DISCUSSION.

The Norwegian Minister, Mr. B. Vogt, expressed his thanks to the Society for the opportunity he had been afforded of being present at the reading of Mr. Scott-Hansen's Paper.

Dr. F. Mollwo Perkin said it had been a pleasure to hear the Paper and see the splendid photographs which Mr. Scott-Hansen had shown them. He agreed that much could be done in the way of conserving energy without destruction of beautiful scenery.

We, in this country, had reason to be grateful for these developments in Norway, which gave us fertilisers, and thus enabled us to improve the agricultural conditions and thereby the health and strength of our countrymen.

He emphasised the fact that cheapness was a great characteristic of hydro-electric power in Norway.

Mr. W. Murray Morrison agreed that the Faraday Society owed a great debt of gratitude to Mr. Scott-Hansen for his exceedingly interesting Paper. He himself, in a small way, had something to do with the great development of water power in Norway, having designed and carried out one of the schemes referred to, and it had been his privilege to see most of what had been described in the Paper.

Norway was, in many ways, much more advanced than we were here. For example, it was very easy to obtain hydrographical data from the Government (data originally collected and published in connection with the salmon fishing and the timber industries). Rainfall records, drainage areas, height of waterfalls and similar data are collected, tabulated, and published by a Government official permanently employed for the purpose. This was an instance of how our Government might take a lesson from Norway.

He agreed with Dr. Perkin with regard to the surprising cheapness of Norwegian water power. He believed that from some falls the figure fell substantially below the 22s. per e.h.p. year mentioned by Mr. Scott-Hansen; perhaps, indeed, as low as 15s. or 16s., including all capital and running charges. Such a figure could not, of course, be approximated to in this country, although we had other advantages as an offset. He was glad to think that Englishmen had had something to do with water-power development in Norway, but he ventured to express the hope that the members of the Norwegian "Storting" would agree to and act upon the views expressed in the last paragraph of the Paper. It was, under the present conditions, difficult to attract capital to Norway, and he hoped Mr. Scott-Hansen and his friends would get over these difficulties, and enable the much-needed capital to be brought into Norway free of onerous Government conditions.

Mr. F. W. Harbord said he had just returned from Norway and Sweden, and it gave him, therefore, special pleasure to hear what Mr. Scott-Hansen had to say. He had been much struck by the great activity he had

found in Norway in the development of the schemes referred to in the Paper, and the utilisation of electric energy in various new directions.

There were one or two points of metallurgical interest which he would like to emphasise. At Trollhättan they were making iron in the electric furnaces equal to the best charcoal iron on quite a commercial scale, and plants were now being put down by several works to replace charcoal furnaces for the smelting of Swedish iron.

He did not believe that we should ever have to compete with the electric furnace as regards iron-smelting in this country, but probably in some other metallurgical processes, such as zinc-smelting, it might prove a serious competitor, as there were already two works producing zinc on a commercial scale in electric furnaces.

Another promising industry in which electric energy was being utilised was the manufacture of soluble phosphates, in view of the large deposits of apatite found in Sweden.

He agreed with the previous speakers that there was no reason why the beauty of the falls should be destroyed by the utilisation of the water power, but the useful and the beautiful might very well, in the majority of cases, co-exist.

Mr. Lewis A. Smart said that, contrary to what might be inferred from the remarks of those who had as yet taken part in the discussion, the manufacture of calcium carbide was really the largest electrochemical industry in Norway, and not the manufacture of nitrates. He was a great believer in the future of the electrothermic smelting of Norwegian iron ore, and particularly the magnetic variety thereof, much of which was not rich enough for export, but contained sufficient lime to be self-fluxing. Magnetic iron ore is too hard for the English smelters, and much of it requires previous concentrating, hence briquetting, all of which means expense to suit the English market, whereas if cheap water power be available near the mines, as is the case in Scandinavia, these magnetic iron ores and even those only classed as low-grade can be turned into first-class steel billets, with a very large margin of profit at present prices. It is a recognised fact that if the grinding be sufficiently fine, the concentrating of iron ore removes the phosphorus, which is a very great benefit.

Like the last two speakers, he had also seen most of the installations referred to by the lecturer, and he welcomed, very heartily, Mr. Scott-Hansen's Paper, which was just the kind of practical treatise he had always suggested should be encouraged in order to broaden the basis of the Society by making it appeal also to others than those who are interested solely in the extremely technical branches of the industry. He put forward the suggestion that it might be possible to arrange a summer meeting of the Society in Norway, which would do much towards making its aims, objects and benefits more widely known, and he was most strongly of opinion the benefits arising from seeing how the practical, theoretical, and financial considerations had been developed, with mutual assistance, side by side, would be most valuable to the Faraday Society. From his own reception by the various leaders of this industry in Norway, he felt sure the members of the Society would receive a hearty welcome from the Norwegians, who would allow the members of the Society to inspect the existing factories and works which Mr. Scott-Hansen had so very ably described.

Mr. Charles Weiss thought that the Paper they had just heard was of such great interest from the engineering point of view that even the old engineering societies might well envy the Faraday Society.

In one point he would like to amplify what Mr. Scott-Hansen said. A

proposition was now being discussed for the establishment of electrolytic copper refining in Norway, which would probably be worked in connection with the direct electric smelting of the ore.

He would like to ask the Author whether the Birkeland-Eyde or the Badische-Anilin Process was the more economical. It had been stated that these two methods would be tried side by side, and the more economical of them adopted by the companies.

Mr. A. Scott-Hansen, in replying to the last speaker first, said that the Badische Anilin Company were working in conjunction with the Norwegian Hydro-electric Company. Many experiments had been made with the two types of furnace, but he could not at present say which was the better. At Rjukan four out of five of the furnaces installed were of the Badische and one of the Birkeland-Eyde type. The difference between them was small, but whereas the former until now was only made in units of 800 kilowatts, the latter has been made in units as high as 4,000 kilowatts each, and this of course meant greater efficiency.

With regard to the political question raised in the discussion he could not say very much. He could only express the belief that things would right themselves in time.

He hoped that the members of the Society would come and see with their own eyes the great developments that were taking place in Norway; he could assure them of a hearty welcome.