Mitigating revelations of climate change (14)

By Geoff O'Brien

Accelerated climate change and increasing variability is one of the greatest threats to the international objectives of sustainable development and the Millennium Development Goals (MDGs).

Addressing climate change requires reducing greenhouse gas emissions. These gases retain heat that is radiated from the planet; the greenhouse effect. Without the greenhouse effect the average temperature of the planet would fall to about minus 14 degrees Celsius.

Life would not be sustainable. We are increasing the concentration of greenhouse gases in the atmosphere and warming the planet. A sharp rise in the average global temperature could lead to catastrophic consequences.

The international community is trying to find ways of reducing or mitigating the emission of greenhouse gases through the United Nations Framework Convention on Climate Change (UNFCCC). Progress has been slow!

The problem is that energy is so fundamental to our lives (the production of electricity, fuels for transport, cooking, heating, industry and commerce, etc.) and most of the energy we use, some 87 percent, is produced from fossil fuels.

Fossil fuel use produces carbon dioxide, a greenhouse gas. We are emitting huge amounts of that gas (and other greenhouse gases) into the atmosphere. The concentration of carbon dioxide has risen from 280 parts per million (ppm) to about 390 ppm since the Industrial Revolution and is increasing at about 1-2 ppm per year.

The use of fossil fuels is predicted to continue rising. If we are to effectively address the issue of climate change mitigation, then we will have to find ways of reducing their use and deploying low or no carbon technologies. This is an immense challenge.

There are broadly four ways of addressing climate change mitigation; nuclear power, renewable technologies, geo-engineering and efficiency. Each has its associated problems. In short there is no easy answer to the challenge of mitigation. Each of these areas is discussed below.

Nuclear power

Nuclear power production from fission is an established technology. It is not without problems as both Chernobyl and Fukushima have taught us. Recently Germany and Japan have decided to phase out nuclear power, citing safety concerns.

There are other problems: nuclear waste. Nuclear waste is very toxic and has to be safely stored, possibly for thousands of years, until it has decayed to a safe level. Deep underground storage seems to be the preferred option, but we have little experience and this raises concerns.

The uranium needed to make fuel for nuclear reactors could be in short supply. Sir David King, the former U.K. chief scientist, predicts that uranium supplies will begin to run out in 2023 if the current global plans for nuclear power stations are implemented. For the U.K., and perhaps other nations, this may mean that plutonium stocks will have to be reprocessed to make nuclear fuel. Considerable investment would be needed. Though nuclear stations do not produce greenhouse gases at the point of production, fission technology does not offer a safe or sustainable future, but could be used as a stop-gap measure.

However there is considerable hope for nuclear fusion. This technology is based on fusing two isotopes of hydrogen to make helium. The advantages of this technology are that the fuel is almost limitless and the fusion reaction does not produce any toxic waste. In Europe the International Thermonuclear Experimental Reactor (ITER) is being developed to further research fusion at a cost of some 16 billion euros.

Though there are some indications that fusion reaction is achievable, to date it has only been sustained for a small fraction of time. At present the amount of energy needed to start the reaction has exceeded the output from the fusion reactor. There is uncertainty about our ability to make this work. If fusion power is possible then it is unlikely that commercial plants will be available before 2050.

Renewable technologies

Renewable energy is all but unlimited. There are three sources of renewable energy: the sun, gravity and geothermal heat from the earth’s core. Renewable technologies such as solar water heaters and photovoltaic cells capture energy from the sun to produce electricity and heat. Wind energy can be used to generate electricity.

Hydro-electric power, a mature renewable technology, relies on rainfall drained by river systems and stored behind dams. Tides, driven by the gravitational interaction of the moon and earth, can be harnessed to produce electricity.

Geothermal energy from hot rocks in the interior of the earth can be used to produce steam to generate electricity. There are limitations associated with these technologies. Wind and geothermal energy, tides and dams are location specific. Solar hot water and solar and wind generated electricity are variable; without the sun or wind they do not produce energy.

Alternative fuels such as hydrogen and biomass have considerable potential. Hydrogen is the most abundant element in the universe and when combined with oxygen produces heat or electricity and water as a waste product.

The problem is the production of hydrogen. Conventionally hydrogen has been produced by stripping methane or natural gas. The byproduct of this process is carbon dioxide. Hydrogen can be produced by the electrolysis of water. If the electricity used is produced from renewable sources, such as wind, then hydrogen production would not contribute to global warming.

Hydrogen can be used directly, for example, in the internal combustion engine, or used in a fuel cell to produce electricity. Hydrogen is a low energy density fuel when compared to, for example, gasoline. When used for transport systems hydrogen has to be stored either at very high pressures or as a liquid at cryogenic temperatures.

Many vehicle manufacturers are developing electric vehicles that rely on batteries to store electricity. At present it is not clear if the battery or hydrogen will emerge as the dominant technology for transport. Electric vehicles have limited battery life and re-charging is time consuming. If charging points use electricity produced from fossil fuels then this would contribute to global warming.

Biomass resources, such as wood and crop residues, are essentially carbon neutral; they release carbon dioxide when used and absorb it when grown. Biomass has been used as a fuel for millennia. Biomass is used to produce electricity in dedicated power stations. The technology is not complex and can work well providing biomass supplies are readily available.

Despite the potential for renewable resources, new technologies such as wind and photovoltaics only produce a small fraction of global energy. Biomass is used throughout the developing world and only produces a small amount of energy in the developed world. Investment in the development and implementation of these technologies is needed if meaningful reductions in emissions are to be made.

Energy use could be reduced by some 20 percent through efficiency measures to both supply and use. The Laws of Thermodynamics limit the efficiency of conventional power stations, typically about 40 percent for a coal-fired station. The wasted energy can be used either for heating or industrial processes. This is known as Combined Heat and Power (CHP).

Energy efficiency

For gas-fired power stations the Combined Cycle Gas Turbine produces electricity in two ways. Gas is used to drive a turbine to produce electricity and the waste heat generates steam for electricity production.

But carbon dioxide is still produced and for a low carbon pathway this must be addressed. Carbon Capture and Storage (CCS) and carbon sequestration are two methods that can be used. CCS captures carbon dioxide either pre or post combustion methods and then stores it underground in depleted oil or gas wells. This technology is currently being tested. CCS will add to the cost of electricity by some 10-15 percent according to current estimates. Carbon sequestration involves enhancing natural carbon sinks such as forests and peat bogs and improving agricultural practices.

More efficient end-use means less energy is needed. Buildings use some 40 percent of energy for heating, cooling, lighting and equipment and appliances. Improved thermal efficiency of buildings reduces the amount of energy used.

The Passive House, developed in Germany, has high thermal efficiency and can maintain a comfortable environment, with little additional energy, even if the external temperatures fall to minus 20 degrees Celsius. More efficient lighting and appliances can reduce domestic demand.

Embedded renewable capacity such as solar hot water, photovoltaics and heat pumps can make a building almost self-sufficient in energy terms. These ideas can be applied to all buildings. Cities could be both energy producers and users.

Geo-engineering works by removing greenhouse gases from the atmosphere or limiting the amount of sunlight reaching the planet’s surface. Artificial trees that absorb carbon dioxide using plastic polymers have been proposed.

There are issues of commercial viability and storage of the collected carbon dioxide to be addressed. Other proposals aim to increase the amount of carbon dioxide absorbed by the oceans by adding large quantities of lime to the water.

Spraying sulphate aerosols into the stratosphere can reflect sunlight back into space. Unmanned ships could increase above-ocean cloud cover by spraying sea water into the air. Placing thousands of tiny mirrors in space between Earth and the sun could reflect sunlight back into space. These ideas have received much criticism as they mask the carbon dioxide problem and can lead to serious side effects, for example, the oceans becoming more acidic.

Any energy technology has positives and negatives. The challenge for policymakers is to balance both supply and use. Low carbon supply options need to be deployed and we must use energy more efficiently. It is not a technological issue. There are three main problems.

Firstly, politics and economics. Within UNFCCC getting all 194 nations to agree a low carbon strategy is fiendishly difficult. Without an international deal that sets targets for all, no one nation can be certain that others will pull their weight. At present the rich nations are transfixed by the economic crisis and there appears to be little appetite to really tackle the climate crisis. Governments are fearful of being first and will not act until something actually goes wrong. By then it may be too late.

Secondly, distorted markets. Renewable energy is plentiful. But their transformation into usable energy supplies appears too costly than fossil fuel polluting alternatives. This hides the fact that the fossil fuel industry received $409 billion in handouts in 2010, compared with $66 billion for renewable technologies. More investment in renewables is needed. In addition the external costs of fossil fuel use are not reflected in price mechanisms. The market is distorted.

Thirdly, technological lock-in. We are still trapped in thinking about energy systems where high density fuels are transformed into energy services, often at a gigantic scale. We are unable to think differently. This is worrying as renewable sources imply a new approach to energy system architecture, an architecture that is based on typically low density variable sources such as wind and solar power.

Low carbon energy

A shift to a low carbon energy economy needs a concerted effort to address both supply and demand. To date the main concern has been on supply of energy. More recently concerns have been raised that fossil fuels will run out in the near future.

Unconventional fossil fuels such as shale gas, tar sands and heavy petroleum are plentiful. Some estimates suggest that there could be sufficient fossil fuels to last into the next century. But their exploitation has severe environmental consequences.

It is not a question of shortage of fossil fuels but more a question of whether we should continue to use them. This is not a technological question but a question of values. If we want a sustainable future for future generations, then we really need to do things differently.

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Environment info
Nuclear energy

Industry leaders meet in Korea to discuss the relevance of nuclear energy and security implications prior to the Nuclear Security Summit Monday and Tuesday. In the left photo, Korean Prime Minister Kim Hwang-sik delivers an address to participants Friday. Korea Times photos Nuclear power is the use of sustained nuclear fission to generate heat and electricity. Nuclear power plants provide about 6 percent of the world's energy and 13-14 percent of the world's electricity, with the U.S., France, and Japan together accounting for about 50 percent of nuclear generated electricity. In 2007, the IAEA reported there were 439 nuclear power reactors in operation in the world, operating in 31 countries. Also, more than 150 naval vessels using nuclear propulsion have been built.

There is an ongoing debate about the use of nuclear energy. Proponents, such as the World Nuclear Association and IAEA, contend that nuclear power is a sustainable energy source that reduces carbon emissions. Opponents, such as Greenpeace International and NIRS, believe that nuclear power poses many threats to people and the environment. Nuclear power plant accidents include, Three Mile Island accident (1979), the Chernobyl disaster (1986), and the Fukushima Daiichi nuclear disaster (2011).

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