



ABSTRACT

Power consumption follows only labor as a top operating expense of any vertical farm. HVAC and LED grow lights have become vastly more efficient in recent years, yet air circulation, vital to the success of the farm, has changed little in decades, until now. This paper will explore the relative power consumption and related costs between fixed or oscillating circular fans, and the Vertical Air Solutions ducted air circulation system.

KEY TAKEAWAYS

- **Effective and consistent air circulation is a requirement for any vertical farm.**
- **Fixed or oscillating circular fans provide uneven air movement, and require complicated electrical sourcing.**
- **Use of a VAS air circulation system, depending upon rack length, will save 46-68% in electricity costs per year, compared to circular fans, and will pay for itself in 12-18 months.**

INTRODUCTION

Vertical Farming is the single most effective way to maximize crop yield per area. It allows control of a large number of variables that are simply left to chance in open air or greenhouse farms, which leads to product consistency and brand equity. But that control and consistency comes at a price, particularly in terms of energy consumption. Maintaining consistent temperatures requires a precise HVAC system; maintaining consistent lighting requires LED grow lights; maintaining consistent homogenized air flow requires intelligent air circulation systems. While HVAC and lighting systems have made impressive technological leaps in recent years, some vertical farms continue to use fixed or oscillating circular fans to provide air flow to the lower tiers of the farm. Not only does the uneven nature of circular fans cause uneven heat and humidity levels, they suffer from high levels of energy inefficiency. This paper studies the comparative costs between multiple circular fans and ducted air circulation systems, and calculates the payback period for a VAS air circulation system.

The Nature of Fan Power Consumption

This table estimates energy costs differences between circular fans, assuming two 8" fans per eight linear rack feet vs. a Vertical Air Solutions air circulation system for the same size installations:

STANDARD CIRCULAR FANS				
Length of rows (feet)	32	40	48	64
Number of fans per row	8	10	12	16
Watts/fan	75	75	75	75
Total annual kW consumption	5,256	6,570	7,884	10,512
PG&E business rate	\$0.30	\$0.30	\$0.30	\$0.30
Annual cost	\$1,577	\$1,971	\$2,365	\$3,154

VAS AIR CIRCULATION SYSTEM				
Length of rows (feet)	32	40	48	64
Number of fans per row	1	1	1	1
365 days/fan	2120	2120	4284	4284
Total annual kW consumption	2,120	2,120	4,284	4,284
PG&E business rate	\$0.30	\$0.30	\$0.30	\$0.30
Annual cost	\$636	\$636	\$1,285	\$1,285

ANNUAL SAVINGS

Small Grow Facility				
Number of rows	25	20	17	13
Op cost of circular fans	\$40,036	\$40,036	\$40,036	\$40,036
Op cost of VAS system	\$16,148	\$12,918	\$21,753	\$16,315
Annual Cost savings	\$23,888	\$27,118	\$18,283	\$23,721
Percentage Savings	60%	68%	46%	59%

Medium Grow Facility				
Number of racks	51	41	34	25
Op cost of circular fans	\$80,072	\$80,072	\$80,072	\$80,072
Op cost of VAS system	\$32,296	\$25,837	\$43,506	\$32,629
Annual Cost savings	\$47,776	\$54,235	\$36,566	\$47,443
Percentage Savings	60%	68%	46%	59%

Large Grow Facility				
Number of racks	127	102	85	63
Op cost of circular fans	\$200,180	\$200,180	\$200,180	\$200,180
Op cost of VAS system	\$80,739	\$64,591	\$108,764	\$81,573
Annual Cost savings	\$119,441	\$135,588	\$91,415	\$118,606
Percentage Savings	60%	68%	46%	59%

Based on the figures above, and assuming a price of \$109.95 per each circular fan, the period of time in which the VAS air circulation system pays for itself is shown here:

INCREMENTAL CAPITAL INVESTMENT PAYBACK CALCULATIONS				
	32'	40'	48'	64'
Circular fan per row	\$880	\$1,100	\$1,319	\$1,759
VAS system per row	\$2,188	\$2,512	\$2,941	\$3,633
VAS Incremental Costs	\$1,308	\$1,413	\$1,622	\$1,874
VAS annual energy savings	\$941	\$1,335	\$1,080	\$1,869
Payback period (years)	1.4	1.1	1.5	1.0