VLA Test Memo # 223
Revision 1

VLA Energy Survey 1999

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Abstract
Power consumption at the Very Large Array (VLA) has been monitored for several years. As operating costs continue to rise, energy conservation can play an important role in running the facility more efficiently.

Several events since 1988 have reduced power consumption at the site. The most significant has been the installation of Direct Digital Controllers (DDC) on the antennas. This modification has reduced our annual power consumption by 1,000,000 kilowatt hours. A history of VLA power consumption and major events are plotted in section 2.01.

Monitoring power consumption at all the site transformers helps to identify the major use areas. Surveys were performed in 1986 and 1999. The survey results are tabulated in section 2.02.

Upgrading old equipment offers power savings in many areas. Upgrading the site chillers can reduce power consumption by 157,000 kilowatt hours annually. Changing out old wall air conditioning units will reduce consumption by an additional 40,000 kilowatt hours. Payback periods for both of these items are less then 4 years. Other initial projects are recommended in section 4.00. The total estimated annual savings for the projects listed would be $22,000 and our annual power consumption would be reduced by 363,000 kilowatt hours (3.5% of present consumption).

Budgeting for Energy related projects should be encouraged and reviewed on a regular basis. The cost per kilowatt-hour is on the rise once again.

1.00 Discussion And Scope

This energy survey focuses on developing a list of areas and items to address in the coming years and budgets. Projects will be initiated to investigate cost and payback.

There are energy savings available by simply upgrading older and inefficient equipment. Equipment upgrades and replacement should be a part of future budgets. With some equipment it makes sense to wait until the piece fails or the next major overhaul. With others as the analyses might show it makes good sense to replace the equipment immediately.

As an example: The chillers are 25 years old and the cost to rebuild a chiller compressor is greater then 50 percent of the cost of a new chiller. When the next compressor is due to be rebuilt a chiller should be replaced. The newer units will reduce power consumption by 157,000 KWH per year.

Electricity saved now is also saved every year into the future.

2.00 VLA Energy History

Even with the efforts to reduce power consumption the overall cost is starting to rise once again. While site consumption has decreased our electric bill has increased.

Year	Energy KWH Consumption	Electric Bill	Cost/KWH
1986	10821000	$800,485	$0.0740
1994	9854400	$495,074	$0.0502
1998	9038400	$569,877	$0.0632
1998 Generated	189000	$15,000	$0.0790

The VLA has two 1500kw Caterpiller generator sets, left from the Voyager Project. During 1989 to 1993 a decision was made to generate our own site power. The intent was to generate power cheaper than we could buy it for from Socorro Electric Cooperative (SEC). Negotiations with SEC lead us to try a few different operating schedules with different load shedding options. Eventually we started generating full time. Toward the end of 1993 a rate was negotiated with SEC and we started purchasing power once again. These rate negotiations with Socorro Electric Cooperative contributed to reducing the VLA electric bill substantially.

During 1993-1997 the VLA antennas were retrofitted with DDC controls on the Vertex Room air conditioning. This upgrade has reduced site kilowatt hour consumption by 8-10% or one million kilowatt hours per year. At today's cost this KWH reduction translates into an estimated $70,000 saved annually. An additional $7200 in demand charges are also saved.

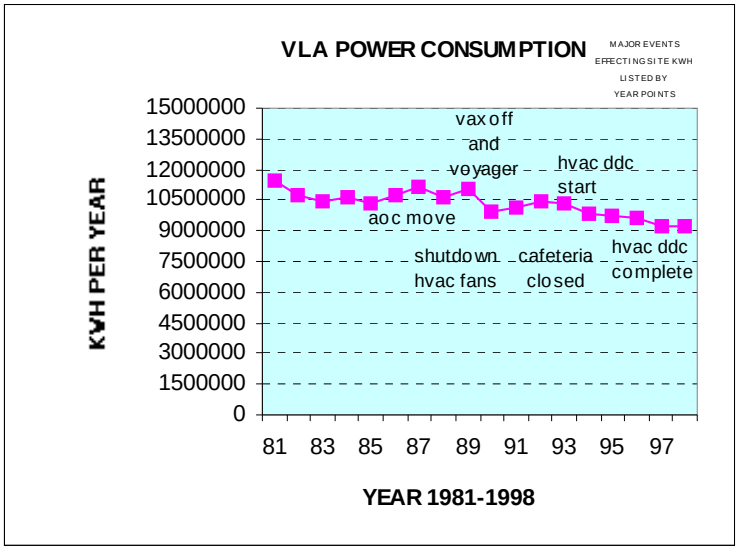
2.01 Major Events

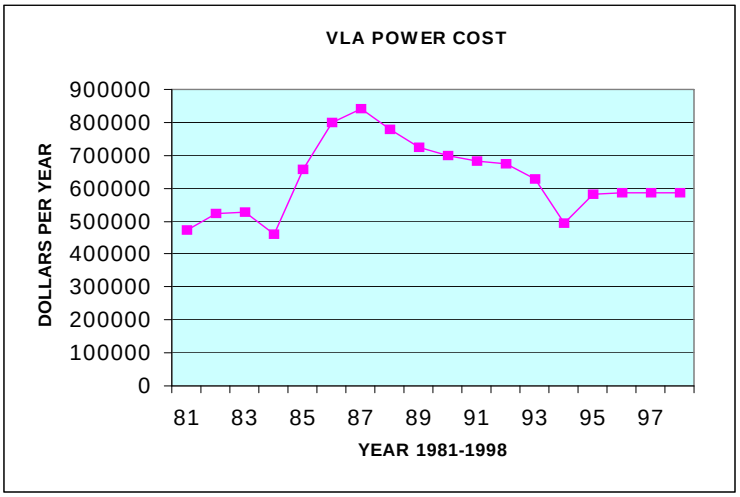
From 1988 to 1997 there were several events that reduced KWH consumption at the site. Site power consumption is plotted from 1981 through 1998 with the events noted on the graph during the year they took place. A plot of yearly power cost is also given.

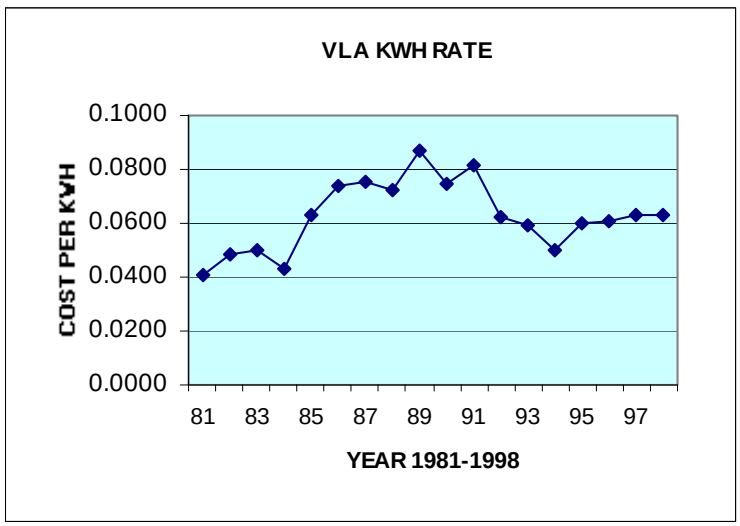
Events:

a. Move to Array Operations Center (AOC) - November of 1988
b. Relocate Vax to AOC - November of 1988
c. Voyager- August of 1989
d. The installation of DDC Controls on the VLA antenna vertex room heating and air conditioning system – November 1993 to October 1997
e. Control Building HVAC system building and computer fans were turned off about1990/1991.
f. Cafeteria was shutdown – February of 1993.

VLA Power Consumption And Power Cost From 1981 Through 1998







2.02 Monitoring Power Consumption 1986 and 1999

In August of 1986 a partial power consumption breakdown were gathered. A power monitor was placed at different transformers to collect usage data. Collections points included the main transformers at the Control Building, Cafeteria, Antenna Barn, Vax/Slob, Technical Services area and one Antenna.

In September of 1999 we also collected usage data to compare the different areas. We will monitor the same transformers in January 2000 to check the winter loading. The table below compares the surveys in the summers of 1986 and 1999.

Power Monitoring 1986 and 1999

	Ranges	Ranges
Site Area	August, 1986	September, 1999
	Kilowatts	Kilowatts
Antenna	18.3	19.25
(19kw/antenna * 27)	494	519.75
Control Building	385	295
MD Panel	68.8	89.05
Cafeteria Building	22.09	10.72
Antenna Building	16.24	37.27
Vax/Slob	45.26	2.2

The comparison shows that our two main consumers of energy are the Antennas and the Control Building. It also shows that in some areas consumption has increased.

3.00 Listing of Energy Items To Review

The listing will be maintained and updated yearly. Projects will be discussed with management and assigned as the budget allows.

3.01 Upgrade Equipment

A) Possible alternates for Heating, Ventilating and Air Conditioning (HVAC) equipment.
   1. Technical Services HVAC wall units: Install heat pump wall unit.
   2. Cryogenics at Tech Services: Install split system heat pump unit.
   3. Antenna Barn: Replace furnace in the VLBA Shop Area.
   4. Antenna Barn: Install heat pump wall unit.
   5. Warehouse offices HVAC: Install heat pump wall unit.
   6. Servo HVAC: Install heat pump wall unit.
   7. Cafeteria Heat Pumps: Install newer heat pumps.
   8. Visitor Sleeping Quarters: Install heat pump wall units.
   9. Control Building: Install new Chillers.

B) Energy efficient motors where justified.
C) Cafeteria: Install a second smaller hot water heater. In progress.
D) Variable Frequency Drives (where applicable).
E) Soft Starts (where applicable).
F) Capacitors to improve power factor (if we pay for low power factor).

3.02 Lighting

A) Review all lighting and replace with energy efficient lights and ballasts.
Use lower wattage light bulbs where possible.
B) Low pressure sodium or LED instead of incandescent.
C) Turn off light stickers.
D) Motion sensors- Identify locations inside and outside of buildings.
E) Skylights.

3.03 Operation (buildings/antennas)

A) Antennas
1. Can some of the equipment be turned off? Pedestal Room air conditioning?
2. Azimuth and Elevation Gearbox Fans. Investigate the need for fans. The cost to operate drive fans is $40,000 a year.
3. Reduce or widen set point temperature range in Pedestal room.
4. Stagger antennas during slew can reduce demand?
5. Feed heaters: Presently all the heaters come on at one time. Redesign for individual switching or automate using weather data.
6. Insulate upper pedestal. Cover openings to yoke.
7. Insulate vertex room.
8. Brushless DC drives for the antennas (manhour maintenance savings).

B) Use swamp coolers for cooling in place of wall units (in progress).
C) Investigate chilled water requirements.
D) Do we need the computer air system any longer?
E) Install enthalpy controller on building system. Controller is already in hand.
F) Reduce seal water usage at Cooling Tower Sump Pump.

3.04 Buildings

A) Insulated windows.
B) Control building boiler for humidity control. Is humidity control required any longer?
C) Waste oil heater mechanics area.
D) Warehouse add ceiling fans min (4)- personnel comfort and mixing.

3.05 Other

A) Solar Panels (are still too expensive)

4.00 Payback Analyses Table

Payback Analyses use the simple payback method. Projects taken from sections 3.01A (1-6), 3.01B, 3.02A, and 3.04C.

	Payback Table	Kilowatt-Hours	LPG Saved	Equipment	**Energy Savings	Payback
	Payback Analyses	Saved Annually	Annually	Cost	Annually	Years
1	Control Building Chillers					
	Replace one Chiller	157000		$38,000	$10,000	3.8
	*Replace two Chillers	157000		$76,000	$10,000	7.6
2	Wall Air Conditioning Units					
	For ten units	42000		$8,000	$2,600	3.1
3	Lighting Ballasts Replacement					
	Four bulb ballast (200)	32000		$6,000	$2,000	3
	Two bulb ballast (390)	17846		$7,800	$1,124	6.94
4	Energy Efficient Motors (HVAC System) mfg claims 3%-5% savings/yr					
	6-15hp motors @4%/yr	29500		$3,000	$1,854	1.7
5	Antenna Barn Furnace					
	Est. 10% savings new unit		276Gal. LPG	$800	$276	~3
6	Waste Oil Heater					
	If only 500 gallons of waste					
	available. Supplement with #2 diesel	50000		$6,000	$2,000	3
7	Cryogenics Area Air Conditioning					
	New Split System Heat Pump	34900		$5,000	$2,200	2.2
	Overall (with one chiller)	363246		$74,600	$22,054	3.38
	Overall (with two chiller)	363246		$112,600	$22,054	5.11
	* Presently we only operate one chiller.					
	Cost to rebuild a compressor is >50% of the cost of a new chiller.					
	**Energy savings based on a 90 day heating season and a 120 day cooling season.					

5.00 Recommendations

This survey is a only a guide. Each of the areas listed should be reviewed closely and where there is a potential for reducing consumption a payback analysis should be completed. The method of analysis can be reviewed by the Business Division.

More important is that NRAO develop an energy budget. Whenever an energy project passes the payback criteria it should be implemented in some reasonable time frame.

The seven projects listed in section 4.00 should be completed. Other projects in section 3.00 such as Brushless DC Motors, Antenna Drive Motor Fan circuitry (which will reduce fan usage), Feed Heaters, Enthalpy Controllers should be reviewed. If the payback criteria is met they should be submitted for approval.