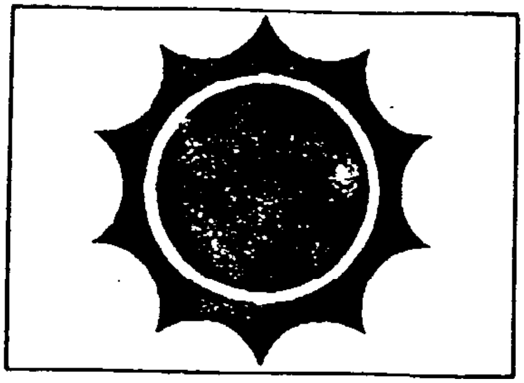

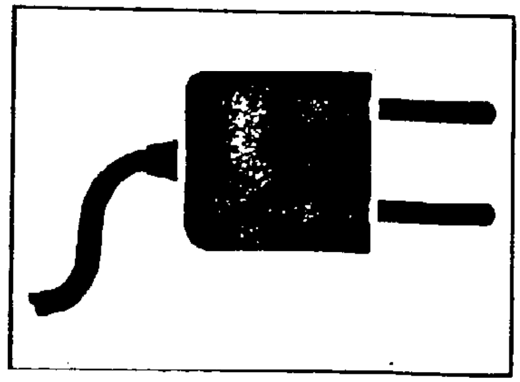

# Staff Guidelines on Photovoltaics

# Versus

# Line Extensions

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pvguide

## Introduction

In remote locations, the cost of extending a power line to provide electric service may not be the most economical option. Stand-alone photovoltaic systems may be economical for residential uses, water pumping, lighting signs, and powering beacons, hydrological measuring stations, microwave repeaters, meters, and other facilities.

This report provides the Commission Staff's guidelines on whether a line extension or stand-alone photovoltaic system is likely to be less expensive in providing electricity to remotely located customers. The guidelines will be updated as additional information on line extension costs and photovoltaic system costs change.

The guidelines are derived from Staff analyses of line extension costs and photovoltaic system costs in Arizona.[1] More detail may be obtained on the derivation of the guidelines by referring to the paper cited in the end notes. The costs are life cycle costs, including capital costs and operating and maintenance costs of photovoltaic systems and line extension costs plus electricity costs for grid power.

## Use of the Guidelines

A utility is expected to use the guidelines to determine whether it is likely that photovoltaics might be cheaper (over a 30 year life cycle) than a line extension to a remotely located customer.

The guidelines consist of three graphs (Figures A, B, and C) which indicate whether a line extension or photovoltaic system is likely to be cheaper over a 30 year period. Figure A pertains to overhead single phase line extensions, Figure B pertains to single phase underground line extensions, and Figure C pertains to three phase underground line extensions. There were insufficient data on the costs of three phase overhead line extensions to develop a graph. In many applications where photovoltaics is likely to be useful, single phase service is most likely.

The horizontal axis of the graphs shows the distance (in feet) of the contemplated line extension.

The vertical axis shows average daily watt-hours of energy used *by a stand-alone customer*. In many uses, the energy required by a customer would be the same whether he or she was connected to the grid or was obtaining power from a stand-alone facility. For example, the energy required to light signs or pump water may be the same in either case. However, for residential uses, stand-alone customers typically manage their demand for electricity so that average daily energy use would be only 10 to 20 percent of what it might be if the household were taking power from a line extension. Demand management can be accomplished in several ways: households can use energy efficient refrigerators, lights, and other appliances; households may substitute other fuels for electricity for some uses, such as heating water, cooking, and even refrigeration; and households may do without some appliances like hair dryers.

The ratio of average daily watt-hours of energy use for a stand-alone user to average daily watt-hours of energy use for a grid-connected user is the "frugality factor," f. For example, if the end user is a household, the value of f might be 0.1 to 0.2, indicating that a stand-alone customer would use only 10 to 20 percent of the energy that a grid-connected customer might. If the end user is a ranch wishing to pump water, f might be around 1.0. To determine a reasonable value of f, it is necessary to obtain information about the end user's needs and expectations for energy use.

The frugality factor, f, affects which line should be used in each of the graphs. If you are dealing with a residential situation, use f = 0.1 or f = 0.2; if you are dealing with most other typical situations, use f = 1.0.

The sloping lines in each graph separate combinations of average daily watt-hours of energy use by stand-alone users and line extension distances into two parts: *above the lines, a line extension is likely to be cheaper over the long run; below the lines a photovoltaic (PV) system is likely to be cheaper over the long run.*

To use the graphs, you should estimate the distance of the line extension which would be needed (in feet) and the average daily watt-hours of energy use by a stand-alone user. You then plot on the graph the point representing the distance of the line extension and stand-alone energy use. If the point falls above the appropriate line (each line representing a different frugality factor), the line extension may be cheaper. If the point falls below the appropriate line, a stand-alone photovoltaic system may be cheaper.

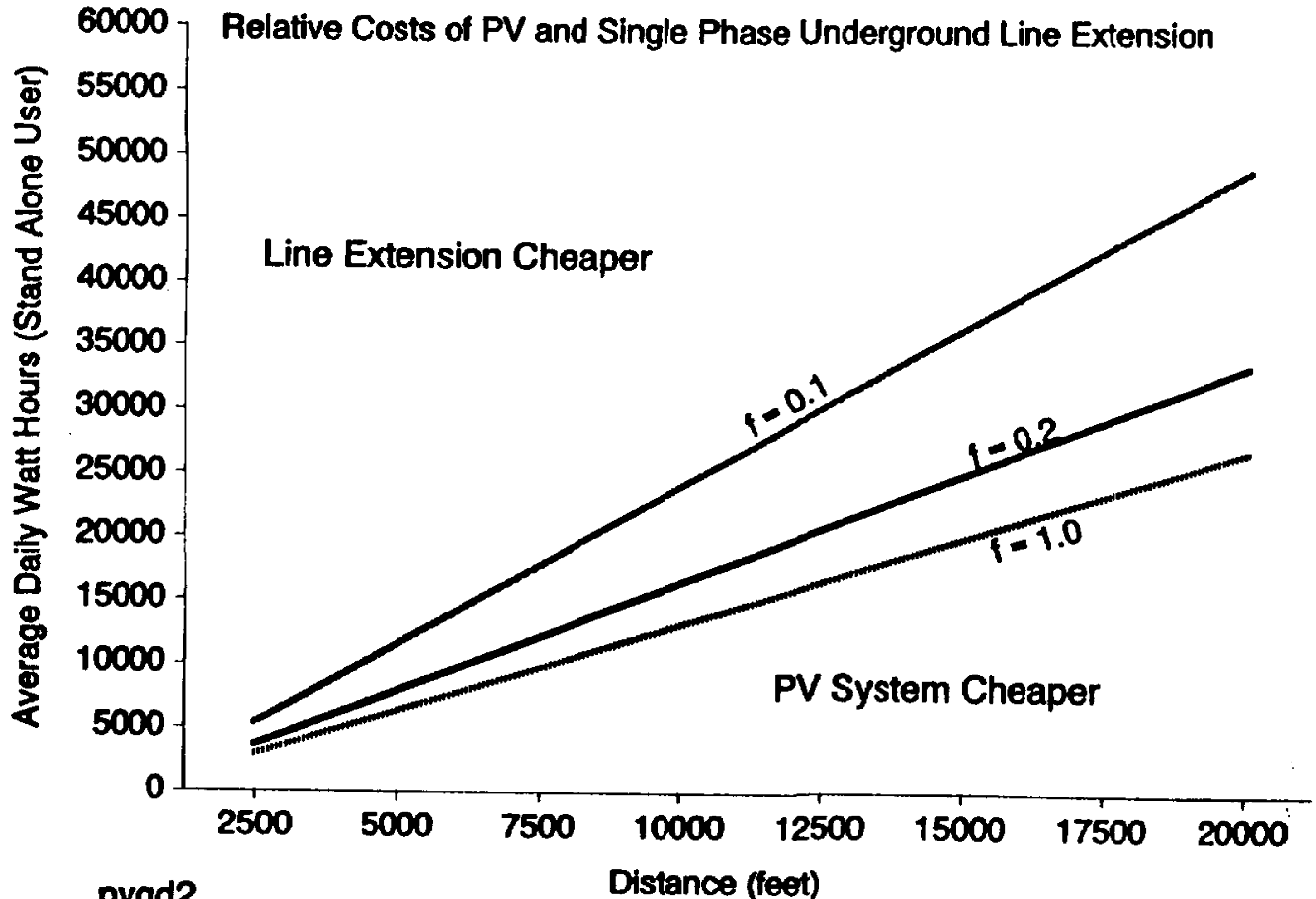
## Informing the End User

If the circumstances at a particular site indicate that a photovoltaic system might be less costly, utilities are required to provide a brochure to the customer explaining the advantages and disadvantages of a stand-alone photovoltaic system versus a line extension. The brochure also provides the customer with sufficient information to assess price quotes for photovoltaic systems. The brochure will be available in the spring or summer of 1993.

## Examples for Using Graphs

**Example 1:** Suppose a rancher needs to install a small water pump using 2000 watt-hours of energy a day. Typically, a water pumping application would have a frugality factor, f, of 1.0 indicating that the pump would require the same amount of energy regardless of the source of energy (PV or grid). Single phase service would be required. The pump site is located 3 miles (about 16,000 feet) from the nearest power line and the power line extension would be overhead. Finding the intersection of 16,000 feet and 2000 watt-hours of energy

FIGURE B

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per day on Figure A (for single phase overhead lines), you observe that the end use will fall below the line for f = 1.0, indicating that a stand-alone photovoltaic system would be cheaper. This consumer would be a good candidate for a PV system and should be provided with information on PV systems.

Example 2: Suppose a household desires to have electric service. After consulting with the homeowner you determine that the household could consume 3000 average daily watt-hours of energy as a stand-alone PV user who is willing to install conservation measures, use propane where possible, and do without some appliances.

Based upon residential usage by similar households in the utility's service area, you conclude that the appropriate frugality factor is between 0.1 and 0.2. The house is located one mile from the nearest power line and would be served by a single phase overhead line. Referring to Figure A, you plot the intersection of 3000 average daily watt-hours and 5280 feet and find that a line extension is likely to be cheaper for a user with a frugality factor of 0.1 or 0.2.

## Reference

1. David Berry and Robert Gray, "Photovoltaics Versus Line Extensions: Creating Informed Consumer Choices," Arizona Corporation Commission, September 1992. This paper is a revision of materials presented at a workshop in July 1992 on photovoltaics versus line extensions.

FIGURE A

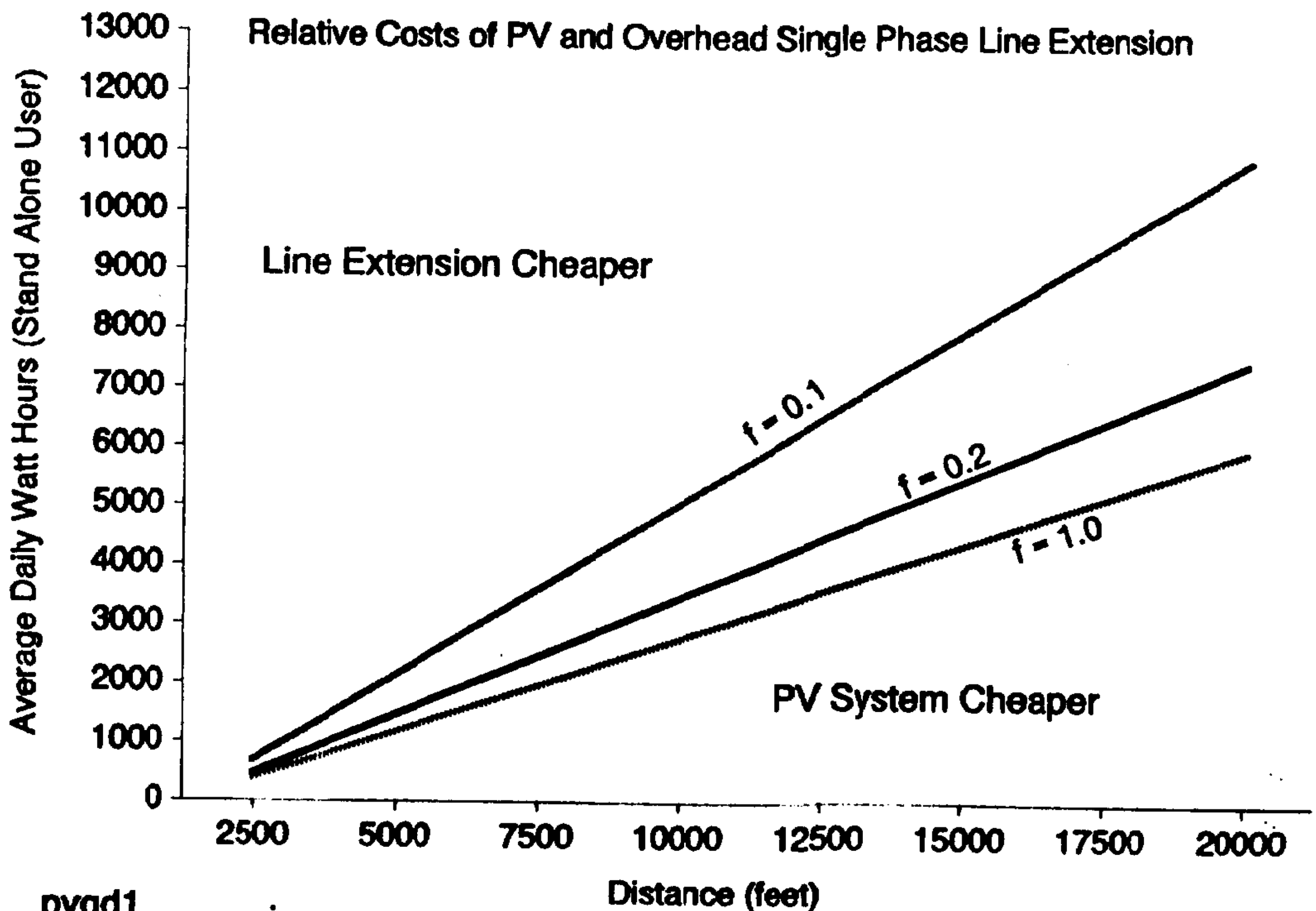


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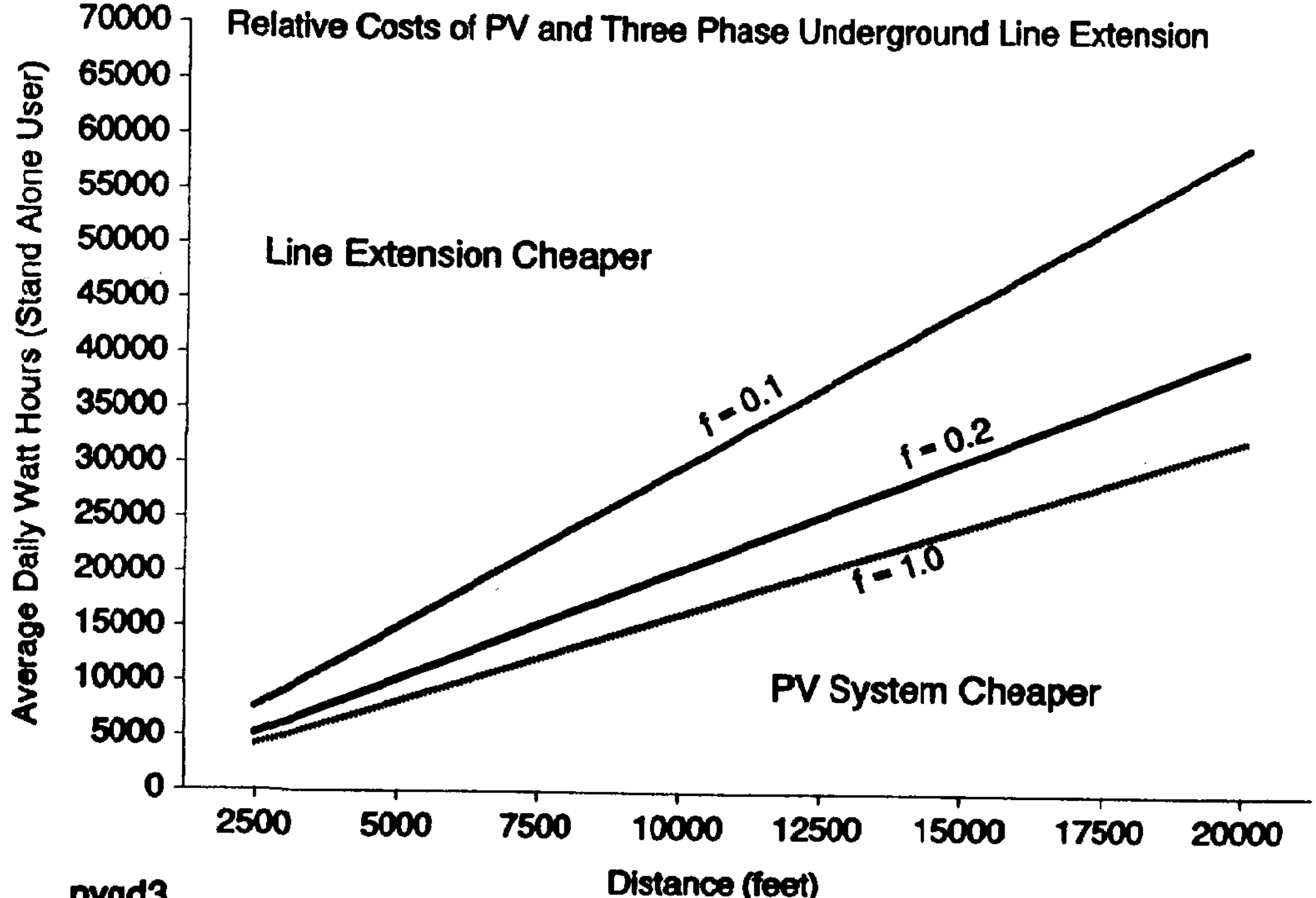
FIGURE C

Relative Costs of PV and Three Phase Underground Line Extension

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