1. Introduction

“Good atoms and bad atoms” is a captivating expression which is self-contradictory as well as self-explanatory. It describes the status of atoms in human minds. Upon the utterance of the word ‘nuclear’, a fearful mood arises. It reminds people of the horrors ensuing from the military uses of nuclear materials; meanwhile the peaceful uses of nuclear energy are rarely focused upon. Consequently, bad atoms were the ones gaining attention whereas the good atoms were marginalised.

It is essential to set out the elementary scientific facts concerning atomic fission. The nucleus of the atom consists of neutrons and protons held together by immensely strong internal forces, normally incapable of being distributed by any force smaller than that provided by bombarding it with another sub-atomic particle. When neutrons, as they exists in nature, hit the nucleus of an atom of one of the components of the heavy metal uranium, it splits into two (atomic fission). This split releases an enormous amount of energy, most of which causes the two fragments to move apart at high speed among the uranium atoms. The metal is so dense that their movement is quickly slowed down, transforming their energy of motion into heat. In part, this heat that is used in nuclear electricity stations to provide steam for the turbo-generators. In atomic fission, however, neutrons are released as well as energy, and some of these neutrons split neighbouring nuclei, spreading the fission reaction through mass uranium. For the nuclei to split most effectively, the bombardment must be by low-energy neutrons, whereas those released by fission are of very high energy. They are therefore slowed down, between their release and their impact with neighbouring fuel, by arranging for them to collide with the atoms of a suitable ‘moderating’ material such as graphite, until their thermal energy has been sufficiently reduced. This is in practice achieved by arranging the pellets or rods of uranium fuel appropriately spaced in a block of moderator. Natural uranium is made
up of two sorts (isotopes) of atoms, uranium-235 (U-235) which can be split by low-energy neutrons, and uranium-238 (U-238) which virtually cannot be split. Only one atom of U-235 exists in 140 atoms of natural uranium. It has been found that if some of the liberated neutrons enter atoms of the non-fissile U-238, they become atoms of plutonium, which is the fissile; thereby the possibility to utilise a larger proportion of the atomic energy in natural uranium. There is also a third isotope, uranium-233 (U-233), which does not exist naturally but is produced by bombarding thorium with neutrons, and is also fissile. There are thus three known nuclear fuels, U-235 that occurs in nature, plutonium, and U-233 that can be produced by neutron bombardment of thorium in nuclear reactors.¹

In this Chapter, the role of good atoms in human life will be discussed, including the use of nuclear energy as a source of power to generate electricity, in industry, agriculture, water management, medicine, animal breeding, pesticides, crime detection and other peaceful uses of nuclear technology for the benefit of humankind. A special emphasis will be given to the costs of acquiring nuclear technology in order to reach a better understanding of the advantages and disadvantages of developing and using nuclear technology and to evaluate the costs that nations pay to obtain it.

Nuclear technology can be used to promote scientific progress and has a positive effect on the economic prosperity of nations that utilise atomic energy for their socio-economic welfare. Atomic energy is capable of producing electricity at a high economic level and has yet to be used on a large scale. In a survey of key technologies for the 21st century, physicist Freeman Dyson saw “the age of nuclear power as a symbol of exaggerated expectations and broken promises”.² This statement makes sense in the case of our recognition that after decades of commercial use of nuclear power, it constitutes only 17% of world electricity.³ This renders several

³ Ibid. Also the NPT Review Conference, ‘Final Document of the 2000 Review Conference of the Parties to the NPT’, NPT/CONF.2000/28, 24 May 2000, stated the same figure in p. 4, “Nuclear power is an important contributor to the world’s electricity needs. In 1999, it supplied more than one sixth of global electricity and a substantial 31% of the electricity in Western Europe.”