Final Report

on the

TEXAS SMALL COMMUNITY SOLAR ELECTRIC POWER ALTERNATIVES

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PARTICIPANTS

Gary C. Vliet	Principal Investigator, Solar Program Consultant
D.G. Hannan	GES Staff Consultant
Ray Hurd	GES Staff Consultant
Rebecca A. Bryant	Research Assistant
Mohammad Saiidi	Research Assistant

ABSTRACT

The potential for electric power generation from various solar concepts was assessed from the perspective of communities of 3,000 to 30,000 population. Biomass, concentrating solar thermal, and wind were identified as having the best potential, with projected costs of 30 to 35 mills per kilowatt-hour, 35 to 40 mills per kilowatt-hour, and 45 to 50 mills per kilowatt-hour respectively, for second generation plants based on present technology. Their respective attractive locations within the state are discussed.

Because long-term energy (thermal or electric) storage is not considered economically feasible, both solar thermal and wind concepts would necessarily be integrated with an electric utility grid or an on-location fuel-powered plant for auxiliary. As such, they would operate essentially as fuel savers; thus, the cost of the backup facility or the cost of auxiliary electric energy would need to be costed into the average price of electricity. Considering the demand schedules of typical Texas electric utilities and the availability of solar energy, for specific cases there appears to be merit in integrating a solar electric plant with an electric utility grid to reduce the normal late afternoon peak load.

The fuels/electricity from biomass concept appears economically attractive, and, because its nature permits long-term energy storage, the concept appears particularly attractive to small communities in Texas. Since none of the concepts has been developed or tested on any reasonable scale, there is a lack of hard cost, operating, and performance

data. Thus none of these can be considered commercially attractive alternatives at this time. However, with the present and projected demonstration programs, significant data should be available in two to four years.

In this report factors considered relevant to community assessment of solar power alternatives are enumerated and discussed. An in-depth tabulation of present data for all existing communities of 3,000 to 30,000 population in the state has been assembled, and an annotated bibliography is included. Implications for the state and communities are evolved, and recommendations pertinent to future solar energy developments in the state are presented.

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I. INTRODUCTION

A. Study Objectives

The primary purpose of this study is to assist the State of Texas Governor's Energy Advisory Council in providing guidance to state and local officials and to communities desiring to explore the near-term solar electric alternative.

The study includes:

1. A survey and evaluation of potential concepts
2. Economic comparisons with conventional power
3. Applicability of the concepts in Texas based on various factors
4. General implications for state and local officials regarding development of solar power

B. Overview of Solar Power Utilization in Texas

The future of solar electric power generation in Texas, as in the nation, depends to a significant extent on the development of solar power alternatives and incentives to use solar energy initiated at the federal level. Essentially all of the research and development work being conducted on solar electric power generation is being supported presently by the federal Energy Research and Development Administration (ERDA). There are at present significant technology and demonstration programs funded by ERDA to develop "solar" electric power.

The major programs are in solar thermal electric and wind energy conversion although there is significant activity in photovoltaics and biomass energy. Of particular importance for near-term modest-scale electric power generation are the development and testing of the 5-megawatt (thermal) solar thermal pilot project at Sandia Laboratories and the design of a 10-megawatt (electric) plant for which management proposals were recently solicited by ERDA for the beginning of construction in 1978. In wind energy conversion NASA/Lewis is presently developing and testing a 100-kilowatt (electric) horizontal axis wind turbine which may be the basis for modest-scale central power stations. A significant portion of ERDA's solar budget is directed toward photovoltaics, but no significant amount is directed to near-term application to central electric power generation. The development of fuels and electricity from biomass is receiving only modest support but appears to be as viable an option as other solar alternatives for modest-scale electric power generation for Texas.

Although Texas is the richest state in the nation in terms of conventional energy resources, the cost of electric power across the state varies widely, from approximately 25 to 50 mills per kilowatt-hour. The higher rates are as high as any in the nation. With the continuing termination of natural gas contracts, rates across the state can be expected in the near future to become more consistent at the higher rates. These rates can also be expected to escalate at least at some modest level of 5 to 10 percent annually.

Largely because of its extent, Texas exhibits various unique geographical/climatological regions which may very likely foster different solar alternatives. Figure 1 depicts the most likely "solar" alternatives for the various regions of the state. In the present study the different solar alternatives considered include the commonly con-

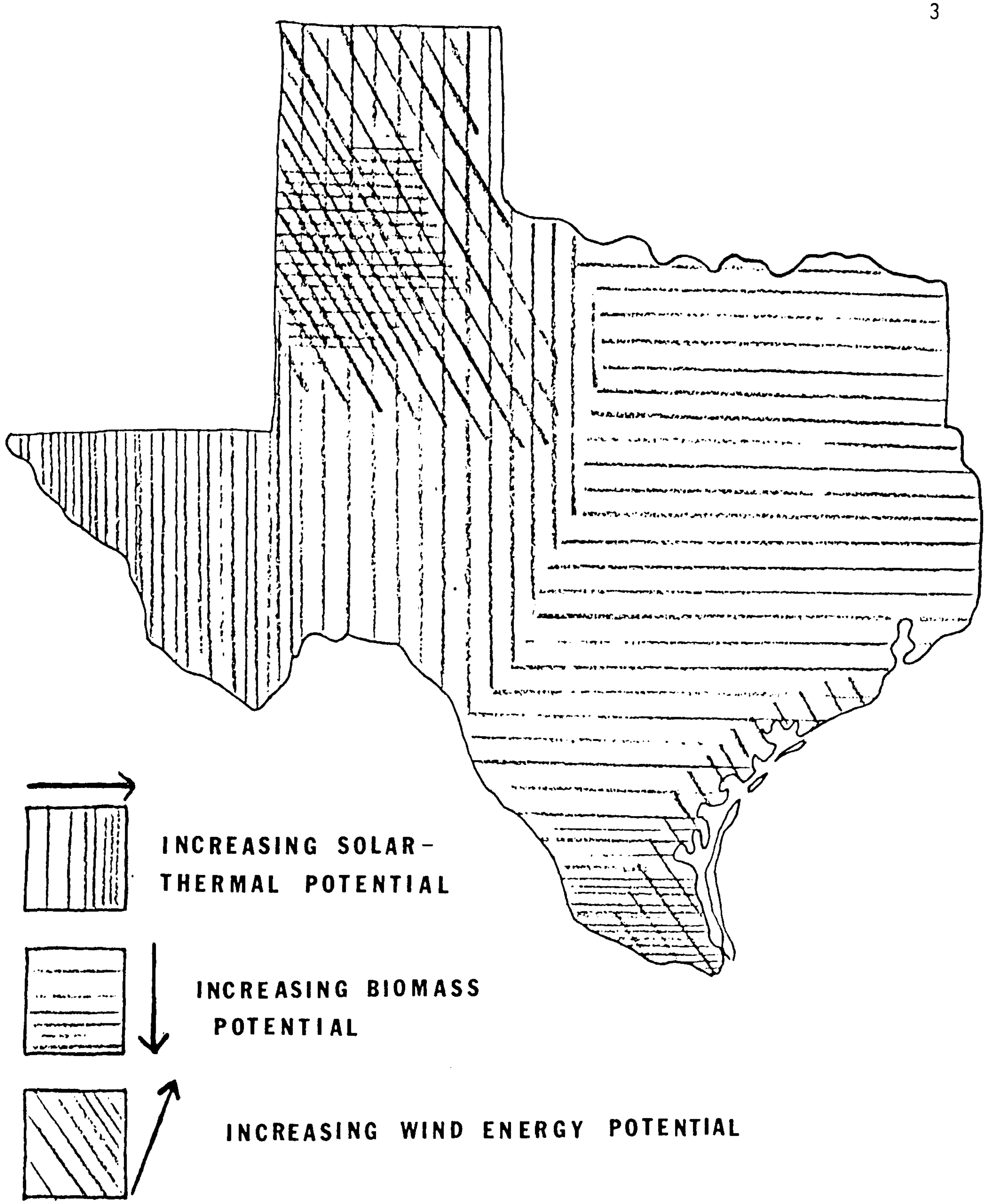

Figure 1

TEXAS SOLAR ALTERNATIVES

sidered solar power concepts (solar thermal and photovoltaic) as well as wind energy conversion and fuels from biomass.

The state exhibits relatively high levels of solar radiation, increasing generally from east to west, and also exhibits regions (Panhandle and Gulf Coast) of acceptably high wind velocity. The only solar thermal concept that appears promising involves concentration of solar energy. Therefore the western regions which receive more direct radiation appear to be most ideal, even with their shortage of water, since it is felt that air cooling could be used without serious efficiency reduction. Central Texas is also considered to have moderate solar thermal potential. The variation of direct normal and total horizontal radiation by months is presented in appendix A. The economics of wind energy conversion systems are strongly dependent upon wind velocity. The potential wind energy areas are the Panhandle and the Gulf Coast region rated one-two. Distribution of wind velocity across the state and by season is presented in appendix B. Biomass energy appears to be attractive in that energy costs appear competitive with other solar alternatives. The concept appears quite environmentally benign, and it does not suffer from the cyclic and intermittent nature of solar energy as do all other solar concepts considered. Its one apparent drawback is a substantial water requirement, and for this reason energy from biomass would appear to have greatest potential in the eastern and southern portions of the state. The water requirement is a drawback, however, only when crops are grown solely for energy. There exists a large potential in use of agricultural and municipal wastes where water is already expended to produce the main product, or in the case of hyacinths, in association with waste treatment plants.

There are or have been two significant efforts directed toward solar electric power generation in the state. The city of Bridgeport (population 3,760) has seriously considered solar electric power generation as an alternative to purchasing electric power. An initially very attractive proposal was made to Bridgeport to install a 4-megawatt (electric) solar power plant using flat plate collectors, thermal storage, and a "novel" engineering concept for approximately $6 million. However, after more careful analysis of the proposed system it was rejected by the city as infeasible and the project abandoned. The city of Crosbyton (population 2,200), also in northwest Texas, has been working with Texas Technological University and E-Systems, Inc., to obtain ERDA funding for a solar electric plant using the stationary hemispherical reflector-tracking absorber concept. Although not yet funded, this project is being approached in the proper manner and could possibly be the first modest-scale solar electric power plant in the country.

It is interesting (and unfortunate) that none of the "solar" energy alternatives considered herein have been developed or tested on a scale consistent with the present study. Thus the subsequent assessment is based on the most up-to-date design analysis and predictions extracted from the literature.

C. Procedure Used in the Study

The literature pertinent to each solar alternative was reviewed from the perspective of small-scale (1 to 10 megawatt) application, that is power to meet the needs of communities of approximately 3,000 to 30,000 persons. For each solar power system pertinent information was extracted to provide a review of the general concept and to permit establishment of a cost estimate for that concept. The various solar power concepts were compared on an economic basis and also compared to conventional power costs to assess their viability.

Data for the communities ranging in population from 3,000 to 30,000 were accumulated to permit profiling of community characteristics and to permit analyses of patterns, trends, and factors which might have a bearing on a community's propensity to seek a solar-based alternative.

The process by which a community might assess its alternatives for solar power was examined to find out what information might be necessary or helpful. Based on analysis of the present state of the art and prognosis of the future status of the various alternatives, implications for the state and the communities were derived and recommendations formulated. Selected bibliographic references were annotated and categorized into subject headings for convenience in reference and for guidance to those wishing to delve further. An attempt has been made to keep the discussions in this report fairly general and to avoid unnecessarily technical jargon or detail, to permit reasonable brevity and to provide for a broader audience.

II. SURVEY OF SOLAR ELECTRIC POWER CONCEPTS

In the assessment of "solar" electric power alternatives for Texas, wind energy conversion and fuels from biomass were considered in addition to the commonly thought of solar energy concepts: solar-thermal conversion (concentrating, flat-plate, and ponds) and photovoltaic. Neither ocean thermal nor satellite solar power was considered because this study deals with the requirements of small communities and it is felt that neither of these alternatives is applicable. A paramount consideration in the application of solar energy is energy storage, and this requirement is also addressed. Finally, a discussion of the integration of a solar system into the community's overall electrical requirements is included.

A. Solar Thermal

1. Solar Thermal Electric Using Concentrating Collectors

Concept

The principal concept underlying the use of concentrating collectors is that higher temperatures can be obtained in the working fluid (usually steam) than with flat plate collectors. The higher temperatures achievable are a result of absorbing the energy in a smaller area; thus losses are smaller and temperatures are higher. The higher temperatures in turn make it possible to convert a larger percentage of the available solar energy into the mechanical energy which drives the electrical generators. High efficiencies are important because they allow the use of smaller areas of collectors, the most expensive part of any solar energy system.

The laws of thermodynamics fix the relationship between the maximum temperature of the working fluid in the cycle and the efficiency with which heat added to the working fluid may be converted to mechanical energy, as in a steam turbine. This relationship is expressed approximately by figure 2, which shows both the theoretical maximum and an estimate of what can actually be obtained with best present engineering practice. The laws of thermodynamics also require that a machine which absorbs heat and converts only part of it to work must have some way to reject the other part. This rejection is done at a lower temperature, called the "sink temperature" by engineers, and this temperature value is also important in determining the efficiency of the conversion. These sink temperatures are fixed by the temperature of available cooling water, or by the temperature of a spray cooling tower, and are in the area of 70 to 100 degrees Fahrenheit. Figure 2 is based on a 100-degree Fahrenheit sink temperature.

Figure 2 makes it possible to estimate how much additional expense can be justified for concentrating collectors over flat plate collectors. At present flat plate collectors, as noted in a subsequent section, generally deliver a working fluid at about 200 degrees Fahrenheit, while concentrating collectors can easily deliver 500 to 700 degrees Fahrenheit steam. The actual obtainable efficiency increases from about 9 percent at 200 degrees to 25 to 30 percent at 500 to 700 degrees, and many concentrating collectors follow the sun, thus making more effective use of the area. As a result, only about one-third to one-fifth of the area of concentrating collectors will deliver about the same mechanical work (and hence electricity) as is required of flat

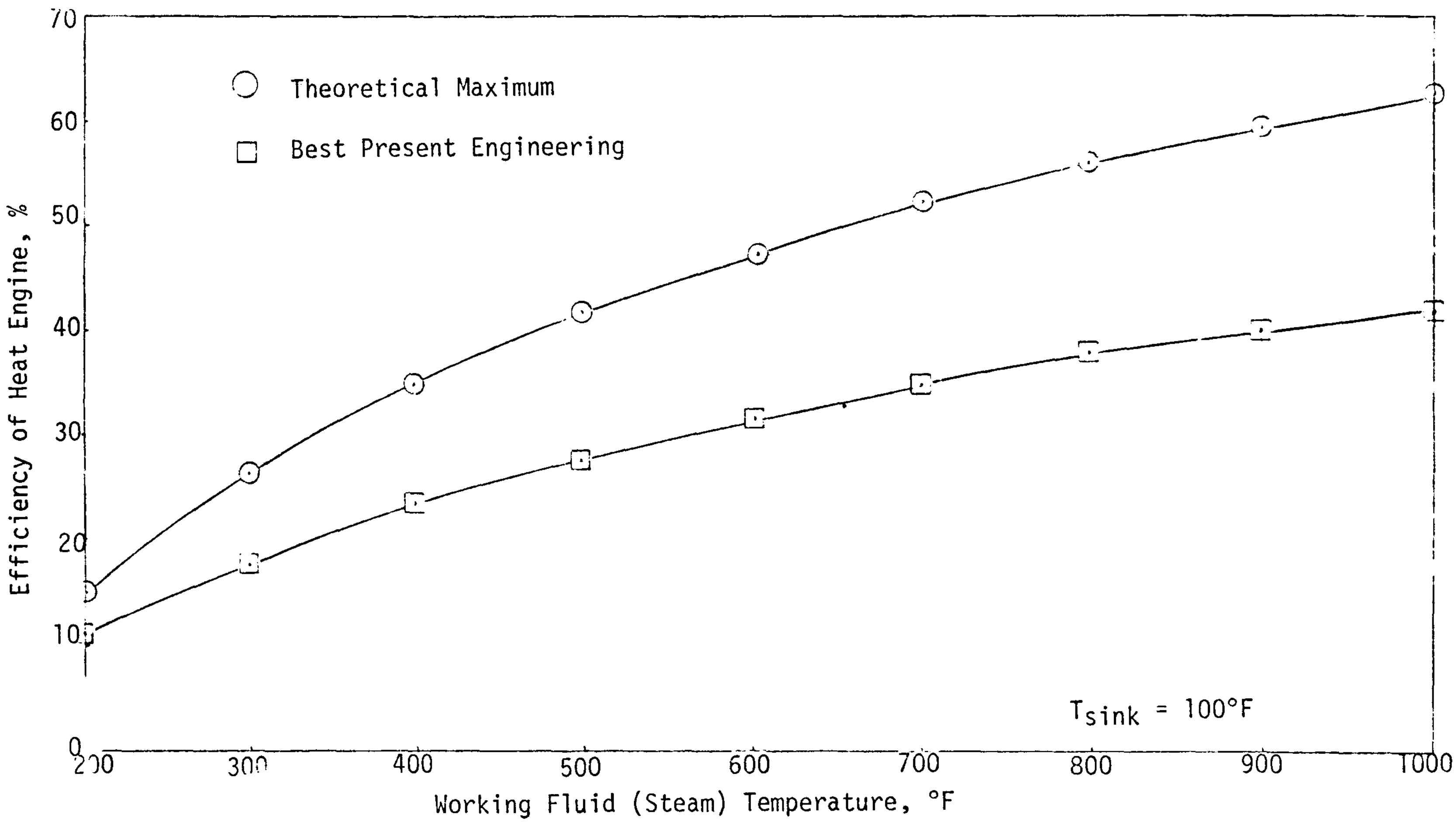

Figure 2

EFFICIENCY VERSUS TEMPERATURE

plate collectors. In addition to this, machines (turbines) to convert steam at 500 to 700 degrees Fahrenheit into mechanical work are readily available at reasonable prices and in a wide variety of sizes, while machines to convert the energy from 200- degree water (or some low boiling fluid such as Freon) usually must be specially designed and custom built, which usually results in more expense and less reliability.

Operation of System

Many types of concentrating collectors have been designed, though very few have been constructed and tested on a large scale. For present purposes, only reflecting systems (as contrasted to refracting, or lens, systems) will be considered. Of the reflecting systems, only three will be given consideration: the parabolic trough (distributed system), the spherical section fixed mirror with a tracking absorber (E-System), and the mirror field with a "power tower" (central tower concept). The latter two concepts are illustrated in figures 3 and 4.

Any of these systems can generate steam temperatures in the desired 500-to-700-degree range, and hence are acceptable heat-collecting systems. The principal disadvantages of all types of concentrating collectors are that they collect only the beam radiation, and at least one component of the system must be continuously oriented so as to reflect the sun's rays onto the absorber. The loss due to collecting only the beam radiation varies from 10 to 15 percent of the total radiation on a clear day, and of course approaches 100 percent during cloudy periods. Although this is a particularly serious problem for concentrating collectors, the performance of all solar systems, including flat plate types, is greatly degraded during cloudy periods.

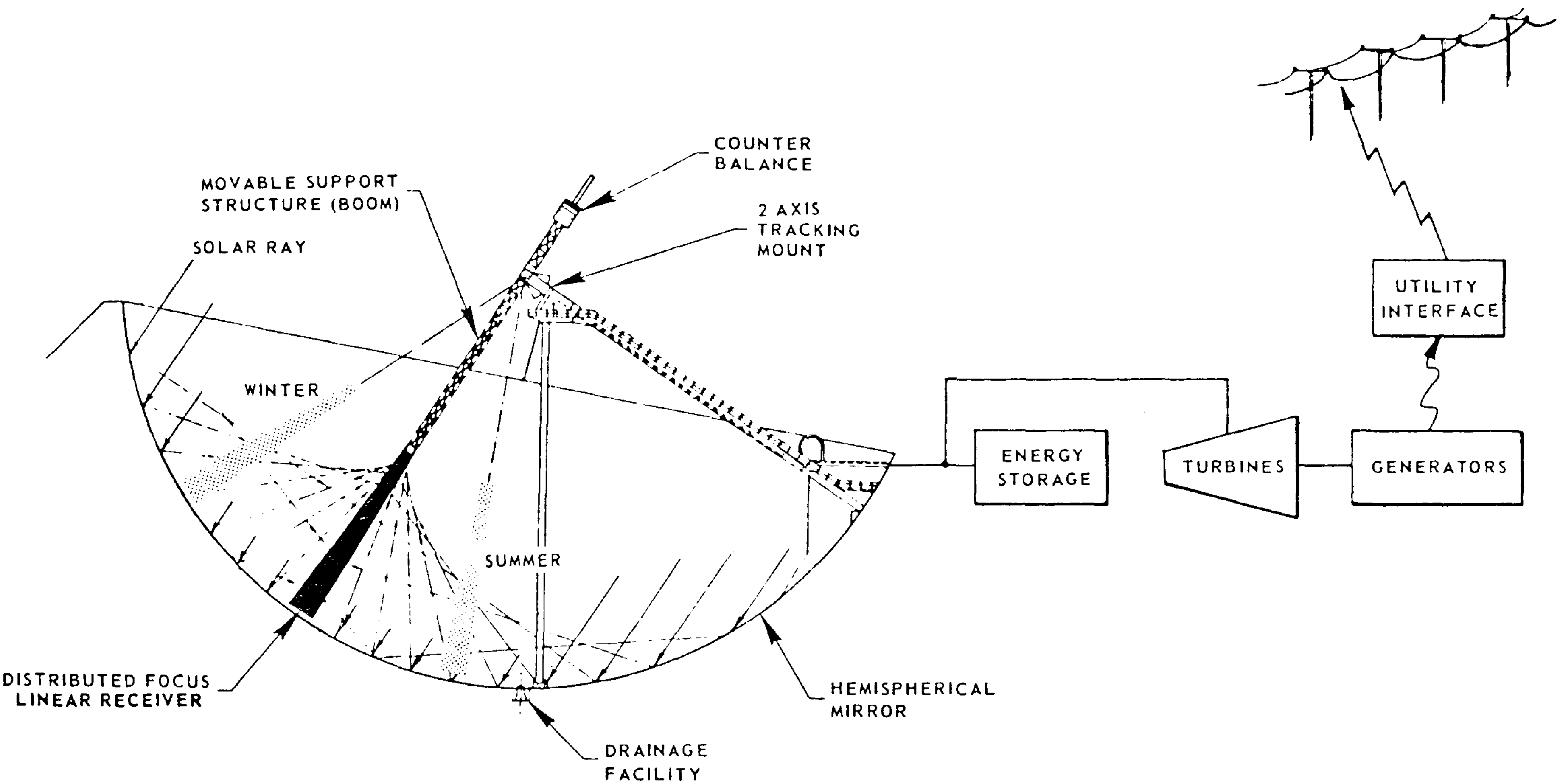

Figure 3

SPHERICAL FIXED MIRROR WITH TRACKING ABSORBER (E-SYSTEM)

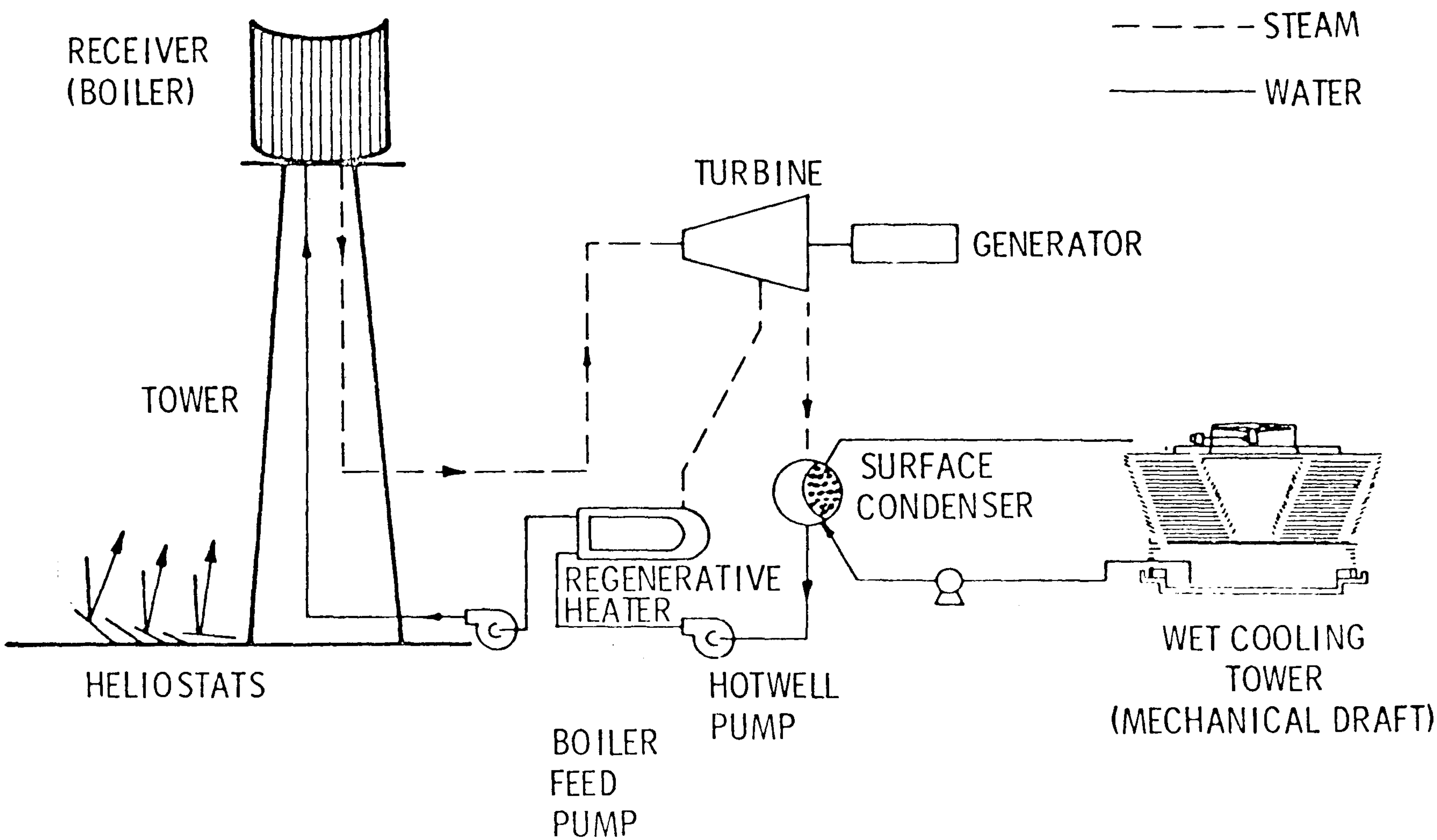

Figure 4

CENTRAL TOWER CONCEPT

In addition to losses already described, concentrating collector systems lose some part of the incoming beam radiation itself, primarily through reflection and refraction at glass surfaces and through inaccuracies in either the geometry of the reflecting surface or the positioning of the sun-tracking device. These losses can run from as little as 5 percent for the best back-surface mirrors to as high as 40 percent or more for poorly finished mirror surfaces. The higher the "concentration ratio"* for the system, the more difficult and expensive is the finishing of the reflective surface, and the more accurate the sun tracking must be. Generally speaking, concentration ratios of 1000 to 1 will give the desired 500 to 700 degree temperatures, and the resulting required accuracy in surface preparation and sun tracking, although clearly difficult to achieve, is not presently thought to be excessive.

The efficiency with which a concentrating collector system delivers the intercepted beam radiation to the absorber for the concentration ratios and steam temperatures described above has been estimated to run from a low of 40 percent to a high of greater than 80 percent. Values actually obtainable in a working system will not really be known until several systems have been constructed on a large enough scale (at least tens of thousands of square feet of intercepted sunlight) to yield meaningful results. We think the low values are unnecessarily pessimistic, and we will use a range of 60 to 80 percent for our estimate of probable efficiencies in small to medium sized power systems.

Combining this figure (60 to 80 percent) with the 25 to 30 percent efficiency which can reasonably be expected from the heat engine yields

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$$\text{*"concentration ratio"} = \frac{\text{intercepted area of sunlight}}{\text{area of absorber (heated) surface}}$$

an overall efficiency factor of 50 to 25 percent for the conversion:

Incident beam radiation on reflectors → Electrical energy out

Note that this is a range of nearly 2 to 1 in the expected efficiency, an uncertainty which makes a tremendous difference in the final economics of any solar power system. The area of collectors required for a 1-megawatt peak plant, with direct normal (beam) radiation at 950 watts per meter (300 Btu per square foot per hour), which is approximately the maximum near midday at any Texas location on a clear day throughout the year, will then be:

7000 square meters (approximately 77,000 square feet) if efficiency is 15 percent

4200 square meters (approximately 46,000 square feet) if efficiency is 25 percent.

Note that this figure represents the actual reflector area; however, the land area required for the mirror field would be two to three times these values. Taking into account the average number of hours of annual sunshine and the fact that efficiency of the plant will drop off sharply near sunrise and sunset, we can estimate that a 1-megawatt (peak) solar power plant will deliver:

2,950,000 kilowatt-hours per year in the El Paso "sun bowl" region,

2,150,000 kilowatt-hours per year in the Panhandle (Amarillo) area,

2,110,000 kilowatt-hours per year in the Central Texas region (Austin/San Antonio and Dallas/Ft. Worth)

1,910,000 kilowatt-hours per year along the coastal region with intermediate values elsewhere in the state, roughly following the direct-normal solar radiation contours presented in appendix A taken directly from [33].

Economics

The United States Energy Research and Development Administration has conducted a series of "mission analysis" economic studies on solar thermal generation of electricity using concentrating collectors. These studies first narrowed the type of concentrating systems down to the two which appeared "best": the power tower concept [1, 2] with its field of sun following flat surface mirrors, and the parabolic trough collectors oriented north-south and tracking the sun daily from east to west [2, 3]. In a later study conducted by a private company and since also sponsored partly by ERDA [4], the fixed spherical mirror section with a moving absorber was also analyzed for economics.

The results of these studies gave suprisingly similar costs for a kilowatt of installed electrical capacity. The large component cost in the systems is the large area of reflecting surface and the associated tracking equipment which account for an estimated 60 to 80 percent of the installed capital cost. The estimated costs for the installed mirror surface vary from a low of $10 per square foot to a high of $20 per square foot, and considering the nearly twofold variation in overall system efficiency discussed earlier, it is readily seen that final cost estimates of solar thermal power plants may easily vary by a factor of three. The truth us that no one is yet in a position to give a truly reliable cost estimate for the installation of hundreds of thousands of square feet of tracking collectors; and since these costs dominate the economics of solar power, it is clear that comparisons of the costs of electricity from solar and from conventional plants are tentative at best.

In addition to the domination of costs by the unknown collector costs, there is also the necessity of making numerous assumptions in the economic calculations in an attempt to compare a conventionally fueled plant, which is capable of producing power 24 hours a day, 365 days a year, to a plant which produces power 8 to 10 hours a day, and this only on clear days. Several schemes have been produced to overcome or compensate for this defect of solar power plants, but the one most likely to be adopted will be to build a plant somewhat larger than will be required by the expected peak load, and then provide some type of system to store excess energy which may be generated at peak solar fluxes and used later to provide power at night or on cloudy days. Balancing the size of the solar plant with the size and type (thermal, electrical) energy storage facility is a tricky economic and technical problem, one which will be solved only as experience on costs and performance of both the solar plant and the storage facility accumulate.

Reported below are the most recent estimates available on projected costs of solar power plants, in dollars per installed kilowatt of power capacity, and on costs of electrical energy derived from solar plants, in cents per kilowatt-hour of energy delivered. These plants include only minimal storage (approximately 2 hours) to allow for intermittent and minor peak shaving. The costs for the extended energy storage will be treated in a separate section of this report.

	Source of Estimate	Cost of Plant, $/kw	Cost of Energy, ¢/kwh
1.	Honeywell proposal on power tower concept [1]	925	3.5
2.	Aerospace mission analysis on parabolic trough concept [3]	1,025	4.0
3.	E-Systems proposal on fixed spherical mirror section, tracking absorber [4]	900	3.8

Although the power tower concept appears superior and the distributed parabolic trough the least attractive from the results of the above table, it is also obvious considering that each concept is undeveloped and untested that they exhibit essentially equal potential. The power costs of 3.5 to 4 cents per kilowatt-hour, when designed essentially as fuel savers (i.e., each needs essentially complete backup for inclement weather), are attractive considering that currently power costs across the state vary from 2.5 to 5 cents per kilowatt-hour. However, considering that either an independent standby system will be required or that auxiliary power is supplied through a utility grid, the additional cost of the standby system or possibly peak-priced auxiliary electric power must be accounted for in the construction of the solar plant. This factor will be addressed in the section on integrated solar systems.

Future Outlook

The Energy Research and Development Administration is putting their greatest emphasis on the power tower concept as the most promising solar electric power alternative. Presently a 5-megawatt (thermal) solar pilot facility is being developed and tested at Sandia Laboratories, Albuquerque, New Mexico. In addition, the design specifications for a 10-megawatt (electric) solar power tower facility are currently being developed, and in mid-1976 proposals were solicited and received by ERDA from electric utilities for the management integration of a 10-megawatt (electric) solar power tower concept into their electric utility system, the latter to initiate in 1978. Recently ERDA let a contract with Texas Technological University and E-Systems for the finalized design for a fixed spherical mirror-tracking absorber solar electric power system to ultimately be constructed for the city of Crosbyton in northwest Texas.

In general the outlook for concentrating solar thermal electric power generation is good, but it will be three to four years before an operating system is available for performance evaluation.

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3. "Solar Thermal Conversion Mission Analysis," Vol. IV, Contract No. NSF-C797, The Aerospace Corporation, January 15, 1974.

4. Gapta, Y. E-Systems, Inc., Dallas, Texas, personal communication.

2. Solar Thermal Electric Using Flat Plate Collectors

The term "flat plate" has come to be a generic name for any solar collector which does not concentrate solar radiation and which normally is fixed in position with regard to the daily movement of the sun from east to west. In some cases flat plate collectors may be adjusted periodically to take advantage of the seasonal variations in the sun's altitude. In its original form, the flat plate collector consisted of a metal absorber plate, usually blackened to enhance absorption of the sun's rays, a fluid (often water) circulating in contact with the metal of the absorber plate, and housed in an insulated enclosure with one or more transparent cover glazings to minimize heat losses to the surroundings.

More recent developments have seen variations introduced into the flat plate configuration, to include honeycombs and evacuation to suppress convection and/or conduction losses, selective surfaces to reduce radiation losses, and cylindrical absorber surfaces and reflecting surfaces built into the system to obtain small concentration. Thus, it is no longer strictly accurate to group collector systems into only the two categories, flat plate and concentrating. Nevertheless, for the purposes of this report, we will make this division an arbitrary one based on the temperature of the working fluid which the collector system delivers to the heat engine, with approximately 250 degrees Fahrenheit as the upper limit available from flat plate systems, and higher temperatures (up to 900 to 1000 degrees Fahrenheit) available from concentrating systems. While it is true that near-term developments in flat plate technology may result in higher temperature outputs, the

250-degree upper limit is considered an accurate reflection of the present state of the art, particularly for collectors now commercially available. Furthermore, to achieve reasonable collection efficiency, a limit of approximately 200 degrees for flat plate collectors is more realistic.

The advantages of the flat plate (fixed) systems over the concentrating (sun-tracking) systems are numerous. They include the greater simplicity in design for factors such as protection from the elements (wind-loading), simpler maintenance, and an ability to absorb energy from scattered radiation as well as from direct (beam) radiation. While this last factor can add as much as 20 percent to the collectable energy, it is more than offset by the ultimate inefficiency in the conversion device which must operate at the lower temperatures supplied by flat plate collectors.

While there are also several disadvantages of the flat plate systems, one factor overrides all others: the low efficiency with which thermal energy at approximately 200 degrees Fahrenheit can be converted into mechanical, and then electrical, energy. As discussed in the previous section, the theoretical limit on this efficiency is about 15 percent, while the practical limit is considerably less. The actual realized overall system efficiency from stationary flat plate systems will probably be no better than approximately 2 to 3 percent based on daily total radiation. This figure results from a "daily" collection efficiency of 20 to 25 percent and an engine efficiency of approximately 8 to 10 percent. (The collectors' peak efficiency near solar noon may exceed 50 percent but is approximately as indicated based on daily total radiation.) Another problem is that of the lack of efficient machinery (such as the highly developed modern steam turbine) to operate on low-temperature fluids. However, the major drawback is the excessive cost of the large area of solar collector panels.

There appear to be no detailed engineering analyses available on the electrical power cost for flat plate solar collector powered systems. Thus an estimate was made for a nominal 10-megawatt (electric) peak plant. For this analysis the collectors were assumed to be capable of somewhat in excess of 50 percent maximum collection efficiency at midday and to have a 25 percent collection efficiency based on total daily radiation. The 50 percent efficiency is chosen based on collection at 180 to 200 degrees Fahrenheit for an ambient temperature of 80 degrees and an insolation level of 300 Btu per hour per square foot. Figure 5 presents the efficiencies of several flat plate collectors tested by NASA/Lewis [5] which at this condition vary from 20 to 60 percent with most in the range of 40 to 50 percent. Thus, the chosen value is reasonable. The 25 percent average daily efficiency is a conservatively high result based on numerous in-house analyses. To produce 10 megawatts (electric) (peak) at 50 percent collection efficiency, an insolation level of 1000 watts per square meter and 8 percent engine efficiency, approximately 0.25 million square meters (2.8 million square feet) of collector are required. For Central Texas the average daily total radiation on a surface tilted at the latitude is approximately 5.8 kilowatt hours per square meter per day, which for 0.25 million square meters of collector, 25 percent daily collection efficiency, and 8 percent engine efficiency results in an annual electrical output of 10.6 million kilowatt-hours per year and an average output (over 4000 operating hours annually) of 2.6 megawatts (electric).

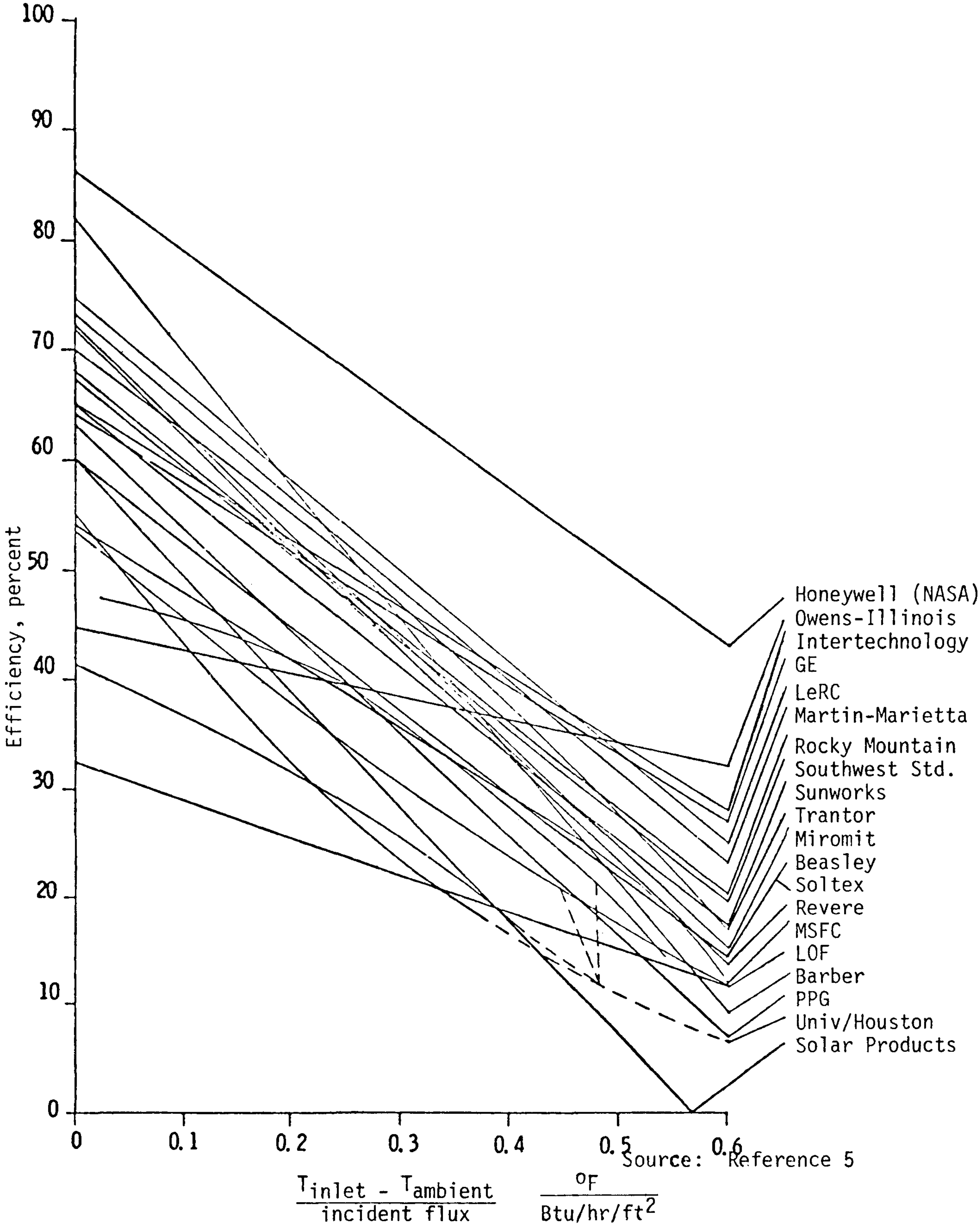

Figure 5

SOLAR COLLECTOR EFFICIENCY FOR VARIOUS FLAT PLAT COLLECTORS
(Measured in Solar Simulator)

For the required collector array at an installed cost estimated at $110 per square meter ($10 per square foot), the collector array itself costs $28 million. Including an additional $10 million for other direct and indirect costs in an analysis similar to that of [6] and a fixed charge rate of 16 percent, the energy cost for the system is projected to be approximately 600 mills per kilowatt-hour. This very high cost is the obvious reason that flat plat solar collector electric power is not receiving any serious attention, and is not a future candidate for electric power generation on a moderate or large scale.

References--Flat Plate Collectors

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6. Powell, J.C.; Fourakis, E.; Hammer, J.M.; Smith, G.A., and Grosskreutz, J.C. "Dynamic Conversion of Solar-Generated Heat to Electricity--Executive Summary." Vol. 11, Honeywell Inc., Minneapolis, Minnesota, and Black and Veatch Consulting Engineers, Kansas City, Missouri, August 1974.

3. Solar Thermal Electric Using Solar Ponds

Solar ponds are bodies of water exposed to and heated by the sun. They fall into two categories: nonconvective and convective. First, a nonconvective pond is a liquid pond in which the convection that is normally associated with the temperature is prevented by establishing an opposing density gradient with a solute (salt). Nonconvective ponds include saltwater ponds, ponds with membrane barriers, and ponds containing gels. Second is the shallow convective pond which is salt-free and behaves like a flat plate collector. The shallow solar pond reported in this study is the one proposed by Lawrence Livermore Laboratory [7]. The various pond configurations are described below.

Nonconvective Saltwater Ponds

A nonconvective saltwater pond consists of a saltwater liquid pool with the denser brine near the bottom of the pool so that the thermal energy absorbed at the bottom will be stored there. Thermal energy near the bottom will be trapped because of the opaque nature of water and because of the inability of the solution to convect due to the imposed salinity gradient. Thermal energy is then extracted from the bottom layer by circulating the hot brine to an external heat exchanger where a higher volatility fluid is boiled and expanded in a turbine which drives a generator. This concept has been investigated in reference [8]. (See figure 6.)

One of the most serious problems encountered in nonconvective saltwater ponds is the diffusion of salt, which travels from high concentration regions to regions of low concentration. This considerable diffusion of salt particles to the surface of the pond will destroy the density gradient. To keep the pond stabilized and functioning the concentration gradient must be continuously restored by replacing the salt water at the surface with fresh water and adding salt to the bottom. However, with this pond concept collections of 20 percent to 30 percent are quite possible, and relatively long-term storage is possible within the system itself.

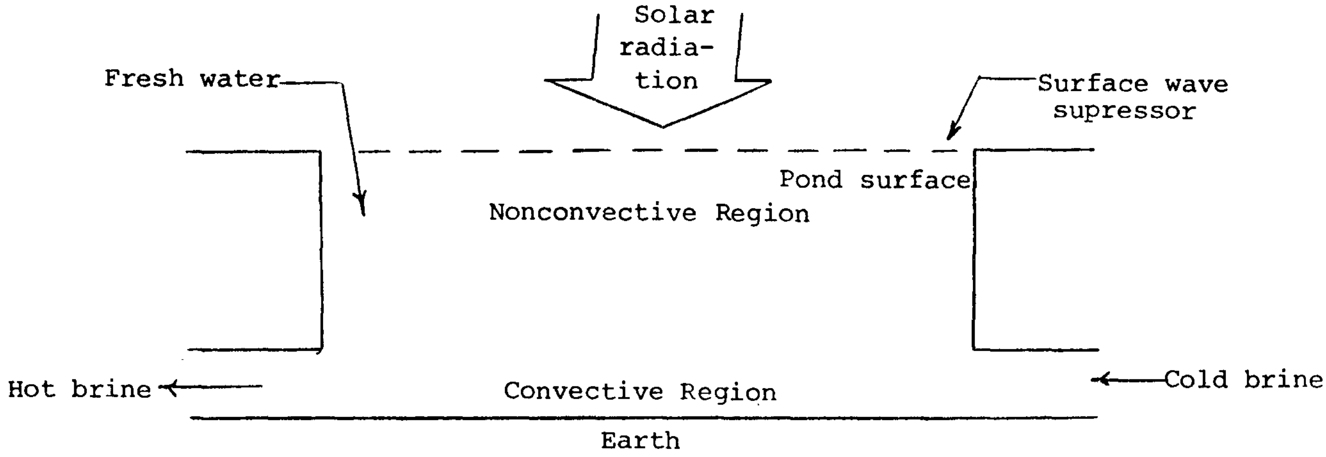


Figure 6

NONCONVECTIVE SALTWATER POND

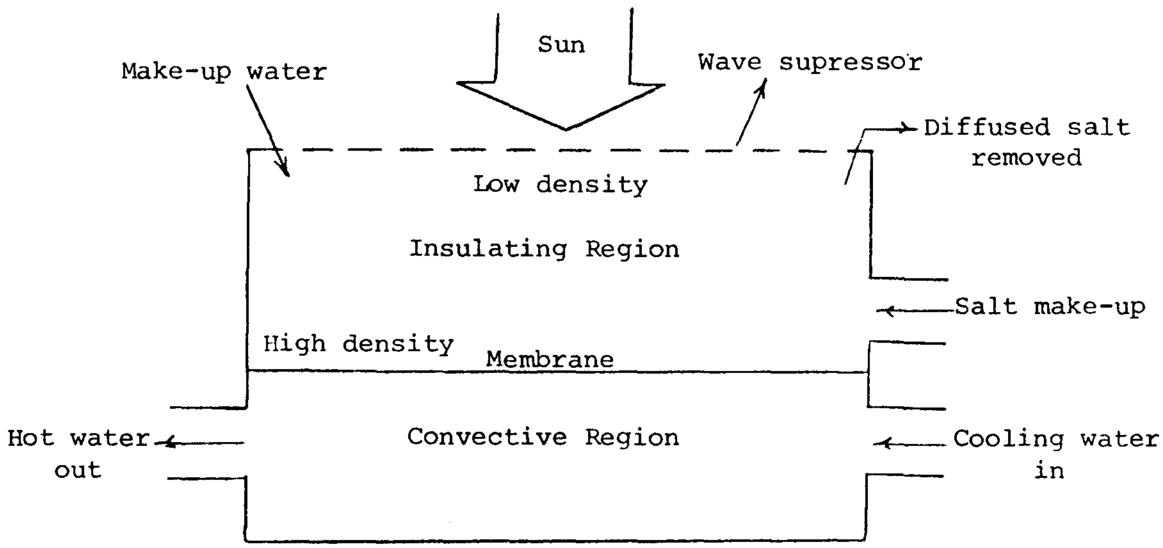


Figure 7

NONCONVECTIVE MEMBRANE POND

Nonconvective Membrane Ponds

A modification on the previous concept is to have a layer of water below the brine and separated from it by a transparent, flexible membrane to help maintain stability. (See figure 7.) The nonconvective component above the membrane is equivalent to the saltwater pond except that it does not contain a bottom convective region. The fluid in the bottom region can move freely with minimum mixing in the upper layer. This mobility would eliminate some possible instability due to energy extraction from conventional nonconvective salt ponds.

Problems associated with membrane ponds are similar to those of the saltwater ponds. Salt will diffuse from the bottom to the surface, and the salinity gradient has to be maintained as dicussed eariler. Generally speaking, the membrane pond is more stable during energy extraction, and fluid can be moved in the convective region freely without excessive perturbation of the insulating layer. This concept as well as another concept called a viscosity stabilized pond has been investigated [9].

Convective Shallow Solar Ponds

Another concept in solar ponds is the shallow (approximately 5 centimeters deep) solar pond composed of modules, each covered by two or three layers of transparent, weatherable plastic film. The modules are connected by plumbing that directs and controls the flow of water through them and into an underground reservoir. (See figure 8.) Typically the water will flow from the reservoir into each module inlet. Its temperature increases in flowing the length of the module, and finally hot water leaves the module outlet flowing back

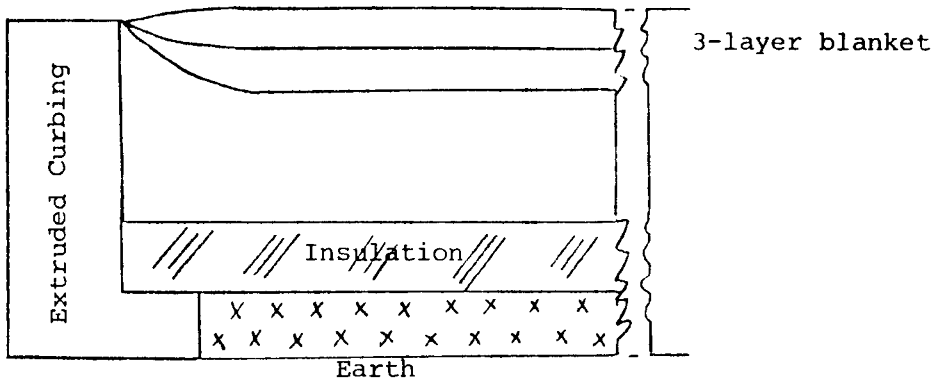


Figure 8

CROSS-SECTIONAL AREA OF A MODULE
FOR A CONVECTIVE SHALLOW SOLAR POND

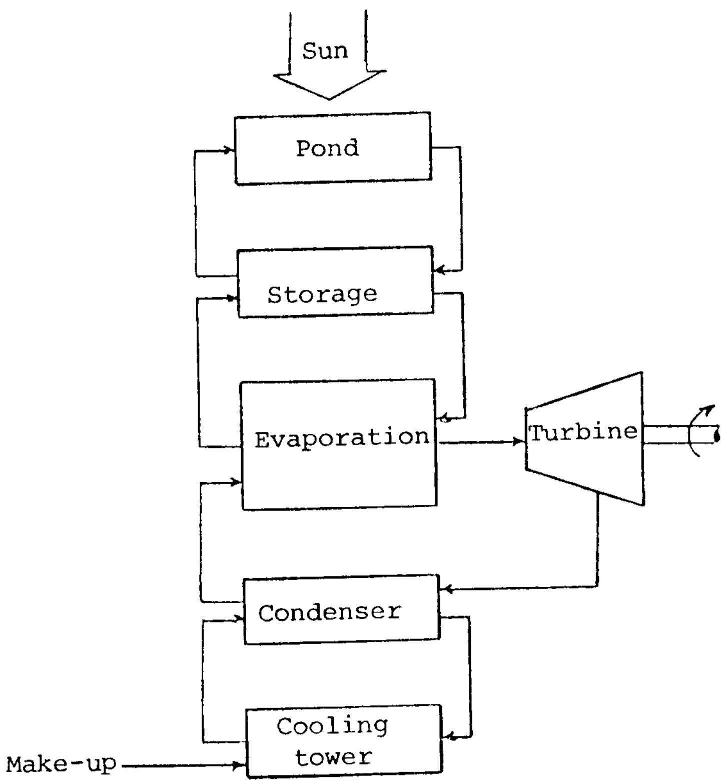


Figure 9

SKETCH OF A SOLAR POND POWER PLANT

to the reservoir. The continuous rate of water flow will be automatically controlled by temperature sensors. The hot water from storage is used to boil a secondary working fluid such a Freon II to drive a turbine, as depicted in figure 9. The Freon II, after expanding through the turbine, is condensed at about room temperature using water from a conventional cooling tower.

In the study done by Lawrence Livermore Laboratory [7], it was shown that the optimum collection temperature of 70 degrees centigrade results in maximum annual average power and minimum heat losses. Data from the study that was done for Phoenix, Arizona, were correlated in the manner shown in figure 10. By means of figure 10, percent collection efficiencies are calculated for three temperature collections using average weather data for San Antonio. Results are presented in figure 11. Figure 12 shows the ambient temperature, insolation, and power output for a collection temperature of 70 degrees centigrade. It shows that maximum power occurs in June-July, corresponding to maximum insolation and peak ambient temperature.

Size of the Solar Pond

Since there are no completely reliable engineering design data on any of the solar pond concepts because none has been built on a large scale, it will be assumed that all pond concepts have similar performance characteristics. On the basis of this study, it has been shown that the annual average collection efficiency is 0.345 for a collector temperature of 70 degrees centigrade. The corresponding average thermodynamic efficiency (Carnot efficiency) is (70-15/530) = 0.16 for a sink temperature of 15 degrees centigrade, resulting in a

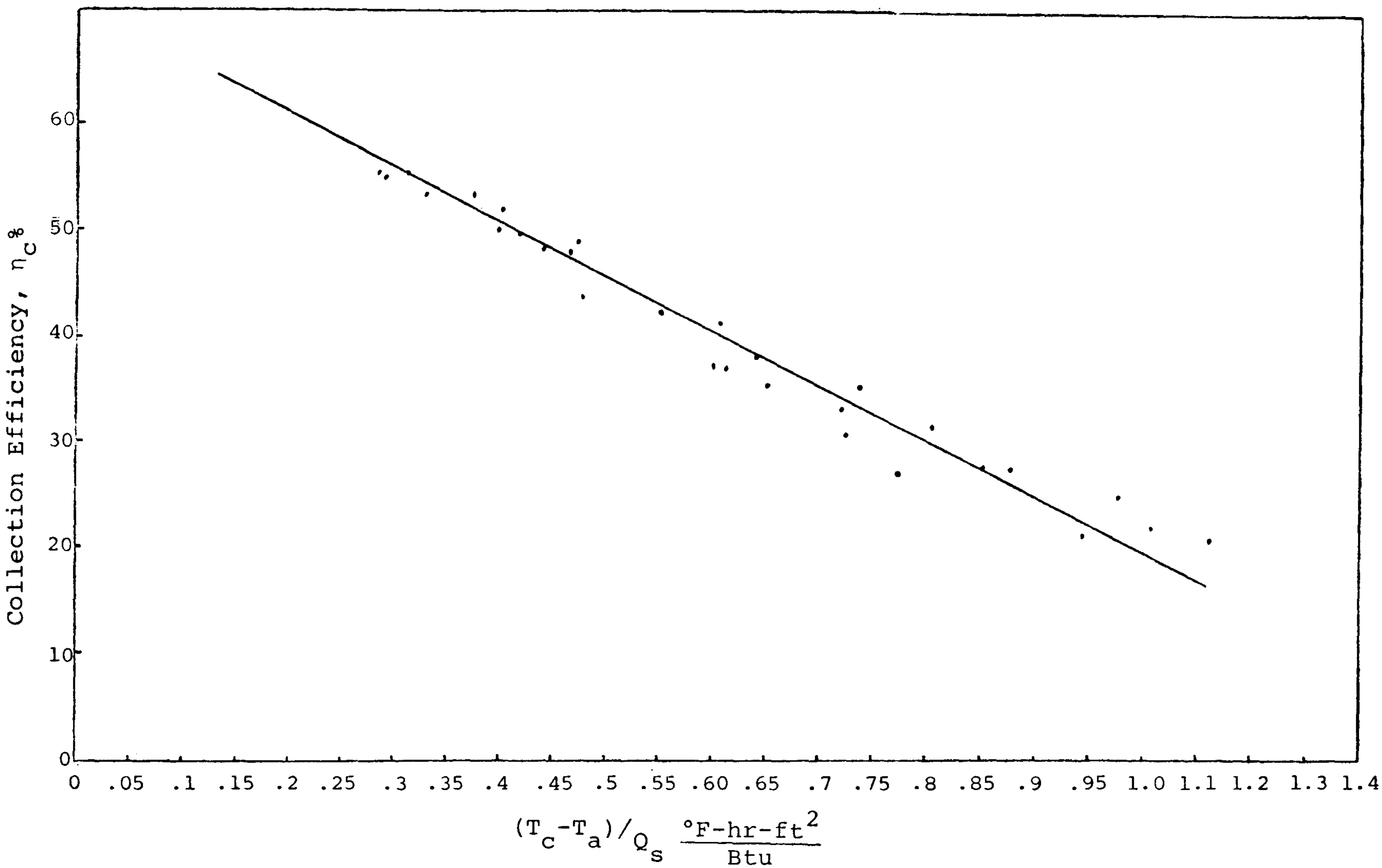


Figure 10

PERFORMANCE EFFICIENCY CURVE FOR A SHALLOW SOLAR POND OPERATING IN SAN ANTONIO

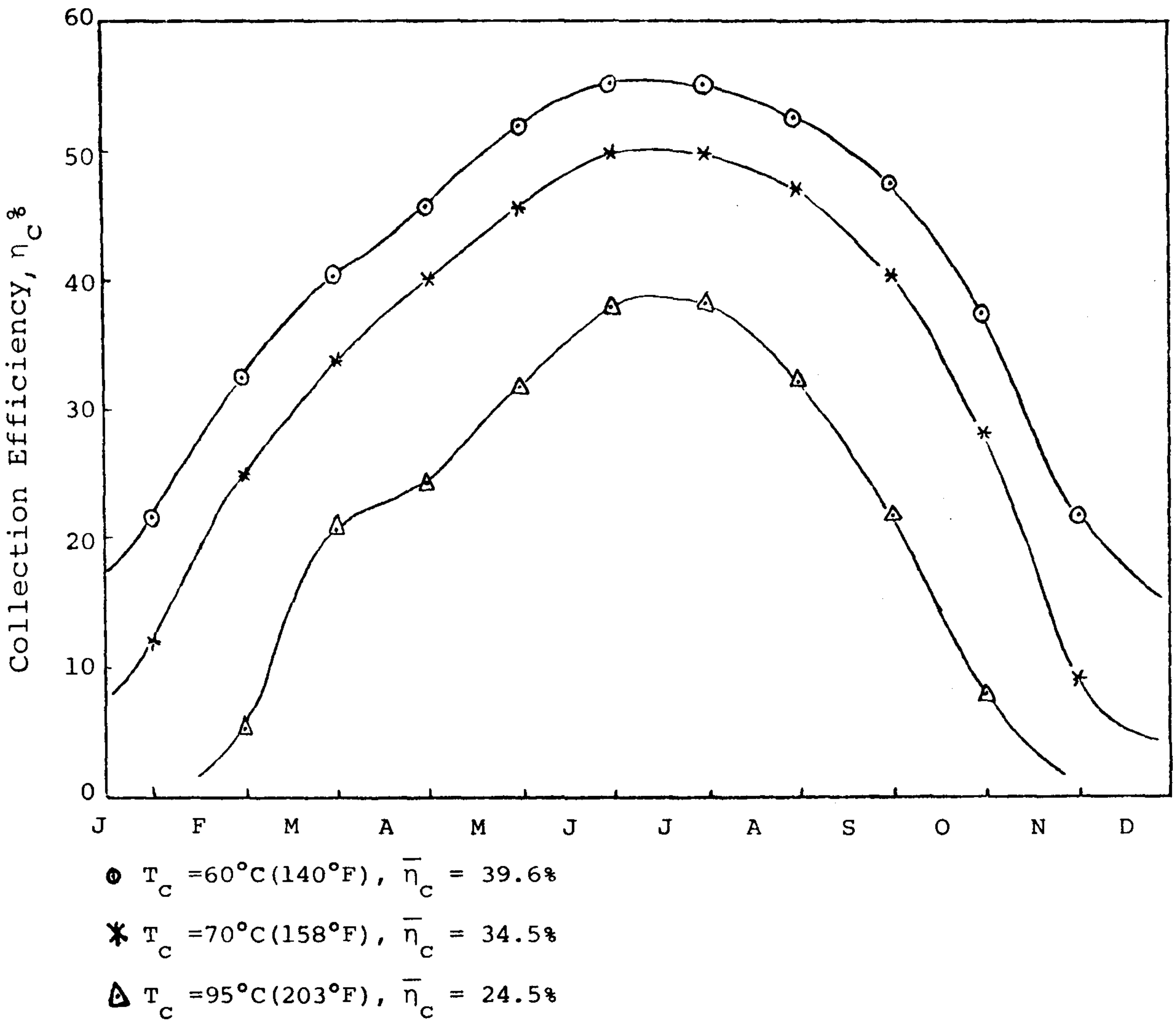
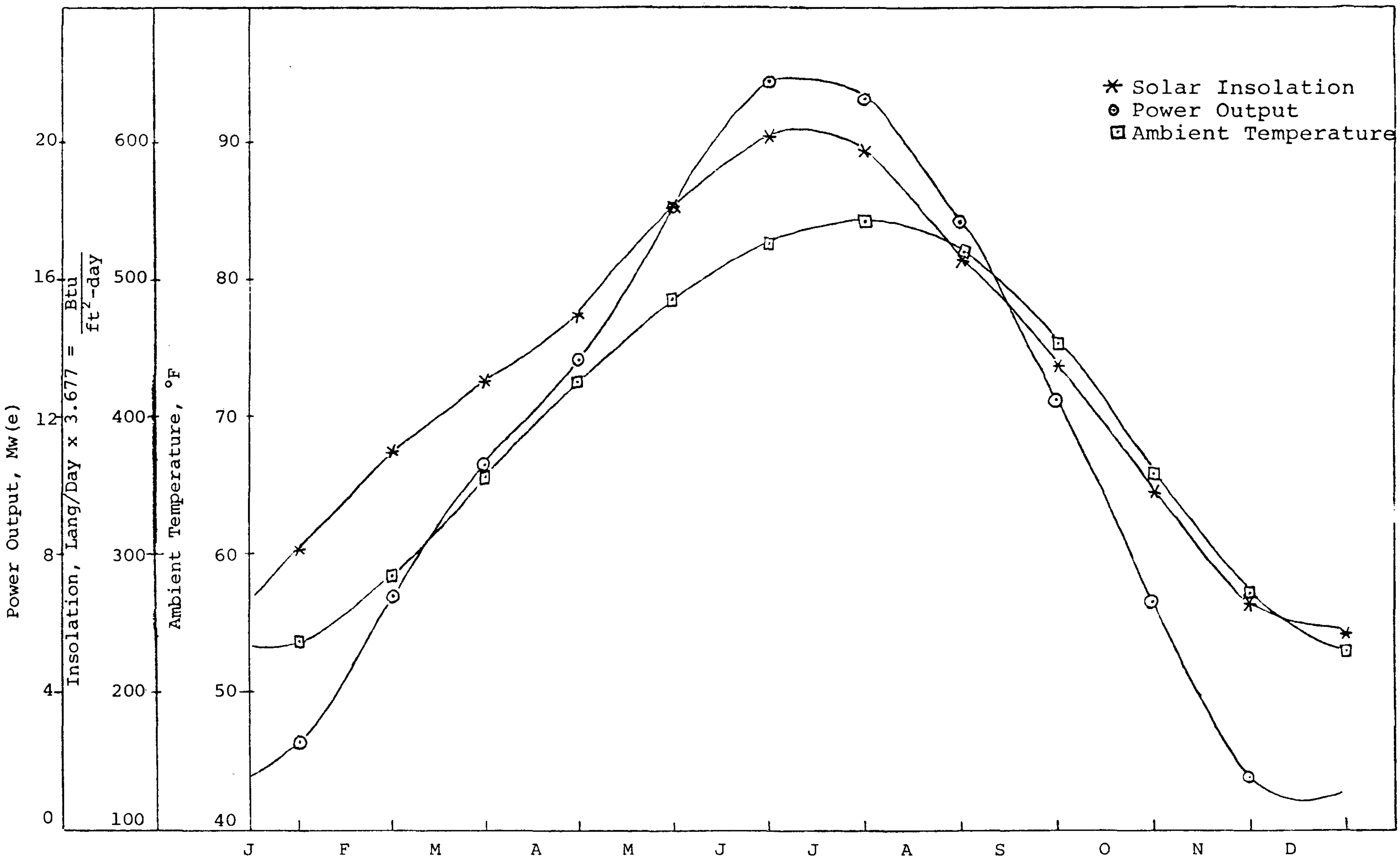


Figure 11

MONTHLY AVERAGE DAILY COLLECTION EFFICIENCIES FOR SAN ANTONIO USING TEDLAR COVERING AT THREE WATER TEMPERATURES



The annual average power output is 11.0 Mw(e).

Figure 12

MONTHLY AVERAGE AMBIENT TEMPERATURE, INSOLATION, AND POWER OUTPUT FOR T_C = 70°C FOR SAN ANTONIO system efficiency of 0.032. The overall system efficiency was calculated by $N_s = 0.58 N_c N_{ca}$ from [7] where N_c is the collection efficiency and N_{ca} is the Carnot efficiency. The constant 0.58 is the product of four quantities: 0.90, the ratio of net power output to generator output; 0.98, the generator efficiency; 0.75, the turbine efficiency; and 0.87, the fraction of Carnot efficiency in the Freon II-Rankine Cycle. Therefore, for an overall efficiency of only about 3 percent and average annual insolation of 430 Langley per day for San Antonio, the size of an average 10-megawatt (electric) solar pond is estimated as:

430 Langley/day = 1581 Btu/square foot-day

$$\text{Pond size} = \frac{\text{Average Power}}{\text{Insolation x Efficiency}} = \frac{10\text{Mw(e)}\text{x}3.413\text{x}10^6\text{x}24}{1581\text{x}.03} =$$

$17.3\text{x}10^6 \text{ft}^2$ (-1.60km^2) = 4160 feet (1.26 kilometer) on each side

In the case of a shallow pond, this area corresponds to 2,000 modules of 4 meters wide by 2000 meters long.

Solar Pond Cost Evaluation

The essential advantage of the solar pond is the relatively low cost per unit area. The disadvantage of the concept is the low overall conversion efficiency of converting solar radiation to mechanical/electrical energy. This low efficiency is inherent in any heat engine device that operates between narrow temperature limits, that is, the collection temperature attainable in a solar pond and the available temperature attainable in a solar pond and the available temperature for rejecting energy, namely that of the atmosphere or water body. Below is an estimate of a nominal 10-megawatt (electric) solar pond power plant. In addition, a summary of cost analyses for different pond concepts from [9] is included in table 1.

Pond Cost ($2 per square foot installed)	$33,000,000
Power Plant ($530 per kilowatt)	$ 5,300,000
Installed Cost ($ per kilowatt)	$ 3,830
Busbar Cost	125 mills/kilowatt-hour

Future Outlook

Solar ponds will probably see application for other uses where a substantial requirement is low-temperature thermal. However, used primarily as a solar electric plant, this concept does not appear promising because there are other solar concepts which exhibit considerably greater potential.

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8. Styris, D.L.; Zaworski, R.; and Harling, O.K. The Nonconvective Solar Pond: An Overview of Technological Status and Possible Pond Application. Richland, Washington: Battelle Pacific Northwest Laboratory, January 1975.

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Table 1

10-MEGAWATT (ELECTRIC) SOLAR POND CONCEPT COSTS OPERATING AT 90 DEGREES CENTIGRADE

	Salt Water		Membrane Barrier	Shallow Pond
	Steam*	Binary	Binary	Binary
Pond Cost (Millions of dollars)	41.6	41.6	28.0	31.1
Plant Capital Cost (millions of dollars)	17.148	7.107	7.107	7.107
Net Power Output (Mw)	6.652	7.653	7.653	7.653
Installed Cost ($/kw net)	8,690	6,366	4,588	4,993
Cost of Power (mills/kwh)	203.6	105.2	114.4	124.9

*Steam refers to the power cycle in which the steam produced by the pond is directly used as a working fluid. The higher cost of this cycle is attributed to the special heat exchanger (i.e., Flash Evaporator) needed. The binary cycle uses hot water from the pond to boil a secondary working medium.

B. Photovoltaic Solar Power

1. General Description

Of the various concepts for direct conversion of solar energy to electricity the so-called solar cell (or photovoltaic cell) is the most common and the closest to practicality. The basic concept in photovoltaic cells is that photons (solar radiation) interact with certain materials (semiconductors) and produce free electrons which will under certain required conditions flow through an external circuit (electricity). The great potential in photovoltaics is the direct conversion from solar energy to electricity without an intermediate energy form. Materials have been developed that result in a favorable efficiency of 10 to 23 percent. The present major drawback with photovoltaics is the high cost of manufacturing the cells; however, low-cost manufacture also represents one of the major potential breakthroughs in solar technology. Electric energy storage also represents a technological problem, although it is not unique to photovoltaics.

There are various types of solar cells [10, 11]. All, however, have several things in common: a semiconducting base layer with a conducting contact on one side and an electrostatic potential barrier on the other, a conducting grid pattern to provide a low series resistance, and an antireflection coating applied to reduce optical losses. The cell is usually encapsulated to protect the cell from the environment. These basic features are presented in figure 13 which is representative of the pn-junction silicon solar cell.

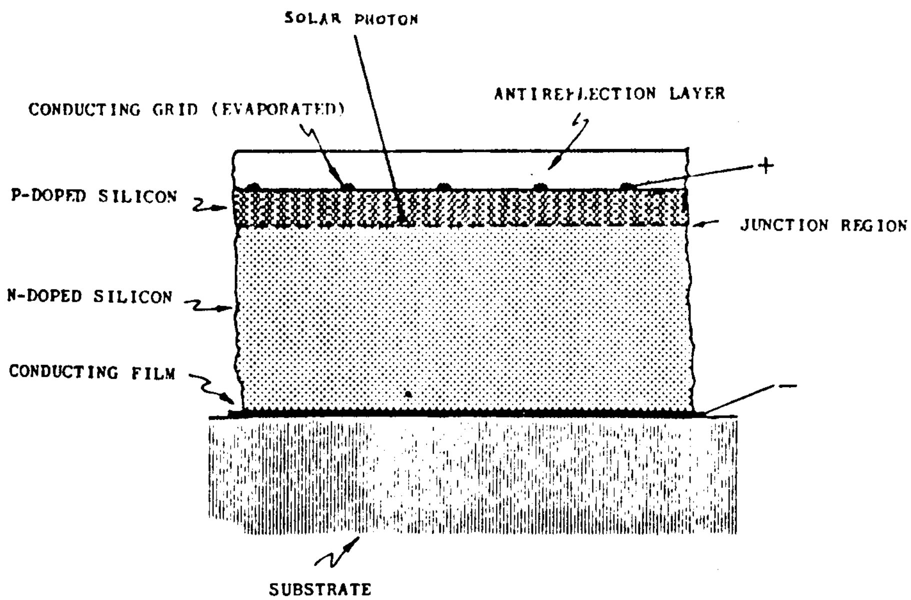

Figure 13

SCHEMATIC CROSS SECTION OF A SILICON (pn) SOLAR CELL

When a photon is absorbed in the silicon, an electron-hole pair is produced. In the silicon cell the junction region provides an electrostatic barrier such that if an electron created near the barrier has enough energy to traverse the barrier, it may flow through the external circuit (load) connecting the conducting grid to conducting contact. In the silicon cell the two layers of silicon are mildly doped with different materials (boron and arsenic), resulting in a so-called pn-junction cell, the pn-junction providing a permanent electric field barrier essential to the operation of the device. The conducting grid is a finely evaporated network which picks up the electrical current with low resistance while still not significantly shadowing the cell. The antireflection coating serves to reduce the losses from reflection of the incident solar energy, and the substrate provides a structural support for the cell material.

The common types of solar cells are as follows:

(a) Silicon: Have the advantages of relatively well-developed technology, relatively good long-term stability of the materials, and moderately high efficiency.

(b) Cadmium Sulfide: Composed actually of layers of copper oxide and cadmium sulfide with the layer between being the barrier. Cadmium sulfide cells which have been developed concurrently with silicon cells have the disadvantages of being subject to degradation because of water vapor and having a somewhat lower efficiency than silicon cells, but they have the advantage of being cheaper than silicon cells.

(c) Gallium Arsenide: A more recent development, composed of gallium aluminum arsenide and gallium arsenide. Their potential advantages are higher absorption of photons and higher operating temperature than silicon, but they are still very expensive.

The current-voltage characteristic of a solar cell is presented in figure 14. To obtain maximum power output, the load must be properly matched to the cell as indicated so that operation is near the maximum power rectangle.

The effect of temperature on efficiency is presented in figure 15 for three different types (silicon, cadmium sulfide, and gallium arsenide). It is seen that increasing temperature decreases efficiency in all cases, but at different rates for various cells.

The efficiency of solar cells may also be dependent upon the solar flux, as a result primarily of increased temperature occurring at higher fluxes. However, cells do not really suffer from "saturation." To maintain low temperature and thus high efficiency, it is important to thermally ground the cell to its substrate and to provide an adequately dense conducting grid to reduce internal resistance. Both silicon and gallium arsenide solar cells have been developed and operated at high concentration ratios [10, 11] without serious degradation of efficiency by adequate design.

2. Application and Economics

An up-to-date reference on the theory, applications, and economics of solar cell technology may be found in [12]. Solar cells may be used in flat panels (no concentration), but since cells are very costly (approximately $15 per watt at peak sun [13], this application is not very competitive. Because the cells are so costly, any method of more

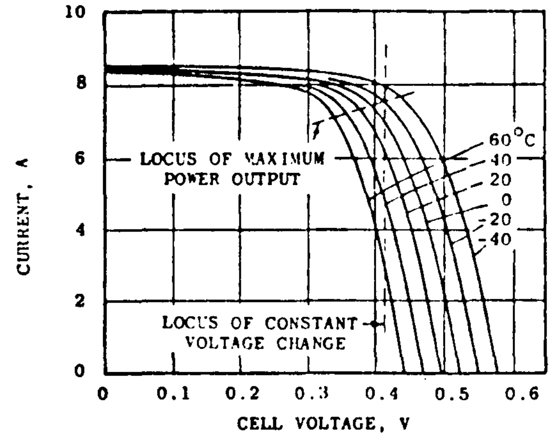

Figure 14

VARIATION OF THE CHARACTERISTIC CURVE FOR CADMIUM SULFIDE CELLS AS A FUNCTION OF TEMPERATURE

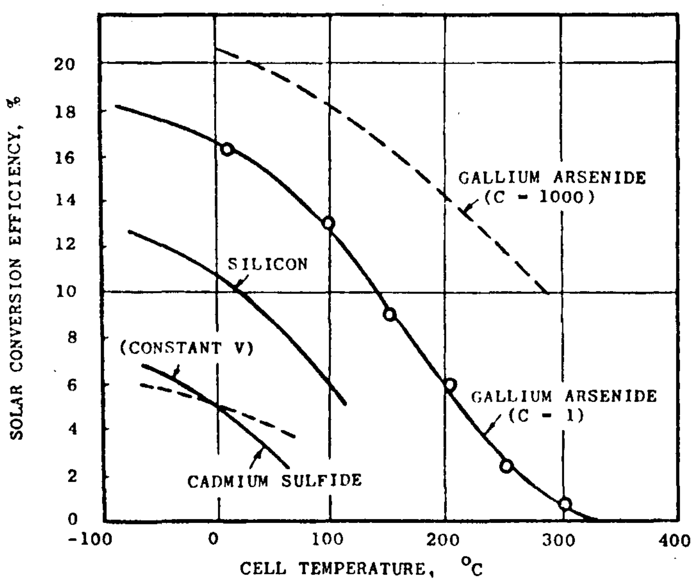

Figure 15

VARIATION OF EFFICIENCY WITH CELL TEMPERATURE FOR THE MAJOR TYPES OF SOLAR CELLS effective utilization--even with added expense--may significantly reduce the cost per unit of power. Examples are simply tracking a flat panel (increasing the daily collection per unit area), or using cells in conjunction with a concentrating collector. This latter method has the potential of greatly decreasing the cost per unit of power. A further application is to integrate solar cells into a total energy system where they are allowed to operate at a moderately high temperature (150 to 300 degrees Fahrenheit). In this case the efficiency is not greatly degraded but the temperature of the coolant fluid is sufficiently high to allow it to be used for other requirements, such as water or space heating or even absorption air conditioning.

Table 2 presents an estimated cost of photovoltaic power for the two cases of flat stationary panels and tracking concentrating collector cells with 100 concentration ratio. The estimate in the table assumes solar cells costing $15 per watt at peak sun (1000 watts per square inch) and with 15 percent efficiency. These figures are consistent with present or very near-term ERDA estimates of cost [13], and the efficiencies are consistent with high quality solar cells which may also be used at moderately high concentration ratios. The cost of the concentrators (individual tracked concentrators or heliostat mirrors in conjunction with a central tower) was based on cost estimates of [14] for the central tower solar thermal electric plant, approximately $100 per square meter. Costs for DC-AC conversion ($40 per kilowatt) and battery storage of 1 hour ($40 per kilowatt-hour) to provide continuous power for short-term intermittency are included. Note that the comparison is based on equal peak output, and thus the annual outputs differ because of tracking versus nontracking.

Table 2

COST OF PHOTOVOLTAIC POWER

	Flat Panels (Stationary)	Tracking Concentrating Collector/Cell (100 conc. ratio)
System Parameters:		
Plant capacity (peak) Mw(e)	10	10
Average output (over 4000 hr) Mw(e)	4.68	6.7
Annual energy production (millions of kwh)	18.7	26.8
Estimated Direct Costs (thousands $):		
Land	40	60
Panels/tracking concentrator cells	150,000	13,500
Tower or cooling	-	600
Electrical/converters DC-AC	400	400
Storage (1 hr)	400	400
Balance of plant	500	500
Total Direct Cost	~ 151,000	15,460
Estimated Indirect Costs*(20%)	~ 3,100*	3,100
	~ 154,000	~ 18,600
Unit Capacity Cost ($/kw of any 4000 hr output)	~ 33,000	~ 2,800
Contribution of Capital Investment to Energy Cost (mills/kwh 16% FCR)	~1,320 ($1.32/kwh)	~110 (11¢/kwh)

*Note: Indirect costs were estimated at 20% for the tracked-concentrating system, but the same total indirect cost was assumed for the flat panel system.

The advantage of the system with moderately high concentration and tracking is evident, i.e., 100 mills per kilowatt-hour versus 1320 mills per kilowatt-hour. The large cost of the untracked system is of course the tremendous investment in high-cost solar cells. However, even for the tracked concentrating system, the cost is not particularly attractive. No great advantage exists in going to higher concentration ratios because, even for the present case of 100 concentration ratio, the cost of the cells is estimated to be only about 15 to 20 percent of the concentrator/cell, and higher concentration will undoubtedly require more expensive cells and/or higher quality mirrors and tracking units. The main reason that the concentrated photovoltaic system is less competitive than solar thermal electric (see II.A.1) is that the overall efficiency of the photovoltaic concept is approximately 10 percent compared to approximately 20 percent for the solar thermal. This assumes 70 percent efficiency for collection of direct radiation in both cases, a 15 percent efficiency for the photovoltaic cells, and a 30 percent efficiency for the solar thermal Rankine cycle.

There appears to be potential for photovoltaic cells used in conjunction with concentrating collectors when they are used in a total energy concept. The cells are cooled to modest temperatures of 150 to 300 degrees Fahrenheit such that efficiencies are not greatly degraded, and the coolant temperature is adequately high for use in water heating, space heating, or even absorption air conditioning. To be most advantageous the system needs to be distributed so that the thermal energy can be used effectively for the above purposes. Present interest is directed toward use in residences to meet electrical and other thermal needs (heating, air conditioning). However, for a community of 3,000 to 30,000, small total solar energy "parks" could conceivably be distributed around the community to facilitate the transport of hot or chilled water for water heating and for heating and cooling of buildings in each area.

3. Future Outlook

The possibility of cost reduction in solar cell production of factors of approximately 30 to 100 is one of the potential breakthroughs in solar technology. The ERDA goal in reducing solar cell cost is from the present value of approximately $15 per watt at peak sun to $.50 per peak watt in 1986. If this is accomplished, generation of electricity with solar cells will be cost-competitive with other conventional and solar energy sources. However, it is felt that solar cells will be used in a decentralized generating system when the advantage of a total energy systems can be realized, rather than in a central generating facility.

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C. Wind Energy Conversion

The potential for extracting power from the wind is through its kinetic energy. Figure 16 shows a plot of power as a function of wind velocity where the power varies as the cube of the velocity up to the "design" velocity and thereafter is constant. Note that in this range a decrease in wind velocity of a factor of 2 results in a decrease in the wind power by a factor of 8. Above the design velocity the rotor (blades) would be feathered in most applications because of structural and dynamic limitations, and that would result in a constant output.

Although the power in the wind varies with different wind speeds, only some fraction of this power can be recovered. The fraction depends on the power coefficient of the system. The maximum percentage of power that can theoretically be extracted by an ideal rotor is 59.3 percent.

The actual power recovery from the wind (actual power coefficient) depends on the type of rotor, and for each type the coefficient is a function of the ratio of the rotor speed (tip speed) to the wind speed. Figure 17 shows the power coefficient for several types of wind turbines as a function of the tip speed ratio. In general, smaller ratios require more blades and result in high starting torque

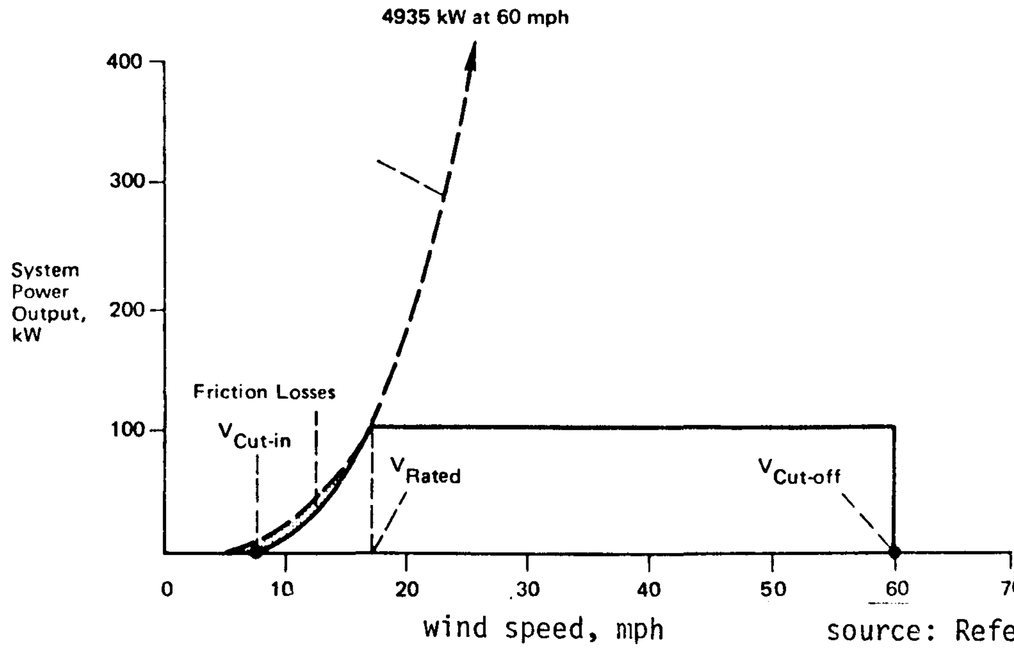

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Figure 16

POWER OUTPUT OF NASA 100 KILOWATT MACHINE

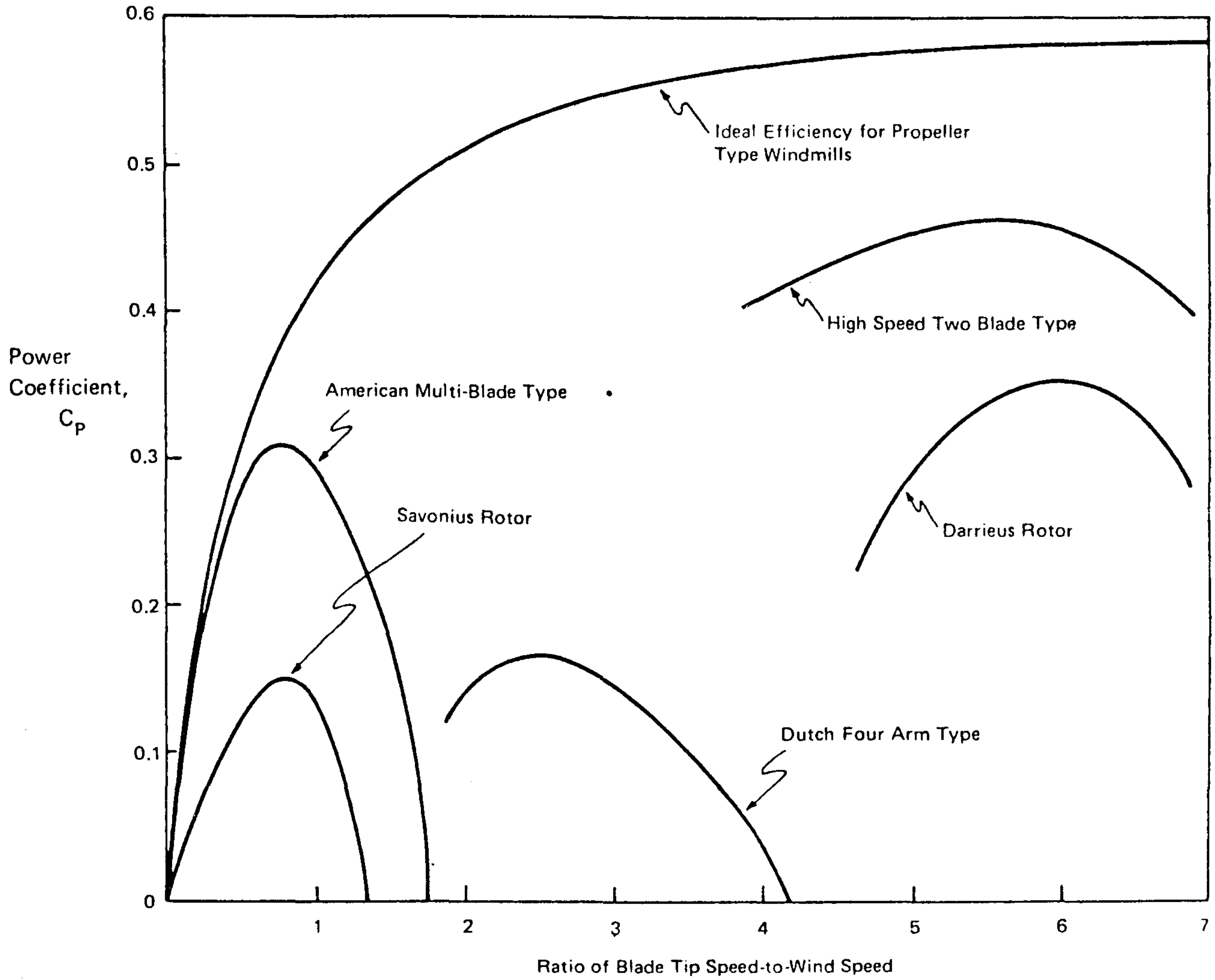

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Figure 17

TYPICAL PERFORMANCES OF WIND MACHINES

and low rotational speeds. Higher ratios require fewer blades and result in low rotational speed and low starting torque.

In practice, only approximately 70 percent of the maximum theoretical limit is recoverable, meaning the overall efficiency from wind power converted to mechanical shaft power is limited to approximately 40 percent. Considering aerodynamic efficiency, mechanical drive, and the electric generator, the overall conversion efficiency of wind power to electricity will be approximately 30 percent.

1. Types of Machines

There are two basic kinds of aeroturbines: horizontal axis and vertical axis. Each configuration has its advantages and disadvantages. There appears to be no simple solution to the selection of the aeroturbine, and the final choice is influenced by economics.

Horizontal Axis Aeroturbine

There are many kinds of this type of aeroturbine; two of the interesting designs are discussed below. Figure 18 shows a schematic of the 100-kilowatt Mod-0 wind turbine developed by ERDA and NASA, which has two blades. It is designed to cut in at wind speeds of 8 miles per hour and achieve its rated 100-kilowatt output at 18 miles per hour. The rated rotor speed is 40 rotations per minute (constant), and the generator speed is 1800 rotations per minute.

Figure 19 shows a photograph of the experimental windmill farm at Oklahoma State University. The multibladed turbine operates at variable speed near the optimum tip-to-wind-speed ratio to maintain a high power coefficient and drives a field-modulated generator to produce a constant frequency electrical output.

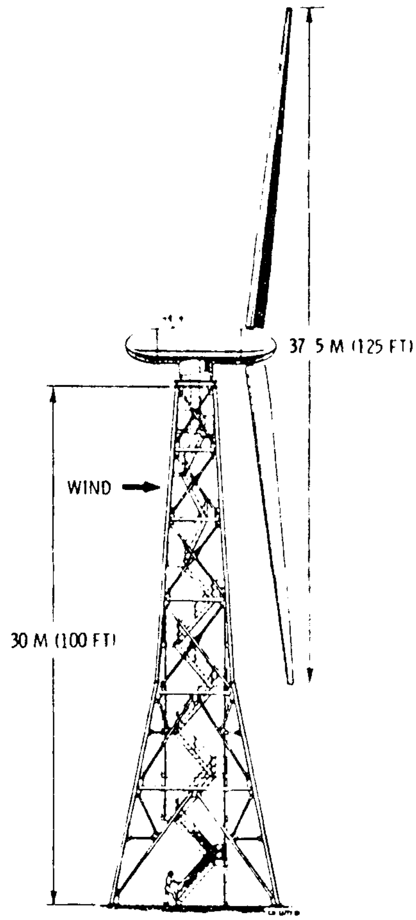

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Figure 18

ERDA/NASA (LeRC)'s 100-KILOWATT MOD-0 SYSTEM

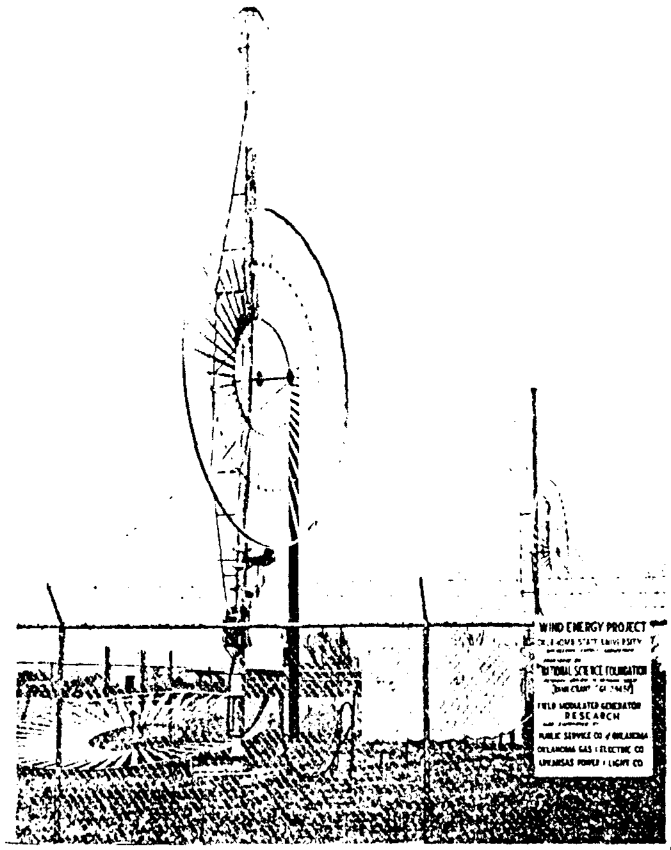

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Figure 19

A VIEW OF OKLAHOMA STATE UNIVERSITY EXPERIMENTAL WINDMILL FARM IN STILLWATER, OKLAHOMA

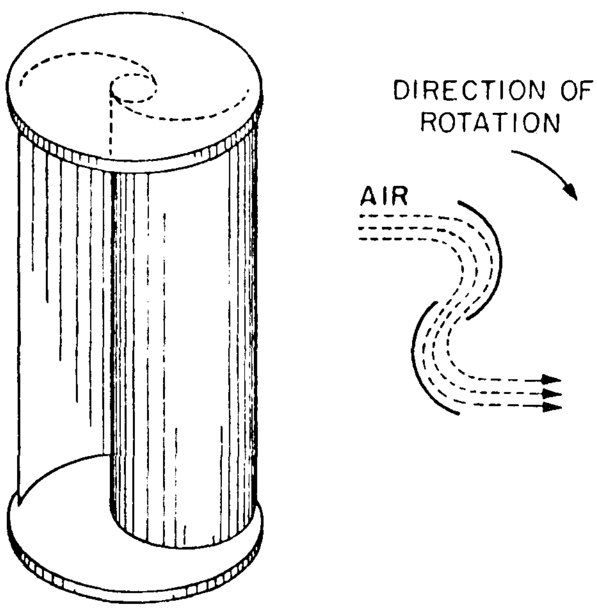

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Figure 20

SCHEMATIC OF THE SAVONIUS ROTOR

Vertical Axis Aeroturbine

These aeroturbines are mounted vertically and thus collect wind from any direction. They have the advantages of delivering mechanical power at ground level, having less weight aloft, not being subject to gyroscopic forces due to changing wind direction, and being simpler in construction. Figure 20 shows a Savonius rotor, which consists of an S-shaped metal air foil supported between two circular end plates. Wind impinging on the concave side is circulated through the center of the rotor to the back of the convex side, there decreasing the negative pressure region. Power coefficients of Savonius rotors are very low (around 16 percent; see figure 17). They operate at low tip speed ratios and have high starting torque.

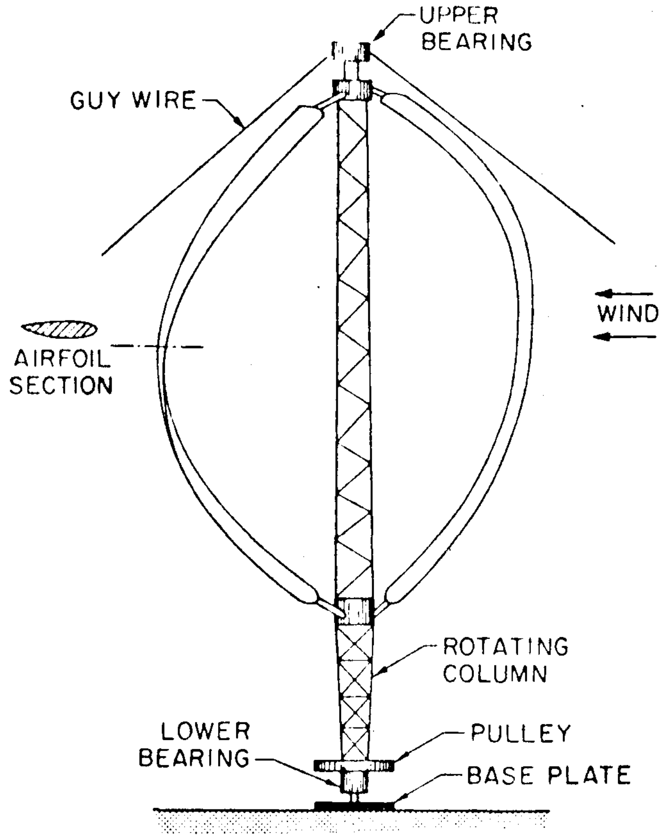
The Darrieus rotor has two or more curved airfoil blades in tension and held together at top and bottom. Figure 21 shows a two-blade arrangement of the Darrieus rotor. The vertical axis rotors are normally supported at the top by guy wires.

Another vertical axis turbine is the giromill, which consists of a set of vertical blades attached to the axis by means of support arms at the top, bottom, and middle. Figure 22 shows an artist's concept of a giromill.

Several other innovative horizontal and vertical axis aeroturbines are being investigated by various organizations. The above types are typical, however, and although there will undoubtedly be further improvements and new designs, it is not felt that there will be any great breakthroughs beyond the present concepts.

2. Economics

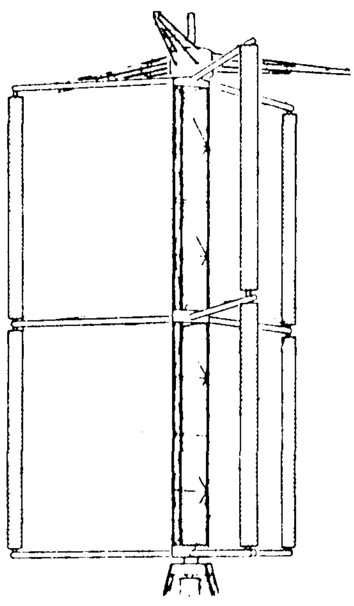
Because of the low energy density and the unpredictable nature of the wind, wind energy utilization is fairly capital-intensive for



source: Reference 15

Figure 21

SCHEMATIC OF THE DARRIEUS ROTOR



source: Reference 16

Figure 22

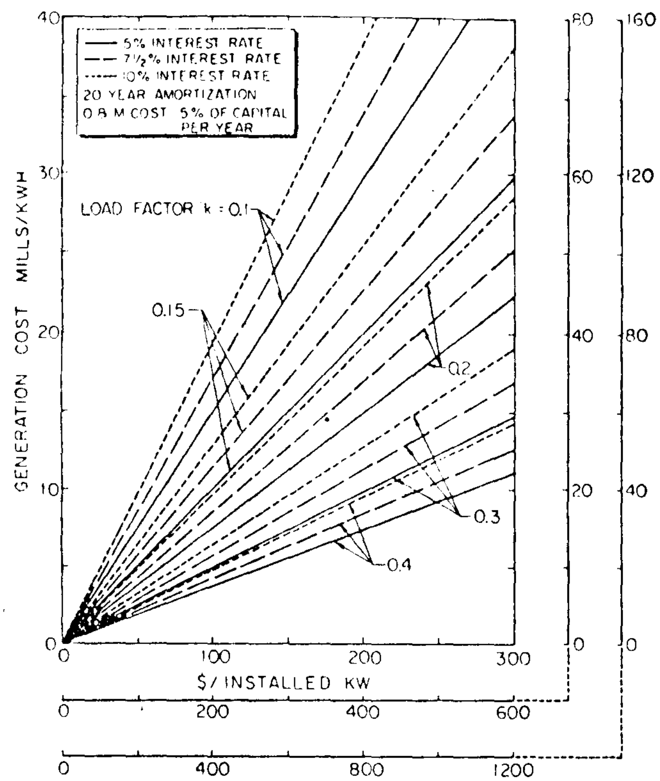
SCHEMATIC OF THE GIROMILL

collection and conversion. This is its major disadvantage. Figures 23 and 24, taken directly from Ramajumar [15], assume a 20-year amortization period with operation and maintenance costs at 5 percent of capital cost per year. Figure 23 shows the generation cost in mills per kilowatt-hour as a function of installed cost and load factor. In figure 24 break-even capital costs are plotted as a function of plant load factor and fuel cost for different interest rates. It is clear that if plant load factor is high and fuel costs continue to escalate, the capital cost of wind energy systems may also be high and still compete.

As an example, consider a wind energy system with a plant load factor of 0.20. If such a system can be built for $400 per kilowatt, then for an interest rate of 7.5 percent the generation cost is 34 mills per kilowatt-hour (figure 23). This amount is equivalent to a fuel cost of $3.28 per million Btu or $19 per barrel of oil.

For a fuel cost of $2 per million Btu or $11.50 per barrel of oil, with the same load factor of 0.20, break-even capital cost will be $262, $231, $205, and $182 per kilowatt for interest rates of 5.0, 7.5, 10.0, and 12.5 percent respectively.

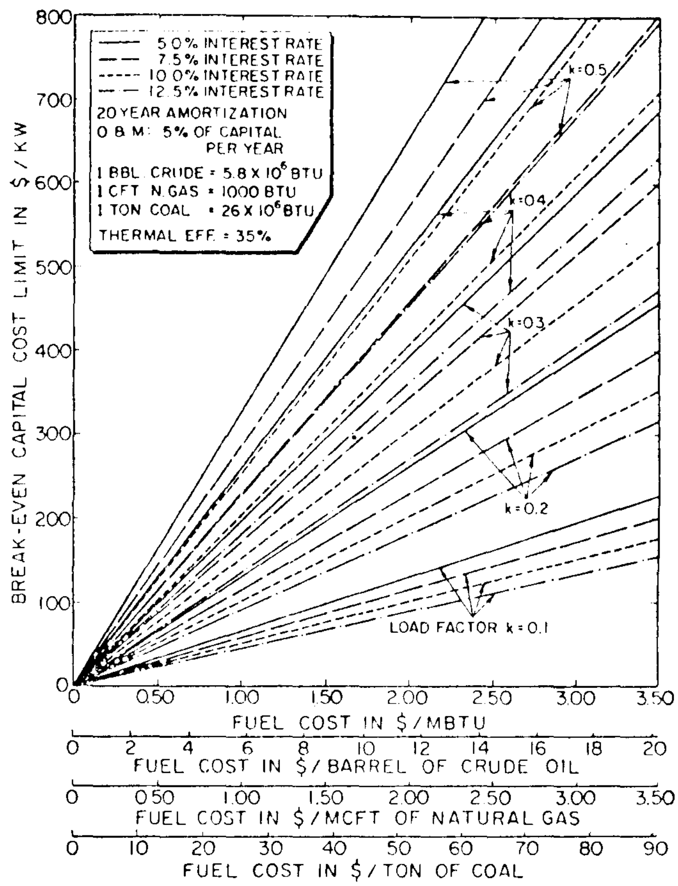
The projected capital cost and capital cost per kilowatt are presented in figures 25 and 26 from reference 16. Even though the capital cost increases with the size and rated output of the machine, the capital cost per kilowatt decreases as is usual in scalings. Therefore, economically, it is preferable to use one large wind machine unit in an application rather than a number of small units. The present and expected turbine costs are shown in figure 27A. To give an idea of a wind energy conversion system cost, the costs for



source: Reference 15

Figure 23

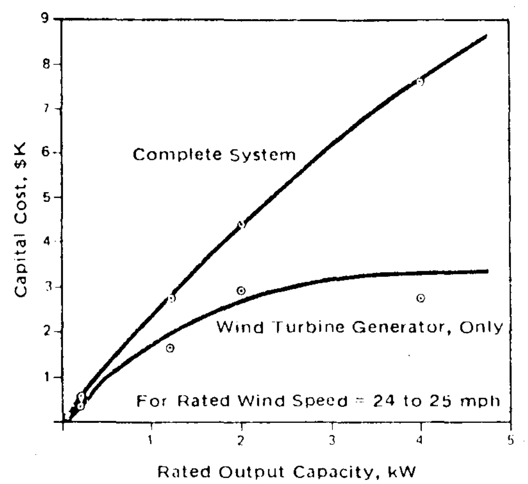
GENERATION COSTS FOR WIND ENERGY SYSTEMS



source: Reference 15

Figure 24

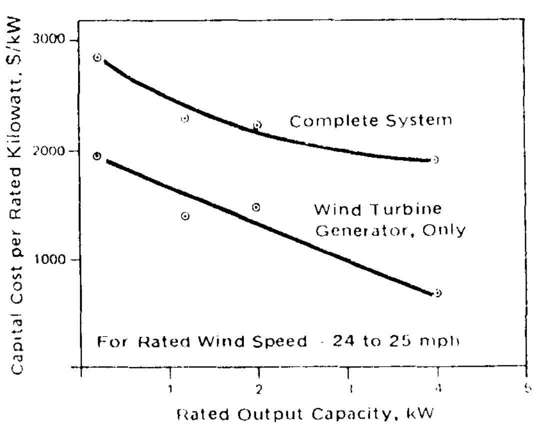
BREAK-EVEN CAPITAL COST LIMITS
FOR WIND ENERGY SYSTEMS



source: Reference 16

Figure 25

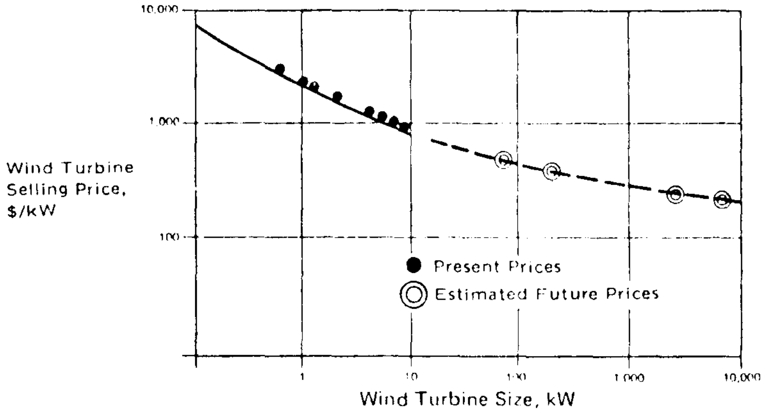
CAPITAL COST OF SMALL CONVENTIONAL WIND MACHINES



source: Reference 16

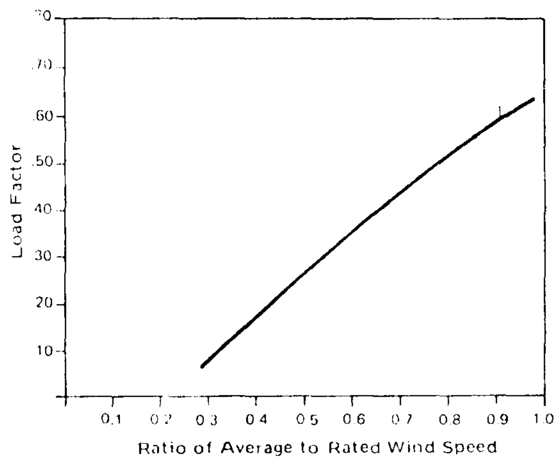
Figure 26

CAPITAL COST PER RATED KILOWATT FOR
SMALL CONVENTIONAL WIND MACHINES



source: Reference 16

A. Expected Wind Turbine Selling Price Versus Size



source: Reference 16

B. Load Factor for Wind Machines
in Typical Wind Regimes

Figure 27

WIND TURBINE PRICE AND LOAD FACTOR CONSIDERATIONS the experimental and production units of the NASA 100-kilowatt system are presented in table 3.

Two important factors in determining the capital cost of a wind machine are the load factor and the rated wind speed. By definition, load factor is the average output of any system divided by its rated power output. Load factor varies with the ratio of average to rated wind speed (figure 27B), and is seen to increase as the wind speed ratio increases. The reason that the load factor is less than one even at an average to rated wind speed ratio is that in actual operation wind speed is variable.

To minimize the capital cost per average kilowatt of capacity (i.e., the capital cost per rated kilowatt divided by the load factor), the load factor must be increased. But for a specific location, an increase in the load factor would require a decrease in the rated wind speed (figure 27B) which consequently decreases the rated power output. This smaller rated output increases the capital cost per rated kilowatt according to figure 26 rather than decreasing it. Therefore, there exists a trade-off between capital cost per rated kilowatt and load factor that results in a minimum energy cost of a wind system.

The busbar price (cost of electricity as produced at the generator) can be calculated as follows:

$$\text{Busbar price (mills per kilowatt-hour)} = \frac{CC \times FCR}{LF \times 8760} + O\&M$$

Where CC = capital cost per rated kilowatt

FCR = fixed charge rate (about 15 percent)

LF = load factor

O&M = Operational and maintenance costs (=2 mills per kilowatt-hour)

8760 = hours in a year

Table 3

SUMMARY OF COSTS FOR NASA 100-KILOWATT (RATED) EXPERIMENTAL

WIND ENERGY CONVERSION SYSTEMS
(12 mph average wind speed)

	Experimental Units 100 kw (Rated) (thousands of $)		Production Units 100 kw (Rated) (thousands of $)	
Rotor				
Blades	$160	50.4%	$ 35	43.7%
Hub, Pitch/Change	$ 95		$ 30	
Mechanical				
Gear Box	$11.5	10.8%	$ 8	18.8%
Bedplate, Shafts, etc.	$43		$ 20	
Electrical Generator, Controls	$68	13.5%	$ 16	10.7%
Tower, Foundation	$128	25.3%	$ 40	26.8%
	$505	or	$149	or
	$5,050/kw (Rated)		$1,490/kw (Rated)	

source: Reference 16

Consider the NASA wind energy system rated at a velocity of 18 miles per hour and 100 feet high operating in the region of Amarillo-Lubbock with annual average wind velocity of 13 miles per hour. The ratio of the average wind speed to rated wind speed is then calculated:

$$\text{ratio} \ \frac{\text{average wind speed}}{\text{rated wind speed}} = \frac{15.5}{18} = .86$$

Where the 15.5 mile per hour average wind speed is the average wind speed of 13 miles per hour at the height of 100 feet (appendix A). Therefore, by use of figure 27B, this ratio results in a load factor of about 0.55, which with a capital cost of $1490 per kilowatt (table 3) results in a busbar price of approximately 48 mills per kilowatt-hour.

References - Wind Energy

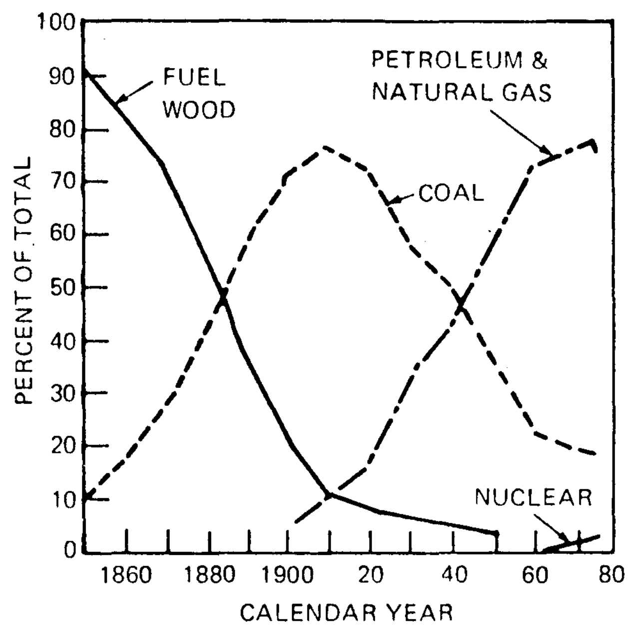
15. Ramakumar, R., "Wind Power: A Review of Its Promise and Future." ASME 16th National Heat Transfer Conference, St. Louis, Missouri, August 1976.

16. Eldridge, Frank R., Wind Machine, Mitre Corporation, Westgate Research Park, McLean, Virginia, October 1975.

D. Fuels From Biomass

1. Introduction

The use of biomass as a fuel is not new. In fact, until about 100 years ago, biomass (primarily wood) was the nation's primary source of energy (see figure 28). The conversion of biomass into more suitable fuel forms, such as methane, is likewise not new, but the process is currently receiving increased attention since the product provides a substitute for natural gas. The use of biomass declined as a result of



SOURCE: HISTORICAL STATISTICS OF THE UNITED STATES BUREAU OF THE CENSUS; U.S. BUREAU OF MINES, 1974

Figure 28

U.S. ENERGY CONSUMPTION PATTERNS

availability of low-cost fossil fuels that had greater versatility and were easy to transport, store, and use. Now, with rapid escalation in costs and threatened exhaustion of fossil fuels it is logical to reconsider use of replenishable biomass energy where practical.

Current production of biomass worldwide (much of it in uncontrolled growth) has been estimated at 146 billion tons [17]. Five percent of the total world biomass could supply energy equivalent to the world's oil and gas demands, and about 6 percent of the United States' land area could provide the energy equivalent to its oil and gas requirements. The amount of land required could be reduced through careful selection of the plants to be grown. The yield of different species ranges from 10 to 20 tons of dry organic matter per acre per year for farm crops to 60 tons per acre per year for algae, grass, and other high yield crops. Generally, marine plants such as algae, kelp, and water hyacinths offer the highest growth rates. Problems of growth, collection, storage, and conversion to suitable fuel forms are the subjects of most current investigations.

Several researchers have proposed large energy crop farms [17, 18, 19, 20, 21, 22, 23] sufficient to power central generating stations of 1,000 megawatt capacity, requiring approximately 250 square mile tracts of land. This approach is interesting and may have some potential for parts of Texas, if one is willing to accept the ecological consequences of intensive cultivation and the competition for land and water with other uses. The large-scale production and utilization of biomass are beyond the scope of this report, which is directed toward small-scale application available to communities.

The potential for biomass production and utilization may be even more interesting from a small community perspective. The necessity to transport and store the product is minimal, and the possibility exists for multiple use of certain facilities. Some communities in Texas have water and land resources which permit serious consideration of biomass as a renewable solar energy converter to reduce their consumption of natural gas. It is from this viewpoint that various concepts will be discussed that may have applicability for certain regions of Texas.

One of the prime attributes of biomass utilization is that the cost of energy storage is minimized. Unlike other solar technologies, conversion and storage occur simultaneously, thus eliminating the high cost of thermal or electrical storage.

An overview of the options a community might have for use of biomass resources for power generation is shown in figure 29. The availability of resources, of course, varies widely from region to region. The technology for conversion to fuels is essentially available, although only limited community experience is available. Some of the processes are more familiar than others. Figure 30 shows three typical biomass fuel conversion systems. The digestion of municipal wastes is a common practice, but the methane produced is often used only for power in the waste treatment process itself. Similarly, the bagasse produced as a by-product of sugar refining has been used only for in-plant power production in Texas, although it is used more extensively for power production elsewhere, such as the Philippine Islands and Hawaii. The newer approach of growing crops specifically for energy production,

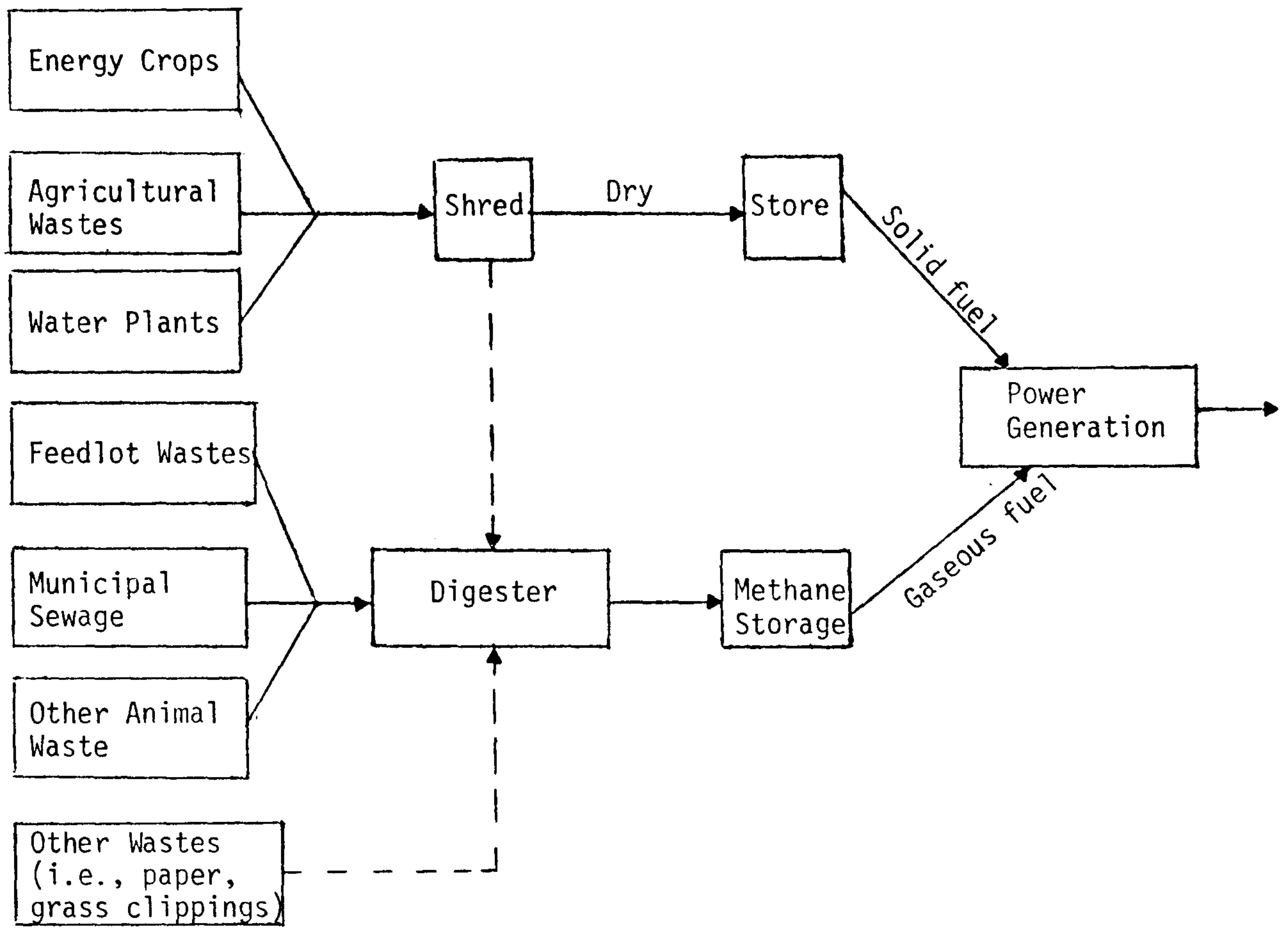
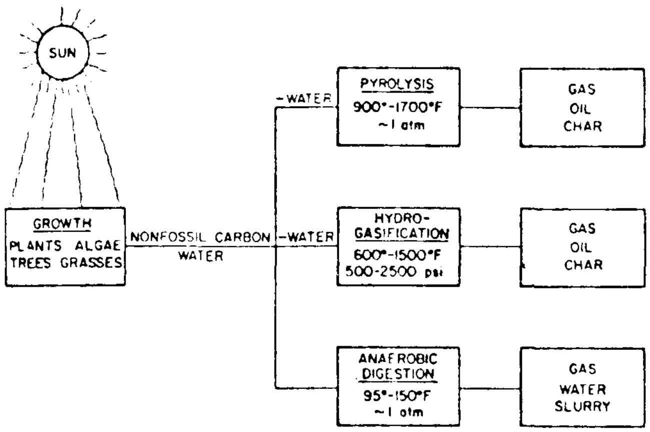


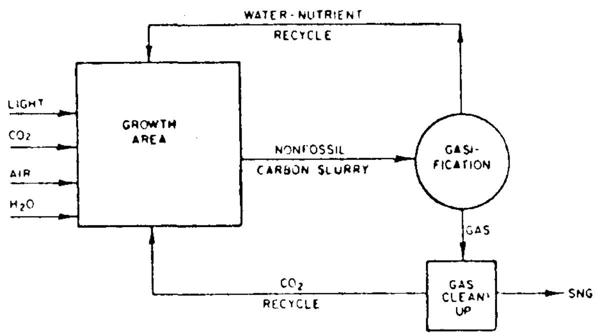
Figure 29

COMMUNITY BIOMASS OPTIONS



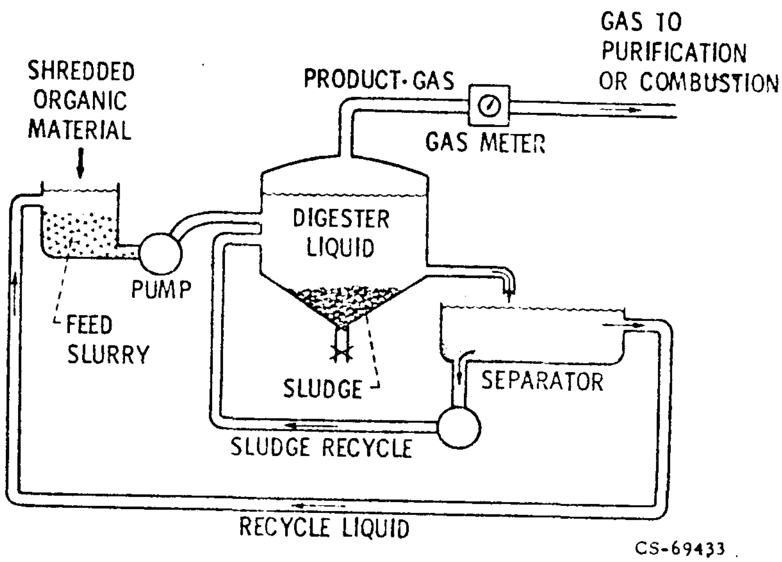
Source: Reference 17

A. The Three Processes for Gasification of Nonfossil Carbon



Source: Reference 17

B. Schematic of SNG-from-Nonfossil-Carbon Processes



Source: Reference 25

C. Typical Fermentation System for Production of Methane

Figure 30

TYPICAL BIOMASS FUEL CONVERSION SYSTEMS

though logically conceived, has not been extensively demonstrated. It is from this approach and from recovery of currently wasted resources that the major potential exists.

Table 4 shows some potential plant biomass resources for Texas. It lists some current agricultural wastes and includes estimated data on two species of marine plants which, although not cultivated at present, might be considered for energy production. Some features of certain species are not readily apparent from the table. For example, cotton trash resources are centrally collected. Bagasse from sugarcane milling is now used to supply power to a sugar refinery in Santa Rosa, Texas. This year 50,000 tons in excess of that needed for power production will be produced [24]. The marine plants offer high productivity per acre and can be most economically produced in conjunction with a sewage treatment facility. The resource requirements of sugarcane-based 1- to 10-megawatt power plants are given in table 5.

Agricultural wastes can be used directly as a solid fuel for power production (such as with bagasse), or the wastes can be converted to methane as with municipal wastes and shredded hyacinths. Methane conversion is the preferred method since the product is a replacement for currently used natural gas, and the sludge residue is more suitable for use as a fertilizer. This process provides the methane needed for fuel, yet permits recycling of the organic residues back to the land or pond to aid the ecological balance.

2. Cost Comparisons

Table 6 shows an estimate of the production and conversion of nonfossil carbon to methane on a considerably larger scale than is

Table 4

POTENTIAL CROP SPECIES FOR BIOMASS CONVERSION IN TEXAS

Crop	Solar Energy Conversion Efficiency	Average Yield/ Acre	Annual Production in Texas	Acreage Under Cultivation	Btu Value/ Pound	Total Btu Value	kwh/Acre Equivalent (thermal)
Cotton Trash (leaves, sticks, burrs)		Stripper harvested: 367-524 lb trash[m] (1.4-2.0 lb trash/1 lb cotton lint harvest)[ℓ] Spindle harvested: 79 lb trash[m] (0.3 lb trash[m]/1 lb harvested cotton lint)[ℓ]	Stripper harvested: 4.7-1.0[m] million tons Spindle harvested: 17,000 tons[m]	4.38 million acres	7000[ℓ] (dry)	13 trillion Btu	Stripper harvested: 908/acre Spindle harvested: 158/acre
Wheat Straw	0.2-0.3%[δ]	1.84 tons[n] (0.08 ton residue/ bushel yield)[ℓ]	10.5 million tons[n]	6.5 million acres[n]	7500[o] (dry)	157 trillion Btu	8304/ acre
Sorghum Residues (stalks)	0.2-0.3%[δ]	1.114 tons[δ] (1 lb residue/1 lb harvested yield)[ℓ]	5.6 million tons[b]	5.77 million acres[b]	6000[δ] (dry)	67 trillion Btu	3926 kwh

Table 4 continued

Crop	Solar Energy Conversion Efficiency	Average Yield/ Acre	Annual Production in Texas	Acreage Under Cultivation	Btu Value/ Pound	Total Btu Value	kwh/Acre Equivalent (thermal)
Corn Residues (stalks, leaves)	0.44-0.69%[h]	more than 100 bushels harvested: 2.7 tons[b] (0.93 lb residue/lb harvested yield)[ℓ] Less than 100 bushels harvested: 1.54 tons[b] (0.535 lb residue/lb harvested yield[ℓ]	1.7 million tons[b]	1.2 million acres[b]	6500[b] (dry)	22 trillion Btu	more than 100 bushels harvested: 10,284 kwh Less than 100 bushels harvested: 5,860 kwh
Sugar-cane	2.0%[c] 5.0%[d] (if bagasse) included)	40 tons[a] (27% dry matter)	1.3 million tons[b]	10,00 acres[a] (35,000 in 1976-1977)[i]	6500 (estimate)	4.567 trillion Btu	13,020 kwh
Bagasse (sugar milling by-product	-	-	63,000[e] tons (estimate)	-	7,281[d] (dry)	0.92 trillion Btu	-
Sugar Beet Tops	-	20.67 tons[a] (16% dry matter)	766,320 tons (estimate)	37,200 acres[b]	6,000 (estimate-dry)	1.5 trillion Btu	107 kwh

Table 4 continued

Crop	Solar Energy Conversion Efficiency	Average Yield/ Acre	Annual Production in Texas	Acreage Under Cultivation	Btu Value/ Pound	Total Btu Value	kwh/Acre Equivalent (thermal)
Water Hyacinth	0.3-0.8% (estimate)	16 dry tons/ acre-year[g] 60 dry tons/ acre-year[i]	not commercially produced	-	5,000[j] (1 lb = 5 ft^3 of methane)	0.6 billion Btu/acre (60 dry tons/ acre-year)	175,800 kwh (60 dry tons/ acre-year)
Algae	0.3-0.8%[k]	8-39 dry[g] tons/acre-year (scenedesmus quadricauda)	not commercially produced	-	5,700[k] (methane)	0.27 billion Btu/acre (24 dry tons/ acre-year)	79,000 kwh (24 dry tons/ acre-year)

[a]Battelle Columbus Labs, Systems Study of Fuels from Sugarcane, Sweet Sorghum, and Sugar Beets, under contract for ERDA, April 14, 1976.

[b]Texas Department of Agriculture, 1975 Field Crop Statistics.

[c]U.S. Bureau of the Census, "Statistical Abstracts of the United States, 1973.

[d]Melvin Calvin, "Solar Energy by Photosynthesis," Science (April 19, 1974): p. 377.

[e]Jack Nelson, General Manager of W.R. Crowley Sugar House, personal communication, August 23, 1976.

[f]Clinton Kemp and George Szergo, "The Energy Plantation," from Hearings on Bioconversion before the Subcommittee on Science and Astronautics. June 13, 1974, p. 92.

[g]John Alich and Robert Inman, "Effective Utilization of Solar Energy to Produce Clean Fuel," from Hearings on Bioconversion before the Subcommittee on Science and Astronautics. June 13, 1974, p. 239.

[h]G.W. Woodwell, Scientific American (September, 1970): pp. 64-70.

[i]"IGT Weighs Potential of Fuels from Biomass," Chemical and Engineering News, February 23, 1976.

[j]Samuel Walters, "The Amazing Hyacinth," Mechanical Engineering, June, 1976.

Table 4 continued

[k]W.J. Oswald and C.G. Goulueke, "Solar Power via a Botanical Process," Mechanical Engineering, February, 1964.

[ℓ]Dr. Wayne LePori, Department of Agricultural Engineering at Texas A&M University, personal communication, September 17, 1976.

[m]Texas Department of Agriculture, Texas Cotton Statistics, 1975.

[n]Texas Department of Agriculture, Small Grains Bulletin, 1975.

[o]Farno L. Green, Energy Potential from Agricultural Field Residues, paper for the Special Non-Nuclear Technology Session of American Nuclear Society, New Orleans, June 9-13, 1975.

Table 5

RESOURCE REQUIREMENTS FOR SUGARCANE POWER PLANT
(Based on 30 tons/acre-yr productivity,
80% capacity, 33% plant efficiency)

	1Mw(e)	5Mw(e)	10Mw(e)
Land (square miles)	0.25	1.25	2.5
Water*(acre ft/yr)	750,000	3,750,000	7,500,000
Nutrients (tons)			
Ammonia	5	25	50
Phosphates	275	550	2750
Potash	7.5	37.5	75

* includes cooling water requirements

Table 6

ESTIMATED COST TO PRODUCE 1 BILLION STANDARD CUBIC FEET PER DAY OF SYNTHETIC NATURAL GAS FROM NONFOSSIL CARBON

	Case I	Case II
Biomass produced,[a] tons/acre-yr	20	50
Biomass fuel value,[b] Btu/lb	8,000	8,000
Area required,[c] acres	3.26×10^6	1.30×10^6
SNG produced, SCF/acre-yr	1.12×10^6	2.81×10^6
Capital Costs, $/acre-yr		
Land[d]	18.62	18.62
Growth and harvesting equipment[e]	8.58	8.58
Gasification plant[f]	14.16	35.40
Operating Costs, $/acre-yr		
Land taxes[g]	6.50	6.50
Growth[h]	10.00	10.00
Harvesting[i]	20.00	50.00
Gasification[j]	20.00	50.00
Other expenses[k]	25.00	25.00
Total capital and operating costs, $/acre-yr	122.86	204.10
SNG price, $/10⁶ Btu	1.10	0.73

[a] Assumed yield of nonfossil carbon form on dry basis.
[b] Assumed fuel value of biomass on dry basis.
[c] From Figure 2, which assumes an overall thermal efficiency of 35% from the nonfossil carbon form to SNG.
[d] Based on $217/acre as the average price of farm land in the United States in 1972 financed at 7% over 25 years.
[e] Based on $100/acre financed at 7% over 25 years.
[f] Based on Biogas Plant investment of $1.50/CF of digester capacity including gas cleanup at a loading of 1.0 lb total solids/CF-day financed at 7% over 25 yr.
[g] Charged at 3% of land purchase price/yr.
[h] Based on estimated cost of growing marine-type crop with recycling of all nutrients in liquid-solid effluent from Biogas Plant.
[i] Based on harvesting crop as slurry at cost of $1.00/ton dry solids.
[j] Based on slurry gasification in Biogas Plant at cost of $1.00/ton dry solids.
[k] Includes supervision, maintenance, insurance, and miscellaneous expenses.

Source: Reference 17

indicated for communities. Starting from this estimate, however, allowing for cost escalations since that time and adjusting for scale of operations, it is reasonable to estimate smaller scale production of methane at about $2 per million Btu. This is competitive with current spot purchases of natural gas. The economics would appear even more favorable where agricultural and municipal wastes are used since the production and collection costs are already incurred and not necessarily attributable to the resource recovery process. In the case of direct combustion of dried and sized biomass wastes, only the costs of collection, sizing, and storage are attributable to the fuel preparation process. The fuel cost for this application is therefore estimated at about $1.50 per million Btu.

Using these fuel cost estimates, the power production costs can be estimated.

Using direct conversion of the biomass, a power plant similar to a coal power plant could be used at a current capital cost of about $750 per kilowatt. This amount is approximately equal to 34 mills per kilowatt-hour busbar cost of electricity assuming 80 percent capacity factor, 2 mills per kilowatt-hour operating and maintainence expense, and 16 percent annual cost of capital. On the same basis, for use of the biomass after conversion to methane, a gas power plant could be used at a current capital cost of about $350 per kilowatt. Using the same assumptions as above, the busbar cost of electricity would be about 30 mills per kilowatt-hour.

These costs are favorable when compared to other solar technologies. The costs can be further reduced in the case of existing facilities for power production. The estimates are conservative since usually the capital cost for municipal financing is considerably lower than that used for the estimate.

3. Future outlook

The ERDA research and development program for biomass conversion is shown in table 7. Since the publication of this program, the budget for this area has been increased substantially by Congress, but with the same elements involved. Current research and development on small-scale applications, particularly the NASA (Bay St. Louis) work with hyacinths [25], show good promise. Small-scale applications could be demonstrated much sooner than what is indicated for the large-scale systems.

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20. Green, Farno L., "Energy Potential from Agricultural Field Residues," American Nuclear Society: Transactions, Volume 21, June 8, 1975.

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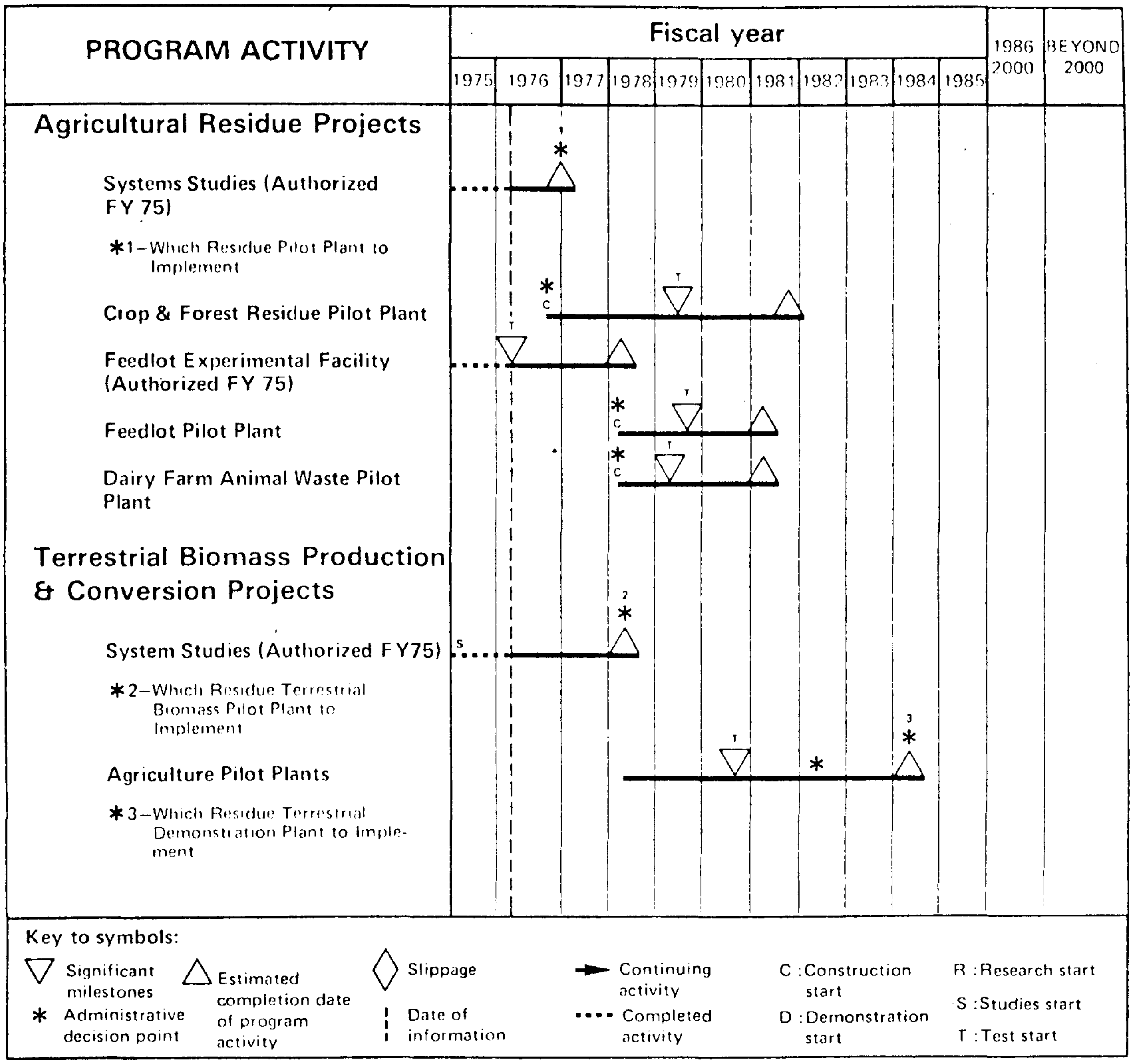
Table 7

FUELS FROM BIOMASS



Source: Reference 26

22. Szergo, George C., and Kemp, Clinton C., "Energy Forests and Fuel Plantations." ChemTech, May, 1973.

23. Zaltzman, Raul; Doner, David; and Bailie, R. C., "Perpetual Methane Recovery System," Compost Science, Volume 15, No. 3, Summer, 1974.

24. Nelson, Jack, General Manager, Rio Grande Valle Sugar Growers, Inc., personal communication, August 1976.

25. Wolverton, McDonald Gordon, Bio-Conversion of Water Hyacinths Into Methane Gas, NTIS 3162, NASA, July, 1975.

26. ERDA, "Solar Energy: Fuels from Biomass," National Plan for Energy Research, Development & Demonstration: Creating Energy Choices for the Future. Volume 2, Program Implementation, ERDA 76-1, U. S. Government Printing Office, Washington, D. C., 1976.

E. Energy Storage

The intermittent nature of solar energy creates a severe problem in the design of a solar thermal power plant if the power plant must be ready to supply electrical energy on demand. This problem can be circumvented by simply choosing to use solar-generated electricity only when it is available, while relying on a conventional fuel-powered plant when it is not available. This is the "fuel-saver" concept of solar electric power. While it does avoid the difficult storage problem, it creates economic problems from the necessity of having a full-sized conventional plant available for only part-time duty, or political problems in purchasing stand-by power from another utility or power grid. These problems will be dealt with in more detail in the section on integrated solar systems.

If either economic or political considerations require that the solar power plant provide a large portion, (75 percent or greater), of the total annual power demand, the plant design must include some form of energy storage. Not only that, but the economic factors in storing and recovering the energy play a significant part in the design of the overall plant. The selection of the type of storage to be used, the size of the storage facility, and the percentage of total demand which the combined solar plant and its storage must supply are all options which are available to the designer. These options, however, create a difficult problem in selecting a "best" design, since the technology of a large-scale energy storage is very limited at present. There is essentially no experience for guidance in any of the suggested storage approaches except in the pumped hydro, a method which is unfortunately not available to the large majority of Texas towns and cities.

It is beyond the scope of this project to develop the economics of specific combinations of solar electric generation and storage modes. Therefore, the concepts involved in selecting among the various systems are reviewed, and brief descriptions for the principal proposed storage technologies are presented.

As stated earlier, it is the intermittent nature of solar energy which creates the storage problem. This intermittent nature has two origins, one the daily and predictable pattern of day and night, the other the irregular and highly unpredictable cloud cover during the day. It is very difficult to design for this latter effect, although statistical data on cloud cover over many years make it possible to estimate the probability that a certain number of successive sunless days may occur.

In general, however, the philosophy adopted by most studies of solar power has been to design either for very long periods (months as with biomass) or for very short periods (hours, for overnight, or brief daytime periods from passing clouds). Long periods of sunless days are a problem only in the latter case, and they are covered by purchased power or standby fuel-powered plants. If the provision for full capacity standby power is made, either from an owned plant or purchased from a supply grid, then the storage problem becomes simply the economic one of minimizing the cost of delivered energy. This approach is almost like the "fuel-saver" concept mentioned earlier. It differs only in that an excess of solar capacity will be installed along with an energy storage facility, but only if the storage facility reduces the cost per kilowatt-hour.

How these economics will work out can be determined only after enough experience on actual operating solar plants and energy storage facilities has been accumulated to give the cost factors of each. From most of the paper studies to date, using assumed costs for both the solar electric plant and the storage, it has been generally concluded that only a very few hours of storage (two to three hours) can be justified economically, and that only to protect boilers and turbines against unexpected and sudden shut-down. The principal reasons for this conclusion are the large cost of storage to effectively reduce standby capacity and the fact that energy placed in storage and later retrieved, regardless of the form in which it is stored, inevitably suffers significant losses of 25 to 30 percent.* Solar-generated electricity taken directly from the plant is at present not considered economically competitive with fuel-powered plants, and hence cannot afford the additional penalty of storage cost and inefficiency.

A number of storage technologies have been proposed, and each has been analyzed for economics in studies financed by the Electric Power Research Institute (EPRI) and ERDA [27]. Thermal energy can be stored in hot molten salt masses, and at a high enough temperature to operate a steam boiler with some superheat, say 400 to 500 degrees Fahrenheit. This form of energy storage is most often proposed for short periods of unexpected cloud cover, just to keep the boiler and turbine operating at steady state. It is not anticipated that energy can be stored in this manner for overnight or several days of operation.

Electrical energy can be stored in batteries; or it can be converted into other forms of energy, such as the potential energy in pumped hydro, mechanical energy in spinning flywheels, energy in the form of compressed gas, or into chemical energy such as hydrogen gas liberated from water. All of these are called "higher forms of energy" by thermodynamicists, since unlike heat they can be used to regenerate electricity at very high efficiencies (70 to 90 percent) instead of at the low (20 to 30 percent) efficiencies with which heat can be converted.

Of these, only the battery is really a potential near-term method of storage, and of the many types of batteries considered, only the

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*The term "round-trip efficiency" is often used to describe the precept of an original quantity of energy placed in storage and later retrieved; as noted, it runs 70 to 75 percent with most proposed storage methods and present technology.

familiar lead-acid cell is likely to be used in the near term. Lead-acid cells especially designed to operate for long periods (10 to 20 years) and to undergo the daily charge-discharge cycle for thousands of times are available at substantially higher costs than the typical automobile battery. Large-scale storage facilities, with megawatts of capacity, are presently being developed under sponsorship of the Electric Power Research Institute and the U.S. Energy Research and Development Administration, and results on these operations should be available in the next three to four years. The latest technical data on projected costs and performance for battery storage have been obtained from ERDA [28], and are presented below:

Battery Costs: $35 to $40 per kilowatt-hour

AC-DC Conversion Equipment: $70 per installed kilowatt capacity (approximately $40 for DC-AC and $30 for AC-DC)

Other Auxiliary Equipment: $30 to $35 per kilowatt-hour

Round-Trip Efficiency: 65 to 70 percent

Life Expectancy: 14 years, or 2,000 cycles

It should be noted that such costs will add from 10 to 15 cents per kilowatt-hour to the cost of solar power, and thus essentially double the cost.

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F. Integrated Solar Systems

1. Comparison of Solar Concepts

The summarized projected cost estimates (mills per kilowatt-hour) for the various solar electric power options are presented in table 8, and for comparison the range of prices presently charged by utilities across the state is included. It should be noted that these solar costs, except for the biomass case, are based on minimal energy storage (two or three hours), and hence are pertinent only when the solar plant is built into a hybrid system, where it acts as a fuel saver. Furthermore, these costs represent the predicted costs of each system based essentially on present technology, but the assumption is that several would be built to achieve these cost goals. It is important to realize that none of these concepts has been developed or operated even on the scale consistent with the needs of a small community.

In any case, three concepts appear to have relatively good near-term potential: concentrating solar thermal, wind, and biomass. All of these fall into the 30 to 50 mills per kilowatt-hour range and therefore compare favorably with the range of electricity costs across the state. The other concepts are judged not to have any near-term potential for small community electric power production. Considering the relatively small difference between the three concentrating solar thermal concepts and the fact that none has been developed or operated, they for all practical purposes exhibit similar potential. Because they operate on direct-beam radiation, the potential for concentrating solar thermal increases the further west the location; far West Texas is a prime location, and the western half of the state exhibits good

Table 8

SUMMARY OF PREDICTED COSTS OF BUSBAR ELECTRICAL ENERGY FROM MEDIUM-SIZED SOLAR POWER PLANTS IN TEXAS

	Mills/kwh Busbar Cost
Electric Utility Cost	25-50*
Type of solar system:	
1. Concentrating collectors	
a. Central tower	35
b. Fixed hemispherical reflector/tracking absorber	38
c. Distributed systems	40
2. Flat plate collector	600
3. Solar pond	
a. Nonconvective	
1. Salt water	105
2. Membrane	114
b. Convective	
1. Shallow pond	125
4. Wind	48
5. Photovoltaic	
a. Untracked flat panel	1320
b. Tracked concentrator	110
6. Biomass	
a. Direct combustion	34
b. Methane generation	30

Note: With exception of biomass, these costs represent systems with minimal energy storage and thus are fuel saving solar power plants.

*Utility rates in general vary from 25 to 35 mills/kwh with the high figure represented by Austin.

potential. Wind energy conversion is considered to have excellent potential for the northwest region of the state, which possesses the highest average winds, and good potential in the Gulf Coast region of moderately high winds. Otherwise, the rest of the state has little potential. Both solar thermal and wind must be considered fuel savers.

Biomass (fuels/electricity from biomass), considering its projected low electric cost and inherent storage capability, exhibits the best potential, particularly for application to small communities in Texas. Agricultural wastes represent one source of biomass, and both the Rio Grande Valley and Panhandle regions exhibit potential in this case. If biomass is grown primarily for energy, the eastern half of the state is considered to have the best potential because of its generally adequate water supply.

2. Discussion of Integration Options

Because of the intermittent nature of solar energy, it is unlikely that any solar system for providing electrical power on a demand basis can stand alone. A possible exception is the biomass scheme, for which very long-term storage is an inherent part of the system. For any other approach, either some form of thermal or electrical energy storage must be provided on a large scale, or an auxiliary source of electrical energy must be provided and be available on a demand basis.

As described in the previous section (II.E), it is clearly not practical in the near future to provide large-scale thermal or electrical energy storage. Thus, any decision to use solar-generated electricity in a demand situation will have to involve another energy source. This can be either fuel-generated electricity from a locally owned plant, or purchased electricity from a tie to a power grid. In either case, the resultant solar-plus-auxiliary combination is called an integrated, or hybrid, system. The economic analysis of such a system will have to include, in addition to the solar plant, the generating costs of the auxiliary plant and fuel, or the contract cost of any purchased power.

Power purchased from a nearby large utility power grid as a supplement to a local solar plant can present political problems which arise from the nature of the requirements. To the seller, the municipality with a solar plant will normally be considered a customer with a highly unpredictable demand, one which may occasionally require 100 percent auxiliary during normal peak demand periods because of intermittent weather conditions, and then none at all for several days. This means that the selling utility must make the investment to provide the additional capacity without any assurance of its being used more than a few days a year--something which utility executives are understandably reluctant to do. The solution to this pricing problem has yet to be resolved, although there has been recent legislation in Colorado [29] providing higher-than-standard rates to the utilities when power is provided on a standby basis to solar users. Widespread adoption of such a pricing policy would of course be detrimental to the development of solar thermal power generation.

There is an unusual set of factors in Texas which may alleviate this problem to some extent, however. Because of the heavy air conditioning load in summer, the peak demand for power nearly coincides with the peak in solar availability, with perhaps a three to four hour lag (that is, peak demand after peak solar availability). There is thus the possibility that a locally owned solar power system could purchase only off-peak power, hopefully at reduced rates, to cover the night and part of the morning loads, while relying exclusively on solar plus a minimal storage to meet the afternoon and early evening peak. While there are no economic studies of such an integrated system, it is a possible development for the state when solar thermal power costs on a "when-available" basis compete favorably with electric utility prices.

As an example of load distribution, that of the City of Austin is presented in figures 31, 32, and 33. They show the peak demand by week during a year (November 1974 to October 1975), the hourly gross system load for the week of August 18-24, 1975, and the hourly load for August 21, 1975. The installed capacity is determined by the July-August peaks (figure 31). It is also seen that the maximum to minimum demand (figures 32) is slightly in excess of 2. The maximum and minimum loads occur at approximately 4:30 p.m. and 5:30 a.m. (daylight savings time), respectively, for the August period.

To show how a solar electric power plant may be integrated into a larger fuel powered system, these Austin load data have been normalized to a 100-megawatt peak demand (figure 34). Assume that a community within the service area, comprising 10 percent of the utility's demand, decides to install a solar electric power plant with a peak generating capacity of approximately 11 megawatts (electric) (as shown), and to purchase auxiliary power from the utility. (Here the time is "solar time," which occurs approximately one and one-half hours later than daylight saving time.) The solid curve, when read on the left scale, shows the original demand made on the large utility, and when read on the right scale, shows the demand made by the small municipality alone.

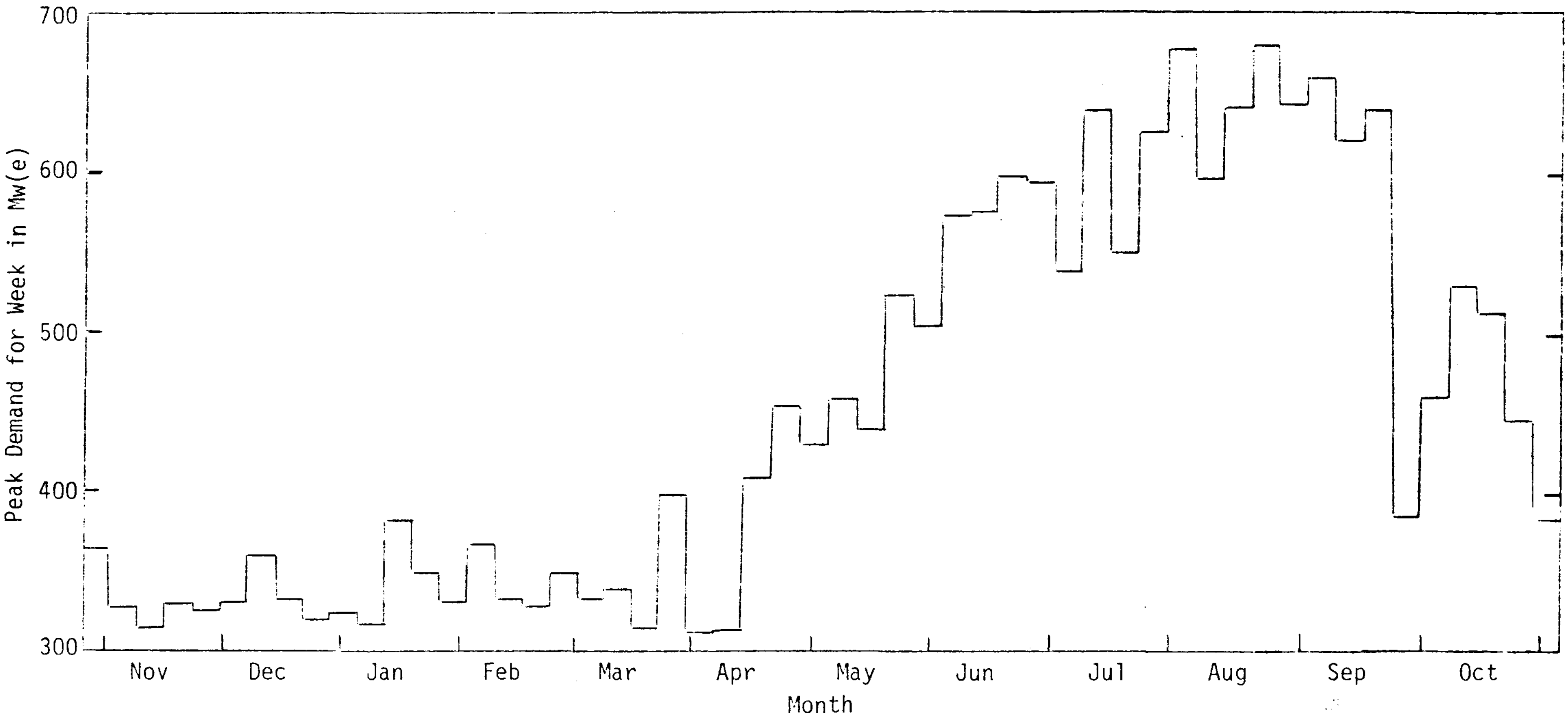

Figure 31

PEAK DEMAND BY WEEK OVER PERIOD OF NOVEMBER 1974 THROUGH OCTOBER 1975

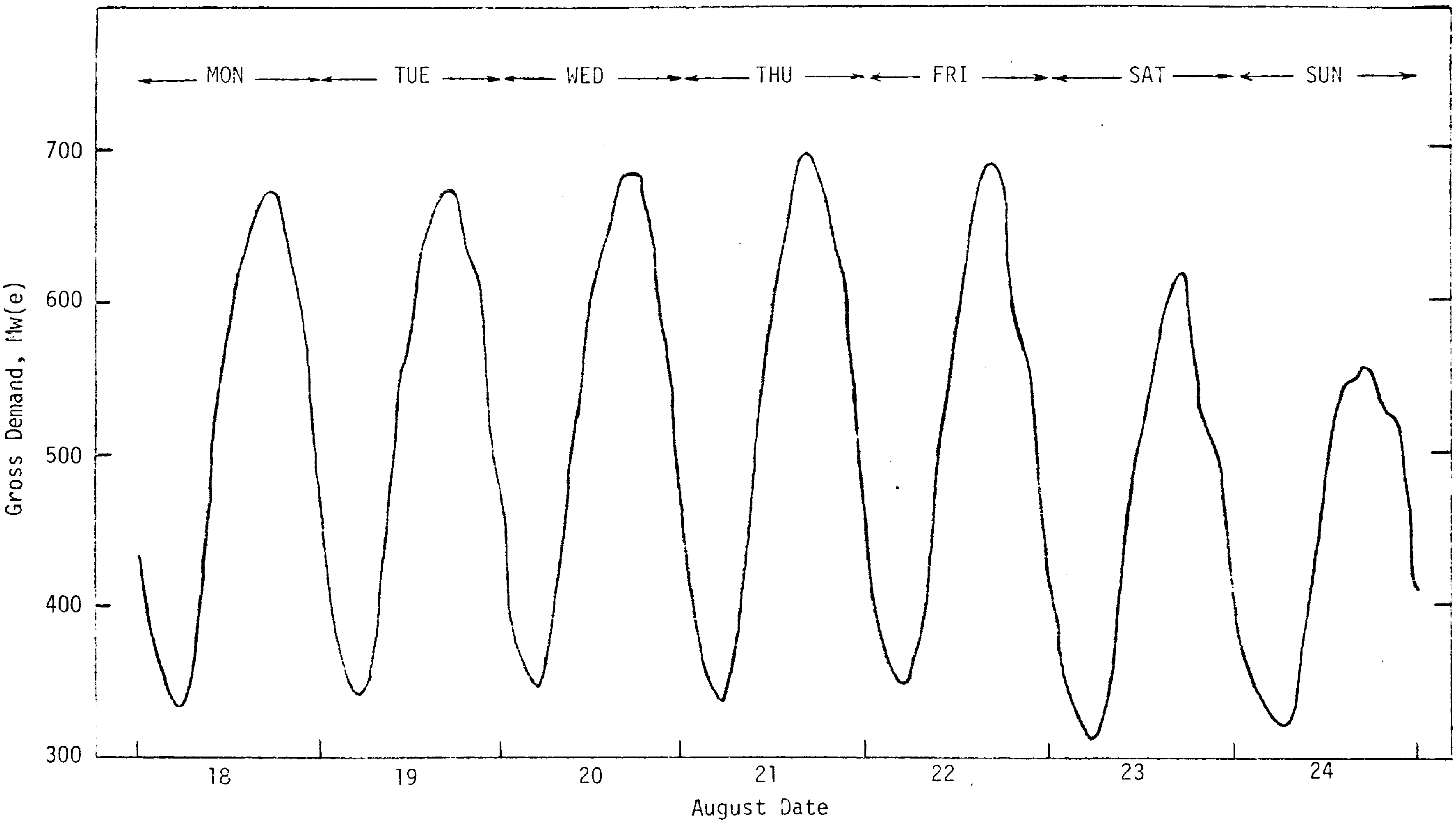

Figure 32

AUSTIN GROSS SYSTEM LOAD VERSUS TIME FOR WEEK OF AUGUST 18 to 24, 1975

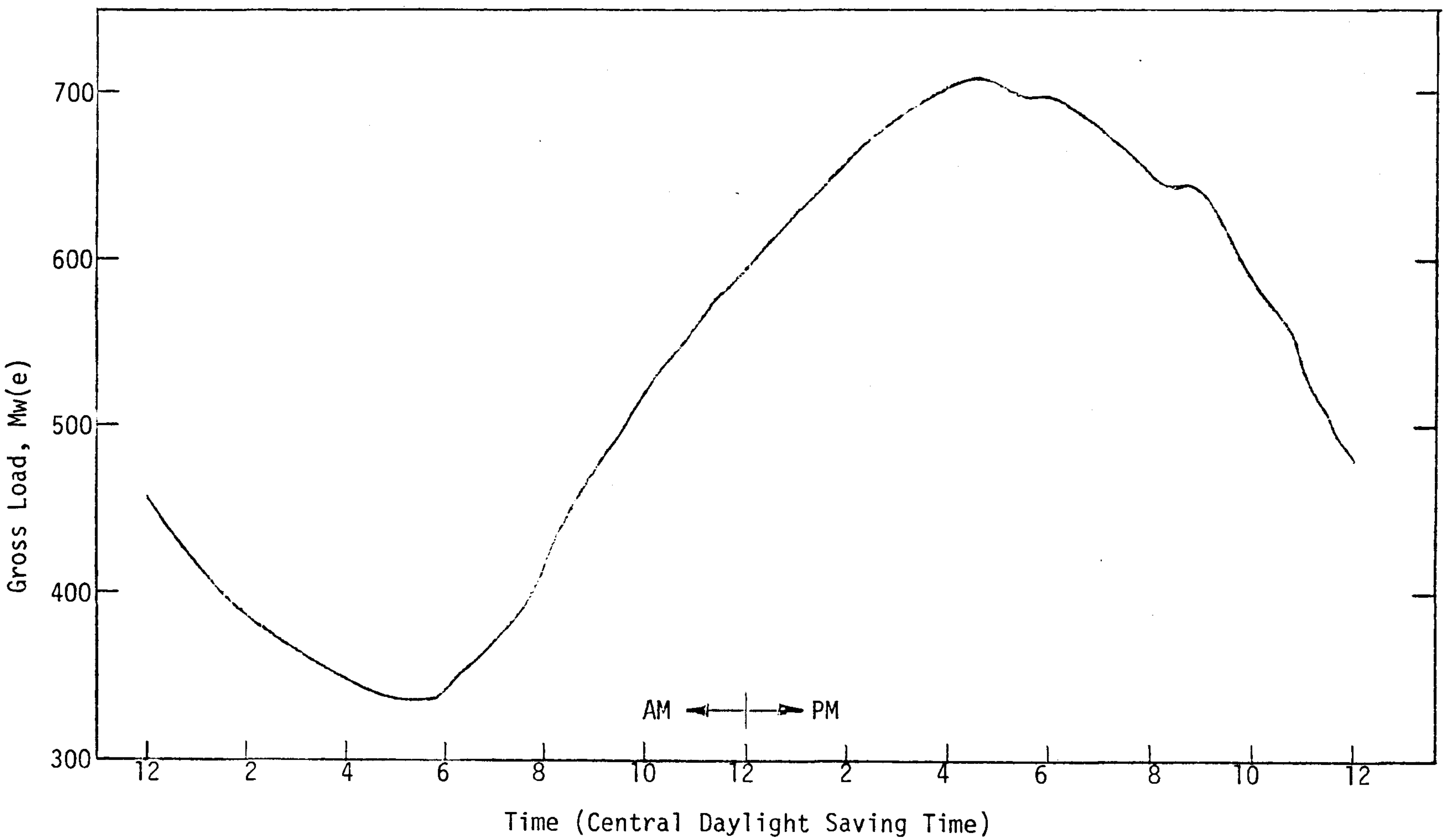

Figure 33

GROSS SYSTEM LOAD VERSUS TIME OF DAY FOR AUGUST 21, 1975

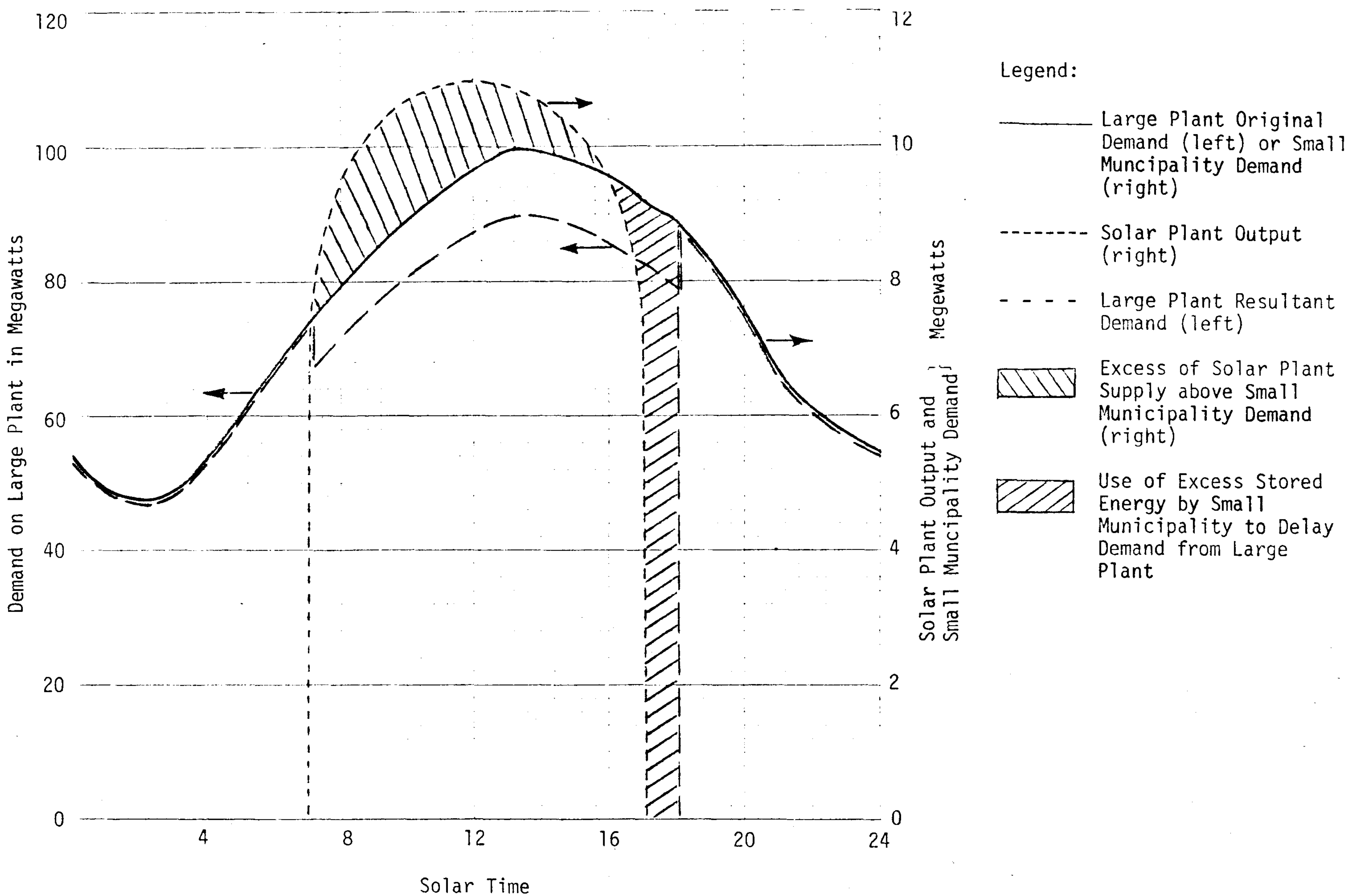

Figure 34

EFFECT ON CONVENTIONAL ELECTRIC PLANT DEMAND WHEN INTEGRATED WTH A SMALL SOLAR ELECTRIC PLANT WITH MINIMAL ENERGY STORAGE

The dotted curve shows the power available to the small municipality from its own solar plant build to 10 percent above its own peak capacity (i.e., 11 megawatts (electric)). This slightly larger than required capacity enables the solar plant to store sufficient energy (10.6 megawatt-hours) between 7:00 a.m. and 4:00 p.m. solar time that it may continue to operate without purchasing outside power until approximately 6:30 p.m. solar time, at which time both loads are declining sharply. The resultant load curve for the large utility is shown by the dashed curve.

It is clear that this arrangement creates a significant improvement in the load factor of the large utility, which is of course an economic plus for it. Thus, if it could be guaranteed that the partially solar powered municipality would not demand power from the large utility in the 7:00 a.m. to 6:30 p.m. period, the large municipality could contract to provide power to another 10-megawatt peak load with no addition to its own capacity. To assess fully the potential of this concept, the interfacing of the solar and utility systems over the entire year needs to be examined to determine: (a) the probability (frequency) that the community will demand power during peak periods and (b) the actual effect on the utility's load factor. This assessment is recommended for future study.

Hybrid systems combining solar with some form of fuel-generated power, or "stand-alone" systems, could consist of any of the potentially attractive solar technologies described in this report in combination with any of the present generating methods (fuel-fired steam, diesel-powered generators, hydroelectric). Because of the size limitations, nuclear is not a viable technology to combine with solar for municipalities of the size considered here. Calculating the net cost of electricity delivered by such hybrid systems is a complicated economic problem which depends, of course, on the cost of each facility, the relative portion of the load carried by each, and assumed fuel escalation factors. Considering the results in table 8, it is difficult (except possibly for biomass) to justify generating any fraction of the total load by solar at present costs, at least on a purely economic basis.

Again, however, there are special circumstances which may arise in the not-too-distant future, and which may justify adding a solar facility to an existing municipal power facility to create a hybrid system. An existing plant may have a dedicated fuel reserve or long-term fuel contract, and because of growth of the municipality be unable to meet the peak demand. In this case it could be turned into a base load plant by the addition of a solar plant. A complete analysis of a system similar to this has been carried out by Martin-Marietta Corporation [30] for the addition of a 36-megawatt solar generating facility to the Horse Mesa, Arizona, hydroelectric plant, also of 36-megawatt peak capacity. The average capacity of the hydroelectric plant is limited by constrained water resources to 27 megawatts. After addition of the solar unit, the average continuous capacity of the combined system would be 36 megawatts, an increase of 33 percent, with solar providing 55 percent of the daily average power. There is only a limited potential for combined solar/hydroelectric in Texas, but the economic analysis for addition of solar to a fossil-fuel-fired facility would be entirely analogous. Another concept, that of a solar thermal (power tower) plus biomass system, has been suggested by Professor Otto Smith of the University of California at Berkeley [31].

Probably the earliest and most complete engineering design study of a small-scale integrated solar electric plant will be that for the city of Crosbyton, Texas, contracted from ERDA to Texas Technological University with E-Systems as the subcontractor [32]. The solar system will consist of the fixed hemispherical reflector/tracking absorber concept and will be integrated with Crosbyton's gas-powered electric plant.

Finally, the first stage demonstration plant planned by ERDA will be a 10-megawatt (electric) solar facility to be integrated with an existing public utility. Presently, detailed design studies are being performed for ERDA under four contracts; a 4-megawatt (thermal) pilot facility is being constructed at Sandia Laboratories, Albuquerque, New Mexico; and proposals have recently been solicited and received from nine public utilities to manage the first demonstration plant.* Unfortunately no equivalent integrated demonstration plant is planned for either wind energy conversion or fuels/electricity from biomass.

Although the prospect of solar electric power is promising, it is not considered to be commercially viable at this point. Fuel escalation factors must be closely watched, and projected solar and conventional power costs must be periodically updated. The demonstration plants which are presently planned, as well as others, are urgently needed to provide the operating experience and performance data required before commercial development can proceed.

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* The City of Austin Electric Department and San Antonio Public Service Board are included in the nine utilities under consideration.

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III. FACTORS IN COMMUNITY ASSESSMENT

A. Community Profile

The map included in appendix C shows the location of communities having populations ranging from 3,000 to 30,000. The intent of the map is merely to show the population distribution of the communities considered in this study. Three patterns are readily apparent. The larger communities (20,000 to 30,000) are located predominantly in the northeastern section of Texas. The remaining communities are distributed fairly uniformly throughout the state, but with lower frequency in the Panhandle region and even more sparsely in West Texas. There is a fairly even split between communities that can be termed urban (within a standard metropolitan statistical area) and those that are rural. These rather broad patterns become more meaningful when considered in conjunction with regional variations in land availability, water resources, and current arrangements for electricity supply.

Nine characteristics of each community are enumerated in the appended table. These data were accumulated to permit profiling of the communities of interest in the study and to permit at least a cursory analysis of patterns, trends, and factors which may have a bearing on the community's propensity to seek a solar-based alternative. Additional data on land and water resources were reviewed but are not included in the appendix.

Both growth characteristics and per capita income give some indication of future power requirements, since electricity demand is normally a function of both population and standard of living. The facilities, number of businesses, and economic base for the community give some limited indication of demand composition. The nature of electric utility service that the community has, whether or not the community owns the utility, whether it currently generates some of its own power, and the community's relative electric prices are all considered factors in the community's current attitude toward and interest in power generation.

B. Factors in Propensity for Solar Alternatives

Many factors influence the collective community attitude toward solar energy for power generation: its constant and replenishable characteristic, its simplicity, its freedom from well known or publicized environmental effects, current high electricity prices from other sources, dissatisfaction with or credibility of the utility, high public interest, the fact that it is a captive source of power and a "natural" versus artificial source, and extensive media coverage.

Add to this the availability of technical awareness in or near the community, political advocacy of the approach, and the general popularity of the approach, and a community pressure for action may arise which is sometimes disproportionate to the means available to satisfy the desire. Provision of appropriate information to the communities in response to their needs is therefore a difficult, though very important, necessity.

C. Planning Considerations for Communities

The problem of assessment of solar alternatives and planning community actions is complex, but it can be visualized as shown in figure 35. The community needs to know which solar technologies are

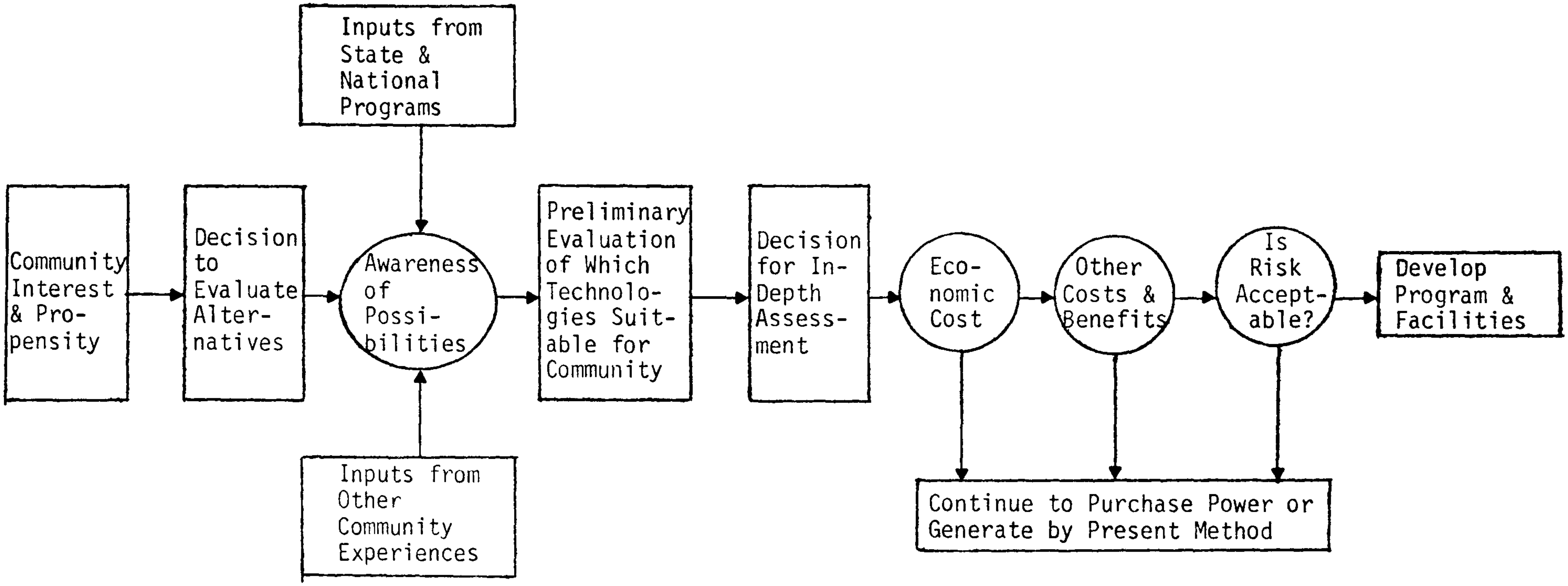

Figure 35

OVERVIEW: COMMUNITY ASSESSMENT OF SOLAR POWER possible, when they are likely to be viable, and the technical and economic trade-offs, as well as the nontechnical costs and benefits of the technology. These complex factors must be assessed in terms of the unique features of the particular community. Resources, economics, impacts, and attitudes all have a place in such an assessment.

Sequentially, the community decides, based on community interest, to evaluate alternatives. This interest leads to an increased awareness as a result of inputs from national and state programs and other community experiences. Next, a preliminary analysis of potentially applicable technologies ordinarily leads to elimination of certain options because of current state of the art, resource constraints, and timing requirements. Remaining options may then be considered for an in-depth evaluation in which economic and noneconomic costs and benefits are assessed and the risk of the undertaking evaluated. Unfavorable outcomes of these evaluations lead to a decision to continue the present source of power. Favorable outcomes throughout the assessment would lead to further development of facilities for alternative methods for the generation of power. The simplicity with which the decision can be described obscures the difficulty of the individual steps in the process.

1. Technoeconomic Evaluation

Many technoeconomic factors of the various solar technologies have been presented in the earlier sections of this report. The relative availability of the technology and life cycle costs of various concepts have been made. For a particular community these costs need to be compared to actual and projected cost of power for the power arrangement for the community. In some cases the question of the competitiveness of the solar option is more a question of when it will be competitive rather than whether, since the cost of energy from fossil-derived sources is in a continuous and unavoidable escalation. Utilization of solar energy is being researched and developed intensively (particularly on a federal level), and its use may be one of only limited choices available in the long run. Thus, communities may be faced with a question of timing and risk acceptance level.

2. Nontechnoeconomic Evaluation

Another facet of the community decision is whether they should be the ones to become involved and take the inherent risks, or whether it should be left to the utilities. The utilities exist and operate under governmental franchise to provide power efficiently and at the lowest possible cost. Hence, it becomes fundamentally a philosophical question whether the communities become involved or collectively bring about more intensive utility consideration of viable future power production alternatives. The community has the opportunity to view the program provincially and on a small scale. The utility, on the other hand, normally has a broader range of alternatives and the normally advantageous economies of scale.

Various environmental, social, political, and institutional impacts, though not part of this study, also need to be considered in any community decisions regarding solar power utilization.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

This study consists of an assessment of the potential for solar electric power generation by small communities in Texas as an alternative to present conventional electric power. A comparative analysis and assessment were made of the various solar electric power options based largely on available design studies for specific solar alternatives. With the exception of biomass the comparison is for minimal energy storage. Thus these concepts represent fuel-saving solar plants.

Considering each option as a fuel saver only (minimal energy storage), the most attractive conversion concept appears to be the fuels/electricity from biomass concept with costs projected at 30 to 35 mills per kilowatt-hour, followed by concentrating solar thermal at 35 to 40 mills per kilowatt-hour, and wind at 45 to 50 mills per kilowatt-hour. Other options, such as flat plate, solar ponds, and photovoltaics, do not appear as attractive in the relatively near term though photovoltaics integrated into a total energy system may be a middle-term option for small communities.

There appears to be little difference in the potential among the three concentrating solar thermal (central tower, fixed reflector/tracking absorber, or distributed systems). The projected cost variation is only 15 percent, and none of these systems has been built or operated. Concentrating solar thermal has its greatest potential in far West Texas, with less applicability for locations in the east. Wind energy exhibits more marked geographical variations in its potential.

The best area by far is the northwestern (Panhandle) area. There is moderate potential along the Gulf Coast, but wind energy is not very attractive in other regions. Fuels from biomass generally fall into two categories: waste materials (agricultural) and plants grown specifically for fuel. The potential for the former (wastes) appears best in the Valley and Panhandle areas where agriculture is more intensive, while the production of fuel from biomass grown specifically for that purpose generally is considered to be applicable to the eastern half of the state where water resources are not considered critical. The fuels/electricity) from biomass concept, in addition to apparently comparing favorably to concentrating solar thermal and wind energy in terms of cost, has the great advantage of having inherently long-term storage.

Based on electric cost variations across the state of 25 to 50 mills per kilowatt-hour, the above options appear competitive. However, with the exception of biomass, a solar plant with minimal energy storage will require an auxiliary power source (local power production or electricity from a grid) to meet demand at night and during periods of intermittent bad weather, and the cost of the auxiliary energy must be included to obtain the community's average power cost. If obtained from a grid, and if it reduces the utility's load factor, the pricing structure may penalize the community. Alternatively, if power is produced locally, the fuel and amortized cost of the auxiliary plant must be accounted for.

A long-term (one day or longer) energy storage concept has not been developed that does not seriously increase the cost of solar energy, with the exception of pumped hydro, and there is not a significant potential for this option in Texas.

In situations where an electric utility's load distribution exhibits a significant summer peak in mid-afternoon, there appears to be merit in integrating a solar electric power plant with the utility. With only minimal energy storage required the summer load factor would be increased. If this is done, the solar plant need not be seriously penalized by high auxiliary electric rates because the bulk of auxiliary power is demanded at off-peak periods.

It is emphasized that no moderate-scale solar electric power plant of any of the above options has been constructed to date. Projected costs, operation, and performance must be verified by pilot plant operation. Fortunately, as a result of demonstration plants, much more reliable data are expected for all three options (concentrating solar thermal, wind, and fuels from biomass) within four to five years and much better component costs within two years. However, solar electric power generation is not considered to be a "commercial" alternative at this time.

B. Recommendations

*Since fuels/electricity from biomass appears to exhibit significant potential in Texas, the state should participate in the funding of a demonstration program in this area related both to agricultural wastes and biomass produced for fuel.

*Since the state has two regions with significant wind levels and wind energy exhibits good potential in these regions, the state should participate in the funding of an integrated wind energy conversion demonstration program parallel to the present federal solar thermal program.

*There should be a continuing and more detailed investigation of the integration of solar electric into small community power systems, exploring the various options in greater depth and with more detailed engineering design and cost studies.

*A more detailed investigation should be carried out to assess the potential merit of incorporating some fraction of solar electric power generation in a larger utility grid to enhance the load factor.

*There should be a serious attempt to assess the possible effect of electric rate structuring on solar electric power generation and to propose rate structuring or state subsidy to facilitate the development of solar electric power generation.

*Considering the potential for power generation from agricultural products or waste, the concept of continuing industrial uses of primary agricultural products (i.e., alcohol from sugarcane as a saleable product) with power generation from agricultural products should be considered as an attractive option to some communities to provide their own power needs, jobs, and an exportable product.

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Ramakumar, R. "Wind Power: A Review of Its Promise and Future." ASME 16th National Heat Transfer Conference, St. Louis, Missouri, August 1976.
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Calet, Charles E., "Not Out of the Woods." Environment, vol. 18, no. 7, (September 1976).
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Dugas, Doris J. Fuel from Organic Matter: Possibilities for the State of California and Fuel from Organic Matter. Rand Paper Series. October 1973.
Discusses processing of organic material--crops, urban waste, agricultural wastes, industrial wastes. Gives theoretical yields, conversion methods, overall costs of fuel, land requirements.

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Presents the national research, development, and demonstration program for biomass conversion.

Graham, R. W. "Fuels from Crops: Renewable and Clean." Mechanical Engineering (May 1975), pp. 27-31.
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Green, Farno L. "Energy Potential from Agricultural Field Residues." Invited paper for Special Non-Nuclear Technical Session of American Nuclear Society. New Orleans, Louisiana, June 9-13, 1975.
Discusses potential uses, efficiencies; heats of combustion; prices; harvesting; heat value of agricultural residues.

"IGT Weighs Potential of Fuels from Biomass." Chemical and Engineering News (February 23, 1976).
Reviews IGT's symposium on fuels from biomass; sewage; urban refuse; and agricultural waste.

Klass, D. L. "A Perpetual Methane Economy--Is It Possible?" ChemTech (March 1974).
Gives advantages of nonfossil carbon fuel sources; photosynthesis and growth; processes of gasification; economics; current status.

Kok, Bessel. "Energy Delta, Supply vs. Demand." Science and Technology, vol. 35 (1975).
Discusses prospects of photosynthetic energy; mechanism and efficiency of plant photosynthesis.

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Describes NASA/St. Louis experimental results using sewage-laden waters to increase growth and methane production of water hyacinths.

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Reports investigations by NASA of growth and use of hyacinths in anaerobic digestion to produce methane gas.

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Includes papers on various aspects of storage applicable to solar energy.

Wentworth, W. E. Storage of Solar Energy from a Solar Chemical Reactor. Final Report for Interagency Cooperation, Contract No. IAC(76-77)-1146.
(See next entry)

Wentworth, W. E., and E. Chen. Simple Thermal Decomposition Reactions for Storage of Solar Thermal Energy. Department of Chemistry and Solar Energy Laboratory. Houston: The University of Houston, October 1975.
Wentworth report and paper: One of these is a report and the other a technical paper published in the open literature; both describe an approach to the storage of thermal energy at the different temperature levels at which it might be available and/or required. The principal focus is on systems which absorb and release heat by chemical reactions; a method of evaluating various reactions for best performances is described.

Integrated Solar Systems

Blake, Floyd A., "Solar/Hydroelectric Combined Power Systems," Presentation to Annual Meeting, American Association for the Advancement of Science, San Francisco, February 26, 1974, (Copy available in CES Energy Information Service, The University of Texas at Austin).
Summarizes an analysis of a combined solar thermal power plant/hydroelectric generating plant as carried out by the Martin-Marietta Corporation. The principal objective of the study was to show how a solar plant could be integrated into an existing hydroelectric plant in such a way as to take maximum advantage of the distinct characteristics of each type of facility.

Milleron, Norman. Letter to Chemical and Engineering News, vol. 54, no. 32. (August 2, 1976), p.3.
Suggests that the combination of mirror tower, thermal storage, and long-term biomass storage requires less than 3 square miles of land area per 100 megawatts of installed capacity with busbar costs of electric power less than 3½ cents per kilowatt-hour.

Solar Energy Intelligence Report, vol. 2, no. 16, August 2, 1976.
Contains a brief news item reporting the passage of a law by the Colorado legislature which grants utilities higher than normal rates for power delivered "on demand" as a backup to solar systems.

Solar Engineering Magazine, vol. 1, no. 7, September 1976, p. 5.
Gives a brief summary of the Crosbyton solar electric power contract.

Appendix A

SOLAR ENERGY DISTRIBUTION

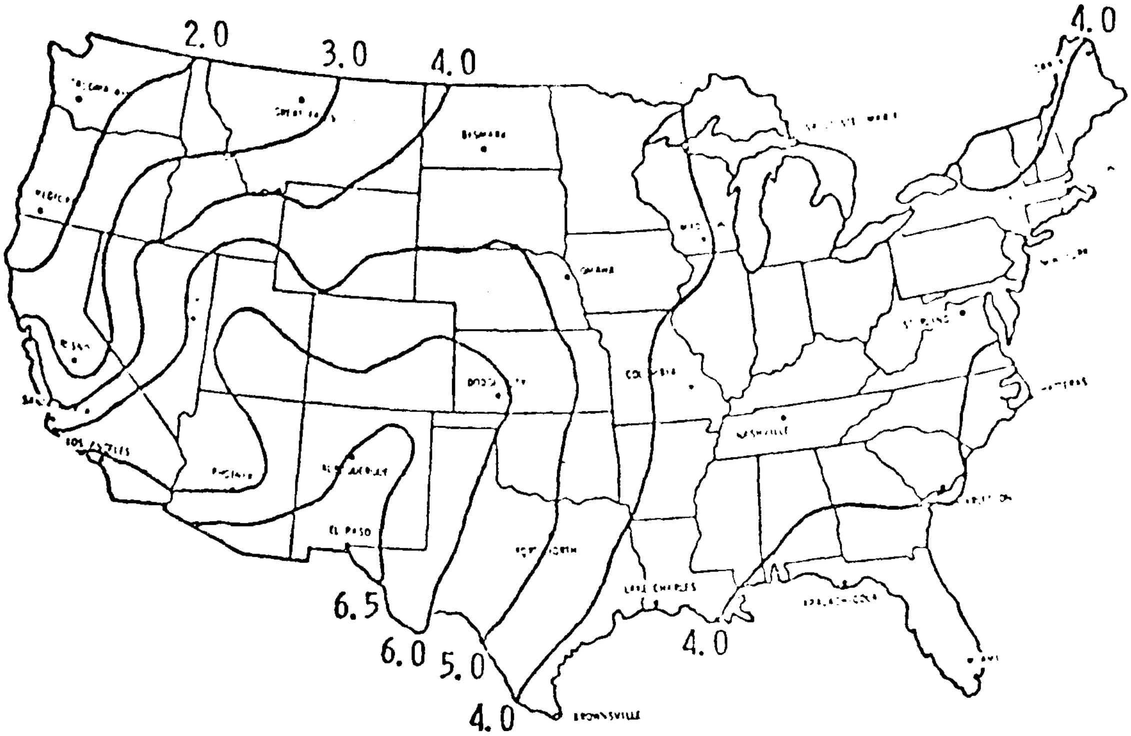
The solar radiation (insolation) maps presented in this appendix (figures A.1-A.12) are taken directly from Distribution of Direct and Total Solar Radiation Availabilities for the U.S.A., by E. C. Boes, I. L. Hall, R. R. Prairie, R. P. Stromberg, and H. E. Anderson, a study performed by Sandia Laboratories and sponsored by the U.S. Energy Research and Development Administration [33].

These insolation maps for the United States are presented for each month and for both the "direct-normal radiation" and the "total-horizontal radiation." The direct-normal radiation represents the daily direct beam radiation received on a surface at that location if continuously pointed toward the sun and is useful for concentrating collector analysis. The total horizontal radiation is the daily direct plus diffuse (total) radiation received by a horizontal surface at that location and is useful for nonconcentrating, nontracking solar collector analysis.

It can be seen that both the total-horizontal and direct-normal radiations exhibit large seasonal changes and also vary substantially across the state, generally increasing from east to west. While total-horizontal insolation for far East Texas varies from 15 to 25 percent below that for far West Texas, the direct-normal radiation for far East Texas varies from 25 to 50 percent below that for far West Texas. Because of this large difference, primarily in the direct-normal radiation, solar thermal electric power generators exhibit greater potential the more westernly the location.

Reference

33. Boes, E.C.; Hall, I.L.; Prairie, R.R.; Stromberg, R.P.; and Anderson, H.E.; Distribution of Direct and Total Solar Radiation Availabilities for the U.S.A., Sandia Laboratory, Albuquerque, New Mexico, 1976.



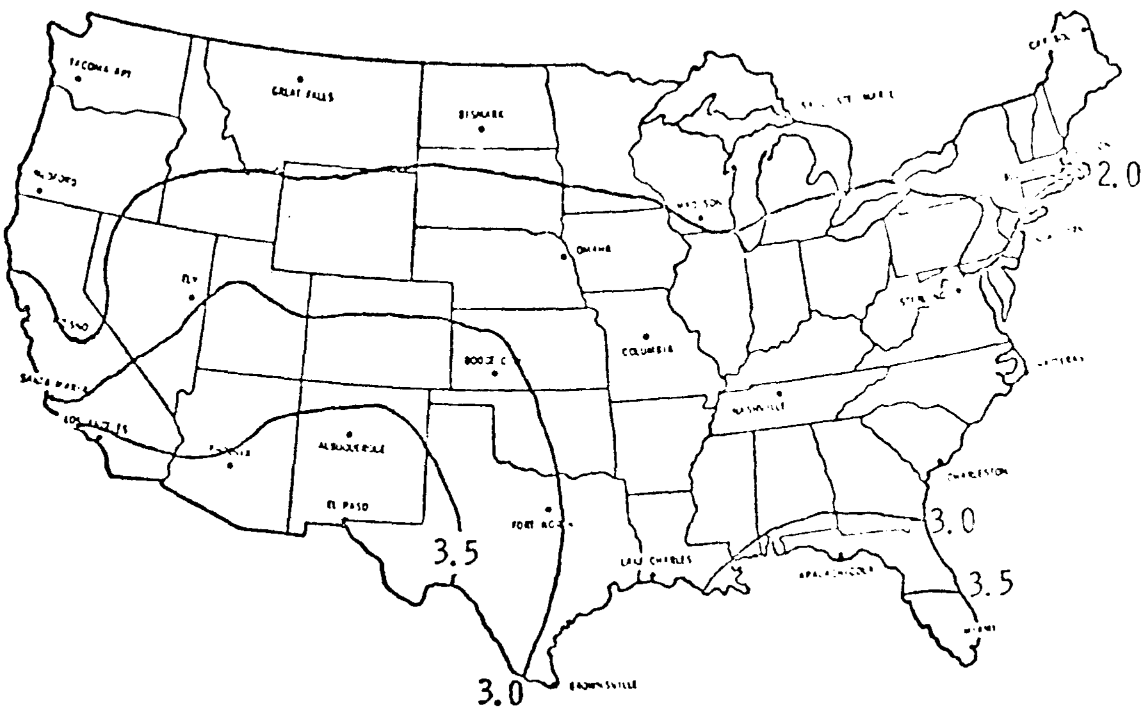


Figure A.1

MEAN DAILY DIRECT-NORMAL (TOP) AND TOTAL-HORIZONTAL (BOTTOM) SOLAR RADIATION FOR JANUARY (kilowatt-hours per square meter)

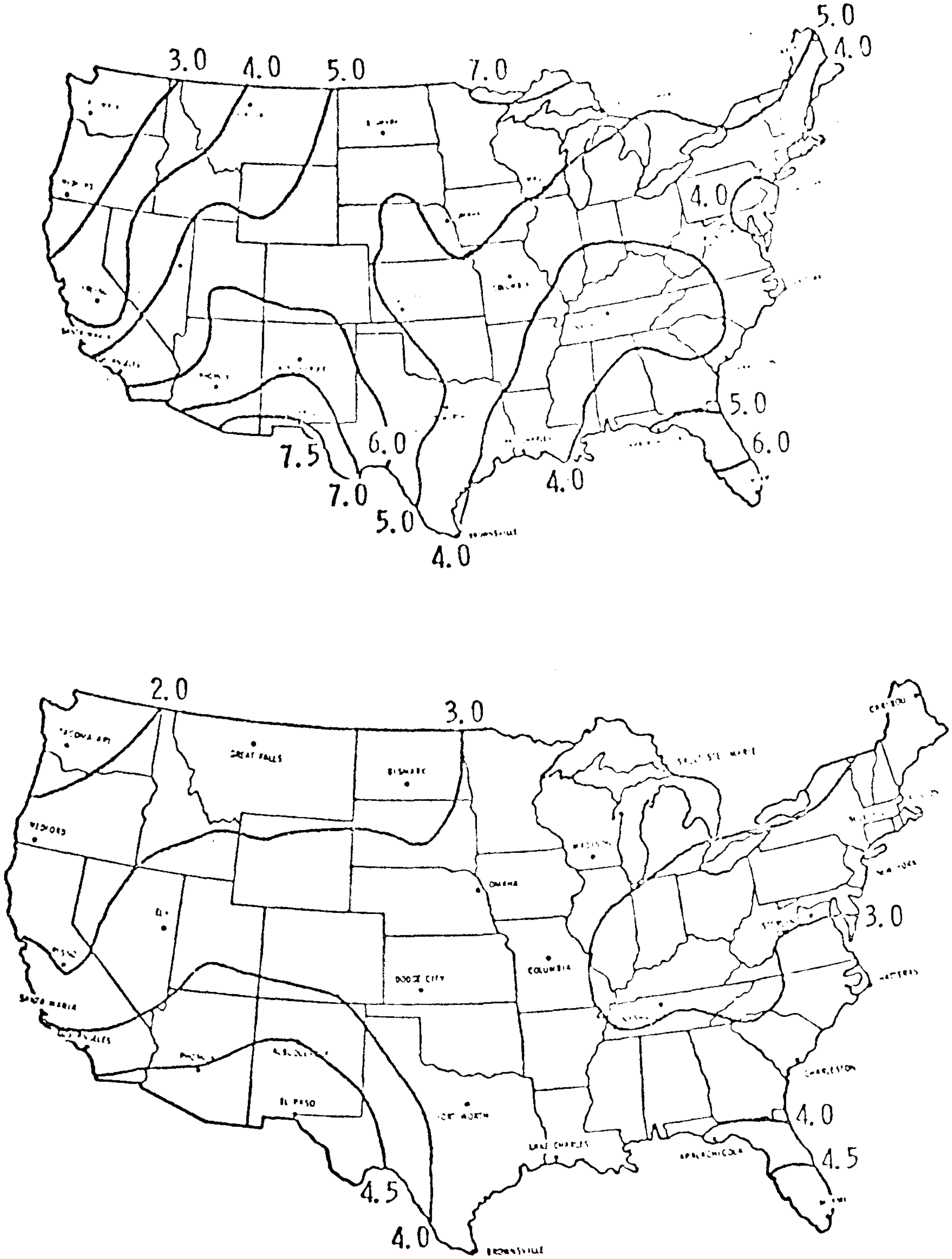
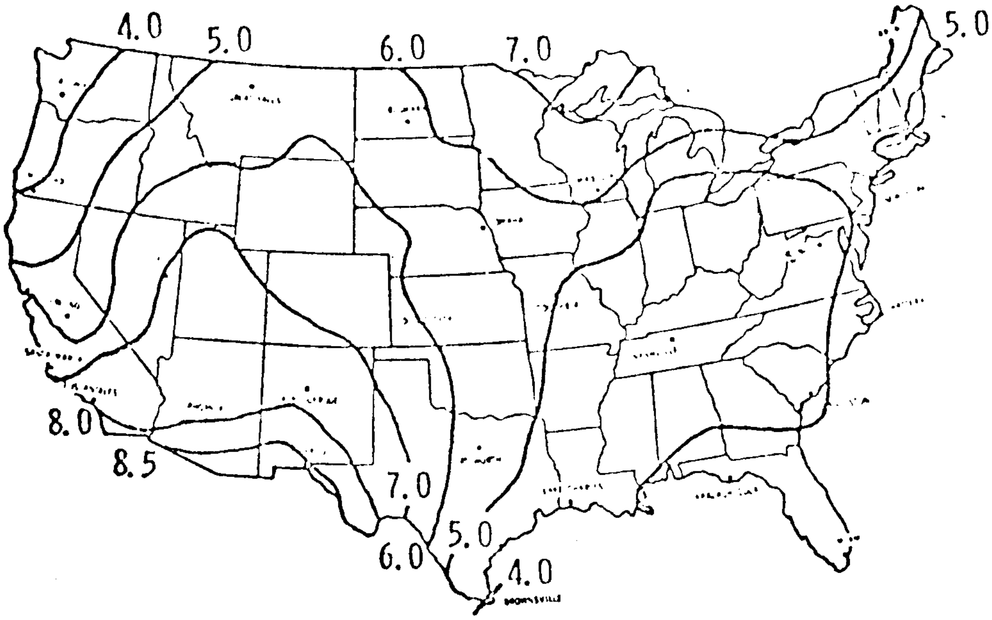


Figure A.2

MEAN DAILY DIRECT-NORMAL (TOP) AND TOTAL-
HORIZONTAL (BOTTOM) SOLAR RADIATION FOR FEBRUARY
(kilowatt-hours per square meter)



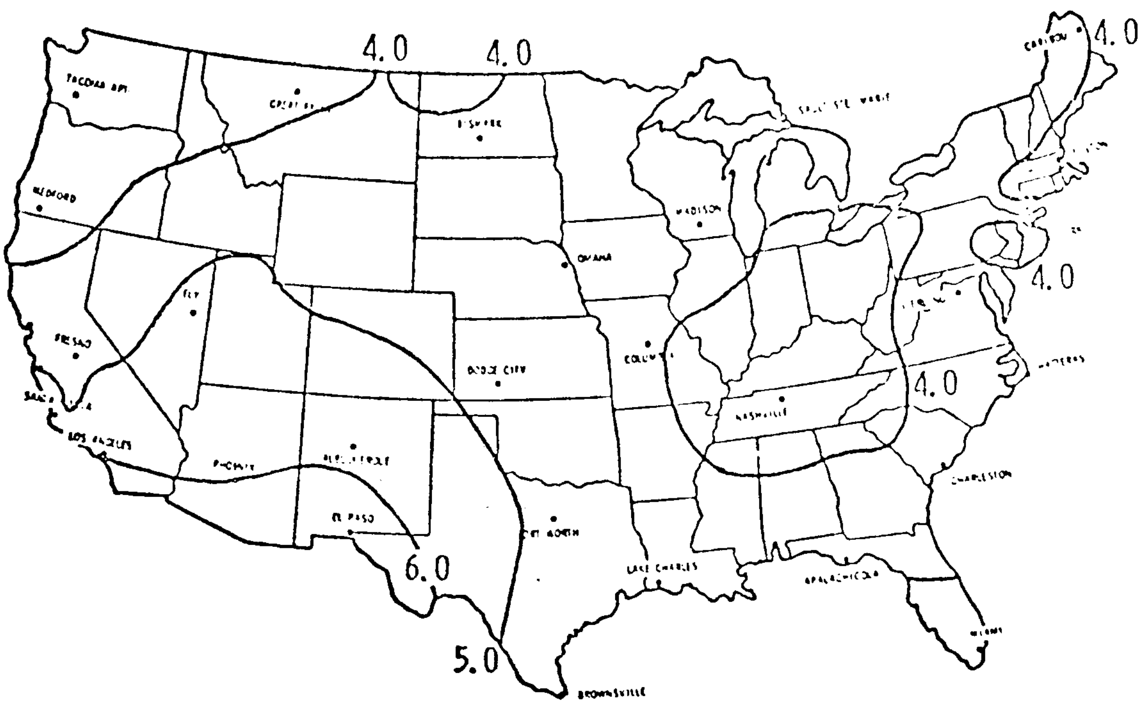
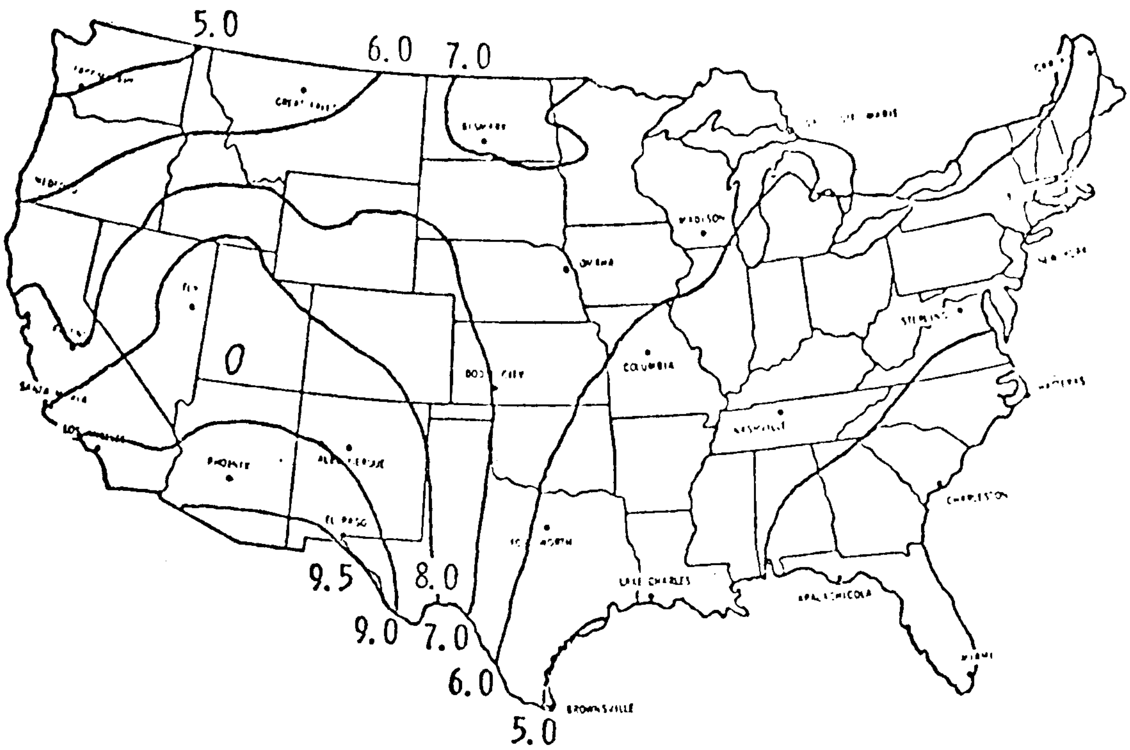


Figure A.3

MEAN DAILY DIRECT-NORMAL (TOP) AND TOTAL-HORIZONTAL (BOTTOM) SOLAR RADIATION FOR MARCH (kilowatt-hours per square meter)



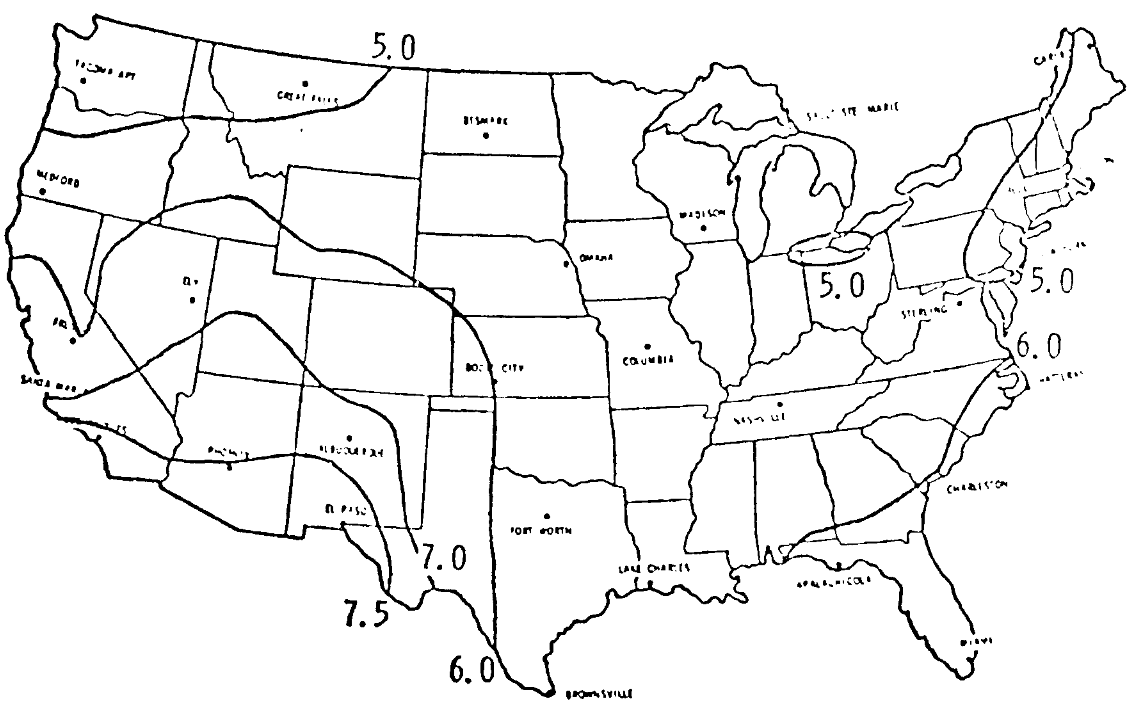
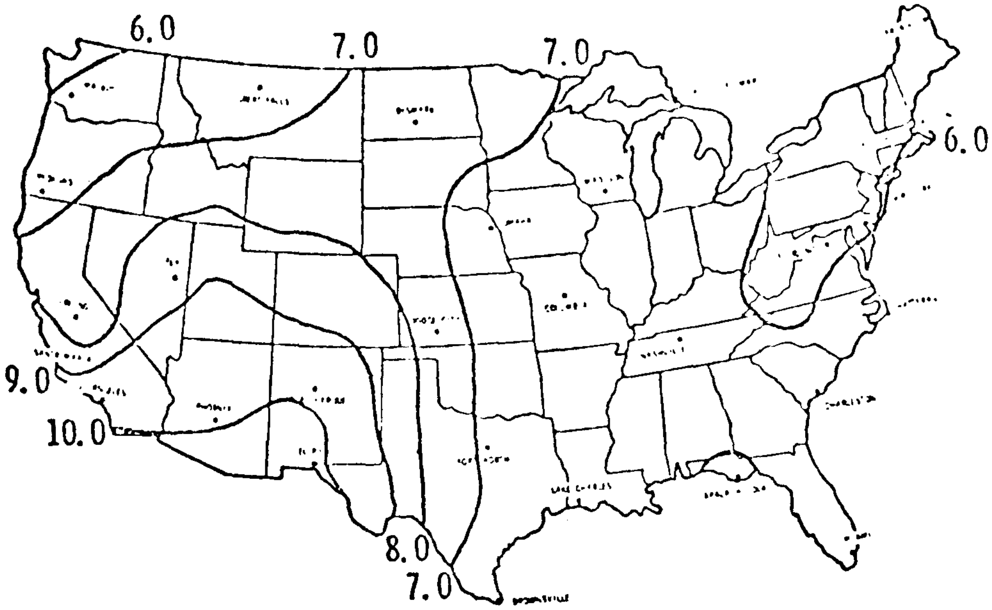


Figure A.4

MEAN DAILY DIRECT-NORMAL (TOP) AND TOTAL-HORIZONTAL (BOTTOM) SOLAR RADIATION FOR APRIL (kilowatt-hours per square meter)



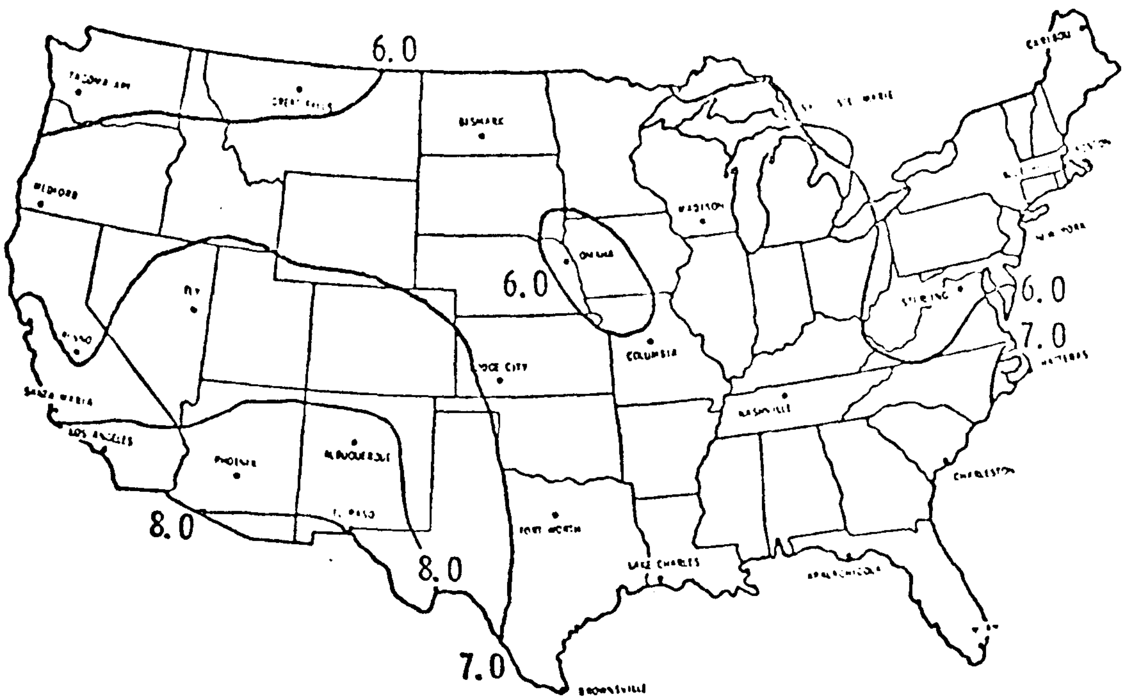


Figure A.5

MEAN DAILY DIRECT-NORMAL (TOP) AND TOTAL-HORIZONTAL (BOTTOM) SOLAR RADIATION FOR MAY (kilowatt-hours per square meter)

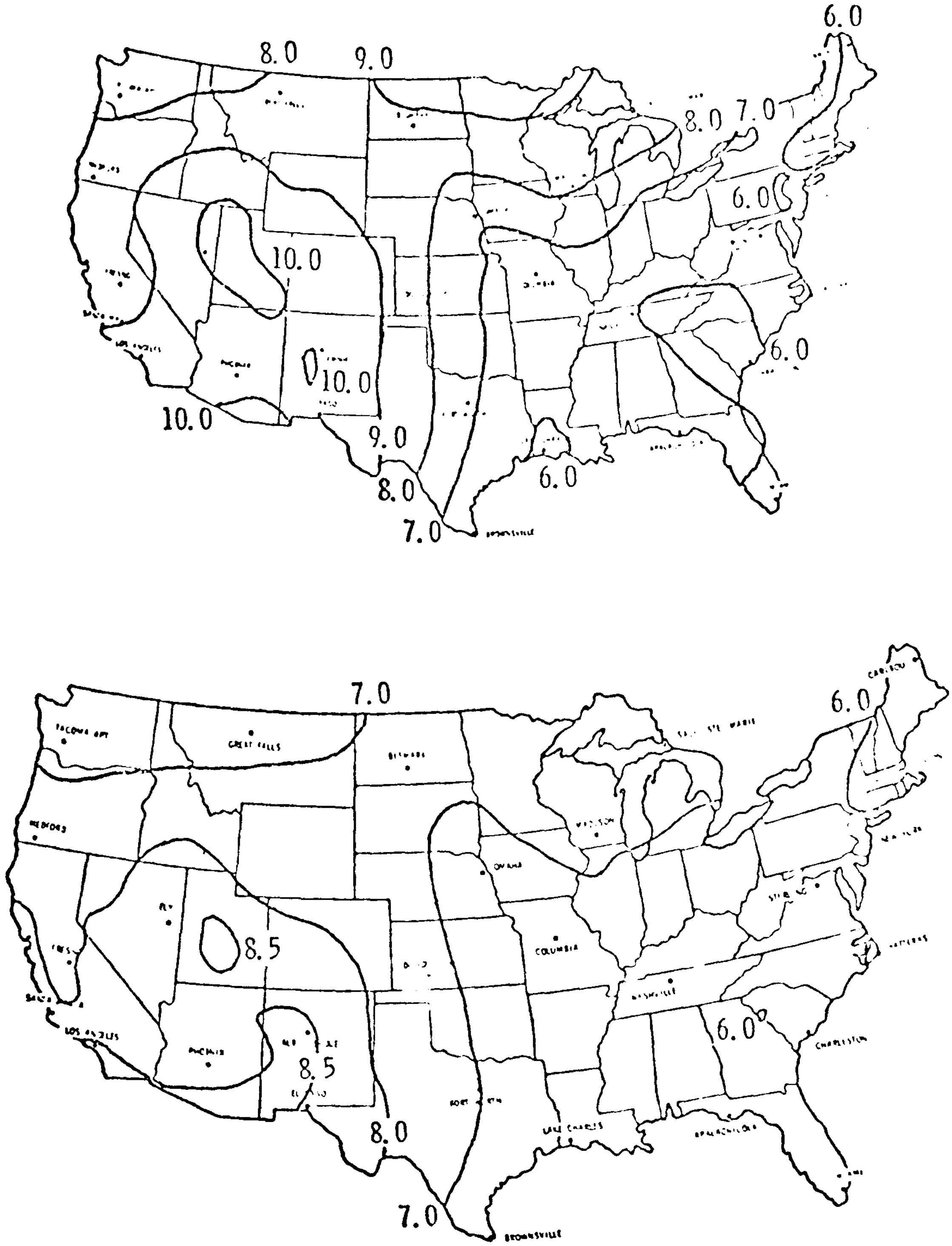
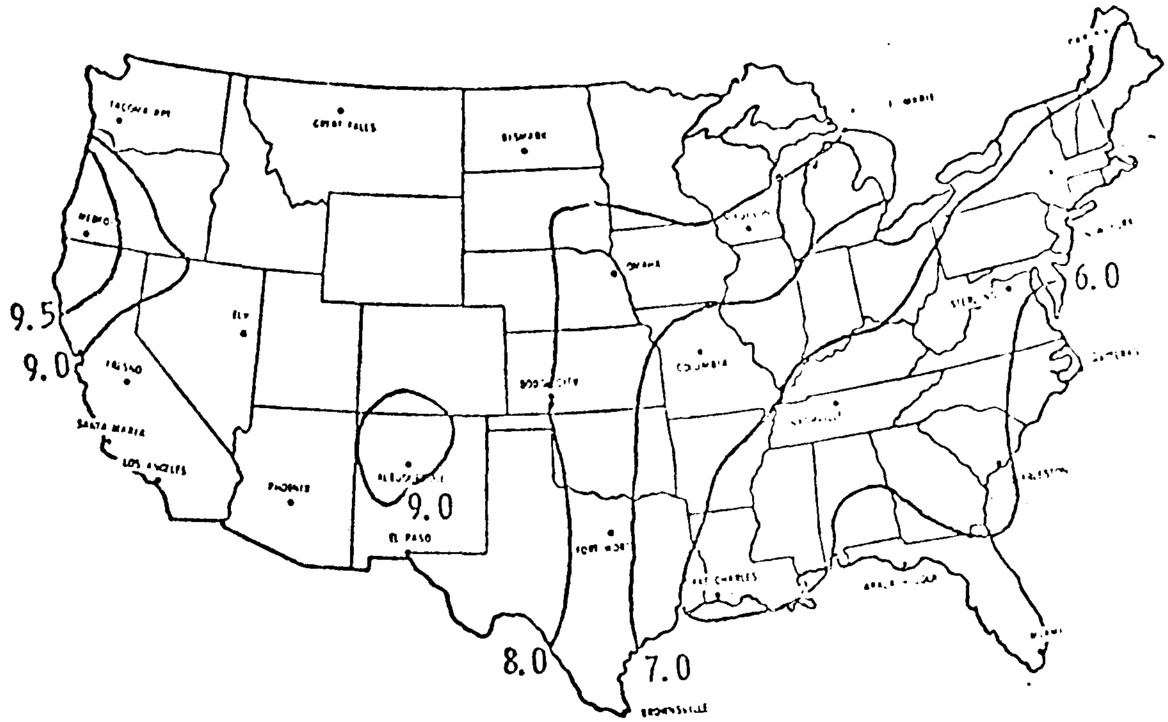


Figure A.6

MEAN DAILY DIRECT-NORMAL (TOP) AND TOTAL-HORIZONTAL (BOTTOM) SOLAR RADIATION FOR JUNE
(kilowatt-hours per square meter)



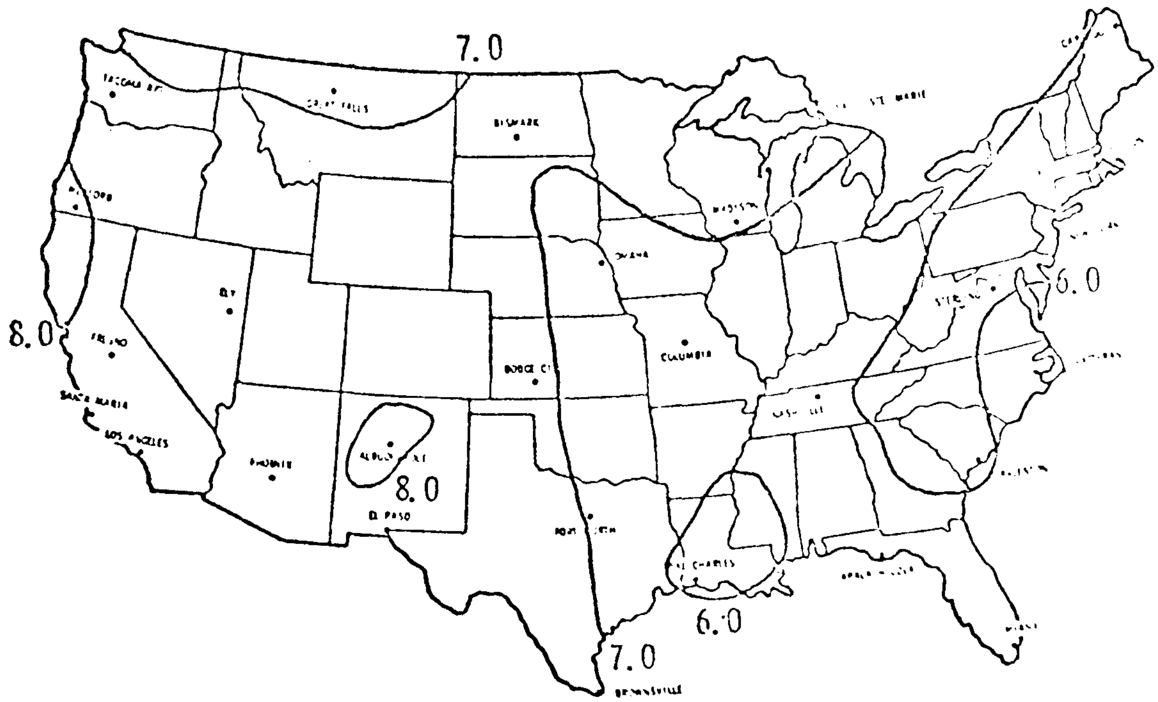
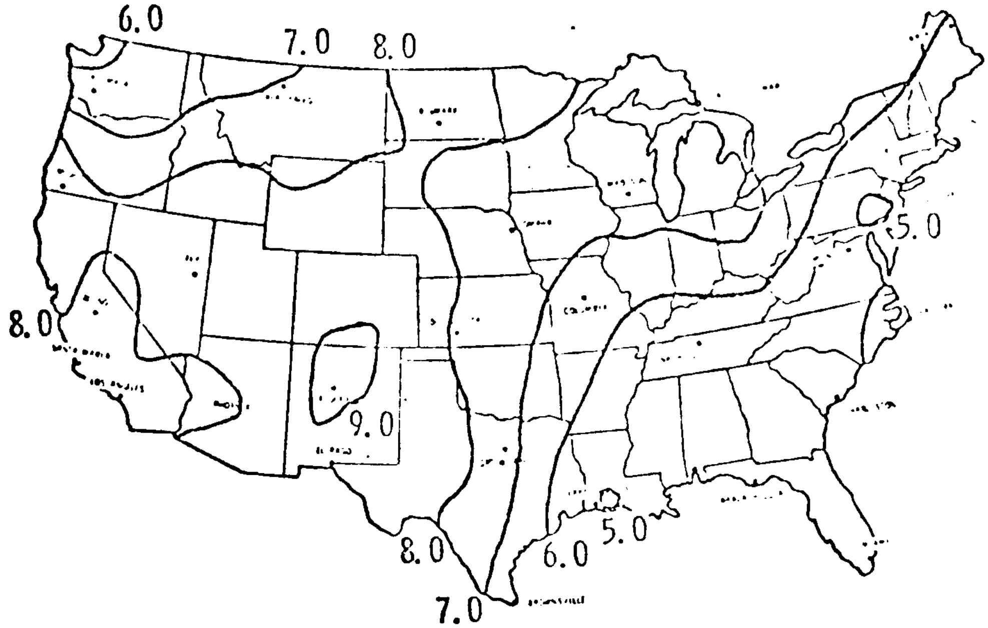


Figure A.7

MEAN DAILY DIRECT-NORMAL (TOP) AND TOTAL-HORIZONTAL (BOTTOM) SOLAR RADIATION FOR JULY (kilowatt-hours per square meter)



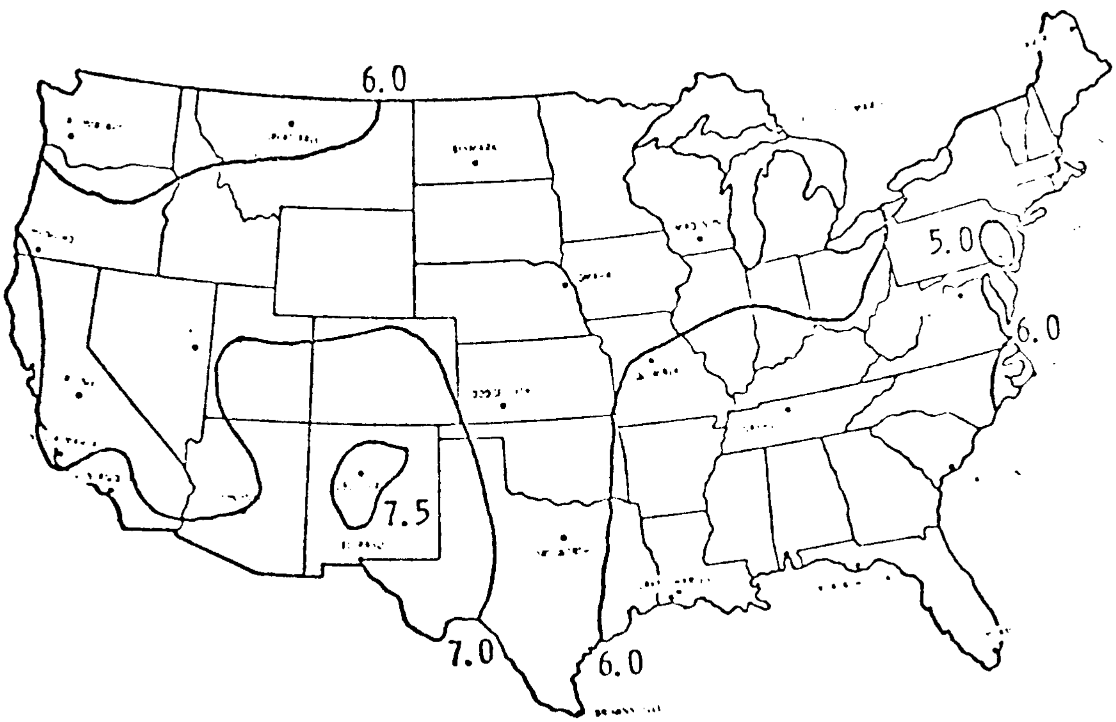
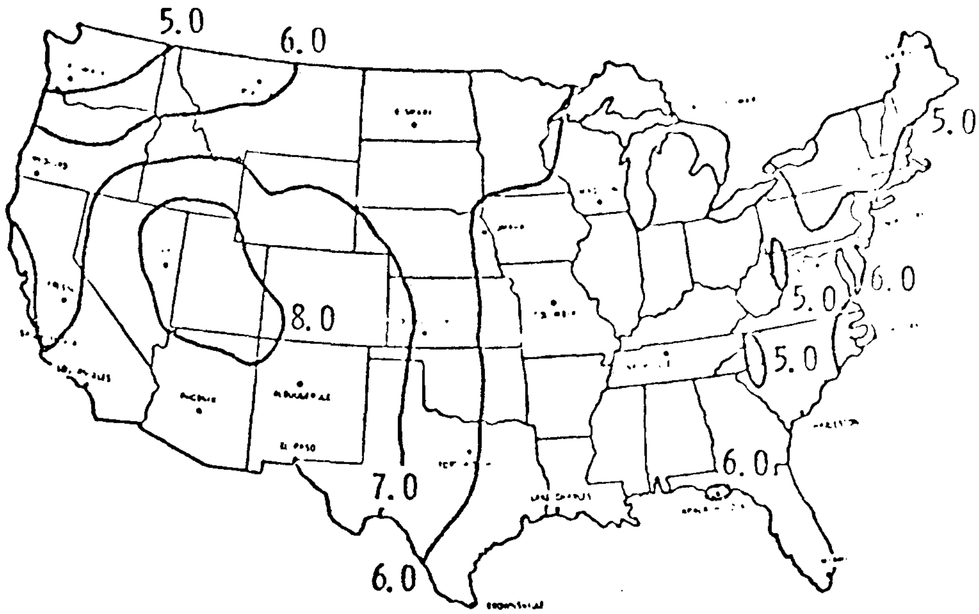


Figure A.8

MEAN DAILY DIRECT-NORMAL (TOP) AND TOTAL-HORIZONTAL (BOTTOM) SOLAR RADIATION FOR AUGUST (kilowatt-hours per square meter)



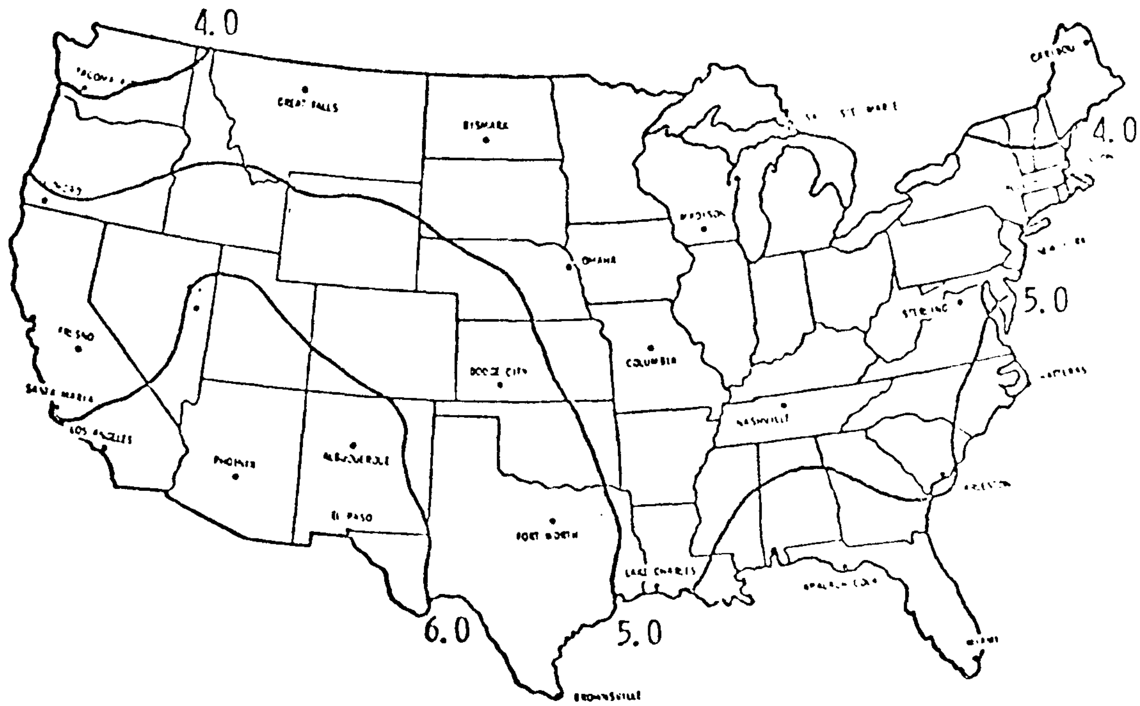
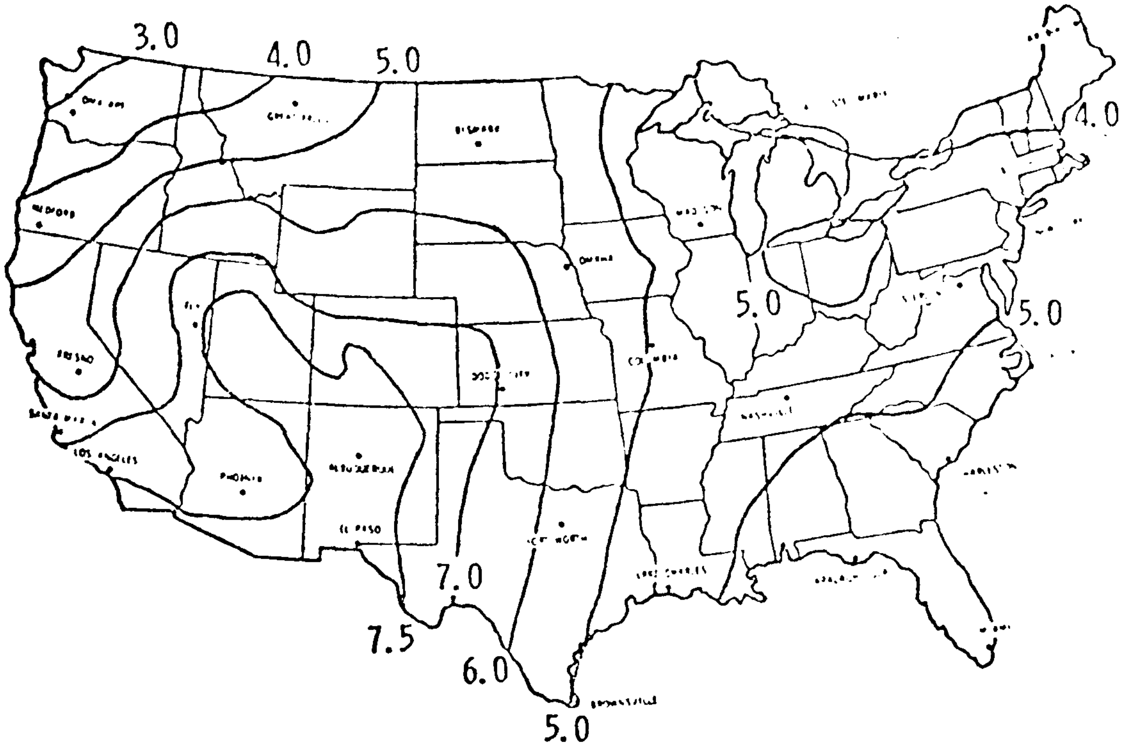


Figure A.9

MEAN DAILY DIRECT-NORMAL (TOP) AND TOTAL-HORIZONTAL (BOTTOM) SOLAR RADIATION FOR SEPTEMBER (kilowatt-hours per square meter)



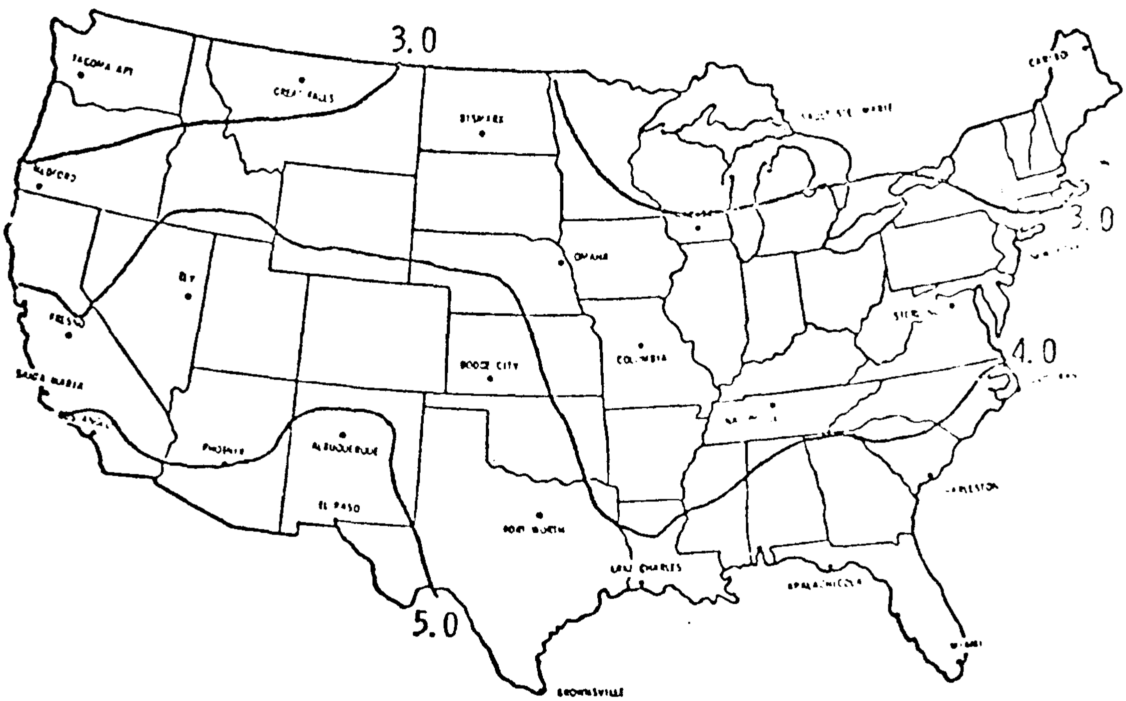


Figure A.10

MEAN DAILY DIRECT-NORMAL (TOP) AND TOTAL-
HORIZONTAL (BOTTOM) SOLAR RADIATION FOR OCTOBER
(kilowatt-hours per square meter)

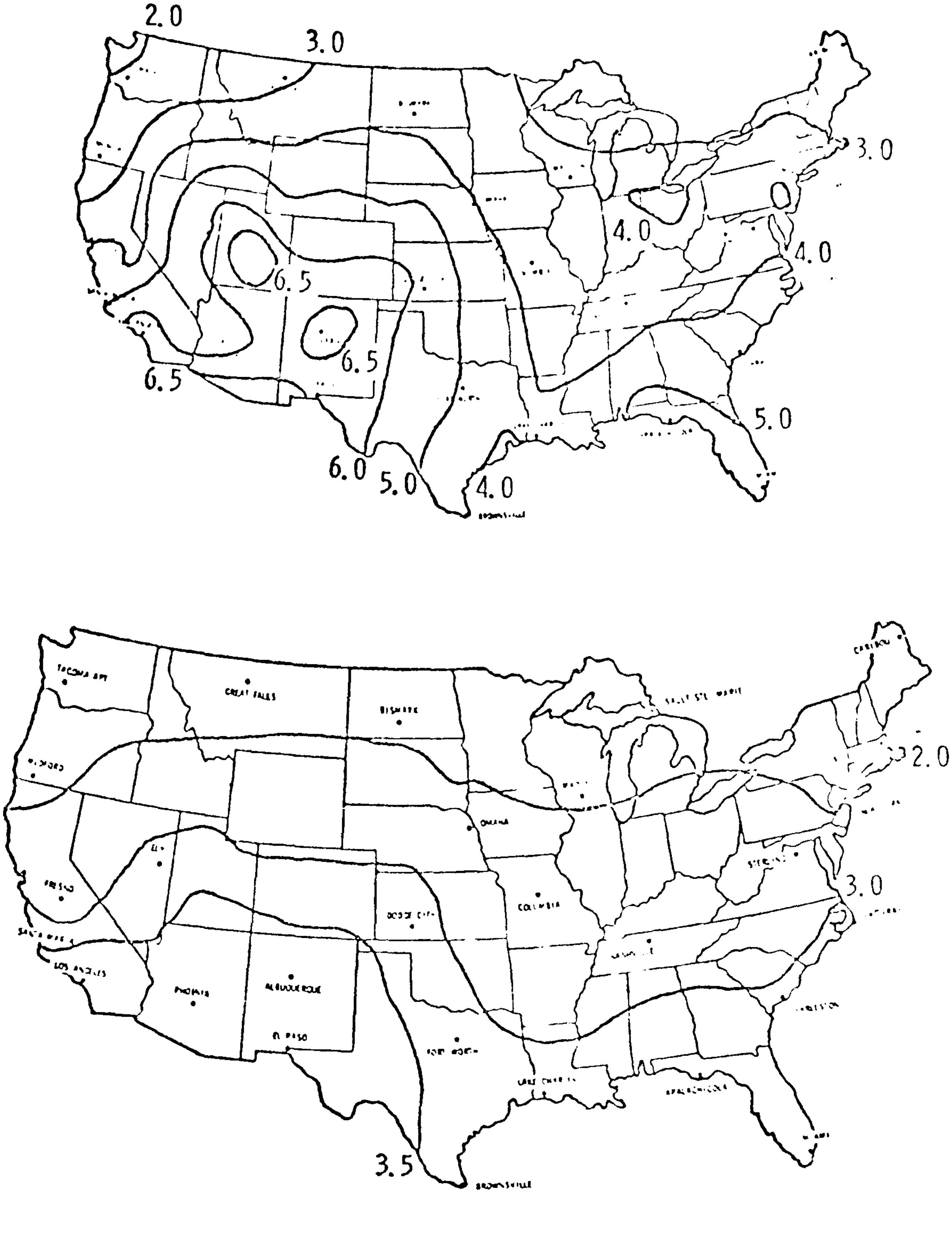
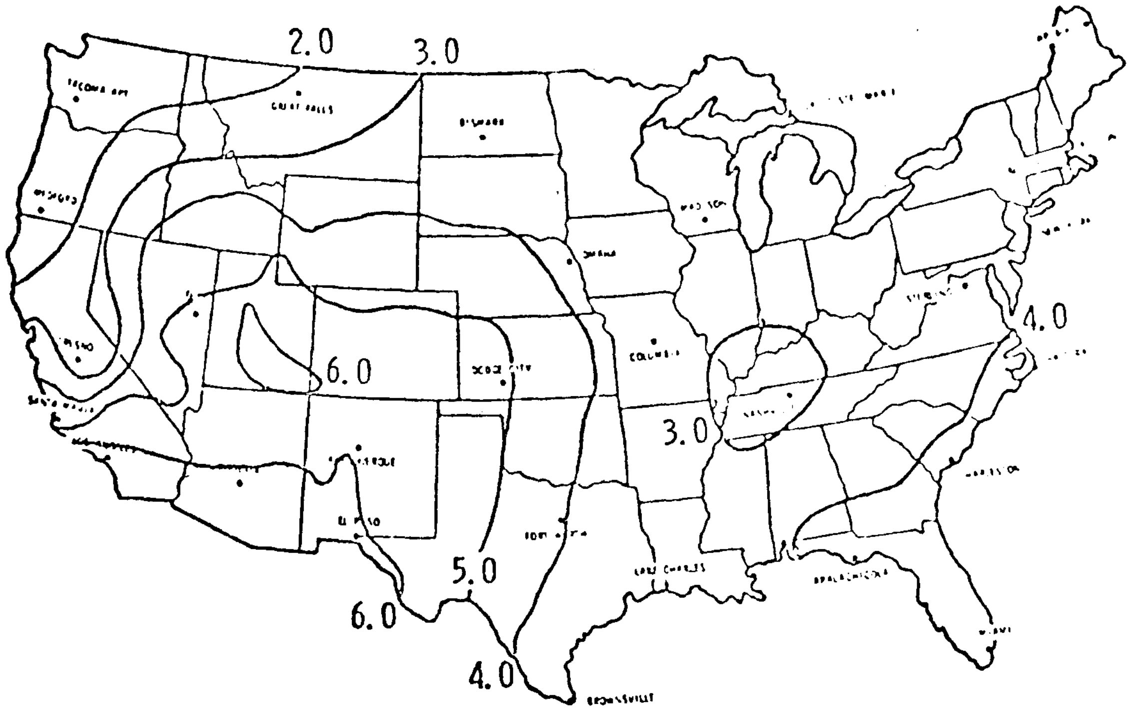


Figure A 11

MEAN DAILY DIRECT-NORMAL (TOP) AND TOTAL-HORIZONTAL (BOTTOM) SOLAR RADIATION FOR NOVEMBER
(kilowatt-hours per square meter)



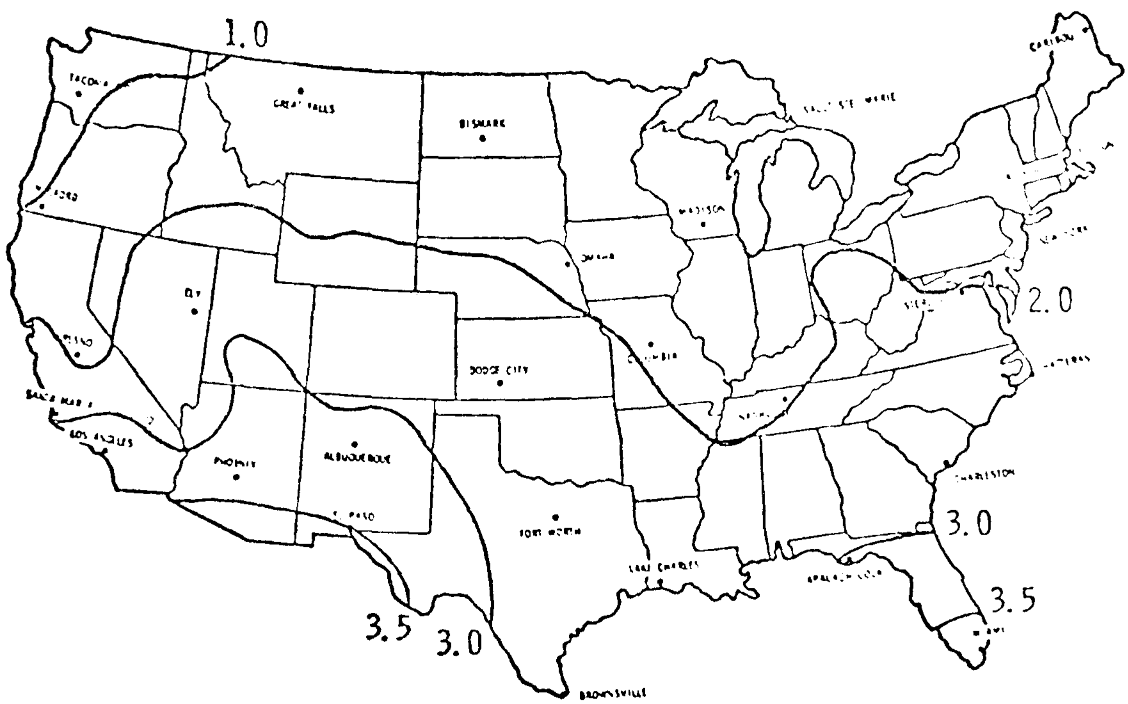


Figure A.12

MEAN DAILY DIRECT-NORMAL (TOP) AND TOTAL-HORIZONTAL (BOTTOM) SOLAR RADIATION FOR DECEMBER (kilowatt-hours per square meter)

Appendix B

WIND DISTRIBUTION

The annual variations in wind velocity for several locations across the state of Texas are presented in figures B.1 through B.5. Data were taken from the U.S. National Weather Service; they are averages over twenty years or more. In considering wind distribution, there are gererally three seasonal periods: winter, spring, and summer. The maximum wind velocities occur during the spring months of March and April; the velocity contours across the state for those months are presented in figure B.6. Minimum wind velocities tend to occur in the summer months of July through September; velocity contours for the state for this period are presented in figure B.7. There is a period of intermediate wind velocities in the winter months of December and January for which the velocity contours are presented in figure B.8. As can be seen from these plots, the northwest regions (such as Amarillo, Lubbock, Abilene) and the Gulf Coast regions (such as Corpus Christi and Brownsville) have the highest wind velocities in Texas.

Major problems in interpretation of the wind velocity data arise because of the heights and locations chosen for the anemometers. If the anemometer is located near buildings or other obstacles, a reduced wind speed can result, or the wind speed can be increased as a result of the Bernoulli effect.

National Weather Service substations are generally located at airports, and the wind speed information is for the benefit of aviation. In the early sixties most anemometers were changed to a height of from 20 to 30 feet and were placed near the runways, at least one-half mile away from major obstacles.

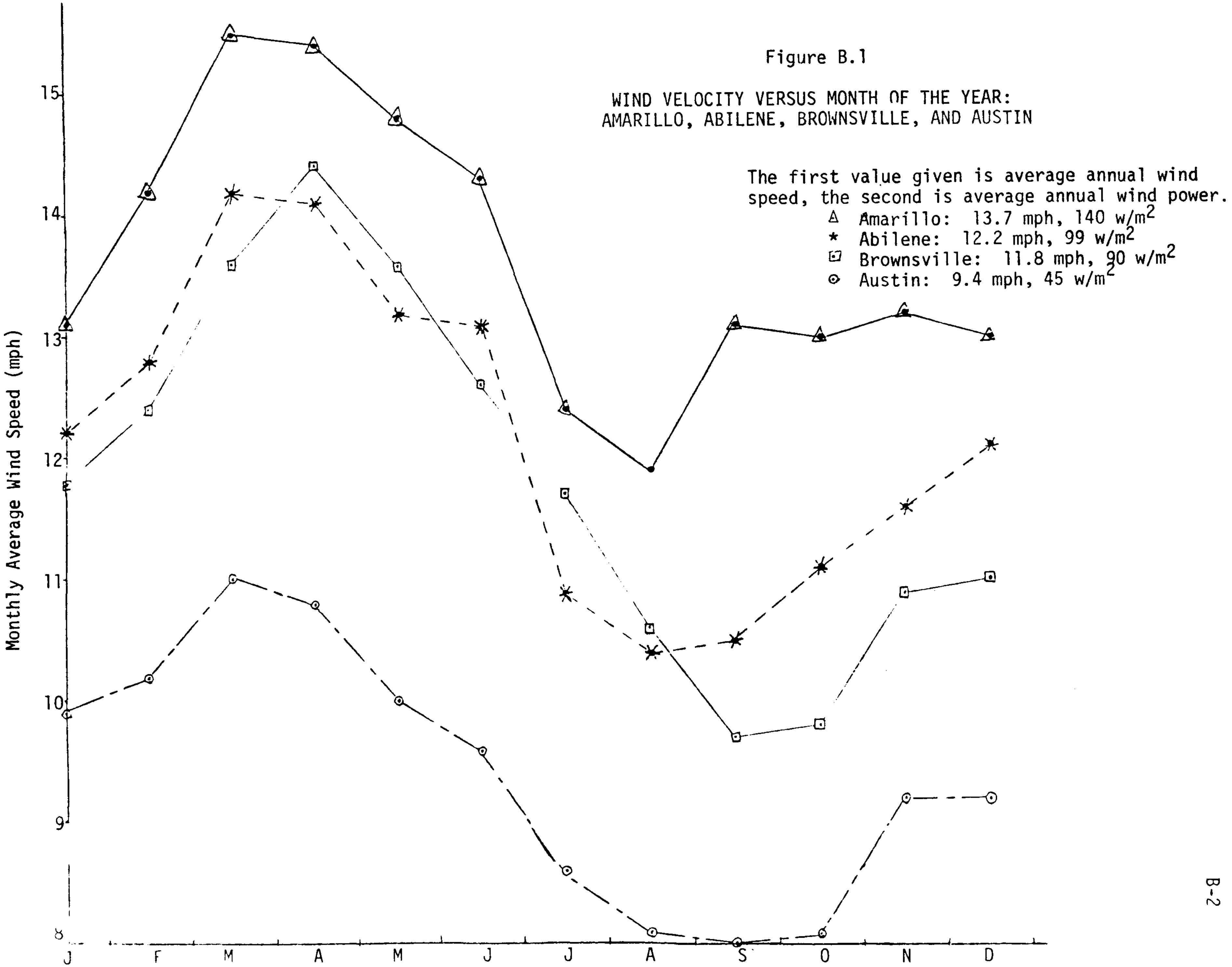


Figure B.1
WIND VELOCITY VERSUS MONTH OF THE YEAR:
AMARILLO, ABILENE, BROWNSVILLE, AND AUSTIN
The first value given is average annual wind speed, the second is average annual wind power.
Amarillo: 13.7 mph, 140 w/m2
Abilene: 12.2 mph, 99 w/m2
Brownsville: 11.8 mph, 90 w/m2
Austin: 9.4 mph, 45 w/m2
Monthly Average Wind Speed (mph)
15
14
13
12
11
10
9
8
J
F
M
A
M
J
J
A
S
O
N
D

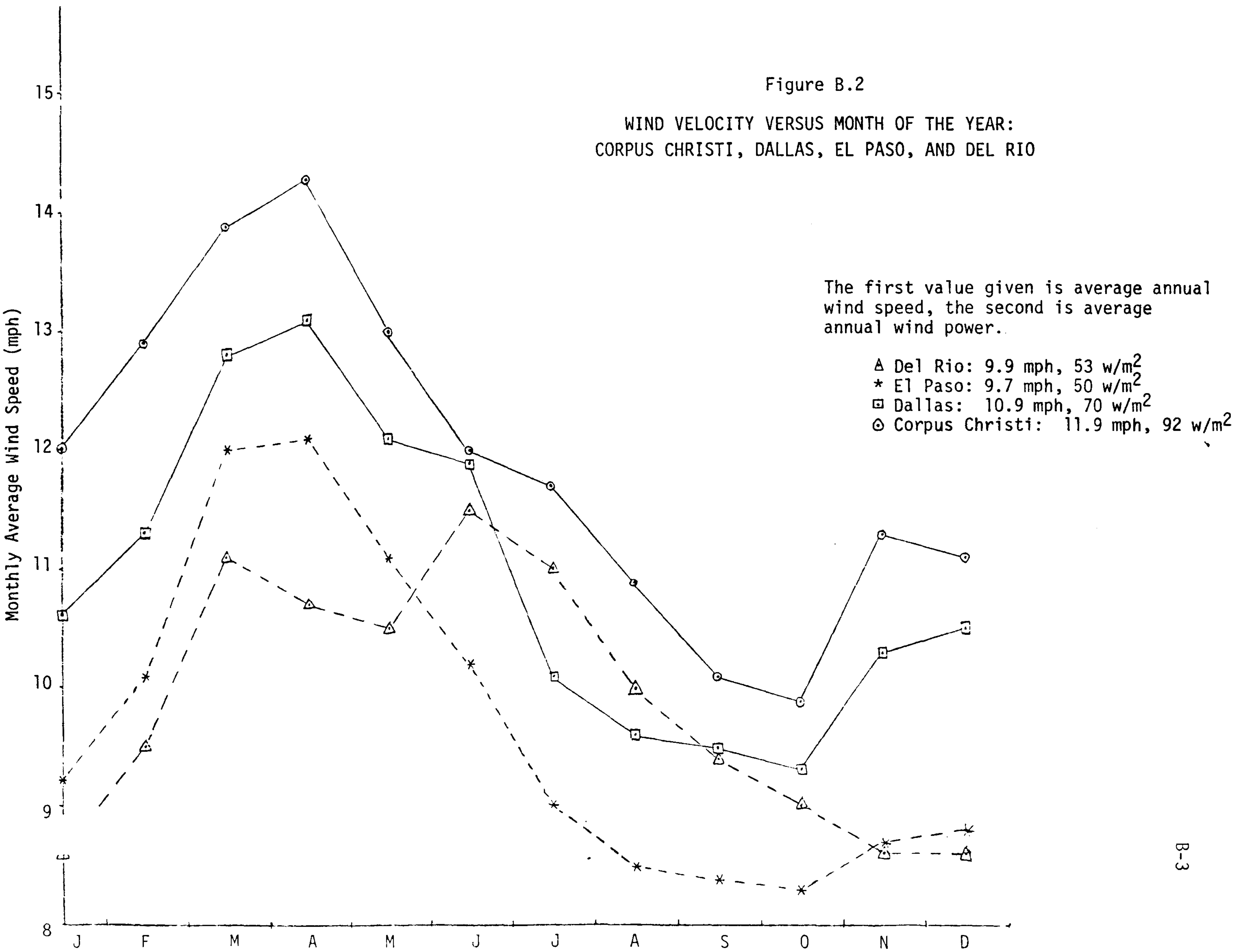


Figure B.2

WIND VELOCITY VERSUS MONTH OF THE YEAR: CORPUS CHRISTI, DALLAS, EL PASO, AND DEL RIO

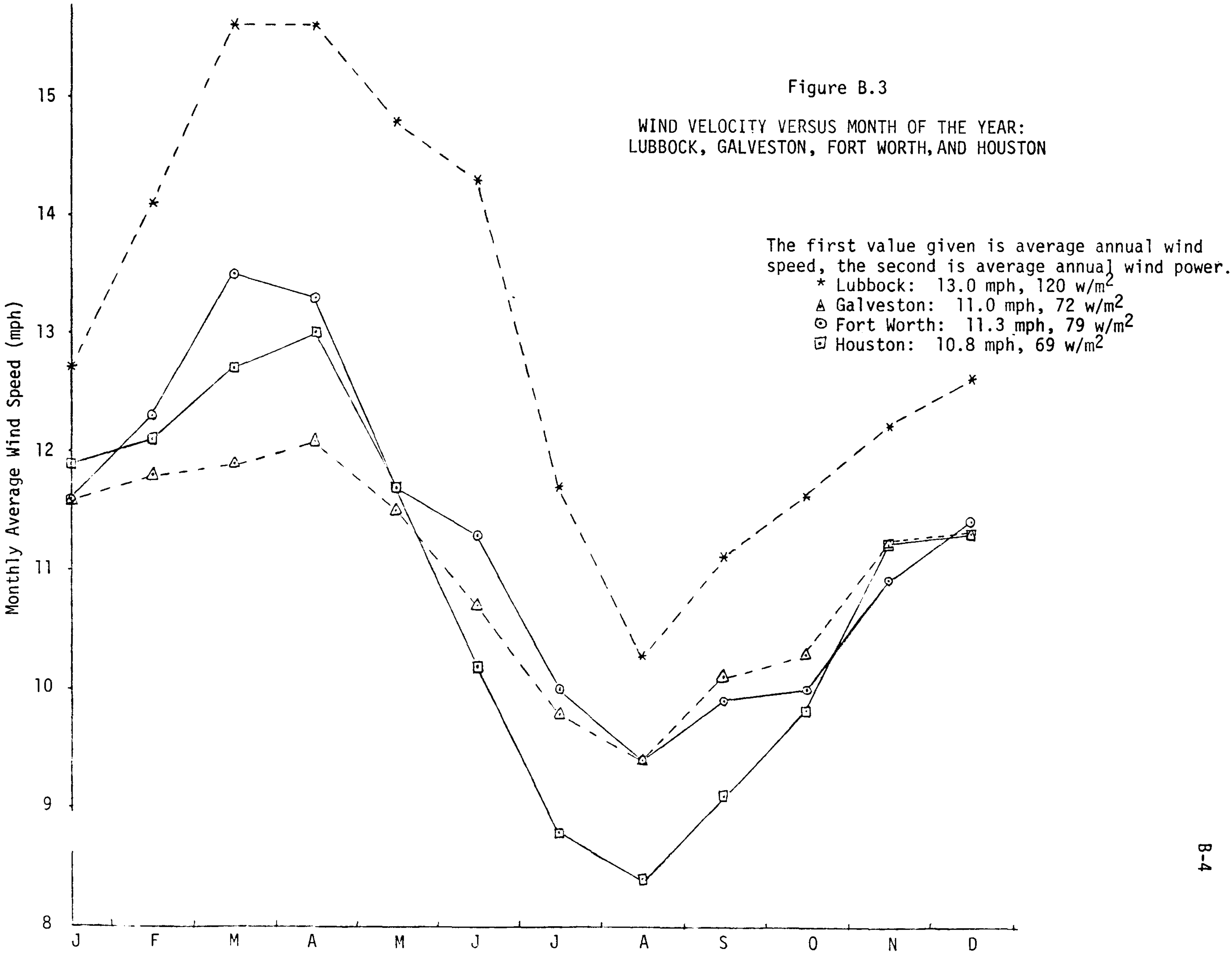
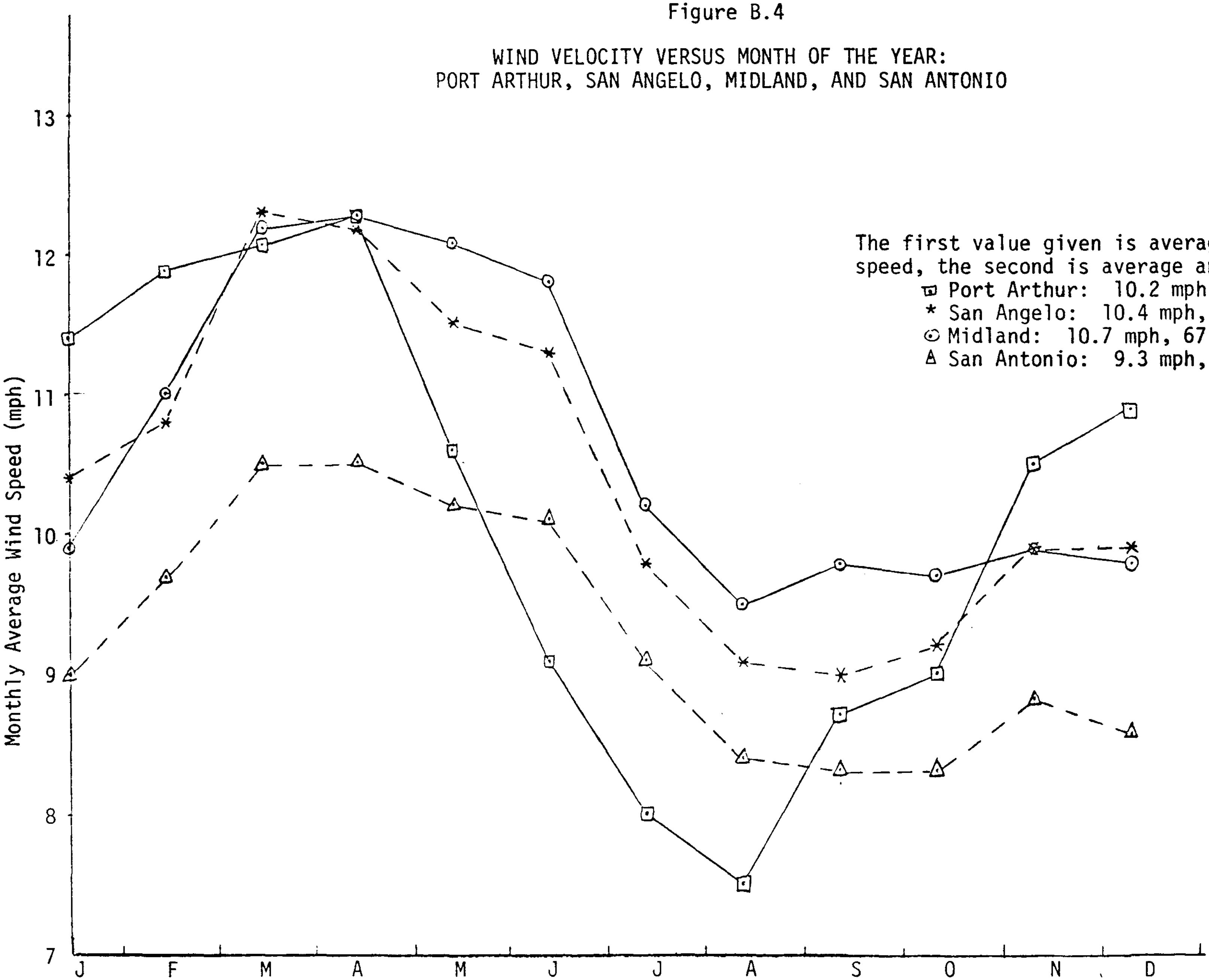


Figure B.3

WIND VELOCITY VERSUS MONTH OF THE YEAR: LUBBOCK, GALVESTON, FORT WORTH, AND HOUSTON

Figure B.4

WIND VELOCITY VERSUS MONTH OF THE YEAR:
PORT ARTHUR, SAN ANGELO, MIDLAND, AND SAN ANTONIO



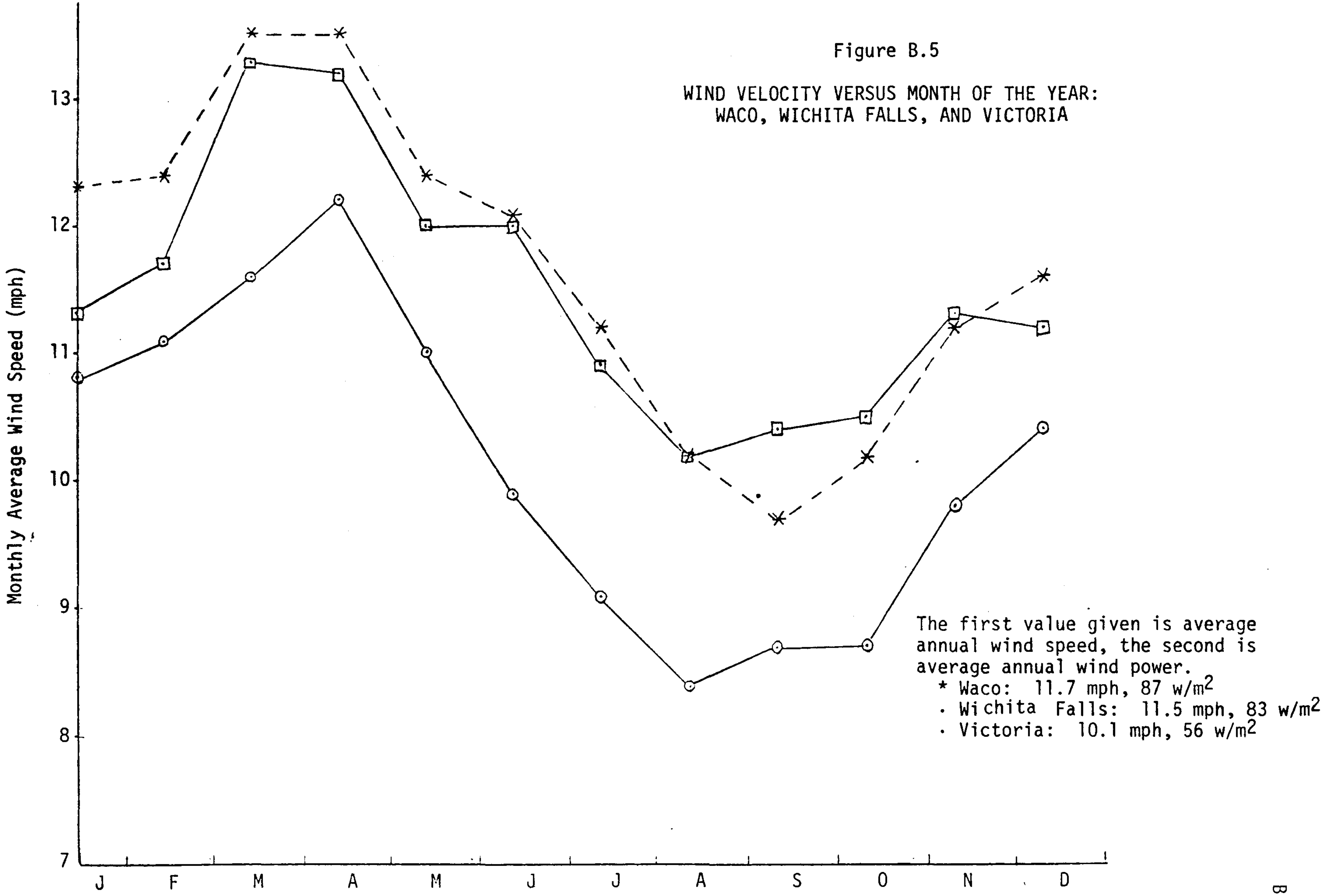


Figure B.5

WIND VELOCITY VERSUS MONTH OF THE YEAR: WACO, WICHITA FALLS, AND VICTORIA

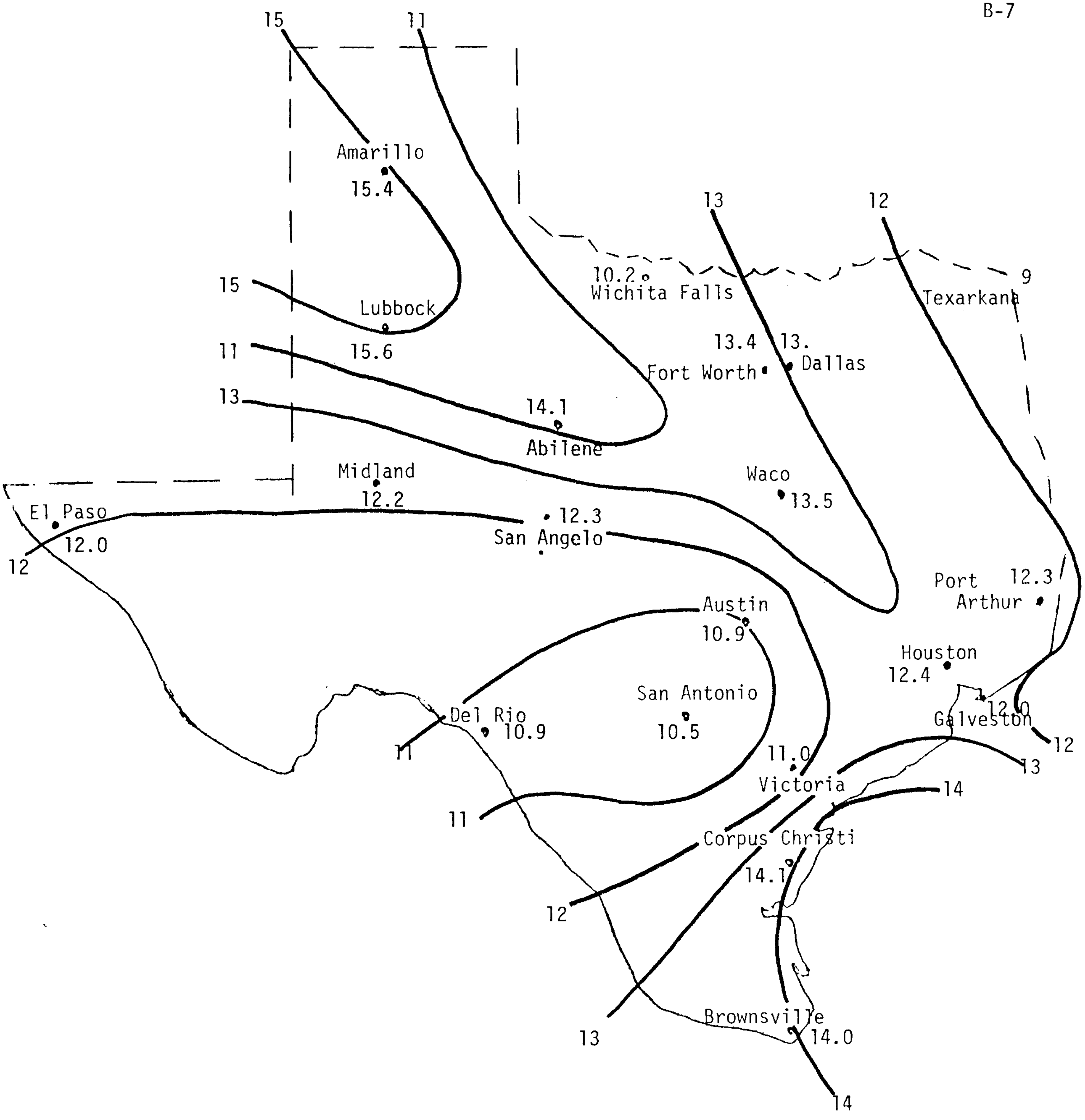


Figure B.6

EQUAL VELOCITY CONTOURS FOR AVERAGE WIND VELOCITIES
OCCURRING DURING MARCH AND APRIL

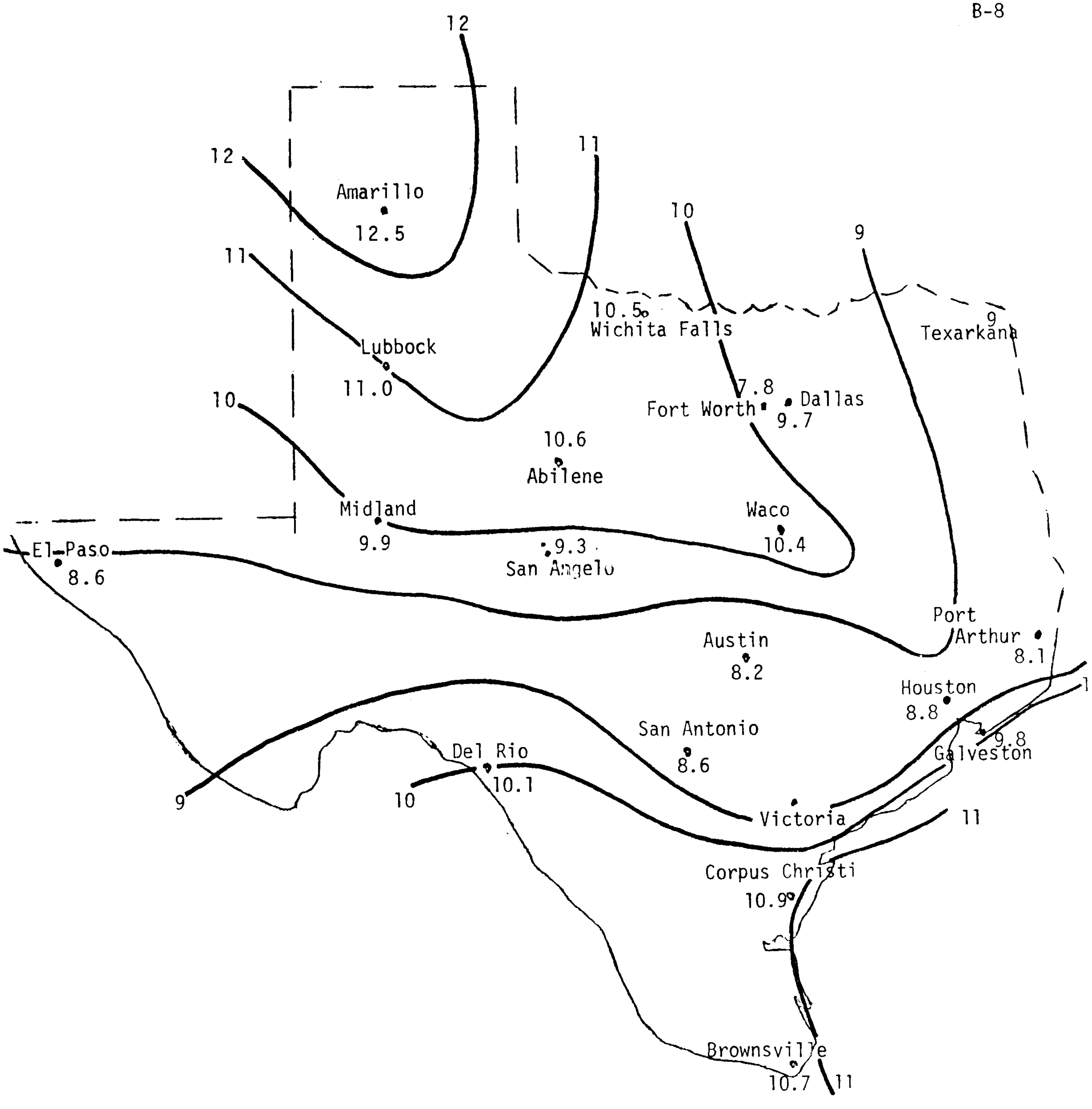


Figure B.7

EQUAL VELOCITY CONTOURS FOR AVERAGE WIND VELOCITY OCCURRING DURING JULY, AUGUST, AND SEPTEMBER

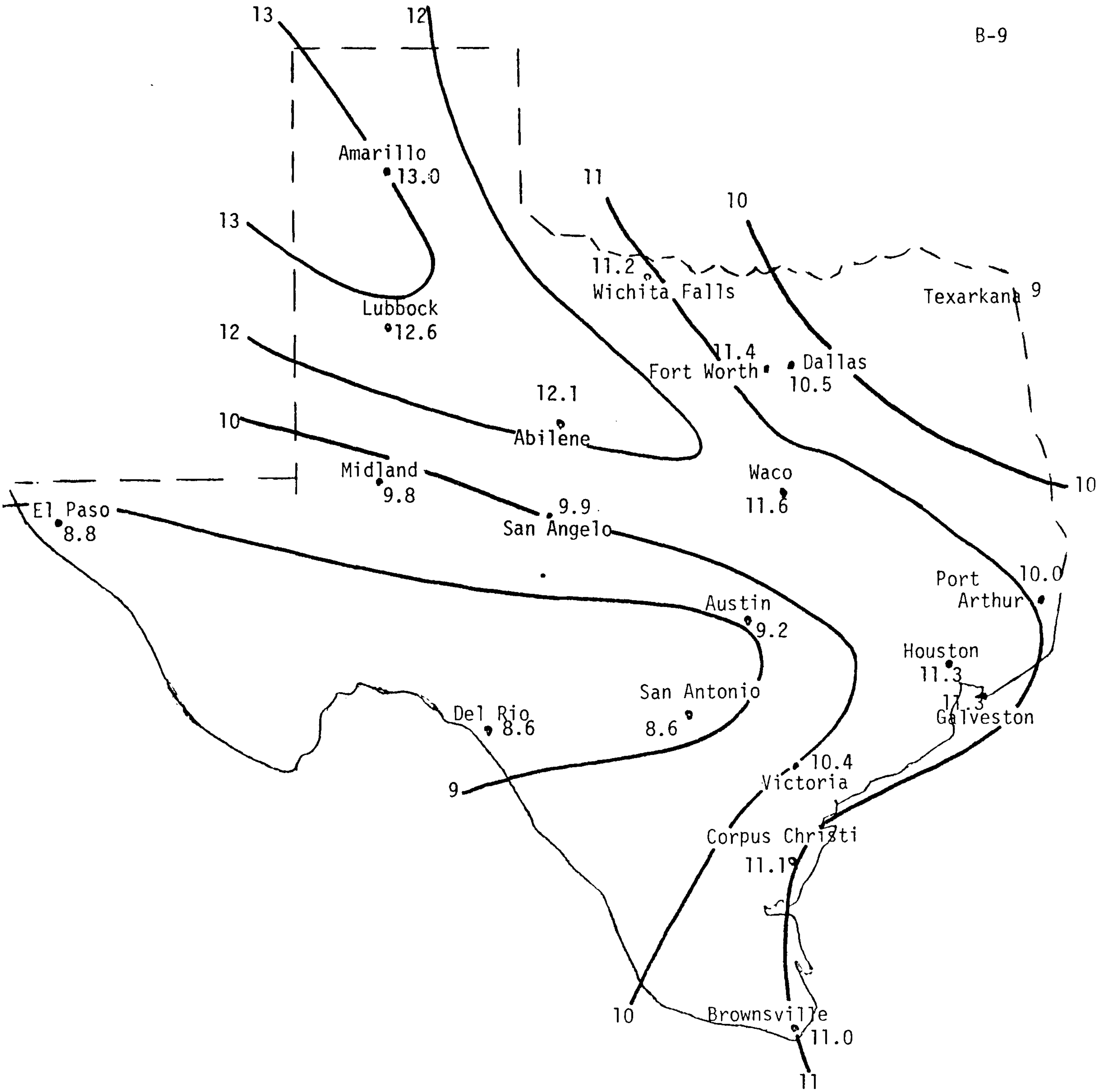


Figure B.8

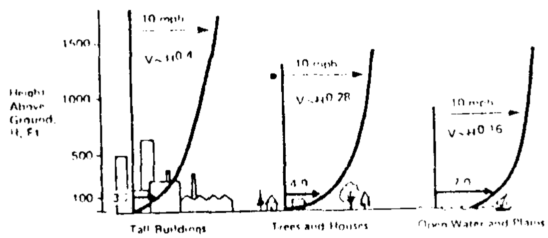
EQUAL WIND VELOCITY CONTOURS FOR AVERAGE WIND VELOCITIES OCCURRING DURING DECEMBER

If a wind speed V_1 is known at some reference height H_1, the wind speed V desired at any height H can be calculated by:

$$V = V_1\left(\frac{H}{H_1}\right)^n$$

where n is an experimental exponent which ranges from $\frac{1}{5}$ to $\frac{1}{7}$.

The value of n depends in a rather complex manner on terrain features, thermal stratification of the air, and the distance from the ground. This variation is illustrated in figure B.9.



Source: Reference [16]

Figure B.9

EFFECT OF GROUND ROUGHNESS ON VERTICAL DISTRIBUTION OF WIND SPEEDS

Height and location, therefore, have a large effect on the velocity. The presented velocity contours over Texas are based on measurements obtained near ground level at airports at heights of approximately 30 feet. Therefore, aeroturbines located at height ranging from 100 to 200 feet, experience greater velocities by a factor of approximately 1.27 to 1.46 times the anemometer's recorded wind speed. These factors assume an exponent of approximately 0.2, which is between the second two cases in figure B.6.

Appendix C

COMMUNITY DATA

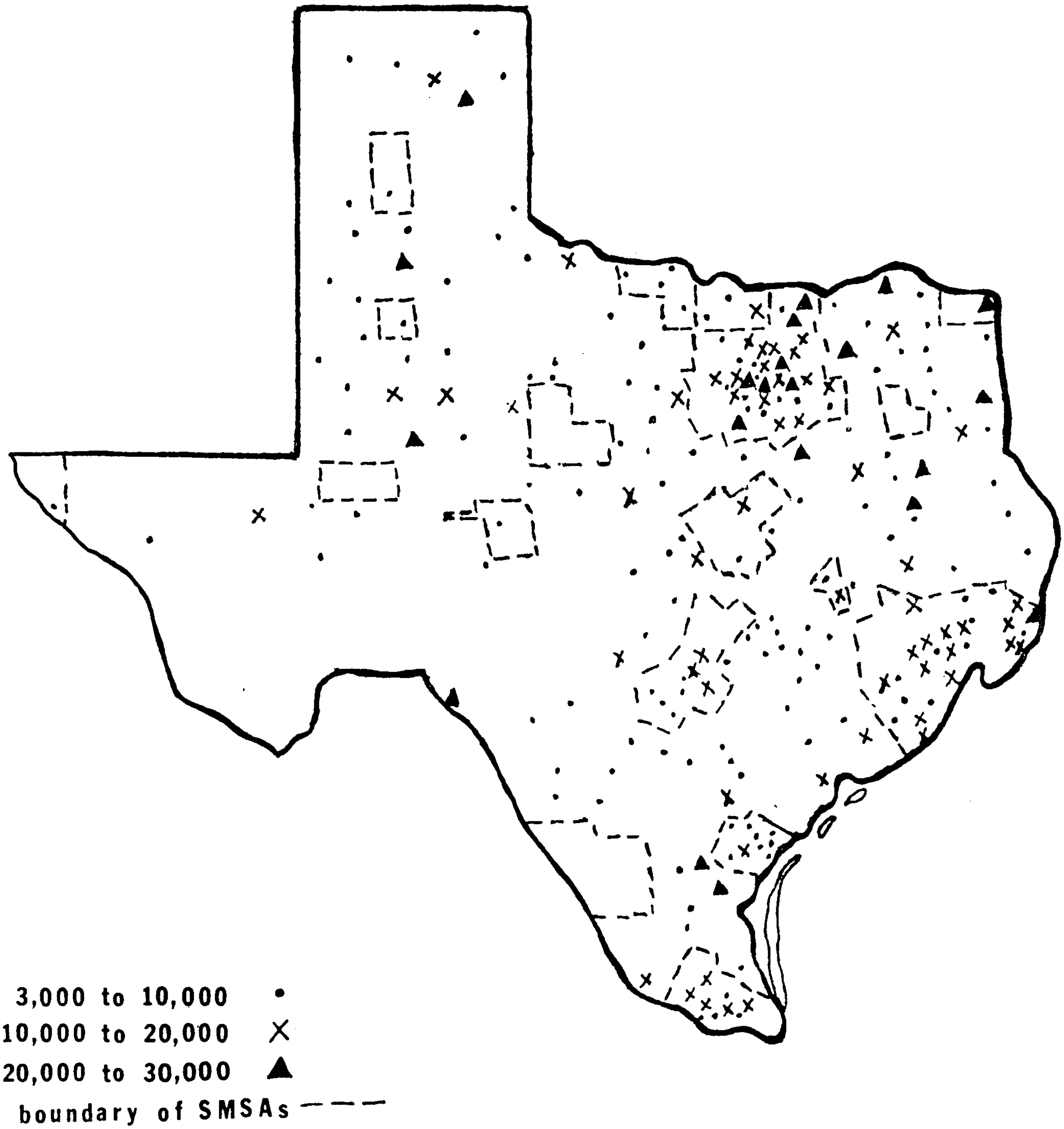


Figure C.1

LOCATION OF TEXAS TOWNS AND CITIES:

POPULATION 3,000 to 30,000

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Alamo	4,237	Edinburg-Pharr-McAllen SMSA	3.31%	$1,251	CP&L	$34.64		60	See section II
Alice	20,200	Jim Wells	-62.%	$2,045	CP&L	$34.64	ApGcLLK PSSpW	493	County seat; oil field servicing center; agribusiness
Allen	3,000	Dallas-Ft. Worth SMSA	89.%		TP&LC	$23.60		30	See section II
Alpine	6,000	Brewster	54.%	$2,031	WTUC	$26.43	ApSSpW	130	County seat; ranching center; university
Alvin	11,000	Houston SMSA	81.11%	$3,220	CPSC	$22.30	CLSW	193	See section II
Andrews	8,655	Andrews	-31.4%	$2,738	TESC	$20.42	SSpW	209	County seat; oil marketing center
Angleton	10,250	Houston SMSA	81.11%	$3,028	CPSC	$22.30	SW	156	County seat; center for rice, cattle, agribusiness
Aransas Pass	5,923	Corpus Christi SMSA	24.14%	$2,352	CP&LC	$34.64	HrPhSW	205	Shrimping and tourist center; aluminum and chemical plants
Athens	9,700	Henderson	40.69%	$2,187	TP&LC	$24.08		270	County seat; plants make T.V. sets, mobile homes, clothing, brick, clay products; college
Atlanta	5,507	Cass	21.2%	$2,759	SEPC	$21.30	AmApCsSpW	170	Varied manufacturing; oil field servicing; argibusiness
Azle	5,200	Dallas-Ft. Worth SMSA	89.%	$2,835	TESC	$20.02		65	See section II

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Balch Springs	14,400	Dallas-Ft. Worth SMSA	89.%	$2,400	TP&LC	$23.60			See section II
Ballinger	5,000	Runnels	66.2%	$2,332	WTUC	$26.03	AmApSSpW	121	County seat; plants make garments, telephone parts metal products; meat processor
Bastrop	3,512	Bastrop	21.%	$2,237	Bastrop Electric Plant	$25.70	ESW	112	County seat; manufacturing plants
Bay City	14,445	Matagorda	38.%	$2,394	CP&LC	$34.64	AmApGSSpW	260	County seat; petrochemical plants; gas, oil, sulfur processing
Bedford	12,500	Dallas-Ft. Worth SMSA	89.%	$3,500	TP&LC	$23.60	CELLKSSpW	70	See section II
Beeville	16,510	Bee	21.%	$1,922	CP&LC	$34.64	AmApFgLPSW	270	County seat; naval air station; agribusiness center; junior college
Bellaire	19,000	Houston SMSA	81.11%	$4,001	HL&PC	$22.42	LLSpW	185	See section II
Bellmead	8,000	Waco SMSA	50.83%	$2,380	TP&LC	$24.08	CeLSSpW	60	
Belton	8,820	Kileen-Temple SMSA	27.76%	$2,213	TP&LC	$24.08	LPPhSW	125	County seat; several industries; college
Benbrook	8,169	Dallas-Ft. Worth SMSA	89.%	$3,842	TESC	$20.02			

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Big Spring	29,500	Howard	8.3%	$2,674	TESC	$20.44	AmCGcLKPSSpW	548	County seat; plants make petrochemicals, carbon black, fiberglass pipe, plastics, teaching aids, clothing; medical center with 6 hospitals; community college
Bishop	4,000	Corpus Christi SMSA	24.14%	$2,529	CP&LC	$34.64	ApSW	52	
Bonham	8,040	Fannin	-0-	$2,516	TP&LC	$24.08		180	County seat; plants make cable, gas pumps, clothing, mobile homes, lawn mowers, fertilizers, other products
Borger	14,560	Hutchinson	-74.8%	$3,021	SPSC	$24.76	PSp	367	Petroleum operating center; petrochemical plants; varied manufacturing; community college
Bowie	5,245	Montague	8.36%	$2,503	Bowie Municipal Light Dept.	$24.15	AmApCELLK SSpW	166	Agribusiness center; apparel manufacturing
Brady	6,000	McCulloch	7.94%	$2,368	Brady Water & Light Works (9.3 MWpd; 16.85 MWgc)[6]	$23.05	ApCCeEg GeHrLLK PhSSpW	162	County seat; ranching and tourist headquarters; plants process mohair, wool, peanuts, sand, make trailers
Breckenridge	6,150	Stephens	5.34%	$2,383	TESC	$20.44	CLKSSpW	220	County seat; oil and agribusiness center; plants make clothing, petrochemicals, mobile homes, other products

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Brenham	8,982	Washington	-6.%	$2,355	Brenham Municipal Light & Power System (2.59 MWpd)	$23.70	AmApEGPSSpW	270	County seat; plants process cotton, make furniture, metalwork, other products; community college
Bridge City	8,277	Beaumont-Port Arthur Orange SMSA	67.78%	$2,877	GSUC	$25.58		75	See section II
Bridge-port	3,760	Dallas-Ft. Worth SMSA	89.%	$2,623	TP&LC Bridgeport Light & Power Plant	$23.60		115	Trade center for lake resort; gas, oil production; agribusiness; plants make brick, clothing, other products
Brown-field	9,934	Terry	7.5%	$2,518	Brownfield Municipal Light & Power Plant (22.92 MWgc)	$21.75	EPhSW	216	County seat; plants make irrigation equipment, carbon black, fertilizer; process minerals
Bunker Hill Village	3,977	Houston SMSA	81.11%	$7,392	HL&PC	$22.42			See section II
Burk-burnett	9,775	Wichita Falls SMSA	14.91%	$2,227	TESC	$20.44	AmCSW	110	Plants make chemical products, plastics, rodeo equipment, machinery, other products
Burleson	9,803	Dallas-Ft. Worth SMSA	89.%	$2,935	TESC	$20.02		130	See section II

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Burnet	3,044	Burnet	15.1%	$2,426	Burnet Electric Dept. (5.04 MWpd)	$31.98	ApCESSpW	102	County seat; stone and graphite products; agri-business; tourism
Cameron	5,575	Milam	-42.4%	$2,091	TP&LC	$24.08	ApCSpW	100	County seat; plants make doors, furniture, other products
Canadian	3,020	Hemphill	16.1%		Canadian Municipal Light & Power Dept.		AmESSpW	75	County seat; feedlot; plant does millwork
Canyon	8,758	Amarillo SMSA	17.55%	$2,407	SPSC	$24.76	CeLPSSpW	150	County seat; university; ranching, farming center
Carrizo Springs	6,115	Dimmit	-14.4%	$1,357	CP&LC	$34.64		75	County seat; agribusiness center; food processing; garment manufacturing; hunting
Carroll-ton	18,500	Dallas-Ft. Worth SMSA	89.%	$3,224	TP&LC	$23.60	CeLSSpW	260	See section II
Carthage	6,100	Panola	-2.25%	$2,581	SEPC	$21.30	ApCSSpW	170	County seat; plants process poultry, petroleum; saw mills; community college
Castle Hills	5,311	San Antonio SMSA	34.54%	$6,254	CPSB	$33.05			See section II
Cedar Hill	4,500	Dallas-Ft. Worth SMSA	89.%	$3,340	TP&LC	$24.09		50	See section II

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Center	5,600	Shelby	9.08%	$2,402	SEPC	$21.30		240	County seat; plants process poultry, timber
Channel-view	8,227	Houston SMSA	81.11%		HL&PC	$23.22		110	See section II
Childress	5,940	Childress	-43.29%	$2,605	WTUC	$26.03	AmApCSSpW	153	County seat; industries
Cisco	4,355	Eastland	-17.5%	$2,018	WTUC	$26.03		105	Junior college; plants make gloves, clay, aluminum, wood products, industrial equipment, agricultural products
Clarks-ville	4,086	Red River	-9.44%	$2,186	TP&LC	$24.08		120	County seat; plants make wood products, aluminum, mobile homes, other products
Clear Lake City	16,000	Houston SMSA	81.11%		HL&PC	$23.22			See section II
Cleburne	20,520	Dallas-Ft. Worth SMSA	89.%	$2,820	TP&LC	$24.08	ApCGeLLK SSpW	290	See section II
Cleveland	7,000	Houston SMSA	81.11%	$1,943	GSUC	$25.63	ApCLPhSSpW	120	See section II
Clute	6,340	Houston SMSA	81.11%	$2,564	HL&PC	$23.22		106	See section II
Cockrell Hill	3,550	Dallas SMSA	89.%	$2,902	DP&LC	$23.78	SW		See section II
Coleman	5,620	Coleman	-34.4%	$2,347	Coleman Municipal Power & Light Dept. (11.7 MWgc)	$22.68	ApCELLKSW	138	County seat; varied agri-business

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
College Station	18,176	Bryan-College Sta. SMSA	131.%	$2,925	College Sta. Electric Dept. (31.3 MWpd)	$19.80	CESW	100	University; see section II
Colley-ville	3,368	Dallas-Ft. Worth SMSA	89.%	$3,125	TP&LC	$24.08		38	See section II
Colorado City	5,300	Mitchell	30.%	$2,511	TESC	$20.44	ApCCePh SSpW	126	County seat; plants make clothing, mobile homes, farm implements, carpet pads; process cotton, cotton seed; electric service center
Columbus	3,800	Colorado	-36.19%	$2,088	CP&LC	$34.64	CGLSSp	94	County seat
Comanche	4,200	Comanche	4.45%	$2,457	TP&LC	$24.08	CSSpW	129	County seat; plants make clothing, cookies, camping equipment; agribusiness
Commerce	9,727	Hunt	43.2%	$2,305	Commerce Light & Power Dept. (4.2 MWgc) TP&LC	$20.87	ESWAp	122	University; plants make wood products, mobile homes, other products
Conroe	16,300	Houston SMSA	81.11%	$3,581	GSUC	$25.67	SW	430	See section II
Copperas Cove	12,950	Killen-Temple SMSA	27.76%	$2,059	TP&LC	$24.08	CLSSpW	90	Business center for Fort Hood

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Corsicana	20,400	Navarro	-8.42%	$2,597	TP&LC	$24.08	ApCHrLLK PSSpw	394	County seat; large bakery; plants make hats, clothing, bottles, mobile homes, chemicals, plastic pipes, other products
Cotulla	3,485	LaSalle	10.4%	$1,396	CP&LC	$34.64	ApGSW	75	County seat; agribusiness center
Crane	3,445	Crane	-71.95%	$2,708	TESC	$20.44	SW	87	County seat; oil well servicing; steel foundry
Crockett	6,630	Houston SMSA	81.11%	$1,671	TP&LC	$24.08	SW	180	County seat; plants make concrete, wood products, steel joists, plastics, furniture, clothing, mobile homes, chemicals, plastic pipes, other products
Crystal City	8,000	Zavala	-74.%	$1,406	CP&LC	$34.64	ApCeGGc LPPhSSpW	109	County seat; varied agribusiness; packing plants for vegetables
Cuero	6,920	DeWitt	-10.%	$2,229	Cuero Electric Dept (11.98 MWpd)	$25.78	ApCEGcLLK	180	County seat; turkey hatcheries; leather goods, furniture, wood products manufactured, agribusiness
Dalhart	6,054	Dallam-Hartley	24.%	$2,698	SPSC	$24.76	ApCPSSpW	175	County seat, agribusiness center for wide area of TX, OK, NM; cattle feedlots, small manufacturing
Dayton	4,000	Houston SMSA	81.11%	$2,276	GSUC	$25.63	SW	71	See section II

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Decatur	3,470	Dallas-Ft. Worth SMSA	89.%	$2,682	TP&LC	$24.08	ApSW	90	County seat; center for petroleum production, dairying, cattle marketing; plants make clothing, trailers, glass, graphite, other products
Deer Park	14,850	Houston SMSA	81.11%	$3,296	HL&PC	$22.42	SW	100	See section II
Del Rio	21,865	Val Verde	66.1%	$1,839	CP&LC	$34.64	CeGPSSpTbw	440	County seat; center for tourism and trade with Mexico; plants make clothing, electronic equipment
Denison	25,500	Sherman Denison SMSA	73.82%	$2,625	TP&LC	$24.08	CHLSSpW	380	See section II
Denver City	4,450	Yoakum	14.76%	$3,060	SPSC	$24.76	ApCGSW	140	Center for oil, farming activities in 2 counties
DeSoto	9,500	Dallas-Ft. Worth SMSA	89.%		TP&LC	$23.60	SSpW	105	See section II
Devine	3,800	Medina	30.6%	$1,994	CP&LC	$34.64	GSW	102	Peanut storage and shipping center, tire testing; 2 cattle feedlots
Diboll	3,787	Angelina	61.53%	$2,061	TP&LC	$24.08	SSpW	42	See section II
Dickinson	11,000	Galveston Texas City SMSA	71.20%	$3,245	CPSC	$22.30		92	See section II

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Dimmitt	4,660	Castro	87.6%	$2,533	SPSC	$24.76	ApSW	108	County seat; corn milling plant; other agribuisness
Donna	7,612	McAllen-Pharr-Edinburg SMSA	3.31%	$1,130	CP&LC	$34.64	CSW	140	Agribusiness center; canning plant; furniture factory; tourism
Dumas	9,850	Moore	60.6%	$1,161	SPSC	$24.76	ApGPSW	220	County seat; petroleum, gas processing plants; feedlots; grain elevators; beef packers, fertilizer plants, other agribusiness
Duncanville	20,000	Dallas-Ft. Worth SMSA	81.%	$3,203	TP&LC	$23.60	LSSpW	120	See section II
Eagle Lake	3,710	Colorado	-36.1%	$2,851	CP&LC	$34.64		85	
Eagle Pass	14,000	Maverick	104.5%	$1,227	CP&LC	$34.64	CeGeLPh SSpThW	302	County seat; varied manufacturing; tourism center
Eastland	3,256	Eastland	-17.5%	$2,310	TESC	$20.44	ApCSSpW	102	County seat; clothing, mobile home. pottery, building stone plants; agribusiness
Edinburg	17,350	McAllen-Edinburg-Pharr SMSA	3.31%	$1,685	CP&LC	$34.64	AmApGeHL SSpW	360	See section II
Edna	5,450	Jackson	-60.39%	$2,199	CP&LC	$34.64	SW	160	County seat; oil industry; agribusiness center

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
El Campo	11,900	Wharton	-47.1%	$2,612	CP&LC	$34.64	CePhSw	237	Plants process aluminum, make metal products, clothing; rice drying and storage
Electra	4,065	Whichita Falls SMSA	14.9%	$2,554	TESC City of Electra	$21.57 $19.78		112	Agribusiness; oil center; varied manufacturing
Elgin	4,232	Bastrop	21.%	$2,204	TP&LC	$24.08		100	Varying manufacturing plants
El Lago	3,550	Houston SMSA	81.11%		HL&PC	$22.42			See section II
Elsa	4,105	McAllen-Pharr-Edinburg SMSA	3.31%	$1,012	CP&LC	$34.64	SW	54	See section II
Ennis	11,500	Dallas-Ft. Worth SMSA	89.%	$2,422	TP&LC	$24.08	ApHLLKPh	190	Agribusiness; several industrial plants
Euless	24,500	Dallas-Ft. Worth SMSA	89.%	$3,336	TP&LC	$23.60	LSSpW		See section II
Everman	4,570	Dallas-Ft. Worth SMSA	89.%	$2,799	TESC	$20.02			See section II
Fabens	3,241	El Paso SMSA	18.85%	$1,452	El Paso Elec. Co.	$26.98		61	See section II
Falfurrias	6,365	Brooks	8.34%	$1,542	CP&LC	$34.64		115	County seat; agribusiness and dairying center

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Farmers Branch	29,000	Dallas-Ft. Worth SMSA	18.85%	$3,944	TP&LC	$23.60	LSSpW		See section II
Flores-ville	3,855	Wilson	26.76%	$1,691	Floresville Electric Light & Power System (13.2 MWpd)	$37.42	ESW	100	County seat; agribusiness center
Floy-dada	4,020	Floyd	68.1%	$2,437	Floydada Electric Dept. SPSC	$22.74 $26 07		122	County seat, plants make farm products, race cars, sheet metal goods, offset printing
Forest Hill	8,236	Dallas-Ft. Worth SMSA	89.%	$3,036	TESC	$20.02	SW		See section II
Fort Stockton	9,000	Pecos	60.8%	$2,491	SPSL	$21.01	CGSW	250	County seat, distribution center for industry; tire testing center; garment plant
Fredricks-burg	5,730	Gillespie	14.1%	$2,520	Fredricks-burg Elec. Utility (11.66 MWpd)	$21.20	ESSpW		County seat; plants make leather goods, trailers; food processing; agri-business; tourism
Freeport	12,550	Houston SMSA	81 1[illegible]	$2,830	HL&PC	$2[illegible] 42		350	[illegible]enter for large chemical development, shrimp fishing

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Friends-wood	5,690	Galveston-Texas City SMSA	71.20%	$3,784	CPSC	$22.30	ESSpW	58	See section II
Friona	3,150	Parmer	64.1%	$2,815	SPSC	$24.76	CSW	93	Grain elevators; meat packing plant; large feedlots; other agribusiness
Gaines-ville	13,980	Cooke	21.53%	$2,732	TP&LC	$24.08	ApCFgGcLK PSSpW	370	County seat; factories make shoes, fishing lures, mobile homes, aircraft equipment; agribusiness; junior college
Galena Park	12,645	Houston SMSA	81.11%	$3,134	HL&PC	$22.42	SSpW	90	See section II
Gates-ville	4,790	Kileen-Temple SMSA	27.76%	$2,545	CPSC	$22.30	SW	120	County seat; agribusiness
George-town	7,426	Williamson	27.79%	$2,248	Georgetown Water & Light Plant (11.95 MWpd)	$25.31	ApCELPPhSSpW	156	County seat; agribusiness center; university; plants make furniture, trailers, electronic products
Giddings	3,015	Lee	18.22%	$1,988	Giddings Light & Power System (5.64 MWpd)	$21.35	ApESW	110	County seat; plants make boats, furniture, process meats; state seed lab; state school for boys
Gilmer	5,011	Upsur	22.54%	$2,518	SEPC	$21.30	CSW	160	County seat; plants make electrical conduits and fittings, ceramic bathroom accessories, dresses, process meat and lumber

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Glade-water	5,625	Gregg-Upsur	25.%	$2,421	SEPC	$25.80	ApCHHrLLK PhSW	150	
Gonzales	5,880	Gonzales	2.82%	$2,050	Gonzales Electric System (10.65 MWpd)		ApCEGCLph SSpW	190	County seat; poultry shipping, processing center; belt factory; feed mills; clay products
Graham	7,665	Young	49.77%	$2,632	TESC	$20.44	AmApCFgHL LKSSpW	278	County seat; plants make computer products, apparel, fences, fiberglass products, mobile homes, aluminum, floral products
Grape-vine	10,459	Dallas-Ft. Worth SMSA	89.%	$3,148	TP&LC	$23.60	LeLPhSW	153	See section II
Green-ville	22,143	Hunt	43.2%	$2,787	Greenville Municipal Light & Power Dept. (51.42 MWpd; 58 MWgc)	$25.31	AmApCEGC LMPSSpW	395	County seat; plants process foods, electric parts, clothing, plastics, drill bits; aircraft modification
Groves	18,067	Bay City-Port Arthur Orange SMSA	67.78%	$3,167	GSUC	$25.67	LSW	100	See section II
Hamilton	3,000	Hamilton	-38.%	$2,286	CPSC	$26.49	ApLKSSpW	110	County seat; plants make garments, wood molding, trailers, steel products, fiberglass
Hamlin	3,310	Abilene SMSA	24.84%	$2,741	WTUC	$26.03	SW	75	See section II

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Harker Heights	7,230	Kileen-Temple SMSA	27.76%	$2,347	TP&LC	$24.08	P		See section II
Haskell	3,650	Haskell	-67.79%	$2,289	WTUC	$26.03	AFgSSpW	84	County seat; farm trading center
Hearne	5,500	Robertson	-3.51%	$1,799	Hearne Municipal Light Dept. (7.2 MWpd)	$28.25	ApCESSpW	100	
Hebbronville	4,050	Jim Hogg	-13.75%	$1,378	CP&LC	$34.64		86	County seat; center for ranching, oil field activities
Hedwig Village	3,255	Houston SMSA	81.11%	$5,215	HL&PC	$22.42	SW		See section II
Henderson	10,645	Rusk	-6.52%	$2,643	GSUC	$20.95	CCeLKPh SSpW	328	County seat; center for agribusiness, oil industry activities; plants make bricks, clothing, fiberglass, other products
Henrietta	3,010	Clay	0	$2,367	TESC	$20.44	CSSpW	56	County seat; mobile home factory; plant makes boots, saddles
Hereford	14,785	Deaf Smith	214.3%	$2,439	SPSC	$24.76	ApCeGcSp	325	County seat; agribusiness; varied industry
Highland Park	10,520	Dallas-Ft. Worth SMSA	89.%	$9,543	DP&LC	$23.78	AmPSSp		See section II

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Highlands	3,462	Houston SMSA	81.11%	$3,163	HL&PC	$23.22		66	See section II
Hillsboro	7,224	Hill	2.6%	$2,177	TP&LC	$24.14	ApCLPSW	205	County seat; gins; oil mill; grain processing
Hitch-cock	5,565	Galveston-Texas City SMSA	71.20%	$2,341	HP&LC	$22.42	SW	28	See section II
Hondo	6,000	Medina	30.6%	$1,827	Hondo Utilities Electric System (6.46 MWpd)	$38.09		110	County seat; several small industrial plants
Humble	3,278	Houston SMSA	81.11%	$3,151	HL&PC	$22.42		142	See section II
Hunters Creek Village	3,959	Houston SMSA	81.11%	$9,728	HL&PC	$22.42			See section II
Hunts-ville	18,875	Walker	154.%		GSUC	$25.67	AmApLSW	265	County seat; state prison; university
Hurst	27,250	Dallas-Ft. Worth SMSA	89.%	$3,569	TESC	$20.02	CeLSSpW	420	See section II
Ingleside	4,000	San Patricio	-23.69%	$2,565	CP&LC	$34.64	SW	42	
Iowa Park	6,000	Wichita Falls SMSA	14.91%	$2,845	TESC	$20.44	LSW	90	Plants make fertilizers, bullets, oil field equipment
Jacinto City	9,563	Houston SMSA	81.11%	$2,314	HL&PC	$22.42	LSSpW		See section II

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Jacksboro	3,575	Jack	-44.22%	$2,314	TP&LC	$24.08	ApSSpW	100	County seat; agribusiness; plants make garments; oil well servicing
Jacksonville	9,840	Cherokee	-1.36%	$2,562	GSUC	$24.87	CLLKSW	345	
Jasper	6,352	Jasper	41.1%	$2,412	Jasper Electric System (19.9 MWpd; 7.36 MWgc)	$20.53	CeELSW	197	County seat; wood industries; plywood mills, saw mills; poultry processing plants; feed mills
Jefferson	3,000	Marion	17.58%	$1,920	SEPC	$21.30		93	County seat; saw mills; plants make trailers, kitchen cabinets
Karnes City	2,970	Karnes	3.57%	$1,706	CP&LC	$34.64	SW	82	County seat; farm trading, processing center; oil field servicing; plants make furniture, fiberglass, farm and oil field equipment
Kaufman	4,750	Dallas-Ft. Worth SMSA	89.%	$2,688	TP&LC	$24.08	SW	99	County seat; plants make steel products, furniture, clothing, other products
Kenedy	4,185	Karnes	3.57%	$1,958	CP&LC	$34.64	ApSSpW	130	Livestock sales; food processing; other agribusiness; plants make furniture, fiberglass, stoneware, other products; hunting center
Kennedale	3,076	Dallas-Ft. Worth SMSA	89.%	$2,667	TESC	$20.02	W	35	See section II

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Kermit	7,884	Dallam	24.%	$2,713	CPSC	$21.01	CSW	156	County seat
Kerrville	14,472	Kerr	15.62%	$2,639	LCRA	$26.02	AmApGeL LKPPhSSpW	395	County seat; tourist center; nearby recreation camps; plants make boats and recreation equipment, jewelry; junior college
Kilgore	10,200	Gregg-Rusk	16.%	$2,910			CHLLKSSpW	440	Junior college; oil center; plants make ceramics, clothing, mobile homes, other products
Kingsville	29,500	Kleberg	44.60%	$2,156	CP&LC	$34.64	CFGLSSpW	360	County seat; industrial plants; university; headquarters of King Ranch
Kleberg	6,000	Dallas-Ft. Worth SMSA	89.%	$2,131	TP&LC	$23.60		10	See section II
La Grange	4,600	Fayette	29.%	$3,060	La Grange Utilities (7.1 MWpd)	$28.76	CESW	125	County seat; plants make boats, laminated timber, livestock feed, process meats and other food products
Lake Jackson	13,786	Houston SMSA	81.11%	$3,742	HL&PC	$22.42	LSSpW	110	See section II
Lakeview	3,567	Bay City-Port Arthur-Orange SMSA	67.78%	$3,376	GSUC	$25.63			See section II
Lake Worth Village	4,958	Dallas-Ft. Worth SMSA	89.%	$3,008	TESC	$20.02	LSW		See section II

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
La Marque	17,000	Galveston-Texas City SMSA	71.20%	$3,081	CPSC	$22.30		120	See section II
Lamesa	11,575	Dawson	-71.51%	$2,696	TESC	$20.44	ApSSpW	290	County seat; agribusiness; food processing
Lampasas	6,150	Lampasas	10.41%	$2,370	Lampasas Public Utilities (11.95 MWpd)	$21.97	ApCeGeLSSpW	145	County seat; ranching, hunting center; plants make feeds, plastics, mobile homes, apparel
Lancaster	14,000	Dallas-Ft. Worth SMSA	89.%	$3,203	TP&LC	$23.60	LSSpW	140	See section II
LaPorte	7,149	Houston SMSA	81.11%	$3,232	HL&PC	$22.42		158	See section II
League City	12,695	Galveston-Texas City SMSA	71.20%	$3,548	CPSC	$22.30		84	See section II
Level-land	11,445	Hackley	-71.29%	$2,474	SPSC	$24.76	ApCSSpW	252	County seat; petroleum processing, agribusiness including vegetable, oil mill, fertilizer plant, cotton gins; community college
Lewis-ville	18,425	Dallas-Ft. Worth SMSA	89.%	$3,209	CPSC	$22.56		198	See section II
Liberty	6,175	Houston SMSA	81.11%	$2,824	Liberty Light & Power Dept.; GSUC	$23.30 $25.63	AmApCELsspW	80	County seat; port on barge canal; sulfur, oil, chemicals, timber, steel processing and shipping

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Littlefield	6,950	Lamb	-72.38	$2,245	SPSC	$24.76	ApPSW	170	County seat; agribusiness and trade center
Livingston	4,150	Polk	22.11%	$2,422	Livingston Municipal Light Dept. (9.1 MWpd)	$24.10	AmApEFgGch SSpW	150	County seat; center for oil, lumbering, tourism
Lockhart	7,270	Caldwell	41.70%	$2,070	Lockhart Utilities	$23.90	ApCEHLPhSW	50	County seat; manufacturing plants
Lufkin	25,430	Angelina	61.53%	$2,698	TP&LC	$24.08	PSSPW	557	County seat; college; center of timber industry
Luling	5,020	Caldwell	41.70%	$2,004	Luling Utilities	$20.33	ApEGcHSSpW	170	Oil industrial center; meat processing plant
Lumberton	5,500	Bay City-Port Arthur Orange SMSA	67.78%		GSUC	$25.63			See section II
McGregor	4,365	Waco SMSA	50.83%	$2,203	TP&LC	$24.08	ApCPhSW	94	See section II
McKinney	15,833	Dallas-Ft. Worth SMSA	89.%	$2,500	TP&LC	$24.08	CEGcLPPhSSpW	270	County seat; varied industry
Madisonville	3,000	Madison	27.57%	$2,292	GSUC	$25.63	SW	95	County seat; farm trading center; plants make work clothes, fiberglass products
Mansfield	5,000	Dallas-Ft. Worth SMSA	89.%	$3,244	TESC	$20.02	SSpW	75	See section II

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Marlin	6,391	Falls	28.83%	$2,206	SESC	$24.87	ACSW	150	County seat; agribusiness; turkey processing; business printing; rug manufacturing
Marshall	23,745	Harrison	14.85%	$2,546	SEPC	$20.95	AmCLSW	445	County seat; petroleum, lumber processing; chemicals; steel products; 2 colleges
Mathis	5,625	San Patricio	-23.69%	$1,208	CP&LC	$34.64	SW	110	
Memphis	3,477	Hall	-26.87%	$2,575	WTUC	$26.03	AmApChSSp	95	County seat; bed sheet manufacturing plant; mobile home factory; cotton gins, compressors; grain elevators
Mercedes	11,000	McAllen-Pharr-Edinburg SMSA	3.31%	$1,230	CP&LC	$34.64		150	See section II
Mexia	6,050	Limestone	-22.47%	$2,068	SEPC	$24.87	AmApCLP PhSW	155	Agribusiness center; wholesale grocery distribution; furniture, sportswear, other products
Mineola	4,050	Wood	4.%	$2,806	SEPC	$21.30	SW	127	Farm trade, tourism center; plants make clothing, farm products
Mineral Wells	17,850	Dallas-Ft. Worth SMSA	89.%	$3,010	TP&LC	$24.08	ApCLLKPS SpW	308	Plants make plastic, electronic products, bricks, feeds, clothes, other products

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Mission	13,100	McAllen Pharr-Edinburg SMSA	3.31%	$1,517	CP&LC	$34.64	CCeGcHLP PhSw	225	See section II
Monahans	8,350	Ward	-76.22%	$2,749	TESC	$20.44	ApCSSpW	320	County seat; center for oil, agribusiness activities; plants make dresses, oil field equipment
Mt. Pleasant	10,160	Titus	11.37%	$2,622	SEPC	$21.30	ApCFgLS SpW	285	County seat; plants make mobile homes, doors, campers; process beef, poultry, dairy products
Muleshoe	4,610	Bailey	-66.25	$3,182	SPSC	$24.76	ApLSSpW		County seat; garment factory; feed lots, feed processing
Nacogdoches	24,000	Nacodoches	47.52%	$2,449	TP&LC	$24.08	APCFgLLK MPSSeW	415	County seat; plants make business forms, brass valves, machine fittings, wood products, sheeting, fertilizer, candy; process poultry; university
Navasota	5,225	Grimes	4.10%	$1,993	GSUC	$25.63	ApCGSW	125	Agribusiness center for parts of 3 counties; small manufacturing
Nederland	17,000	Bay City-Port Arthur-Orange SMSA	67.78%	$3,088	GSUC	$25.67	LSW	180	Oil and chemical plants
New Boston	4,730	Bowie	38.58%	$2,928	SEPC	$21.61	AmSSpW	77	

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
New Braunfels	18,000	San Antonio SMSA	34.53%	$2,467	New Braunfels Electric Dept. (54.5 MWpd)	$27.05	ApCCeFFgCg LKPhSSpW	500	County seat; textile, furniture, metal products, factories, tourism
N. Richland Hills	16,514	Dallas-Ft. Worth SMSA	89.%	$3,708	TESC	$20.02			See section II
Olney	3,730	Young	-49.77%	$2,657	CPSC	$24.24		125	Agribusiness center; plants make apparel, recreational vehicles, weather equipment, rifles, aluminum, wood products
Orange	26,900	Bay City-Port Arthur-Orange SMSA	67.78%	$2,761	GSUC	$25.67	LSSpW	400	See section II
Ozona	3,245	Crockett	-63.78%	$2,590	WTUC	$26.43		65	County seat; trade center for large ranching area, hunting leases
Palacios	3,642	Matagorda	38.%	$2,156	CP&LC	$34.64		65	
Palestine	15,600	Anderson	6.41%	$2,491	TP&LC	$24.08	ApCSSpW	390	County seat; junior college; manufactures containers, meat, auto equipment, wood products, railroad yards
Pampa	20,979	Gray	19.%	$3,068	SPSC	$24.76	AmCeFg LSSpW	460	County seat; petrochemical plants; feedlots; meat packers, other industry

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Paris	24,050	Lamar	28.34%	$2,410	TP&LC	$24.08	ApFgLLK PPhSW	460	County seat; plans to make canned soups, steam generating equipment, apparel, food products, farm supplies; community college
Pearland	7,400	Houston SMSA	81.11%	$3,403	HP&LC	$21.17	SW	130	See section II
Pear Ridge	3,697	Bay City-Port Arthur-Orange SMSA	67.78%	$2,908	GSUC	$25.63	SW		See section II
Pearsall	5,665	Frio	70.99%	$1,541	CP&LC	$34.64	GLPPhSW	125	County seat; oil, ranching center, food processing; melon, vegetable, livestock shipping
Pecos	13,450	Reeves	41.90%	$2,232	CPSC	$21.01	ApCGcPh SSpW	288	County seat; ranching, oil industry center; vegetables, cotton marketing, sulfur processing; auto proving grounds; plants make garments, pumps
Perryton	8,100	Ochiltree	36.26%	$3,104	CPSC	$24.91	ApGGcSSpW	226	County seat; cattle feeding; grain center; plastics plant
Pharr	16,000	McAllen-Pharr-Edinburg SMSA	3.31%	$1,229	CP&LC	$34.64		260	Agribusiness and trading center
Pittsburg	3,875	Camp	18.%	$2,095	SEPC	$21,30		97	County seat; several industries

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Plainview	20,916	Hale	19.30%	$2,708	SPSC	$24.76	ApGCLPh SSpW	480	County seat; meat packing plants; other industry; college
Plano	22,800	Dallas-Ft. Worth SMSA	81.%	$3,414	TP&LC	$23.60	GcLSSpW	300	Boats, metals, other manufacturing; research centers
Pleasanton	5,510	Atascosa	25.04%	$1,978	CP&LC	$34.64	ApPhSSpW	140	
Port Boliver	3,400	Galveston-Texas City SMSA	71.20%					17	See section II
Port Isabel	3,740	Brownsville-Harlingen-San Benito SMSA	24.96%	$1,432	CP&LC	$34.64		140	See section II
Portland	8,000	Corpus Christi SMSA	24.14%	$3,018	CP&LC	$34.64	SSpW	110	See section II
Port Lavaca	12,142	Calhoun	52.21%	$2,382	CP&LC	$34.64	HrSSpW	200	County seat; fishing and tourist center; chemical and other manufacturing
Port Neches	11,150	Bay City-Port Arthur Orange SMSA	67.78%	$3,012	GSUC	$25.67	LWWpW	90	See section II
Post	4,010	Garza	-75.33%	$2,786	SPSC	$24.74		94	County seat; textile mill
Poteet	3,012	Atascosa	25.04%	$1,344	CP&LC	$34.64		35	
Prarie View	3,875	Houston SMSA	81.11%	$1,448	GSUC	$22.42		3	University

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Premont	3,250	Jim Wells	-3.1%	$2,120	CP&LC	$34.64	GSW	38	
Quanah	3,975	Haredman	34.32%	$2,872	WTUC	$26.03	ApCSSpW	96	County seat; agribusiness; plant makes surgical garments
Randolph	5,329	San Antonio SMSA	34.53%	$2,491	CPSB	$33.05			See section II
Ranger	3,194	Eastland	-17.5%	$1,809	TESC	$20.44	AmApCe HSSp	60	Oil field center; junior college
Raymondville	7,987	Willacy	-75.95%	$1,271	CP&LC	$34.64	CGcSSpW	168	County seat; agribusiness and oil center
Refugio	4,950	Refugio	73.03%	$2,507	CP&LC	$34.64	SSpW	122	County seat; center for petroleum production, agribusiness activities
Richland Hills	8,865	Dallas-Ft. Worth SMSA	89.%	$3,993	TESC	$20.02	LSW		See section II
Richmond	6,925	Houston SMSA	81.11%	$2,116	HP&LC	$22.42	SW	73	See section II
Rio Grande City	5,720	Starr	-39.08%	$1,175	CP&LC	$34.64		130	County seat; agribusiness center; brick factory
River Oaks	8,193	Dallas-Ft. Worth SMSA	89.%	$3,313	TESC	$20.02	SW		See section II
Robinson	4,000	Waco SMSA	50.83%	$2,709	TP&LC	$24.08			See section II

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Robstown	16,394	Corpus Christi SMSA	24.14%	$1,790	Robstown Utility System (20.5 MWpd)	$36.69	EGLPhSSp	200	See section II
Rockdale	4,722	Milam	-42.4%	$2,525	TP&LC	$24.08	CSSpW	90	Large aluminum plant
Rockport	4,007	Aransas	39.32%	$2,815	CP&LC	$34.64	SW	180	County seat; fishing and tourist center
Rockwall	3,600	Dallas-Ft. Worth SMSA	89.%	$2,866	TP&LC	$24.08	APCSW	80	County seat; plants make aluminum, leather goods
Rosen-berg	14,528	Houston SMSA	81.11%	$2,557	HL&PC	$22.42	CCeSSpW	220	See section II
Round Rock	3,500	Williamson	27.79%	$1,876	TP&LC	$24.08		85	Plants make electronic equipment, generators, lime, tools
Rusk	4,930	Cherokee	-1.36%	$2,084	SESC	$24.87	HSW	106	County seat; pulpwood shipping center; woodworking plants; mild processor
San Augustine	3,000	San Agustine	18.58%	$1,915	San Agustine Light & Water Dept.	$22.00	CEHPSW	80	County seat; plants process poultry; make boats, feed-mills; lumbering
San Benito	16,840	Brownsville-Harlingen-San Benito SMSA	24.96%	$1,355	CP&LC	$34.64	AmApPSSpW	190	Agribusiness; tourism; varied manufacturing
San Diego	4,500	Duval	3.42%	$1,299	CP&LC	$34.64		35	County seat; ranching, oil field, tourist center

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
San Juan	5,100	Edinburg-Pharr-McAllen SMSA	3.31%	$1,375	CP&LC	$34.64	SW	90	See section II
San Marcos	20,000	Austin SMSA	73.18%	$1,947	LCRA	$26.02	ApCLSSpW	340	University; see section II
Schertz	5,500	San Antonio SMSA	34.53%	$2,289	Guadalupe Valley Elec. Coop	$31.80	SWSp	32	See section II
Seabrook	3,242	Houston SMSA	81.11%	$4,232	HL&PC	$22.42	SSpW	45	See section II
Seagoville	6,250	Dallas-Ft. Worth SMSA	89.%	$2,550	TP&LC	$24.08	SW	150	See section II
Seguin	16,510	San Antonio SMSA	34.53%	$1,971	Seguin Electric Systems (21.5 MWpd; .5 MWgc)	$30.90	CEGePhSSpW	400	See section II
Seminole	5,050	Gaines	27.87%	$2,565	SPSC	$24.76	SW	155	County seat; market for farmers, oil workers; petro-chemical plants; plants make campers, anchors, paints
Seymour	3,494	Baylor	26.%	$2,764	TESC; Seymour Municipal Light Plant	$24.36 $23.48	AmApESSpW	111	County seat; agribusiness center

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Sherman	30,000	Sherman-Denison SMSA	73.82	$2,987	TP&LC	$24.08	AmApLPPh SSpW	574	See section II
Silsbee	10,000	Bay City-Port Arthur-Orange SMSA	67.78%	$2,365	GSUC	$25.63	CLSW	150	Trade, manufacturing center; timber products; oil, gas processing, rail division point
Sinton	5,750	San Patricio	-23.69%	$2,147	CP&LC	$34.64	GcLLKPhSSpW	160	County seat; oil, agribusiness center
Slaton	7,200	Lubbock SMSA	-9.05%	$2,138	SPSC	$24.76	SW	150	See section II
Smithville	3,000	Bastrop	21.05%	$1,932	Smithville Light & Water Dept. (4.5 MWpd)	$19.79	CELSW	65	Varying manufacturing plants
Snyder	11,365	Scurry	67.33	$2,678	TESC	$20.11	SW	291	County seat; plants process oil, gas, magnesium; make apparel, mobile homes, other products
Spearman	3,800	Hansford	28.86%	$3,164	CPSC	$24.91	ApGSSpW	116	County seat; feedlots; center for grain marketing and storage; gas processing
Spring Valley	3,170	Houston SMSA	81.11%	$4,616	HL&PC	$22.42	S		See section II
Stafford	3,500	Houston SMSA	81.11%	$2,773	HL&PC	$22.42	ApCEHSSpW	75	See section II
Stamford	4,550	Haskell	-67.97%	$2,538	WTUC	$26.03	ApCLKSSpW	105	Agribusiness; apparel manufacturing

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Stephen-ville	9,730	Erath	15.%	$2,433	TP&LC	$24.08	AmCPSSpW	243	County seat; university; varied agribusiness; plastic plant
Sugar Land	3,950	Houston SMSA	81.11%	$3,652	HL&PC	$22.42	SW	28	See section II
Sulphur Springs	11,400	Hopkins	27.%	$2,734	TP&LC	$24.08	ApLLKPSSpW	331	County seat; milk plants; factories make candy, clothing, bricks, valves, points, plastics, motor homes, weather balloons, shutters
Sweeney	3,210	Houston SMSA	81.11%	$2,951	HL&PC	$22.42		45	See section II
Sweet Water	12,220	Nolar	-65.62%	$2,359	TESC	$20.44	AmApCFgGe LLKPPhSSpW	250	County seat; plants make gypsum products, cement, metal detectors, brooms, clothing; process beef, cotton
Taft	3,300	San Patricio	-23.69%	$2,048	CP&LC	$34.64		62	
Tahoka	3,050	Lynn	-74.78	$2,302	SPSC	$24.76	ApSSpW	60	County seat; agribusiness center
Taylor	9,616	Williamson	27.79%	$2,017	TP&LC	$24.08	ApCLPjSSpW	248	
Terell	16,000	Dallas-Ft. Worth SMSA	89.%	$2,044	TP&LC	$24.08	ApCLSW	225	See section II
Terrell Hills	5,225	San Antonio SMSA	34.53%	$8,197	CPSB	$33.05			See section II

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Tex-arkana	30,000	Texarkana SMSA	71.47%	$2,724	SESC	$20.80	APCLLKPh	990	Distribution, manufacturing center; college; university; Texas correctional unit
Tulia	5,500	Swisher	26.76%	$2,518	Tulia Power & Light (15 MWgc)	$36.45	ELKSW	156	County seat; center for farming activities; plants make clothing, farm implements, lotions, fertilizers; meat processors
Universal City	7,613	San Antonio SMSA	34.53%	$3,087	CPSB	$33.05	SW	145	See section II
Uvalde	10,871	Uvalde	7.47%	$1,904	CP&LC	$34.64	ApCCeFgG GcSSpW	302	County seat; plants make clothes, asphalt products, pipes; process vegetables, wool, mohair; junior college
Vidor	10,000	Bay City-Port Arthur-Orange SMSA	67.78%	$2,204	GSUC	$25.67		120	See section II
Watauga	3,778	Dallas-Ft. Worth SMSA	89.%		TESC	$20.62			See section II
Waxa-hachie	14,240	Dallas-Ft. Worth SMSA	89.%	$2,575	TP&LC	$22.08		232	County seat; plants make glass, fiberglass, refrigeration equipment, containers, clothing, college
Weather-ford	13,300	Dallas-Ft. Worth SMSA	89.%	$2,808	Weatherford Elec., Light & Water System (17 Mwpd; 5 Mwgc)	$19.34		300	See section II

CITY OR TOWN	1973 POPULATION[1]	LOCATION BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
Webster	3,250	Houston SMSA	81.11%		HL&PC	$22.42		40	See section II
Wellington	3,215	Collings-worth	-44.67%	$1,831	WTUC	$26.03		82	County seat; 2 feedlots; other agribusiness
Weslaco	16,824	McAllen-Pharr-Edinburg SMSA	3.31%	$1,778	CP&LC	$34.64		278	Food processing center; many agribusinesses; clothing manufacturing; steel fabricator; tourist center; citrus and vegetable research
West Columbia	3,375	Houston SMSA	81.11%	$2,724	CPSC	$22.42		56	See section II
W. University Place	14,750	Houston SMSA	81.11%	$4,624	HL&PC	$22.42			See section II
W. Worth Village	4,758	Dallas-Ft. Worth SMSA	89.%	$2,464	TESC	$20.02			See section II
Wharton	9,456	Wharton	-47.06%	$2,189	HL&PC	$22.42		150	County seat; plants process minerals, rice, hides, clay aggregate, microfilming; aircraft manufacturing; beverage packing; junior college
Whitesboro	3,000	Sherman-Denison SMSA	73.82%	$2,196	Whitesboro Municipal Light & Power Dept. (18 MWpd; 2.86 MWgc)	$29.38		70	See section II

CITY OR TOWN	1973 POPULATION[1]	LOCATION - BY COUNTY OR SMSA	1970-2000 PROJECTED GROWTH RATE BY COUNTY OR SMSA[2,3]	PER-CAPITA INCOME[4]	ELECTRIC UTILITY[5,6]	TYPICAL RESIDENTIAL ELECTRIC BILL[7]	MUNICIPAL FACILITIES & UTILITIES[8]	NUMBER OF BUSINESSES[1]	ECONOMIC BASE[1,3]
White Settlement	13,449	Dallas-Ft. Worth SMSA	89.%	$2,835	TESC	$20.02			See section II
Windcrest	3,371	San Antonio SMSA	34.53%	$4,979	CPSB	$33.05			See section II
Winnie	5,512	Chambers	45.28%					76	
Winnsboro	3,195	Wood	4.%	$2,518	Brazos Elec. Coop.	$21.30		120	
Woodway	5,137	Waco SMSA	50.83%	$2,986	TP&LC	$24.08			See section II
Yoakum	5,755	Lavaca	-34.25%	$1,931	Yoakum Municipal Utilities (4.16 MWpd)	$31.65		180	Plants make leather goods, furniture, process foods

[1]Dallas Morning News, Texas Almanac 1975-1976.

[2]Dudley L. Poston, Population Projections for Texas Counties: 1980-2000, The University of Texas at Austin Population Research Center, June, 1973.

[3]Department of Commerce, Population and Economic Activity in the United States and Standard Metropolitan Statistical Areas, Department of Commerce, July, 1972.

[4]U.S. Department of Commerce, Characteristics of the Population 1970, Tables 107 and 118.

[5]Electrical World, Directory of Electric Utilities, N.Y.: McGraw-Hill, Inc., 1975.

[6]Figures in parentheses represent peak demand and generating capacity.

[7]Federal Power Commission, Typical Electric Bills, 1975.

[8]Texas Municipal League, "Texas Municipal Taxation and Dept., 1976," Texas Town and City, March, 1976.

*Abbreviations used for Electric Utilities

CP&CL - Central Power and Light Co.
CPSB - City Public Service Board of San Antonio
CPSC - Community Public Service Co.
DP&LC - Dallas Power and Light Co.
GSUC - Gulf States Utilities Co.
HL&PC - Houston Lighting and Power Co.
LCRA - Lower Colorado River Authoirty
SEPC - Southwestern Electric Power Co.
SPSC - Southwestern Public Service Co.
TESC - Texas Electric Service Co.
TP&LC - Texas Power and Light Co.
WTUC - West Texas Utilities Co.

*Abbreviations used for Municipal Utilities and Facilities

Am - Auditorium
Ap - Airport
C - Cemetary
Ce - Civic center
E - Electric
Fg - Fairgrounds
G - Gas
Gc - Golf course
H - Hospital
Hr - Boat harbor or marina
L - Library
Lk - Lake
P - Parking lot
Ph - Public housing
S - Sewer
Sp - Swimming pool
T - Transit system
W - Waterworks

SMSA - ABILENE, TEX.
(BEA CODE NUMBER - 300)

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED.
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	86,236	118,182	119,209	114,542	119,900	122,500	126,800	131,300	143,000	170,300
PER CAPITA INCOME (1967$)*	1,856	2,210	2,840	3,166	3,598	4,237	4,856	5,566	7,490	13,154
PER CAPITA INCOME RELATIVE (US=1.00)	.90	.91	.86	.91	.88	.89	.90	.90	.90	.92
TOTAL EMPLOYMENT	32,124	47,281				46,800	48,200	49,600	54,700	65,600
EMPLOYMENT/POPULATION RATIO	.37	.40				.38	.38	.38	.38	.39
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	160,031	261,234	338,522	362,628	431,800	519,400	616,100	730,900	1,071,400	2,240,200
TOTAL EARNINGS	126,795	209,338	258,776	275,297	326,600	392,700	464,800	550,200	799,200	1,637,500
AGRICULTURE, FORESTRY & FISHERIES	17,009	11,796	13,860	19,749	14,000	13,800	14,300	14,700	17,400	30,500
AGRICULTURE	16,914	11,732	13,851	19,740	14,000	13,800	14,200	14,700	17,400	30,500
FORESTRY & FISHERIES	95	64	9	9	(S)	(S)	(S)	(S)	(S)	(S)
MINING	16,298	11,797	12,518	10,905	11,900	14,000	14,500	15,100	16,700	19,500
CRUDE PETROLEUM & NATURAL GAS	15,507	10,706	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
NONMETALLIC, EXCEPT FUELS	791	1,091	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CONTRACT CONSTRUCTION	7,906	9,408	11,874	14,102	15,800	18,700	22,100	26,100	38,000	78,900
MANUFACTURING	12,867	25,062	25,093	26,313	30,800	35,000	40,100	45,900	62,300	117,100
FOOD & KINDRED PRODUCTS	7,274	7,019	8,514	8,347	9,300	10,100	10,800	11,500	13,800	20,300
TEXTILE MILL PRODUCTS				1,615						
APPAREL & OTHER FABRIC PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
LUMBER PRODUCTS & FURNITURE	(D)	(D)	167	206	(S)	(S)	(S)	(S)	(S)	(S)
PAPER & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PRINTING & PUBLISHING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CHEMICALS & ALLIED PRODUCTS	(D)	(D)	372	187	(S)	(S)	(S)	(S)	(S)	(S)
PETROLEUM REFINING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
FABRICATED METALS & ORDNANCE	(D)	(D)	646	918	1,000	1,100	1,500	2,000	3,400	9,300
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
ELECTRICAL MACHINERY & SUPPLIES	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TOTAL MACHINERY (1950 ONLY)	70									
MOTOR VEHICLES & EQUIPMENT			326	282	(S)	(S)	(S)	(S)	(S)	(S)
TRANS. EQUIP., EXCL. MTR. VEHS.	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
OTHER MANUFACTURING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TRANS., COMM. & PUBLIC UTILITIES	11,516	15,528	16,868	16,981	19,500	22,700	26,000	29,800	41,100	78,500
WHOLESALE & RETAIL TRADE	28,639	43,522	48,836	45,998	61,500	74,500	86,300	100,000	141,700	271,000
FINANCE, INSURANCE & REAL ESTATE	4,702	9,172	12,424	11,999	15,200	18,600	22,200	26,500	39,200	83,400
SERVICES	17,822	30,482	46,514	51,916	64,900	81,100	98,600	119,900	180,800	381,800
GOVERNMENT	10,035	52,572	70,788	77,335	92,100	113,900	139,900	171,800	261,500	576,100
CIVILIAN GOVERNMENT	9,306	19,651	36,733	41,715	54,600	73,300	93,300	118,800	192,500	459,500
ARMED FORCES	730	32,922	34,056	35,621	36,800	40,600	46,300	52,900	69,000	116,600

See page C-62 for table notes

Source: Population and Economic Activity in the United States and Standard Metropolitan Statistical Areas, Environmental Protection Agency, U.S. Department of Housing and Urban Development, July, 1972.

SMSA - AMARILLO, TEX.
(BEA CODE NUMBER - 307)

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	87,873	146,768	174,546	145,135	157,300	155,200	156,600	158,000	170,600	209,000
PER CAPITA INCOME (1967$)*	2,764	2,550	2,808	3,322	3,546	4,118	4,684	5,327	6,995	12,293
PER CAPITA INCOME RELATIVE (US=1.00)	1.34	1.04	.85	.96	.86	.86	.86	.86	.84	.86
TOTAL EMPLOYMENT	36,938	63,789				67,700	67,700	67,600	72,300	86,200
EMPLOYMENT/POPULATION RATIO	.42	.43				.44	.43	.43	.42	.41
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	242,853	374,244	490,152	482,205	558,100	639,500	733,800	842,000	1,193,700	2,570,400
TOTAL EARNINGS	196,285	296,740	373,423	359,032	412,000	475,500	540,100	613,500	855,100	1,728,700
AGRICULTURE, FORESTRY & FISHERIES	17,418	9,477	9,129	12,079	9,600	8,400	8,600	8,800	10,500	18,400
AGRICULTURE	17,407	9,442	9,107	12,054	9,600	8,300	8,600	8,800	10,400	18,300
FORESTRY & FISHERIES	11	35	22	25	(S)	(S)	(S)	(S)	(S)	(S)
MINING	12,841	15,015	9,677	9,366	10,400	12,500	13,400	14,400	16,700	21,100
CRUDE PETROLEUM & NATURAL GAS	(D)	(D)	9,661	9,179	10,400	12,500	13,400	14,400	16,700	21,000
NONMETALLIC, EXCEPT FUELS	(D)	(D)	15	187	(S)	(S)	(S)	(S)	(S)	(S)
CONTRACT CONSTRUCTION	17,044	21,007	20,052	19,822	21,100	23,200	26,000	29,100	40,100	80,500
MANUFACTURING	20,955	20,773	30,602	43,103	43,000	44,900	50,600	57,000	78,500	155,700
FOOD & KINDRED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TEXTILE MILL PRODUCTS	(D)	(D)	17	17	(S)	(S)	(S)	(S)	(S)	(S)
APPAREL & OTHER FABRIC PRODUCTS	(D)	(D)	2,914	3,792	4,200	4,900	5,500	6,200	8,100	13,600
LUMBER PRODUCTS & FURNITURE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PAPER & ALLIED PRODUCTS	(D)	(D)	6							
PRINTING & PUBLISHING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CHEMICALS & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PETROLEUM REFINING	(D)	(D)	2,352	2,553	2,600	2,700	2,800	3,000	3,500	4,800
PRIMARY METALS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
FABRICATED METALS & ORDNANCE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
MACHINERY, EXCLUDING ELECTRICAL		1,263	1,686	1,266	2,200	3,000	3,700	4,500	6,800	15,300
ELECTRICAL MACHINERY & SUPPLIES		133	931	1,106	1,100	1,400	1,600	2,300	3,600	7,000
TOTAL MACHINERY (1950 ONLY)	1,410									
MOTOR VEHICLES & EQUIPMENT			11	812	(S)	(S)	(S)	(S)	(S)	(S)
TRANS. EQUIP., EXCL. MTR. VEHS.		93	118	9,435	4,[illegible]00	2,400	2,000	1,600	1,100	600
OTHER MANUFACTURING	(D)	(D)	2,337	2,568	3,100	3,900	4,900	6,200	10,100	25,100
TRANS., COMM. & PUBLIC UTILITIES	23,755	37,060	40,613	40,116	46,100	52,000	58,200	65,000	86,400	158,500
WHOLESALE & RETAIL TRADE	61,459	73,510	82,130	89,777	96,000	106,300	118,500	132,100	180,500	356,700
FINANCE, INSURANCE & REAL ESTATE	6,842	16,568	23,362	20,638	25,900	29,700	33,600	38,200	53,700	111,500
SERVICES	22,940	37,934	59,331	65,203	75,200	87,400	102,700	120,700	179,900	405,000
GOVERNMENT	13,030	65,396	98,527	58,926	82,200	110,600	127,800	147,700	208,400	421,000
CIVILIAN GOVERNMENT	12,252	33,333	52,757	55,153	68,900	85,900	99,900	116,100	167,800	353,800
ARMED FORCES	777	32,062	45,768	3,773	11,400	24,600	27,900	31,600	40,600	67,200

See page C-62 for table notes

SMSA - AUSTIN, TEX.
(BEA CODE NUMBER - 315)

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	162,333	208,268	265,448	297,027	320,600	357,400	394,000	434,500	514,400	701,800
PER CAPITA INCOME (1967$)*	1,673	2,022	2,871	2,927	3,543	4,149	4,748	5,434	7,383	12,944
PER CAPITA INCOME RELATIVE (US=1.00)	.81	.83	.87	.84	.86	.87	.88	.88	.89	.91
TOTAL EMPLOYMENT	60,275	80,573				139,500	153,100	168,000	204,600	283,000
EMPLOYMENT/POPULATION RATIO	.37	.39				.39	.39	.39	.40	.40
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	271,627	421,078	762,018	869,296	1,135,900	1,482,800	1,871,000	2,361,100	3,798,100	9,084,100
TOTAL EARNINGS	217,604	336,782	607,741	702,984	906,300	1,174,600	1,482,300	1,870,700	3,003,600	7,138,200
AGRICULTURE, FORESTRY & FISHERIES	7,198	4,850	4,850	5,149	5,200	5,400	5,400	5,400	6,400	11,300
AGRICULTURE	7,144	4,794	4,811	5,098	5,100	5,300	5,300	5,300	6,300	11,100
FORESTRY & FISHERIES	54	56	40	50	(S)	(S)	(S)	(S)	(S)	(S)
MINING	3,122	3,138	1,825	881	1,700	2,300	2,600	2,800	3,500	5,400
CRUDE PETROLEUM & NATURAL GAS	559	117	955	758	800	1,200	1,300	1,500	1,900	2,800
NONMETALLIC, EXCEPT FUELS	2,563	3,021	871	124	900	1,100	1,200	1,300	1,600	2,600
CONTRACT CONSTRUCTION	24,032	30,144	45,903	51,918	69,500	85,600	106,000	131,300	204,200	459,700
MANUFACTURING	13,711	27,031	60,286	87,320	94,600	117,200	144,500	178,100	276,700	637,100
FOOD & KINDRED PRODUCTS	3,658	6,773	9,136	9,409	11,600	14,100	16,500	19,400	27,000	50,000
TEXTILE MILL PRODUCTS			8	7	(S)	(S)	(S)	(S)	(S)	(S)
APPAREL & OTHER FABRIC PRODUCTS	(D)	(D)	43	48	(S)	(S)	(S)	(S)	(S)	(S)
LUMBER PRODUCTS & FURNITURE	2,507	4,092	5,364	5,783	6,600	7,900	9,200	10,600	14,600	27,300
PAPER & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PRINTING & PUBLISHING	3,595	7,600	11,505	12,791	16,000	20,100	24,900	30,800	47,700	107,500
CHEMICALS & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PETROLEUM REFINING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PRIMARY METALS				100						
FABRICATED METALS & ORDNANCE	639	1,385	2,373	3,839	3,300	4,600	5,900	7,700	13,200	35,000
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
ELECTRICAL MACHINERY & SUPPLIES	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TOTAL MACHINERY (1950 ONLY)	73									
MOTOR VEHICLES & EQUIPMENT	(D)	(D)	843	463	900	900	1,200	1,500	2,500	5,900
TRANS. EQUIP., EXCL. MTR. VEHS.	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
OTHER MANUFACTURING	1,490	3,237	6,809	20,764	11,600	14,700	19,200	25,100	42,900	116,100
TRANS., COMM. & PUBLIC UTILITIES	9,239	15,498	21,616	25,316	31,000	39,600	49,600	62,200	99,400	237,800
WHOLESALE & RETAIL TRADE	46,882	59,647	99,605	114,672	150,600	197,700	251,700	320,500	525,000	1,292,300
FINANCE, INSURANCE & REAL ESTATE	11,969	24,511	38,910	40,359	55,300	71,300	88,900	110,700	174,100	402,200
SERVICES	33,209	53,687	104,693	118,888	165,300	219,800	284,800	369,000	619,300	1,566,400
GOVERNMENT	68,241	118,276	230,052	258,482	332,200	435,400	548,200	690,200	1,094,600	2,525,600
CIVILIAN GOVERNMENT	55,423	98,956	193,679	214,652	289,900	389,600	495,500	630,400	1,016,500	2,393,700
ARMED FORCES	12,819	19,320	36,373	43,830	41,500	45,800	52,300	59,800	78,100	131,900

See table C-62 for table notes

SMSA - BEAUMONT-PORT ARTHUR-ORANGE, TEX.
(BEA CODE NUMBER - 320)

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	237,631	300,435	314,903	317,558	348,000	376,800	413,200	453,100	532,800	746,000
PER CAPITA INCOME (1967$)*	1,999	2,365	3,147	3,327	4,168	4,575	5,204	5,919	7,985	13,642
PER CAPITA INCOME RELATIVE (US=1.00)	.97	.97	.95	.96	1.02	.96	.96	.96	.96	.96
TOTAL EMPLOYMENT	87,497	106,779				149,600	162,700	177,000	213,900	302,400
EMPLOYMENT/POPULATION RATIO	.37	.36				.40	.39	.39	.40	.41
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	475,018	710,471	990,969	1,056,401	1,450,800	1,723,900	2,150,400	2,682,200	4,254,800	10,177,500
TOTAL EARNINGS	402,493	604,815	858,718	903,953	1,160,900	1,445,100	1,773,400	2,176,200	3,381,300	7,961,200
AGRICULTURE, FORESTRY & FISHERIES	8,230	10,794	6,513	5,715	7,700	8,100	8,800	9,500	11,500	20,200
AGRICULTURE	7,739	10,294	6,034	5,182	7,000	7,400	7,900	8,500	10,100	17,600
FORESTRY & FISHERIES	491	500	480	533	(S)	(S)	(S)	(S)	(S)	(S)
MINING	11,659	36,102	20,475	13,066	18,700	22,000	23,700	25,500	30,400	42,500
CRUDE PETROLEUM & NATURAL GAS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
NONMETALLIC, EXCEPT FUELS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CONTRACT CONSTRUCTION	28,068	42,793	73,488	80,332	101,200	122,000	147,900	179,200	271,800	609,000
MANUFACTURING	162,251	228,658	359,283	381,894	477,000	576,300	691,800	830,400	1,238,300	2,729,800
FOOD & KINDRED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TEXTILE MILL PRODUCTS	(D)	(D)		29						
APPAREL & OTHER FABRIC PRODUCTS	(D)	(D)	131	140	(S)	(S)	(S)	(S)	(S)	(S)
LUMBER PRODUCTS & FURNITURE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PAPER & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PRINTING & PUBLISHING	2,539	3,412	4,423	4,696	6,000	7,600	9,500	11,900	19,100	48,200
CHEMICALS & ALLIED PRODUCTS	20,777	46,631	87,608	98,765	134,300	178,000	229,400	295,700	496,100	1,297,800
PETROLEUM REFINING	(D)	(D)	177,506	188,026	206,000	230,200	256,500	285,900	364,500	590,200
PRIMARY METALS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
FABRICATED METALS & ORDNANCE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
ELECTRICAL MACHINERY & SUPPLIES	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TOTAL MACHINERY (1950 ONLY)	2,993									
MOTOR VEHICLES & EQUIPMENT	119	163	2,878	2,674	(S)	(S)	(S)	(S)	(S)	(S)
TRANS. EQUIP., EXCL. MTR. VEHS.	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
OTHER MANUFACTURING	3,182	4,377	10,553	6,266	8,100	10,400	12,700	15,500	23,700	53,100
TRANS., COMM. & PUBLIC UTILITIES	41,432	60,953	76,912	79,166	97,200	118,400	140,700	167,100	244,400	513,300
WHOLESALE & RETAIL TRADE	65,304	91,790	111,738	116,917	152,500	193,500	240,400	298,600	475,300	1,162,700
FINANCE, INSURANCE & REAL ESTATE	11,129	20,454	27,543	27,367	35,600	44,900	55,700	69,100	109,400	266,400
SERVICES	44,434	63,058	103,592	110,712	149,900	197,600	253,000	323,900	539,800	1,402,900
GOVERNMENT	29,983	50,214	79,173	88,784	119,400	161,800	209,900	272,400	460,100	1,214,000
CIVILIAN GOVERNMENT	23,663	39,639	73,318	82,953	112,800	154,700	201,700	263,100	448,100	1,193,700
ARMED FORCES	6,320	10,575	5,854	5,833	6,500	7,100	8,100	9,200	12,000	20,300

See page C-62 for table notes

SMSA - BROWNSVILLE-HARLINGEN-SAN BENITO, TEX.
(BEA CODE NUMBER - 329)

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	126,222	148,343	136,596	141,086	143,900	148,300	154,300	160,600	176,300	214,200
PER CAPITA INCOME (1967$)*	1,256	1,367	1,987	2,096	2,527	3,065	3,552	4,116	5,679	10,514
PER CAPITA INCOME RELATIVE (US=1.00)	.61	.56	.60	.60	.62	.64	.66	.67	.69	.74
TOTAL EMPLOYMENT	39,439	47,195				49,400	50,900	52,500	58,300	72,000
EMPLOYMENT/POPULATION RATIO	.31	.32				.33	.33	.33	.33	.34
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	158,480	202,767	271,361	295,713	363,800	454,600	548,200	661,000	1,061,300	2,252,500
TOTAL EARNINGS	135,405	171,950	215,282	230,162	282,900	349,600	420,300	505,300	760,000	1,684,900
AGRICULTURE, FORESTRY & FISHERIES	37,349	22,006	31,067	31,995	32,400	34,900	36,700	38,500	46,600	82,100
AGRICULTURE	35,615	19,428	27,566	27,753	28,000	30,400	31,400	32,400	38,400	67,200
FORESTRY & FISHERIES	1,735	2,578	3,501	4,242	4,400	4,500	5,200	6,100	8,300	14,800
MINING	(D)	(D)	719	665	(S)	(S)	(S)	(S)	(S)	(S)
METAL	(D)	(D)	3	3						
CRUDE PETROLEUM & NATURAL GAS	28	42	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
NONMETALLIC, EXCEPT FUELS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CONTRACT CONSTRUCTION	6,743	6,343	11,534	11,763	15,300	18,300	22,200	26,800	40,800	92,400
MANUFACTURING	10,745	16,210	22,075	22,343	27,400	33,900	39,800	46,700	66,600	133,800
FOOD & KINDRED PRODUCTS	3,828	9,562	11,699	10,601	13,600	16,300	18,500	21,100	28,000	48,600
TEXTILE MILL PRODUCTS	(D)	(D)	71	70	(S)	(S)	(S)	(S)	(S)	(S)
APPAREL & OTHER FABRIC PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
LUMBER PRODUCTS & FURNITURE	72	106	138	293	200	200	300	300	400	600
PAPER & ALLIED PRODUCTS	32	3		21	(S)	(S)	(S)	(S)	(S)	(S)
PRINTING & PUBLISHING	723	1,018	1,320	1,353	1,800	2,200	2,700	3,300	5,200	12,500
CHEMICALS & ALLIED PRODUCTS	1,944	1,423	2,129	2,407	2,600	3,500	4,100	4,900	6,900	14,200
PETROLEUM REFINING	(D)	(D)	19	48	(S)	(S)	(S)	(S)	(S)	(S)
FABRICATED METALS & ORDNANCE	(D)	(D)	761	795	1,000	1,300	1,600	2,000	2,600	5,900
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
ELECTRICAL MACHINERY & SUPPLIES	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TOTAL MACHINERY (1950 ONLY)	247									
MOTOR VEHICLES & EQUIPMENT			90	87				100	200	700
TRANS. EQUIP., EXCL. MTR. VEHS.	240	683	1,056	757	1,100	1,500	1,800	2,100	3,400	7,200
OTHER MANUFACTURING	261	828	1,674	1,533	1,900	2,100	2,400	2,800	3,800	7,100
TRANS., COMM. & PUBLIC UTILITIES	19,503	22,311	14,018	14,905	18,000	20,900	24,400	28,400	40,700	83,300
WHOLESALE & RETAIL TRADE	30,168	35,709	47,983	49,685	61,100	74,600	87,400	102,400	144,400	283,500
FINANCE, INSURANCE & REAL ESTATE	(D)	(D)	9,010	9,061	11,700	14,700	17,800	21,500	32,800	75,000
SERVICES	13,393	20,296	30,212	34,096	42,900	54,800	67,800	83,800	132,200	314,800
GOVERNMENT	12,652	41,439	48,664	55,649	72,200	96,100	122,300	155,600	253,600	616,600
CIVILIAN GOVERNMENT	11,523	25,663	46,786	52,949	69,900	93,600	119,500	152,400	249,500	609,700
ARMED FORCES	1,129	15,777	1,877	2,700	2,200	2,400	2,700	3,100	4,100	6,900

See page C-62 for table notes

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	38,713	44,076	48,868	58,275	67,400	81,600	93,800	107,800	134,600	193,900
PER CAPITA INCOME (1967$)*	1,256	1,633	2,637	2,483	3,099	3,677	4,220	4,843	6,644	11,887
PER CAPITA INCOME RELATIVE (US=1.00)	.61	.67	.80	.72	.75	.77	.78	.79	.80	.83
TOTAL EMPLOYMENT	12,512	15,826				34,600	39,000	43,800	55,000	77,900
EMPLOYMENT/POPULATION RATIO	.32	.36				.42	.42	.41	.41	.40
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	48,635	71,994	128,850	144,672	209,000	300,200	396,000	522,300	894,500	2,305,100
TOTAL EARNINGS	39,376	57,439	98,722	110,355	159,600	226,300	296,500	388,500	660,600	1,692,500
AGRICULTURE, FORESTRY & FISHERIES	4,867	2,946	5,696	5,822	6,100	7,200	7,600	8,100	9,700	16,900
AGRICULTURE	4,801	2,774	5,605	5,724	6,000	7,100	7,500	8,000	9,400	16,600
FORESTRY & FISHERIES	66	173	91	98	(S)	(S)	(S)	(S)	(S)	(S)
MINING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CRUDE PETROLEUM & NATURAL GAS	(D)	(D)	118	194	(S)	(S)	(S)	(S)	(S)	(S)
NONMETALLIC, EXCEPT FUELS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CONTRACT CONSTRUCTION	2,997	4,905	6,290	8,273	12,400	16,900	22,200	29,000	49,300	124,900
MANUFACTURING	1,913	4,071	9,240	9,724	13,100	17,500	22,300	28,400	46,700	117,800
FOOD & KINDRED PRODUCTS	678	883	1,488	1,869	1,900	2,200	2,600	3,100	4,300	8,000
TEXTILE MILL PRODUCTS	(D)	(D)	2		(S)	(S)	(S)	(S)	(S)	(S)
APPAREL & OTHER FABRIC PRODUCTS				13						
LUMBER PRODUCTS & FURNITURE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PRINTING & PUBLISHING	255	271	427	757	(S)	(S)	(S)	(S)	(S)	(S)
CHEMICALS & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PRIMARY METALS				29						
FABRICATED METALS & ORDNANCE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
ELECTRICAL MACHINERY & SUPPLIES	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TOTAL MACHINERY (1950 ONLY)	77									
MOTOR VEHICLES & EQUIPMENT			79	130	(S)	(S)	(S)	(S)	(S)	(S)
TRANS. EQUIP., EXCL. MTR. VEHS.			334	421	(S)	(S)	(S)	(S)	(S)	(S)
OTHER MANUFACTURING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TRANS., COMM. & PUBLIC UTILITIES	912	2,149	3,317	3,765	4,900	6,400	8,100	10,300	16,800	40,900
WHOLESALE & RETAIL TRADE	8,419	10,707	14,887	16,374	24,900	36,900	48,400	63,500	107,500	269,100
FINANCE, INSURANCE & REAL ESTATE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
SERVICES	5,385	7,402	12,382	14,014	21,600	32,800	44,700	60,800	109,500	300,800
GOVERNMENT	13,687	22,848	43,003	47,885	69,800	99,900	131,800	173,900	297,300	763,800
CIVILIAN GOVERNMENT	12,941	21,222	40,933	45,573	67,100	96,900	128,300	169,700	291,500	753,300
ARMED FORCES	745	1,626	2,070	2,312	2,500	2,900	3,500	4,100	5,700	10,500

See page C-62 for table notes

SMSA - CORPUS CHRISTI, TEX.
(BEA CODE NUMBER - 345)

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	203,005	261,733	287,394	286,289	299,000	309,300	320,500	332,100	355,400	409,800
PER CAPITA INCOME (1967$)*	1,838	1,935	2,611	2,840	3,297	3,869	4,446	5,107	6,881	12,144
PER CAPITA INCOME RELATIVE (US=1.00)	.89	.79	.79	.82	.80	.81	.82	.83	.83	.85
TOTAL EMPLOYMENT	70,650	86,286				106,700	110,500	114,500	124,800	147,100
EMPLOYMENT/POPULATION RATIO	.35	.33				.34	.34	.34	.35	.36
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	373,043	506,335	750,337	813,080	985,700	1,196,800	1,424,900	1,695,800	2,445,900	4,977,000
TOTAL EARNINGS	302,654	413,771	590,953	635,149	759,400	906,700	1,074,200	1,272,600	1,821,600	3,646,100
AGRICULTURE, FORESTRY & FISHERIES	31,216	28,556	24,533	26,103	31,600	33,600	36,000	38,500	46,400	81,800
AGRICULTURE	29,314	26,928	22,836	24,104	29,400	31,100	33,000	35,000	41,500	72,800
FORESTRY & FISHERIES	1,903	1,627	1,697	1,999	2,200	2,400	2,900	3,400	4,800	9,000
MINING	27,442	28,164	40,937	38,120	43,200	49,900	54,000	58,500	69,300	91,400
METAL			2	64						
CRUDE PETROLEUM & NATURAL GAS	(D)	(D)	40,482	37,547	42,700	49,400	53,500	57,900	68,400	90,000
NONMETALLIC, EXCEPT FUELS	(D)	(D)	452	510	(S)	(S)	(S)	(S)	(S)	(S)
CONTRACT CONSTRUCTION	25,273	33,577	47,364	51,432	58,800	66,800	77,400	89,800	123,700	233,500
MANUFACTURING	30,901	66,383	90,621	100,726	120,700	145,300	173,100	206,300	302,100	630,700
FOOD & KINDRED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TEXTILE MILL PRODUCTS			6							
APPAREL & OTHER FABRIC PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
LUMBER PRODUCTS & FURNITURE	1,081	1,168	1,209	1,339	1,500	1,800	2,000	2,300	3,100	5,700
PAPER & ALLIED PRODUCTS	(D)	(D)	65							
PRINTING & PUBLISHING	1,753	2,849	3,777	4,221	4,900	5,900	7,100	8,500	12,300	26,200
CHEMICALS & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PETROLEUM REFINING	5,553	11,883	19,991	22,284	26,300	32,000	38,400	46,100	67,100	137,000
PRIMARY METALS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
FABRICATED METALS & ORDNANCE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
ELECTRICAL MACHINERY & SUPPLIES	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TOTAL MACHINERY (1950 ONLY)	551									
MOTOR VEHICLES & EQUIPMENT			57	58						
TRANS. EQUIP., EXCL. MTR. VEHS.	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
OTHER MANUFACTURING	1,834	2,754	3,516	3,520	4,000	4,900	5,800	6,900	10,200	20,400
TRANS., COMM. & PUBLIC UTILITIES	28,233	31,253	41,551	45,735	51,500	60,400	71,500	84,600	121,600	248,400
WHOLESALE & RETAIL TRADE	61,089	78,259	105,930	117,335	135,800	162,700	192,800	228,400	327,200	658,300
FINANCE, INSURANCE & REAL ESTATE	9,051	17,588	25,726	26,989	33,800	40,400	48,200	57,300	82,600	168,500
SERVICES	32,032	50,809	82,665	90,758	114,000	141,600	174,100	214,100	325,500	711,000
GOVERNMENT	57,417	79,183	131,625	137,950	169,100	205,600	246,100	294,600	422,800	822,100
CIVILIAN GOVERNMENT	29,252	42,105	81,515	91,286	112,800	144,000	175,800	214,700	319,000	648,000
ARMED FORCES	28,166	37,077	50,110	46,664	55,700	61,600	70,100	79,900	103,700	174,100

See page C-62 for table notes

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	787,390	1,098,998	1,445,657	1,563,908	1,785,100	2,057,000	2,319,900	2,616,400	3,239,900	4,832,300
PER CAPITA INCOME (1967$)*	2,489	2,782	3,664	3,755	4,455	5,066	5,725	6,469	8,615	14,628
PER CAPITA INCOME RELATIVE (US=1.00)	1.21	1.14	1.11	1.08	1.09	1.06	1.06	1.05	1.04	1.03
TOTAL EMPLOYMENT	327,122	455,396				862,200	966,400	1,087,700	1,385,200	2,088,000
EMPLOYMENT/POPULATION RATIO	.42	.41				.42	.42	.42	.43	.43
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	1,960,051	3,057,930	5,296,589	5,872,005	7,952,200	10,421,300	13,281,700	16,927,100	27,912,600	70,689,400
TOTAL EARNINGS	1,678,451	2,615,043	4,523,571	5,006,258	6,634,400	8,462,700	10,678,100	13,473,400	21,843,500	53,901,600
AGRICULTURE, FORESTRY & FISHERIES	51,180	30,523	31,697	37,012	32,700	37,500	42,200	47,600	56,500	98,500
AGRICULTURE	50,975	30,346	31,608	36,917	32,600	37,400	42,100	47,400	56,300	98,500
FORESTRY & FISHERIES	204	179	89	95	(S)	(S)	(S)	(S)	(S)	(S)
MINING	115,812	79,640	74,054	85,555	84,100	90,000	93,100	96,200	105,400	123,900
METAL	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CRUDE PETROLEUM & NATURAL GAS	111,919	76,347	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
NONMETALLIC, EXCEPT FUELS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CONTRACT CONSTRUCTION	140,569	165,581	258,752	312,896	413,500	520,900	659,900	836,000	1,363,200	3,377,200
MANUFACTURING	282,152	660,897	1,248,744	1,259,284	1,797,200	2,271,500	2,824,600	3,512,300	5,541,700	13,163,800
FOOD & KINDRED PRODUCTS	45,820	75,734	98,969	100,403	122,600	145,100	167,600	193,500	263,000	472,700
TEXTILE MILL PRODUCTS	(D)	(D)	2,168	2,341	2,600	2,800	3,100	3,400	4,300	6,900
APPAREL & OTHER FABRIC PRODUCTS	35,288	46,984	68,455	67,441	85,700	105,200	124,400	147,200	210,000	416,800
LUMBER PRODUCTS & FURNITURE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PAPER & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PRINTING & PUBLISHING	29,960	48,689	77,703	88,050	110,900	137,900	170,100	209,900	326,000	749,900
CHEMICALS & ALLIED PRODUCTS	(D)	(D)	44,650	45,786	68,200	91,200	117,500	151,400	253,600	661,300
PETROLEUM REFINING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PRIMARY METALS	4,003	7,459	16,819	17,288	24,000	29,600	35,400	42,300	60,300	117,600
FABRICATED METALS & ORDNANCE	19,863	37,489	80,566	74,236	114,200	149,600	188,000	236,100	378,400	911,600
MACHINERY, EXCLUDING ELECTRICAL		48,941	100,029	119,325	152,200	185,200	230,100	285,800	449,600	1,055,400
ELECTRICAL MACHINERY & SUPPLIES		88,446	337,203	330,224	513,400	696,700	905,600	1,177,100	1,996,700	5,286,600
TOTAL MACHINERY (1950 ONLY)	31,156									
MOTOR VEHICLES & EQUIPMENT	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TRANS. EQUIP., EXCL. MTR. VEHS.	46,279	192,623	224,409	217,110	337,200	411,700	495,600	596,600	887,100	1,895,700
OTHER MANUFACTURING	20,111	37,658	74,035	82,802	110,000	138,900	173,000	215,500	340,500	811,000
TRANS., COMM. & PUBLIC UTILITIES	188,872	226,223	417,973	474,536	577,100	703,400	863,300	1,059,400	1,633,100	3,715,000
WHOLESALE & RETAIL TRADE	443,219	644,975	1,011,545	1,150,918	1,469,200	1,851,500	2,326,300	2,922,800	4,709,400	11,465,400
FINANCE, INSURANCE & REAL ESTATE	131,837	230,863	398,873	432,120	561,400	707,800	877,700	1,088,200	1,706,600	3,972,600
SERVICES	199,618	347,863	665,554	784,960	1,057,100	1,409,300	1,839,100	2,400,000	4,104,900	10,870,000
GOVERNMENT	125,193	228,480	416,380	468,975	635,700	870,200	1,146,500	1,510,500	2,622,300	7,114,300
CIVILIAN GOVERNMENT	113,775	205,677	382,499	432,609	596,800	829,600	1,100,600	1,460,100	2,559,400	7,014,400
ARMED FORCES	11,419	22,804	33,881	36,366	37,500	40,500	45,100	50,300	62,900	99,800

See page C-62 for table notes

SMSA - EL PASO, TEX.
(BEA CODE NUMBER - 356)

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	196,607	308,342	366,359	361,128	367,700	370,900	384,800	399,300	429,200	502,800
PER CAPITA INCOME (1967$)*	2,038	2,054	2,524	2,636	3,218	3,828	4,399	5,056	6,896	12,290
PER CAPITA INCOME RELATIVE (US=1.00)	.99	.84	.76	.76	.78	.80	.81	.82	.83	.86
TOTAL EMPLOYMENT	75,151	111,910				134,300	139,800	145,500	161,200	194,600
EMPLOYMENT/POPULATION RATIO	.38	.36				.36	.36	.36	.38	.39
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	400,712	633,280	924,758	952,056	1,183,500	1,419,800	1,693,100	2,019,000	2,960,100	6,180,300
TOTAL EARNINGS	341,495	527,862	796,167	801,716	1,001,800	1,190,100	1,409,700	1,669,900	2,395,900	4,775,400
AGRICULTURE, FORESTRY & FISHERIES	17,222	7,726	16,759	19,175	12,800	10,900	10,100	9,400	11,100	19,500
AGRICULTURE	17,206	7,726	16,747	19,163	12,800	10,900	10,100	9,400	11,100	19,500
FORESTRY & FISHERIES	17		13	11	(S)	(S)	(S)	(S)	(S)	(S)
MINING	1,399	1,784	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
COAL			22	19						
CRUDE PETROLEUM & NATURAL GAS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
NONMETALLIC, EXCEPT FUELS	(D)	(D)	393	231	(S)	(S)	(S)	(S)	(S)	(S)
CONTRACT CONSTRUCTION	20,105	30,747	34,853	38,341	44,200	51,600	61,200	72,700	105,700	217,500
MANUFACTURING	34,902	58,323	109,919	126,057	143,600	169,500	197,800	230,700	322,700	618,600
FOOD & KINDRED PRODUCTS	6,048	9,920	12,204	12,739	13,500	15,700	17,900	20,400	26,900	45,500
TEXTILE MILL PRODUCTS			9	33						
APPAREL & OTHER FABRIC PRODUCTS	6,420	14,489	52,496	60,813	70,200	84,500	99,000	116,000	163,000	313,300
LUMBER PRODUCTS & FURNITURE	1,224	1,051	3,475	3,565	4,600	5,500	6,500	7,700	11,100	22,500
PAPER & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PRINTING & PUBLISHING	2,418	1,867	4,940	5,185	6,400	7,800	9,600	11,700	17,700	40,100
CHEMICALS & ALLIED PRODUCTS	440	430	915	899	1,300	1,600	2,100	2,500	3,800	9,000
PETROLEUM REFINING	(D)	(D)	5,886	5,841	6,700	7,700	8,600	9,600	12,400	20,300
PRIMARY METALS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
FABRICATED METALS & ORDNANCE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
MACHINERY, EXCLUDING ELECTRICAL		353	446	569	(S)	(S)	(S)	(S)	(S)	(S)
ELECTRICAL MACHINERY & SUPPLIES		9	107	2,231	(S)	(S)	(S)	(S)	(S)	(S)
TOTAL MACHINERY (1950 ONLY)	491									
MOTOR VEHICLES & EQUIPMENT	509	437	486	552	800	1,000	1,200	1,400	2,400	4,600
TRANS. EQUIP., EXCL. MTR. VEHS.			189	228	100	100	100	100	200	600
OTHER MANUFACTURING	6,464	6,655	10,577	10,912	12,700	14,900	17,400	20,200	28,300	54,600
TRANS., COMM. & PUBLIC UTILITIES	46,406	63,477	69,451	71,671	84,600	97,900	112,900	130,200	178,900	336,000
WHOLESALE & RETAIL TRADE	67,680	99,463	125,446	134,605	162,800	196,200	234,400	280,100	413,000	871,500
FINANCE, INSURANCE & REAL ESTATE	9,656	20,621	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
SERVICES	28,778	49,278	82,705	93,533	114,500	142,200	175,700	216,900	335,800	751,200
GOVERNMENT	115,347	196,444	325,032	286,453	397,700	472,800	558,600	660,000	925,800	1,742,900
CIVILIAN GOVERNMENT	28,860	69,959	130,269	146,991	181,100	229,700	281,400	344,700	516,200	1,054,500
ARMED FORCES	86,487	126,485	194,763	139,463	215,700	243,100	276,800	315,300	409,600	688,300

See page C-62 for table notes

SMSA - FORT WORTH, TEX.
(BEA CODE NUMBER - 368)

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	335,943	562,762	692,786	765,983	816,100	895,700	988,200	1,090,300	1,300,100	1,535,300
PER CAPITA INCOME (1967$)*	2,254	2,506	3,419	3,286	4,067	4,716	5,351	6,072	8,144	13,974
PER CAPITA INCOME RELATIVE (US=1.00)	1.09	1.03	1.03	.95	.99	.99	.99	.98	.98	.96
TOTAL EMPLOYMENT	162,938	220,340				374,900	411,900	452,500	554,800	791,100
EMPLOYMENT/POPULATION RATIO	.41	.39				.42	.42	.42	.43	.43
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	892,378	1,410,480	2,368,519	2,516,923	3,319,700	4,224,100	5,288,400	6,620,600	10,589,100	25,646,500
TOTAL EARNINGS	744,107	1,173,047	1,947,703	2,040,694	2,762,000	3,543,300	4,417,300	5,507,000	8,740,400	20,852,500
AGRICULTURE, FORESTRY & FISHERIES	18,591	9,117	13,441	13,586	13,800	15,100	17,000	19,200	22,800	39,800
AGRICULTURE	18,572	9,033	13,364	13,504	13,700	15,000	16,900	19,000	22,600	39,600
FORESTRY & FISHERIES	19	85	76	82	(S)	(S)	(S)	(S)	(S)	(S)
MINING	19,829	29,441	24,459	23,146	26,200	29,200	30,100	[illegible]	[illegible]	39,400
METAL			3	3	(S)	(S)	(S)	(S)	(S)	(S)
CRUDE PETROLEUM & NATURAL GAS	(D)	(D)	23,873	22,544	25,400	28,300	29,100	29,900	32,400	36,900
NONMETALLIC, EXCEPT FUELS	(D)	(D)	582	599	(S)	(S)	(S)	(S)	(S)	(S)
CONTRACT CONSTRUCTION	58,482	58,946	84,457	96,134	128,300	156,500	193,000	238,000	370,100	854,900
MANUFACTURING	219,350	368,784	765,311	737,016	1,039,500	1,317,300	1,597,800	1,937,900	2,922,600	6,420,900
FOOD & KINDRED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TEXTILE MILL PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
APPAREL & OTHER FABRIC PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
LUMBER PRODUCTS & FURNITURE	6,620	10,390	14,472	15,459	19,700	23,500	27,100	31,300	43,100	80,600
PAPER & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PRINTING & PUBLISHING	(D)	(D)	25,959	27,983	37,600	46,200	57,100	70,500	109,700	253,000
CHEMICALS & ALLIED PRODUCTS	(D)	(D)	9,740	11,977	14,300	17,800	22,000	27,400	42,900	100,900
PETROLEUM REFINING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PRIMARY METALS	5,821	10,626	18,501	17,329	26,000	30,300	35,500	41,600	57,600	106,000
FABRICATED METALS & ORDNANCE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
ELECTRICAL MACHINERY & SUPPLIES	(D)	(D)	14,816	14,153	21,000	30,600	39,800	51,800	87,800	232,600
TOTAL MACHINERY (1950 ONLY)	4,836									
MOTOR VEHICLES & EQUIPMENT	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TRANS. EQUIP., EXCL. MTR. VEHS.	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
OTHER MANUFACTURING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TRANS., COMM. & PUBLIC UTILITIES	69,982	111,392	115,902	122,747	153,400	185,600	224,600	271,800	409,100	899,000
WHOLESALE & RETAIL TRADE	153,293	213,163	319,159	350,620	469,200	605,700	765,900	968,400	1,576,200	3,917,400
FINANCE, INSURANCE & REAL ESTATE	31,131	61,898	93,036	98,336	126,600	161,100	198,200	243,800	377,300	860,200
SERVICES	84,757	166,097	274,271	300,420	414,600	549,600	705,400	905,300	1,505,800	3,831,900
GOVERNMENT	88,692	154,207	257,666	298,489	368,000	522,800	682,500	891,100	1,520,300	3,988,400
CIVILIAN GOVERNMENT	58,478	120,082	222,664	254,013	346,500	481,200	635,600	839,500	1,455,800	3,886,000
ARMED FORCES	30,213	34,126	35,002	44,476	39,700	41,500	46,300	51,600	64,500	102,400

See page C-62 for table notes

SMSA - GALVESTON-TEXAS CITY, TEX.
(BEA CODE NUMBER - 371)

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	114,016	137,805	170,473	170,681	190,000	207,900	228,100	250,400	292,200	403,500
PER CAPITA INCOME (1967$)*	2,176	2,295	2,852	3,004	3,492	4,182	4,745	5,384	7,329	12,742
PER CAPITA INCOME RELATIVE (US=1.00)	1.05	.94	.86	.87	.85	.88	.88	.87	.88	.89
TOTAL EMPLOYMENT	45,174	51,442				81,900	88,800	96,400	115,800	160,300
EMPLOYMENT/POPULATION RATIO	.40	.37				.39	.39	.39	.40	.40
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	248,108	316,300	486,211	512,684	663,700	869,400	1,082,700	1,348,300	2,142,100	5,142,300
TOTAL EARNINGS	198,031	249,632	382,445	400,657	506,900	654,200	809,000	1,000,500	1,569,800	3,705,800
AGRICULTURE, FORESTRY & FISHERIES	3,409	2,307	3,327	1,760	2,900	3,200	3,500	3,800	4,700	8,200
AGRICULTURE	2,146	1,748	2,674	995	2,000	2,300	2,500	2,600	3,200	5,500
FORESTRY & FISHERIES	1,263	559	652	765	800	800	1,000	1,100	1,500	2,600
MINING	1,471	5,376	2,243	3,518	2,200	2,800	3,100	3,400	4,100	5,800
CRUDE PETROLEUM & NATURAL GAS	1,471	5,376	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
NONMETALLIC, EXCEPT FUELS			(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CONTRACT CONSTRUCTION	11,929	18,524	52,139	39,732	53,800	78,100	92,200	108,900	156,600	314,200
MANUFACTURING	46,843	75,120	110,147	127,567	151,600	188,600	232,400	286,400	446,000	1,043,500
FOOD & KINDRED PRODUCTS	4,362	6,640	7,384	6,868	9,100	10,500	11,900	13,500	17,900	31,000
TEXTILE MILL PRODUCTS			12		(S)	(S)	(S)	(S)	(S)	(S)
APPAREL & OTHER FABRIC PRODUCTS	(D)	(D)	97	94	(S)	(S)	(S)	(S)	(S)	(S)
LUMBER PRODUCTS & FURNITURE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PRINTING & PUBLISHING	1,764	2,426	2,324	2,564	3,100	3,700	4,500	5,400	8,000	17,300
CHEMICALS & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PETROLEUM REFINING	13,153	24,841	27,440	32,972	33,800	38,700	44,000	50,000	66,000	113,500
PRIMARY METALS	6,576	1,312	2,179	2,018	2,600	3,100	3,600	4,200	5,800	10,500
FABRICATED METALS & ORDNANCE	6	2,031	2,474	4,280	3,800	5,000	6,500	8,400	14,200	36,600
MACHINERY, EXCLUDING ELECTRICAL		40	893	1,529	1,200	1,700	2,100	2,600	4,100	9,500
ELECTRICAL MACHINERY & SUPPLIES			7		(S)	(S)	(S)	(S)	(S)	(S)
TOTAL MACHINERY (1950 ONLY)	182									
MOTOR VEHICLES & EQUIPMENT			963	1,077	(S)	(S)	(S)	(S)	(S)	(S)
TRANS. EQUIP., EXCL. MTR. VEHS.	5,352	4,103	10,984	12,612	14,600	17,400	21,100	25,400	38,100	83,000
OTHER MANUFACTURING	37	148	1,155	1,407	2,000	2,900	3,800	5,200	9,200	25,400
TRANS., COMM. & PUBLIC UTILITIES	24,613	32,023	37,084	35,369	44,700	57,600	68,800	82,100	120,600	254,600
WHOLESALE & RETAIL TRADE	32,886	36,469	45,780	48,807	59,600	71,200	84,400	100,100	144,700	294,800
FINANCE, INSURANCE & REAL ESTATE	34,936	16,694	23,219	23,613	29,500	36,700	43,800	52,200	76,400	159,500
SERVICES	21,144	25,945	46,009	49,798	64,500	81,300	101,900	127,900	204,600	490,900
GOVERNMENT	20,800	37,174	62,496	70,492	96,700	134,300	177,700	235,300	411,400	1,134,000
CIVILIAN GOVERNMENT	17,832	32,189	59,498	67,782	93,400	130,600	173,500	230,500	405,300	1,123,700
ARMED FORCES	2,968	4,985	2,998	2,710	3,200	3,600	4,100	4,700	6,100	10,200

See page C-62 for table notes

SMSA - HOUSTON, TEX.
(BEA CODE NUMBER - 382)

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED, SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	943,402	1,392,460	1,909,637	1,995,164	2,200,500	2,429,700	2,705,700	3,013,000	3,613,500	5,157,600
PER CAPITA INCOME (1967$)*	2,518	2,626	3,323	3,571	4,090	4,701	5,296	5,966	8,003	13,682
PER CAPITA INCOME RELATIVE (US=1.00)	1.22	1.08	1.01	1.03	1.00	.99	.98	.97	.97	.96
TOTAL EMPLOYMENT	371,661	527,464				928,900	1,030,100	1,142,200	1,425,400	2,084,500
EMPLOYMENT/POPULATION RATIO	.39	.38				.38	.38	.38	.39	.40
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	2,375,736	3,656,508	6,346,637	7,124,493	9,001,000	11,422,100	14,328,400	17,974,500	28,919,100	70,705,300
TOTAL EARNINGS	1,997,148	3,056,873	5,238,115	5,882,577	7,404,000	9,338,900	11,633,800	14,492,600	23,014,100	55,002,400
AGRICULTURE, FORESTRY & FISHERIES	37,558	29,497	34,049	34,275	35,100	36,200	38,400	40,700	49,300	85,200
AGRICULTURE	36,197	28,368	32,777	32,779	33,400	34,400	36,400	38,400	46,100	79,700
FORESTRY & FISHERIES	1,362	1,130	1,271	1,495	1,600	1,700	2,000	2,300	3,100	5,500
MINING	233,454	265,080	291,325	327,980	330,700	367,200	391,400	417,100	482,200	619,600
METAL			5	4						
COAL			9	25						
CRUDE PETROLEUM & NATURAL GAS	224,105	253,255	282,090	318,285	319,400	354,400	376,700	400,400	459,600	578,300
NONMETALLIC, EXCEPT FUELS	9,349	11,823	9,222	9,669	11,300	12,800	14,600	16,700	22,600	41,200
CONTRACT CONSTRUCTION	199,656	204,049	521,308	611,364	726,800	878,500	1,080,600	1,329,100	2,059,700	[illegible]
MANUFACTURING	421,284	754,943	1,253,317	1,366,338	1,755,100	2,192,400	2,696,600	3,317,200	5,143,400	11,918,200
FOOD & KINDRED PRODUCTS	51,277	68,065	97,005	105,507	124,300	145,700	168,300	194,400	264,900	481,200
TEXTILE MILL PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
APPAREL & OTHER FABRIC PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
LUMBER PRODUCTS & FURNITURE	24,887	20,333	27,870	25,617	33,600	38,800	44,300	50,500	67,700	121,000
PAPER & ALLIED PRODUCTS	(D)	(D)	29,231	30,792	38,700	47,800	58,100	70,700	107,300	235,200
PRINTING & PUBLISHING	20,352	31,130	53,182	60,137	76,200	95,400	118,700	147,800	234,300	561,600
CHEMICALS & ALLIED PRODUCTS	66,507	137,712	245,512	278,580	359,400	469,000	596,100	757,700	1,240,500	3,115,100
PETROLEUM REFINING	80,857	139,406	171,040	191,291	210,500	240,300	272,600	309,200	407,000	[illegible]
PRIMARY METALS	21,134	43,570	80,160	79,555	98,300	115,900	135,000	157,100	215,300	387,400
FABRICATED METALS & ORDNANCE	35,104	73,696	156,231	174,093	225,600	293,100	368,100	462,400	741,400	1,789,900
MACHINERY, EXCLUDING ELECTRICAL		134,171	206,200	232,119	310,300	387,100	478,200	590,600	919,700	2,122,600
ELECTRICAL MACHINERY & SUPPLIES	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TOTAL MACHINERY (1950 ONLY)	76,569									
MOTOR VEHICLES & EQUIPMENT	1,699	2,557	10,869	8,296	11,600	13,400	16,100	19,300	28,500	60,800
TRANS. EQUIP., EXCL. MTR. VEHS.	3,687	11,063	43,657	26,097	54,200	73,500	91,800	114,600	182,300	434,600
OTHER MANUFACTURING	13,794	50,609	96,618	112,987	154,200	198,200	250,000	315,200	509,700	1,255,200
TRANS., COMM. & PUBLIC UTILITIES	224,226	326,816	459,986	509,707	600,800	725,400	867,200	1,036,700	1,526,200	3,220,600
WHOLESALE & RETAIL TRADE	437,346	642,722	1,098,710	1,219,654	1,575,100	2,022,000	2,542,800	3,197,700	5,157,500	12,587,300
FINANCE, INSURANCE & REAL ESTATE	89,838	182,511	307,083	338,969	425,900	533,500	657,400	810,000	1,256,200	2,668,000
SERVICES	235,220	418,805	850,503	991,595	1,308,000	1,723,600	2,228,800	2,882,100	4,852,800	12,539,600
GOVERNMENT	118,564	232,450	421,834	482,694	637,000	859,700	1,121,000	1,461,500	2,486,500	6,534,000
CIVILIAN GOVERNMENT	96,954	207,229	390,892	449,244	600,400	821,800	1,077,400	1,412,500	2,423,000	6,427,600
ARMED FORCES	21,610	25,219	30,942	33,451	35,300	37,900	43,100	49,000	63,500	106,300

See page C-62 for table notes

SMSA - KILLEEN-TEMPLE, TEX.
(BEA CODE NUMBER - 558)

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	90,865	115,905	145,698	160,612	162,600	170,900	179,300	188,200	205,200	250,000
PER CAPITA INCOME (1967$)*	1,935	2,099	3,075	3,311	3,752	4,263	4,824	5,468	7,412	13,007
PER CAPITA INCOME RELATIVE (US=1.00)	.94	.86	.93	.96	.91	.89	.89	.89	.89	.91
TOTAL EMPLOYMENT	38,160	50,290				66,700	70,100	73,700	82,800	103,400
EMPLOYMENT/POPULATION RATIO	.42	.43				.39	.39	.39	.40	.41
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	175,826	243,309	448,023	531,837	610,200	728,600	865,400	1,029,400	1,521,000	3,252,600
TOTAL EARNINGS	151,290	206,896	367,335	438,018	489,500	571,400	682,400	815,000	1,177,500	2,418,800
AGRICULTURE, FORESTRY & FISHERIES	16,038	9,840	8,827	9,850	8,700	8,900	9,600	10,300	12,500	22,600
AGRICULTURE	16,026	9,798	8,818	9,841	8,700	8,900	9,600	10,300	12,500	22,800
FORESTRY & FISHERIES	12	42	9	9	(S)	(S)	(S)	(S)	(S)	(S)
MINING	(D)	(D)	539	383	(S)	(S)	(S)	(S)	(S)	(S)
CRUDE PETROLEUM & NATURAL GAS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
NONMETALLIC, EXCEPT FUELS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CONTRACT CONSTRUCTION	7,931	6,488	11,657	11,826	13,900	17,900	21,700	26,400	39,600	86,600
MANUFACTURING	5,770	11,839	22,391	24,808	31,200	39,800	48,900	60,200	93,400	217,800
FOOD & KINDRED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
APPAREL & OTHER FABRIC PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
LUMBER PRODUCTS & FURNITURE	2,358	4,955	7,677	8,426	10,000	11,800	13,900	16,300	22,900	44,400
PRINTING & PUBLISHING	638	860	1,392	1,573	1,800	2,200	2,700	3,400	5,100	11,800
CHEMICALS & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PRIMARY METALS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
FABRICATED METALS & ORDNANCE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	1,225	1,114	1,600	2,400	3,000	3,800	5,900	14,200
TOTAL MACHINERY (1950 ONLY)	50									
MOTOR VEHICLES & EQUIPMENT			22	45	(S)	(S)	(S)	(S)	(S)	(S)
TRANS. EQUIP., EXCL. MTR. VEHS.	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
OTHER MANUFACTURING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TRANS., COMM. & PUBLIC UTILITIES	6,814	9,489	11,449	12,685	14,700	17,200	20,700	24,900	36,700	79,800
WHOLESALE & RETAIL TRADE	15,463	21,807	30,568	36,026	43,300	53,300	67,300	84,800	135,800	328,700
FINANCE, INSURANCE & REAL ESTATE	(D)	(D)	6,653	6,853	8,600	10,800	13,400	16,700	26,100	60,700
SERVICES	10,754	15,532	28,041	31,689	40,200	51,700	65,300	82,400	131,100	310,200
GOVERNMENT	85,557	127,323	247,210	303,701	327,300	370,800	434,200	508,300	701,200	1,311,000
CIVILIAN GOVERNMENT	15,838	27,004	50,622	56,845	74,400	97,400	121,800	152,400	237,600	528,900
ARMED FORCES	69,719	100,319	196,588	246,856	251,700	273,400	311,900	355,800	463,500	782,100

See page C-62 for table notes

SMSA - LAREDO, TEX.
(BEA CODE NUMBER - 399)

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	56,613	63,610	76,530	73,232	75,400	75,800	77,500	79,300	83,100	92,900
PER CAPITA INCOME (1967$)*	1,021	1,268	1,848	2,187	2,520	3,013	3,534	4,144	5,736	10,554
PER CAPITA INCOME RELATIVE (US=1.00)	.49	.52	.56	.63	.61	.63	.65	.67	.69	.74
TOTAL EMPLOYMENT	15,987	18,208				23,100	24,100	25,100	27,600	32,900
EMPLOYMENT/POPULATION RATIO	.28	.29				.31	.31	.32	.33	.35
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	57,799	80,663	141,400	160,149	190,100	228,600	274,200	328,900	476,800	981,100
TOTAL EARNINGS	48,316	68,170	110,369	122,751	146,300	175,600	211,000	253,500	366,500	747,700
AGRICULTURE, FORESTRY & FISHERIES	6,977	8,498	9,423	11,238	11,300	12,500	14,500	16,800	19,900	34,800
AGRICULTURE	6,872	8,383	9,400	11,213	11,300	12,400	14,400	16,700	19,800	34,800
FORESTRY & FISHERIES	105	115	22	25	(S)	(S)	(S)	(S)	(S)	(S)
MINING	1,481	774	1,511	776	(S)	(S)	(S)	(S)	(S)	(S)
CRUDE PETROLEUM & NATURAL GAS	1,380	774	1,491	776	(S)	(S)	(S)	(S)	(S)	(S)
NONMETALLIC, EXCEPT FUELS	101		20		(S)	(S)	(S)	(S)	(S)	(S)
CONTRACT CONSTRUCTION	3,868	1,951	3,765	3,035	5,500	6,500	8,100	10,000	15,200	32,800
MANUFACTURING	2,186	2,931	3,877	5,106	5,600	6,400	7,400	8,500	11,500	21,700
FOOD & KINDRED PRODUCTS	367	484	1,026	1,298	1,400	1,500	1,700	2,000	2,700	4,700
APPAREL & OTHER FABRIC PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
LUMBER PRODUCTS & FURNITURE	(D)	(D)	81	75	(S)	(S)	(S)	(S)	(S)	(S)
PAPER & ALLIED PRODUCTS	(D)	(D)	7							
PRINTING & PUBLISHING	370	492	605	707	800	1,000	1,200	1,500	2,200	5,000
CHEMICALS & ALLIED PRODUCTS			3	-1	(S)	(S)	(S)	(S)	(S)	(S)
PETROLEUM REFINING				42						
PRIMARY METALS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
FABRICATED METALS & ORDNANCE					(S)	(S)	(S)	(S)	(S)	(S)
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	131	180	(S)	(S)	(S)	(S)	(S)	(S)
ELECTRICAL MACHINERY & SUPPLIES	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
OTHER MANUFACTURING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TRANS., COMM. & PUBLIC UTILITIES	6,167	7,399	9,906	10,387	12,000	13,300	15,300	17,700	24,100	45,000
WHOLESALE & RETAIL TRADE	12,182	14,648	26,529	28,360	35,600	44,200	53,600	64,900	96,500	204,100
FINANCE, INSURANCE & REAL ESTATE	1,224	2,199	3,755	4,101	5,100	6,200	7,500	9,100	13,500	28,700
SERVICES	6,421	7,691	13,977	15,930	19,300	24,500	30,100	37,100	56,500	123,500
GOVERNMENT	7,609	22,079	37,627	43,818	50,300	60,900	73,400	88,400	128,300	256,100
CIVILIAN GOVERNMENT	7,424	12,074	22,352	25,385	31,900	41,300	50,700	62,200	93,400	195,700
ARMED FORCES	385	10,006	15,275	18,433	18,100	19,600	22,600	26,200	34,800	60,400

See page C-62 for table notes

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	101,897	153,422	178,881	180,212	171,500	164,900	164,500	164,000	163,900	189,400
PER CAPITA INCOME (1967$)*	2,153	2,273	2,878	3,121	3,555	4,144	4,709	5,351	7,161	12,890
PER CAPITA INCOME RELATIVE (US=1.00)	1.04	.93	.87	.90	.87	.87	.87	.87	.86	.90
TOTAL EMPLOYMENT	39,700	58,181				63,200	62,900	62,600	63,700	76,200
EMPLOYMENT/POPULATION RATIO	.39	.38				.38	.38	.38	.39	.40
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	219,426	348,788	514,780	562,424	609,600	683,700	774,700	877,700	1,173,600	2,441,600
TOTAL EARNINGS	182,105	277,428	396,166	431,056	465,400	520,800	590,000	668,400	894,400	1,830,500
AGRICULTURE, FORESTRY & FISHERIES	26,940	33,575	43,202	46,304	37,200	37,100	37,500	37,900	40,600	66,700
AGRICULTURE	26,940	33,575	43,181	46,267	37,200	37,100	37,400	37,800	40,500	66,700
FORESTRY & FISHERIES			20	37	(S)	(S)	(S)	(S)	(S)	(S)
MINING	5,209	3,308	950	736	(S)	(S)	(S)	(S)	(S)	(S)
CRUDE PETROLEUM & NATURAL GAS	5,197	3,308	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
NONMETALLIC, EXCEPT FUELS	12		(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CONTRACT CONSTRUCTION	21,748	22,354	22,380	28,051	26,200	28,900	32,500	36,500	48,200	93,900
MANUFACTURING	11,051	23,634	39,110	44,354	52,700	61,100	71,700	84,200	121,000	260,200
FOOD & KINDRED PRODUCTS	5,795	10,013	13,567	13,780	13,600	13,800	14,200	14,700	16,200	24,300
TEXTILE MILL PRODUCTS		81	667	474	1,000	1,100	1,400	1,700	2,500	5,200
APPAREL & OTHER FABRIC PRODUCTS	(D)	(D)	191	704	(S)	(S)	(S)	(S)	(S)	(S)
LUMBER PRODUCTS & FURNITURE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PAPER & ALLIED PRODUCTS	(D)	(D)								
PRINTING & PUBLISHING	1,454	2,264	3,622	4,031	4,200	4,500	5,000	5,700	7,400	15,200
CHEMICALS & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PETROLEUM REFINING	(D)	(D)	293	330	(S)	(S)	(S)	(S)	(S)	(S)
PRIMARY METALS	(D)	(D)	657	954	1,000	1,200	1,400	1,500	2,200	3,600
FABRICATED METALS & ORDNANCE	1,315	2,817	3,872	4,697	6,300	8,400	10,700	13,800	23,000	60,500
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
ELECTRICAL MACHINERY & SUPPLIES	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TOTAL MACHINERY (1950 ONLY)	740									
MOTOR VEHICLES & EQUIPMENT	(D)	(D)	289	441	(S)	(S)	(S)	(S)	(S)	(S)
TRANS. EQUIP., EXCL. MTR. VEHS.		33	310	1,713	1,700	2,100	2,500	3,000	4,300	9,000
OTHER MANUFACTURING	157	1,956	3,197	3,360	4,600	5,700	7,000	8,500	12,300	25,600
TRANS., COMM. & PUBLIC UTILITIES	15,826	27,297	30,205	32,097	34,400	37,200	41,200	45,700	59,100	108,700
WHOLESALE & RETAIL TRADE	43,801	70,394	94,586	99,113	110,200	121,800	136,200	152,300	199,600	401,900
FINANCE, INSURANCE & REAL ESTATE	6,522	16,645	23,341	23,930	27,000	30,000	33,600	37,700	49,700	101,300
SERVICES	23,257	39,536	64,108	68,583	79,200	90,800	104,900	121,200	167,100	363,200
GOVERNMENT	27,751	40,685	78,265	87,887	96,900	112,900	131,000	152,000	208,200	428,900
CIVILIAN GOVERNMENT	15,831	31,316	58,772	66,769	75,800	89,700	104,600	122,000	169,000	362,800
ARMED FORCES	11,920	9,369	19,513	21,118	21,000	23,100	26,300	30,000	39,100	66,000

See page C-62 for table notes

SMSA - MCALLEN-PHARR-EDINBURG, TEX.
(BEA CODE NUMBER - 532)

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	161,794	177,605	175,636	182,464	180,600	181,800	182,200	182,700	188,500	209,600
PER CAPITA INCOME (1967$)*	1,017	1,131	1,662	1,744	2,067	2,482	2,944	3,491	5,006	9,784
PER CAPITA INCOME RELATIVE (US=1.00)	.49	.46	.50	.50	.50	.52	.54	.57	.60	.69
TOTAL EMPLOYMENT	50,036	57,425				54,700	55,300	55,900	60,100	71,000
EMPLOYMENT/POPULATION RATIO	.31	.32				.30	.30	.31	.32	.34
				IN THOUSANDS OF 1967 $						
TOTAL PERSONAL INCOME *	164,594	200,822	291,948	318,300	373,400	451,300	536,600	638,000	943,700	2,050,900
TOTAL EARNINGS	143,594	169,134	223,452	235,990	283,400	345,000	409,400	485,700	716,000	1,549,000
AGRICULTURE, FORESTRY & FISHERIES	59,633	44,404	45,023	44,697	42,500	46,500	48,000	49,600	58,800	103,000
AGRICULTURE	59,507	44,277	44,969	44,604	42,400	46,400	47,900	49,400	58,600	102,600
FORESTRY & FISHERIES	126	126	54	93	(S)	(S)	(S)	(S)	(S)	(S)
MINING	3,104	5,451	7,592	7,193	7,600	9,300	10,200	11,200	13,700	19,400
CRUDE PETROLEUM & NATURAL GAS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
NONMETALLIC, EXCEPT FUELS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CONTRACT CONSTRUCTION	7,551	8,459	11,089	8,645	13,700	17,000	20,300	24,300	36,200	79,700
MANUFACTURING	8,073	10,937	13,949	15,981	18,900	22,500	26,600	31,500	45,800	95,100
FOOD & KINDRED PRODUCTS	5,396	4,603	6,006	6,068	7,400	8,800	10,200	11,800	16,100	29,000
APPAREL & OTHER FABRIC PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
LUMBER PRODUCTS & FURNITURE	109	147	274	189	500	500	600	700	1,100	2,100
PAPER & ALLIED PRODUCTS	210	1,089	1,927	2,325	2,400	3,000	3,600	4,300	6,500	14,200
PRINTING & PUBLISHING	(D)	(D)	1,031	1,105	1,300	1,600	1,900	2,300	3,500	5,100
CHEMICALS & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PETROLEUM REFINING	(D)	(D)	214	334	(S)	(S)	(S)	(S)	(S)	(S)
PRIMARY METALS	(D)	(D)	67	77	(S)	(S)	(S)	(S)	(S)	(S)
FABRICATED METALS & ORDNANCE	(D)	(D)	324	281	(S)	(S)	(S)	(S)	(S)	(S)
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
ELECTRICAL MACHINERY & SUPPLIES	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TOTAL MACHINERY (1950 ONLY)	411									
MOTOR VEHICLES & EQUIPMENT			49	42	100	200	200	300	700	2,300
TRANS. EQUIP., EXCL. MTR. VEHS.		3	53	44	(S)	(S)	(S)	(S)	(S)	(S)
OTHER MANUFACTURING	345	1,083	555	697	600	600	700	800	1,100	2,100
TRANS., COMM. & PUBLIC UTILITIES	6,850	7,513	10,002	10,479	12,900	15,600	18,600	22,100	32,800	71,500
WHOLESALE & RETAIL TRADE	30,725	39,100	49,376	54,335	62,800	72,900	83,900	96,700	132,500	249,500
FINANCE, INSURANCE & REAL ESTATE	2,942	5,056	7,124	7,175	9,100	11,300	13,500	16,200	24,400	54,500
SERVICES	11,252	19,419	30,496	32,719	43,200	55,000	67,600	83,000	129,400	302,600
GOVERNMENT	13,463	28,794	48,801	54,766	71,400	94,500	119,400	150,700	241,900	573,400
CIVILIAN GOVERNMENT	12,268	24,568	45,730	51,837	67,800	90,300	114,600	145,300	234,900	561,500
ARMED FORCES	1,195	4,226	3,071	2,929	3,500	4,100	4,700	5,400	7,000	11,800

See page C-62 for table notes

SMSA - MIDLAND, TEX.
(BEA CODE NUMBER - 421)

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	26,002	66,482	60,669	65,768	71,200	78,500	79,700	81,000	85,600	99,500
PER CAPITA INCOME (1967$)*	3,403	2,870	4,307	4,060	4,771	5,415	6,167	7,024	9,339	16,116
PER CAPITA INCOME RELATIVE (US=1.00)	1.65	1.18	1.30	1.17	1.16	1.14	1.14	1.14	1.13	1.13
TOTAL EMPLOYMENT	10,362	26,151				29,200	30,000	30,800	33,800	41,000
EMPLOYMENT/POPULATION RATIO	.40	.39				.37	.38	.38	.40	.41
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	88,475	190,792	261,306	267,044	339,700	425,400	491,900	569,000	799,900	1,605,000
TOTAL EARNINGS	73,107	151,870	203,915	205,065	251,500	302,400	350,300	405,800	566,600	1,106,600
AGRICULTURE, FORESTRY & FISHERIES	6,224	1,115	2,970	4,521	2,600	2,100	2,000	2,000	2,400	4,200
AGRICULTURE	6,224	1,115	2,969	4,520	2,600	2,100	2,000	2,000	2,400	4,200
FORESTRY & FISHERIES			1	1						
MINING	32,649	63,005	80,253	71,720	86,500	101,600	110,600	120,400	144,000	193,600
METAL			3	2	(S)	(S)	(S)	(S)	(S)	(S)
CRUDE PETROLEUM & NATURAL GAS	32,649	63,005	80,201	71,642	86,400	101,500	110,500	120,300	143,800	193,200
NONMETALLIC, EXCEPT FUELS			49	76	(S)	(S)	(S)	(S)	(S)	(S)
CONTRACT CONSTRUCTION	7,470	9,737	9,083	9,124	11,800	14,200	15,900	17,700	23,300	41,800
MANUFACTURING	1,757	4,682	7,684	9,728	11,700	14,400	17,700	21,800	34,500	82,600
FOOD & KINDRED PRODUCTS	(D)	(D)	1,141	1,456	1,300	1,400	1,600	1,800	2,300	3,900
APPAREL & OTHER FABRIC PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
LUMBER PRODUCTS & FURNITURE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PRINTING & PUBLISHING	584	1,165	1,099	1,087	1,400	1,700	2,000	2,300	3,400	7,100
CHEMICALS & ALLIED PRODUCTS	425	46	274	796	700	500	600	800	1,400	3,600
PETROLEUM REFINING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PRIMARY METALS	(D)	(D)								
FABRICATED METALS & ORDNANCE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
ELECTRICAL MACHINERY & SUPPLIES	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TOTAL MACHINERY (1950 ONLY)	40									
MOTOR VEHICLES & EQUIPMENT										
TRANS. EQUIP., EXCL. MTR. VEHS.			4	7	(S)	(S)	(S)	(S)	(S)	(S)
OTHER MANUFACTURING	83	585	638	998	1,100	1,400	1,700	2,100	3,300	8,200
TRANS., COMM. & PUBLIC UTILITIES	2,725	10,060	11,835	11,820	15,000	18,100	21,500	25,400	36,700	75,500
WHOLESALE & RETAIL TRADE	8,992	21,943	29,556	31,165	39,200	47,000	55,500	65,700	96,000	203,400
FINANCE, INSURANCE & REAL ESTATE	2,205	7,923	10,879	10,099	13,200	16,100	19,200	22,800	33,800	73,600
SERVICES	8,923	23,139	33,647	36,441	45,400	56,400	67,900	81,700	122,600	269,100
GOVERNMENT	2,162	10,267	18,007	20,447	25,300	32,100	39,200	48,000	73,000	162,400
CIVILIAN GOVERNMENT	1,943	9,249	17,040	19,374	24,100	31,000	37,900	46,500	71,100	159,200
ARMED FORCES	219	1,018	967	1,073	1,100	1,100	1,300	1,400	1,900	3,200

See page C-62 for table notes

SMSA - ODESSA, TEX.
(BEA CODE NUMBER - 440)

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	42,456	89,336	83,671	92,275	93,300	98,000	100,500	103,000	110,700	131,700
PER CAPITA INCOME (1967$)*	2,482	2,397	3,336	3,195	3,839	4,449	5,083	5,806	7,757	13,474
PER CAPITA INCOME RELATIVE (US=1.00)	1.20	.98	1.01	.92	.94	.93	.94	.94	.94	.94
TOTAL EMPLOYMENT	15,755	33,336				37,900	39,100	40,300	44,400	54,300
EMPLOYMENT/POPULATION RATIO	.37	.37				.39	.39	.39	.40	.41

IN THOUSANDS OF 1967 $

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
TOTAL PERSONAL INCOME *	105,389	214,098	279,123	294,851	358,400	436,200	510,900	598,200	858,700	1,774,700
TOTAL EARNINGS	71,268	185,116	219,798	232,576	279,000	333,700	389,200	453,900	647,000	1,327,600
AGRICULTURE, FORESTRY & FISHERIES	1,072	244	309	526	(S)	(S)	(S)	(S)	(S)	(S)
AGRICULTURE	1,072	244	309	526	(S)	(S)	(S)	(S)	(S)	(S)
MINING	21,246	46,041	45,923	42,500	46,700	53,000	55,800	58,700	66,100	80,300
CRUDE PETROLEUM & NATURAL GAS	21,010	45,718	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
NONMETALLIC, EXCEPT FUELS	236	323	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CONTRACT CONSTRUCTION	7,831	18,582	18,565	21,232	25,700	31,900	36,400	41,600	57,100	109,600
MANUFACTURING	3,578	18,248	27,748	31,649	41,600	53,300	66,600	83,100	132,900	325,600
FOOD & KINDRED PRODUCTS	475	995	784	746	900	1,000	1,100	1,300	1,700	2,900
TEXTILE MILL PRODUCTS				8						
APPAREL & OTHER FABRIC PRODUCTS		25		40	(S)	(S)	(S)	(S)	(S)	(S)
LUMBER PRODUCTS & FURNITURE	99	195	116	143	(S)	(S)	(S)	(S)	(S)	(S)
PRINTING & PUBLISHING	357	931	1,120	1,283	1,400	1,700	2,000	2,400	3,400	7,200
CHEMICALS & ALLIED PRODUCTS	834	5,220	14,745	16,789	22,400	29,900	36,100	48,500	79,900	202,400
PETROLEUM REFINING	(D)	(D)	2,067	1,320	2,200	2,400	2,600	2,900	3,500	5,400
PRIMARY METALS			278	361	(S)	(S)	(S)	(S)	(S)	(S)
FABRICATED METALS & ORDNANCE	923	2,543	2,409	2,957	3,800	4,900	6,200	7,900	12,800	32,600
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	4,788	6,529	7,200	8,800	10,800	13,200	20,400	46,900
ELECTRICAL MACHINERY & SUPPLIES	(D)	(D)	30	69	(S)	(S)	(S)	(S)	(S)	(S)
TOTAL MACHINERY (1950 ONLY)	367									
MOTOR VEHICLES & EQUIPMENT	43	16	24	24						
TRANS. EQUIP., EXCL. MTR. VEHS.			5	6	(S)	(S)	(S)	(S)	(S)	(S)
OTHER MANUFACTURING	(D)	(D)	1,384	1,375	2,400	3,300	4,200	5,500	9,200	24,600
TRANS., COMM. & PUBLIC UTILITIES	5,451	17,183	16,045	16,541	19,700	22,500	25,700	29,300	40,000	75,700
WHOLESALE & RETAIL TRADE	17,882	41,106	47,481	50,023	57,900	66,600	75,500	86,400	118,700	230,200
FINANCE, INSURANCE & REAL ESTATE	1,931	7,551	8,281	6,365	9,500	10,900	12,500	14,200	19,300	36,900
SERVICES	8,388	21,534	29,728	32,478	40,400	48,700	58,800	70,900	106,400	231,500
GOVERNMENT	3,889	14,628	25,718	29,241	36,300	46,200	56,600	69,200	105,900	237,400
CIVILIAN GOVERNMENT	3,588	13,247	24,372	27,727	34,700	44,600	54,700	67,200	103,200	233,000
ARMED FORCES	301	1,381	1,346	1,514	1,500	1,500	1,800	2,000	2,600	4,400

See page C-62 for table notes

SMSA - SAN ANGELO, TEX.
(BEA CODE NUMBER - 474)

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	59,424	63,452	71,334	71,410	75,500	79,100	84,200	89,700	103,700	137,900
PER CAPITA INCOME (1967$)*	1,966	1,999	2,906	3,145	3,582	4,198	4,828	5,553	7,594	13,612
PER CAPITA INCOME RELATIVE (US=1.00)	.95	.82	.88	.91	.87	.88	.89	.90	.92	.95
TOTAL EMPLOYMENT	23,144	25,139				31,200	33,100	35,100	41,400	55,800
EMPLOYMENT/POPULATION RATIO	.39	.40				.40	.39	.39	.40	.41
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	116,814	126,838	207,277	224,549	270,500	332,200	406,900	498,400	788,100	1,877,300
TOTAL EARNINGS	93,291	98,245	153,350	165,395	193,400	232,200	284,700	349,200	549,700	1,295,800
AGRICULTURE, FORESTRY & FISHERIES	8,924	9,255	8,503	13,472	8,700	8,300	8,300	8,300	9,900	17,400
AGRICULTURE	8,894	9,237	8,494	13,464	8,700	8,300	8,300	8,300	9,900	17,300
FORESTRY & FISHERIES	30	18	9	9	(S)	(S)	(S)	(S)	(S)	(S)
MINING	3,261	2,099	2,833	2,138	2,600	2,800	2,900	2,900	3,100	3,500
CRUDE PETROLEUM & NATURAL GAS	3,053	2,099	2,820	2,119	2,600	2,800	2,800	2,900	3,100	3,500
NONMETALLIC, EXCEPT FUELS	208		13	19						
CONTRACT CONSTRUCTION	10,936	5,778	7,354	6,202	8,700	10,400	13,000	16,200	26,300	65,400
MANUFACTURING	6,460	9,727	16,741	19,426	21,200	25,400	30,400	36,500	55,900	125,800
FOOD & KINDRED PRODUCTS	2,189	4,264	4,887	4,544	4,700	4,900	5,400	6,000	7,800	13,200
TEXTILE MILL PRODUCTS	(D)	(D)	101	112	(S)	(S)	(S)	(S)	(S)	(S)
APPAREL & OTHER FABRIC PRODUCTS	15	14	923	1,334	1,200	1,500	1,800	2,200	3,100	6,600
LUMBER PRODUCTS & FURNITURE	83	141	1,090	1,081	1,400	1,700	2,100	2,500	3,700	7,800
PAPER & ALLIED PRODUCTS		12		4						
PRINTING & PUBLISHING	1,086	1,542	2,536	2,876	3,100	3,500	4,100	4,900	7,400	16,600
CHEMICALS & ALLIED PRODUCTS	(D)	(D)	22	25	(S)	(S)	(S)	(S)	(S)	(S)
PRIMARY METALS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
FABRICATED METALS & ORDNANCE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
ELECTRICAL MACHINERY & SUPPLIES				14						
TOTAL MACHINERY (1950 ONLY)	88									
MOTOR VEHICLES & EQUIPMENT	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TRANS. EQUIP., EXCL. MTR. VEHS.			468	889	1,000	1,300	1,700	2,200	3,200	8,100
OTHER MANUFACTURING	959	2,081	4,359	6,132	6,400	8,500	10,700	13,600	22,900	58,400
TRANS., COMM. & PUBLIC UTILITIES	4,478	4,514	12,740	15,265	17,400	20,500	24,700	29,900	45,200	99,200
WHOLESALE & RETAIL TRADE	22,501	22,563	28,206	28,900	35,200	41,400	50,600	61,700	97,300	231,300
FINANCE, INSURANCE & REAL ESTATE	2,730	4,319	6,968	6,944	8,200	9,700	11,800	14,300	22,200	52,400
SERVICES	12,596	15,816	24,208	25,790	32,400	40,000	50,200	62,900	103,200	258,400
GOVERNMENT	21,405	24,175	45,798	47,258	58,200	73,300	92,300	116,100	186,200	442,000
CIVILIAN GOVERNMENT	8,915	12,663	23,634	26,705	36,000	49,000	64,300	84,300	144,700	372,000
ARMED FORCES	12,490	11,512	22,164	20,553	21,900	24,300	27,800	31,800	41,500	70,000

See page C-62 for table notes

SMSA - SAN ANTONIO, TEX.
(BEA CODE NUMBER - 475)

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED, SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	530,271	703,108	840,723	868,433	903,300	945,500	1,000,000	1,057,500	1,168,300	1,415,100
PER CAPITA INCOME (1967$)*	1,807	1,873	2,666	2,845	3,388	3,970	4,574	5,270	7,138	12,727
PER CAPITA INCOME RELATIVE (US=1.00)	.88	.77	.81	.82	.83	.83	.84	.85	.87	.89
TOTAL EMPLOYMENT	199,961	257,787				354,700	374,300	395,000	447,400	552,200
EMPLOYMENT/POPULATION RATIO	.38	.37				.38	.37	.37	.38	.39
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	958,051	1,316,893	2,241,543	2,470,596	3,060,700	3,754,200	4,574,100	5,573,100	8,397,900	18,011,300
TOTAL EARNINGS	794,841	1,076,270	1,841,935	2,000,759	2,487,800	3,023,800	3,670,100	4,454,600	6,644,900	13,941,800
AGRICULTURE, FORESTRY & FISHERIES	16,163	6,815	12,705	15,054	13,700	12,800	13,700	14,700	18,600	34,900
AGRICULTURE	16,154	6,815	12,704	15,053	13,700	12,800	13,700	14,700	18,600	34,900
FORESTRY & FISHERIES	10		1	1						
MINING	11,237	7,096	14,571	13,008	15,900	18,700	20,200	21,900	26,200	35,100
METAL			3	3	(S)	(S)	(S)	(S)	(S)	(S)
COAL			3	9						
CRUDE PETROLEUM & NATURAL GAS	10,291	6,045	12,235	11,194	12,600	15,000	16,100	17,300	20,100	25,900
NONMETALLIC, EXCEPT FUELS	945	1,051	2,332	1,803	3,300	3,600	4,000	4,500	6,000	10,000
CONTRACT CONSTRUCTION	56,277	59,622	107,217	93,001	125,300	149,200	182,900	224,300	341,600	7[illegible],000
MANUFACTURING	65,116	100,355	173,687	203,337	243,400	293,000	352,300	423,600	629,200	1,357,800
FOOD & KINDRED PRODUCTS	24,007	36,539	53,834	55,964	62,100	69,800	77,500	86,100	108,200	167,000
TEXTILE MILL PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
APPAREL & OTHER FABRIC PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
LUMBER PRODUCTS & FURNITURE	3,601	4,137	6,847	7,720	9,200	10,700	12,300	14,200	19,500	36,600
PAPER & ALLIED PRODUCTS	378	482	2,376	2,643	3,500	4,600	5,800	7,400	11,900	30,200
PRINTING & PUBLISHING	9,160	13,198	16,022	18,108	21,900	26,200	32,000	39,100	59,000	127,800
CHEMICALS & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PETROLEUM REFINING	589	1,320	1,734	3,341	2,800	3,300	3,800	4,300	5,900	10,600
PRIMARY METALS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
FABRICATED METALS & ORDNANCE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	12,636	15,113	18,600	22,300	26,800	32,000	47,600	100,400
ELECTRICAL MACHINERY & SUPPLIES		769	3,694	6,173	6,200	8,100	10,400	13,400	21,800	55,200
TOTAL MACHINERY (1950 ONLY)	3,400									
MOTOR VEHICLES & EQUIPMENT	524	1,023	2,135	3,411	3,300	3,400	4,100	4,800	6,600	12,700
TRANS. EQUIP., EXCL. MTR. VEHS.	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
OTHER MANUFACTURING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TRANS., COMM. & PUBLIC UTILITIES	56,125	60,113	77,791	83,656	99,400	116,300	139,900	168,400	248,900	519,700
WHOLESALE & RETAIL TRADE	165,324	214,865	325,294	329,716	425,000	528,100	646,200	790,700	1,203,500	2,617,000
FINANCE, INSURANCE & REAL ESTATE	37,615	66,153	109,966	116,334	143,700	174,700	211,000	254,800	377,600	788,000
SERVICES	91,860	136,242	245,722	270,748	352,500	452,900	572,300	723,200	1,157,900	2,707,200
GOVERNMENT	295,122	425,006	774,983	875,705	1,067,000	1,277,700	1,530,200	1,832,700	2,641,000	5,137,700
CIVILIAN GOVERNMENT	123,794	231,405	433,997	491,971	610,700	783,400	967,300	1,194,400	1,815,400	3,761,800
ARMED FORCES	171,329	193,602	340,986	383,735	452,200	494,300	561,700	638,300	825,600	1,375,900

See page C-62 for table notes

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	71,059	71,711	81,705	83,651	92,600	101,700	111,800	122,900	145,400	202,300
PER CAPITA INCOME (1967$)*	1,619	1,981	2,807	3,116	3,682	4,278	4,899	5,611	7,667	13,549
PER CAPITA INCOME RELATIVE (US=1.00)	.78	.81	.85	.90	.90	.90	.90	.91	.92	.95
TOTAL EMPLOYMENT	26,803	27,198				44,700	48,600	52,900	63,700	88,100
EMPLOYMENT/POPULATION RATIO	.38	.38				.44	.44	.43	.44	.44
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	115,020	142,064	229,319	260,644	340,900	435,100	547,800	689,800	1,115,300	2,741,100
TOTAL EARNINGS	91,526	112,987	175,610	199,034	257,800	323,600	404,900	506,700	808,100	1,939,700
AGRICULTURE, FORESTRY & FISHERIES	9,573	4,350	3,527	4,042	3,300	3,400	3,400	3,400	4,000	7,100
AGRICULTURE	9,509	4,350	3,527	4,042	3,300	3,400	3,400	3,400	4,000	7,100
FORESTRY & FISHERIES	63									
MINING	905	3,232	2,149	2,564	2,100	2,300	2,400	2,400	2,500	2,800
CRUDE PETROLEUM & NATURAL GAS	628	2,917	1,958	2,460	1,800	2,000	2,000	2,000	2,000	2,000
NONMETALLIC, EXCEPT FUELS	277	315	191	124	(S)	(S)	(S)	(S)	(S)	(S)
CONTRACT CONSTRUCTION	4,722	6,765	7,913	10,994	13,100	16,900	20,900	25,500	40,300	93,100
MANUFACTURING	11,973	22,568	48,294	64,358	80,200	92,500	117,600	149,500	245,300	619,700
FOOD & KINDRED PRODUCTS	5,694	8,105	10,951	12,839	14,300	17,500	20,700	24,600	34,900	66,700
TEXTILE MILL PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
APPAREL & OTHER FABRIC PRODUCTS	1,220	2,169	4,423	4,805	5,700	6,700	7,900	9,300	12,800	23,800
LUMBER PRODUCTS & FURNITURE	755	158	1,151	1,077	1,200	1,400	1,700	1,900	2,600	4,900
PAPER & ALLIED PRODUCTS	149	1,843	2,810	3,138	4,100	5,200	6,500	8,000	12,700	29,400
PRINTING & PUBLISHING	500	1,252	1,411	1,521	1,800	2,200	2,600	3,200	4,700	9,900
CHEMICALS & ALLIED PRODUCTS	(D)	(D)	3	50	(S)	(S)	(S)	(S)	(S)	(S)
PRIMARY METALS	(D)	(D)	1,076	736	1,700	1,900	2,300	2,800	4,100	8,200
FABRICATED METALS & ORDNANCE	(D)	(D)	901	1,145	1,300	2,000	2,600	3,400	5,800	15,100
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	2,476	3,327	3,700	4,100	5,000	6,000	8,600	18,800
ELECTRICAL MACHINERY & SUPPLIES	(D)	(D)	9,267	19,609	24,200	24,000	33,300	46,100	86,000	258,100
TOTAL MACHINERY (1950 ONLY)	1,401									
MOTOR VEHICLES & EQUIPMENT	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TRANS. EQUIP., EXCL. MTR. VEHS.	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
OTHER MANUFACTURING	68	1,027	8,632	10,461	14,300	19,500	25,700	33,900	58,900	160,000
TRANS., COMM. & PUBLIC UTILITIES	13,607	10,599	12,686	13,294	16,600	21,200	25,800	31,500	47,600	104,400
WHOLESALE & RETAIL TRADE	16,619	18,431	24,265	25,603	34,900	45,700	56,000	68,600	105,400	236,100
FINANCE, INSURANCE & REAL ESTATE	2,160	3,605	6,328	6,073	8,200	10,100	12,200	14,800	22,300	48,100
SERVICES	10,636	14,717	23,778	27,130	36,800	50,600	65,600	85,100	144,000	375,300
GOVERNMENT	21,329	28,721	46,470	44,956	61,400	80,400	100,400	125,300	196,300	451,400
CIVILIAN GOVERNMENT	8,955	14,342	26,636	29,908	39,400	52,700	67,800	87,300	144,700	359,300
ARMED FORCES	12,374	14,379	19,835	15,049	21,900	27,700	32,400	38,000	51,600	92,100

See page C-62 for table notes

SMSA - TEXARKANA, TEX.-ARK.
(BEA CODE NUMBER - 502)

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	95,075	90,026	95,235	101,592	111,700	124,200	136,400	149,700	174,200	237,100
PER CAPITA INCOME (1967$)*	1,341	1,641	3,334	3,117	3,946	4,587	5,202	5,901	8,039	14,024
PER CAPITA INCOME RELATIVE (US=1.00)	.65	.67	1.01	.90	.96	.96	.96	.96	.97	.98
TOTAL EMPLOYMENT	32,539	30,397				52,500	57,500	62,900	76,700	108,300
EMPLOYMENT/POPULATION RATIO	.34	.34				.42	.42	.42	.44	.46
					IN THOUSANDS OF 1967 $					
TOTAL PERSONAL INCOME *	127,472	147,757	317,493	316,644	441,100	569,900	709,700	883,700	1,400,600	3,325,100
TOTAL EARNINGS	102,052	119,588	253,054	242,217	345,800	439,800	547,400	681,200	1,076,600	2,541,000
AGRICULTURE, FORESTRY & FISHERIES	7,331	5,759	6,015	8,003	7,300	7,900	8,400	8,900	10,500	14,500
AGRICULTURE	7,109	5,616	5,964	7,947	7,300	7,900	8,400	8,800	10,500	14,400
FORESTRY & FISHERIES	222	143	51	57	(S)	(S)	(S)	(S)	(S)	(S)
MINING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CRUDE PETROLEUM & NATURAL GAS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
NONMETALLIC, EXCEPT FUELS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CONTRACT CONSTRUCTION	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
MANUFACTURING	10,962	15,944	87,749	63,236	113,500	142,600	179,700	226,400	367,100	915,500
FOOD & KINDRED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
APPAREL & OTHER FABRIC PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
LUMBER PRODUCTS & FURNITURE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PAPER & ALLIED PRODUCTS			509	893	1,200	1,900	2,300	2,800	4,300	9,800
PRINTING & PUBLISHING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CHEMICALS & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PETROLEUM REFINING	(D)	(D)	188	224	(S)	(S)	(S)	(S)	(S)	(S)
PRIMARY METALS				4	(S)	(S)	(S)	(S)	(S)	(S)
FABRICATED METALS & ORDNANCE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TOTAL MACHINERY (1950 ONLY)	50									
MOTOR VEHICLES & EQUIPMENT	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TRANS. EQUIP., EXCL. MTR. VEHS.	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
OTHER MANUFACTURING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TRANS., COMM. & PUBLIC UTILITIES	9,926	10,792	17,010	17,179	21,200	25,700	30,300	35,700	51,000	101,600
WHOLESALE & RETAIL TRADE	20,853	24,843	35,447	37,000	50,300	65,200	81,600	102,000	163,800	399,300
FINANCE, INSURANCE & REAL ESTATE	3,288	5,410	8,021	7,256	10,500	13,600	17,000	21,100	33,700	81,800
SERVICES	11,957	15,770	27,265	29,686	41,600	56,300	73,000	94,600	160,400	422,200
GOVERNMENT	32,391	32,438	61,916	67,913	86,000	109,800	133,700	162,900	242,500	486,100
CIVILIAN GOVERNMENT	30,542	31,098	59,066	64,302	82,300	105,300	128,500	156,700	234,100	471,100
ARMED FORCES	1,849	1,339	2,850	3,609	3,600	4,500	5,200	6,100	8,400	15,000

See page C-62 for table notes

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED,
SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	75,329	84,775	92,922	97,593	105,700	115,300	126,300	138,200	162,300	221,400
PER CAPITA INCOME (1967$)*	1,732	2,050	3,021	3,195	3,794	4,474	5,074	5,754	7,667	13,096
PER CAPITA INCOME RELATIVE (US=1.00)	.84	.84	.91	.92	.92	.94	.94	.93	.92	.92
TOTAL EMPLOYMENT	28,162	32,102				49,400	53,300	57,500	68,100	91,900
EMPLOYMENT/POPULATION RATIO	.37	.38				.43	.42	.42	.42	.42
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	130,502	173,814	280,691	311,612	401,300	516,000	640,800	795,600	1,244,600	2,900,300
TOTAL EARNINGS	105,992	138,141	214,968	237,531	304,000	386,600	480,300	596,700	935,700	2,184,300
AGRICULTURE, FORESTRY & FISHERIES	9,402	5,500	1,974	2,491	2,200	2,400	2,600	3,000	3,500	6,200
AGRICULTURE	9,363	5,460	1,965	2,482	2,200	2,300	2,600	3,000	3,500	6,200
FORESTRY & FISHERIES	39	40	9	9	(S)	(S)	(S)	(S)	(S)	(S)
MINING	15,494	7,330	11,242	9,859	10,000	11,000	11,100	11,200	11,700	12,500
CRUDE PETROLEUM & NATURAL GAS	15,494	7,330	11,236	9,716	10,000	11,000	11,100	11,200	11,700	12,500
NONMETALLIC, EXCEPT FUELS			6	143	(S)	(S)	(S)	(S)	(S)	(S)
CONTRACT CONSTRUCTION	7,811	8,324	10,560	11,545	14,900	18,900	23,600	29,500	46,500	108,900
MANUFACTURING	16,440	33,047	63,828	75,523	88,900	106,000	127,500	153,400	226,100	473,700
FOOD & KINDRED PRODUCTS	1,913	3,729	3,914	4,087	4,600	5,200	5,700	6,300	7,800	12,100
APPAREL & OTHER FABRIC PRODUCTS	538	1,165	2,385	2,435	2,600	3,000	3,400	3,900	5,100	3,600
LUMBER PRODUCTS & FURNITURE	955	2,233	2,571	3,410	3,900	4,400	5,300	6,300	9,200	18,700
PAPER & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PRINTING & PUBLISHING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CHEMICALS & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PETROLEUM REFINING	(D)	(D)	2,668	3,151	3,400	4,100	4,900	5,800	8,400	16,800
PRIMARY METALS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
FABRICATED METALS & ORDNANCE	3,667	2,916	3,669	4,822	5,400	6,500	7,700	9,200	13,400	28,100
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	8,087	13,255	12,500	13,500	16,600	20,300	31,000	69,800
ELECTRICAL MACHINERY & SUPPLIES	(D)	(D)	1,846	35	(S)	(S)	(S)	(S)	(S)	(S)
TOTAL MACHINERY (1950 ONLY)	30									
MOTOR VEHICLES & EQUIPMENT				133	(S)	(S)	(S)	(S)	(S)	(S)
TRANS. EQUIP., EXCL. MTR. VEHS.	192	18	6	1,574	(S)	(S)	(S)	(S)	(S)	(S)
OTHER MANUFACTURING	2,572	2,763	11,420	16,383	18,600	21,300	25,800	31,200	47,100	102,500
TRANS., COMM. & PUBLIC UTILITIES	9,515	11,522	15,629	16,261	20,900	25,500	30,800	37,200	55,600	120,600
WHOLESALE & RETAIL TRADE	20,930	27,922	36,568	40,467	52,000	67,200	83,400	103,600	162,700	381,300
FINANCE, INSURANCE & REAL ESTATE	3,283	6,497	11,779	11,378	15,700	20,700	25,900	32,500	51,600	123,500
SERVICES	13,918	22,438	35,129	38,328	54,100	73,600	95,200	123,100	205,900	528,600
GOVERNMENT	9,199	15,559	28,260	31,678	44,100	61,000	79,300	103,000	171,700	428,400
CIVILIAN GOVERNMENT	8,585	14,285	26,844	30,155	42,300	59,000	76,900	100,200	168,000	421,900
ARMED FORCES	614	1,274	1,416	1,523	1,700	2,000	2,300	2,700	3,600	6,400

See page C-62 for table notes

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED, SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	131,288	147,354	152,370	148,308	159,900	168,200	181,500	195,800	223,700	291,600
PER CAPITA INCOME (1967$)*	1,703	2,051	2,871	3,069	3,660	4,382	5,005	5,717	7,661	13,296
PER CAPITA INCOME RELATIVE (US=1.00)	.82	.84	.87	.89	.89	.92	.92	.93	.92	.93
TOTAL EMPLOYMENT	48,335	56,358				74,000	78,400	83,100	94,700	120,700
EMPLOYMENT/POPULATION RATIO	.37	.38				.44	.43	.42	.42	.41
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	223,641	302,259	437,481	455,119	585,200	737,300	908,500	1,119,500	1,714,400	3,878,200
TOTAL EARNINGS	184,167	242,169	336,859	344,833	449,600	568,900	702,100	866,600	1,336,400	3,055,600
AGRICULTURE, FORESTRY & FISHERIES	14,542	7,373	8,905	8,264	6,900	7,600	8,300	9,200	10,900	19,000
AGRICULTURE	14,498	7,315	8,887	8,245	6,900	7,600	8,300	9,100	10,800	19,000
FORESTRY & FISHERIES	44	59	17	19	(S)	(S)	(S)	(S)	(S)	(S)
MINING	805	880	703	698	800	1,000	1,100	1,100	1,400	2,000
CRUDE PETROLEUM & NATURAL GAS	18	96	89	50	(S)	(S)	(S)	(S)	(S)	(S)
NONMETALLIC, EXCEPT FUELS	787	784	615	648	700	900	1,000	1,100	1,300	2,000
CONTRACT CONSTRUCTION	12,797	15,920	18,862	18,470	25,000	31,500	39,400	49,300	77,400	181,600
MANUFACTURING	32,656	49,028	88,849	81,682	119,200	149,000	182,400	223,300	342,500	784,600
FOOD & KINDRED PRODUCTS	4,906	6,105	7,899	8,050	9,400	10,600	11,800	13,100	16,400	26,400
TEXTILE MILL PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
APPAREL & OTHER FABRIC PRODUCTS	3,491	3,574	7,124	7,171	9,600	11,700	13,800	16,200	23,100	45,300
LUMBER PRODUCTS & FURNITURE	9,530	6,626	9,156	7,446	11,300	13,200	15,200	17,400	23,600	43,500
PAPER & ALLIED PRODUCTS	(D)	(D)	2,915	2,768	4,300	5,500	7,100	9,000	14,700	37,300
PRINTING & PUBLISHING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CHEMICALS & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PETROLEUM REFINING	(D)	(D)	53	59	(S)	(S)	(S)	(S)	(S)	(S)
PRIMARY METALS				19						
FABRICATED METALS & ORDNANCE	2,393	1,487	9,958	3,800	14,500	18,900	24,300	31,200	52,300	136,100
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
ELECTRICAL MACHINERY & SUPPLIES	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TOTAL MACHINERY (1950 ONLY)	1,056									
MOTOR VEHICLES & EQUIPMENT	50	73	1,462	1,521	(S)	(S)	(S)	(S)	(S)	(S)
TRANS. EQUIP., EXCL. MTR. VEHS.		4,929	14,904	15,921	22,200	30,800	38,200	47,300	74,000	172,600
OTHER MANUFACTURING	8,463	20,287	23,848	26,028	33,800	42,700	52,900	65,600	103,100	243,500
TRANS., COMM. & PUBLIC UTILITIES	16,979	18,777	20,124	21,539	24,600	29,100	34,700	41,500	60,600	129,500
WHOLESALE & RETAIL TRADE	43,669	48,179	57,634	62,150	78,200	99,700	122,800	151,400	233,400	534,100
FINANCE, INSURANCE & REAL ESTATE	8,686	14,403	20,132	19,491	25,800	31,900	39,100	47,900	73,000	164,700
SERVICES	21,896	32,361	52,652	59,720	77,900	101,900	130,800	167,900	275,100	685,100
GOVERNMENT	32,137	55,247	68,998	72,817	90,600	116,900	142,800	174,600	261,600	554,500
CIVILIAN GOVERNMENT	20,934	33,305	61,502	70,021	84,800	107,300	132,200	162,800	247,000	531,400
ARMED FORCES	11,203	21,943	7,496	2,796	5,400	9,500	10,500	11,700	14,600	23,000

See page C-62 for table notes

SMSA - WICHITA FALLS, TEX.
(BEA CODE NUMBER - 519)

POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED, SELECTED YEARS, 1950 - 2020

	1950	1959	1968	1970	1975	1980	1985	1990	2000	2020
POPULATION, MIDYEAR	106,194	127,275	126,962	128,273	129,100	130,200	134,100	138,100	147,400	170,600
PER CAPITA INCOME (1967$)*	2,536	2,180	3,376	3,503	4,147	4,749	5,427	6,202	8,295	14,290
PER CAPITA INCOME RELATIVE (US=1.00)	1.23	.89	1.02	1.01	1.01	1.00	1.00	1.01	1.00	1.00
TOTAL EMPLOYMENT	48,141	52,560				59,300	60,800	62,300	67,000	76,500
EMPLOYMENT/POPULATION RATIO	.45	.41				.46	.45	.45	.45	.45
IN THOUSANDS OF 1967 $										
TOTAL PERSONAL INCOME *	269,352	277,445	428,678	449,294	535,300	618,600	728,000	856,800	1,223,300	2,438,400
TOTAL EARNINGS	233,325	221,318	330,015	340,037	408,400	469,000	553,600	653,400	932,600	1,852,800
AGRICULTURE, FORESTRY & FISHERIES	11,834	4,396	5,918	7,069	4,800	3,900	3,700	3,600	4,300	7,500
AGRICULTURE	11,803	4,313	5,876	7,022	4,700	3,800	3,700	3,500	4,200	7,400
FORESTRY & FISHERIES	30	83	42	48	(S)	(S)	(S)	(S)	(S)	(S)
MINING	34,533	18,105	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CRUDE PETROLEUM & NATURAL GAS	34,347	17,971	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
NONMETALLIC, EXCEPT FUELS	186	134	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CONTRACT CONSTRUCTION	8,313	12,165	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
MANUFACTURING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
FOOD & KINDRED PRODUCTS	3,602	5,499	3,788	2,719	3,900	4,300	4,800	5,200	6,500	10,300
APPAREL & OTHER FABRIC PRODUCTS	(D)	(D)	2,512	2,777	3,000	3,700	4,200	4,900	6,600	11,700
LUMBER PRODUCTS & FURNITURE	(D)	(D)	912	959	1,200	1,600	2,000	2,500	3,900	9,300
PRINTING & PUBLISHING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CHEMICALS & ALLIED PRODUCTS	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PETROLEUM REFINING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
PRIMARY METALS	500	733	1,399	1,350	1,500	1,700	1,800	2,000	2,400	3,500
FABRICATED METALS & ORDNANCE	3,112	1,918	2,801	1,727	2,900	4,100	4,800	5,700	7,900	15,000
MACHINERY, EXCLUDING ELECTRICAL	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
ELECTRICAL MACHINERY & SUPPLIES	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TOTAL MACHINERY (1950 ONLY)	3,458									
MOTOR VEHICLES & EQUIPMENT			23	166						
TRANS. EQUIP., EXCL. MTR. VEHS.	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
OTHER MANUFACTURING	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TRANS., COMM. & PUBLIC UTILITIES	18,554	18,054	18,066	17,716	20,500	23,200	26,700	30,600	42,100	80,100
WHOLESALE & RETAIL TRADE	34,871	42,514	55,086	58,041	66,600	77,300	92,100	109,700	160,600	334,900
FINANCE, INSURANCE & REAL ESTATE	(D)	(D)	14,218	13,092	16,600	20,100	23,800	28,200	40,900	84,400
SERVICES	20,807	29,130	43,015	46,098	57,300	69,800	85,200	104,000	157,600	343,200
GOVERNMENT	84,110	69,209	139,740	147,609	182,200	206,000	245,100	291,600	415,400	806,500
CIVILIAN GOVERNMENT	13,739	28,669	53,779	60,954	75,900	97,300	121,000	150,500	232,100	498,300
ARMED FORCES	70,371	40,541	85,961	86,655	105,000	108,700	123,800	141,000	183,300	308,200

See page C-62 for table notes

TABLE NOTES

Data may not add to higher level totals due to rounding.

(D) Deleted to avoid disclosure of data pertaining to an individual establishment.

(S) Too small to project.

(*) Total and per capita income are expressed on a residence basis (income of residents of the area). Earnings are on a where-earned basis.