Energy lies at the heart of the world’s sustainability challenge. On the one hand, abundant, accessible, low-cost energy is vital for economic prosperity. On the other hand, the world’s pattern of energy use, based on fossil fuels, threatens massive future climate change with devastating potential consequences. The greatest sustainability challenge, therefore, is to meet the energy needs of a growing world economy while moving to a safer pattern of energy use.

The difficulty can be explained in the following way. Currently, the world energy system uses the equivalent of around 170kg of oil in primary energy for every
$1,000 (Dh3,678) of output, if one adds up the annual use of oil, gas, coal, nuclear and renewable energy and converts each primary energy source into units of oil equivalent. On an average, each unit of primary energy (again measured in tonnes of oil equivalent) contributes 2.4 tonnes of carbon dioxide (CO2) into the atmosphere. With a world economy of around $90 trillion, measured in purchasing-power adjusted prices, the result is around 36 billion tonnes of CO2 emitted into the atmosphere.

The basic tendency is for CO2 emissions to grow. This is because the world economy is growing around 3-4 per cent per year. That global economic growth is vital for the well-being of at least 6 billion of the world’s 7.2 billion people — notably those living in developing countries. Energy forecasts made by the International Energy Agency, the US Energy Information Agency and others point to the likelihood that global emissions could reach 50 billion tonnes of CO2 per year by 2050, if not higher.

The problem, of course, is that such rates of CO2 emission would be a devastating threat to the world’s climate. Most scientists concur that the world should do everything within its reach to keep the world’s average temperature from rising by more than 2 degrees Celsius, compared with the Earth’s temperature in the pre-industrial age (say in the year 1800). Some scientists say that even a 2 degree Celsius rise threatens the well-being of the planet and that the limit should be no higher than 1 degree Celsius. Yet, the current global trajectory of energy use and the resulting high rates of CO2 emissions will likely lead to an
increase of more than 3 degrees Celsius this century and can indeed unleash a series of physical feedback processes that cause runaway warming, even beyond 5 degrees Celsius.

Again, we can put numbers on the problem. To keep the rise in mean temperature below 2 degrees Celsius would require that today’s annual emissions of around 36 billion tonnes should decline by mid-century to around 15 billion tons, and perhaps even less. Therefore, we need to meet the needs of a growing world economy combined with a sharp cut in global CO2 emissions. The world economy may grow by a factor of more than three times by mid-century, from today’s $90 trillion to around $280 trillion, the result of population growth from 7.2 billion people to 9.3 billion people, combined with a tripling of average income per person. Yet, that increase in the world economy needs to be combined with a cut in global emissions by more than half!

There are two basic dimensions of change that can make this possible. The first is a massive rise in energy efficiency, meaning a sharp decline in primary energy use per unit of economic output. As stated earlier, the world currently uses around 170kg of oil equivalent to produce $1,000 of output. That needs to come down by around 5 times, to around 30-35kg of oil equivalent per $1,000 of output.

The second is a shift to lower CO2 emissions per unit of energy. The current energy mix leads to 2.4 tonnes of CO2 for each tonne of oil equivalent. That could be reduced to around 1.5 tonnes of CO2 for each tonne of
oil equivalent by shifting the global energy mix towards low-carbon or zero-carbon energy sources. With a world economy of $280 trillion, using 31kg of oil equivalent per $1,000 of output and emitting 1.4 tonnes of CO2 for each tonne of oil equivalent of primary energy, the result will be global annual emissions of around 13 billion tonnes of CO2 as of 2050, with the boundaries needed to keep the rise of temperatures below 2 degree Celsius.

Yet, is such a massive energy transformation feasible? The answer is yes. Enormous gains in energy efficiency are possible in every major energy sector. Residential and commercial buildings can use far less energy for heating, cooling and ventilation by using state-of-the-art methods. Transport energy use can be cut sharply through more energy-efficient vehicles and modes of public transport. Many large cities can reduce their energy loads substantially through better urban design and using the heat exhaust of power generation for heating of buildings. Many industrial energy processes can cut energy use substantially and can save on energy use through the shift to new energy-efficient materials in manufactured goods.

At the same time, the energy that is used can emit far less CO2 per unit of energy. This involves a phase-out of coal use and its replacement by lower-carbon natural gas as well as by zero-carbon energy from nuclear, hydro, wind, and solar power. Oil use would also be cut sharply, though not as sharply as coal. Today's automobiles running on petrol will, by 2050, almost surely have to be run on electricity or hydrogen fuel cells (with the hydrogen produced by low-carbon electricity).
These transformations are feasible, but they are not easy to accomplish. They will require a major degree of global cooperation, to replace coal with low-carbon or zero-carbon alternatives; to shift to electric vehicles; to improve the energy efficiency of our buildings, cities and industrial processes. Each part of the world will need a road map on deep decarbonisation to ensure that it can have the energy that it needs for prosperity, while reducing drastically the CO2 emissions per unit of final output.

As Director of the UN Sustainable Development Solutions Network (UNSDSN) on behalf of the United Nations Secretary-General, Ban Ki-Moon, I am committed to working with every nation to find a practical pathway to deep decarbonisation. For that purpose, the UNSDSN has launched a Deep Decarbonisation Pathways Project (DDPP) to help nations identify their own cost-effective transition path to a low-carbon future. My colleagues and I look forward to working with governments around the world — both national and metropolitan — to identify those practical pathways and governments are warmly invited to contact the SDSN for further information.

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