TABLE 7
Employment, power, water, and area, 1940-87

	Goods producers % employment[1]	Manufacturing employees[1] (millions)	Factory horsepower[2] (millions)	Factory Kwh[3] (millions)	Water[4] (billion gallons/ day)	Area[5] (million acres)
1940	50	13.2	21.7	83.3	28.9	—
1950	49.7	18.4	32.9	181.3	37.9	0.8
1960	44.9	20.4	42	361.9	61.0	—
1970	39.4	23.3	54	573	62.9	1.5
1980	24.8	18.3	64	794	45.0	1.5
1985	22.3	17.4	65	824	30.0	—
1987	21.3	17.4	65	847	—	—

Sources:
[1] Bureau of Labor Statistics, U.S. Department of Labor
[2] "America's Needs and Resources," Twentieth Century Fund, New York; John A. Waring, Arlington, Va.
[3] Bureau of Census, U.S. Department of Commerce; Edison Electric Institute, Washington, D.C.
[4] U.S. Geological Survey
[5] "Land Uses In American Cities," Harland Bartholomew; "America's Land and Its Uses," "Resources for the Future"; *EIR* estimates.

for an employed work force in manufacturing of 41 million, then about 520 billion gallons per day would be required for manufacturing alone. Or, for 1980, four times more water ought to have been available for industry than was.

The first is more than the "dependable" daily runoff of 515 billion, and about as much as peak growing season irrigation use.

Per horsepower applied, for factory-based prime movers, an engineering estimate for cooling feed, and boiler "make-up" water, runs in the order of five gallons per horsepower. This would come to 325 million gallons per day, for the reported 65 million factory horsepower of 1987.

Again, estimates of feed water requirements for cooling and condensing in electricity generation run from 10 gallons per kilowatt-hour to 40 gallons per kilowatt-hour.

The water used for such purposes can be recirculated. It has to be cleaned, almost to the standards of drinking water, to prevent scaling and other fouling of working surfaces, so why not re-use it, rather than pump cleaned water back into the dirty source from which it was extracted? Water is re-used in this way, seven times and more. That part lost in the process of generating steam, through evaporation, has to be replaced, called "make-up" water. In electricity generation, it can amount to 5% of the throughput.

The variabilities depend both on the thermodynamics of the process employed, and on the method chosen for the heat-sink. Some 60-70% of the heating value of the fuel employed to power an industrial boiler system, or an electricity generating station, is not converted in the process, and has to be vented as waste heat. In U.S. practice, where water has been relatively plentiful, and cheap, this has either meant, once-

The 'nuclear option' for electricity and water

Following are excerpts from a presentation to the American Power Conference in Chicago April 29-May 1, by General Atomics officers R.W. Schleicher and C.J. Hamilton, titled "Exploiting the Nuclear Option for Both Electricity and Water."

. . . In many regions of the U.S., an acute need for new sources of fresh water is emerging as a consequence of sustained drought conditions, high local population growth, and deterioration of existing water supplies from contamination and overuse.

Concomitant with the need for new fresh water is the need for new electric power sources. Both population growth and industrial development bring about increased energy utilization, particularly in the form of electricity.

Although desalination has been a major water source for Middle East countries and island nations, it has not been a significant source of water in the U.S. However, the need for both water and electric power is a significant problem in populous regions with high growth projections, particularly Southern California and Florida.

In Southern California, which is in the fifth consecuthrough coolant and condensing cycles for plants located on ocean coastlines or rivers, or recycling coolant and condenser feed from plant-dedicated ponds and lakes. Phoenix, Arizona, powered from desert-located nuclear plants, uses treated and recycled municipal waste water as the source for coolant and condenser feed-water to the plants.

The waste-heat can also be air-cooled, through cooling tower arrangements. As long as technologies, such as magnetohydrodynamic (MHD)-based direct generation of electricity from coal, for example, are not developed, cooling and condensing needs of steam-cycle generators and boilers are going to be with us.

Given the variability, we estimated requirements simply by, in the case of industrial use, increasing the 1980 manufacturing withdrawals of water by a factor of 2.5 to reflect a full-employment policy. We also assumed that industrial use of electricity would increase proportionally, by the same factor, and then took an industry standard, 40 gallons per kilowatt-hour (kwh), as the cooling and condensing requirement for all electricity. Household uses of electricity were based on the 9,025 kwh per household, 1980 requirement to power the array of appliances, lighting, and heating functions, which such a household ought to have. The results are 112.5 billion gallons per day for the manufacturing industries, and 275.4 billion gallons per day for steam-electric generation.

In the government's nonsense view, the labor force is supposed to increase by about 1 million per year. Under actual population growth, such a margin of increase could easily be doubled, but the increase will not be reflected in the employment profile until about 20 years after we convince ourselves that such a change would be in order, if we are to survive. Meanwhile, the question becomes, how rapidly can resources be mobilized to create the capital improvements, including expansion of the water supply, which can begin to shift the country back to producing its own way in the world. For each such million jobs in the productive sector, about 2.5 billion gallons of water will be required per day, 48 million kwh per year, and 60,000 acres of land at current per worker productivities. What happened between 1940 and 1970, as reflected in Table 7, ought to provide some idea of how such parameters might change over that 20-year period.

tive year of drought, recent water authority demands for 50% cutback in water use have raised interest in the possibility of desalination for urban water supply. Desalination represents not just a short-term solution, but a long-term water source to cope with the high population growth and loss of existing water supplies.

Florida is in a similar position. Despite a large annual rainfall, the topography and soil structure induce excessive runoff . . . [and] drawdown of the water table has permitted seawater intrusion into the coastal water supply. Hence, brackish water and seawater desalination solutions are being developed. With respect to power needs, Florida is already in a critical situation. . . .

The MHTGR: an ideal source

Nuclear power is the ideal energy source for meeting the new demand for water and electricity. . . . Nevertheless, to be a practical reality for desalination, nuclear power must overcome several barriers which have interrupted development for the past 12 years in the U.S. These are: 1) achievement of exceptional safety characteristics; 2) economic competitiveness, with water and power production costs equal to or lower than alternative new sources; 3) acceptable financial risk for prospective owners and/or investors.

The Modular High-Temperature Gas-Cooled Reactor (MHTGR) is an energy source for both water and power production which has the potential to overcome the above barriers. The MHTGR features inherent safety characteristics, tolerance of operational transients, and benign environmental impact, all of which have the potential to make it an ideal candidate for water and power production at sites near coastal population centers.

A study initiated by the Metropolitan Water District of Southern California, in conjunction with the Department of Energy and private companies in the energy and desalination fields, has evaluated the technical and economic viability of using the MHTGR for desalination in Southern California. The major findings are:

1) Growth in normal water demand in Southern California requires development of about 460,000 acre feet per year (AFY) of new reliable water by the year 2000. By the year 2010, a total of 890,000 AFY must be developed. There is a corresponding need for additional large sources of electric power after the year 2000.

2) A dual-purpose MHTGR desalination plant consisting of four 350 megawatt modules with a multieffect distillation desalination system supplied with backpressure steam from the MHTGR can produce 106 million gallons of fresh water per day (MGD) in addition to 466 MW net electric power output.

3) The MHTGR will meet all established safety, environmental, and seismic criteria for siting in Southern California.

4) The institutional issues, which include public acceptance and demonstration of a means of waste disposal, loom as the most significant factors affecting viability of MHTGR desalination.