



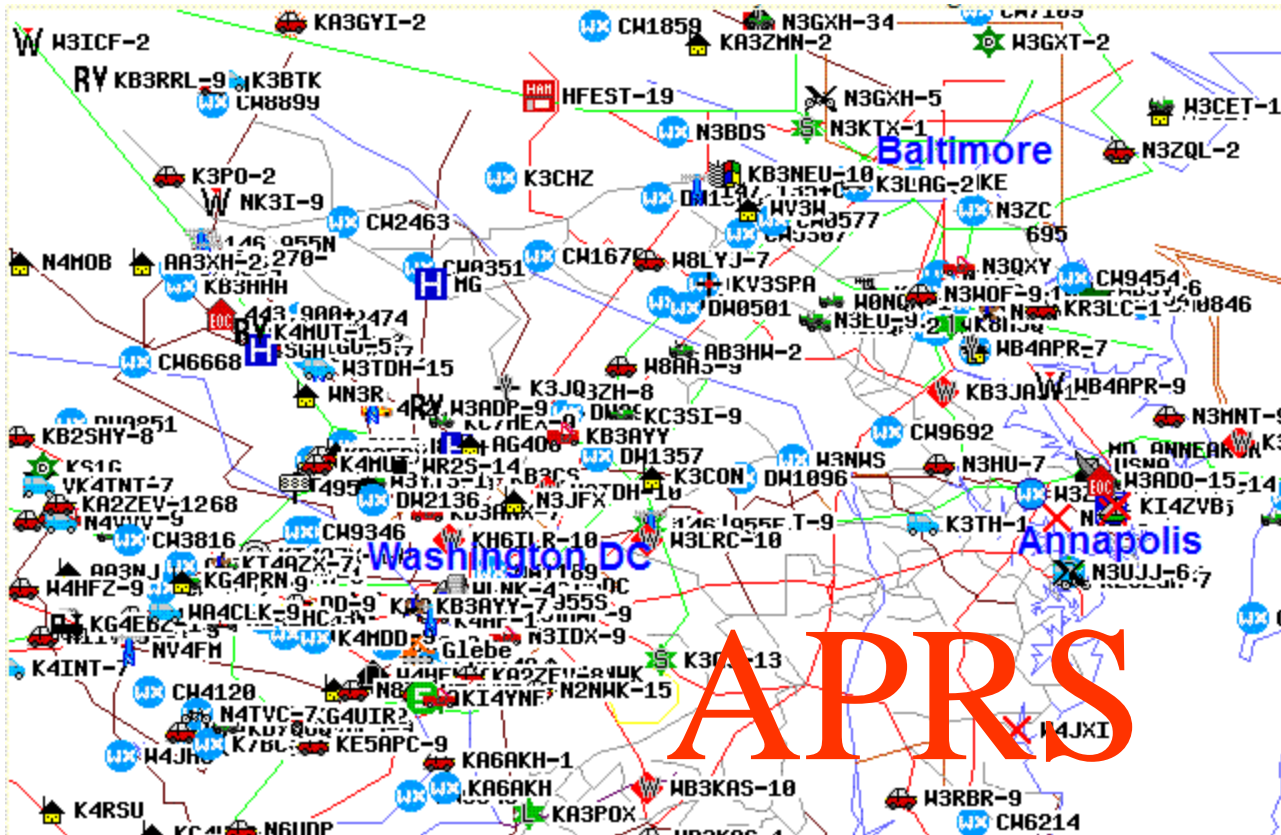
Peoria Superfest 2015

APRS Satellites and Solar/EV Energy



- APRS Satellites
- APRStt !!!
- Solar Energy
- Electric Cars

APRS is everywhere *



300 stations
In 35 miles

35 mi

Find any station, Any map, Anywhere- <http://aprs.fi>

APRS Terrestrial Data Relay Network

- Supports over 20,000+ terrestrial users and experimenters.



- But stops at the shoreline and has huge holes in the wilderness

The Saga of The Elect-Reck



1970 1970

WB4APR Background



Energy!

← 1965 QST



1983



2010



1990



2012



2007



2013



Future?



2009

WB4APR Background

2015

I can't believe I have lived long enough to see Solar cost half of the utilities and EVs cost less than, and out perform gas cars!

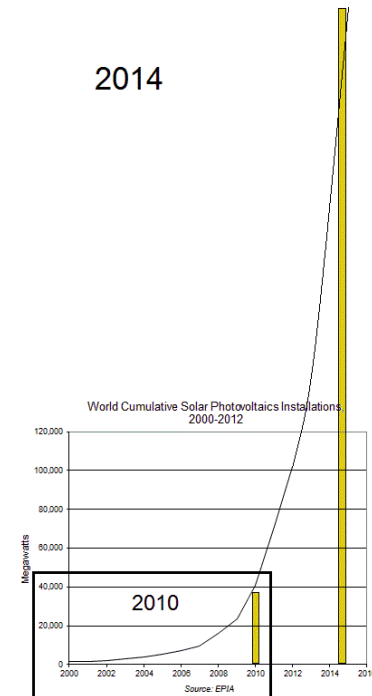
The Electric Vehicle Association of Greater Washington DC evaa.org

Electric Vehicle Information Sheet

	Base Price (\$USD)	Net Price (\$USD)	Range (mi)	Batt. (kWh)	Speed (mph)	MPG equiv.	Fuel / QC	QC
Zenm Z-219-A	\$13,345	\$13,345	76	9.4	95	462	---	Y
Brammo Empulse	\$24,995	\$26,995	80	10.2	110	---	\$19	
Mitsubishi i (e-AMiV)	\$22,995	\$23,995	62	16	80	122	\$46	Y
Smart electric	\$25,000	\$27,000	88	17.6	79	207	\$46	
Chery Spark EV	\$26,885	\$28,385	82	21.8	80	139	\$42	Y
Nissan LEAF	\$29,010	\$29,510	84	24	95	134	\$46	Y
Ford Focus Electric								Y
Ford Focus Energi								Y
Ford C-Max Energi								Y
Chery Walli								Y
Ford Focus Energi								Y
Honda Accord Plug-in								Y
Audi A3 e-tron								Y
Audi A3 e-tron								Y
Cadillac ELR								Y
Porsche Cayenne								Y
VW VR6 (e-up)								Y
Porsche Panamera								Y
BMW i3								Y
Porsche 918 Spyder								Y
Panamera SE Hybrid								Y
Cayenne SE Hybrid								Y
Porsche 918 Spyder								Y
Tesla Model S								Y
Tesla Model X								Y
BMW i3								Y

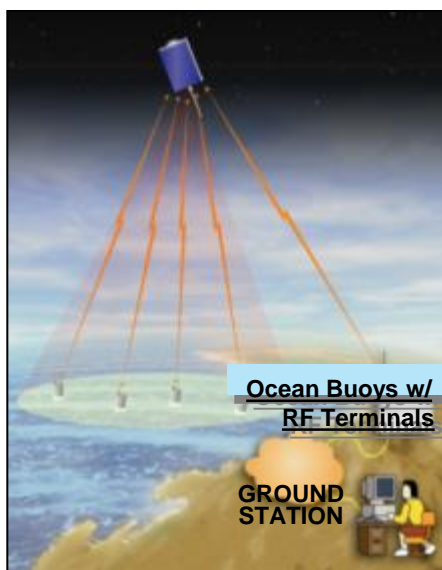
40 full size EVs in 2015!

2014

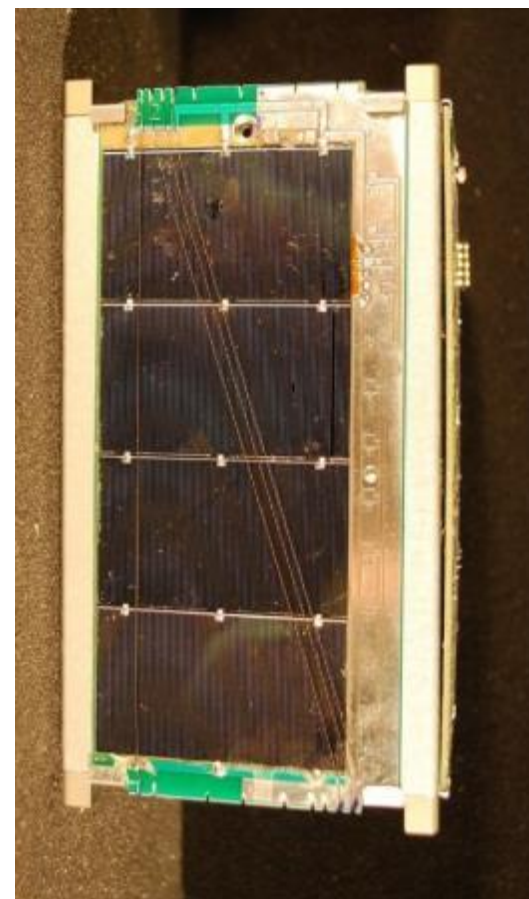


APRS Satellites

2015 Smallsat Cubesat Conference, Utah



PCSAT	2001
ISS	2006
PSAT	2015
QIKCOM2	2016



**A satellite relay channel for Amateur
Satellite User data anywhere on earth.**

PSAT

Solution: Ground Terminal Applications Focus

Supports Student Experimenters world wide



OR

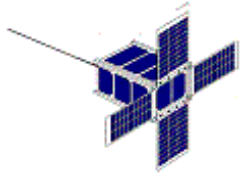


OR

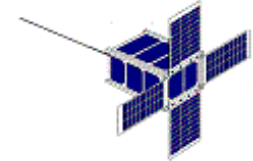


Quicker Student involvement using a Ground Terminal Operational Concept

Ground Terminal Applications Focus (force tracking and text-messaging)



Supports Student Experimenters
School missions/movements
Theater area communications
and Emergency Response Comms



The Yard Patrol Craft



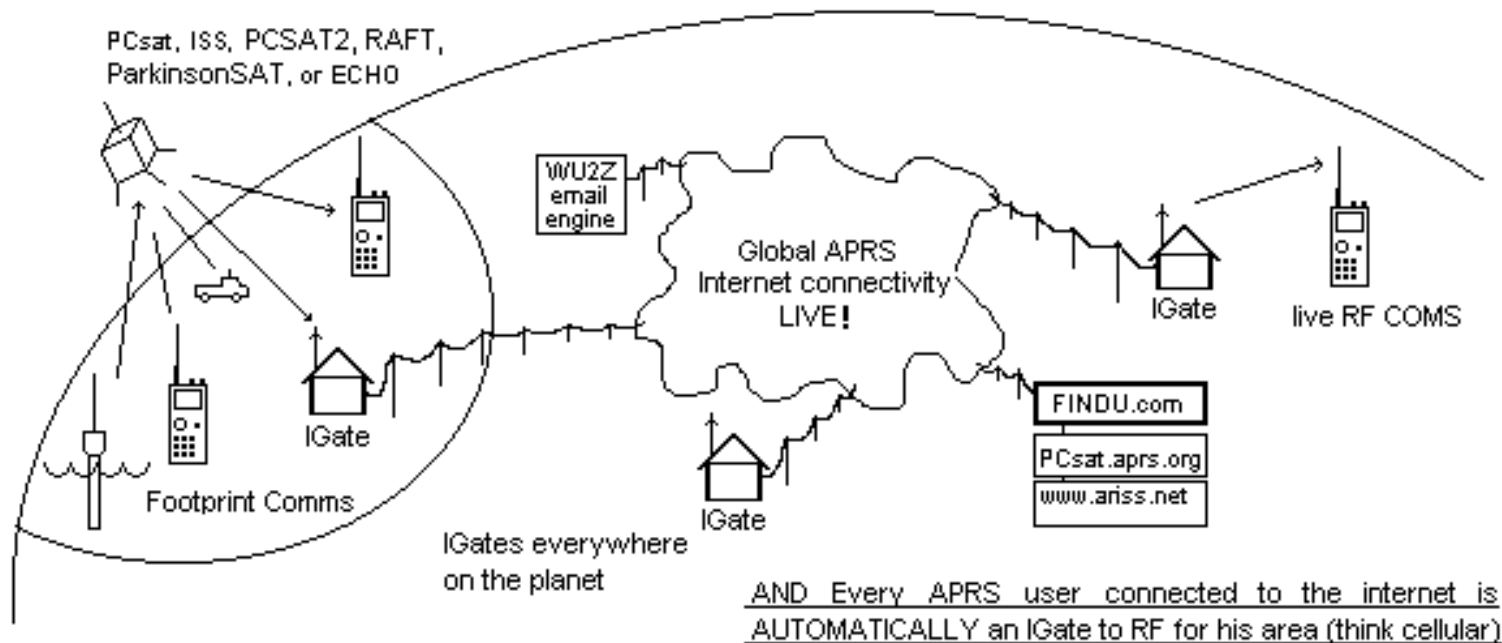
13th Co Army/Navy Football Run
Comms by USNA Radio Club
W3ADO



Education
Force
Multiplier!

APRS Local & Global Internet linked Data Network

Global APRS Real-Time Connectivity (End-to-End Everywhere)



APRS Global Packet Radio Network

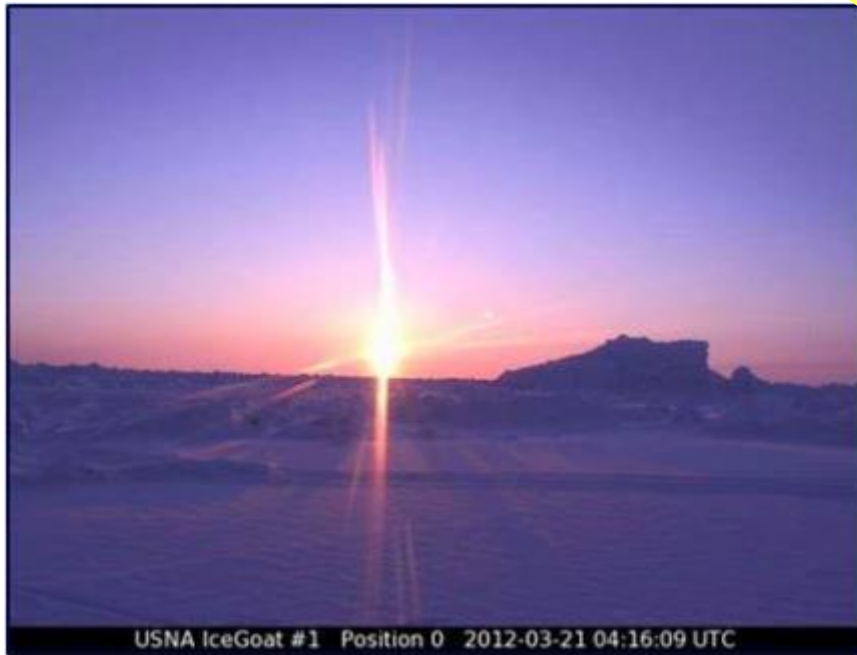
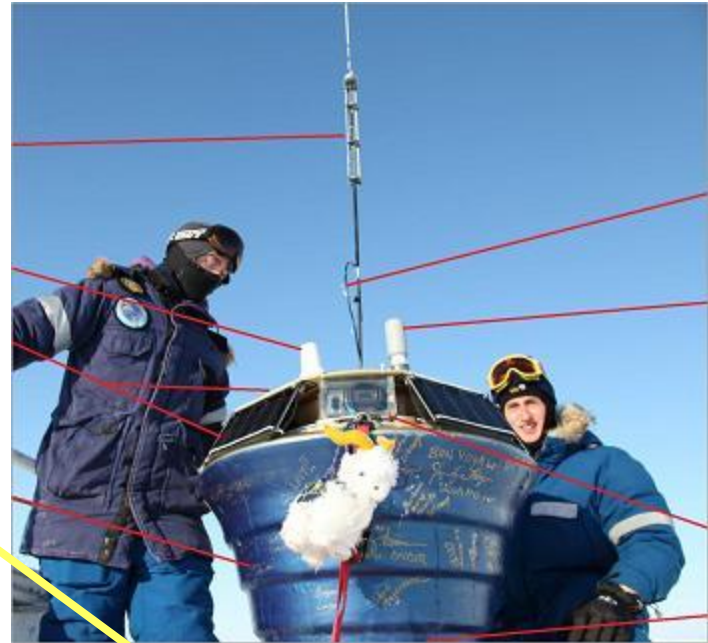
Internet Linked for live Communications

Automatic Packet Reporting System

Arctic Buoy Student Experiment

- USNA Arctic Buoy deployed March 2012

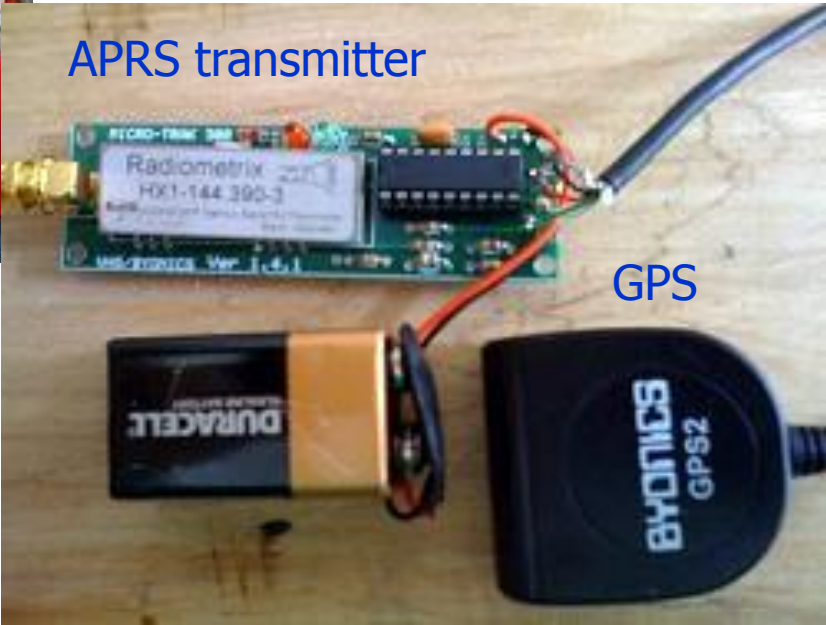
The APRS piece



Example Remote Sensors using APRS Protocol



Very Simple



APRS transmitter

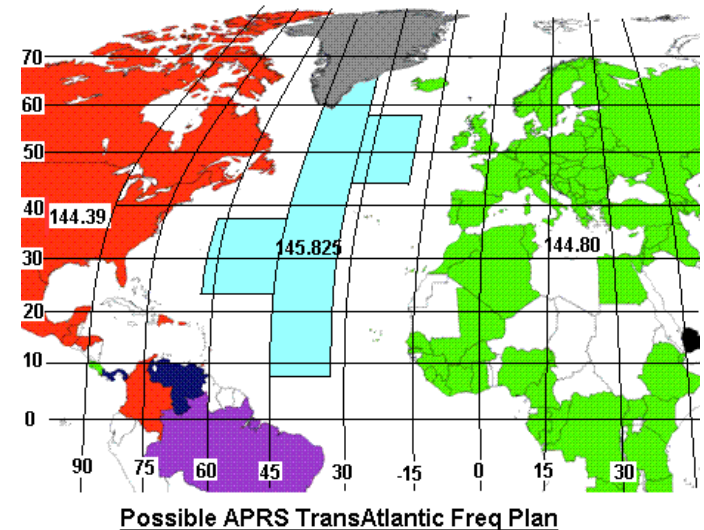
GPS



Why We Need Psat Satellite Transponders



- Transatlantic APRS balloon launched and tracked through terrestrial network
- Lost comms over Atlantic Ocean
- It could have been picked up by our Psat/Pcsat transponder or the ISS



Global Wilderness Areas (90% of Earth)

- Live Global APRS Balloon Tracking Web Page



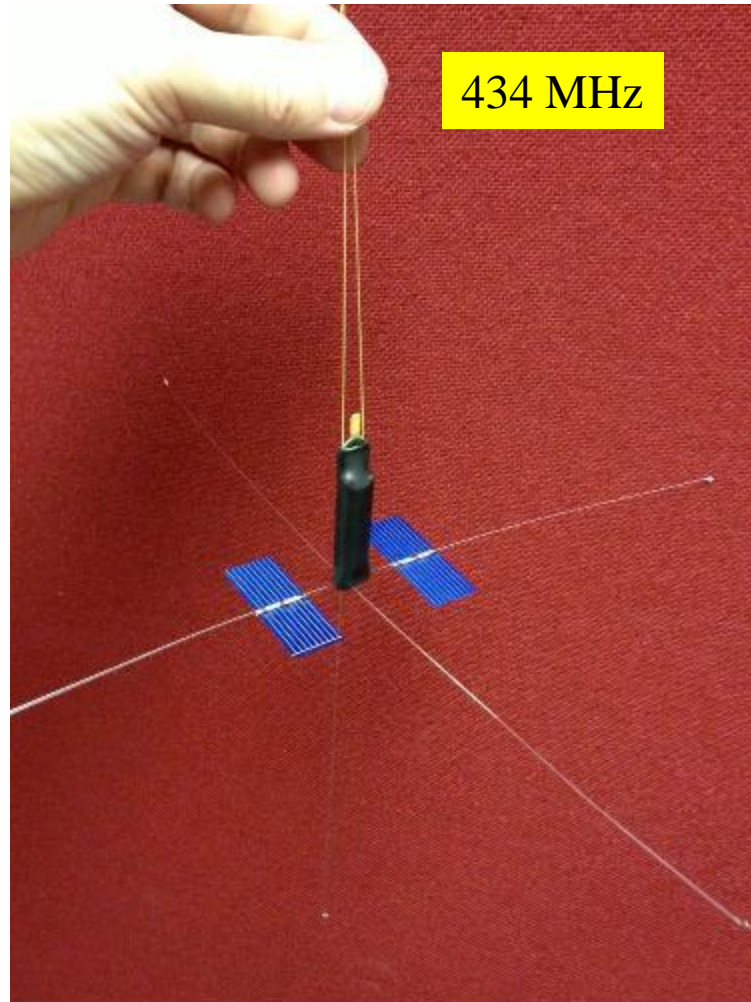
Global Wilderness Areas (90% of Earth)

MOXER-3, 4 and 6

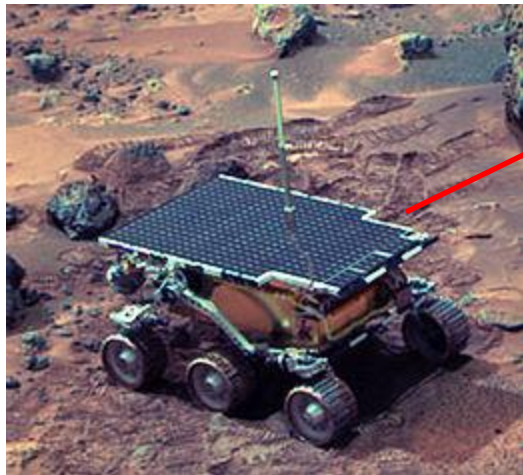
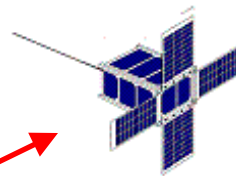
- Live Global APRS Balloon Tracking Web Page



Tiny M0XER APRS (balloon data) payloads



MAREA* Rover Projects (ARRL)



- STEM School projects
- Excite kids with Robotics
- Drive anywhere on Earth!
- Via APRS links
- School-to-school

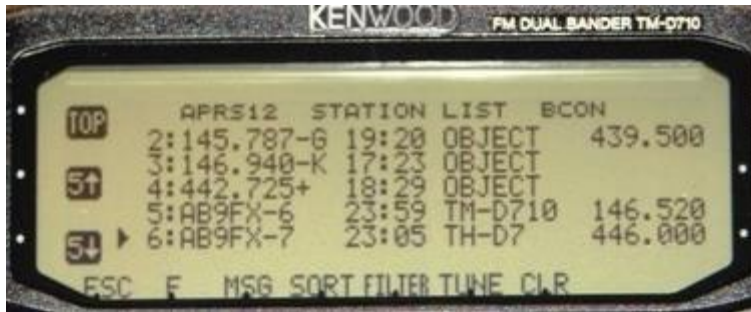


*<http://www.arrl.org/marea-ham-radio-robotics>

Ground Terminal Applications Focus

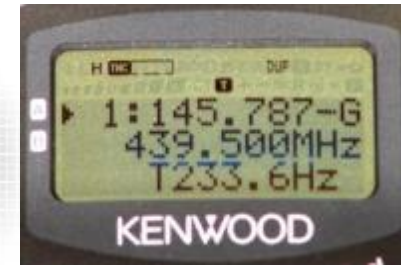
Tactical Situational Awareness and Text Messaging

Last 100 stations!



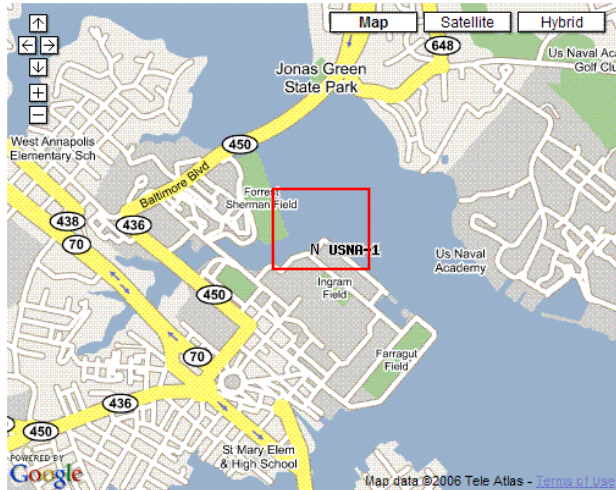
Direction & Distance

Frequency and Tone



Tracking (on Google Earth)

<http://aprs.fi>



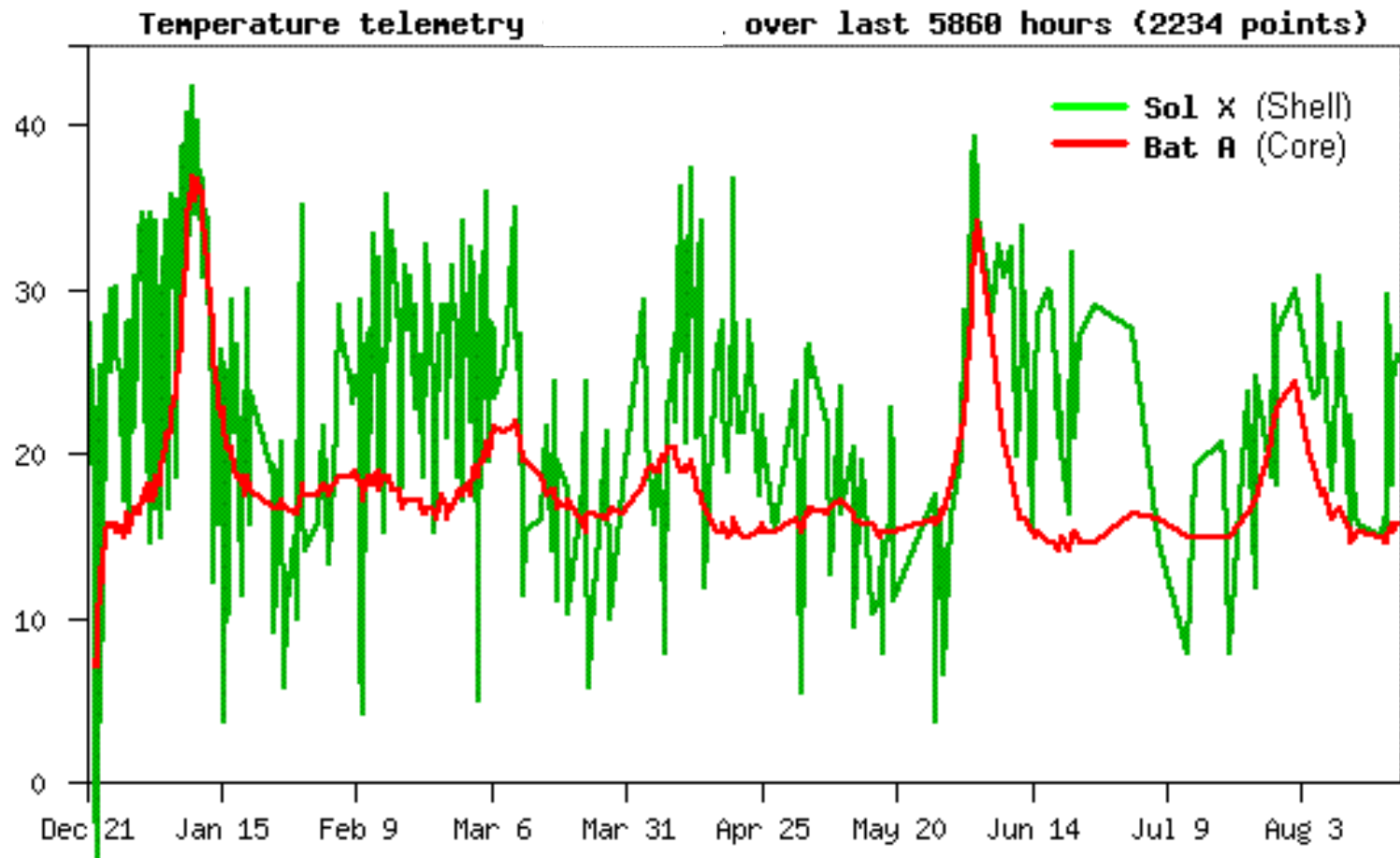
Tactical situational awareness



Findu.com Telemetry Plots

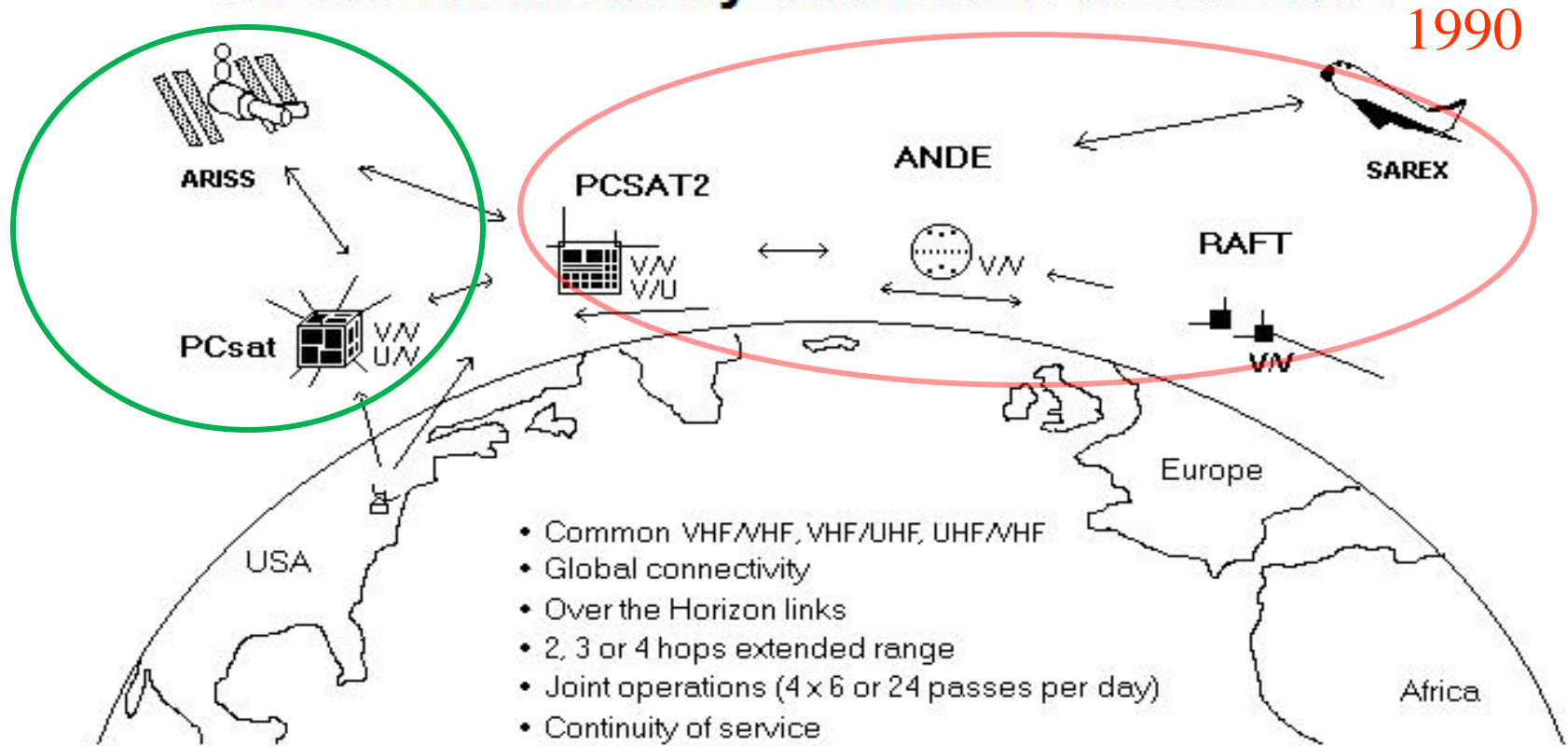


Live Example: www.aprs.org/wb4apr-15.html



All on 145.825 MHz

APRS Data Relay Satellites since 2001



See live downlink on <http://pcsat.aprs.org> and www.ariss.net

WB4APR

Huge reduction from transponders on PCSAT's 1,2, ANDE and RAFT missions

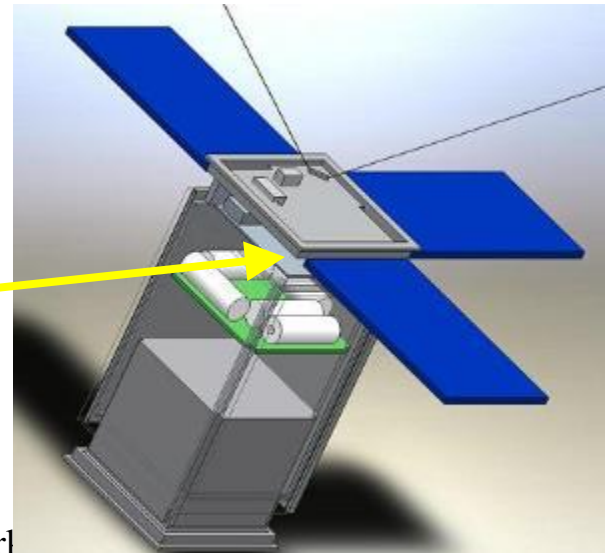
Posat USNA-0601



Earlier reductions to 5" cubesat on RAFT (2006)

4:1

Now reduced 18:1
in volume/mass for
4" cubesat 2009



APRS Global data network

Psat APRS Network Architecture



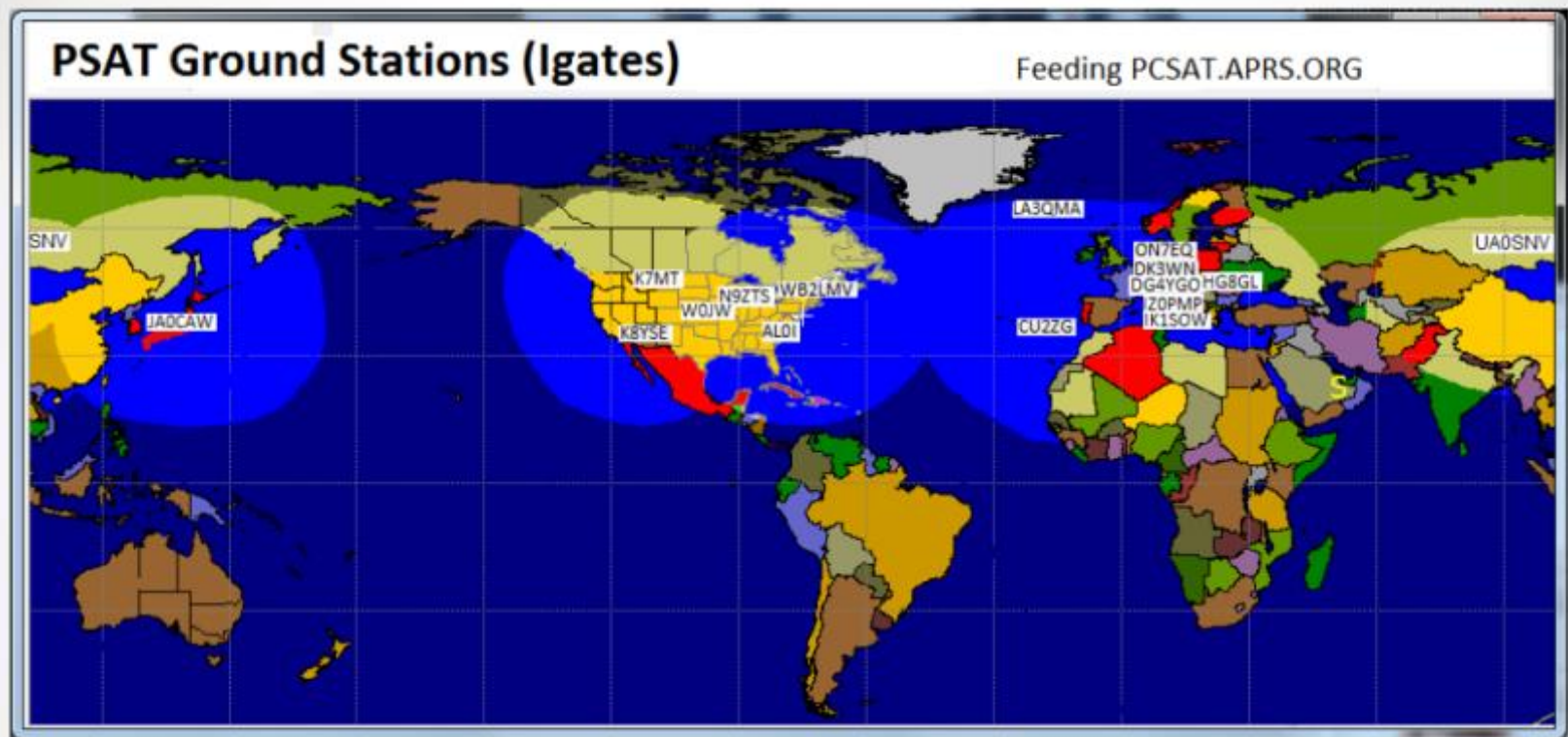
Global Volunteer Ground Station Network

Internet Linked for live Telemetry



APRS Global data network

70 APRS Satgates hear ISS, but only 10 hear PSAT (-17 dB)



9W2CEH, 9W2DIE, 9W2JDY, AI9IN, AL0I, BD8TE, CU2ZG, DG4YGO, DH7JC, DK3WN, DL5MAM, EA1JM, EA6XQ, F4GUK, F8COD, FR1GZ, HG8GL, HR1PAQ, HS0BBD, IK1SOW, IS0AML, IZ0PMP, JA0CAW, JA2PIT, JA5BLZ, JE9PEL, JH1LWU, JH4XSY, JJ1WTK, K0KOC, K4AG, K7GPS, K7MT, K8YSE, KB1CHU, KB1PVH, KB3KBR, KB9ZWL, KC2WBX, KC4AAC, KC9DOA, KD0KZE, KD0PGM, KD8TH, KG6HSQ, LA3QMA, LU1DZL, LU1WU, LU2HAM, LW2DTZ, M0NRT, N0AGI, N5DUX, N5KAR, N9ZTS, NK7N, ON7EQ, PA3EKM, PA3GUO, PA6HAP, PP5CAM, PT2AP, R4UAB, RA2FG, SM5RVH, SQ5RTW, SV3RNJ, UA0SNV, UW7HR, VK2JNG, VK4CBW, VK8MA, VO1BIL, W0JW, W7HR, W7KKE, WA8LMF, WB2LMV, YD0NXX, ZL1KM, ZL2CIA, ZS5YE, ZS6AAG

APRS iGate

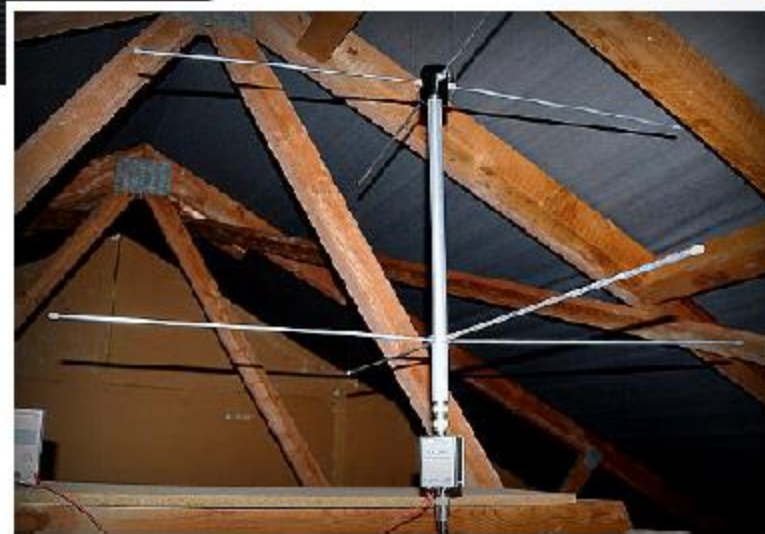


APRS iGate
with Raspberry Pi
and DVB-T stick

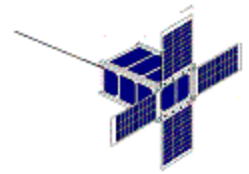
DK3WN

<http://www.kubonweb.de/?p=130>
<http://www.mstewart.net/super8/aprs/RASP/index.htm>
<http://n5dux.com/ham/raspberrypi/igate.php>
<http://www.radio.cc/post/aprs-igate-with-raspberr-pi-setup>

Raspberry PI iGate APRX with soundmodem
https://www.youtube.com/watch?v=MtUnuJn_70o



Remote APRS Sensor Baseline



Naval Academy Student Project

- * If free-floating, do not disturb.
- * If aground, move to deep water and advise bruninga@usna.edu
- * If later than 30 Nov 2006, recover and advise above.



2006 15:1 reduction

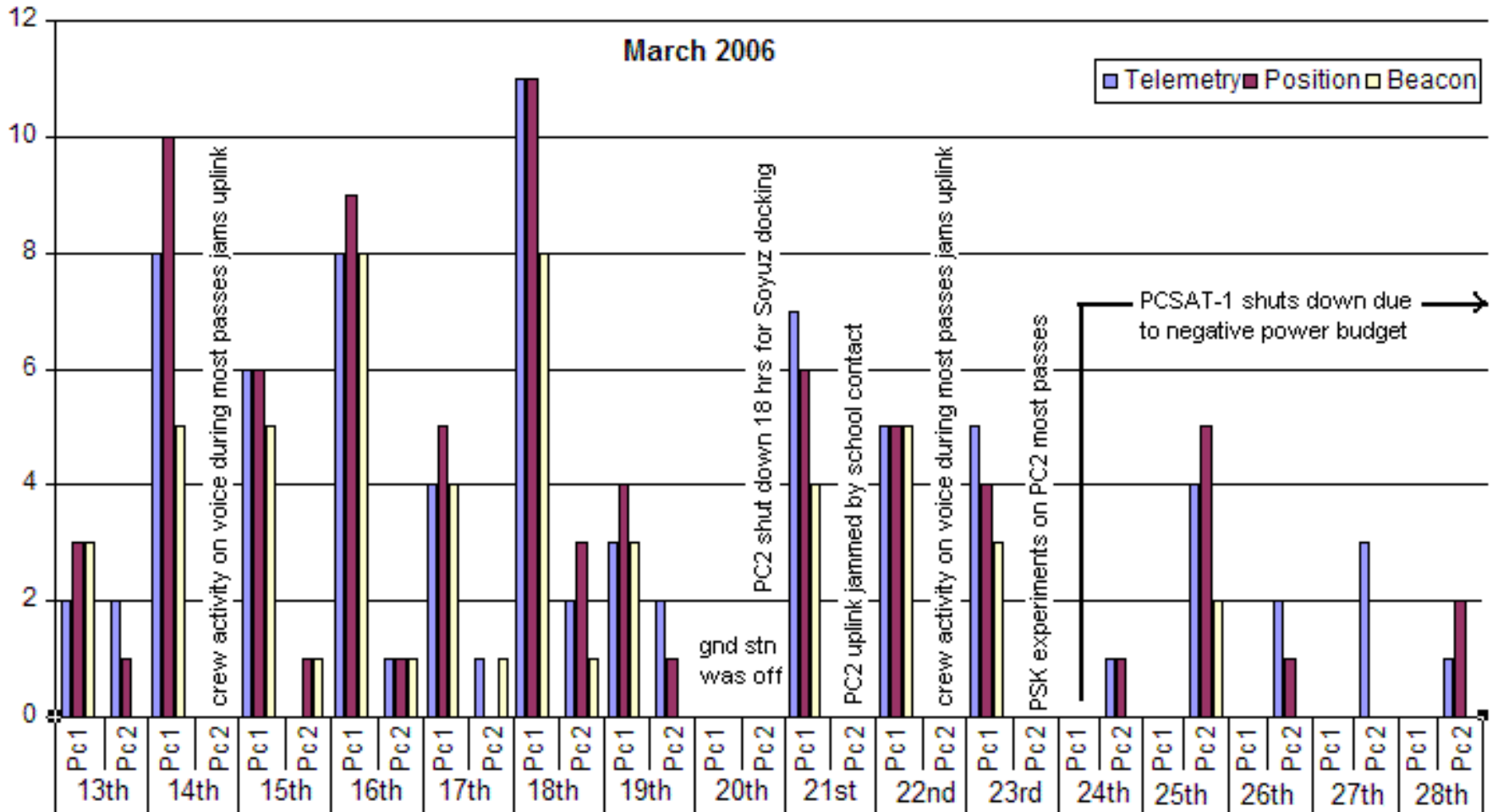
2
0
0
8



See Buoy Location and Telemetry at
<http://www.ew.unsa.edu/~bruninga/buoy4.html>

Remote Buoy Baseline Test – Success of 1 min Xmit rate

Number of Buoy Packets Received Per Day via PCSAT-1 and PCSAT2

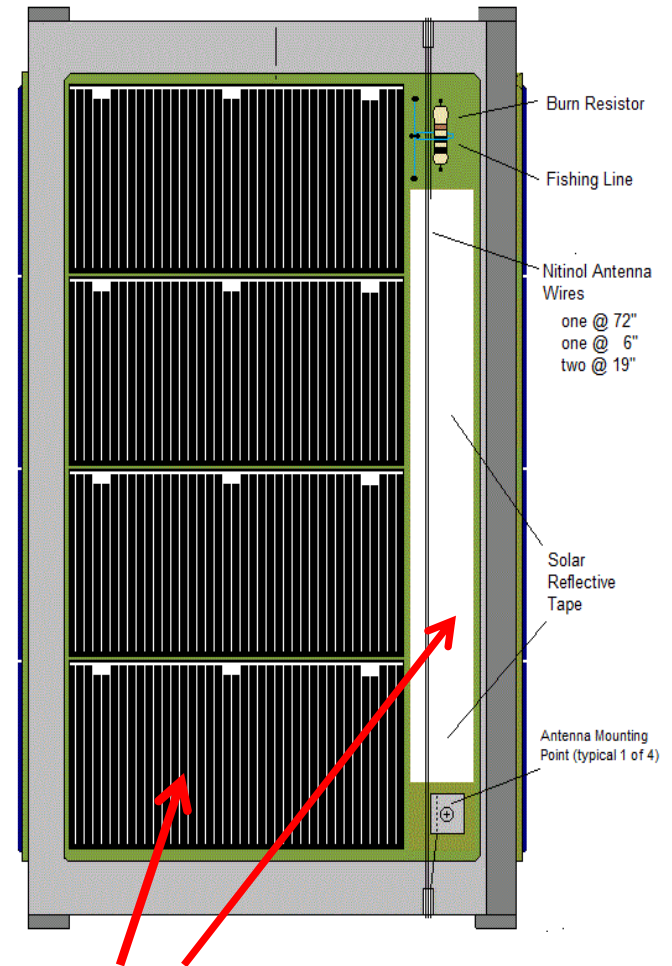
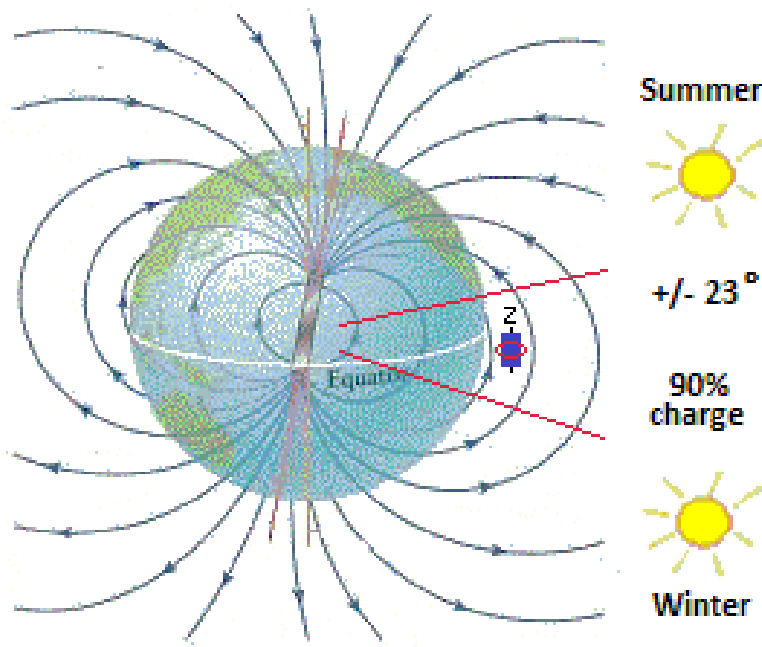


QuickLook: Global APRS Data Network

- aprs.fi - Every Packet on Earth
- ariss.net - Every packet via ISS
- pcsat.aprs.org – Every packet via PCSAT

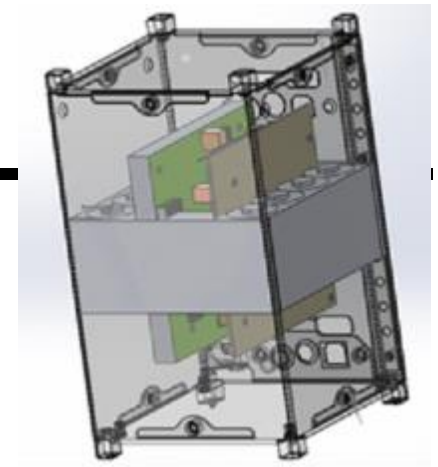
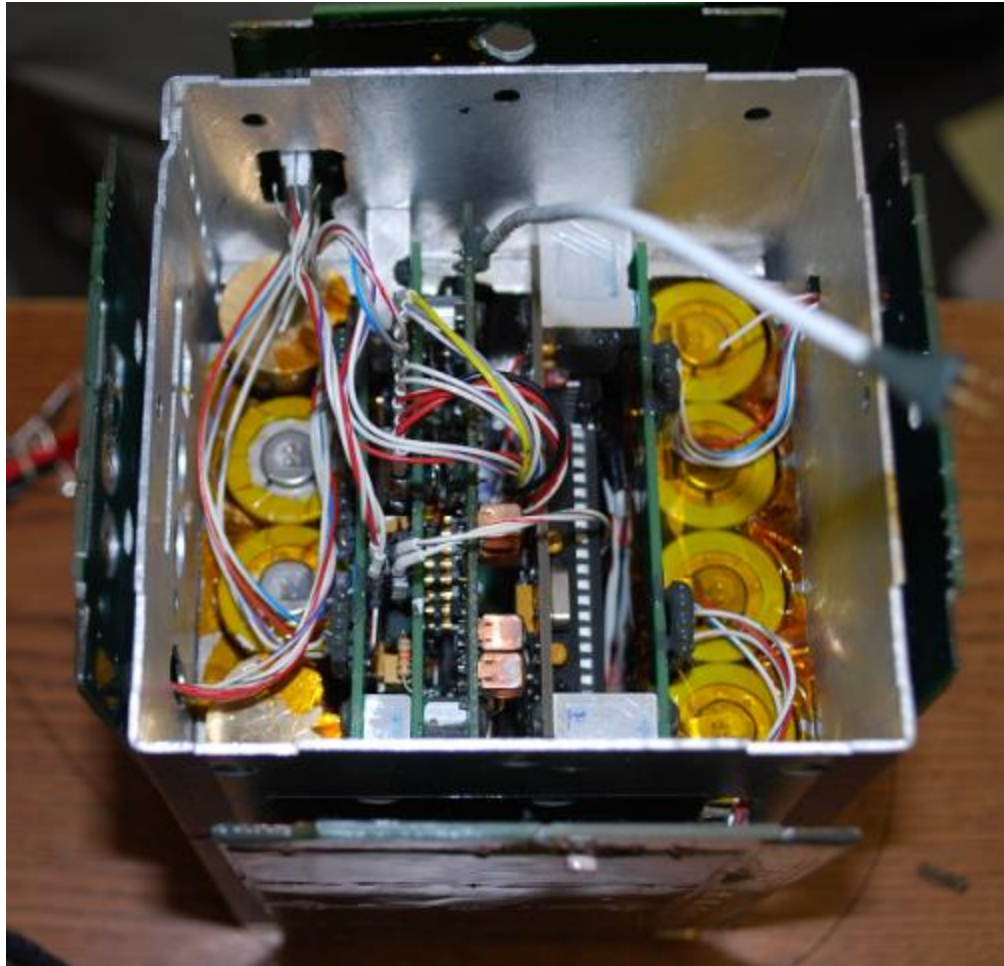
Psat Unique Power Attitude – Z coil ADCS

- Uses only one Z coil for attitude Control
 - Fires only within +/- 20 deg of Equator
 - Solar Panel angle better than 95% power
 - Higher reliability
 - Passive Spin maintenance



Differential Radiation Spin

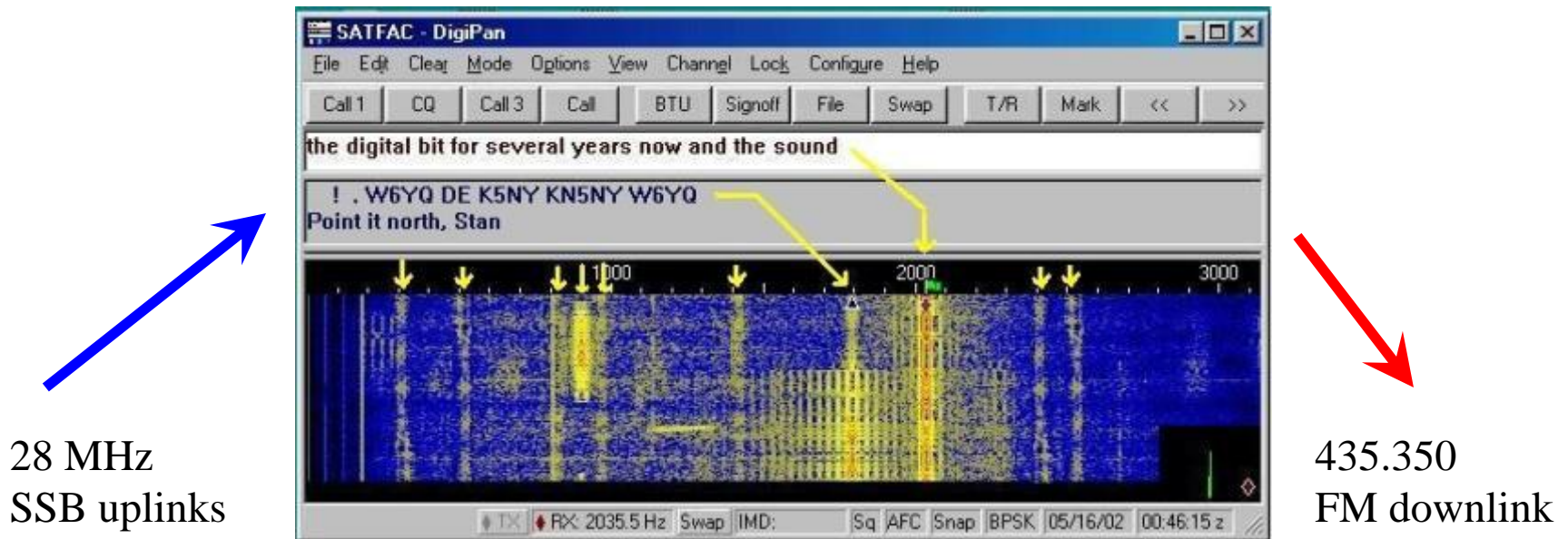
PSAT's mass is centered in Z



- For Maximum MOI about Z
- Batteries to outside for MOI & Shielding
- Stainless steel belt around everything

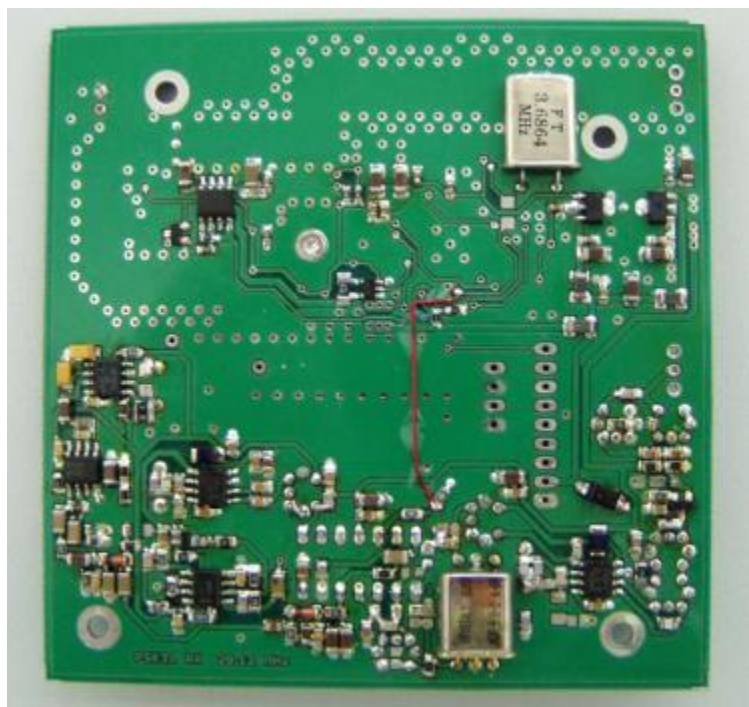
PSAT: Aux PSK31 Transponder Payload

- Flew on PCSAT2 on ISS but astronaut broke off HF antenna
- Flew on RAFT but took 1 kW uplink and negative power budget
- Now Operational since May 2015 launch of PSAT and BRICsat
- Both transponders built at Brno Univ, Czech Republic.

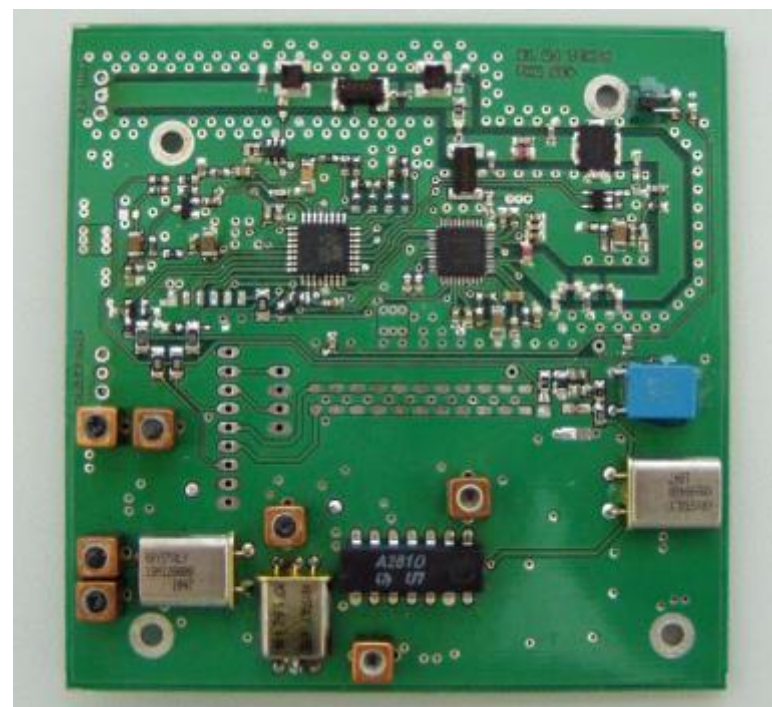


PSAT: PSK31 Transponder Payload !!!

Built *Dr. Mirek Kasal OK2AQK* and students Tomas Urbanec, P. Vágner



HF Linear RX



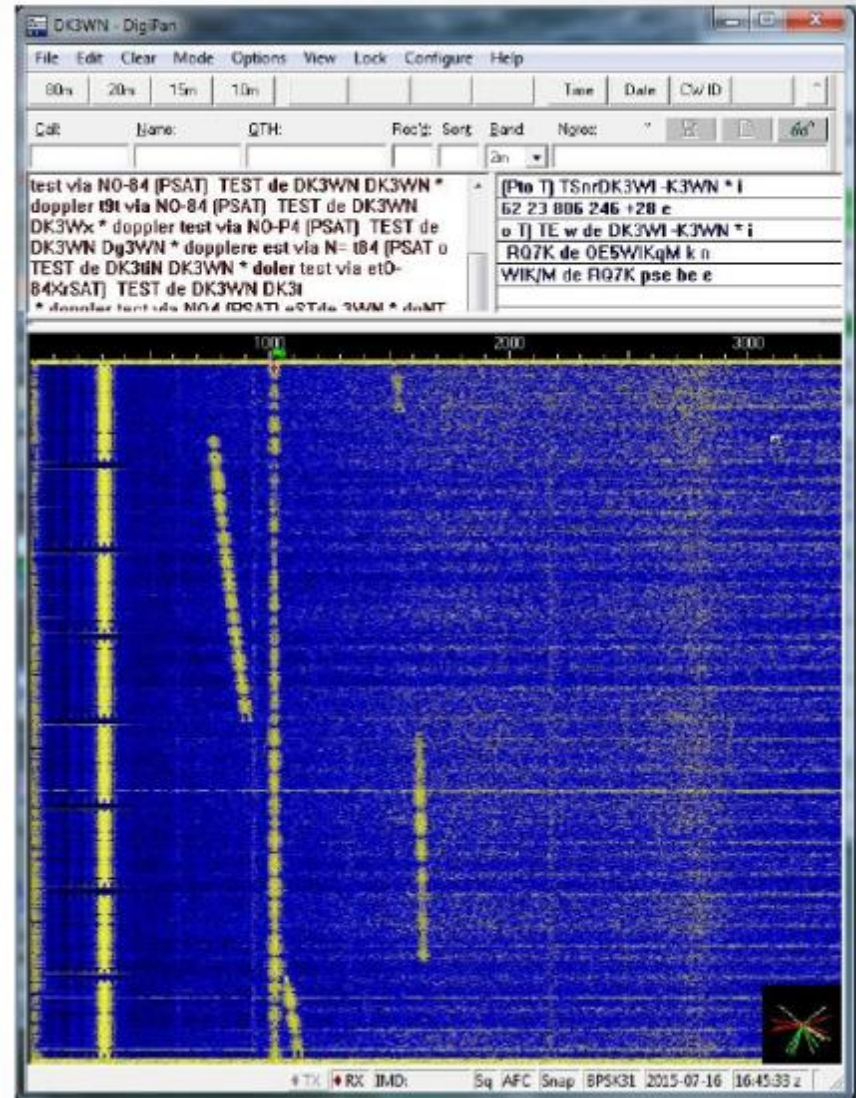
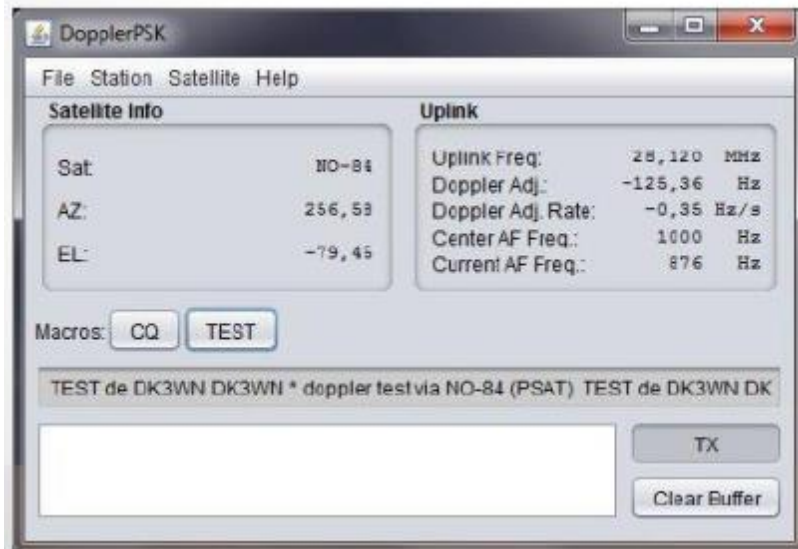
FM XMTR

PSK DopplerPSK

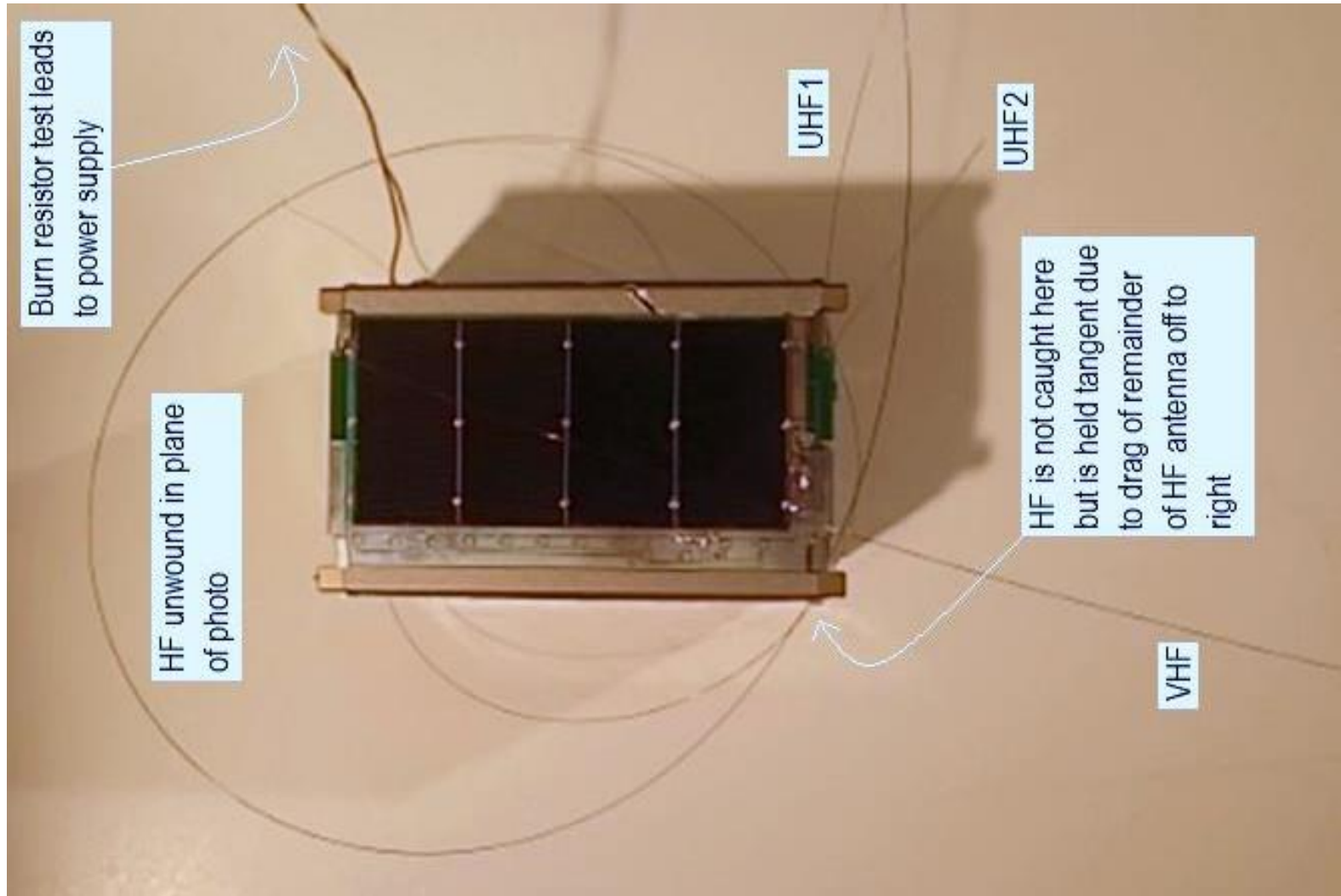
by Andrew Flowers K0SM

- experimental program to compensate the doppler shift on PSK31 uplinks
- its a PSK31 transmitter that is merged with an orbital propagator to cause your the transmitted signal to drift exactly opposite to uplink doppler effect

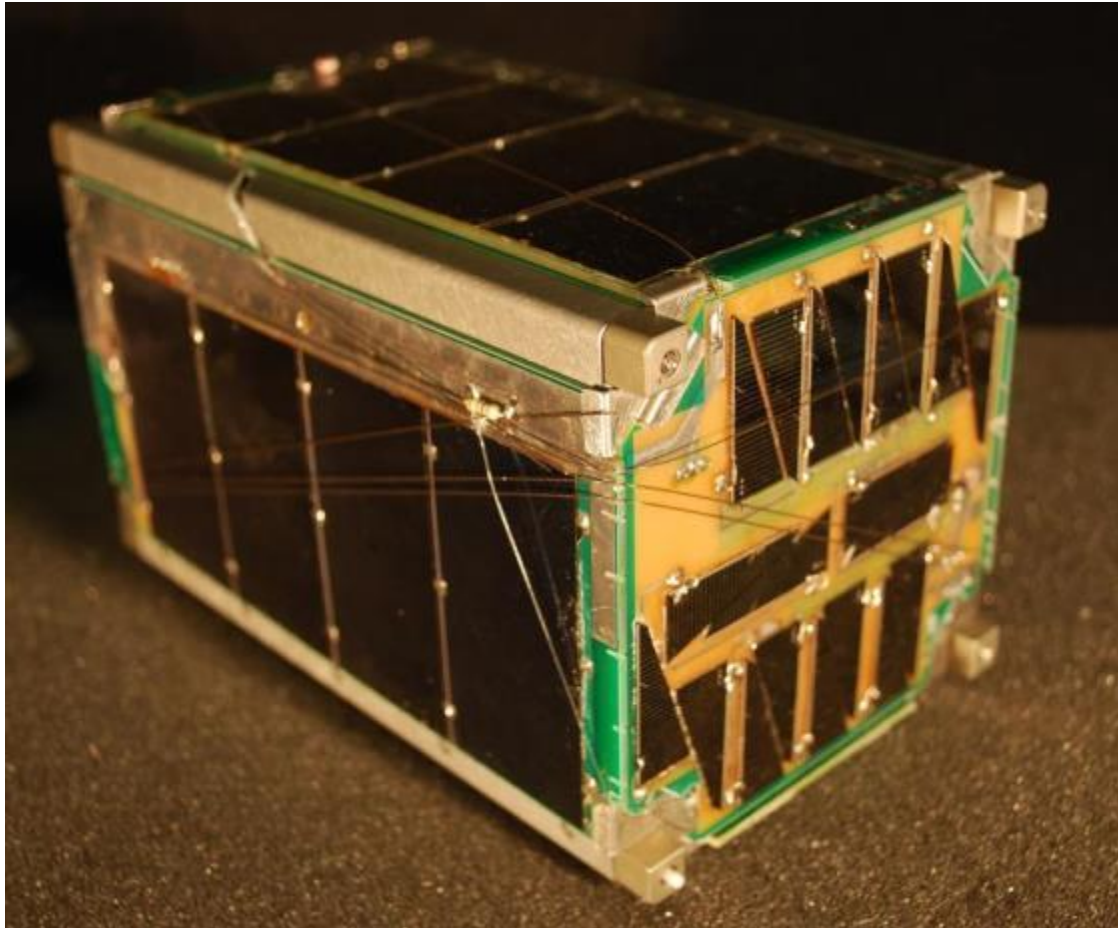
<http://www.frontiernet.net/~aflowers/dopplerpsk/dopplerpsk.html>



PSAT Nitinol Wire Whip Antennas



Wrapping Antennas to one Burn Resistor



2 Orthogonal
UHF whips

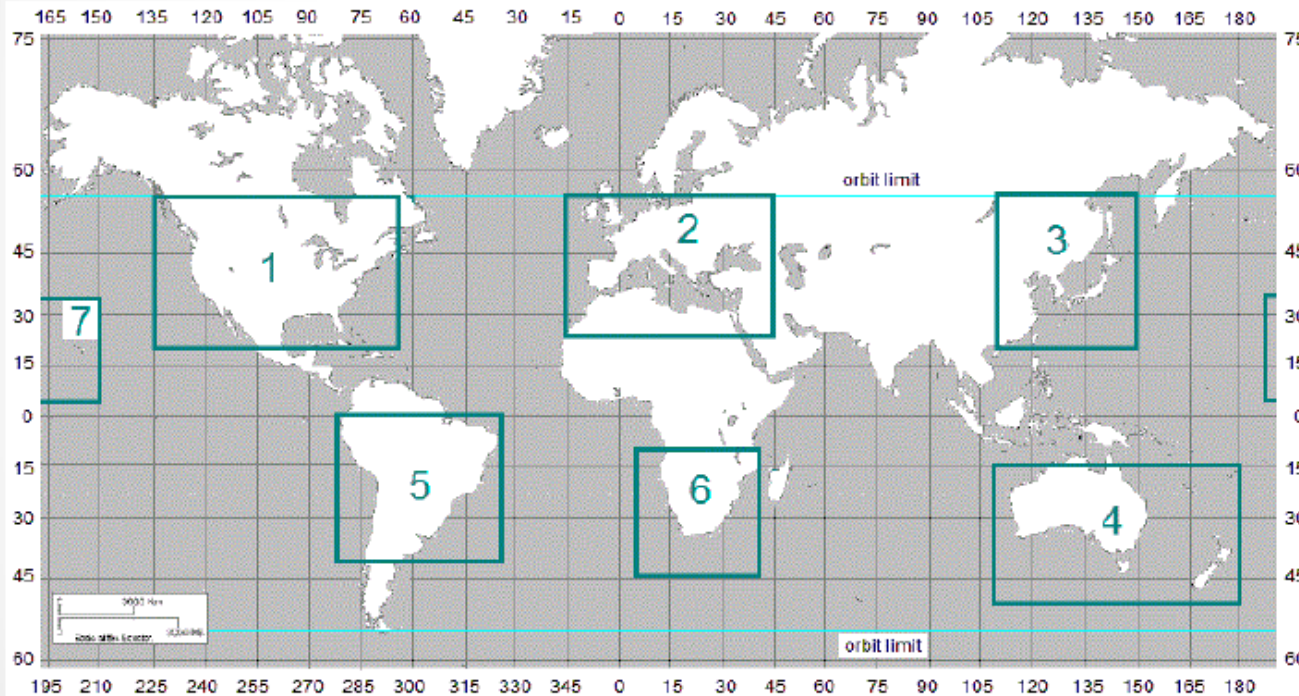
One VHF whip

One 6' HF whip

3rd Enable Switch

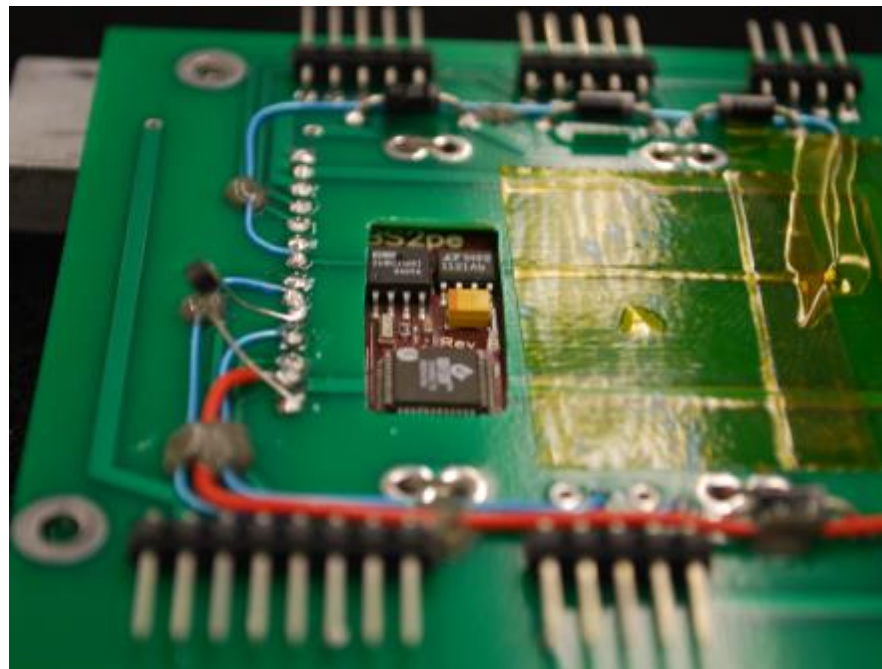
PSAT bulletin packets

PSAT contains 3 bulletins for every country area, BLN0USA, BLN1USA, BLN2USA for example over the USA. The same geographical areas are used for sending Bulletins.



```
PSAT-1>APOFF,ARISS,qAR,ON7EQ-10::BLN0USA :PSK31 435.35 Up on 28.12
PSAT-1>APOFF,ARISS,qAR,HG8GL-5::BLN1USA :ARISS.NET & PCSAT.APRS.ORG
PSAT-1>APOFF,ARISS,qAR,ON7EQ-10::BLN2USA :See APRS.FI & 144.39 users
PSAT>APRSON,ARISS,qAR,DK3WN-8::BLN0EUR :PSK31 435.35 Up on 28.12
PSAT>APRSON,ARISS,qAR,DK3WN-8::BLN1EUR :Coming soon -> AMSAT-UK Colloquium July 24-26th at Guildford
PSAT>APRSON,ARISS,qAR,DK3WN-8::BLN2EUR :See APRS.FI & 144.80 users
```

How not to Make a Satellite



Make sure it fits

Stop adding neat features...

Our Next APRS Satellites

QIKcom-1

- APRS system (PSAT)
- Release from ISS in October 2015
- flies on host spacecraft (28V, no solar panels or ADCS)

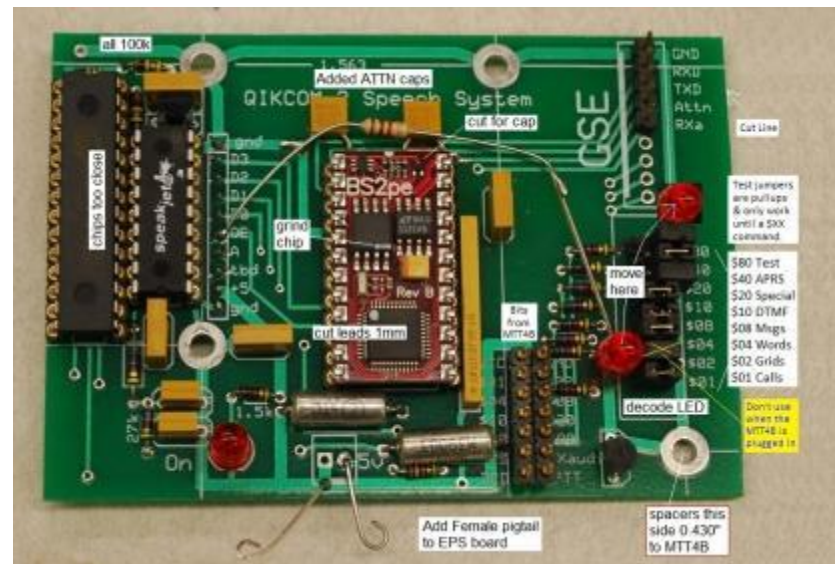
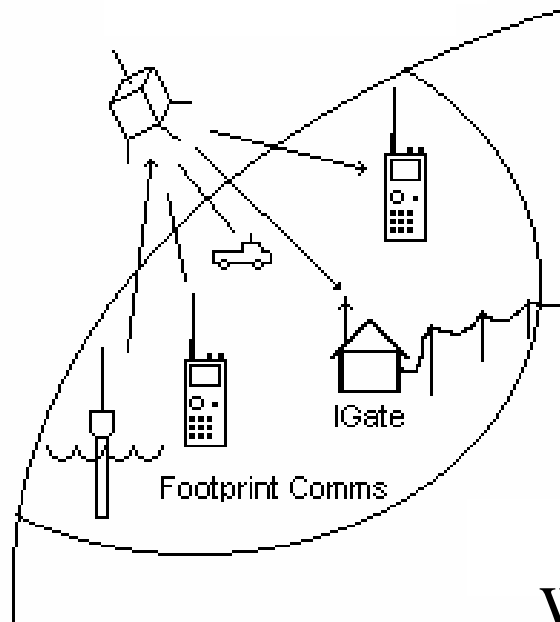


QIKcom-2

- launch December 2015
- 1st APRS TouchTone Satellite
- APRStt is a complete two way system that enters data using DTMF and receives APRS information by synthesized voice response.



QIKCOM-2 converts DTMF to both Voice and APRS and APRS data to voice!



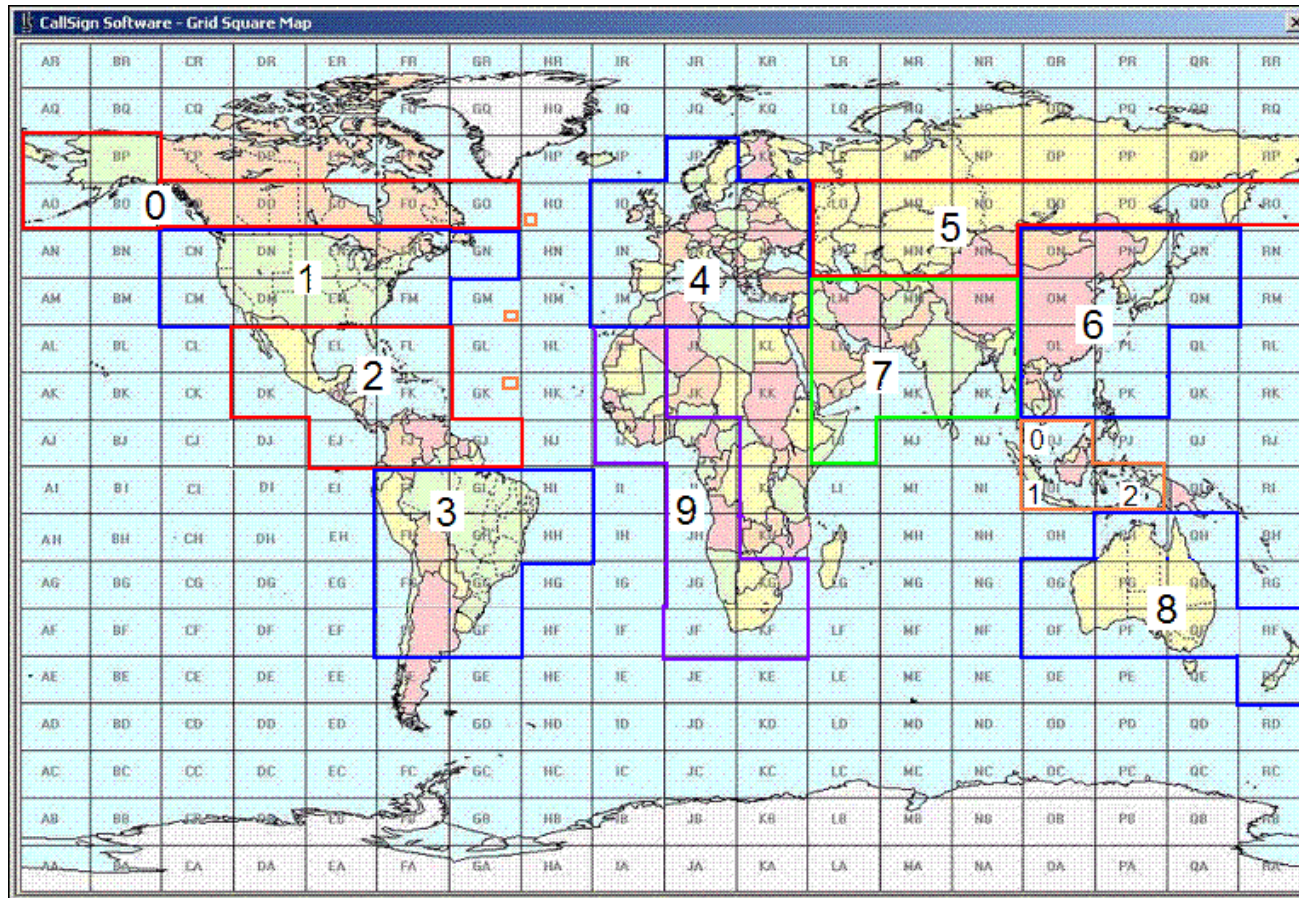
With QIKCOM-2, not just APRS but DTMF data sources can be relayed among all users.

The 324 Grid system has 99 grids...

Position to 60 miles in 4 digits

FM	19	WB	4	APR		
*18	19	9	24	277	1558	#
1 2 0 1 1 2						
six 2 bit nos showing locations of 6 letters on keys then converted to 4 digit decimal						

wb4apr



- 0 - Canada
AP, BP, AO, BO, CO
DO, EO, FO, GO, OJ
- 1 - USA
CN, DN, EN, FN, GN
CM, DM, EM, FM, OI
- 2 - C. America
DL, EL, FL, DK, EK
FK, EJ, FJ, GJ, PI
- 3 - S. America
FI, GI, HI, FH, GH
HH, FG, GG, FF, GF
- 4 - Europe
JP, IO, JO, KO, IN
JN, KN, IM, JM, KM
- 5 - Russia
LO, MO, NO, OO, PO
QO, RO, LN, MN, NN
- 6 - Japan, China
ON, PN, QN, OM, PM
QM, OL, PL, OK, PK
- 7 - India
LM, MM, NM, LL, ML
NL, LK, MK, NK, LI
- 8 - Aus/NZ
PH, QH, OH, PG, QG
OF, PF, QF, RF, RE
- 9 - Africa
IL, IK, IJ, JJ, JI,
JH, JG, KG, JF, KF

The table at right begins at 00 thru 99 to give worldwide 4 digit Grids for the next APRStt DTMF satellite using DTMF only.

Standard Message communications (4 bytes)

- Since 1800's for telegraph
- since 1927 or so for radio
- Most of the time, most of what is said, has been said before
- Q2 has 99 messages and 99 modifiers

One Group -- For Possible **RELIEF EMERGENCY** Use

ONE Everyone safe here. Please don't worry.

TWO Coming home as soon as possible.

THREE Am in _____ hospital. Receiving excellent care and recovering fine.

FOUR Only slight property damage here. Do not be concerned about disaster reports.

FIVE Am moving to new location. Send no further mail or communication.

SIX Will contact you as soon as possible.

SEVEN Please reply by Amateur Radio through the amateur delivering this message.

EIGHT Need additional _____ mobile or portable equipment for immediate emergency use.

NINE Additional _____ radio operators needed to assist with emergency at this location.

TEN Please contact _____. Advise to standby and provide further emergency information.

ELEVEN Establish Amateur Radio emergency communications with _____ on _____ MHz.

TWELVE Anxious to hear from you. No word in some time. Please contact me as soon as possible.

THIRTEEN Medical emergency situation exists here.

FOURTEEN Situation here becoming critical. Losses and damage from _____ increasing.

FIFTEEN Please advise your condition and what help is needed.

SIXTEEN Property damage very severe in this area.

SEVENTEEN **RLACI** communications services also available. Establish **RLACI** communication with _____ on channel _____.

EIGHTEEN Please contact me as soon as possible at _____.

NINETEEN Request health and welfare report on _____. (State name, address and telephone number.)

TWENTY Temporarily stranded. Will need some assistance. Please contact me at _____.

TWENTY ONE Search and Rescue assistance is needed by local authorities here. Advise availability.

TWENTY TWO Need accurate information on the extent and type of conditions now existing at your location. Please furnish this information and reply without delay.

TWENTY THREE Report at once the accessibility and best way to reach your location.

TWENTY FOUR Evacuation of residents from this area urgently needed. Advise plans for help.

TWENTY FIVE Furnish as soon as possible the weather conditions at your location.

TWENTY SIX Help and care for evacuation of sick and injured from this location needed at once.

Remember, lots of Space APS here on Earth



- STEM School projects
- Excite kids with Robotics
- Drive anywhere on Earth!
- Via APRS links



*<http://www.arrl.org/marea-ham-radio-robotics> ...

All need Energy!

Finish this Sentence:

- There is nothing certain in life except

Death and

Finish this Sentence:

- There is nothing certain in life except

Death and

Taxes ...

Finish this Sentence:

- There is nothing certain in life except

Death and

Taxes ...

and Utilities!

Finish this Sentence:

- There is nothing certain in life except

Death and

Taxes ...

and Utilities!

But you can do something about these!

Finish this Sentence:

- There is nothing certain in life except

Death and

Taxes ...

Save
30%

Eliminate
100% to
Zero!

and Utilities!

But you can do something about these!

Lets talk Solar!

Big Picture!

Our Daily Fossil Burning Costs

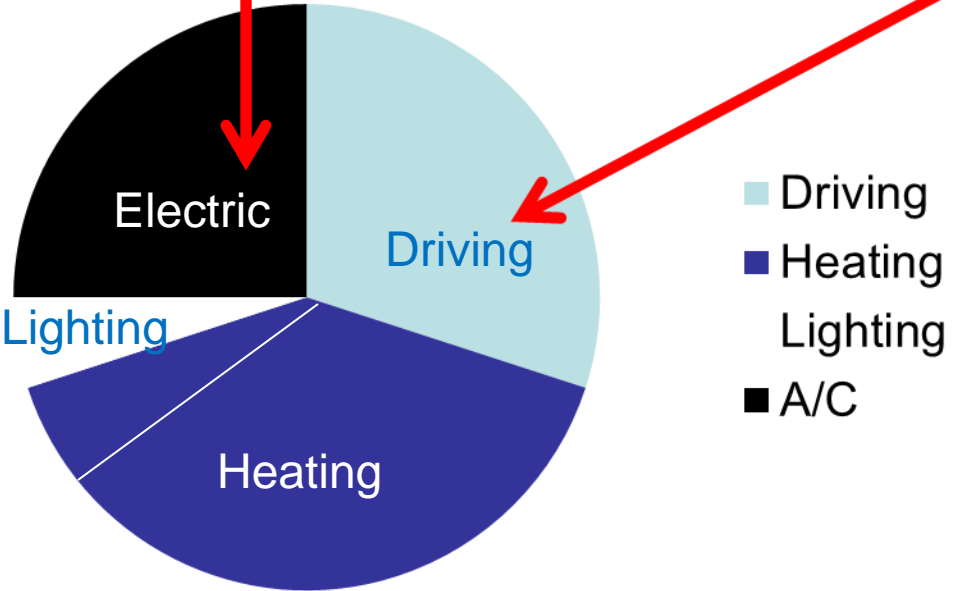


Solar Power for Electricity

& Wind



Electric Vehicle Support



We include EV's because about half of our easily-fixed energy is spent driving



Big
Picture!

When is the Payback ??? When is the Breakeven ???



Paying for at-home Garbage Pickup -
was from Day ONE !



Big
Picture!

When is the Payback ??? When is the Breakeven ???



Paying for Sewage Plants –
was from Day ONE !



Big
Picture!

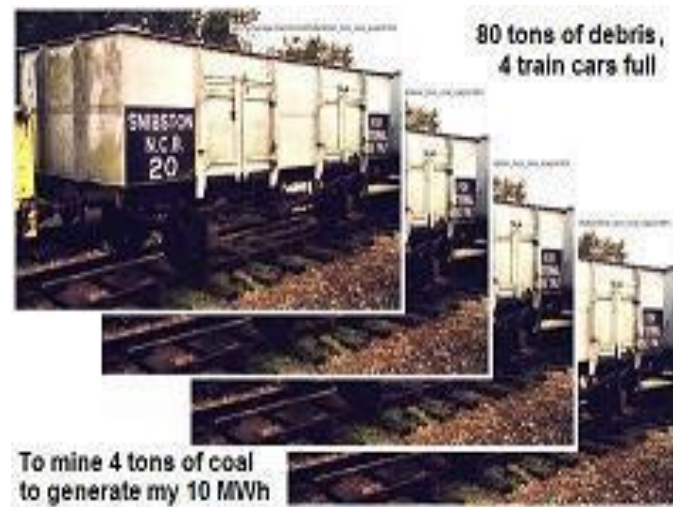
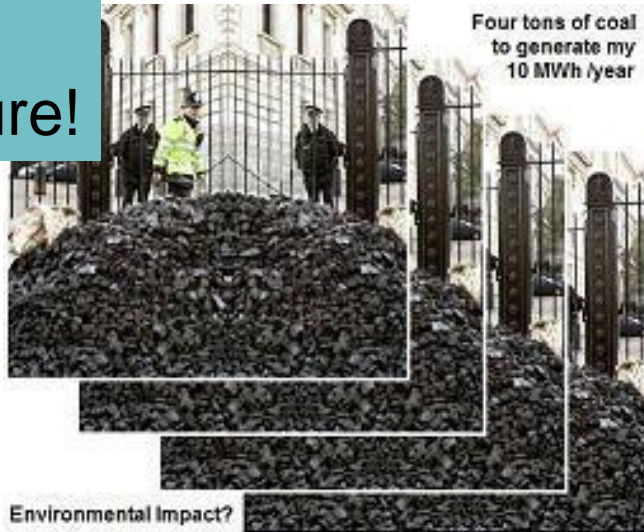
When is the Payback ??? When is the Breakeven ???



Investing in Solar Power - is from Day ONE !
Because that's when we Stop Beating Mother
Nature and stealing from our kids future.



Big
Picture!



**1 House,
1 Year
4 Tons of
Coal**



Yes, we have 100 years of coal, but there won't be anything left of WV!

OUR PRESENT LIFESTYLE IS NOT SUSTAINABLE!



Are we
part of
the
problem?



Or part of the
Solution?



Lighting: Save 4 to 1 Energy!

(breakeven in 5 days!)



Cost ~~50 cents.~~
\$1

Save \$50 over the
life of the bulb!

House with 50
bulbs saves \$2500



Only 1 in 4 households do it!

- - Life's Major Energy Milestones - - -

Although we all want to move forward on Renewable Energy, the up-front investment is often intimidating even though we will actually save money in the long run and benefit mankind. It is hard to make these big steps toward change.

But, remember that we face these big Energy Milestone opportunities throughout our lives. If we have to spend the money anyway just to keep our systems going, then a little forethought and preparation may lead us to do the right thing.

When is your next energy milestone?

Every 20 years - A new roof - why not solar

Every 6 years - A new car - why not a Plug-in?

Every 8 years - A new water heater - why not a heatpump

Every 15 years - A new Heating system - switch from oil/gas

Every year - Your utility offers energychoice - Choose wind

Every 12 years - New job/move/retirement - all of the above

On average, you will face one of these every 2 years. Are you ready to make the choice for clean energy and savings for the rest of your life?



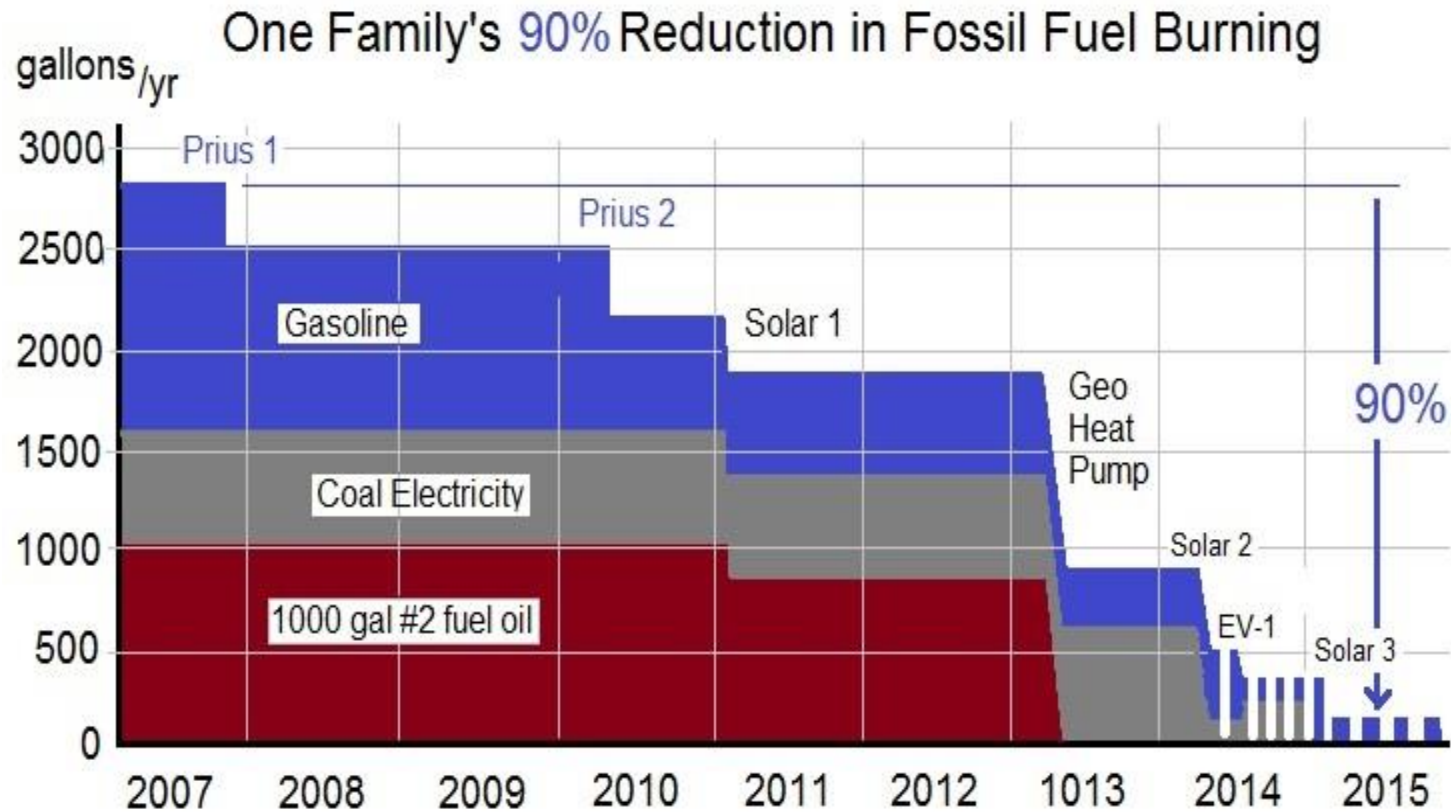
My Energy re-awakening 2007

- Adding solar panels to junkyard prius(s)



We CAN reduce emissions!

My family did from 3000 gal/year down to 200 gal/yr



Help the Environment

And save money!

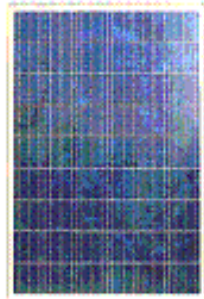


8 Trees Eliminate these Pollutants 1yr

400 lbs of carbon dioxide
48 lbs of particulates
9 lbs of nitrogen dioxide
6 lbs of sulfur dioxide
2 lb of carbon monoxide



Derived from data on: <http://www.coloradotrees.org/benefits.htm>



One 220W solar panel Eliminates Per Year:

440 lbs of Carbon Dioxide
57 lbs of Particulates
7 lbs of Sulfur Dioxide
1.4 lbs of Nitrous Oxide
0.4 lbs of Carbon Monoxide
.0012 lbs of Uranium and Thorium
.0000008 oz of Mercury

Derived from http://en.wikipedia.org/wiki/Fossil_fuel_power_plant

Bob Bruninga, WB4APR

Big Picture!

Clean Energy, SOLAR

Carbon Equivalence!

Each Panel = 8 Trees.

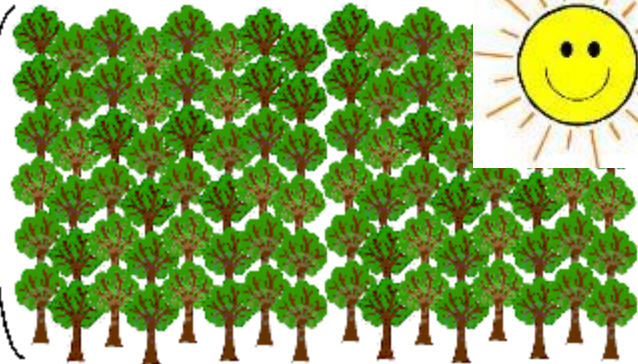
Our system = 312 trees!

= (3 acres of trees)

Proposed Array
1 set = 100 trees



The 3 arrays = 300 trees!



100 trees!

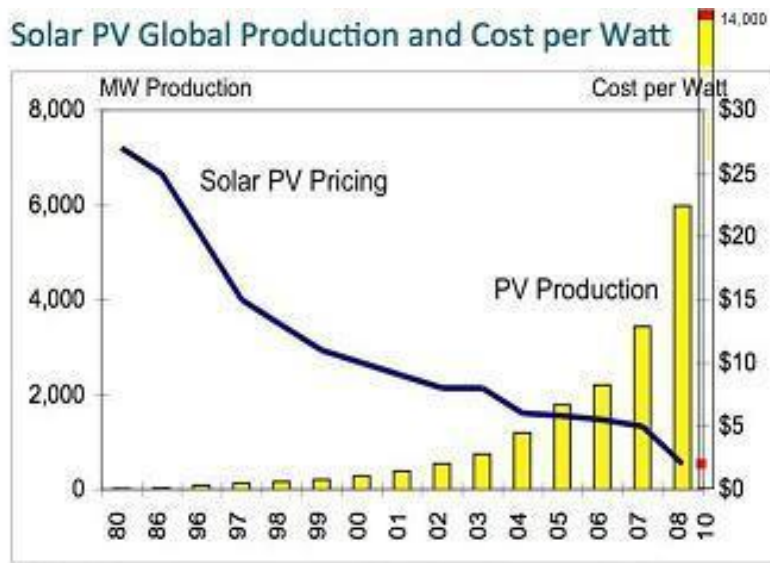
WB4APR

Solar Power is here & Growing Exponentially

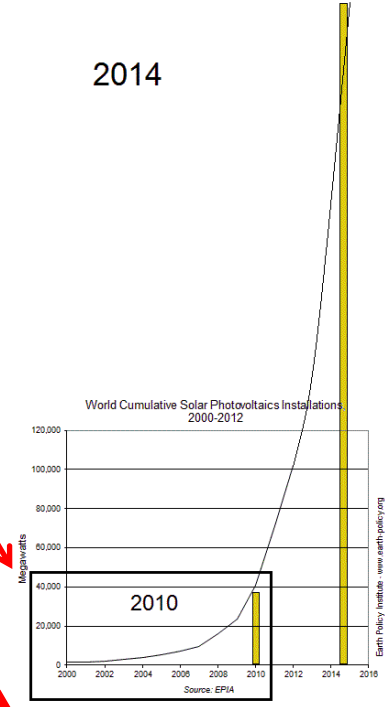
2015

Graph when I first started talking in 2010

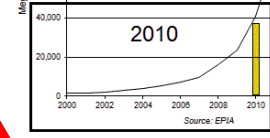
Graph now!



Solar Buzz. Company reports.. Green Econometrics research
<http://greenecon.net/wp-content/uploads/2009/10/price.jpg>

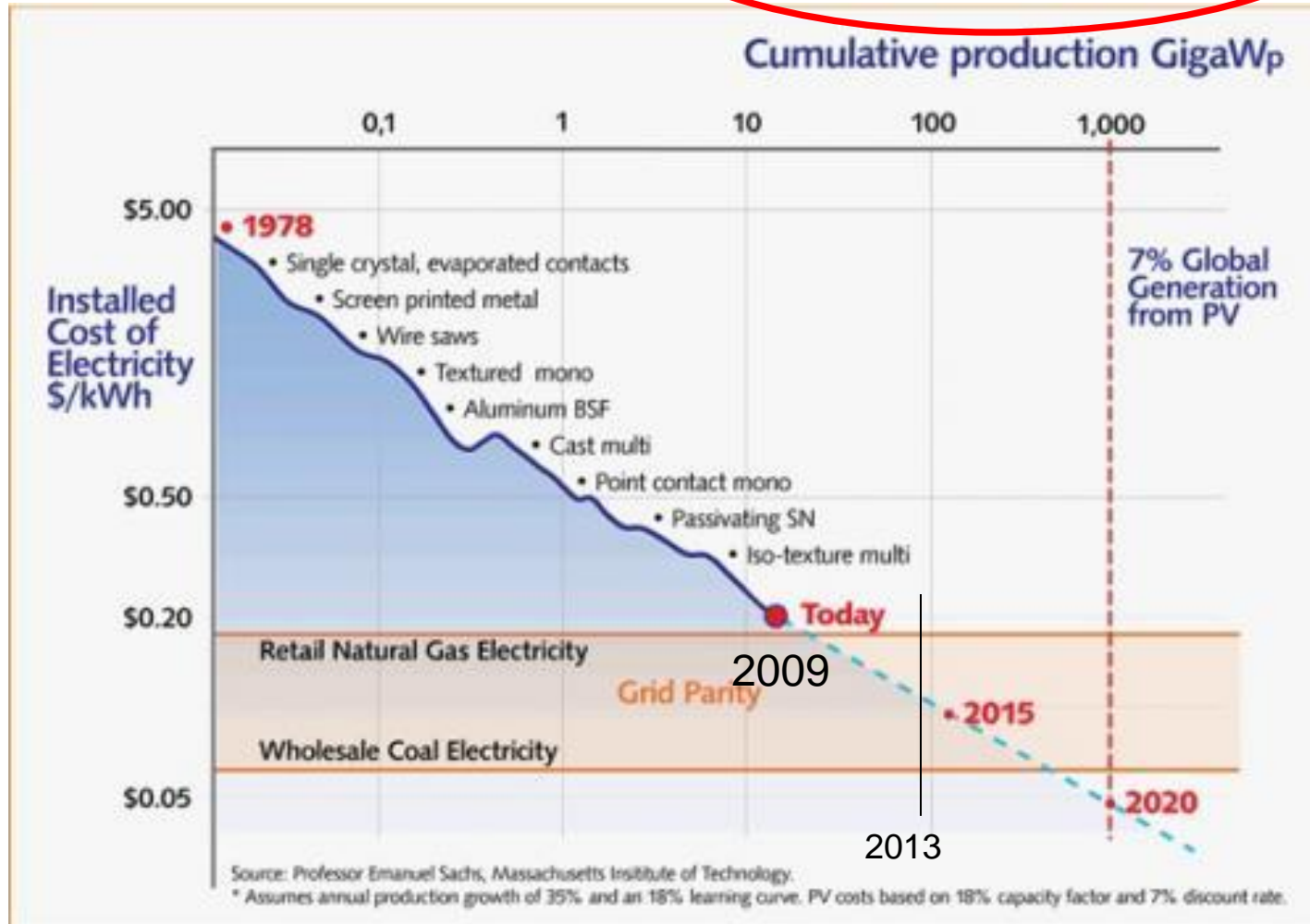


2014



Solar Cost!

Equaled Utility in 2010
Half the Utility in 2013



As a Ham, I was so wrong!

- My concept of solar power was always this:



Grid-tie Revolutionized Solar

- No Batteries!

Grid-Tie



Every Watt Produced is valued at full Retail Rates!

ZERO MAINTENANCE FOR LIFE!

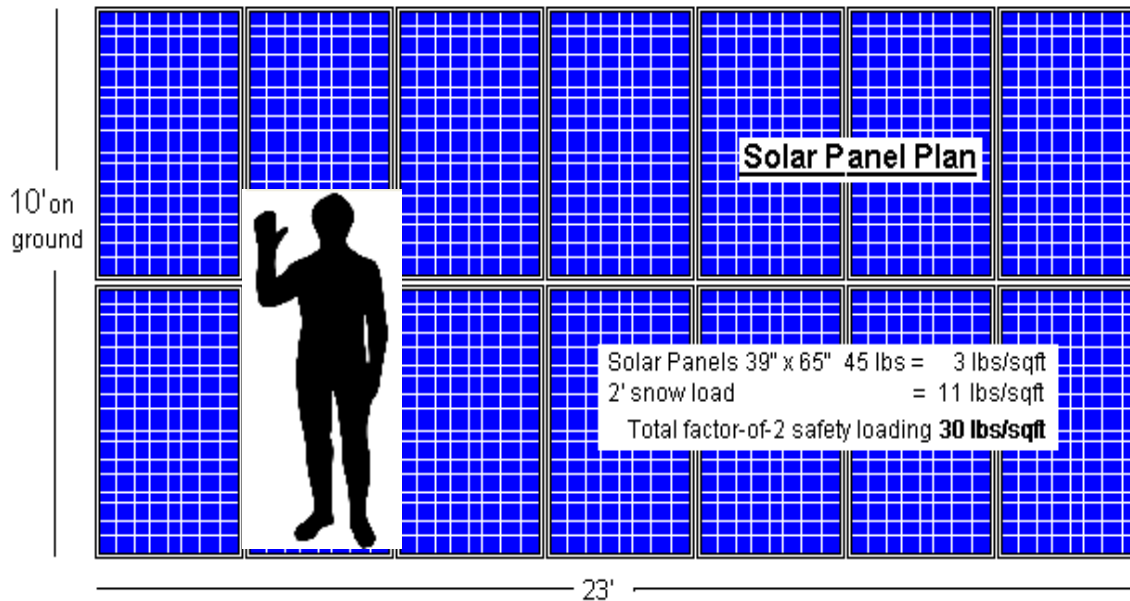
Falling Prices 10-to-1

Panel

Array Cost

A 3 kW array

200 W
220 W
250 W
(300W)



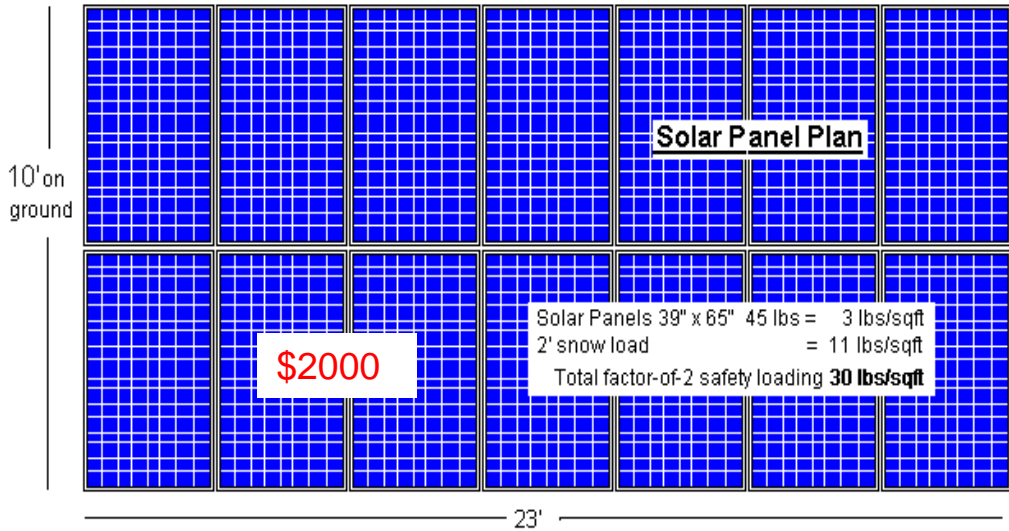
\$15,000 2007
\$ 9,000 2010
\$ 6,000 2012
\$ 3,000 2013
\$ 2,000 2014
\$ 1,900 2015

\$5/watt down to 50c/watt* for panels in only 10 years

*Contractor cost tho is still about \$3/w

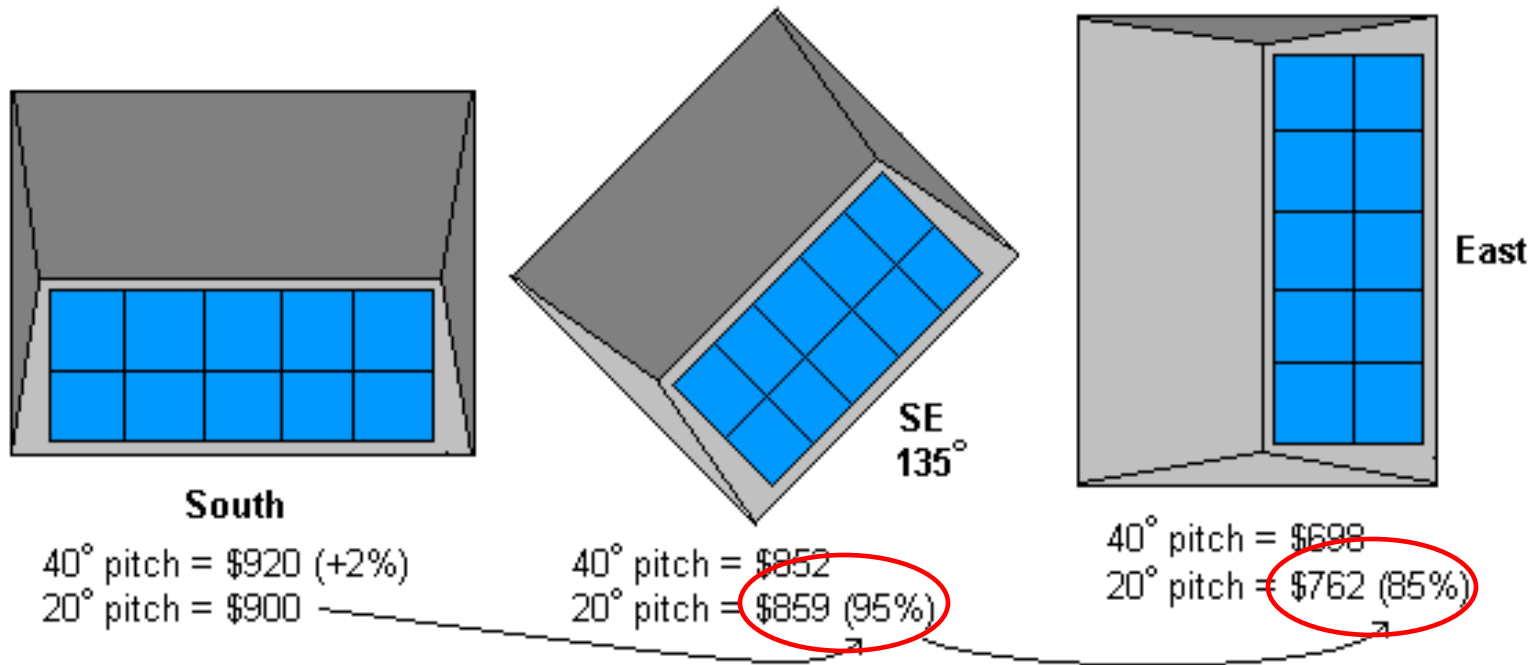
Home 1000 x better

10x cheaper and
100 times more roof



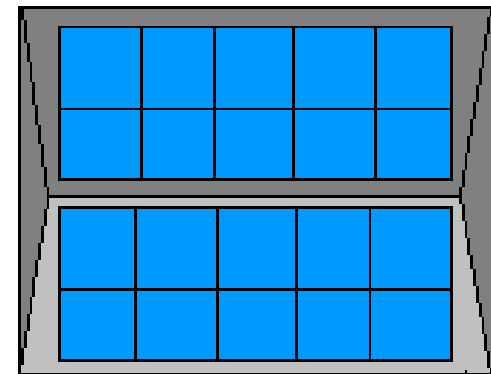
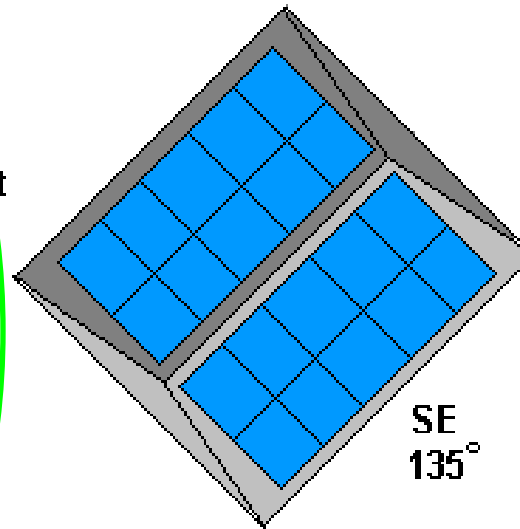
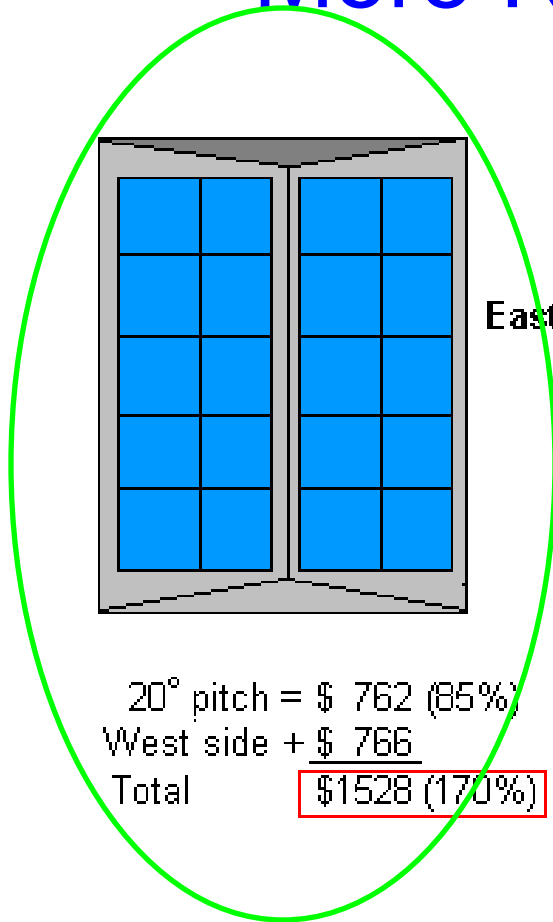
Comparing solar on the car roof compared to home solar.

Angles - not important with Grid-Tie



Amazing, even due East, you still get 85% effectiveness!

Angles - less important, More Roof is!



Amazing! Increase power by 60% to 100% on other side!

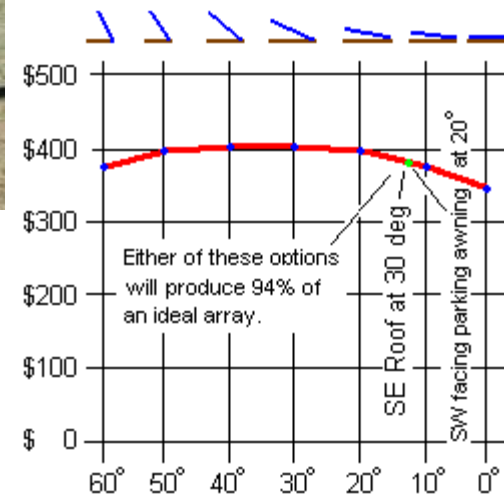
Tilt Angle not important with Grid-tie



Tilt angle chosen was 25 deg instead of 35 deg to reduce visibility (<1% loss)

Any angle from 20° to 50° is within 1% of annual total

Annual Power Production
2.2kW South Array versus Angle



For annual total power, the tilt angle is not that important. The more important parameter is shade (location)

10% or more Return on Investment for Life!



x21633867 fotosearch.com

- Federal gives 30% tax credit. No limit
- State of Maryland Grant
 - In 2010 for our 8kW system was \$7000
 - In 2011 was \$5000
 - In 2013 was \$1000
- AA County Real Estate Tax credit
 - \$2500



- Total Gov't Tax Credits return ~ 40% of investment!
- ENDS IN 2016?... Congress?

What to do with \$12,000?



and \$60/mo elec bill

Put in bank @ 1%
Pay \$700/yr for life for electricity*



Buy 4 kW solar \$12k equity
Get back \$3600 immediately on taxes
Get back \$600/yr in SRECs (5 yrs)
Get \$700 free electricity/year
Get \$3000 from Illinois? County? City?

\$5,000 Equity left
\$ 900 Earned interest
\$5,900 Equity
Own nothing
Continue \$700/yr for life
\$ 0 after 7 more years

10 yrs

\$12,000 System Value
\$ 6,600 Tax refund
\$ 3,000 SREC's
\$21,600 Equity
You own your own Energy system
NO utilities for life!



Remember:

- There is nothing certain in life except

Death and

Save
30%

Eliminate
100% to
Zero!

Taxes ...

and Utilities!

But you can do something about these!

And 10% return for life!

Solar panels better than a pension, says minister

8% - 10%

Energy minister says those approaching retirement should consider putting some of their savings into solar panels to deliver a better financial return than a pension



Greg Barker, the energy minister, said that anyone approaching retirement should consider putting some of their savings into solar panels because they would deliver a better financial return than a pension.

Email

Facebook

Big Picture!

Our Church Fossil Fuel Costs

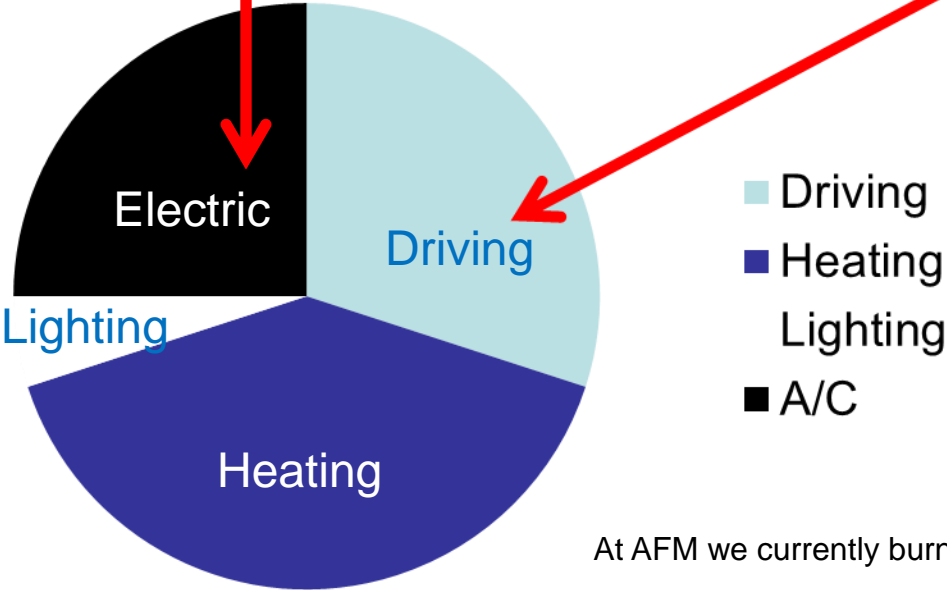


Solar Power for Electricity

& Wind



Electric Vehicle Support



We include EV's because about half of our easily-fixed energy is spent driving

At AFM we currently burn Propane for heat





50% Energy Driving to Church

50% of Church's energy/emissions due to driving!
With the Solar array, EV driving is 100% renewable



Bob Bruninga, PE

IEEE Transportation Committee

<http://aprs.org/EV-charging-everywhere.html>

Most of what we think we know about EV's might be wrong

Bob Bruninga, EVADC

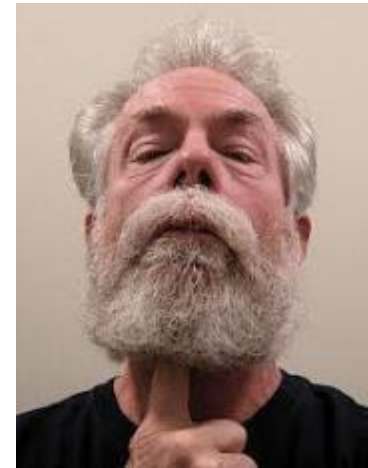
- ⤴ Cost too much!
- ⤴ Runs on coal from Power Plant (Carbon)
- ⤴ Range too short
- ⤴ Useless in power outage
- ⤴ Planet Impact worse than a Hummer
- ⤴ No Infrastructure
- ⤴ Not enough chargers
- ⤴ Takes too long to charge

Bob Bruninga, PE

IEEE Transportation Committee



Most of us,
Greybeards too,
drive gas cars with
gas-tank thinking



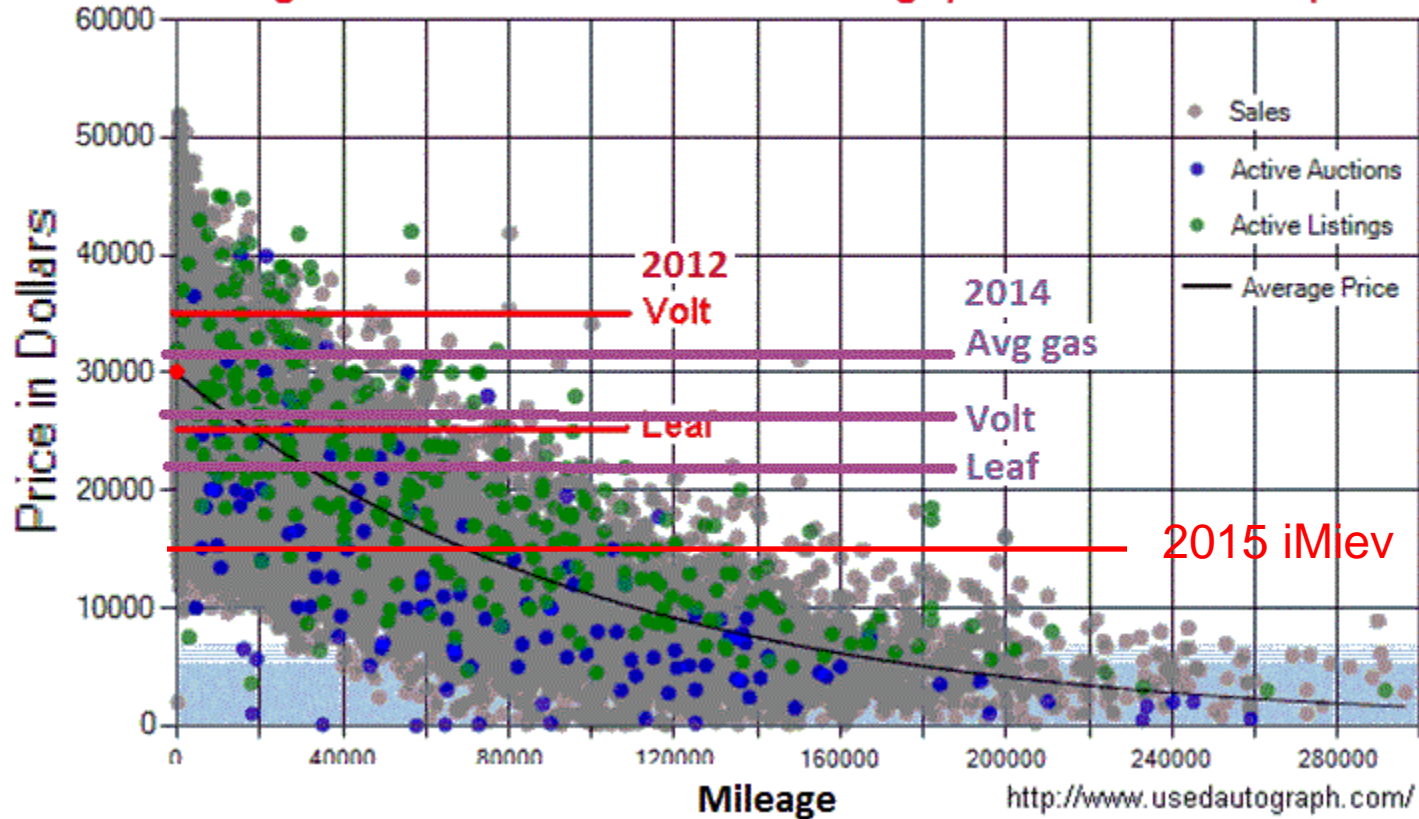
<http://aprs.org/payin-to-plugin.html>

EVs Now cheaper than gas!....?

2013

2000-2012 Ford F-150 Pickup Truck #1 selling vehicle in USA

Average EV cost is the **LESS** than the average price of a New Pickup!



Over 40 EV's now on Market!

(in just 5 years!)
Over 40 by 2015!

Only 4 cost more than the average gas car! (\$33k)

The Electric Vehicle Association of Greater Washington DC
www.evga.org

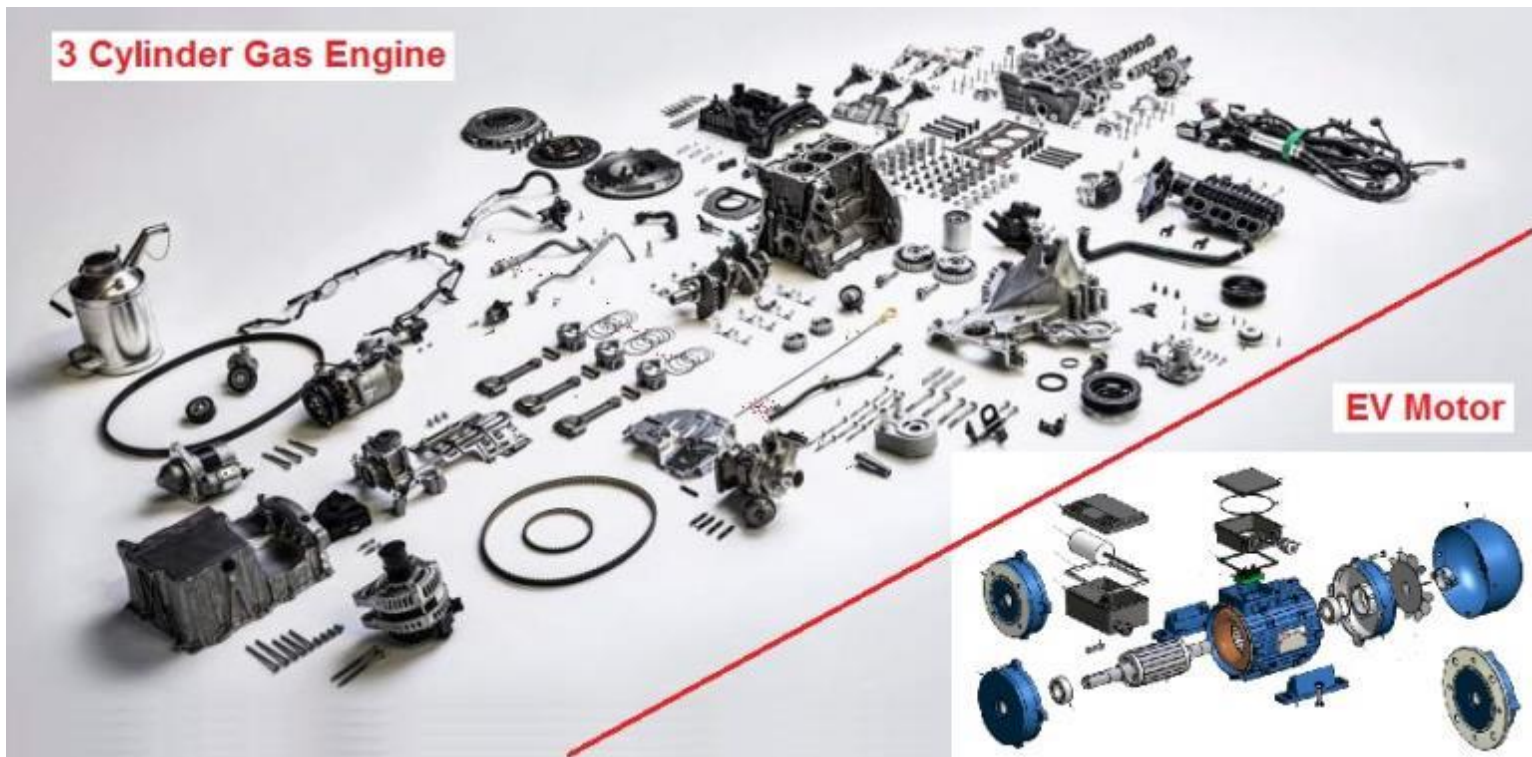
Electric Vehicle Information Sheet

	Base Price (\$USD) ¹	Net Price (\$USD) ²	Range (mi) ³	Batt. (kWh) ⁴	Speed (mph) ⁵	MPG equiv. ⁶	Fuel / Co. ⁷	OC ⁸
Zero S	\$13,345	\$13,345	76	9.4	95	462	---	Y
Brammo Empulse	\$16,995	\$16,995	80	10.2	110	---	\$19	
Smart	\$22,995	\$15,495	82	16	80	112	\$48	Y
Smart electric	\$25,000	\$17,500	88	17.6	78	107	\$46	
Chevy Spark EV	\$26,885	\$18,385	82	21.8	90	119	\$42	Y
Nissan LEAF	\$29,010	\$21,510	84	24	95	114	\$48	Y
Ford Focus Electric	\$29,170	\$21,670	76	23	84	105	\$50	
Flat 500e	\$31,800	\$24,300	87	24	85	116	\$48	
Kia Soul EV	\$33,700	\$26,200	93	27	90	105	\$50	Y
VW e-Golf	\$35,445	\$27,945	83	24	87	116	\$48	Y
Honda Fit EV	\$259/ma	(same ma)	82	20	90	118	\$42	
BMW i3 (140kwh)	\$41,350	\$33,850	81	22	93	124	\$42	Y
Mercedes B-Class	\$41,450	\$33,950	87	28	101	84	\$58	
Toyota RAV4 EV	\$49,800	\$42,300	100	41.8	103	76	\$67	
Tesla Model S 85	\$79,900	\$72,400	265	85	125	89	\$58	Y
Tesla Model X 85	---	---	265	85	125	89	\$58	Y
Toyota Prius Plug-in	\$29,990	\$27,490	11-gas	4.4	112	95	\$58	
Ford C-Max Energi	\$31,770	\$27,768	20-gas	7.6	102	88	\$71	
Chevy Volt	\$34,170	\$26,670	38-gas	17.1	100	98	\$67	
Ford Fusion Energi	\$34,800	\$30,793	20-gas	7.6	104	88	\$71	
Honda Accord Plug-in	\$39,780	\$36,154	13-gas	6.7	114	115	\$63	
Audi A3 e-tron	---	---	21-gas	8.8	140	95	---	
Cadillac ELR	\$75,000	\$67,500	37-gas	16.5	106	82	\$79	
Porsche Cayenne	\$76,400	\$71,065	14-gas	10.8	151	47	\$142	
VW VTRUX (plug)	\$79,000	\$71,500	11-gas	23	85	---	\$76	
Porsche Panamera	\$96,100	\$91,348	18-gas	9.4	167	50	\$125	
BMW i8	\$135,700	\$131,907	15-gas	7.1	160	76	\$108	
Porsche 918 Spyder	\$845,000	\$841,333	12-gas	6.8	210	67	\$138	Y

Panamera SE Hybrid
 Cayenne SE Hybrid
 Porsche 918 Spyder
 Tesla Model S
 Tesla Model X
 BMW i8

Only ONE moving part!

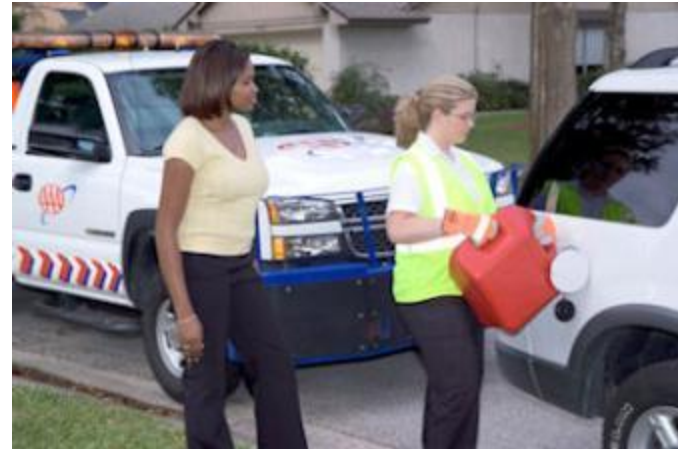
- Electricity less than 30% cost of gas
- Maintenance 10% of a gas car



Public Charging – only a security blanket



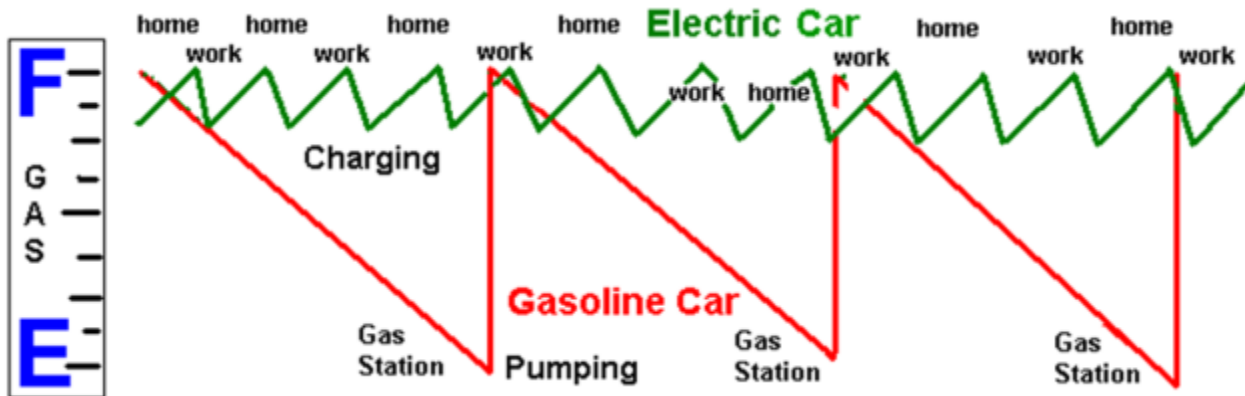
Only Provides comfort & security
... like a spare gas can



85% of all charging is at home

Buying an EV with the idea of **public charging**, means not **understanding EV's** and maybe **buying the wrong car!**

A Battery is not a TANK!



The Complete Paradigm Shift:

Gas cars drive-to-empty, then fill-to-full at Public Stations

EV's charge daily at home and at work while parked



Bob Bruninga, PE

IEEE Transportation Committee

<http://aprs.org/payin-to-plugin.html>

Every EV can charge from any 120v outlet

Every EV comes with a 120v charge cord



Exist or \$15 each

Charging stations for every EV is not sustainable at-work:



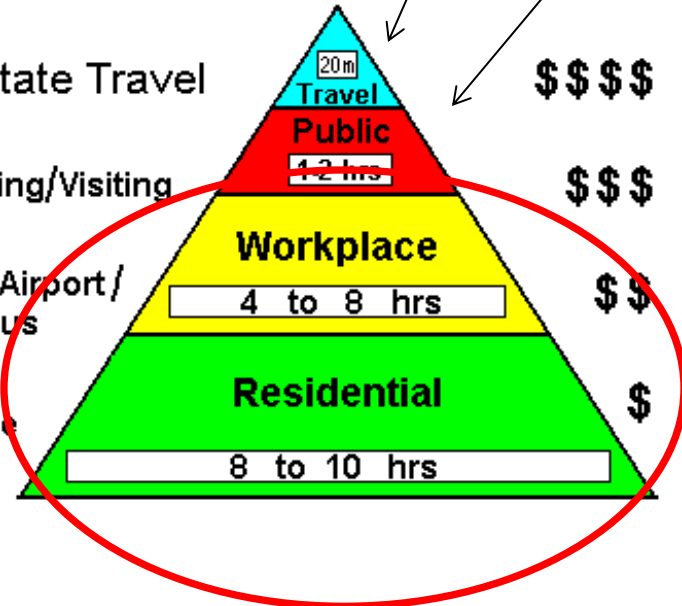
\$6000 installed

Charge at Home (and at work)

0.3% of the need

Public Charging is like looking for \$10 gas!

<u>Location</u>	<u>Charge Time</u>	<u>Price</u>	<u>Level</u>	<u>Cost</u>	<u>Driver?</u>	<u>Speed?</u>
Interstate Travel	20m Travel Public 4-2 hrs	\$\$\$\$	L3	\$10,000	Waiting...	20 min
Shopping/Visiting	4-2 hrs	\$\$\$	L2/3	\$2,000	Parked	10 Sec*
Work / Airport / Rail / Bus	4 to 8 hrs	\$\$	L1	\$25	Parked	10 Sec*
At home	8 to 10 hrs	\$	L1	\$25	Sleeping	10 Sec*



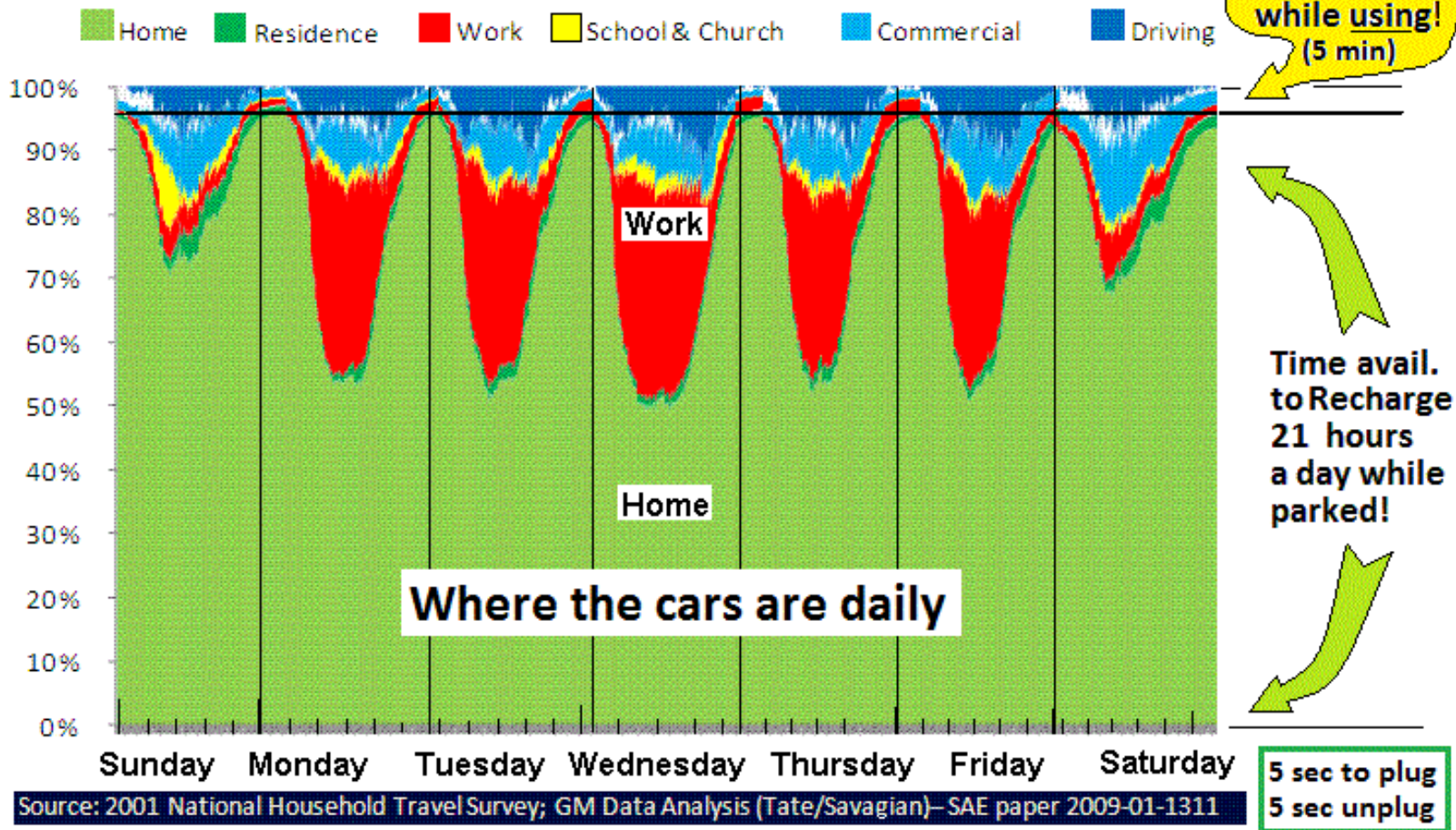
bruninga

* connect/disconnect time

85% of all charging is at home on standard 120v outlets

Charging While Parked (21 hrs/day)

Gas-up while Using, Charge-up while parked!



Bob Bruninga, PE

IEEE Transportation Committee

<http://aprs.org/payin-to-plugin.html>

Our Legacy experience



Oh the Horror!

People see this
And think \$50



Reality with EV's is



20¢/hr

\$1 a day



Bob Bruninga, PE
IEEE Transportation Committee

<http://aprs.org/payin-to-plugin.html>

Charging Load at 120v:

1 Coffee Pot = Level 1 EV charging



Employee's pay for coffee mess
and yet get free electricity

S
A
M
E

=

L
O
A
D



We don't want free electricity, we want to pay for it, and simply be allowed to plugin!

Pay \$20/mo
For 20mi commute



Bob Bruninga, PE

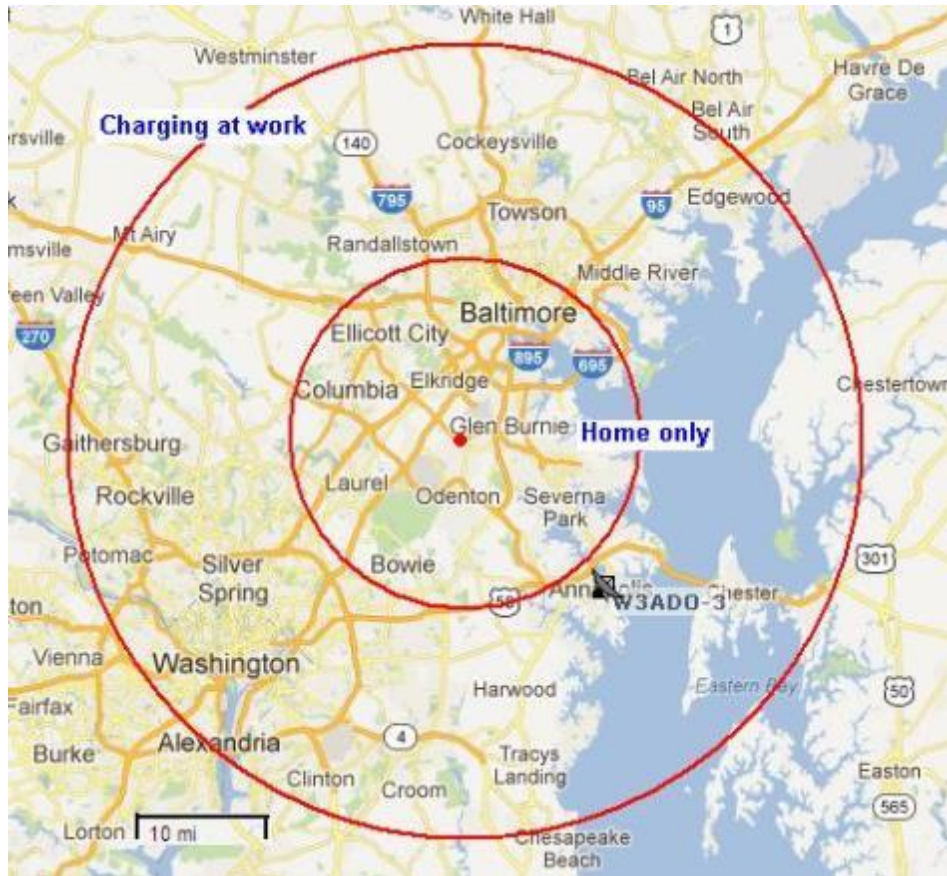
IEEE Transportation Committee

<http://aprs.org/payin-to-plugin.html>

Plug-in at work (double range, quadruple area)

Charge at home only = 16 mi range (chevy Volt)

Charge L1 at work/home = 64 mi range



Big Picture!

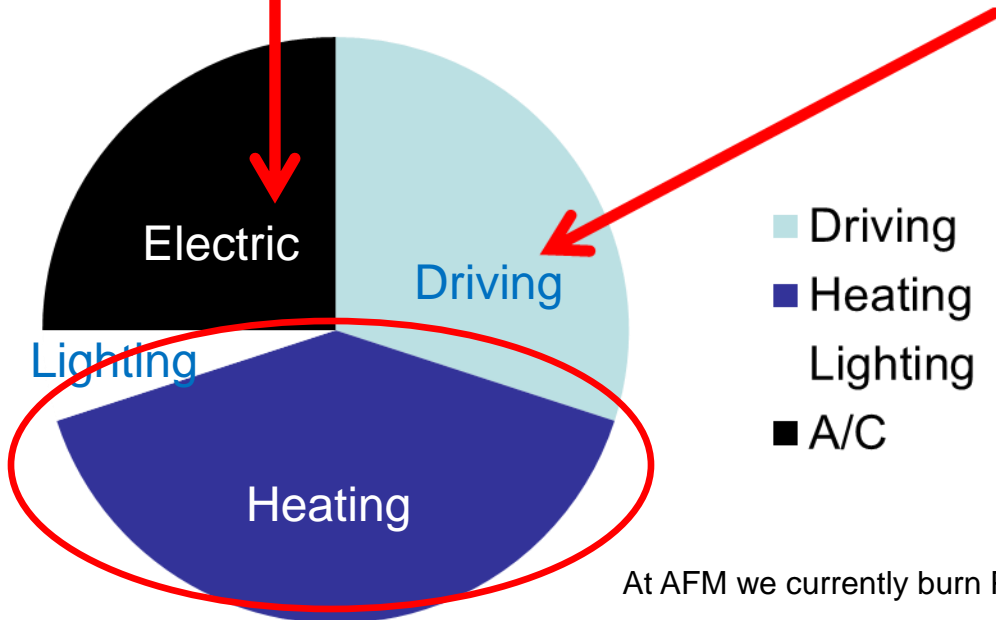
Fossil Burning Costs



Solar Power for Electricity



Electric Vehicle Support



We include EV's because about half of our easily-fixed energy is spent driving

At AFM we currently burn Propane for heat



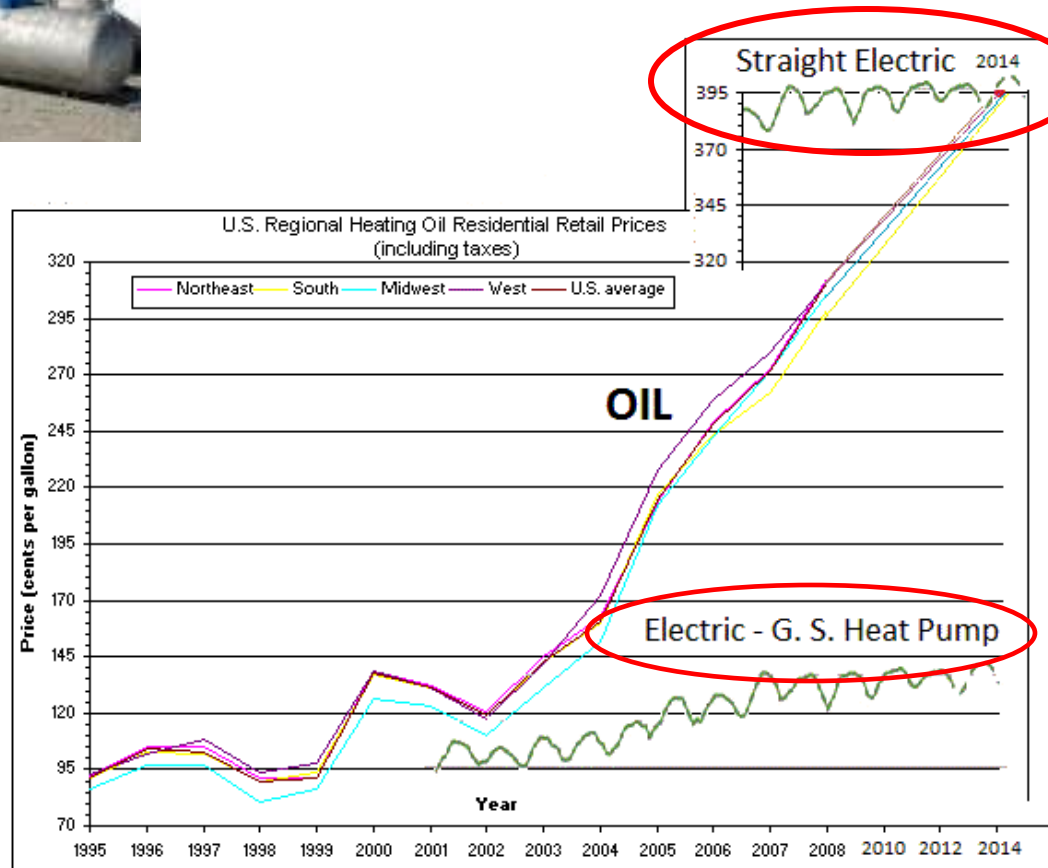


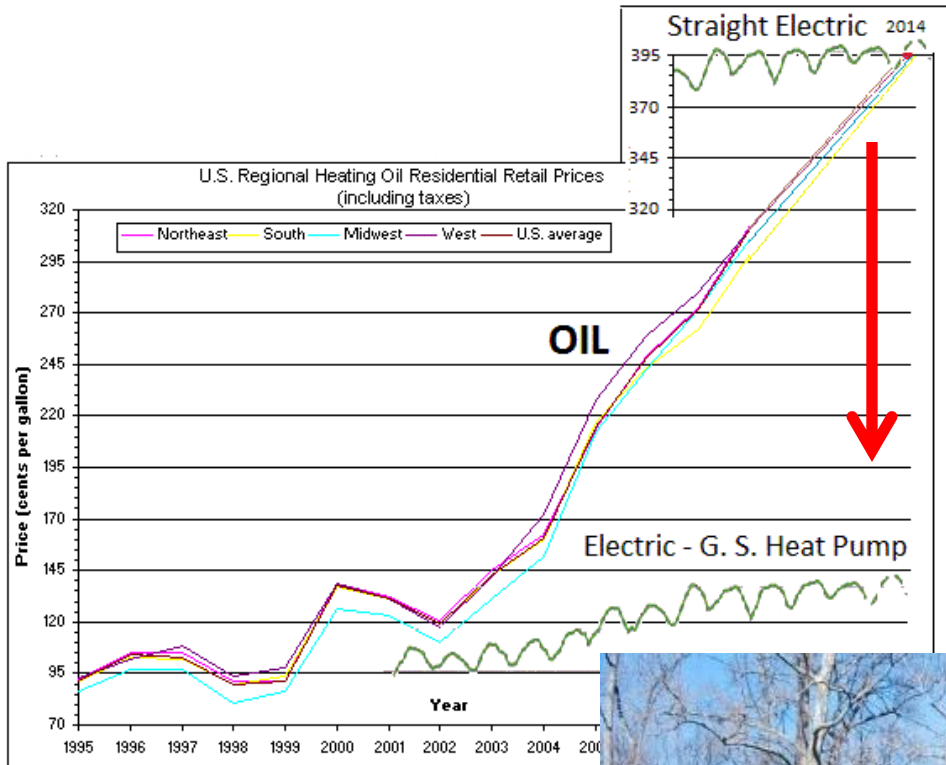
Heating Costs – Oil, Propane...



Actually our biggest Energy cost is our Propane heating.

Switching to Heatpump can **save 60%** of our energy costs!





Switching from Propane to Ground Source Heatpump

Our heating costs will go down 60% AND being electric, we can replace that with solar free heating for decades!



So, Lets do the right thing...

Move forward with clean Energy



Bob Bruninga, WB4APR
Annapolis, MD 21401
<http://www.aprs.org/AFM-environment.html>
410-293-6417





Summary

You can do something

- If you have sun, **solar is best investment** ever...
- Pre-think your next personal energy decision.
- Water heater dies – **get a heatpump one**
- Heating dies – **get a heat pump** (and solar)
- Car ages – **get an EV** for commuting
- Put charging signs on **outdoor outlets**
- **Power them for life with Solar! \$\$\$**



Its cheaper and cleaner!