along either with his classification or his dating of the "three industrial revolutions" which he describes: (1) the 'Steam Revolution' (1780-1840); (2) the 'Electric Revolution' (1860-1910) and (3) the 'Atomic Revolution' (1942 to the present). The description of the last four decades as the 'Atomic Revolution' bears no relation to anything in the book and is an extremely inadequate account of the main new developments in post-war technology. The dating of the 'Electric Revolution' as starting in 1860 is extraordinary, and there is little or no indication of what was happening from 1840 to 1860 or from 1910 to 1942.

Barry Jones does make a half-hearted attempt to relate his periodisation to the notion of Kondratiev cycles, but he fails to make the connection or to relate his own analysis to the possibility of a recovery phase in the present long cycle. He is surely right to emphasise the phenomenon of discontinuity and disequilibrium in relation to economic growth and employment, but he should have given more consideration at least to the possibility of a cyclical upturn in relation to the longer term trends with which he is preoccupied. This is related to his failure to recognise the significance of capital-saving technical change in all sectors of the economy, and of the importance of producer-services supplied to manufacturing industry by the tertiary and quaternary sectors. Many of the prophets of 'post-industrial' society have failed to recognise the importance of Gershuny's point, that a substantial part of the apparent shift from the secondary to the tertiary and quaternary sectors represents the transfer of activities that were once carried out 'in-house' in manufacturing firms to a 'contracted-out' basis.

The book is also relatively weak in its treatment of the information services *per se*. It has little to add to the story of computerisation or to the economics of information processing and distribution.

Neither of these criticisms, however, should be allowed to detract from the overall extremely positive assessment of the book. Moreover, it is strong on the **political** implications of the information revolution and has admirable things to say on the dangers of technological disfranchisement and technological determinism. The critique of the role of the automobile in urban societies has seldom been put better, even by Mishan, and the problems of public access to information in the next twenty years have seldom been so well posed. Altogether it is a book which should not be missed.

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Solar Energy Patents *by Australian Patent Office*
(Australian Government Publishing Service, Canberra, 1983) pp. vi + 306, $21.95, ISBN: 0-644-02453-4.

This new publication by the Australian Patent Office is described as a "technology evaluation report". It contains two effectively separate reports; one of these summarises patents for thermal uses of solar energy, while the second is concerned with the generation of electricity from the sun. Each report is a description of technology for which patent application has been made. The reports include explanations of the underlying principles applicable

to each process described. All patent documents surveyed are listed in chronological sequence.

The study of solar thermal devices covers Australian patent documents from 1920 to 1983. It includes flat-plate collectors, concentrating collectors, tracking systems, absorbing surfaces and solar ponds, as well as thermal and chemical storage systems.

The survey of what the report calls "direct energy conversion" recognises the relative paucity of Australian effort in this field by casting its net more widely. Thus it covers Australian patent applications from 1950 to 1983 and United States applications from 1973 to 1982. It also includes documents published by the European Patent Office and the World Intellectual Property Organisation, for the period from 1978 to 1982 in each case. This study covers photovoltaic devices and ancillary technologies (arrays of devices, anti-reflective surfaces and coatings, concentrators and housings); also included are photo-galvanic, photo-electrolytic, thermo-electric and thermionic devices.

Together, the two studies constitute a comprehensive account of current technology for harnessing solar energy by means of active devices. With about 170 A4 pages devoted to describing the patent applications, there is a wealth of detail provided. It is well illustrated, with over 400 line drawings, and in general the expression is clear. There appears to have been a commendable attempt to avoid jargon and other affronts to the linguistically sensitive; the most conspicuous lapse is the consistent use of the American 'sulfide' in place of 'sulphide'. The second part of the report does, however, assume at least a nodding acquaintance with the physical principles of semiconductors; for example, while the section on photovoltaic cells is introduced by a commendably succinct and clear summary of the principles of these devices, distinguishing between intrinsic, p-type and n-type semiconductors, subsequent pages refer without hesitation to such esoteric matters as p^+-type materials and Schottky barriers!

The report states as a primary aim the demonstration of the usefulness of the patent system as a source of information. It certainly succeeds in illustrating the range of devices for which patent applications have been made. It is less obviously useful for an assessment of the utility of each device. A device for which patent application has been made may not have reached production because industrialists are not accustomed to using the patent literature as a source of information; it may also not have reached production for a host of other reasons, including impractability. The patent application may well not reveal the **practical** utility of a proposal (or, conversely, its lack of practical utility).

As an example of this general point, the section of the report on "antireflective" [sic] coatings and surfaces for photovoltaic cells is prefaced by the important statement that an un-coated cell reflects about 35 per cent of the incident light in the middle of the visible spectrum, thus specifying clearly the motivation for developing surfaces or coating to reduce this loss of potentially-useful energy. Various techniques are then described; however, presumably because the patent documents surveyed are equally coy, in only one case can the reader discern any indication of the effectiveness of the treatment.

While the report is remarkably free of the sort of crackpot schemes which are generally assumed to inundate patent offices, it could fairly be said that not all the applications described are equally practical. Thus the report, while an invaluable source of information, needs to be read with a critical eye. There is no *a priori* reason why the applicants for solar energy patents should be any more objective about the strengths and weaknesses of their proposals than the advocates of other technologies.

That qualification notwithstanding, the report does demonstrate in general terms the value of a determined search of the patent literature to provide a survey of potentially-available technology. It also provides, in specific terms, a valuable source of data on solar conversion devices. Additionally, the report is a potentially valuable source for examining what could be called the political economy of solar technology.

Some examples from a cursory perusal of the report illustrate the possibilities for using the information which has been compiled. Tables have been drawn up to show how patent applications are distributed by country of origin. These tables reinforce the general conclusions drawn by Morris (*Prometheus* **1**, 1, 144-59) concerning Australia's dependence on imported technology. Looking first at solar thermal devices, the period from 1920 to 1974 saw 136 applications for Australian patents, 52 of them (38 per cent) originating in Australia compared with 20 (15 per cent) of US origin. By contrast, between 1975 and 1981 there were 583 applications; 149 of these (26 per cent) were of Australian origin, while 179 (31 per cent) originated in the USA. Thus the last seven years surveyed saw a dramatic jump in the degree of American involvement in Australian solar energy patents; while 15 per cent of Australian patent applications up to 1974 had been of US origin, the figure is now near 30 per cent. In the same period, the proportion of Australian patents originating in this country fell from 38 per cent to 28 per cent.

The survey of devices to convert solar energy to electricity shows an even more dramatic picture. Of the 194 Australian patent applications surveyed, a massive 55 per cent originated in the USA. Two other countries, the Netherlands and the Federal Republic of Germany, each account for about ten per cent of the applications. Australia is the country of origin for only **eleven** applications over the entire period surveyed. In this area of devices for the direct conversion of solar energy, it is a salutary fact that Exxon Research and Engineering Co. have originated more Australian patent applications than all Australian organisations together.

That specific observation can be extended to note in more general terms the increasing dominance of solar technology by large corporations. The acquisition by Shell of 50 per cent of the equity in Solahart Pty Ltd marked the entry of the oil industry into the Australian solar marketplace. A cursory analysis of the recent patent applications shows the increasing role of the oil companies at the level of ownership of technology. Among the companies with the largest numbers of applications for direct conversion devices are Exxon (27), Mobil (16) and Atlantic Richfield (16). Only seven of those 59 patent applications were made before 1978, showing the extent of the move into solar tehcnology by these oil companies in the last five years.

There is, of course, room for vigorous disagreement about both the factors motivating oil companies to move into solar technology and the implications of that move. What this report provides is a most useful source of basic data

on this and other developments in the field of solar technology. It is therefore a potentially useful source of information for policy analysts as well as solar technologists.

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Telecommunications and Economic Development *by Robert J. Saunders, Jeremy J. Warford and Bjorn Wellenius*
(Johns Hopkins University Press for the World Bank, Baltimore, 1983) pp. 395, $US32.50 (hb), $14.95 (pb), ISBN: 0-801-82828-7 (hb), 0-801-82829-3 (pb).

The authors have accomplished a comprehensive survey of needs and demand for telecommunications in less developed countries (LDCs). They focus mostly on the excess demand for telephones rather than on other costlier telecommunications services. This is justifiable on the grounds of funding constraints for low-income countries as well as for reasons of two-way communication needs of periphery people. The old paradigm of mass media being the most effective tool for socioeconomic development has been rightly set aside.

The beginnings of this book are best seen in an article by Saunders (Chapter 12) in *Communication Economics and Development,* Jussawalla and Lamberton (eds), Pergamon, New York, 1983. One of the authors of the book under review, Wellenius, in an article for *Telecommunications Policy* (March 1983, pp. 79-81) pointed out the lack of a framework for analysis when economists speak of telecommunications as a determining variable for economic development. These three authors have attempted to overcome this when they analyse the inadequacy of developing governments' investment in telecommunications infrastructure. Conventional tools of economic analysis have been used to quantify benefits of telecommunications services as well as to assess pricing, consumption, and distribution of such services. The difficulties encountered in the application of economic analysis to critical issues of communication policies have been adequately elaborated.

Right at the outset the authors have tackled the question so often raised by proponents of technology transfer, namely when costs of most telecommunications goods and services are declining, why is there a persistent shortage of investment in this sector in LDCs? There is no simple or straightforward answer. Data on economies of scale and network efficiencies are amply provided in the book. A discussion of the organisation and management of the telecommunications sector in developing countries forms the preamble to an in-depth review of the macroeconomic analysis of social benefits in Part II of the book. In this section the authors recognise the value-added aspects of telecommunications infrastructure, but encounter many difficulties in evaluating the benefits of telecommunications in quantitative or disaggregated terms, making the analysis more descriptive than analytical. There is sufficient evidence, however, to indicate that telecommunications is becoming a significantly important input in the production process and even a "factor of production" (p. 73). Statistics regarding telephone and telex densities are abundantly presented to support the aggregate correlation