VERDIGRE SHARED ENERGY SAVINGS PROGRAM

APPENDIX J

August 31, 1989

TO: John Osterman

FR: Kirk Conger

RE: Verdigre Shared Energy Savings Project Analysis

Attached is a summary sheet of my review of the businesses in the Verdigre project. The attached page explains the source and physical meaning of each of the columns on the spreadsheet.

Raw Data. The raw data for fuel consumption is taken from reports by the businesses themselves, while estimated savings are taken from the energy audits. The project costs are the actual costs, taken from contractor bids.

Actual time periods during which consumption data was reported vary depending on the timing of the project(s) in a particular building. Several businesses did two different projects at different times. In those cases, the "before" consumption data is before the first project was begun and the "after" data is after the second project was completed.

Adjustments. There were an amazing number of businesses which changed size during the period of this analysis. Most reduced the amount of space they used, but a few increased. This seems to be the largest extraneous factor, and is the only one for which correction was attempted. The adjustment factor changes the "after" consumption and cost in proportion to the change in floor area, a questionable but readily available correction. In four cases, the data was considered so unreliable that the buildings were removed from further analysis. This was done by setting the adjustment factor to zero.

The heating degree days during these years did not vary appreciably from normal, so no correction was made for weather differences.

Unit prices for all fuels decreased slightly during the period covered by this analysis. It was decided to base cost savings analysis on the actual costs being paid by the businesses, so no correction was made for this change.

Cost Savings. An adjusted cost savings of $7374/year was realized during this time period. It is assumed that this was all due to the conservation measures installed and the change in occupant habits resulting from this program. This savings amounts to a 9% reduction in the annual cost paid for energy in this community. It is only 26% of the cost savings estimated by the energy auditor.

Payback. When project costs for the four businesses not used for this analysis are removed, a total of $169,131 was spent for energy conservation improvements in this program. The $7374 annual savings gives a simple payback of 22.9 years. This is considerably higher than the 5.1 year payback estimated by the energy auditor.

The 22.9 year payback looks excessive from an administrative/financial viewpoint, but there were capital improvements as well as energy-savings in the minds of the participating business owners. Comments on some of their response sheets indicate that they were satisfied with the program. The real problem of the disparity in paybacks is that people were not given the best information on which to base their decisions and it's possible that a few might feel that the audits falsely represented the proposed projects.

Energy Savings. Energy savings were tracked for four fuels used in these businesses. The fuel oil catagory includes two businesses which heat at least partially with waste oil, and one which used a small amount of kerosene. All savings totals are net because there was a considerable amount of fuel-switching which occurred under this program. Most of the switching was away from oil or wood to propane heat, as high-efficiency gas furnaces were installed, but one large business replaced its all-electric heating system with waste oil furnaces. Many of the businesses increased electric use. This was probably more due to changes in operating practices and increased use of electric appliances rather than a direct effect of this program.

Overall, there was a net annual reduction of 1042 MBtu among the participating businesses. The 10% savings for the group is consistent with the cost savings calculated, since the fuel mix changed over time. This is only 25% of the savings estimated by the energy auditor. The estimated numbers are unrealistic as can be seen by inspection of column 48. Several of the savings estimates are more than 100% of the "before" energy consumption, whereas a savings of 30-40% should be considered optimistic in most cases -- the exact number depending on the business and the projects proposed. Several of these high estimates are due to changes in building use which were known to the auditor at the time. The auditor then tried to estimate what the current consumption should have been, and based his savings on that.

Adjusted savings of the various fuels are:

fuel	savings	% saved
electricity	62,760 kWh	6.4
propane	-434 gallons	-0.9
fuel oil	1559 gallons	19.2
wood	23.3 cords	32.7

Analysis

Why did the businesses in Verdigre realize only a quarter of the estimated energy and cost savings? Some possible reasons are listed below.

1. The audit was idealized, based on average conditions which may not have been true in these businesses (eg. normal winter indoor temperature may have been 65F rather than the 70F assumed by degree day calculations).

2. The auditor was inexperienced, and may not have recognized when some assumptions were invalid or needed correction.

3. The audit did not account for interaction between different energy-savings projects, or the reduction in savings that results from interaction. This was a deficiency in the audit -- probably because the reduction is difficult to calculate. When this was analyzed a couple of years ago, it was found that interaction would reduce the typical estimate by about a third.

4. The program was set up to encourage weatherization improvements, so there was a motivation to show potential improvements in the best possible light.

5. Siege mentality. When this program was initiated, Verdigre was a village in deep financial trouble. People had more of a conservation mindset at the time, which may have since disappeared or become less acute. The accompanying change in personal habits can greatly influence energy consumption.

6. The biggest single factor in heating savings is the thermostat setting. Following from #5, general indoor temperatures may be higher, now that owners can afford it because their buildings are insulated. Certainly in the case of wood stove heat which was changed to forced air heat, the average indoor temperature will have increased, so energy use will go up even though the unit itself is more efficient.

7. Some businesses have reduced their floor area, but there's no guarantee that the part of the building they are still using is the best insulated or most efficiently heated. In the case of store-front businesses, they are probably using the part up front, next to the windows and door, and have discontinued use of back rooms which may have been minimally heated or ventilated.

8. Some of the ECMs may not have been appropriate to the building or business, or may have been installed incorrectly. There is no reason the suspect any particular installation, but in this number of buildings, there were probably a few incorrect installations. Also, owner dissatisfaction may have led to some of the measures being removed or short-circuited. One business owner reported disconnecting the automatic thermostat.

9. There is a lot of uncertainty in the consumption data due to the use of wood, propane and/or fuel oil. The fuel may have been delivered and charged in an entirely different month than when it was used. Lacking any better knowledge of schedules, energy use was based on the month and year in which the charges occurred. Buildings with a large storage capacity might only take delivery of such fuels a couple of times each winter, and the timing of those deliveries could seriously skew the results. For example, a building might receive a large delivery of fuel soon after completing the energy savings projects. The use would be charged against the "after" consumption even though the fuel was used before the project was installed. In a large sample of buildings, you could assume that the differences would balance out, but it is not certain that this occurred .

The above sounds like damage control for a failed program, but that is not the point at all. The 10% reduction in energy use and costs, across the board, is considered to be significant. Any real problems probably lie in the energy auditing rather than in the program itself, since it gave unrealistic expectations of energy savings.

APPENDIX. Spreadsheet columns: where they come from and what they mean.

col	source	meaning
2-9	raw data	consumption & cost for 12 months before project
10-17	raw data	consumption & cost for 12 months after project
18	3+5+7+9	annual energy costs before improvements
19	11+13+15+17	annual energy costs after improvements
20	18-19	difference in energy costs (raw)
21	20/18	percent change in energy costs (raw)
22	raw data	annual cost savings estimated by energy auditor
23	20/22	how much of estimated savings was realized (raw)
24	raw data	change in building size = area_before / area_after
25	18-(19*24)	savings proportional to original building size
26	25/18	percent change in energy costs (adjusted for size)
27	25/22	fraction of the estimated savings realized (adjusted)
28	raw data	actual cost of energy conservation projects
29	28/22	simple payback estimated by energy auditor
30	28/20	simple payback based on actual cost savings
31	28/25	simple payback based on adjusted cost savings
32-35	2,4,6,8	conversion of fuel units to MBtu for "before"
36	32+33+34+35	annual energy units consumed before improvements
37-40	10,12,14,16	conversion of fuel units to MBtu for "after"
41	37+38+39+40	annual energy units consumed after improvements
42	32-37	electric savings (raw)
43	33-38	propane savings (raw)
44	34-39	fuel oil savings (raw)
45	35-40	wood savings (raw)
46	42+43+44+45	net annual energy savings (raw)
47	46/36	percent savings in annual energy consumption (raw)
48	raw data	annual energy savings estimated by energy auditor
49	48/36	percent savings estimated by energy auditor
50	32-(37*24)	electric savings (adjusted for building size)
51	33-(38*24)	propane savings (adjusted)
52	34-(39*24)	fuel oil savings (adjusted)
53	35-(40*24)	wood savings (adjusted)
54	50+51+52+53	net annual energy savings (adjusted for building size)
55	54/36	percent net annual energy savings (adjusted)
56	54/48	fraction of the estimated energy savings realized

factors for converting fuel to energy units:

fuel	factor (HHV)
electricity	0.003413 MBtu/kWh
propane	0.095 MBtu/gallon
fuel oil	0.14 MBtu/gallon
wood	28 MBtu/cord

(1 MBtu = 10E6 Btu = 1 million Btu)

These factors are used in columns 32-35 and 37-40 of the spreadsheet.