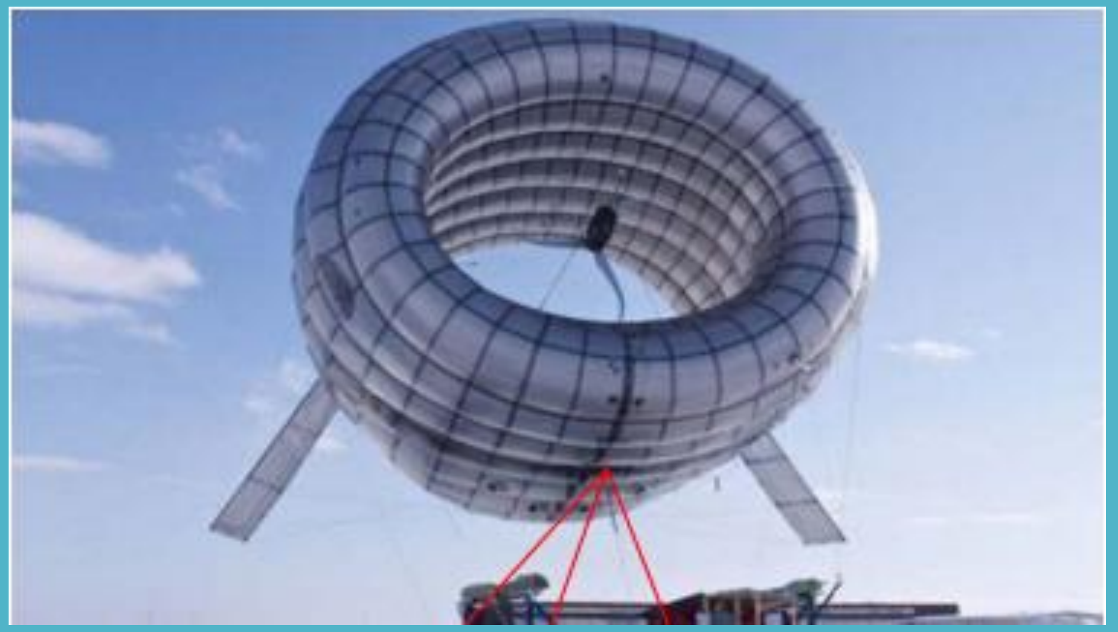
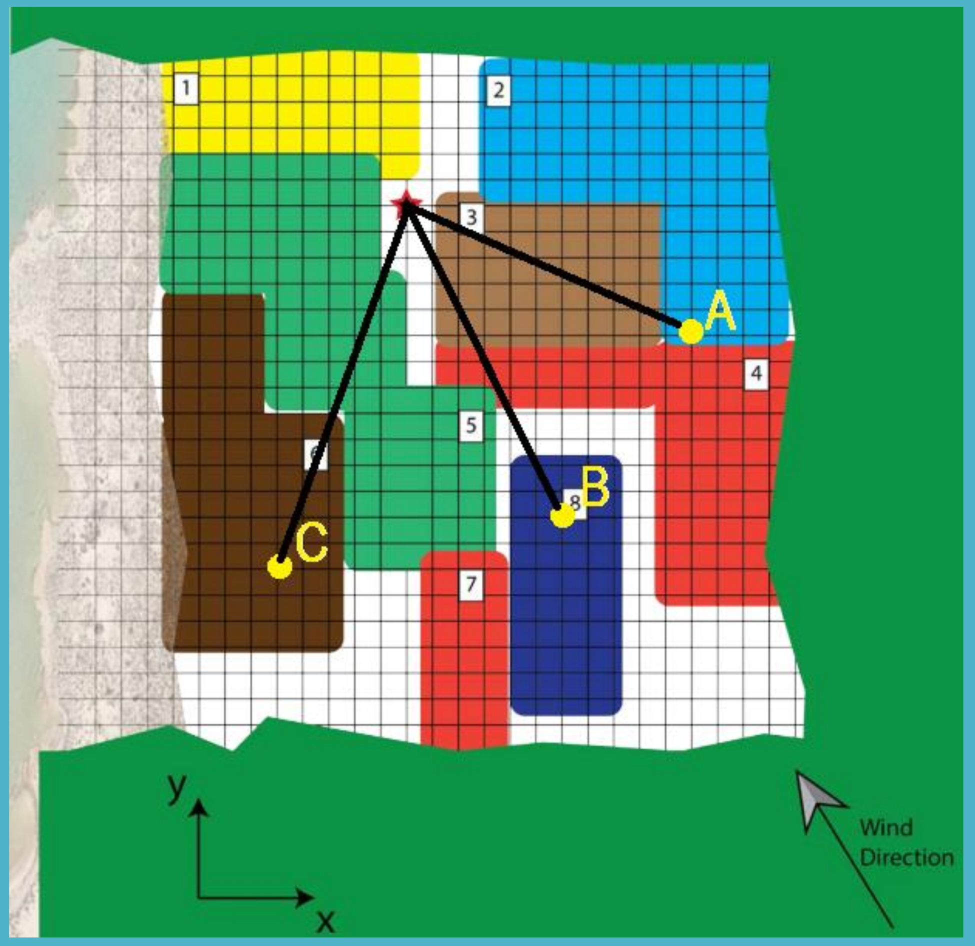
Group 1 - Poster

Wind Turbine Project

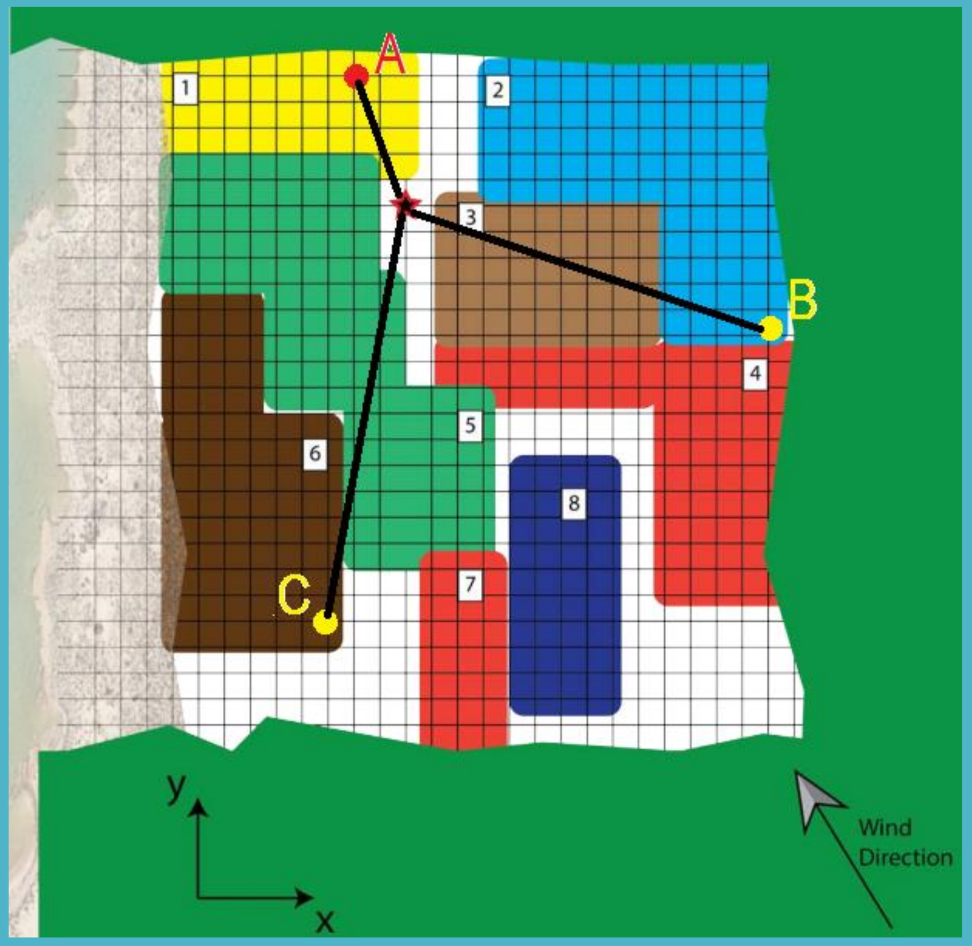
ES2501 [redacted] [redacted]

	Configuration 1	Configuration 2
Cable Sector, Location (x,y) in meters, A	2,(11,-5)	4,(11,-13)
B	6,(-5,-14)	7,(3,-19)
C	8,(6,-12)	8,(6,-12)
Height of Balloon (m)	59.60	77.00
Vector, **bA** (m)	11i-5j-59.60**k**	11i-13j-77.00**k**
bB (m)	-5i-14j-59.60**k**	3i-19j-77.00**k**
bC (m)	6i-12j-59.60**k**	6i-12j-77.00**k**
Length bA ($\|bA\|=\sqrt{A_x^2+A_y^2+A_z^2}$) (m)	60.81	78.86
bB ($\|bB\|=\sqrt{B_x^2+B_y^2+B_z^2}$) (m)	61.43	79.37
bC ($\|bC\|=\sqrt{C_x^2+C_y^2+C_z^2}$) (m)	61.09	78.16
Total Length (bA+bB+bC) (m)	183.33	236.39
Cost of Cable ($75/m*Total Length)	**$13,749.75**	**$17,729.02**
Unit Vector of F_A (**bA**/ba)	.181i-.082j-.980**k**	.139i-.165j-.976**k**
u F_B (**bB**/bB)	-.081i-.228j-.970**k**	.038i-.239j-.970**k**
u F_C (**bC**/bC)	.098i-.196j-.976**k**	.077i-.154j-.985**k**
Required Resultant Force (N)	100i-200j-1000**k**	100i-200j-1000**k**
X-Balance Equation	$.181F_A -.081F_B +.098F_C =100$	$.139F_A +.038F_B +.077F_C =100$
Y	$-.082F_A -.228F_B -.196F_C =-200$	$-.165F_A -.239F_B -.154F_C =-200$
Z	$-.980F_A -.970F_B -.976F_C =-1000$	$-.976F_A -.970F_B -.985F_C =-1000$
F_A (N) (using equation solver)	14.62	595.63
F_B (N)	10.46	415.00
F_C (N)	999.93	16.03
Cost of A	$250	$500
B	$10,000	$1,000
C	$500	$500
Total Construction Cost	**$10,750**	**$2,000**
Cost of Balloon	**$125,000**	**$125,000**
Total Cost (Constn+Balloon+Cable)	**$149,499.75**	**$144,729.02**
Power Revenue ($5/meter/day*height)	**$298/day**	**$385/day**
Payback Time (Total Cost/Power Rev)	**502 days**	**376 days**
Social Impact Score A	-3	-6
B	+8	-4
C	0	0
Net SIS	**+5**	**-2**





Configuration 1



Configuration 2

Note: All coordinates are from the point directly below the balloon (0,0,0).

Zone	Construction Cost	Social Impact Score
1	$5000	-4
2	$250	-3
3	$400	-4
4	$500	-6
5	$1,000	-4
6	$10,000	+8
7	$1,000	+4
8	$500	0

Breakin' Wind in Sub Saharan Africa

Group E1A: [redacted]

Group 2 - Poster

Configuration A

Optimizing Social Impact Score

Zones used: 2, 6, 8
Height: 70 m

Position vectors:
$\mathbf{r}_{z2} = 10\mathbf{i} - 5\mathbf{j} - 70\mathbf{k}$ m
$\mathbf{r}_{z6} = -3\mathbf{i} - 17\mathbf{j} - 70\mathbf{k}$ m
$\mathbf{r}_{z8} = 8\mathbf{i} - 19\mathbf{j} - 70\mathbf{k}$ m

Length of cables:
C_2: 70.89 m
C_6: 72.10 m
C_8: 72.97 m

Equations:
$\Sigma F_x : -100 + (0.141)F_{z2} - (0.042)F_{z6} + (0.110)F_{z8} = 0$
$\Sigma F_y : 200 - (0.071)F_{z2} - (0.236)F_{z6} - (0.260)F_{z8} = 0$
$\Sigma F_z : 1000 - (0.987)F_{z2} - (0.971)F_{z6} - (0.959)F_{z8} = 0$

$F_{z2} = 339.917$ N
$F_{z6} = 157.446$ N
$F_{z8} = 533.494$ N

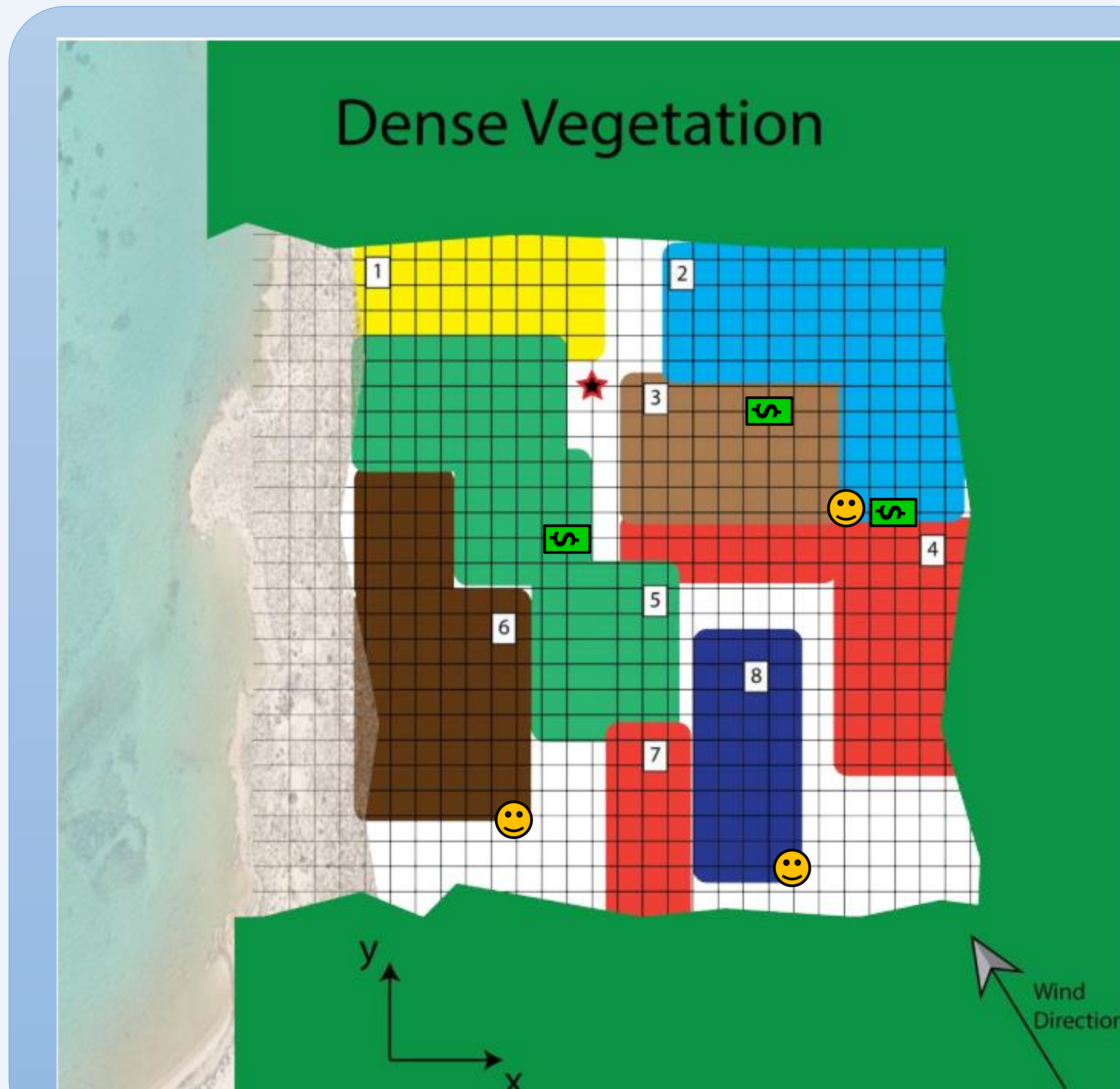
Cost of build:
Balloon: $125,000
Cables: ($75/m)($C_2 + C_6 + C_8$) = $16,197
Zones: $10,750
Total: $151,947

Revenue:
Revenue per day: ($5/m)(70 m) = $350
Payback time: $\frac{(Total\ cost\ of\ build)}{(Revenue\ per\ day)}$ = 434 days ~ 1.2 year

Social Impact Score: +5

Costs and Social Impact Scores of Zones

Zone	Construction Cost	Social Impact Score
1	$5000	-4
2	$250	-3
3	$400	-4
4	$500	-6
5	$1,000	-4
6	$10,000	+8
7	$1,000	+4
8	$500	0



Key
= configuration A
= configuration B

Configuration B

Optimizing Zone Costs

Zones used: 2, 3, 5
Height: 28 m

Position vectors:
$\mathbf{r}_{z2} = -1\mathbf{i} - 6\mathbf{j} - 28\mathbf{k}$ m
$\mathbf{r}_{z6} = 7\mathbf{i} - 1\mathbf{j} - 28\mathbf{k}$ m
$\mathbf{r}_{z8} = 12\mathbf{i} - 5\mathbf{j} - 28\mathbf{k}$ m

Length of cables:
C_2: 28.65 m
C_6: 28.88 m
C_8: 30.87 m

Equations:
$\Sigma F_x : -100 - (0.035)F_{z2} + (0.242)F_{z6} + (0.389)F_{z8} = 0$
$\Sigma F_y : 200 - (0.209)F_{z2} - (0.035)F_{z6} - (0.162)F_{z8} = 0$
$\Sigma F_z : 1000 - (0.977)F_{z2} - (0.970)F_{z6} - (0.907)F_{z8} = 0$

$F_{z2} = 714.5$ N
$F_{z6} = 25.33$ N
$F_{z8} = 305.61$ N

Cost of build:
Balloon: $125,000
Cables: ($75/m)($C_2 + C_6 + C_8$) = $6630
Zones: $1,650
Total: $133,280

Revenue:
Revenue per day: ($5/m)(28 m) = $140
Payback time: $\frac{(Total\ cost\ of\ build)}{(Revenue\ per\ day)}$ = 952 days ~ 2.6 years

Social Impact Score: -11

Anchor Configuration for Balloon Wind Generator

[redacted]

Group 3 - Poster

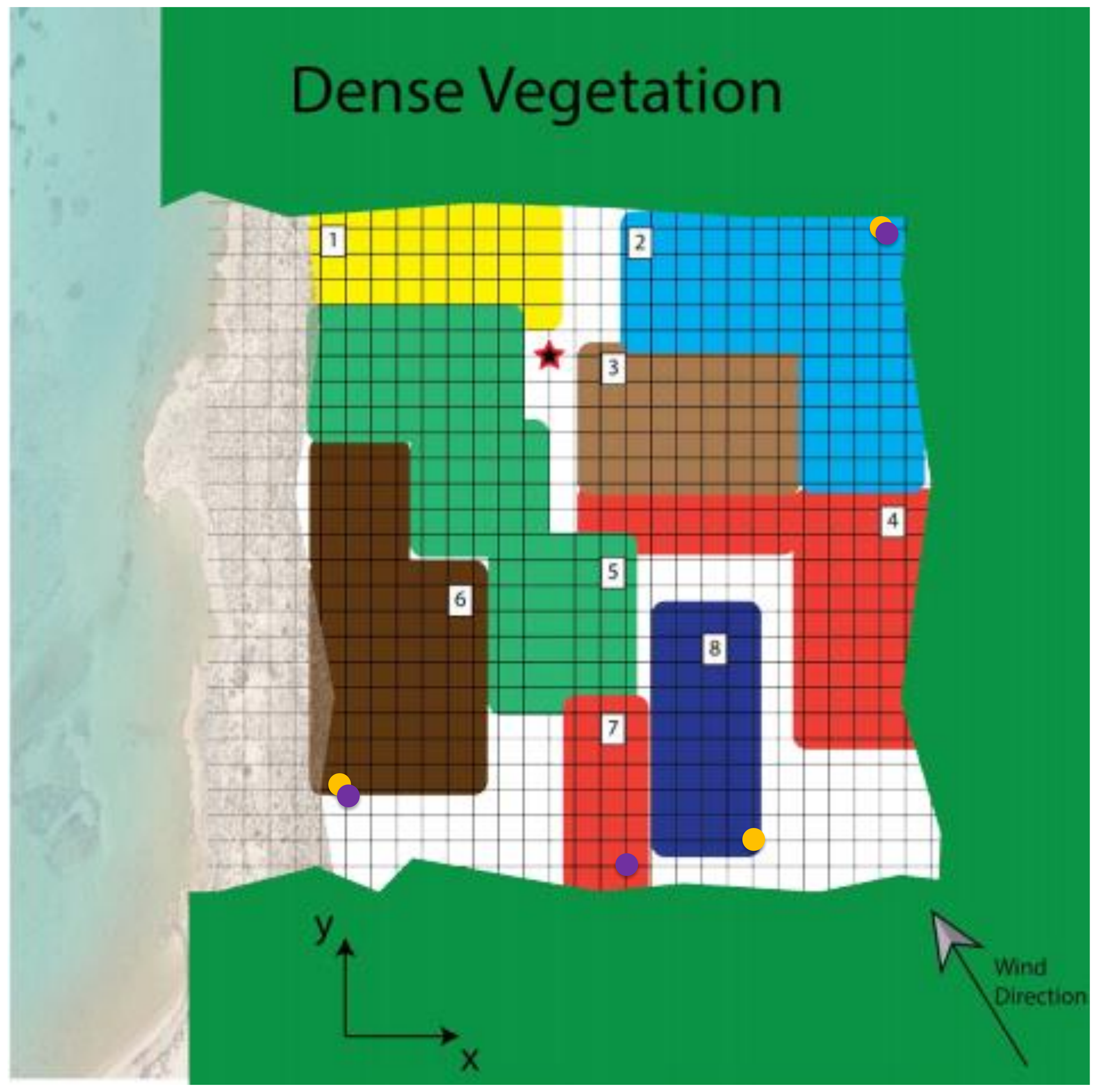
Background

One of the largest problems facing sub-Saharan Africa currently is the lack of access to electricity. Bringing electricity to small villages allows residents to efficiently purify their own water, cook without risking fires, and light their homes with more than just daylight. The Alaeros Energies balloon wind tunnel will allow a village the benefits of power at relatively low cost, provided the design will last.

Building Costs and Social Impact Summary

Zone	Construction Cost	Social Impact Score
1	$5000	-4
2	$250	-3
3	$400	-4
4	$500	-6
5	$1,000	-4
6	$10,000	+8
7	$1,000	+4
8	$500	0

Building Site Map



1 grid square = 1 meter
Balloon may not be anchored in dense vegetation, on beach, or in a non- numbered zone.
Configuration 1: Orange; Configuration 2: Purple

Proposed configurations

Our first proposed configuration is with one anchor each in Zones 2, 6, and 8. Zone 2 is less desirable because it interferes with rhinoceros migration. However, the desirability of the government-subsidized land in Zone 8, and the positive social impact of Zone 6 require that Zone 2 also be used to reduce the maximum force on the cables helping to anchor the balloon.

The second proposed configuration places the same anchors in Zones 2 and 6. However, this configuration moves the third anchor point to Zone 7. Building an anchor point in Zone 7 would help reduce the region's mosquito population. This further increases the social impact of the balloon project. However, in this configuration altitude is limited to 60 m, increasing the payback time.

Calculations

Configuration 1:

$$\vec{F}_{wind} = -100\hat{\imath} + 200\,\hat{\jmath} + 1000\,\hat{k}\ N$$

$$\vec{r}_1 = -8\hat{\imath} - 18\hat{\jmath} - 80\hat{k}\ m$$

$$\vec{r}_2 = 13\hat{\imath} + 5\hat{\jmath} - 80\hat{k}\ m$$

$$\vec{r}_3 = 8\hat{\imath} - 19\hat{\jmath} - 80\hat{k}\ m$$

$$r_1 = \sqrt{(-8)^2 + (-18)^2 + (-80)^2} = 82.39\ m$$

$$r_2 = 81.20\ m$$

$$r_3 = 82.61\ m$$

$$\Sigma F_x = -100 + F_1\left(\frac{-8}{82.39}\right) + F_2\left(\frac{13}{81.20}\right) + F_3\left(\frac{8}{82.61}\right) = 0$$

$$\Sigma F_y = 200 + F_1\left(\frac{-18}{82.39}\right) + F_2\left(\frac{5}{81.20}\right) + F_3\left(\frac{-19}{82.61}\right) = 0$$

$$\Sigma F_z = 1000 + F_1\left(\frac{-80}{82.39}\right) + F_2\left(\frac{-80}{81.20}\right) + F_3\left(\frac{-80}{82.61}\right) = 0$$

$$F_1 = 31.71\ N$$

$$F_2 = 125.25\ N$$

$$F_3 = 865.61\ N$$

$$Price = 75 * (r_1 + r_2 + r_3) + 125{,}000 + 10{,}000 + 500 + 250 = \$154{,}215.00$$

$$Payback\ time = \frac{Price}{5 * 80} = 386\ days$$

Configuration 2:

$$\vec{F}_{wind} = -100\hat{\imath} + 200\,\hat{\jmath} + 1000\,\hat{k}\ N$$

$$\vec{r}_1 = -8\hat{\imath} - 18\hat{\jmath} - 60\hat{k}\ m$$

$$\vec{r}_2 = 13\hat{\imath} + 5\hat{\jmath} - 60\hat{k}\ m$$

$$\vec{r}_3 = 3\hat{\imath} - 21\hat{\jmath} - 60\hat{k}\ m$$

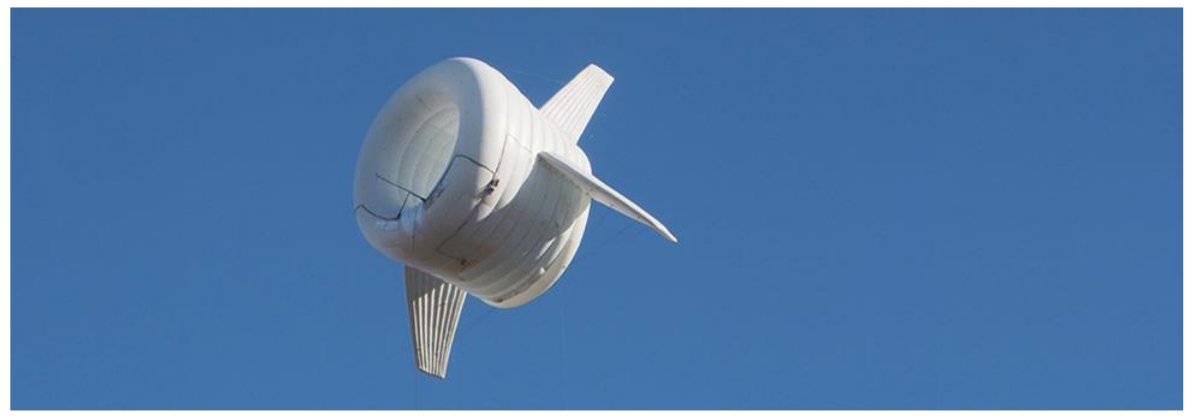
$$F_1 = 39.97N$$

$$F_2 = 350.86\ N$$

$$F_3 = 657.88\ N$$

$$Price = 75 * (r_1 + r_2 + r_3) + 125{,}000 + 10{,}000 + 1000 + 250 = \$150{,}378.92$$

$$Payback\ time = \frac{Price}{5 * 80} = 502\ days$$



http://www.altaerosenergies.com/company.html

Social Impact

The social impact of the first proposed solution is +5. The social impact of the second proposed solution is +9. Both have positive social impact, meaning overall the presence of the balloon will positively affect the community.

Benefits

Both of these systems are static, so they will not move in the wind, reducing fatigue on the cables. Assuming the wind stays constant, the overall stress on the cables will never exceed the 1000 N force limit for the cables, so they will likely last several years. Both of these systems also have positive social impact, meaning that despite disruptions to some environments, overall the building of the system will positively impact the community, providing job opportunities and minimal impact on the environment.

Comparison of Configurations

The first configuration will cost approximately $154,000. The village will be able to pay this figure back in approximately 386 days. The second configuration will cost $150,000 and will require 502 days to pay back. While both configurations will last a very long time and will provide the necessary power to this community, the first configuration is preferred due to the significantly shorter payback time.