BOOK REVIEWS

Alaska Water Exports: A Discussion Paper
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Alaska Water Exports is an important initiative which deserves to be widely read and discussed throughout the world. In the North American context it is concerned with transfers of high-quality Alaskan water to the south-western states and Mexico, but its wider interest is in opening up debate on the general application of water transfers by sea for reducing water deficits.

Alternative options of land-based water resources development are becoming increasingly costly and often environmentally undesirable. There is brief discussion of desalination as a means of establishing a possible baseline cost threshold but this is a subject that needs much fuller debate.

The most unusual aspect of the paper is the serious discussion of large-scale water transfers by 'bags and tugs' and 'tankers and bags'. A third option, that of using pipelines, had been investigated previously and found to be infeasible at the present time. The authors conclude:

> Although we continue to explore the numbers on bag/tanker configurations, we believe the application of bag technology for storage and especially for transport will bring the economics of transporting water into competition with reclaimed water, desalination, and some conventional land-based delivery systems in the market area. Due to our interest in bag applications, we are encouraging investment groups actively pursuing water imports from Alaska to develop a full-size bag and begin trials immediately.

Partly as a result of this encouragement, development of full-size bags is now under development and sea trials are likely to be commenced during 1994. It is therefore desirable to examine critically some of the author's assessments.

The water deficit in Southern California alone, even if it rains, is officially estimated to reach 4–6 million acre feet (AF) per year (4935–7402 million m^3/yr) by 2010. The direct economic cost of a one-year 30% water shortage is also officially estimated at $8 billion and 56 000 jobs statewide. A similar study done in southern Nevada showed that there could be a loss of 10 000 jobs and a steady decline in employment thereafter. Water deliveries to Baja California, which is supplied from the Colorado river, could enable equivalent supplies to be withdrawn by Nevada from sources upstream. The Baja government has requested meetings with the Alaskan government to explore such ideas.

Some 20 initial sources of water are proposed on the assumption that it will be possible to load tankers or bags from storage bags to be filled by local communities. This would seem to be a doubtful proposition unless sources can be linked to specific destinations since uniformity of quality is necessary for

economical water treatment. Moreover, if the economic benefits are to be maximized for buyers and sellers the economic benefits of all elements of the processes of production and delivery must be maximized. In this, conveyance costs will play only a small part.

Details are given of the so-called Alaska Glacier project by which four shipments of water a year will be shipped to Saudi Arabia for bottling, using surplus capacity of the recently constructed new water supply system at Anchorage. A similar approach, if applied to new sources of water in SE Alaska, would seem to be a viable and economic source of good quality water for the south-western states and Mexico.

'Tanker and bag' transportation is presented as a viable transfer system and the most likely front runner. However, there are great problems with tankers, which are well known to all those who have been this way before:

- Availability of such tankers is questionable. According to published statistics, on 1 January 1992 53.4% of the world tanker fleet of VLCC Class tankers was over 15 years old. Most of these tankers will not be suitable for conversion to carriage of water, besides which the oil trade could not stand their loss. Only 29 tankers in the world fleet are ULCC Class (capable of hauling 300 AF) and only another 130 VLCC Class (capable of hauling 225 AF). A million AF/yr (173 Ml/day), which the author suggests would be the first step in meeting the 4–6 million AF deficit in Southern California alone, would require 122 VLCC Class tankers. This does not seem realistic.

The inevitable conclusion must be that only one or two VLCC or ULCC Class tankers could, in reality, be transferred to the water trade. The balance of requirements must therefore be met by bags.

- The 'day cost' of VLCC Class tankers is assumed to be $30 460 for a 10-year contract, yet the current break-even cost to owners is $40 000 according to Lloyds List and other authorities. The break-even rate represents the threshold for new building. At $40 000 per day the net receipt for transportation would have to be $2124/AF ($1.72/m^3) instead of the assumed $1700/AF ($1.38/m^3). This does not seem likely to be viable.
- Tankers require larger bunkers of diesel fuel or fuel oil, which represent serious environmental hazards despite the proposed cargo of water.
- 'Tankers and bags' assumes bag storage and bag development to be essential for this form of water transfer to be viable.

'Bags and tugs' is as yet an unproven system of transport except on a small scale. However, the characteristics of the system are now quite well understood and are generally well described. Some other statements are somewhat unrealistic:

- Costings are based on 225 AF and 1600 AF bags (270 000 m^3 and 1 936 000 m^3) which are unlikely to be realistic and insurable, though benefits of scale may be realizable by multiple-bag operation using smaller bags.
- There appears to be omission of fabrication labour costs in calculating estimated bag costs.
- There also appears to be under-estimation of towing costs, which neglects control requirements which are likely to govern tug requirements.

- There is no discussion of cost sensitivities which are significantly different from those of desalination and of 'tankers and bags'.
- Discussion is limited to use of very large bags, which would have drafts comparable to VLCC and ULCC Class tankers.

Copies of the latest version of *Alaska Water Exports* are available upon request from the publisher at a nominal charge of US$10 including postage and packing.

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Solar Pumping: An Introduction and Update on the Technology, Performance, Costs and Economics
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This Guidebook is the World Bank's (WB) Technical Paper No. 168, published by Intermediate Technology Publications (ITB & WB), to provide both a simple introduction to potential users and purchasers of solar pumps, and to review the current state of the art in technology, costs and economics. It starts by quickly reviewing in the introduction past, mostly unsuccessful experience of introducing solar pumps to the developing world, leading on to the WB and UNDP demonstration projects, the final output of which was published in 1984 as the *Handbook on Solar Water Pumping*.

The reader is then directly informed of when to use solar pumping, by first giving a simple formula to calculate the hydraulic energy of water pumping: E (kWh) = V (m^3) * h (m)/367. Hence, it could be used easily by non-technical people. The quantity volume-head, Vh m^4, is then introduced and used throughout the book, sometimes under the name of 'hydraulic duty'. Although physically the term may sound meaningless, it was found to be useful practically, e.g., the reader is told that solar pumping systems for irrigation begin to become cost-effective compared with diesel engines when the peak daily water consumption is less than 250 m^4 (e.g., 50 m^3/day through a head of 5 m, or 25 m^3/day through a head of 10 m), and where the monthly average insolation is LLgreater than 4 kWh/m^2. This rule of thumb cannot of course be generalized, as it does not take into account the cost of diesel fuel which still varies considerably in developing countries, or the cost of the diesel engine itself, which also depends on whether it is locally manufactured—as in China and India—or imported, as in the case of many other developing countries.

The above formula could be criticized on the grounds of over-simplification, and of not introducing the pump's and the electric motor's efficiencies in order to calculate the total system efficiency or the input power required, particularly as the market contains a collection of pumps and motors of different types and efficiencies. This, unfortunately is not covered adequately later

in the section on motors and pumps, and the reader is not informed of the importance of selecting high-efficiency pumps and motors and how this could considerably reduce the total cost of the system by decreasing the number of solar arrays needed. Also, the different types of motors and pumps are summarized without emphasizing this point, and that the use of new efficient motors and pumps could decrease the cost of the solar array by over 20 or 30%. On the other hand, the importance of selecting a pump/motor subsystem capable of operating efficiently over a wide range of power is emphasized adequately.

Detailed information is given on 17 current suppliers of PV pumping equipment including the type of pump, the power ranges in Wp (Watt peak), discharge in m^3/day, volume-head in m^4/day and costs in $/Wp. The smallest size is 17 Wp and the largest 5.1 kWp. The highest specific flow rate is 700 m^3/day at a 5 m head. These commercial data are presented in two diagrams giving the pumped head in m vs discharge in m^3/day, all of which is certainly useful information for users.

Of particular interest is the information on PV pump price history during the last decade. The maximum price of the set has decreased to less than one quarter, whereas the minimum price has decreased to about one-third, of their values at the beginning of the decade. The cost of the PV array is still sensitive to the amount of PV manufactured and sold; accordingly a further price decrease is expected through the current decade, particularly as more advanced technology and efficient processes are finding their way to the manufacturing line.

The general impression from the book is that it contains a lot of valuable and very useful information to users and purchasers of solar pumps. The section on practical cost appraisal is well written and the introduction of the life-cycle cost analysis is justified and well explained and demonstrated, although the investment costs and the effect of interest rates are completely ignored. It would not have been too complicated to add the annuity factor to the equation, and one more nomogram to calculate the total investment costs depending on the rate of interest.

On the other hand, the present book cannot be called a guidebook as the reader will often wonder what should be done next or what to do if. . ? . It would have been more useful if section 5, on general field experience, was merged with more comprehensive examples explaining step by step the practical use of guidelines, starting from the idea of using a solar pump to its installation, operation and maintenance. These guidelines are very important and helpful for the non-technical reader who, after becoming acquainted with the material in the book, wants to start applying it. An attempt at this, in chapter 9 on implementation and operation, is not fully successful. Any guidelines/guidebook should be extremely clear, systematic and to the point, with sufficient cross-reference. The purpose is to guide the reader and minimize time losses leafing to and fro between both ends of the book.

Finally, as a WB publication, the book should have met certain criteria and fulfilled similar standards to those of UN publications but, unfortunately, this is not the case. It is clear that the book was not revised by a senior expert, not even by an editor. A number of explanations and definitions lack scientific accuracy and the text suffers from many printing errors: nomograms

are called nonograms, 'this' has become 'the', 'varies' is replaced by 'varie', and the maps of solar insolation have been reduced in size to such a degree that they have become illegible. Although the book cover has changed, the contents have not and the publisher has missed this opportunity for some constructive editing.

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