, not including subsidies, which enhance its attractiveness. If countries installed turbines on every optimal spot on the earth, wind could provide thirty times the world’s energy needs. And once you construct the turbines, wind energy is virtually free.

> “Once we have got over the humps in the road, everybody will wonder why we took so long to switch to pollution-free, easy-to-maintain, super-efficient battery cars.”

Wind is not consistent, so matching the output of coal-fired power plants requires thousands of turbines. But “microgeneration” of energy using small wind turbines lacks important economies of scale. Rooftop turbines can capture only a fraction of the energy that a commercial-scale turbine can. However, the new “vertical axis wind turbine” can take better advantage of urban wind conditions and will make microgeneration more attractive. The device plus installation costs around $5,000 and can generate about half the electricity required for the average European house (but much less for an average American house). Community wind farms would pay for themselves in half the time microgeneration would.

> “Simply put, 600 million cars are competing with six billion people for the products of the land.”

Offshore turbines minimize aesthetic and environmental objections associated with wind power generation, but they pose challenging engineering problems, including the manufacture of parts that are sturdy enough to withstand rough conditions at sea. Whether their power potential will outweigh their initial cost is unknown. Wind is predictable enough to provide reliable energy. Using “better electricity grids, greater energy storage and load shedding,” providers can compensate for variations in wind levels.

2. “Solar Energy”

Each day, the Earth receives enough sunlight to generate 7,000 times more power than the daily consumption of fossil fuels. Solar power offers the best long-term value for emerging economies in warm climates.

> “One of wind’s primary but underestimated virtues is that it delivers electricity without...financial volatility. The output of a wind farm may be uncertain, but the cost is not.”

Photovoltaic (PV) cells made of highly purified silicon convert sunlight to electricity. The efficiency and cost of PV solar generation has improved, but problems remain. Recently the price of refined silicon shot up. This should subside once more refineries come on line. Demand for solar energy is still high, as many governments offer subsidies, but taxpayers will not support this technology forever. PV manufacturers are racing to develop PV cells that will achieve “grid parity” and rival the current costs of fossil fuel. Some companies are working to increase the efficiency of PV panels, which at best convert about 20% of the energy that hits them. Other companies, like NanoSolar, are betting on “printing” large volumes of nanoengineered PV materials, which are easy and cheap to mass manufacture. Both approaches will slash prices. Maintenance costs for PV cells are negligible, but PV cell design is proprietary, which may hamper the speed of deployment.

> “Solar energy is likely to be the best way of balancing wind supply...because of the inverse relationship between the amount of wind energy available and the strength of the sun.”

“Concentrated solar thermal power” (CSP) is a promising large-scale solar technology. Sunlight boils water, which causes steam turbines to turn and generate electricity. Using CSP, a plant in the Sahara desert could power all of Europe. CSP does not use scarce resources as PV technology does, but it does have drawbacks. It requires a large supply of water in dry regions and the capacity to transmit energy over long distances. The Trans-Mediterranean Renewable Energy Cooperation, which represents investor nations in Europe and the Middle East, believes that both of these challenges are easy to overcome. A bigger barrier may be cultivating the crossborder cooperation necessary to implement such a large project.

3. “Electricity from the Oceans”

“Barrages” are large dam-like contraptions that capture incoming tidal waters and release energy using the force of the outgoing tide. A network of coastal barrages and other tidal collectors could provide stable, continuous electricity, with predictable variations throughout the seasons. However, barrages may cause ecological damage and construction costs are high.

> “Tidal power is concentrated in a small number of areas, but wave power is widely spread around the globe.”

Underwater turbines can capture tidal energy using technology similar to that of wind turbines. Engineers have designed the turbine rotors to move slowly so they don’t damage sea creatures, and tidal collectors on a sea bed are less environmentally intrusive than barrages. Transmitting the power from underwater turbines is a challenge, as sea beds are remotely located, and even more problematic is the worldwide shortage of ships capable of doing industrial deep-sea work. Sea power is strong and predictable, but the technology to capture it is nascent, and venture capitalists are unwilling to invest in untried technology. Fortunately, governments are subsidizing the development of ocean power, and the private sector is also making some progress.

4. “Combined Heat and Power”

At best, fossil fuel-based energy plants convert about 60% of the energy they burn to electricity. The remainder escapes as heat in what companies consider to be a wasteful by-product. But, what if a power station could transmit this heat to meet the warming needs for nearby homes? This is the idea behind the combined heat and power system: Small, microgeneration plants would produce electricity on-site and capture the waste heat energy with fuel cells, which neighboring houses could use.

> “The amount of energy Britons use to drive their cars each day is eight or ten times the caloric value of the food they eat. In the U.S., the multiple is about

twentyfold."

One Australian company, Ceramic Fuel Cells, builds "home power plants" that use solid-oxide ceramic core batteries. These extract about 50% of the energy from natural gas as electricity and reutilize the heat, thus making use of about 85% of the original energy. However, the system is very expensive and parts require frequent replacement. Ceramic Fuel Cells sells its units to energy providers, which lease them to customers.

5. "Superefficient Homes"

Lots of energy goes into managing the temperatures of interior spaces. In fact, this may be the top emitter of damaging greenhouse gases. People now waste much of the energy they use to control their interior climates because of inefficient design. "Passivhaus" principles of airtight construction with forced-air ventilation underpins most new advances in eco-friendly architecture. A Passivhaus requires no heating in cold climates and little air conditioning in hot ones. However, Passivhaus construction has some drawbacks: Passivhauses are so airtight that, with windows closed, residents cannot hear any outside sounds. In the winter, the air becomes very dry because of the combined effects of the ventilation system and the building's airtightness. Some designs rely on electricity for supplemental heat, which adds more in terms of carbon dioxide emissions to the air than oil or gas. A Passivhaus can cost more to construct because of the extra insulation it requires, but it returns savings year after year.

"Biodiesel from algae involves few, if any, of the problems of biofuels made from foodstuffs."

The U.K. has legislated a "zero-carbon" standard for 2016, meaning that homes will have to balance any emissions with renewable sources. This will require even more airtightness and insulation than Passivhaus standards. The extra carbon savings may not be worth the substantial construction-cost increase; upgrading existing structures to reduce emissions is probably a more efficient use of money. Simply installing "foil-faced insulation" can reduce heat loss by 30% and block heat in the summer. Germany, in contrast to the U.K., encourages the renovation of existing structures as part of its overall approach to mitigating climate change.

6. "Electric Cars"

Hydrogen-fueled cars are unlikely to emerge as the automobiles of the future because they would require an entirely new infrastructure. Biofuels look like they will not significantly reduce emissions, no matter how efficient engines become. Electric motors can work at 80% efficiency, compared to the internal combustion engine's 30%. Thus, the shift to all-electric cars is inevitable. The simplicity of an all-electric design means vehicles will be light-weight and low-maintenance. Lithium-ion batteries will give electric vehicles greater range, although lithium supplies could become a problem. Nanotechnology could significantly reduce charging time, although not battery weight.

7. "Motor Fuels from Cellulose"

Most of the world's machines run on petroleum, a liquid fuel. While switching to battery power requires retooling motor vehicles, ethanol or diesel fuel is usable right now, with no need to replace the internal combustion engines most machines rely on. The trouble is, whether you're talking about corn and sugar to make ethanol or rapeseed, or palm oil to make diesel, biofuels compete with food for agricultural lands and ultimately cause more ecological and economic harm than good. However, improving land usage and extracting ethanol from agricultural wastes and fast-growing cellulosic materials such as switchgrass, hold promise.

8. "Capturing Carbon"

Although the world should strive to use renewable fuels, the cheapest and most abundant fuel on earth is coal. Coal-powered plants will be a reality for a while, even though they emit a large volume of carbon dioxide. Thus, carbon capture and storage (CCS), which traps gas underground, is an important technology. The ability to filter carbon dioxide and transport it over distances is already in place. However, without a high carbon tax to discourage companies from emitting carbon dioxide, they have no financial incentive to use this technology.

"Arresting the loss of trees may be the cheapest of all techniques for carbon capture and will also improve the long-term ability of the world to feed itself and support its rural populations."

Another cheap way to capture carbon is through "biofixation," using algae to synthesize carbon dioxide into useful byproducts. Global Research Technologies in Arizona has developed a plastic that extracts carbon dioxide from the air. Primarily targeting commercial horticultural use, this method may eventually rival other methods for efficiency and costs.

9. "Biochar"

Another simple way of "sequestering" carbon is to burn wood to create charcoal, which people then return to the soil as a fertilizer. Fuel-efficient stoves that burn wood and produce biochar would diminish the amount of wood people cut down for fuel in developing countries, while improving crop yields. The technology is so simple that no large international corporation has figured out how to profit from it. Therefore, biochar stoves are underfunded. The best way to develop this technology seems to be to organize and compensate experts in poor countries to create and bury biochar. This solution also would boost the local economies of less-developed states.

10. "Soil and Forests"

Only half the carbon human activity creates each year ends up in the atmosphere. The world's lands and oceans absorb the rest. However, many scientists believe the Earth's ability to absorb carbon is diminishing. "Zero-till" farming methods that preserve soil integrity and techniques to revive "brittle" rangelands into fertile grasslands would provide the land necessary to meet world demands. Improving cooking methods around the world with solar, biogas and biochar stoves will help protect forests and improve air quality. Sorting out a balance in land use between fuel needs and food needs is a significant challenge. As the world's economies grow, so does the demand for farmed meat, and in turn, pressure to cultivate forested lands.

"Sensible taxation policy needs to keep the cost of carbon-based energy high and increasing, whatever the market price of oil or coal."

While all these renewable technologies will become less expensive over time, nuclear power plant construction is growing more expensive. Of all the other good reasons not to invest in nuclear power – including radioactive waste storage and nuclear weapons proliferation – its lack of cost competitiveness is probably the most compelling.

About the Author

Chris Goodall is an expert on climate change issues. He edits the Carbon Commentary Web site and wrote *How to Live a Low-Carbon Life*.
