

Automated Wind Warning System

Caltrans – District 9 Bishop



District 9 - Bishop

- Area weather and topography
- Facility – highway
- Vehicles – Volume & Class
- Windssocks

Background...



Google earth

miles 1
km 1



Red Hill RWIS – Focus Area



Google earth

feet 3000
km 1



Cut & Fill – “One-Two” Punch



Previous Solution...



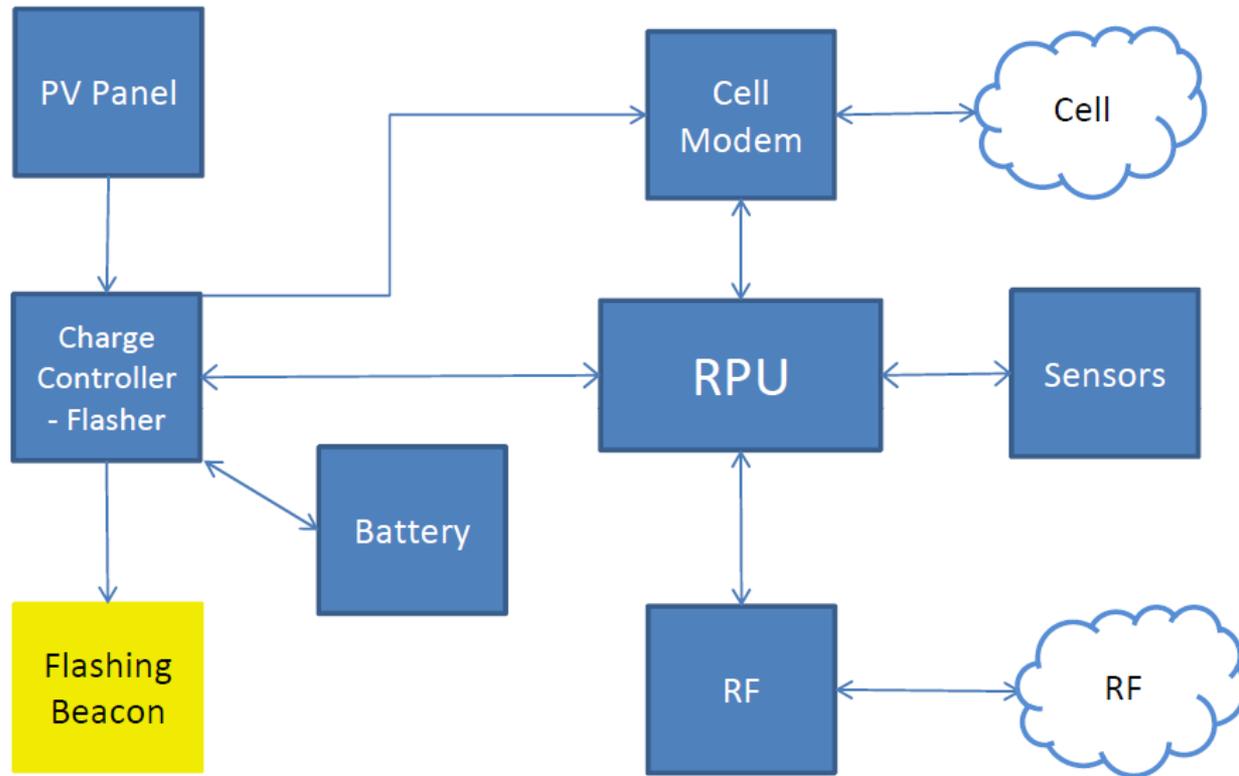
Current Solution...

- Reduce occurrence of accidents due to UNEXPECTEDLY high cross winds by...
- Advising drivers of conditions and...
- Alerting Caltrans and CHP of conditions or need for high profile vehicle closure

Need & Purpose

- Remote power & communications
- Stand-alone system – no operator required
- Info to operators via text/email
- Off the shelf hardware & software
- High quality and value
- Part of Minor B Project (\$150k max)
- Construction + equipment - \$105k (5 sites)
- Designed, inspected, installed, and maintained by D9 Operations/Electrical

System design considerations



System Diagram

- Solar Power System
- Flashing Beacons
- RWIS
- RF RPU Links
- Cellular Modem
- Miscellaneous...

The System...

- Design Criteria – Excel Spreadsheets
- Equipment - List

Solar Power System

AC LOADS	AMPS	WATTS	HR/DAY	DAY/WK	WH/WK
TOTAL		0	0	0	0
INVERTER EFFICIENCY		1			0
AC Amps	0				0
SYSTEM VOLTAGE					12
AC AMP-HOURS				0	0

DC LOADS	AMPS	WATTS	HR/DAY	DAY/WK	WH/WK
RWIS	0.001	0.01	24	7	2.0
RF	0.050	0.60	24	7	100.8
Ctek 4400 (Standby)	0.100	1.20	16	7	134.4
Ctek 4400 (Transmit)	0.650	7.80	8	7	436.8
					674.0
DC AMP-HOURS				8.02	56.2
TOTAL LOAD AMP-HRS				8.02	56.2

CHARGE-DISCHARGE LOSS	20%			1.60	11.23
AVERAGE SUN HRS/DAY				4	
PEAK AMPS/PV MODULE				5.4	
Watts (Calc'd)				64.8	
AMP-HRS/DAY/MODULE				21.6	
NUMBER OF MODULES REQ'D				1	
ADDITIONAL SAFETY FACTOR				124%	
SYSTEM VOLTAGE	12				

BATTERY SIZING

AMP-HRS/DAY		9.63
MAX # of NO SUN DAYS		7
AMP-HRS w/ RESERVE		53.9
PERCENT RESERVE	20%	
Special Conditions		
Lead Acid Battery Low Temp Factor		1.5
AMP-HR BATTERY RATING		85
MAX ALLOW'D DISCHARGE/DAY	15%	12.75
AVG. DAILY DISCHARGE HRS		20
AVG. DAILY DISCHARGE AMP-HRS		6.69
NUMBER of BATTERIES REQ'D		
For Load		1
ADDITIONAL SAFETY FACTOR		5.1%
For Max Daily Discharge		1
ADDITIONAL SAFETY FACTOR		90.7%

Solar Power System - Master

AC LOADS	AMPS	WATTS	HR/DAY	DAY/WK	WH/WK
TOTAL		0	0	0	0
INVERTER EFFICIENCY		1			0
AC Amps	0				0
SYSTEM VOLTAGE					12
AC AMP-HOURS				0	0

DC LOADS	AMPS	WATTS	HR/DAY	DAY/WK	WH/WK
RWIS	0.001	0.01	24	7	2.0
RF	0.050	0.60	24	7	100.8
Beacon	1.000	12.00	12	7	1008.0
		0.00	12	7	0.0
					1110.8
DC AMP-HOURS				13.2	92.6
TOTAL LOAD AMP-HRS				13.2	92.6

CHARGE-DISCHARGE LOSS	20%		2.64	18.51
AVERAGE SUN HRS/DAY			4	
PEAK AMPS/PV MODULE			5.4	
Watts (Calc'd)			64.8	
AMP-HRS/DAY/MODULE			21.6	
NUMBER OF MODULES REQ'D			1	
ADDITIONAL SAFETY FACTOR			36%	
SYSTEM VOLTAGE	12			

BATTERY SIZING	
AMP-HRS/DAY	15.87
MAX # of NO SUN DAYS	7
AMP-HRS w/ RESERVE	88.9
PERCENT RESERVE	20%
Special Conditions	
Lead Acid Battery Low Temp Factor	1.5
AMP-HR BATTERY RATING	85
MAX ALLOW'D DISCHARGE/DAY	15%
AVG. DAILY DISCHARGE HRS	20
AVG. DAILY DISCHARGE AMP-HRS	11.02
NUMBER of BATTERIES REQ'D	
For Load	2
ADDITIONAL SAFETY FACTOR	27.5%
For Max Daily Discharge	2
ADDITIONAL SAFETY FACTOR	131.4%

Solar Power System – FB Signs

- PV panels: Kyocera KC85T - 62 watt
- Charge controller: Precision Solar Controls
- DPC2000
- Batteries: Concorde Sun Xtender 89 A-hr

Solar Power System Equipment

- Standard AC vs. DC Power?
- One or two per sign?
- Size?
- Visor type?
- Flasher: DPC2000 – auto or local control

Flashing Beacons

- RPU: Campbell Scientific CR1000
- Anemometer: R.M. Young 05103-5
- Temperature & Humidity: CS HMP45C

RWIS – Road & Weather Information System



Some Pictures...

- Powers sensors
- Converts sensor outputs to values
- Performs calculations
- Makes control & communication decisions
- Sends commands via RF
- Sends texts via cell modem when needed
- Sends data periodically via cell modem

Campbell Scientific RPU – CR1000

- “BASIC” type programming
- Define variables
- Define “scans”
- Gets sensor data
- Calculations
- Decisions
- Notifications
- Stores data to tables

RPU Program

- Historical Weather Data
- Text & Email Notifications

Data Examples

Table Name: USER_DATA_2hr

TimeStamp	Record	Beacon	MpeakGust	MavgWind	NBpeakGust	NBavgWind	SBpeakGust	SBavgWind	Air/TF	RH
2013-05-28 18:00:00.0	505	"OFF"	18	5.8	17.3	5.8	12.2	3.3	61.04	21.96
2013-05-28 20:00:00.0	506	"OFF"	10.1	6.7	9.7	7.7	10.1	5.7	52.11	30.86
2013-05-28 22:00:00.0	507	"OFF"	16.5	6.5	6.9	2.9	14.1	2.8	52.08	28.47
2013-05-29 00:00:00.0	508	"OFF"	7.8	4.9	6.6	1.4	9.2	5	49.81	44.01
2013-05-29 02:00:00.0	509	"OFF"	9	3.5	9.2	2.2	6.4	3	47.02	44.5
2013-05-29 04:00:00.0	510	"OFF"	10.5	4.3	7.5000	2.1	11.3	4.5	45.78	45.82
2013-05-29 06:00:00.0	511	"OFF"	19.1	4	16.8	6.2	18	2.9	50.08	56
2013-05-29 08:00:00.0	512	"ON"	36.5	9.6000	22.4	6.5	18.5	9.8	55.82	46.82
2013-05-29 10:00:00.0	513	"ON"	36.5	18.8	27.5	15.2	32.1	19.5	59.52	28.78
2013-05-29 12:00:00.0	514	"OFF"	29.7	8	29.4	14.1	25.7	8.4	58.8	23.81
2013-05-29 14:00:00.0	515	"OFF"	27.2	7.7	24	10.6	27.8	9	63.05	18.09
2013-05-29 16:00:00.0	516	"OFF"	21.8	12.8	26.7	16.8	18.3	6.8	64.79	14.68
2013-05-29 18:00:00.0	517	"OFF"	23.2	9.5	19.4	9.6000	20.4	6.6	64.02	18.22
2013-05-29 20:00:00.0	518	"OFF"	12.6	9.3	9.9	8.2	9.8	5.5	56.63	28.51
2013-05-29 22:00:00.0	519	"OFF"	16.7	9.6000	8.3	2.1	15.9	8.1000	52.54	29.86
2013-05-30 00:00:00.0	520	"OFF"	9.1000	6.4	6.2	3.7	6.7	2.8	50.46	32.66
2013-05-30 02:00:00.0	521	"OFF"	6.6	1.1	7.5000	3.8	11.5	5.7	46.47	41.56
2013-05-30 04:00:00.0	522	"OFF"	4.7	0.6	8.3	2.6	5.8	1.2	44.03	48.32
2013-05-30 06:00:00.0	523	"OFF"	7.7	2.3	7.9000	3.2	4.8	1.7	44.66	40.35
2013-05-30 08:00:00.0	524	"OFF"	7.5000	2.9	8.1000	2.7	5.1	2.5	51.93	46.92
2013-05-30 10:00:00.0	525	"OFF"	9.6000	4.9	7.6	3.9	7.0000	3	54.97	30.39
2013-05-30 12:00:00.0	526	"OFF"	14.5	9.5	15.9	7.7	9.6000	4.5	67.49	13.42
2013-05-30 14:00:00.0	527	"OFF"	17.5	6.4	18.4	10.3	13.7	6.3	72.75	6.931
2013-05-30 16:00:00.0	528	"OFF"	20	7.1	18.8	12	14.7	6.1	70.24	11.35

Data Table – 2 hour

-----Original Message-----

From: rwismonod9@yahoo.com [<mailto:rwismonod9@yahoo.com>]

Sent: Tuesday, May 21, 2013 5:25 AM

To: Ngo, Mitchell M@DOT; 7609370565@vtext.com

Subject:

Wind Beacons ON @ 05/21/2013 12:25:13.32

Gust (MPH): Main 26.3, NB 30.5, SB 27.5

-----Original Message-----

From: rwismonod9@yahoo.com [<mailto:rwismonod9@yahoo.com>]

Sent: Tuesday, May 21, 2013 10:33 AM

To: Ngo, Mitchell M@DOT; 7609370565@vtext.com

Subject:

Wind Beacons OFF @ 05/21/2013 17:32:52.28

Gust (MPH): Main 18.9, NB 29.1, SB 27.3

Sample SMSs – Beacons On & Off

-----Original Message-----

From: rwismonod9@yahoo.com [<mailto:rwismonod9@yahoo.com>]

Sent: Tuesday, May 21, 2013 5:43 AM

To: Ngo, Mitchell M@DOT; 7609370565@vtext.com

Subject:

Wind Beacons ON and Recommending Close Watch @ 05/21/2013 12:42:28.39

Gust (MPH): Main 41.1, NB 31.8, SB 30.5

-----Original Message-----

From: rwismonod9@yahoo.com [<mailto:rwismonod9@yahoo.com>]

Sent: Tuesday, May 21, 2013 6:00 AM

To: Ngo, Mitchell M@DOT; 7609370565@vtext.com

Subject:

RH High Wind Watch Update @ 05/21/2013 13:00:00.78

Gust (MPH): Main 46.6, NB 35, SB 30.5

Beacon NB:ON

Beacon SB:ON

Sample SMSs – High Winds

- Anemometer: R.M. Young 03105-5
- Propeller type
- Accurate, durable, serviceable
- Icing not a problem
- Mounted at 16 feet for serviceability
- Temperature/Humidity: SC HMP45C
- Mounts in solar shield

Weather Sensors

- Campbell Scientific RF401
- 900 MHz spread spectrum – unlicensed
- Actual distance: <1 mile
- Tested range: 4 miles
- 3dB Omni-directional antennas

RF RPU Links

- Ctek 4400
- Advantages – versatility & configurability
- Accessory: Power Minder - for voltage data
- “Trucker” Omni antenna – same as used for many D9 Census sites.

Cellular Modem

- Two Post Signs – 6"x8" wood
- 16' Tower – 1A signal pole (4 ½" galv.) with 2" square metal extension
- Security...

Miscellaneous

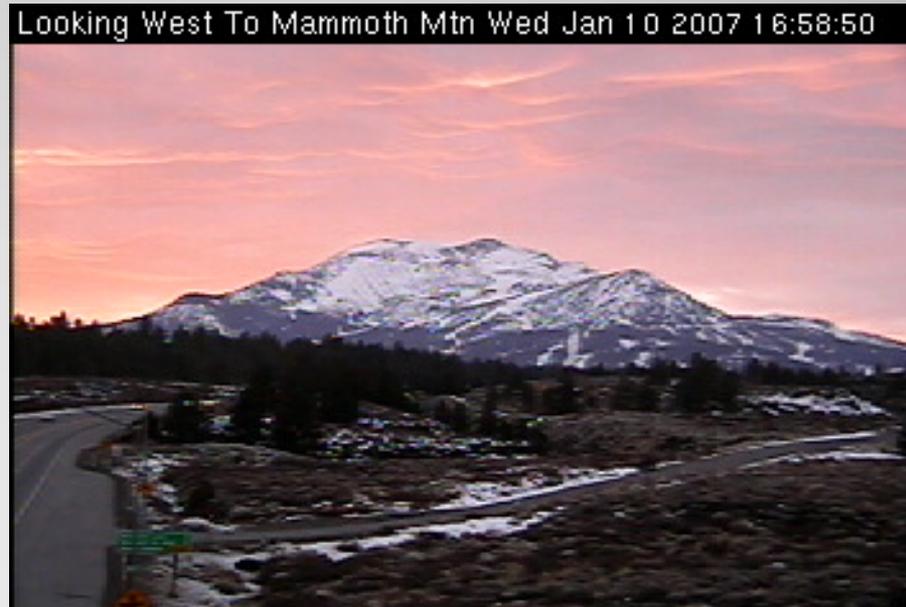
- Calculate & Use Crosswind Vectors
- US 6 – Benton, US 395 – Jct. SR14 to Independence

Future Work & Projects

- Learn from pioneers
- Keep it simple...
- as long as it works!
- Expect unforeseen challenges

Lessons Learned

- Philip Graham: philip.graham@dot.ca.gov
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- Mitchell Ngo: mitchell.ngo@dot.ca.gov
(760) 872-0628



Contacts...

Questions? Comments?