Chapter 24

Branching out into the Universe

Cesare Marchetti

Work on diffusion models started at IIASA in 1974 when we were searching for a solution to the problem of putting some internal logic into the dynamics of energy markets (Marchetti, 1975). The problem was formally solved by using multiple competition dressed in logistics which are the simplest coder for the simplest diffusion process, the epidemic one.

The immensely complex phenomenon of using energy in various forms with all the interfacing of economics, technologies, and politics, and over a period of more than 100 years, showed up as a crystalline substitution, i.e., a multiple diffusion process (*Figure 24.1*). The result was a philosophical shock to me, because it robbed the process of its contemporaneity. A single set of equations, each with an input of only two parameters, was capable of describing the whole process even 100 years or more ago. In addition the description did not require the notion of money or other economic paraphernalia. Everything could be reduced to the timing and speed of the introduction of each new competitor. All the rest was a consequence, even 100 years later. Apart from the isolation resulting from the effects of daily affairs, the system showed an incredible long-term self-consistency, in spite of the continuously changing technical, economic, and political substrate. The

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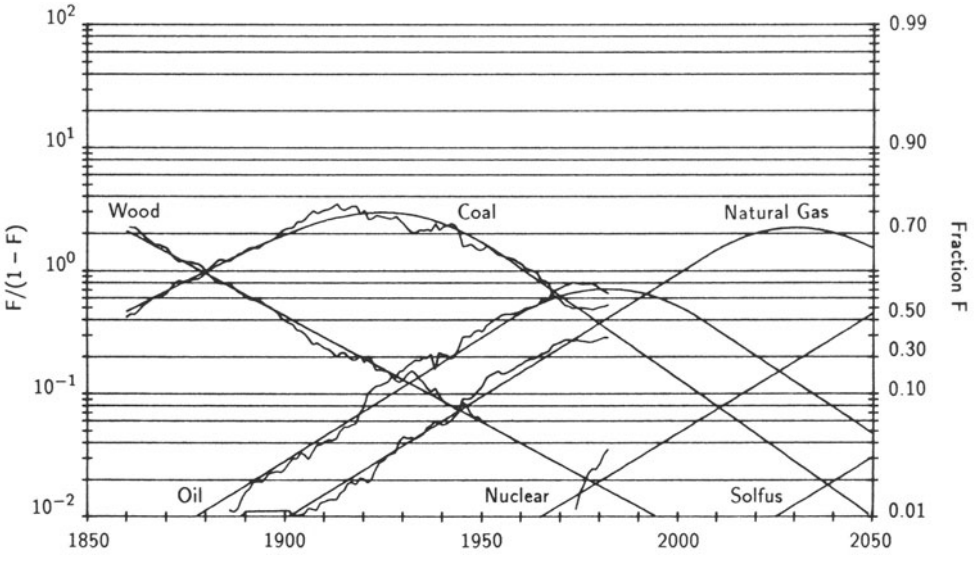

Figure 24.1. World primary energy substitution, in fractional shares of primary energy consumption by source. (Source: Marchetti and Nakićenović, 1979.)

precision of the match discouraged any thoughts that it was a pure coincidence. The next step was in fact the initial branching out into a whole set of cases of primary energy substitution, from single countries to electricity production, to single industries.

Altogether we collected about 300 cases (Marchetti and Nakićenović, 1979), showing that the multiple diffusion process was an unsinkable descriptor of the dynamics of the real world in the energy area. The first branching out from energy proper started here, where we were using proxies, like the number of diesel versus steam locomotives to pattern the substitution of oil versus coal for railway transport, or the amount of coal extracted using various technologies, to pattern the competition between these technologies. Everything worked very well, and the suspicion was that the methodology could be of very broad significance.

Our ancestors operated in the thirties under the spur of the work of Volterra in Italy and Lotka in the USA. Both gentlemen were dealing with