Quelle

Soddy, Frederick: Transmutation, a Vital Problem of the Future (1912)[1]

[…] So far, knowledge is confined to the one case of natural transmutation, that of the heavier elements into ones of lesser atomic weight with evolution of energy. It seems natural to assume that the elements of greater atomic weight possess, generally, greater intrinsic internal energy than lighter ones. If this be so, the transmutation of silver into gold would be, in all probability, a ruinous process. It is probable that, if ever transmutation becomes practically possible, the material products of the process will be of little more account than the products of combustion of the furnaces of the industrial world to day. With energy at its present value, no known elementary substance, probably, is so valuable that it could be built up with profit from elements of less atomic weight, owing to the enormous expenditure of energy required, or that could not be disintegrated into lighter forms, were this possible, for the sake of the energy that would be obtained. The modern alchemist would probably be more eager to succeed first in turning gold into silver than the opposite.

If the problem of transmutation is ever solved, it is to be expected that the synthesis of entirely new forms of matter will also be possible. Engineering and allied sciences in the great development of the past few decades, have requisitioned many of the elements hitherto thought to be rare and of no technical application. The cases of the use of thorium in the manufacture of the incandescent gas-mantle, and of all kinds of rare elements in the composition of alloys for special purposes, are illustrations which could be multiplied indefinitely. In this respect the progress of science is at present absolutely limited by the elements available. In the present state of the science of aviation it is difficult to believe that an entirely satisfactory solution will be arrived at, until a constructional material as light as wood and as strong as steel is available, and the choice of light elementary materials at the disposal of the chemist is so limited that probably no great advances can be expected in this direction. But if new elements could be prepared to a definite specification by artificial synthetical processes in the same way as chemical com- pounds are now turned out of almost any structure required, within certain limits, this fundamental limitation of further progress would be overcome.

Such would however be but a side issue of the main result, which would place at the disposal of science a new and practically inexhaustible fund of energy incomparably more abundant than any at present available. Even the partial solution of the problem, as far as the acceleration at will of the natural rate of disintegration of one of the two parent radio-elements, uranium or thorium, would bring about an enormous revolution, for both of these elements are sufficiently common and widely distributed to supply all the energy the world is likely to be able to use for a very long period. For every million tons of coal burnt to-day a single ton of either of these elements, under the new circumstances, would suffice. The world's annual consumption of thorium for the gas-mantle industry amounts to several hundreds of tons.

Even among scientific men the general modern method of treating energy as a fundamental commodity is often obscured by the survival of less direct and more special habits of thought. Sir William Crookes in a remarkable address to the British Association some years ago considered the great question of the world's future supply of wheat and drew the somewhat disturbing conclusion that a limit must soon be reached to possible further expansion in this direction, and that then a wheat famine would be inevitable. It happens that in this particular case we have an easily understood and specially glaring instance of what is really a universal question. For wheat is only

[1] Soddy, Frederick, Transmutation, the Vital Problem of the Future, in: Scientia 6 (1912), S. 186–2002, hier: S. 196–200.

energy associated with some of the commonest and most abundant chemical elements, by means of the ancient, still not perfectly understood, and doubtless highly laborious and inefficient methods of agriculture. The source of the energy in this case is the sun. It is supplemented in modern agriculture by manuring the soil, the most valuable constituents of the manure being nitrogen in the combined form, that is to say, nitrogen either in combination with hydrogen as ammonia and its compounds, or with oxygen as nitrates, etc. In this complex series of changes it is apt to be overlooked that the combined nitrogen is essentially nitrogen plus energy, not nitrogen plus hydrogen, or nitrogen plus oxygen, as it is usually regarded, and that the abundant and almost inexhaustible supply of atmospheric nitrogen as such is practically unavailable for agricultural purposes because it lacks energy. Atmospheric nitrogen is 'self-combined nitrogen', for the individual atoms of elementary nitrogen are combined in pairs to form nitrogen molecules and in this combination there is evolved an enormous quantity of energy. To make atmospheric nitrogen available this energy must be returned. In Nature there is a very slow but continuous process going on, transforming the self-combined nitrogen of the air into 'combined nitrogen' i.e. ammonia and nitrates. It has been sup- posed that the sun was the source of the energy required in this transformation, which was effected by means of lightning flashes and silent electrical discharges. It seems much more probable however that the energy is really derived from the radioactive materials in the atmosphere, the rays of which cause the combination of atmospheric nitrogen and oxygen with ease. This is however a big question and cannot be dealt with here. This process, which sufficed for primitive agriculture, is insufficient to-day, and in consequence, combined nitrogen - ammonium salts from gas-works and the Chilean deposits of sodium nitrate - are supplied to the soil. Now the Chilean deposits happen to be the only ones of their kind and are certainly not inexhaustible. When they are used up one of the vital assets of agriculture will have disappeared, and thus the 'wheat problem', a phase on a small scale of the still unrecognised 'energy problem' that awaits the future, is the first to have attracted attention.

The sequel is perhaps even more instructive. Great commercial corporations, content to work for years or even decades, spending great sums in the hope of a future harvest, quickly grasped the inwardness of the 'wheat problem'. There are more direct sources of energy than the sun's light and heat. Such are, for example, coal and waterpower. The conversion of atmospheric nitrogen into combined nitrogen was effected by Cavendish in the 18th century by means of an electrical machine, the energy of which was supplied by himself and his assistant, taking turns at the wheel. In the modern industrial development, known as 'the utilisation of atmospheric nitrogen', the wheel, in this case the modern dynamo, is turned by the water power of Norwegian hill sides or by steam turbines driven by coal. The problem is one of engineering rather than of pure science. There is little doubt that by the time the Chilean deposits are worked out the great scientific genius of the 20th century will be credited with having created an even more satisfactory substitute.

Modern science, and its synonym modern civilisation, however create nothing. Their raw material is energy, and this though immaterial in the literal sense, is vital in the most fundamental sense it is possible to use the word. Life came and slowly developed on this planet at a rate allowed by the day-to-day supply of natural energy, subject to its fluctuations, imperilled by every drought or other abnormal condition affecting the intricate ramifications of the supply. Then science, still popularly misunderstood as a creator, developed, and at each stage of its growth it has drawn on some otherwise valueless store of energy for its raw material. It is ransacking the globe of stores which have required geological epochs of the past to lay down, and which itself it is powerless to replace.

Coal must follow ultimately the threatened fate of the Chilean nitrate beds and considering the rapidly increasing rate at which the available resources of energy are being used up, the end may come sooner than even the most pessimistic anticipate. The popular idea that when the coal supply is exhausted 'the great scientific genius of the n-th century will have provided an even more satisfactory substitute' is pernicious. Energy cannot be created and the utmost accomplishment of science, so far as can be seen, is to use to the best advantage what Nature has provided.

It is possible, of course, to quibble over the exact term of years the visible energy resources of the globe may be expected to last, but of their rapid ultimate exhaustion it does not seem possible to doubt. It is true that as the surface supplies give out fresh supplies may be found at greater depths, but there is an obvious limit, when the energy that must be expended in deep mining becomes comparable with the energy obtained.

As regards energy, and therefore as regards every other commodity, the modern world is undoubtedly living far beyond its income. It has recently come into a legacy from the remote past and it is living on the capital. It cannot now be very long before it wakes up to the appreciation of this fact.

Soddy, Frederick: Transmutation, a Vital Problem of the Future (1912). In: Themenportal Europäische Geschichte (2014), URL: <http://www.europa.clio-online.de/2014/Article=706>.

Auf diese Quelle bezieht sich ein einführender und erläuternder Essay von Cirkel-Bartelt, Vanessa: „A million times the energy of coal or other fuel". Frederick Soddys vorwissenschaftliche Ideen zur Nutzung radioaktiver Energie im Kontext der europäischen Energiegeschichte. In: Themenportal Europäische Geschichte (2014), URL: <http://www.europa.clio-online.de/2014/Article=705>.