Peoria Superfest 2015

APRS Satellites and Solar/EV Energy

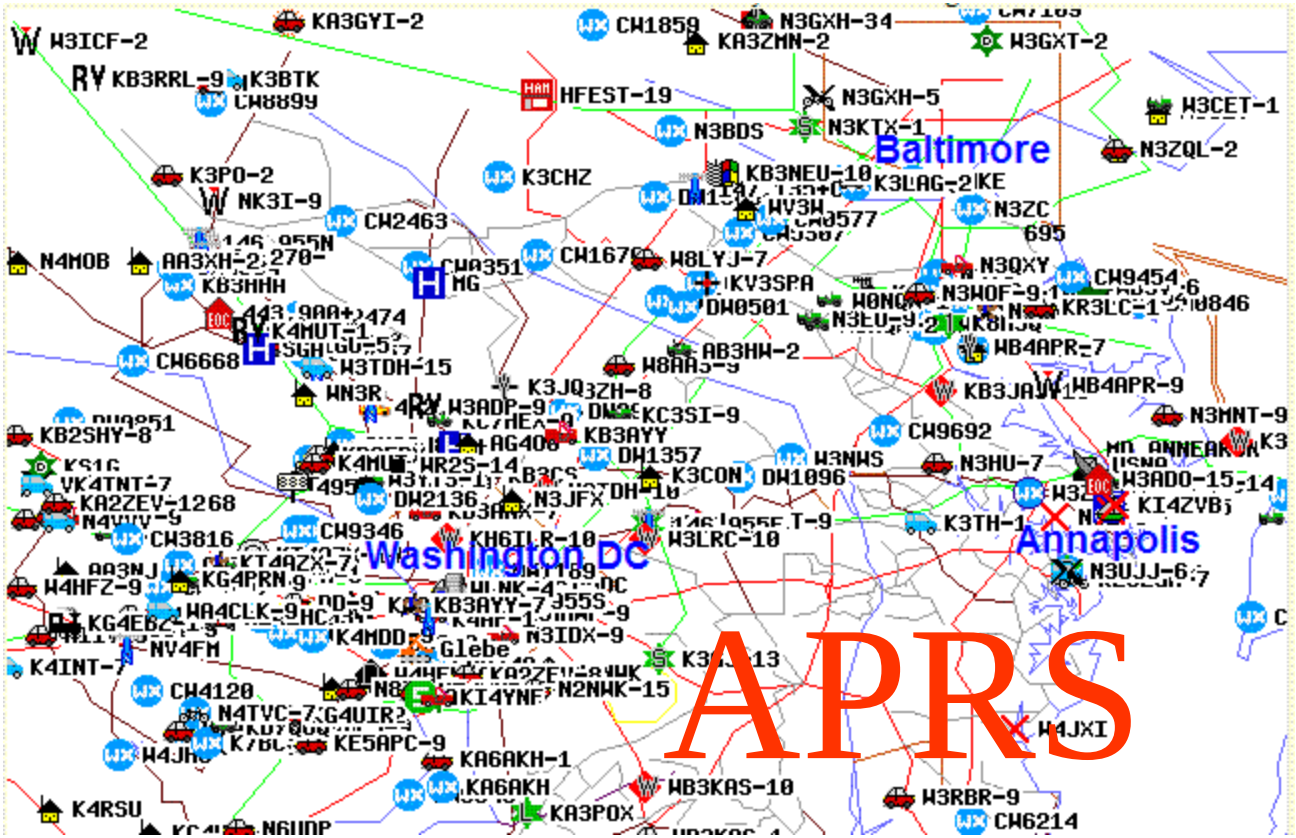
APRS Satellites

APRStt !!!

Solar Energy

Electric Cars

APRS is everywhere *

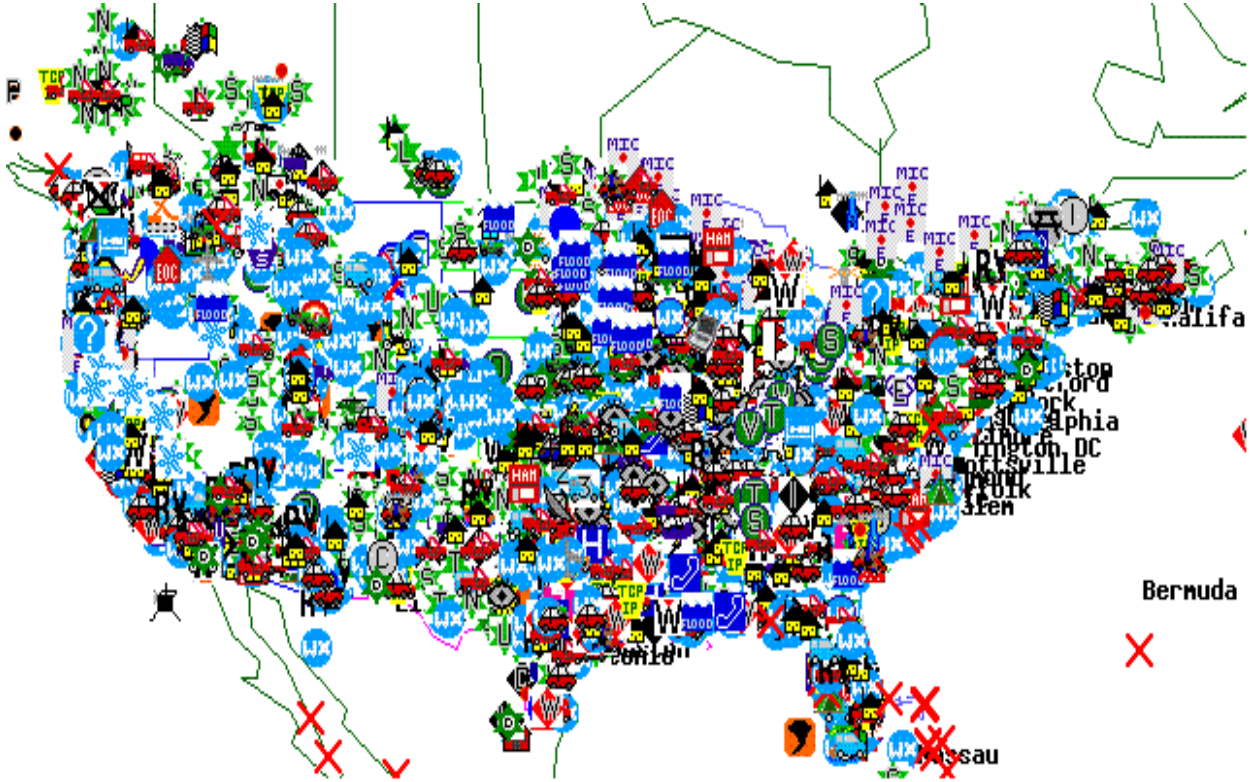


300 stations
In 35 miles

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

APRS Terrestrial Data Relay Network

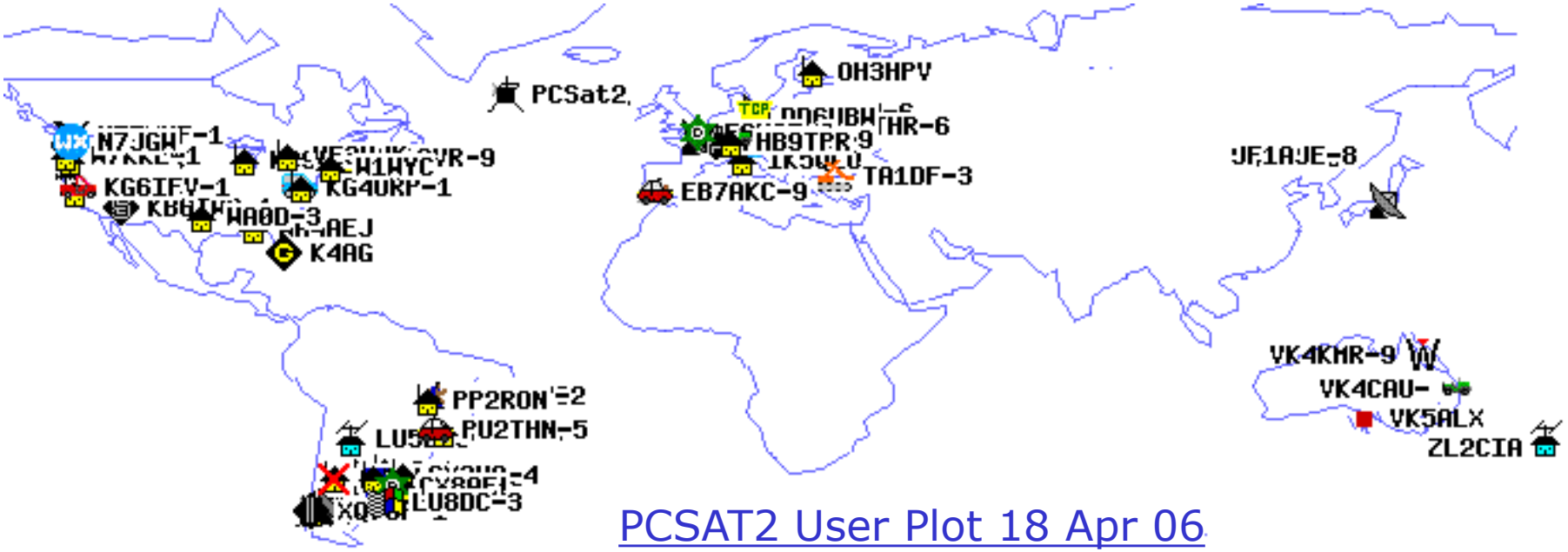
- Supports over 20,000+ terrestrial users and experimenters.



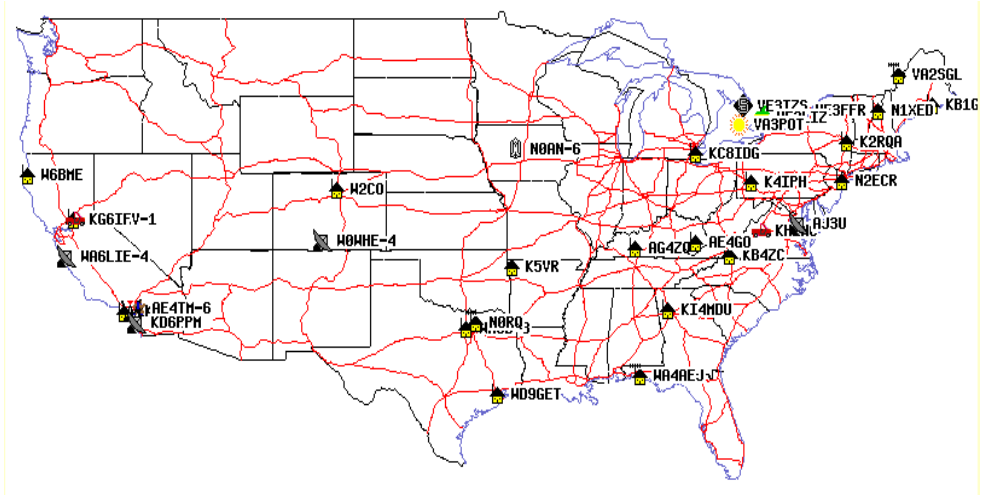
- But stops at the shoreline and has huge holes in the wilderness

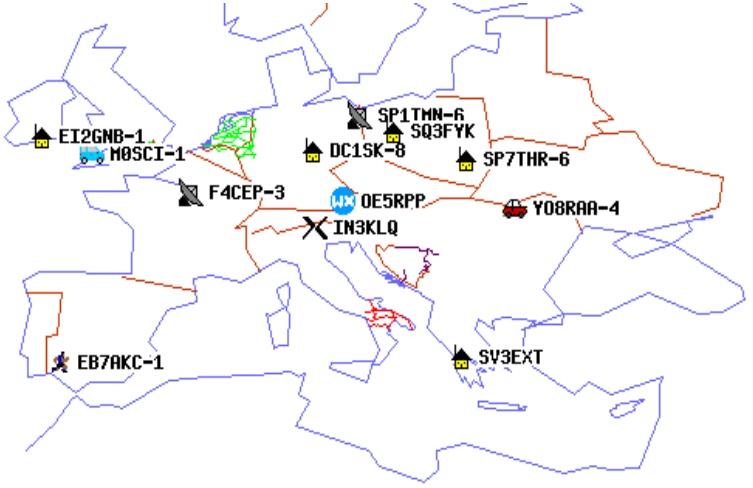
APRS Global data network

Satellite Users more sparse – but global



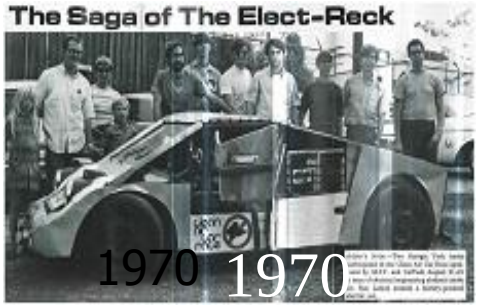
PCSAT2 User Plot 18 Apr 06





APRS Global data network

WB4APR Background



Energy!

←1965
QST

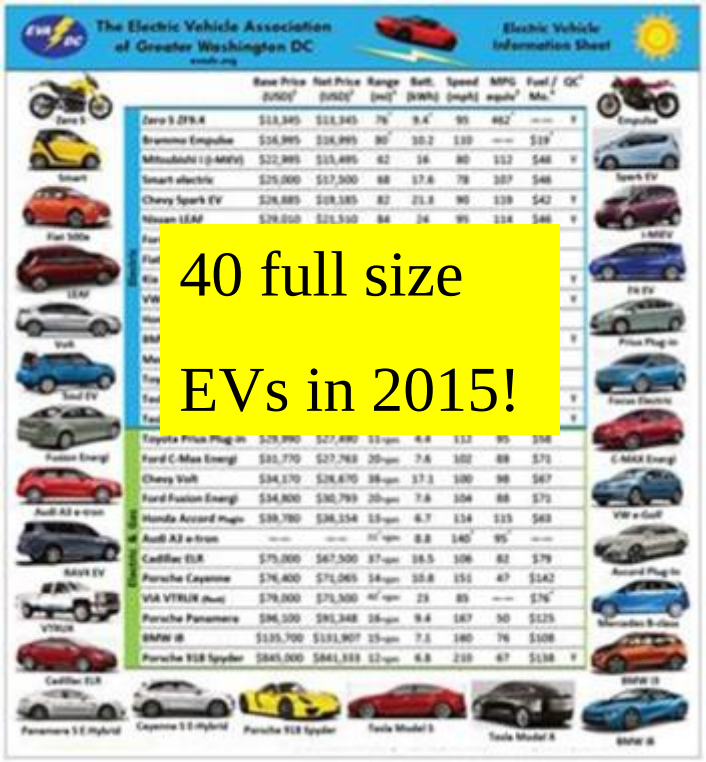
APRS

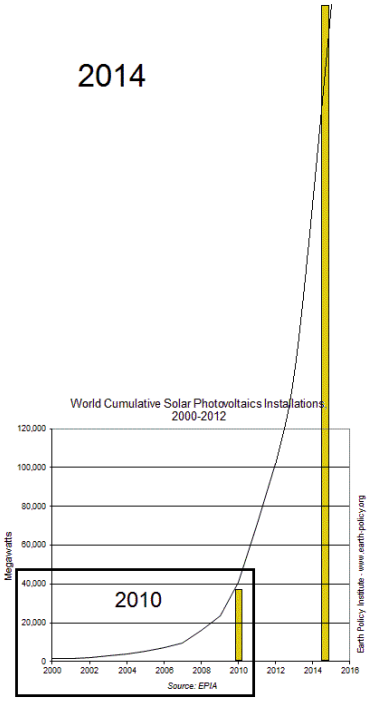
1990

WB4APR Background

2015

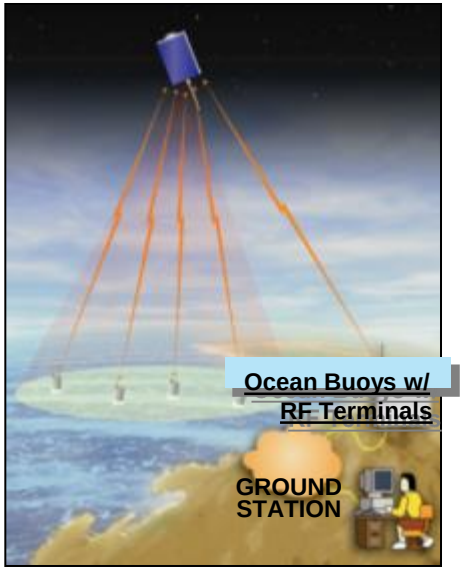
I can't believe I have lived long enough
to see Solar cost half of the utilities
and EVs cost less than, and out perform gas cars!



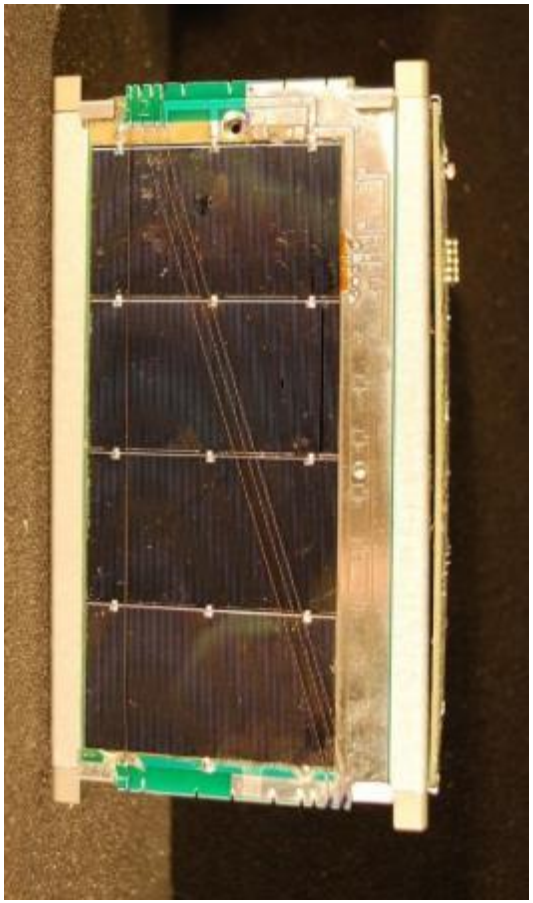


APRS Satellites

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

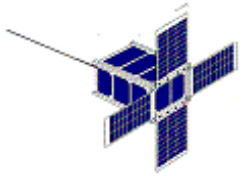
OR

OR

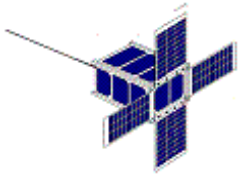
OR

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

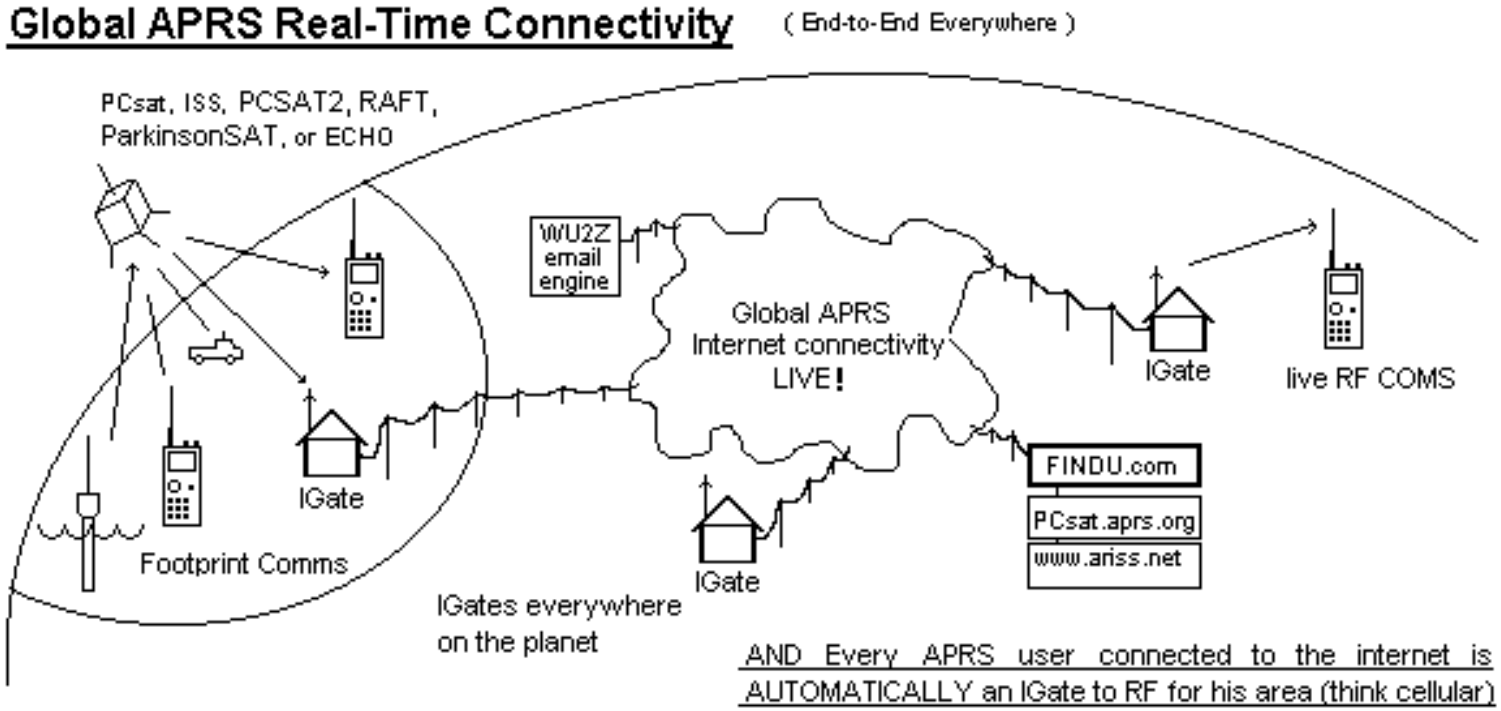
Education

Force

Multiplier!

APRS Global data network

APRS Local & Global Internet linked Data Network



APRS Global Packet Radio Network

Internet Linked for live Communications

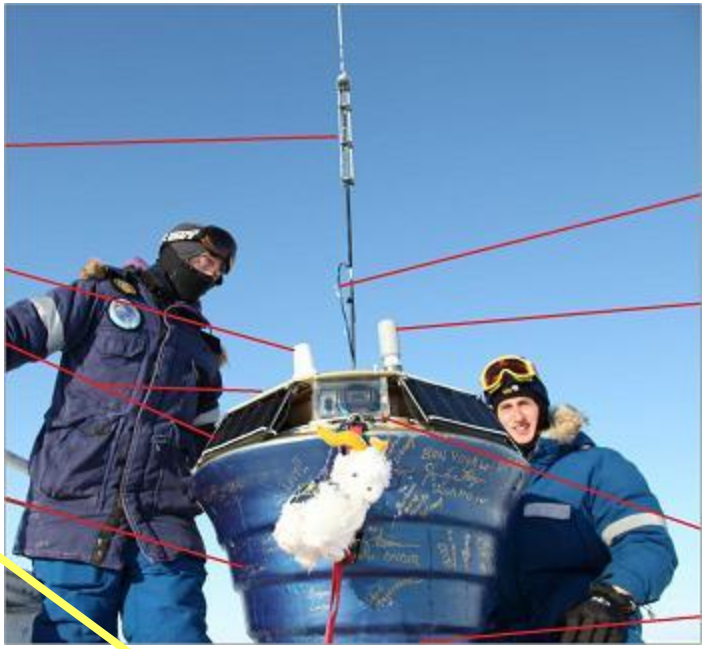
Automatic Packet Reporting System

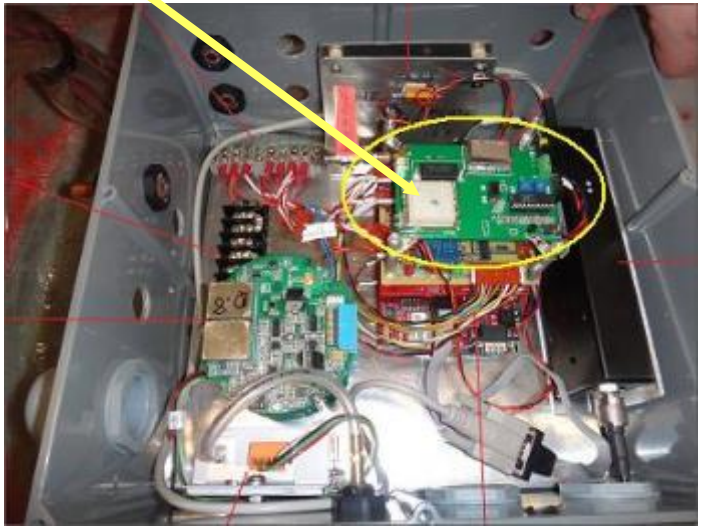
APRS Global data network

Arctic Buoy Student Experiment

- USNA Arctic Buoy deployed March 2012

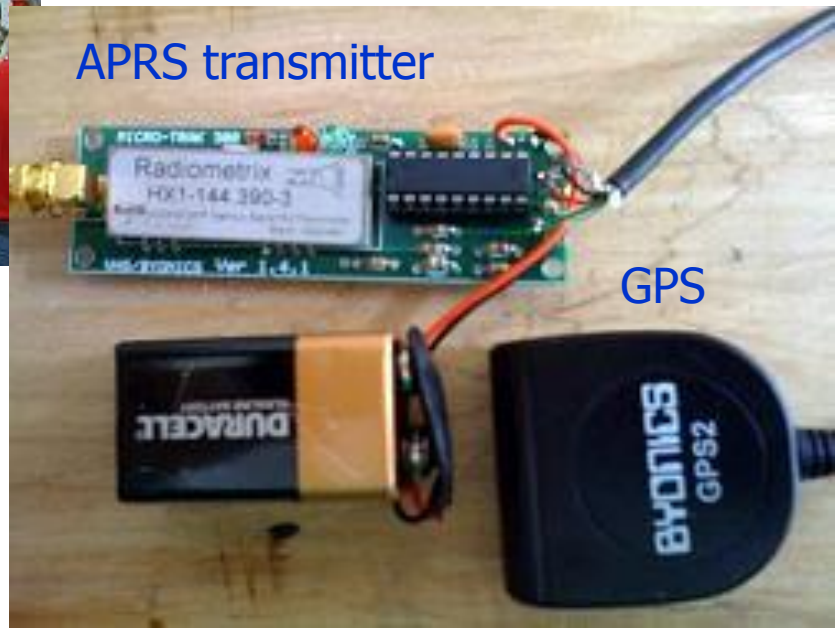
The APRS piece





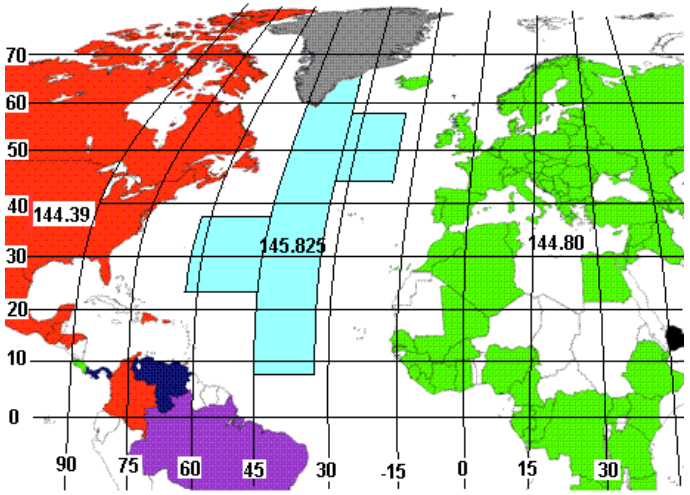
Example Remote Sensors using APRS Protocol

Very Simple



Why We Need Psat Satellite Transponders

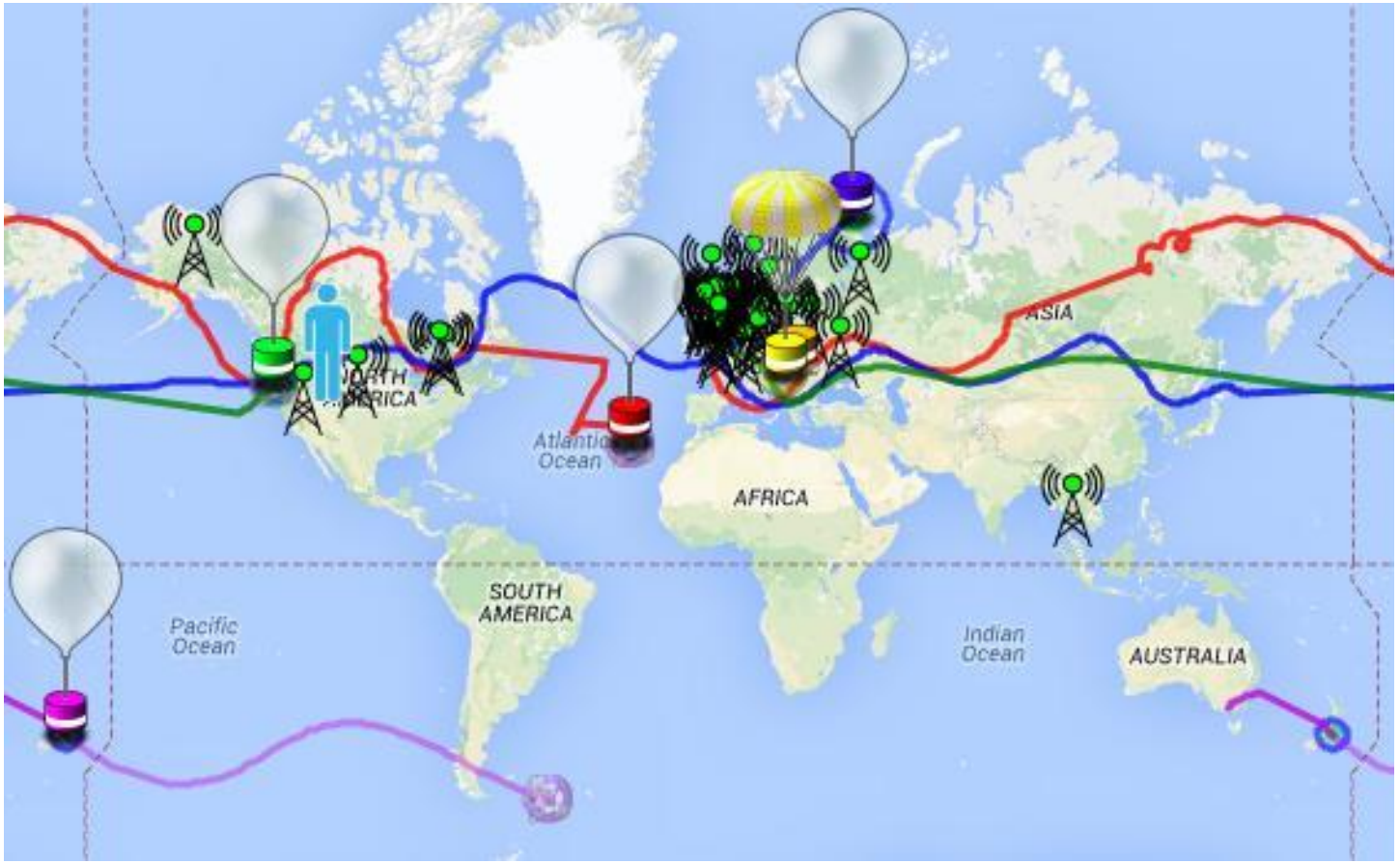
- Transatlantic APRS balloon launched and tracked through terrestrial network
- Lost comms over Atlantic Ocean
- It could have been picked up by our Psat/Pcsat transponder or the ISS



Possible APRS TransAtlantic Freq Plan

Global Wilderness Areas (90% of Earth)

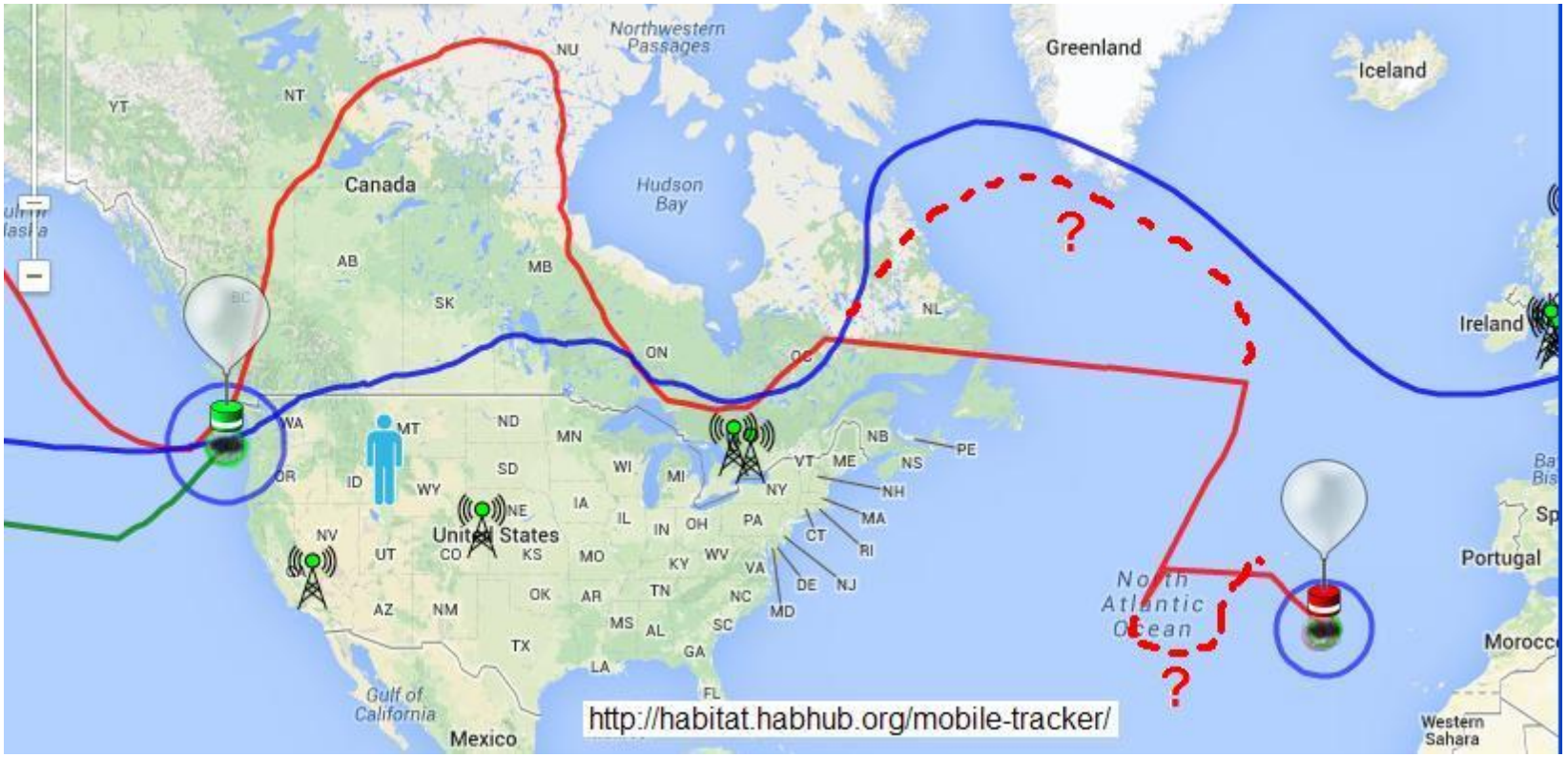
- Live Global APRS Balloon Tracking Web Page



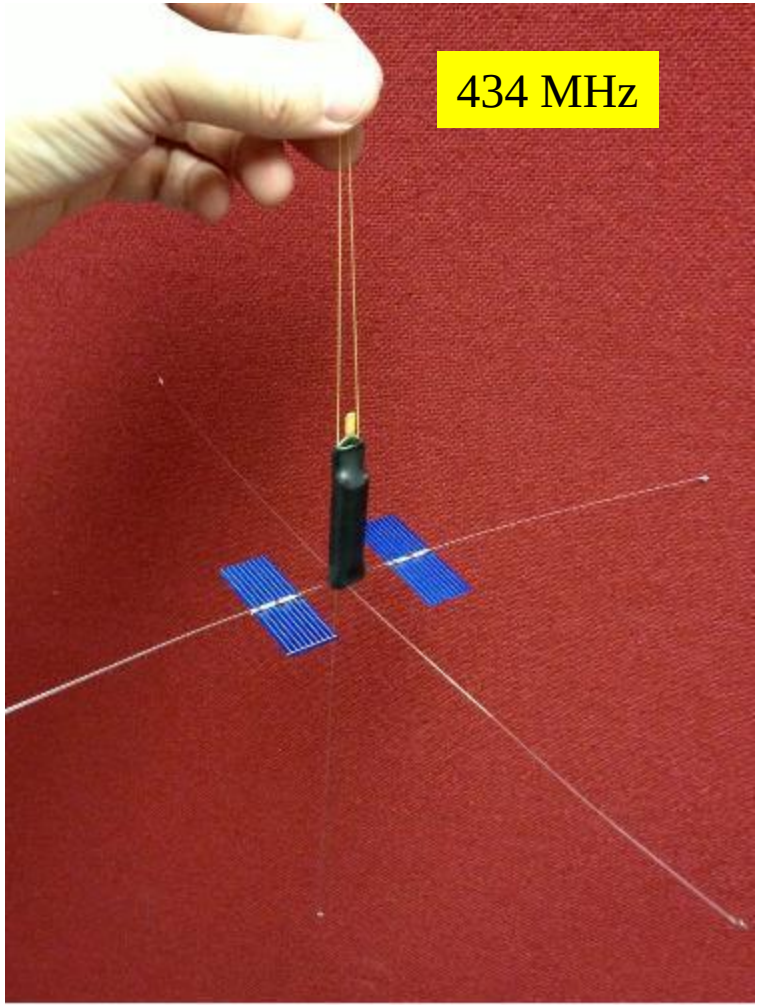
Global Wilderness Areas (90% of Earth)

M0XER-3, 4 and 6

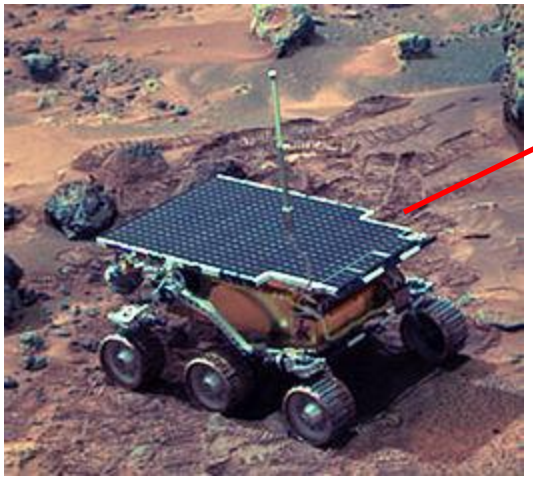
- Live Global APRS Balloon Tracking Web Page



Tiny M0XER APRS (balloon data) payloads



MAREA* Rover Projects (ARRL)



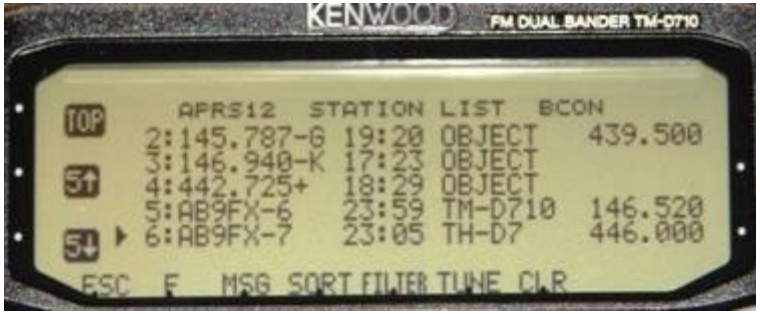
- STEM School projects
- Excite kids with Robotics
- Drive anywhere on Earth!
- Via APRS links
- School-to-school

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

Ground Terminal Applications Focus

Tactical Situational Awareness and Text Messaging

Last 100 stations!

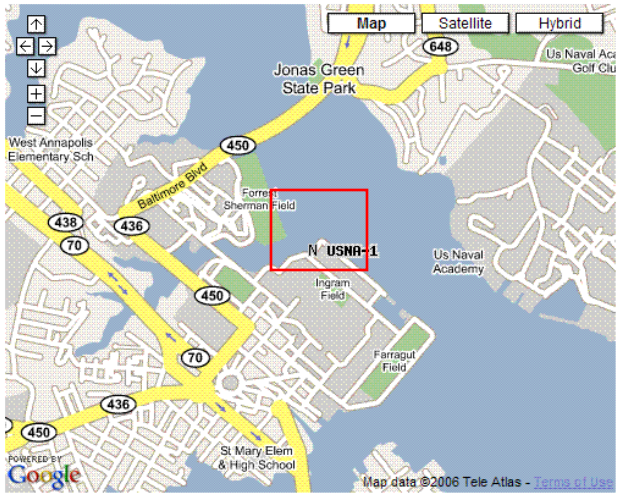


Direction & Distance

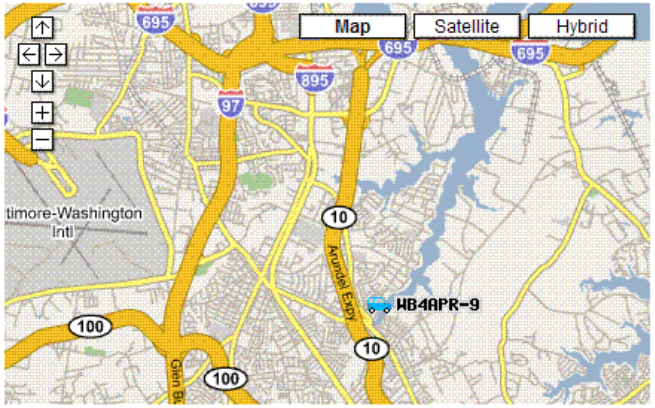
Frequency and Tone

Tracking (on Google Earth)

http://aprs.fi

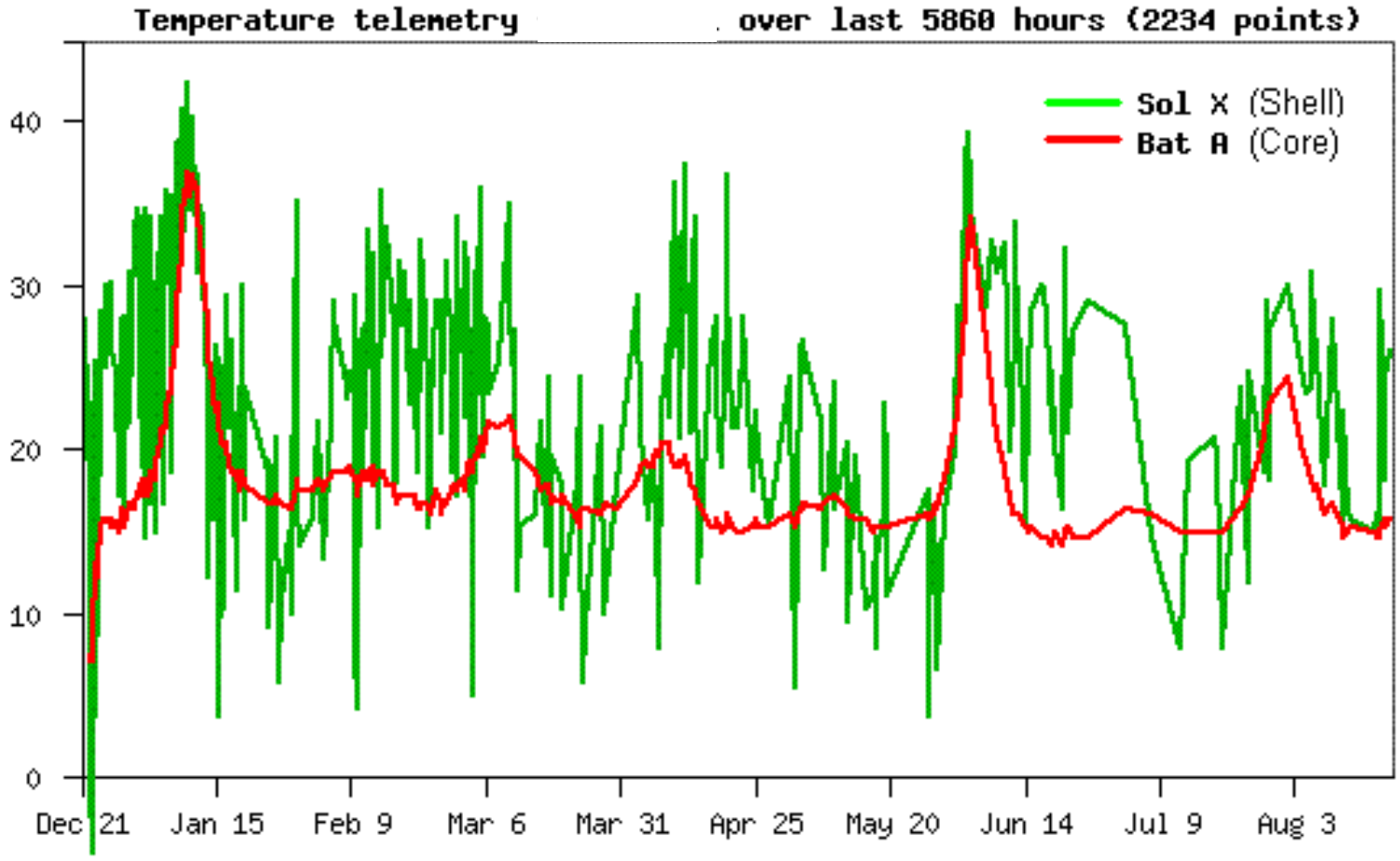


Tactical situational awareness

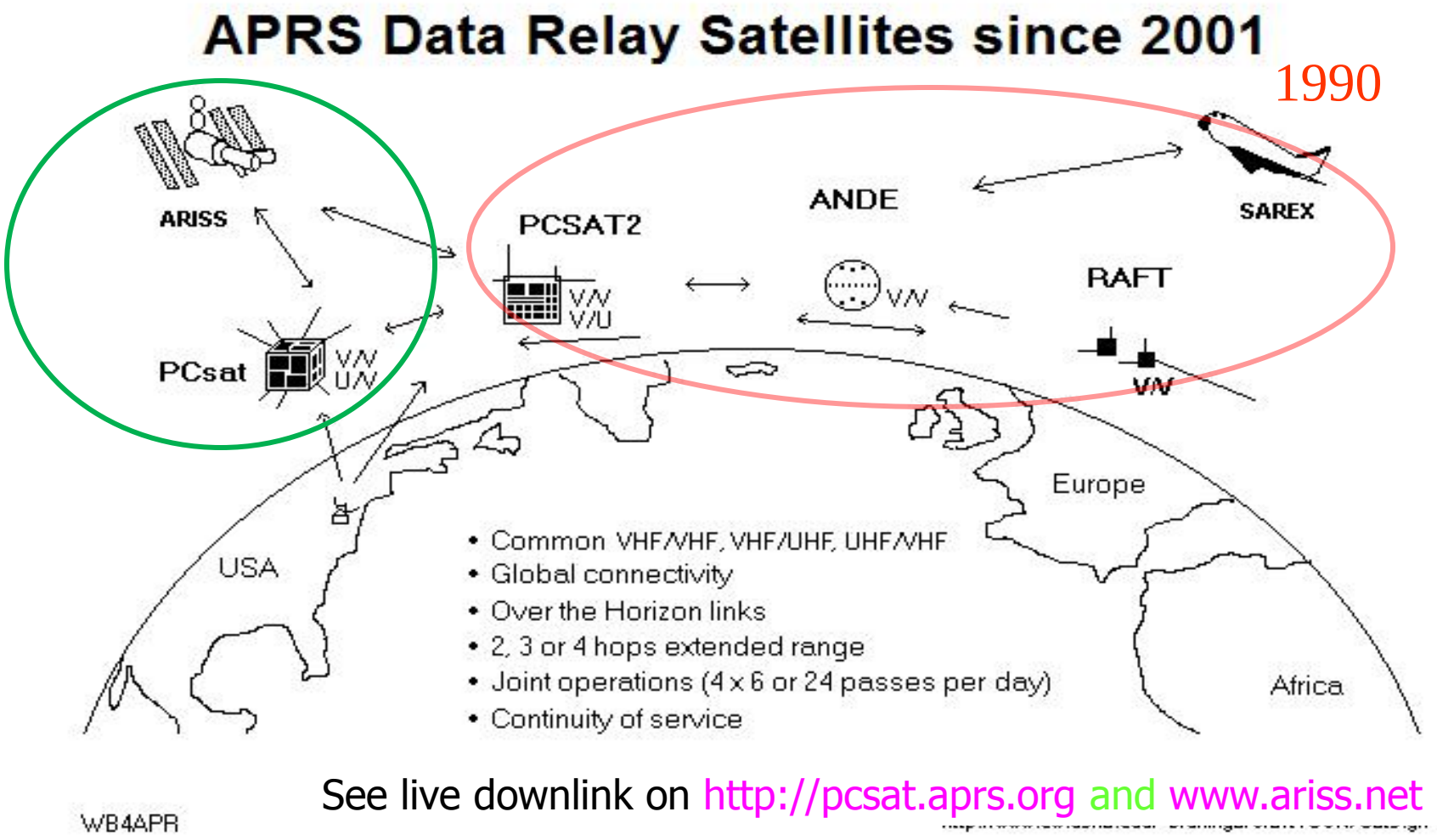


Findu.com Telemetry Plots

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

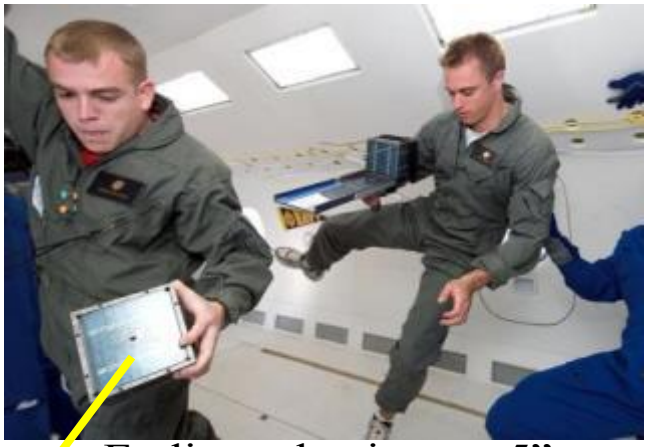


All on 145.825 MHz



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

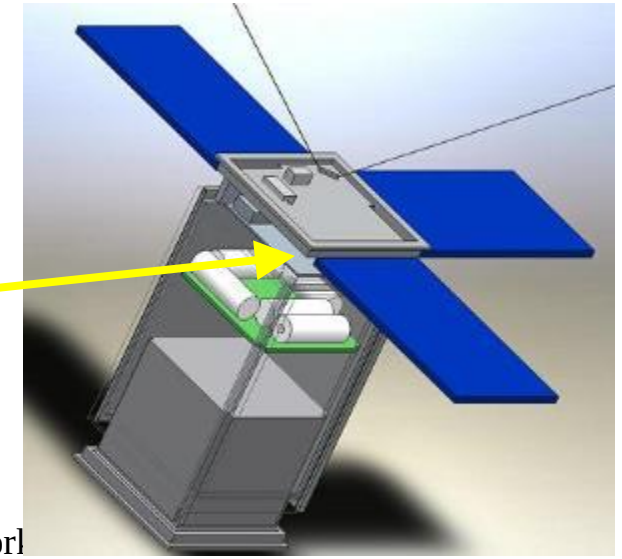
Huge reduction from transponders on PCSAT's 1,2, ANDE and RAFT missions



Earlier reductions to 5" cubesat on RAFT (2006)

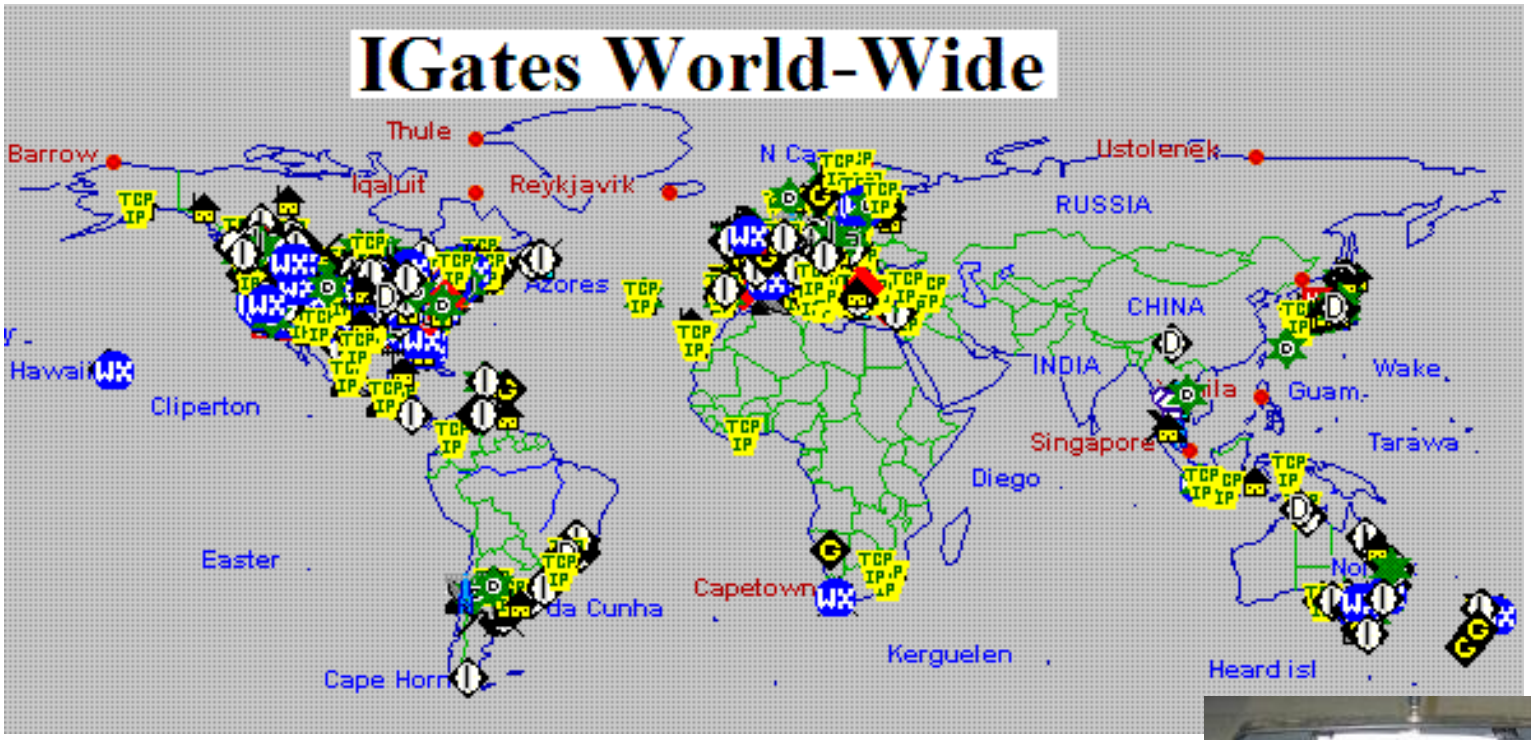
4:1

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



APRS Global data networ

Psat APRS Network Architecture

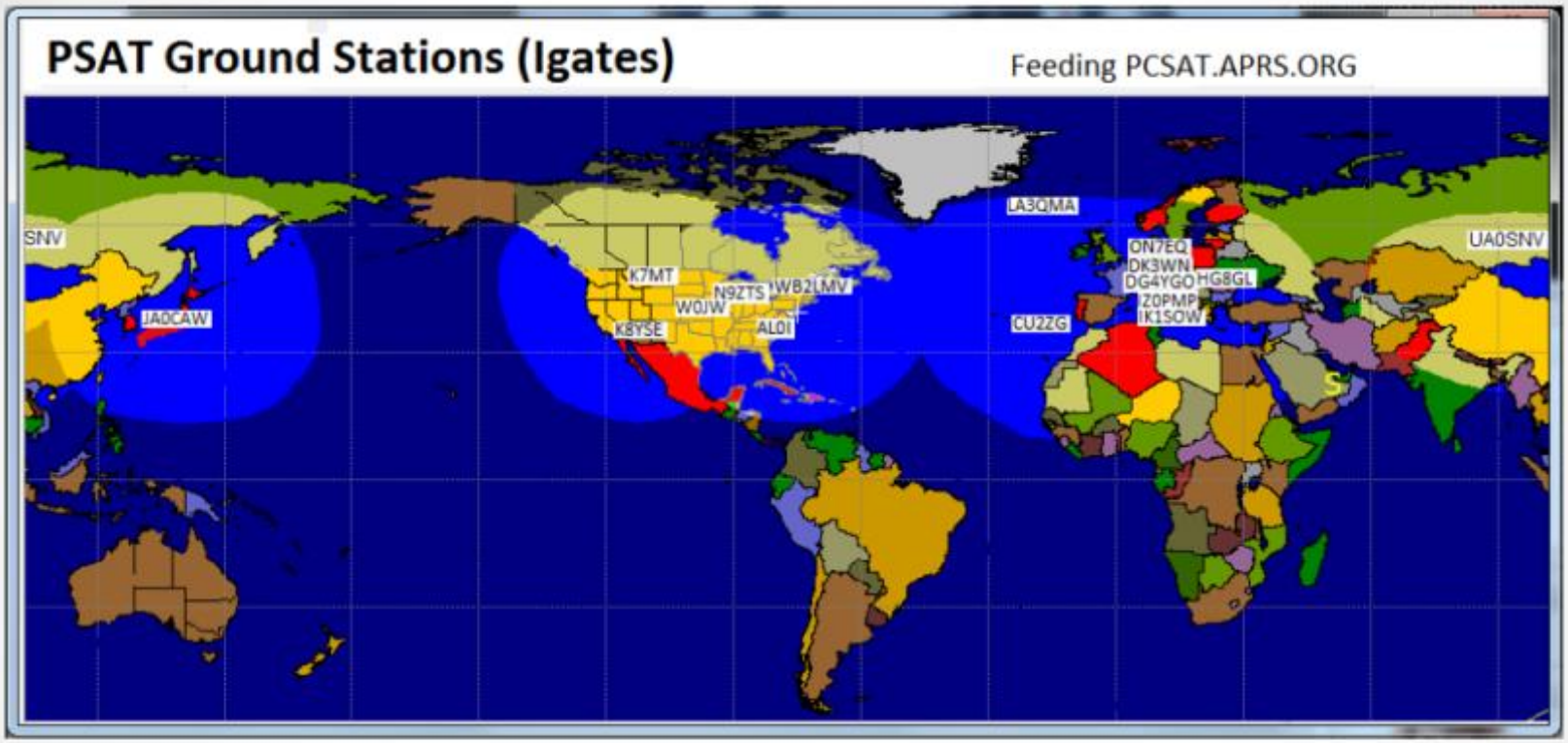


Global Volunteer Ground Station Network

Internet Linked for live Telemetry

APRS Global data network

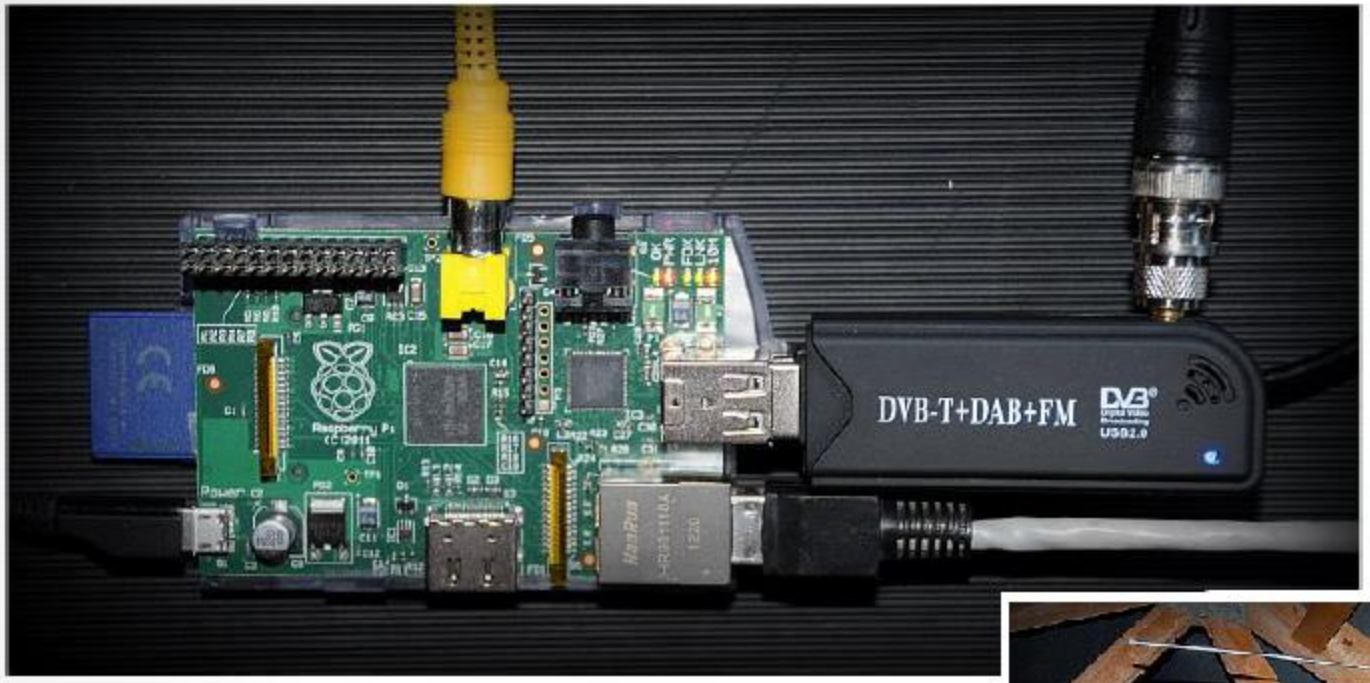
70 APRS Satgates hear ISS, but only 10 hear PSAT (- 17 dB)



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, LU1WFU, 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 Global data network

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

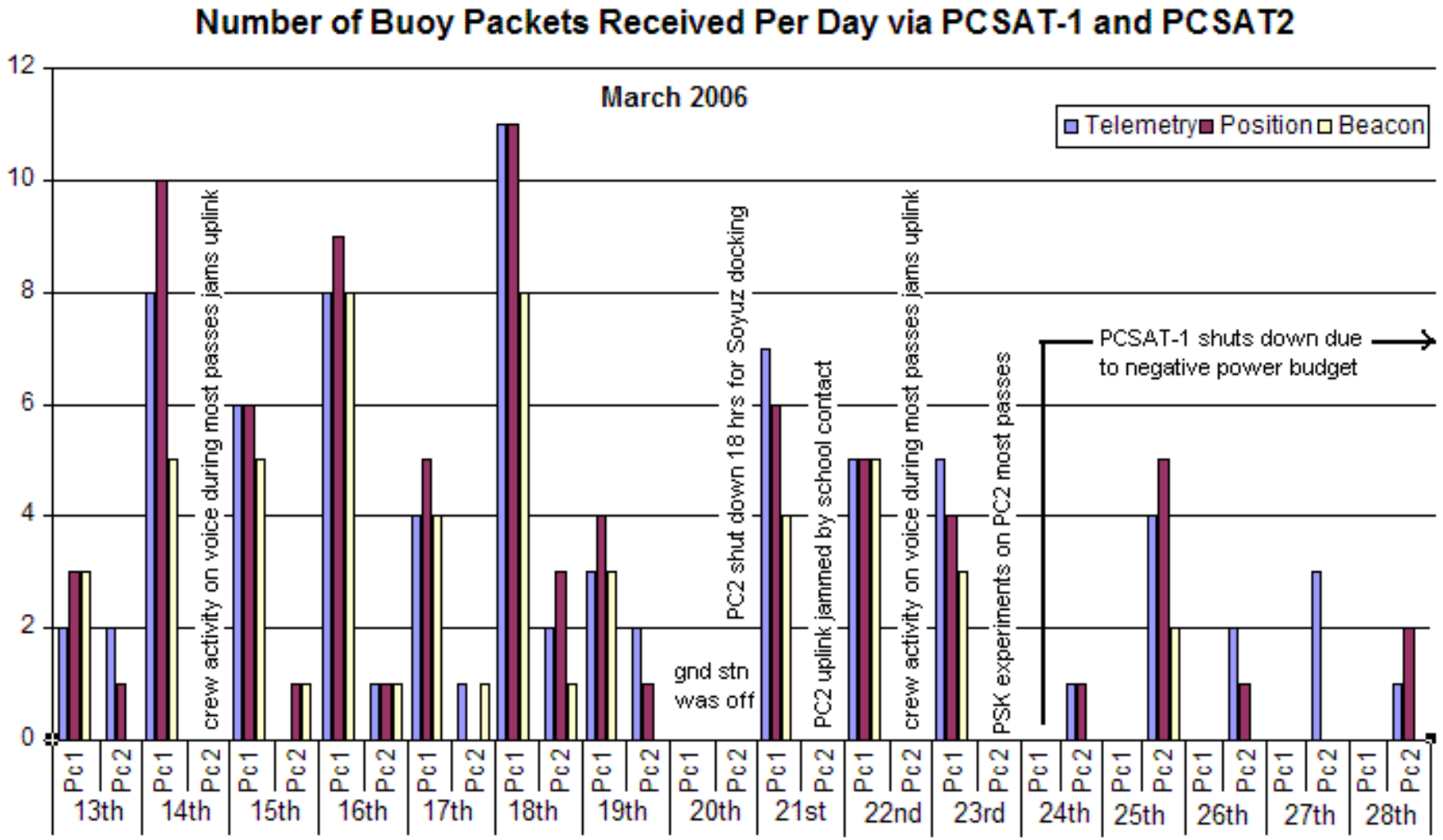
- If free-floating, do not disturb.
- If aground, move to deep water and advise bruninga@usna.edu
- If later than 30 Nov 2006, recover and advise above.

2006 15:1 reduction 2008

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

Piggrem

Remote Buoy Baseline Test – Success of 1 min Xmit rate

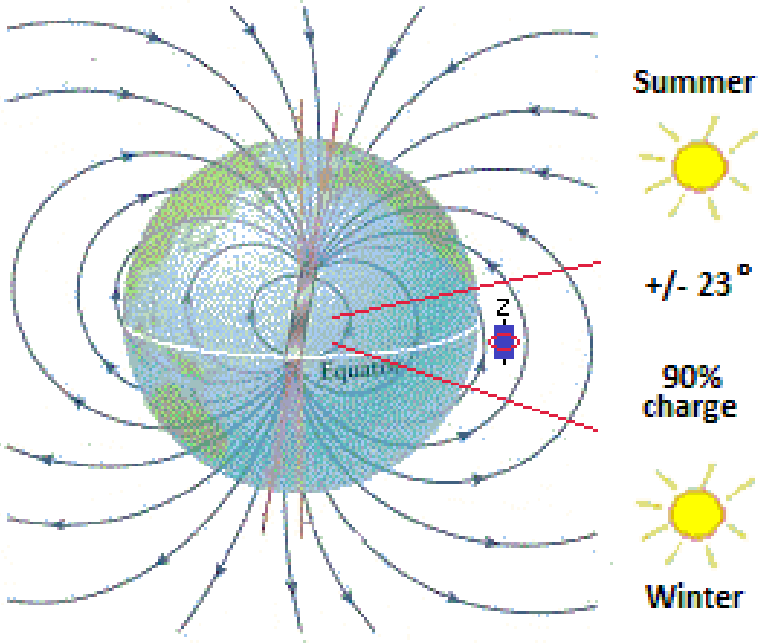


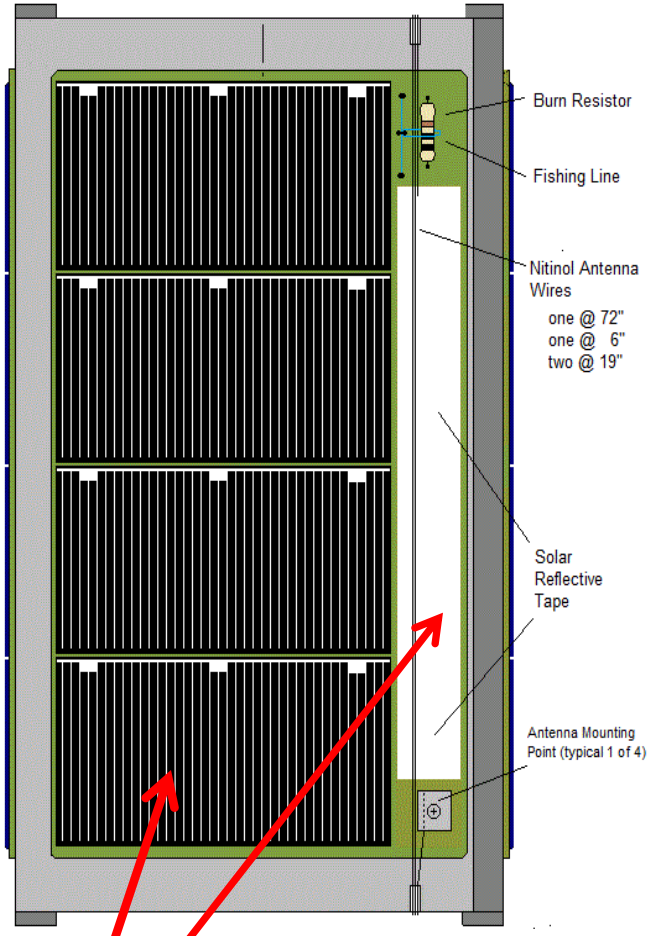
QuickLook: Global APRS Data Network

- 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

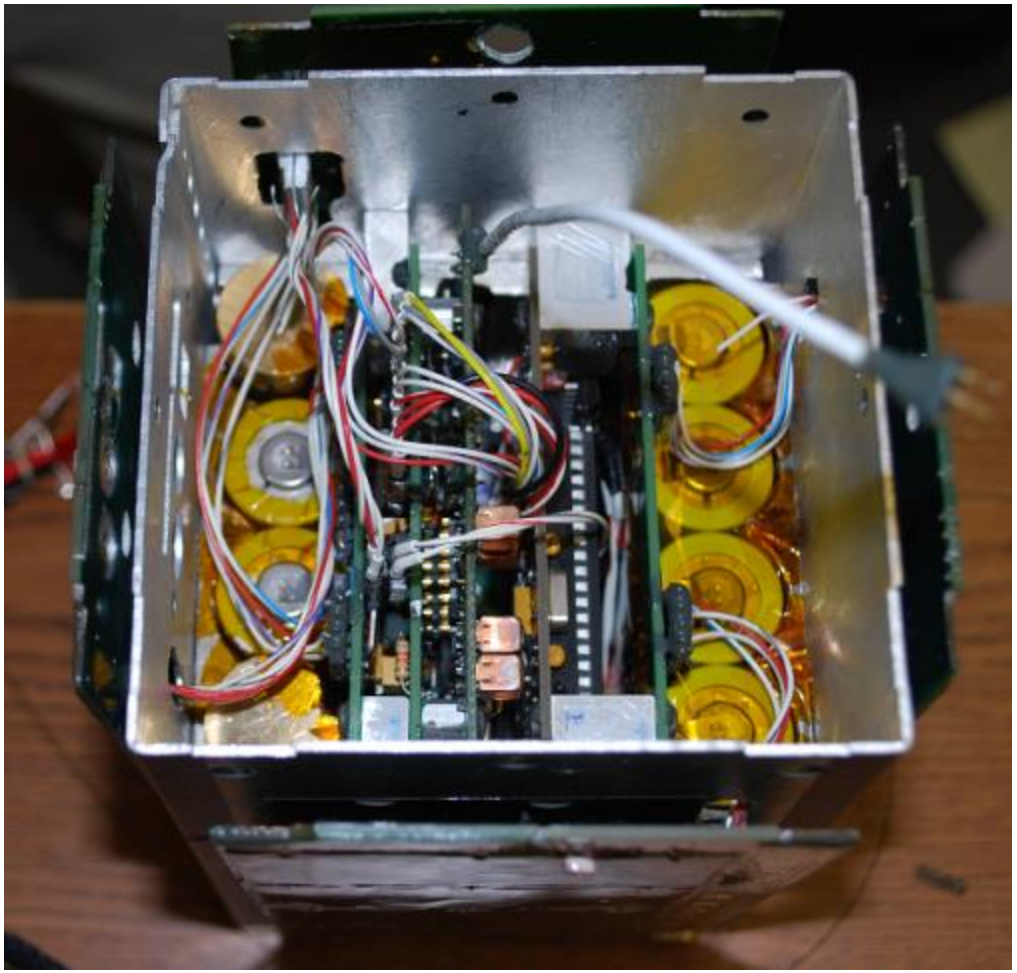
- Uses only one Z coil for attitude Control
  - Fires only within +/- 20 deg of Equator
  - Solar Panel angle better than 95% power
  - Higher reliability
  - Passive Spin maintenance

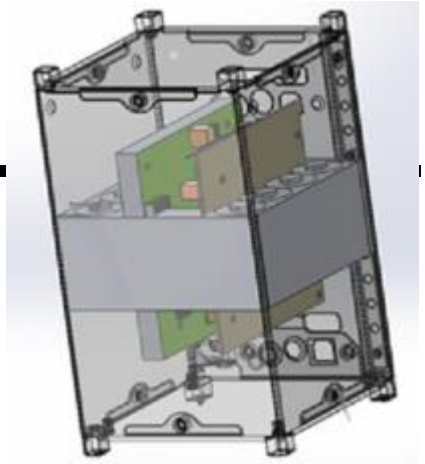




Differential Radiation Spin

PSAT's mass is centered in Z



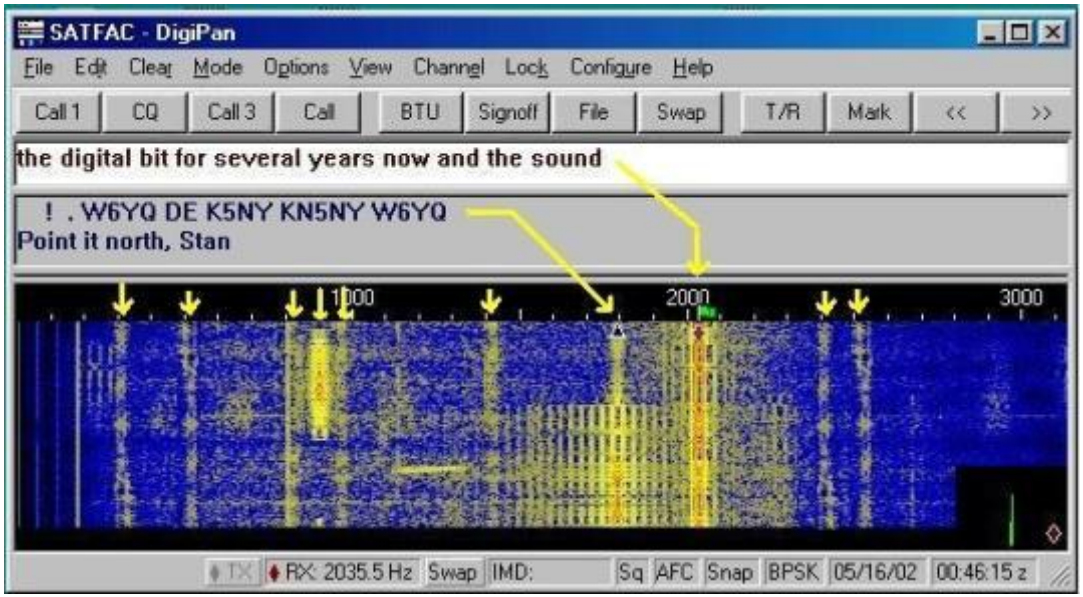


- For Maximum MOI about Z
- Batteries to outside for MOI & Shielding
- Stainless steel belt around everything

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.

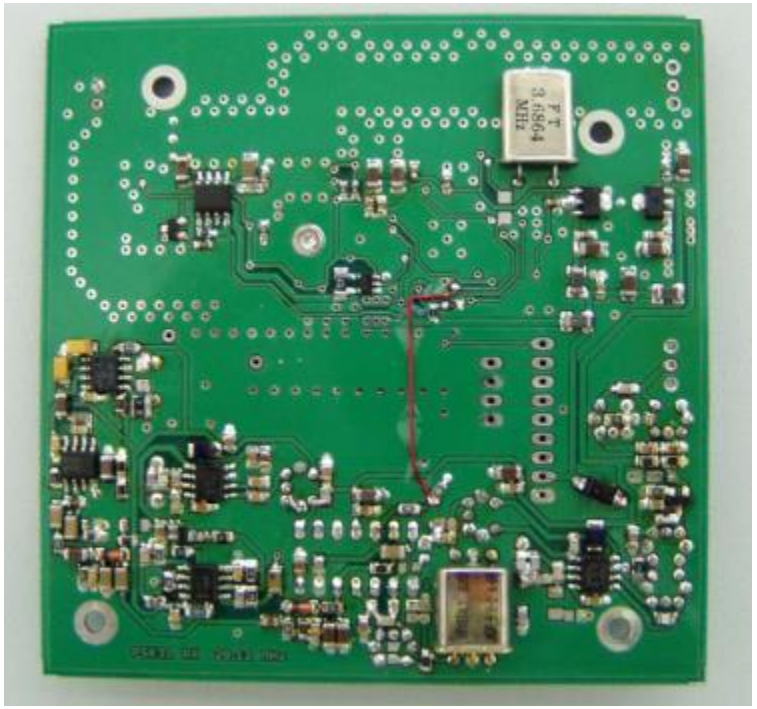
28 MHz
SSB uplinks



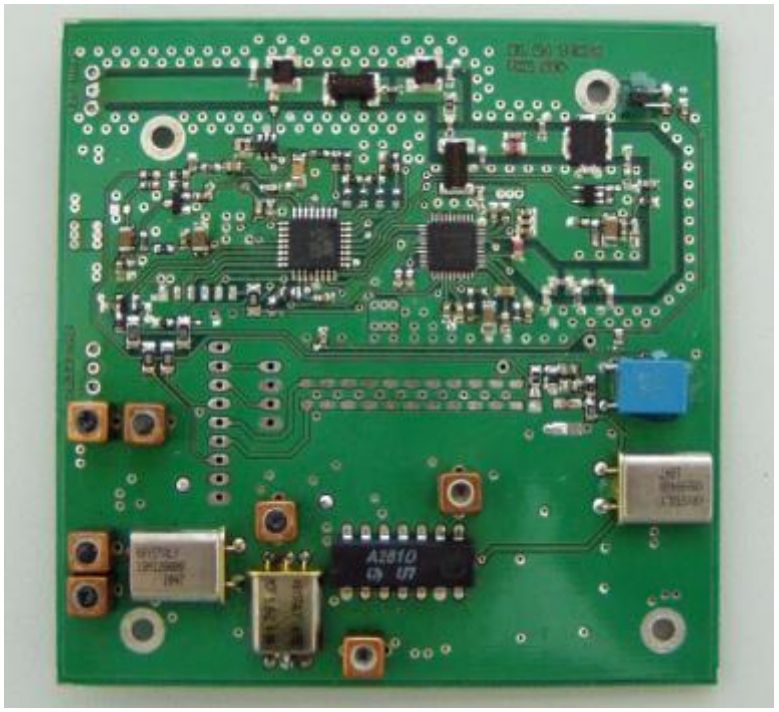
435.350
FM downlink

PSAT: PSK31 Transponder Payload !!!

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



HF Linear RX



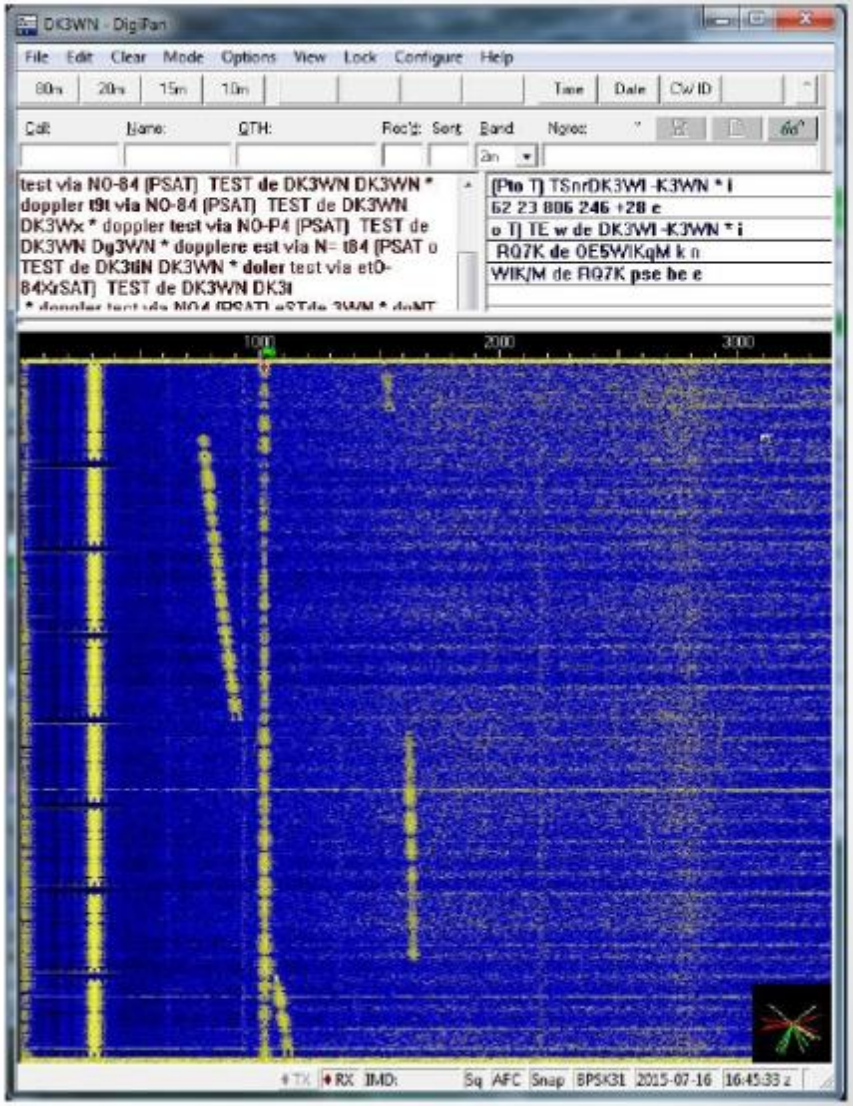
FM XMTR

PSK DopplerPSK

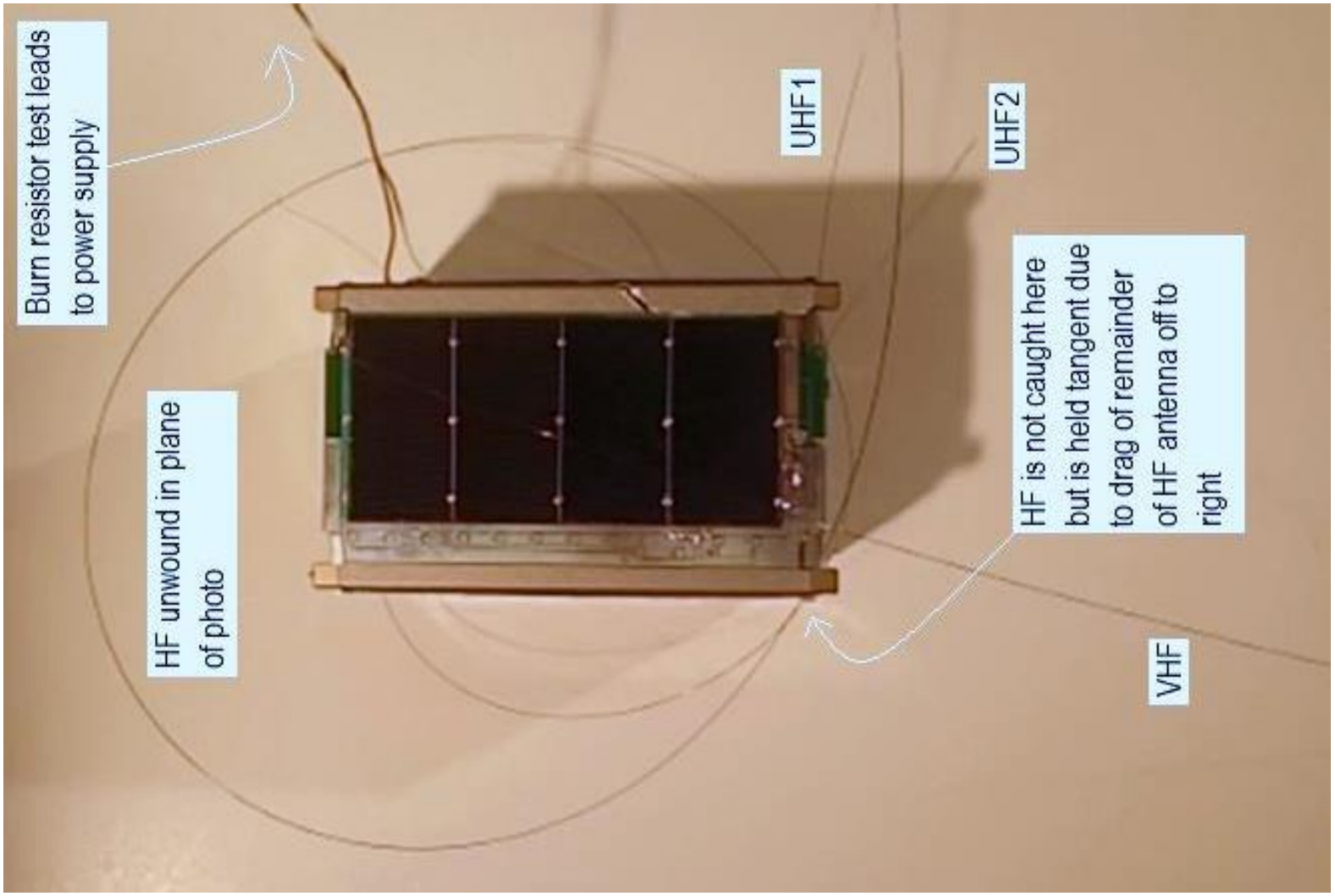
by Andrew Flowers K0SM

- 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

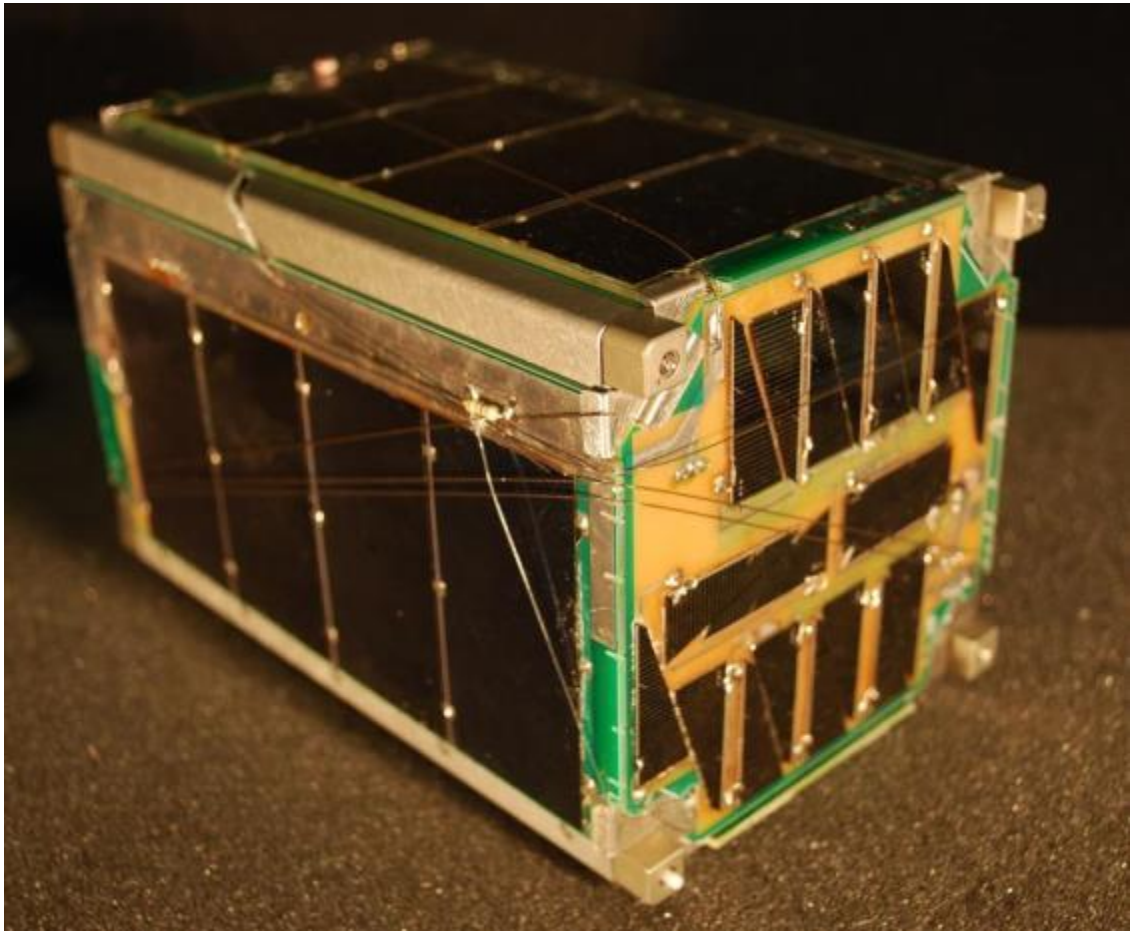
http://www.frontiernet.net/~aflowers/dopplerpsk/dopplerpsk.html



PSAT Nitinol Wire Whip Antennas



Wrapping Antennas to one Burn Resistor



2 Orthogonal UHF whips

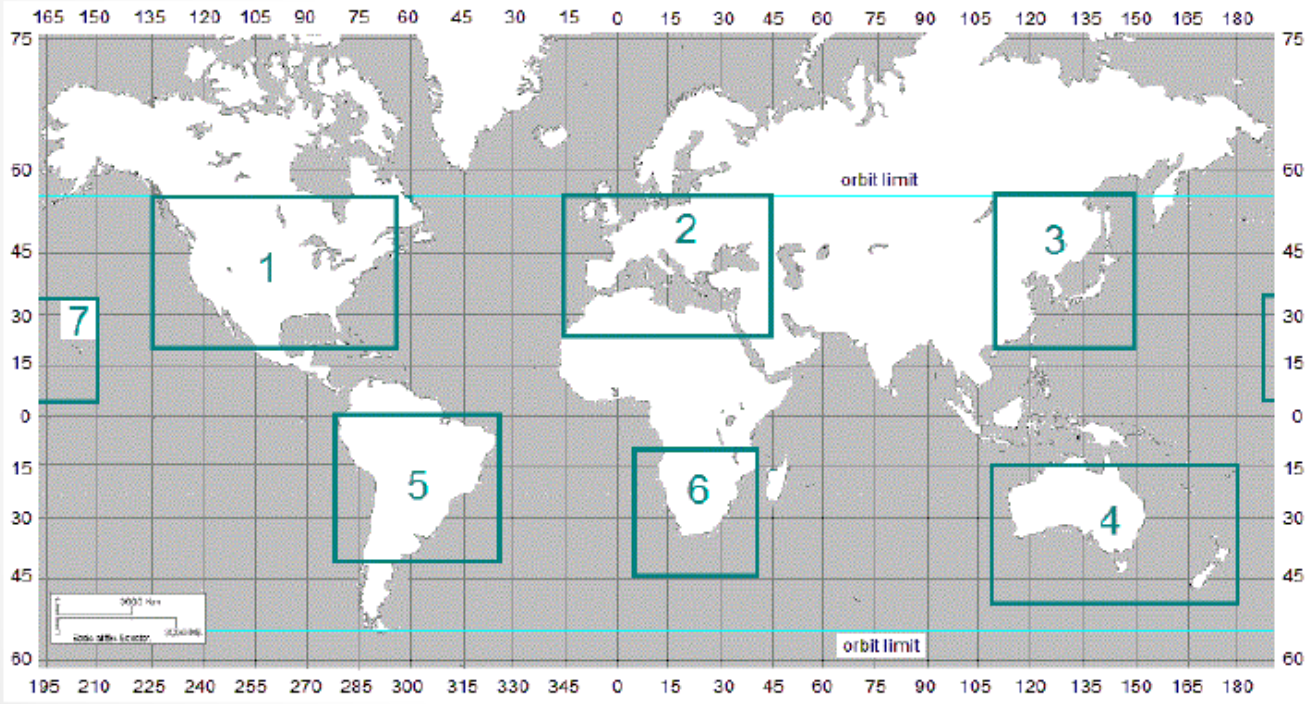
One VHF whip

One 6’ HF whip

3rd Enable Switch

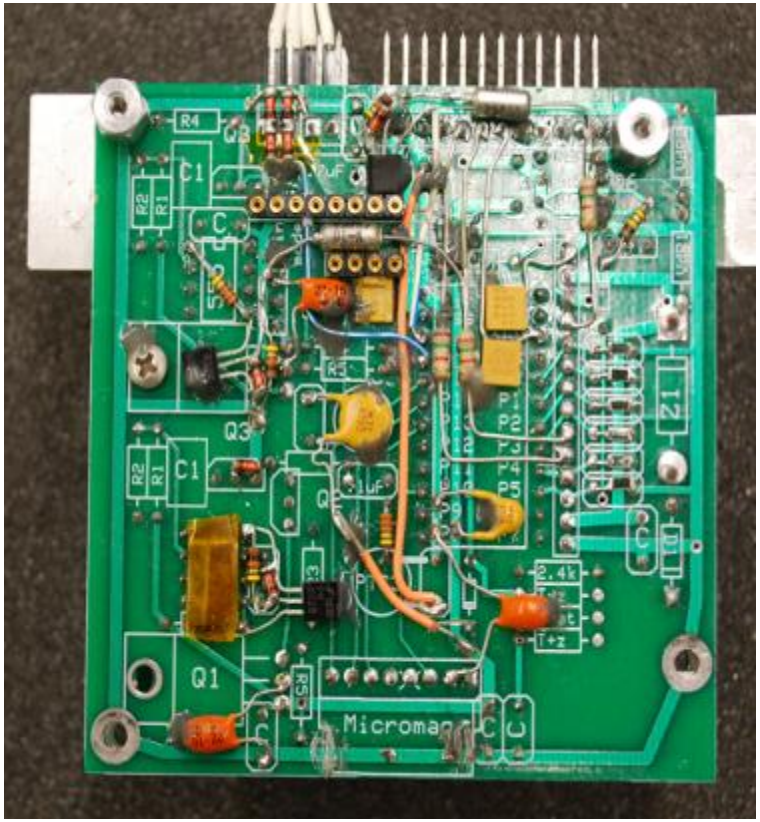
PSAT bulletin packets

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.

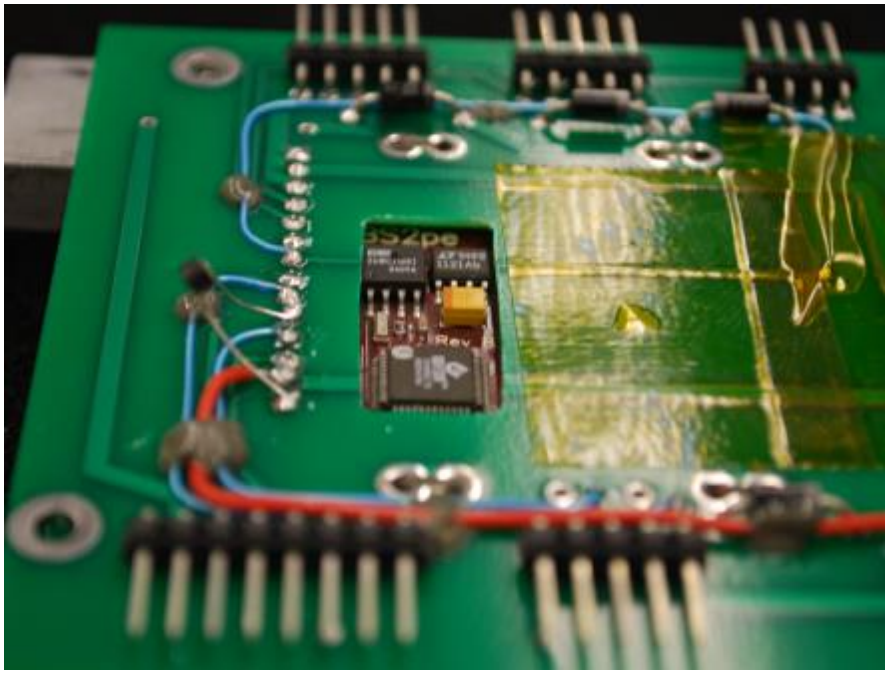



```
PSAT-1>APOFF,ARISS,qAR,ON7EQ-10::BLN0USA :PSK31 435.35 Up on 28.12
PSAT-1>APOFF,ARISS,qAR,HG8GL-5::BLN1USA :ARISS.NET & PCSAT.APRS.ORG
PSAT-1>APOFF,ARISS,qAR,ON7EQ-10::BLN2USA :See APRS.FI & 144.39 users
PSAT>APRSON,ARISS,qAR,DK3WN-8::BLN0EUR :PSK31 435.35 Up on 28.12
PSAT>APRSON,ARISS,qAR,DK3WN-8::BLN1EUR :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



Stop adding neat features…



Make sure it fits

Our Next APRS Satellites

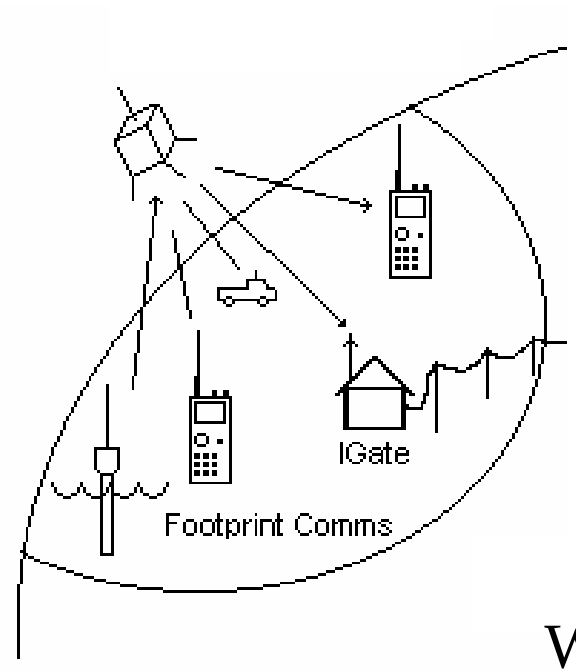
QIKcom-1

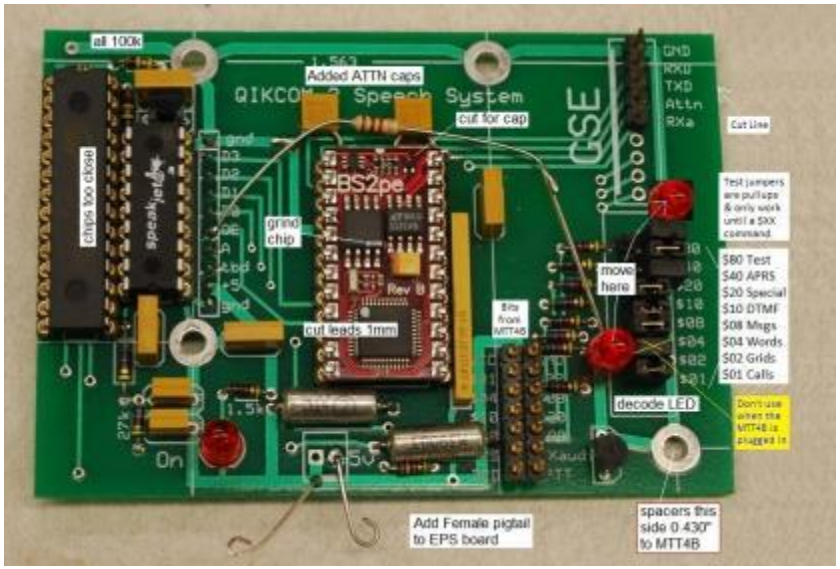
- APRS system (PSAT)
- Release from ISS in October 2015
- flies on host spacecraft (28V, no solar panels **or** ADCS)

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.

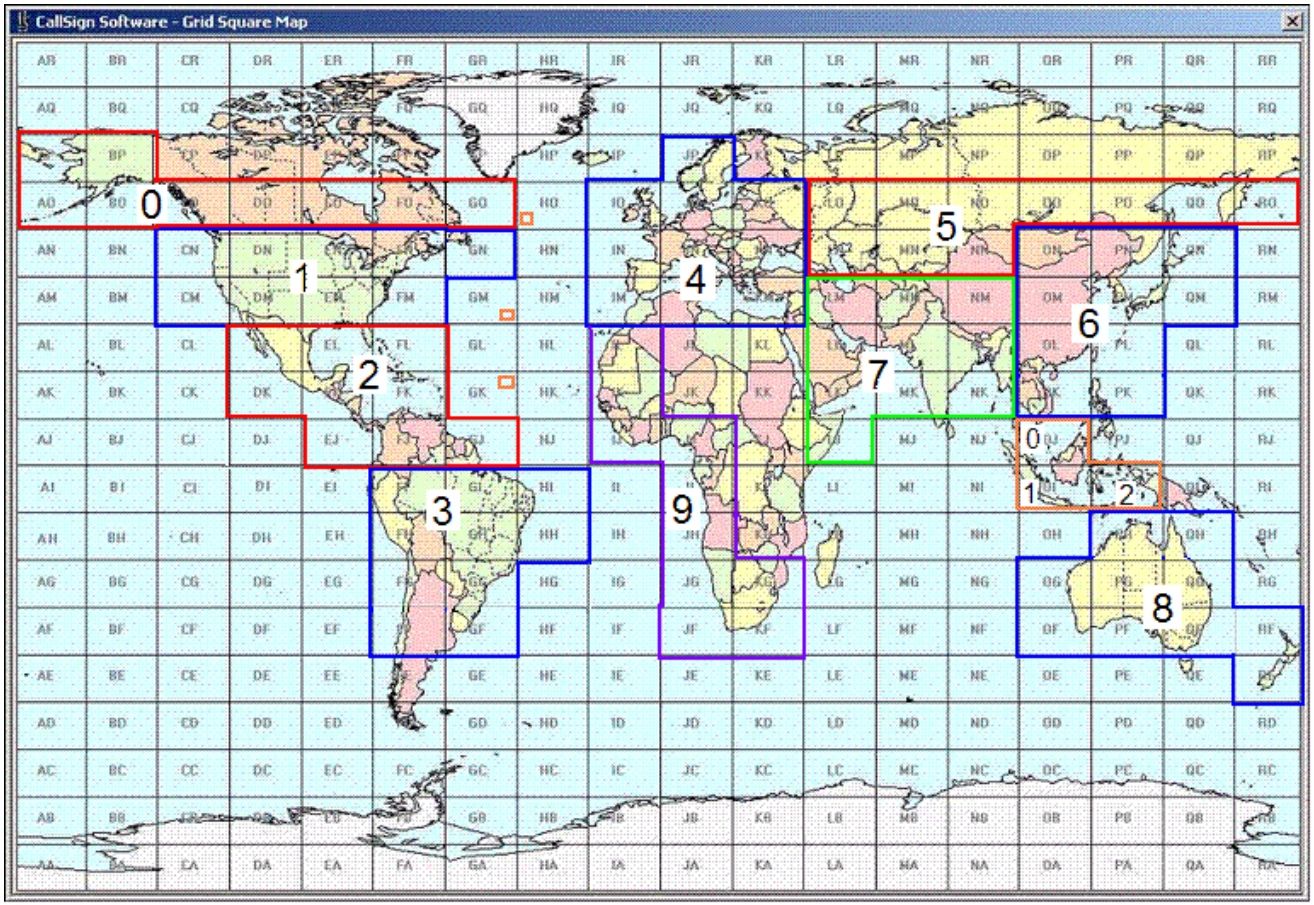
The 324 Grid system has 99 grids…
Position to 60 miles in 4 digits

	FM19	WB4APR		
*	18 19	9 24 27 7	15 58	#

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, LJ

8 - Aus/NZ
PH, QH, OG, 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)

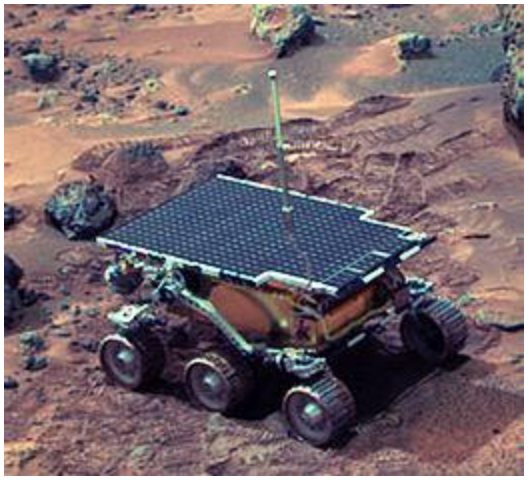
- Since 1800's for telegraph
- since1927 or so for radio
- Most of the time, most of what is said, has been said before
- Q2 has 99 messages and 99 modifiers

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 exits 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 REACT communications services also available. Establish REACT 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 ….

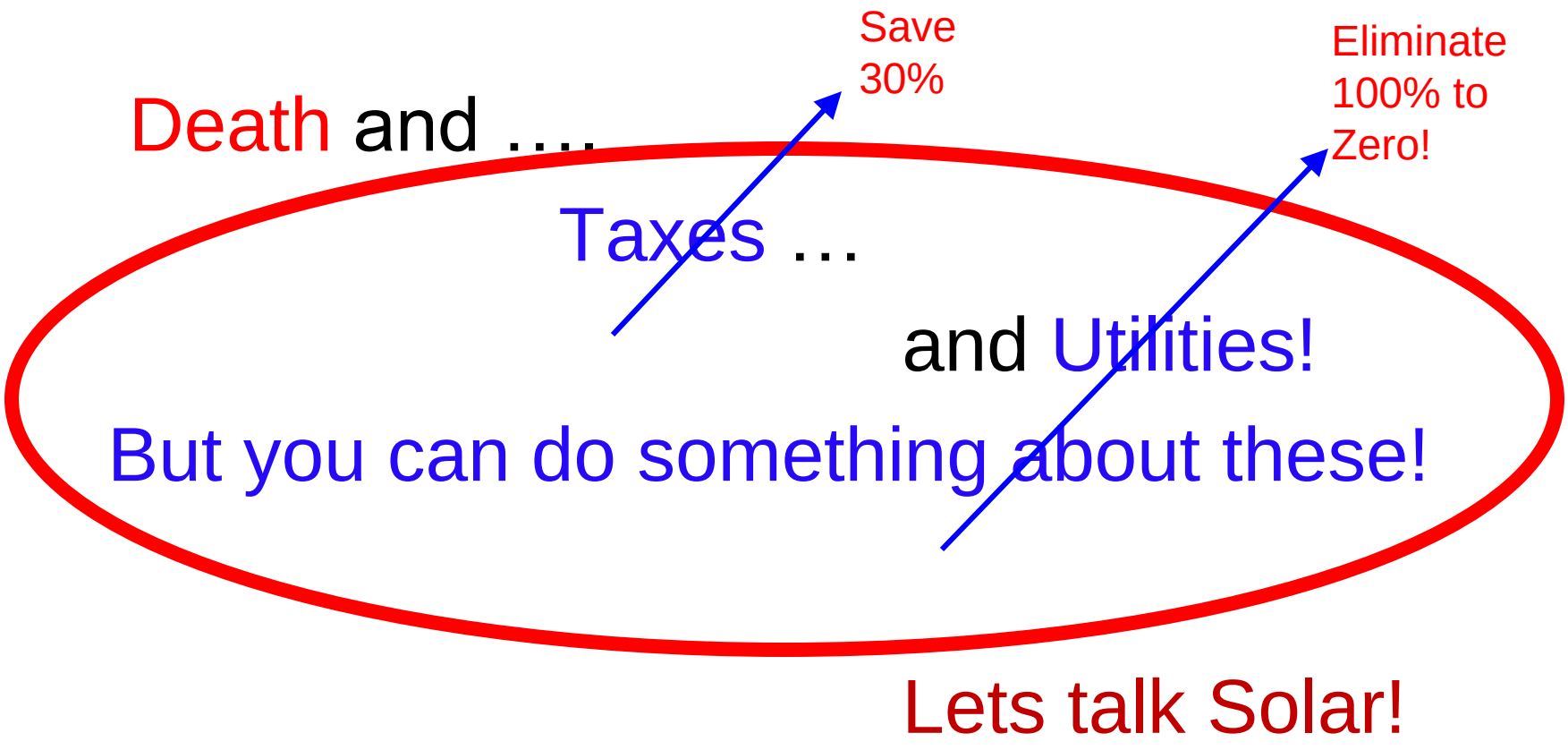
Taxes …

and Utilities!

But you can do something about these!

Finish this Sentence:

- There is nothing certain in life except



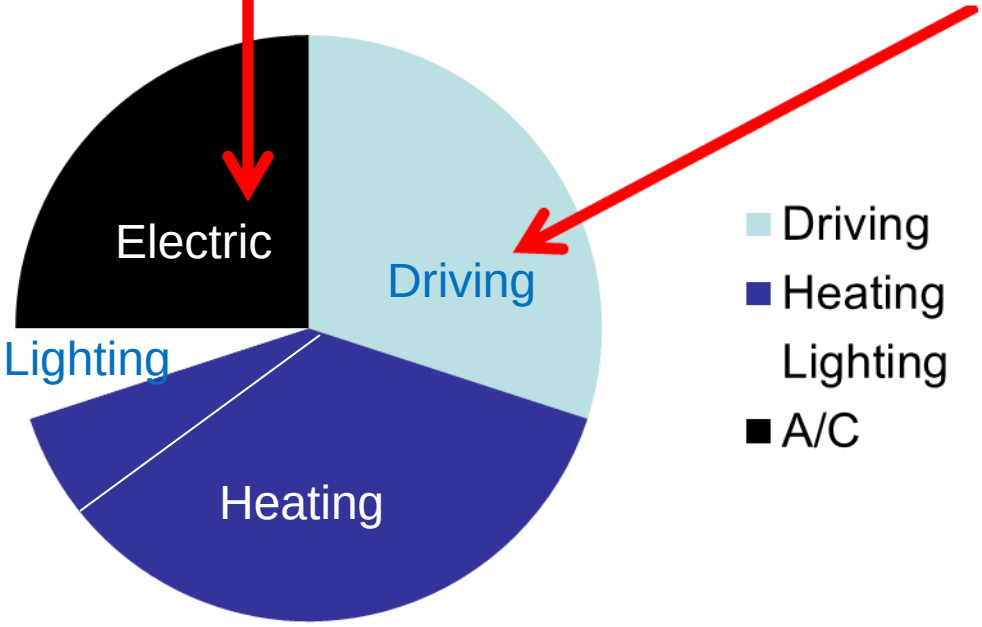
Big Picture!

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 ???

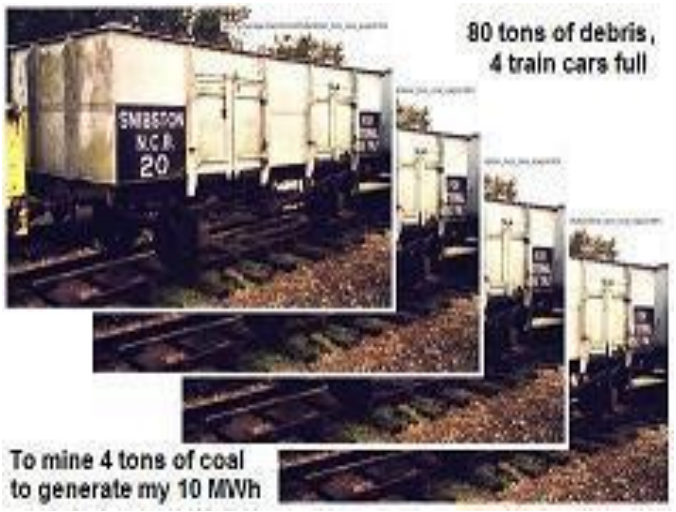
Paying for Sewage Plants –
was from Day ONE !

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!

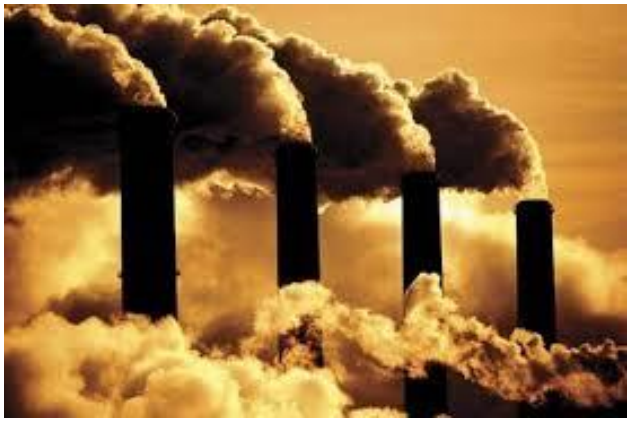


1 House, 1 Year 4 Tons of Coal

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~~ $1 cents.

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

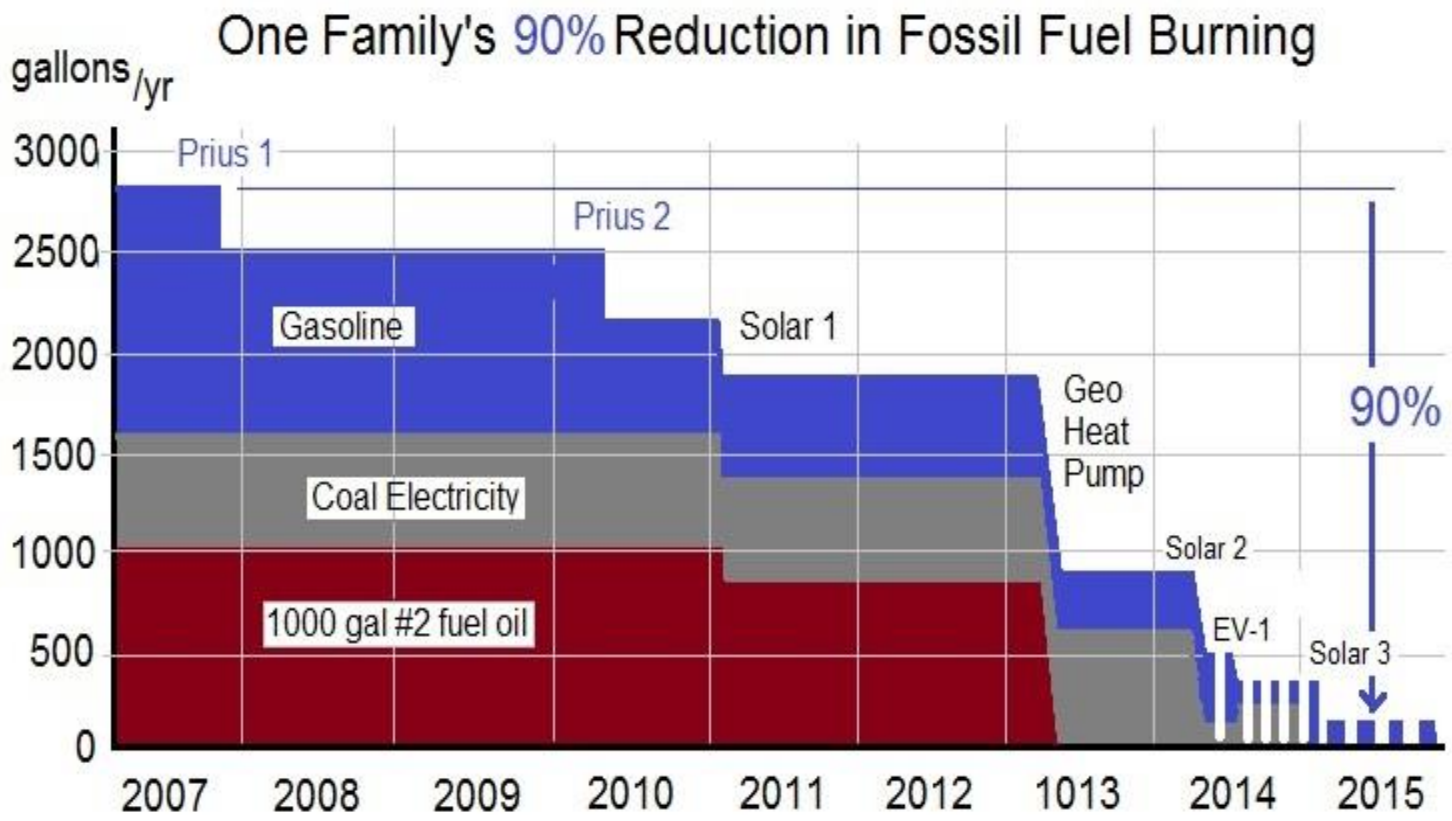
On average, you will face one of these every 2 years. Are you ready to make the choice for clean energy and savings for the rest of your life?

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/year



Help the Environment

And save money!

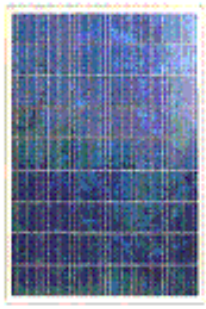
8 Trees Eliminate these Pollutants /yr

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

Big Picture!

Clean Energy, SOLAR



One 220W solar panel Eliminates Per Year:

440 lbs of Carbon Dioxide
57 lbs of Particulates
7 lbs of Sulfer 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

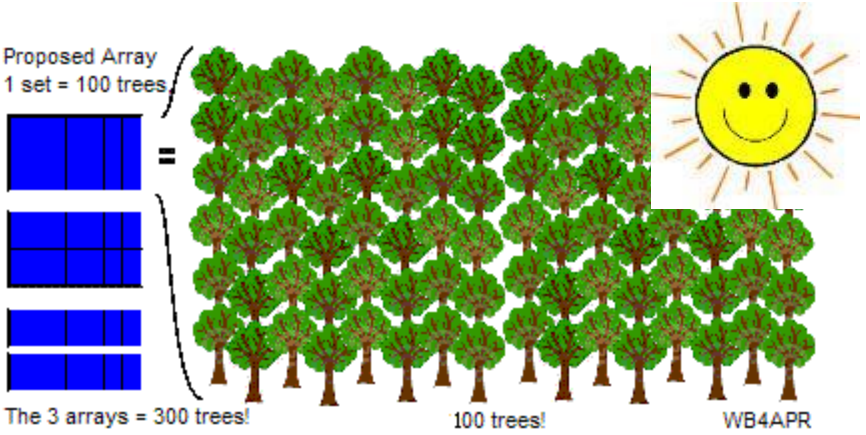
Bob Bruninga, WB4APR

Carbon Equivalence!

Each Panel = 8 Trees.

Our system = 312 trees!

= **(3 acres of trees)**

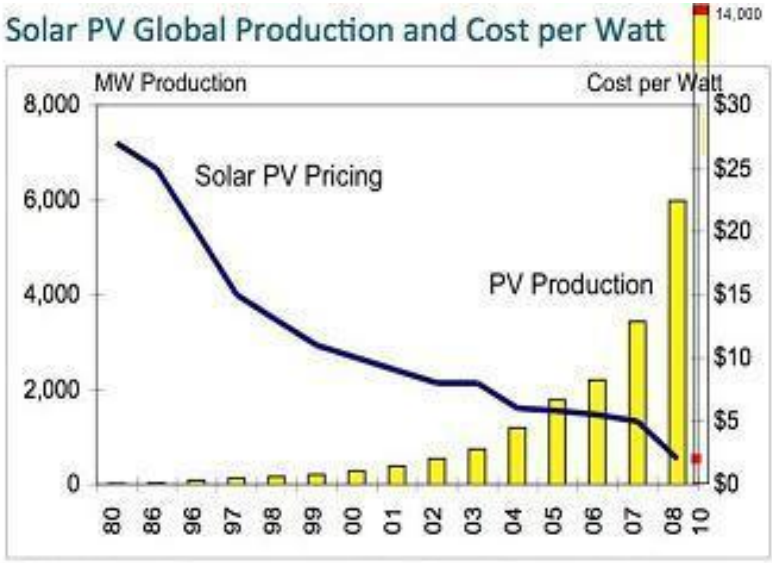


Solar Power is here & Growing Exponentially

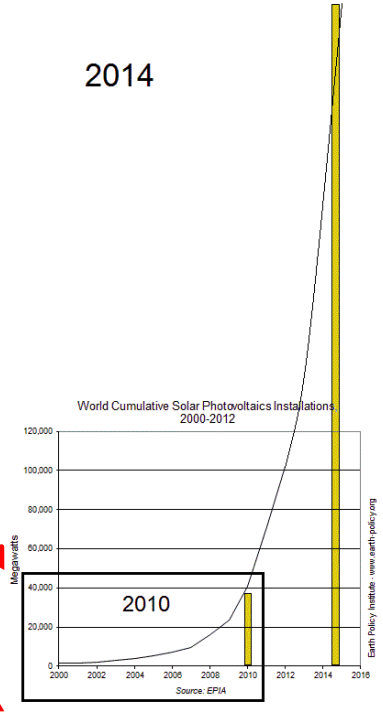
2015

Graph when I first started talking in 2010

Graph now!

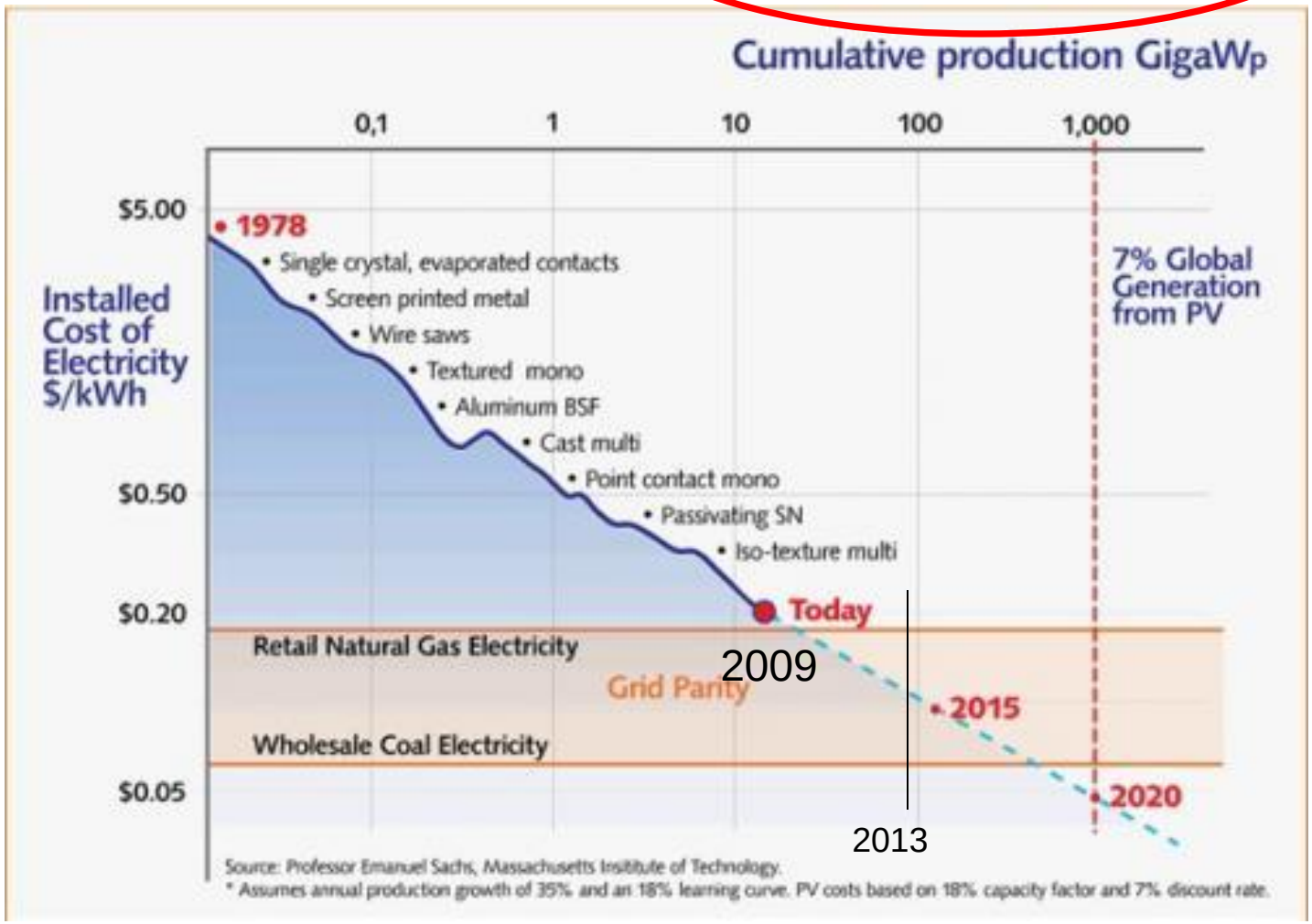


Solar Buzz. Company reports.. Green Econometrics research
http://greenecon.net/wp-content/uploads/2009/10/price.jpg



Solar Cost!

Equaled Utility in 2010
Half the Utility in 2013



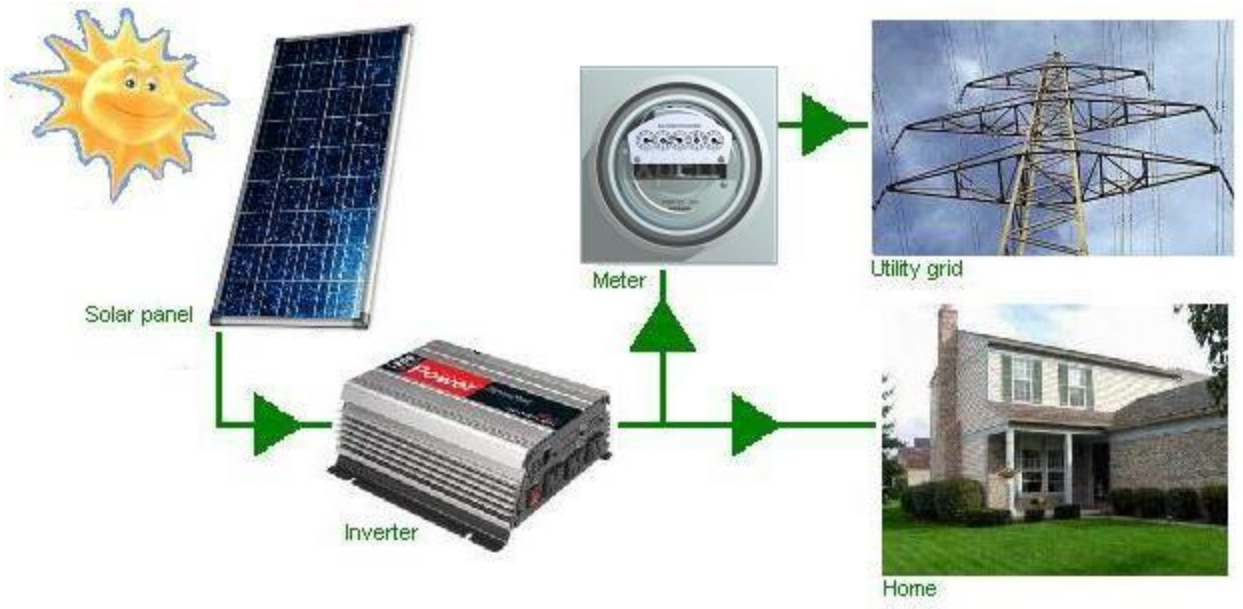
As a Ham, I was so wrong!

- 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 MAINENANCE FOR LIFE!

Falling Prices 10-to-1

Panel

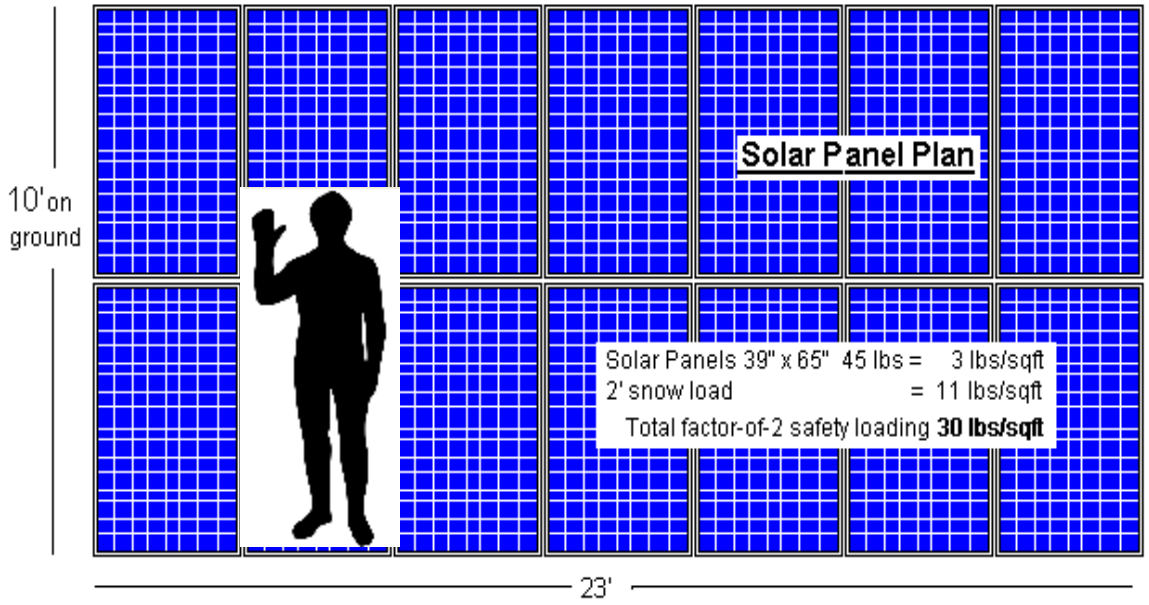
A 3 kW array

200 W

220 W

250 W

(300W)



Array Cost

$15,000 2007

$ 9,000 2010

$ 6,000 2012

$ 3,000 2013

$ 2,000 2014

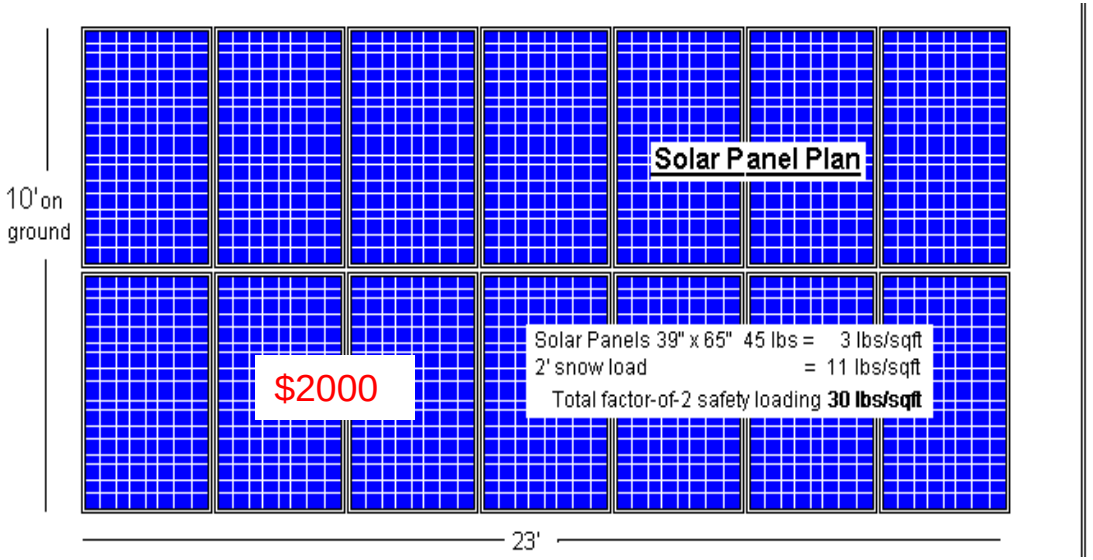
$ 1,900 2015

$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

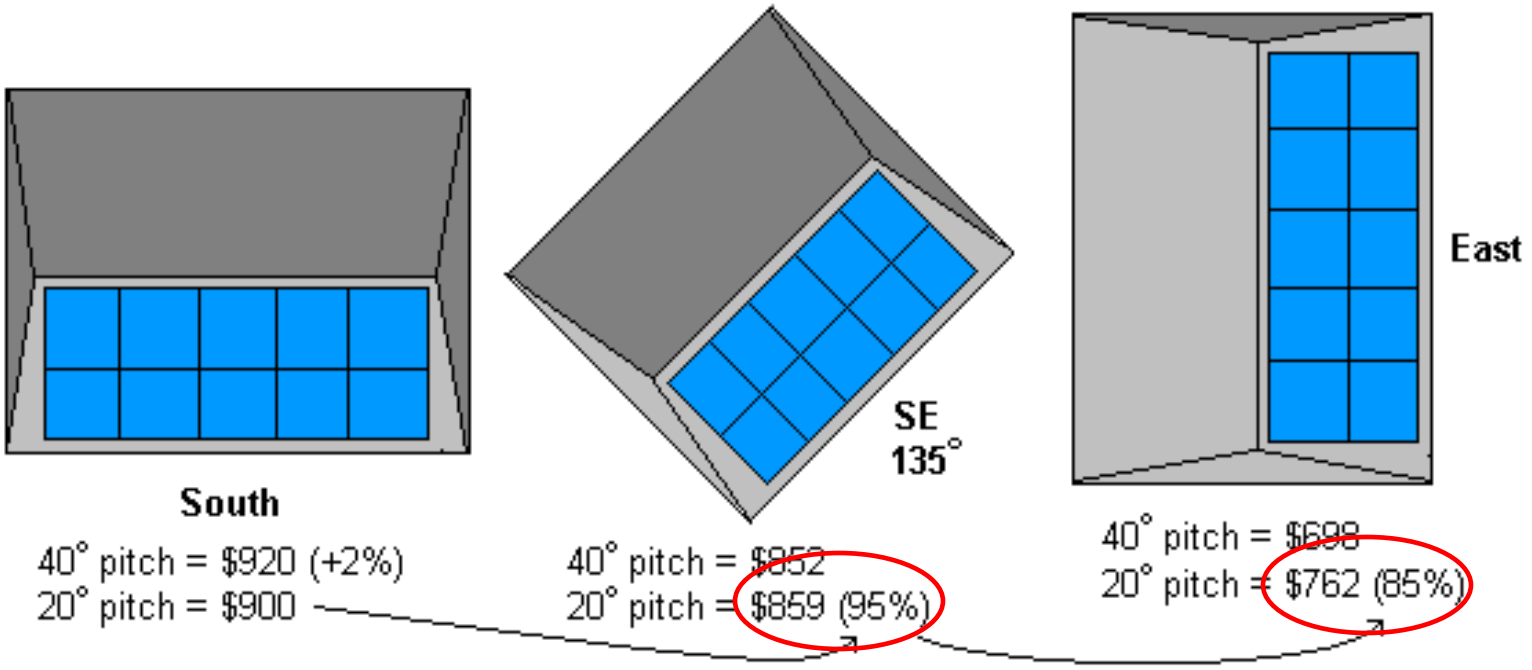


Comparing solar on the car roof compared to home solar.

Angles - not important with Grid-Tie

PVWatts AC Energy & Cost Savings

http://www.nrel.gov/rredc/pvwatts/

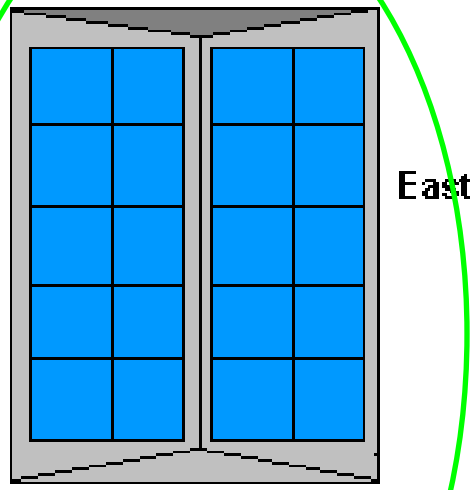


Amazing, even due East, you still get 85% effectiveness!

Angles - less important, More Roof is!

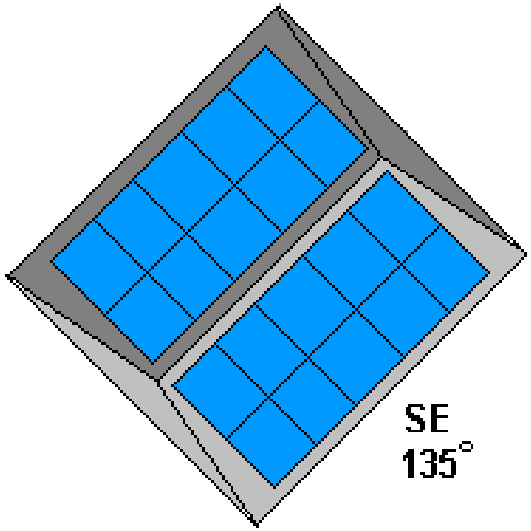
PVWatts AC Energy & Cost Savings

http://www.nrel.gov/rredc/pvwatts/



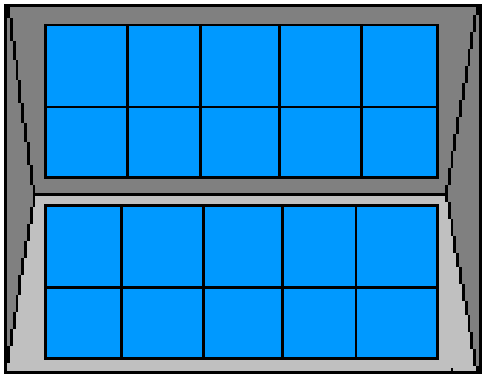
East

20° pitch = $ 762 (85%)
West side + $ 766
Total $1528 (170%)



SE 135°

20° pitch = $ 859 (95%)
NW side + $ 657
Total $1516 (168%)



South

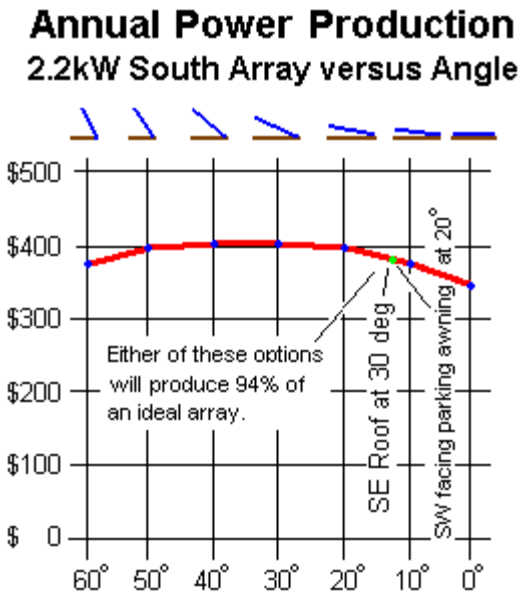
20° pitch = $ 900
North side + $ 604
Total $1504

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 visibiity (<1% loss)

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



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!

- 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?

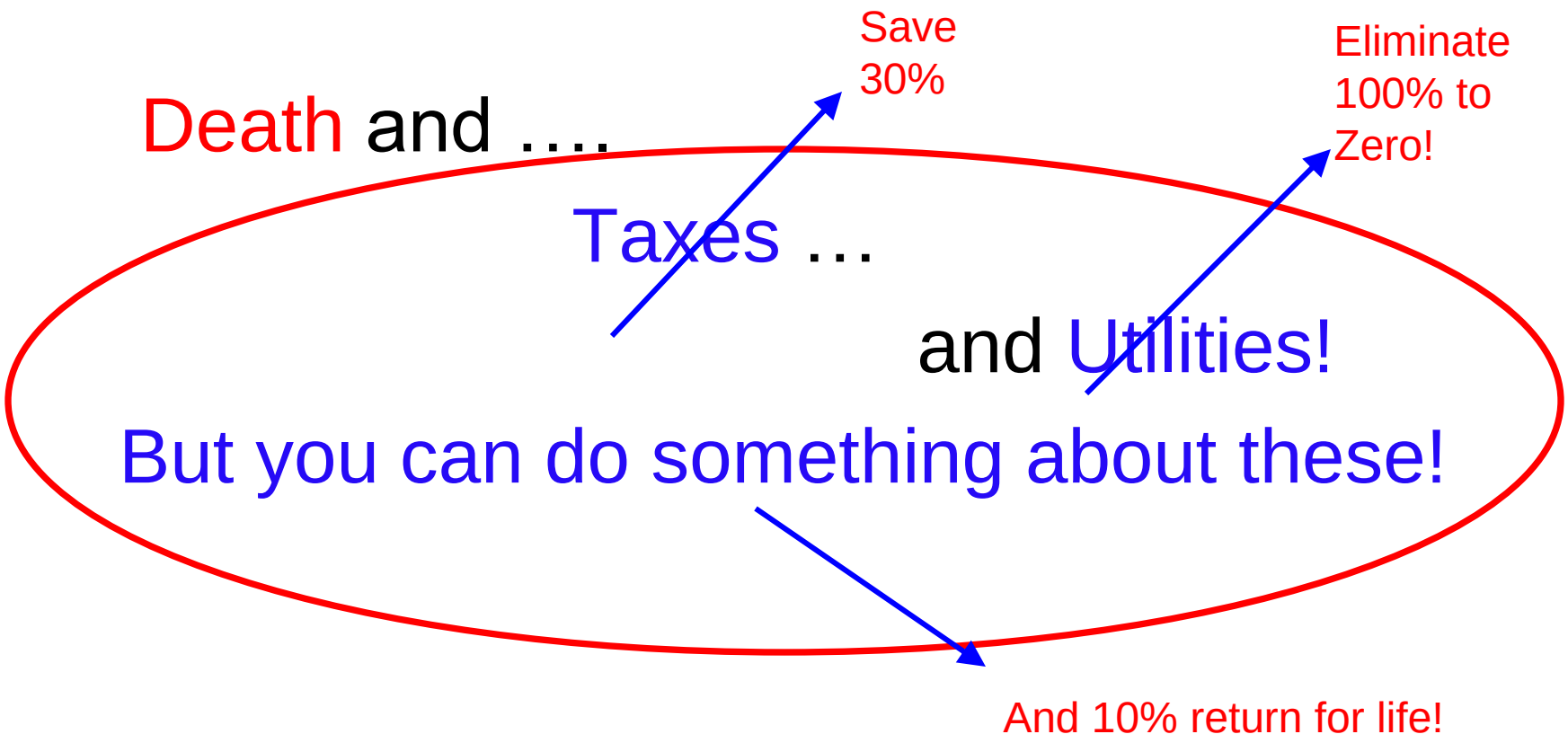
10 yrs

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

$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



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.

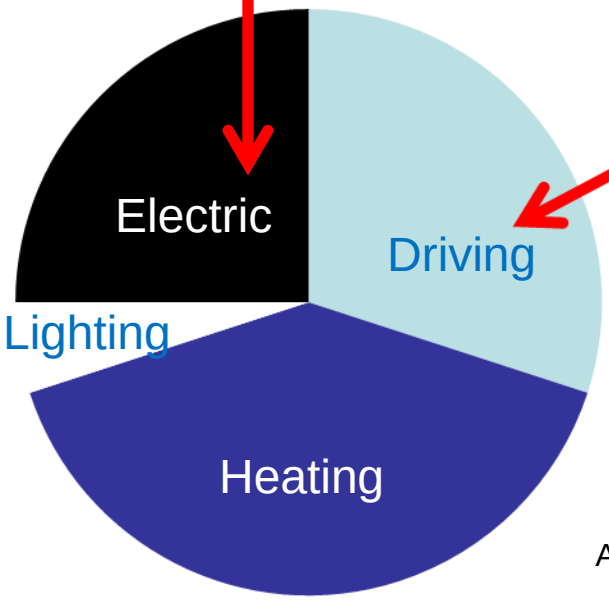
Big Picture!

Our Church Fossil Fuel Costs

Solar Power for Electricity

& Wind

Electric Vehicle Support



- Driving
- Heating
- Lighting
- A/C

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

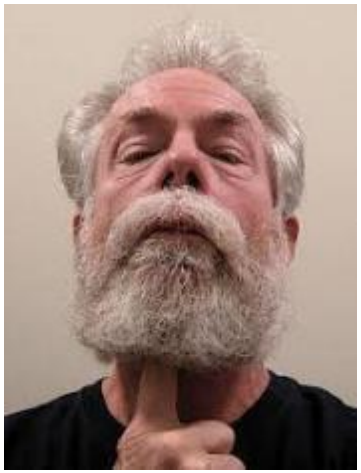
http://aprs.org/EV-charging-everywhere.html

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

Bob Bruninga, EVADC

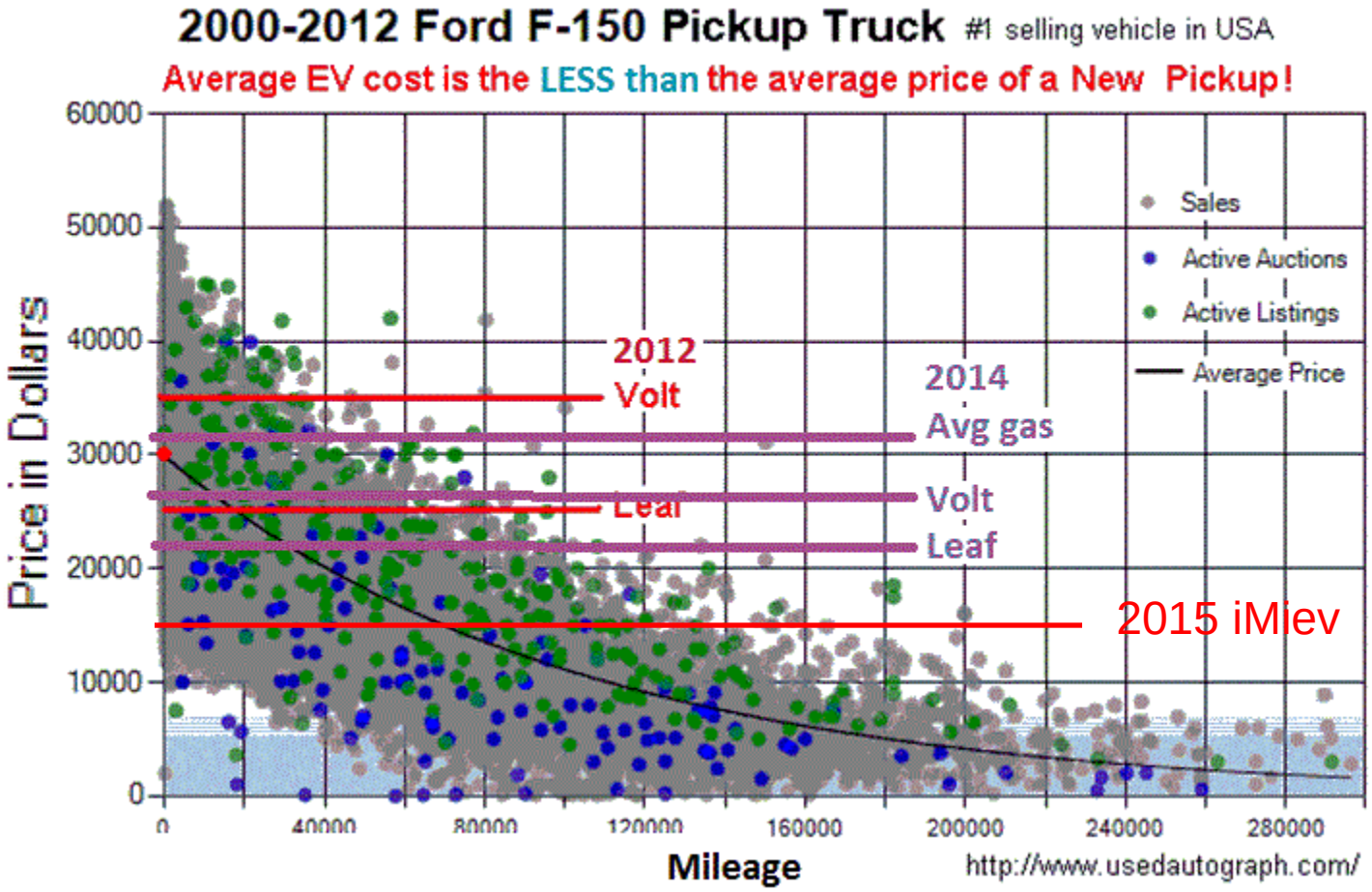
- Cost too much!
- Runs on coal from Power Plant (Carbon)
- Range too short
- Useless in power outage
- Planet Impact worse than a Hummer
- No Infrastructure
- Not enough chargers
- Takes too long to charge

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

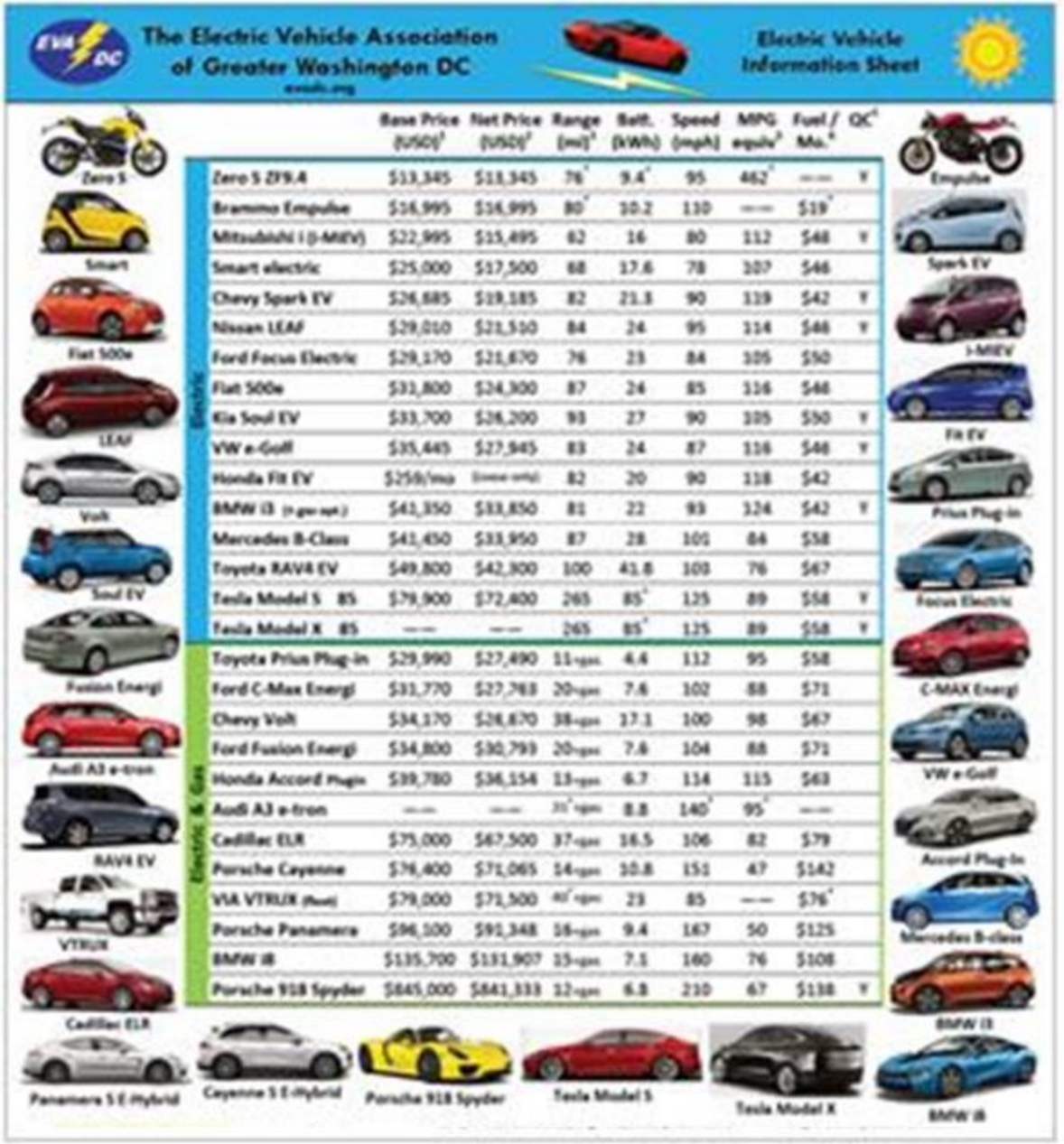


Over 40 EV's now on Market!

(in just 5 years!)

Over 40 by 2015!

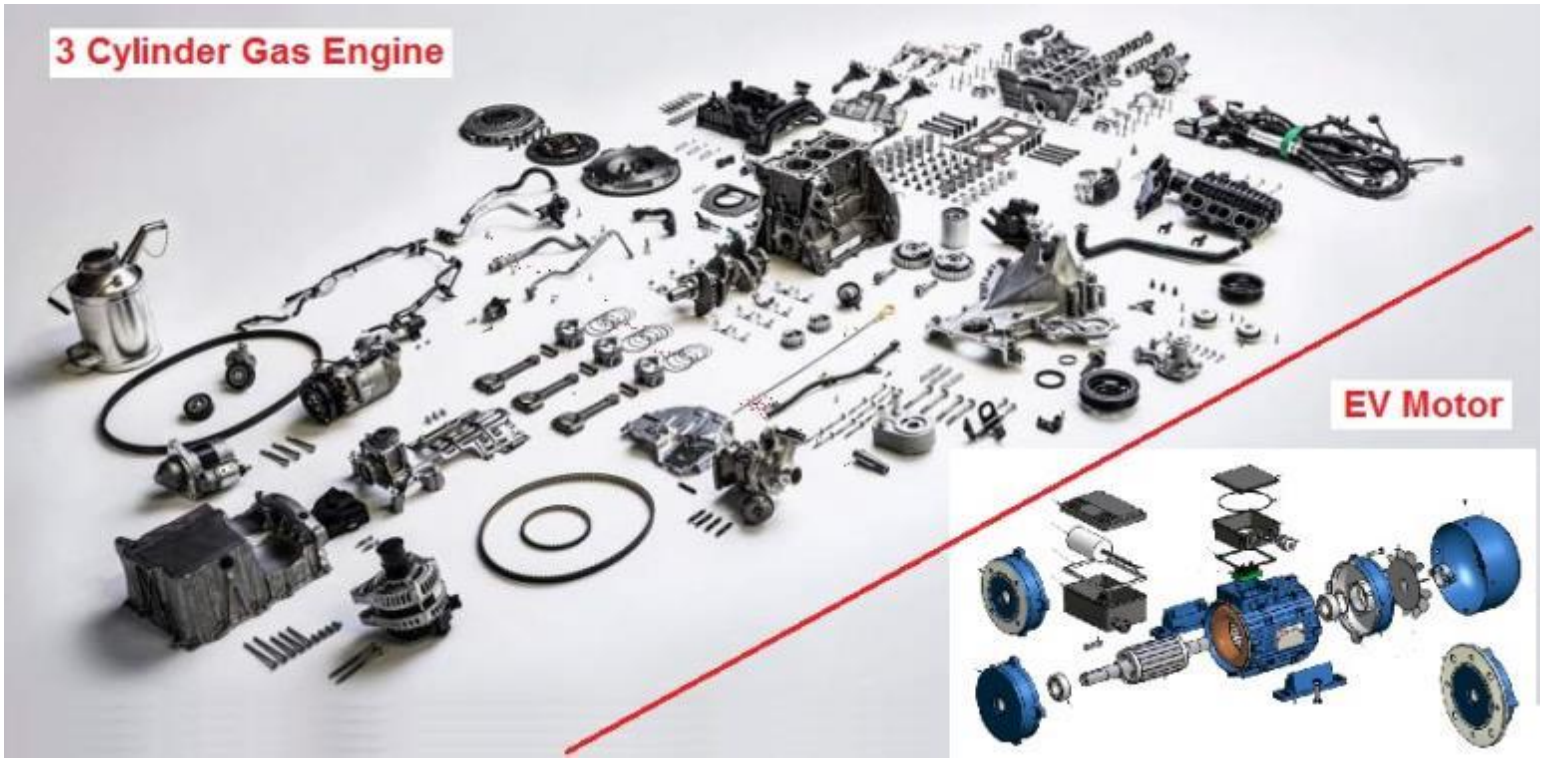
Only 4 cost more than the average gas car! ($33k)



		Base Price (USD)	Net Price (USD)	Range (mi)	Batt. (kWh)	Speed (mph)	MPG equiv	Fuel / Mo.	QC
Electric	Zero S ZF9.4	$13,345	$13,345	76	9.4	95	462	—	Y
	Brammo Empulse	$16,995	$16,995	80	10.2	110	—	$19	
	Mitsubishi i (i-MiEV)	$22,995	$15,495	62	16	80	112	$48	Y
	Smart electric	$25,000	$17,500	68	17.6	78	107	$46	
	Chevy Spark EV	$26,685	$19,185	82	21.3	90	119	$42	Y
	Nissan LEAF	$29,010	$21,510	84	24	95	114	$46	Y
	Ford Focus Electric	$29,170	$21,670	76	23	84	105	$50	
	Fiat 500e	$31,800	$24,300	87	24	85	116	$46	
	Kia Soul EV	$33,700	$26,200	93	27	90	105	$50	Y
	VW e-Golf	$35,445	$27,945	83	24	87	116	$46	Y
	Honda Fit EV	$258/mo	(lease only)	82	20	90	118	$42	
	BMW i3 (+ gas opt.)	$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
Electric & Gas	Toyota Prius Plug-in	$29,990	$27,490	11-gas	4.4	112	95	$58	
	Ford C-Max Energi	$31,770	$27,783	20-gas	7.6	102	88	$71	
	Chevy Volt	$34,170	$28,670	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	—	—	31 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	
	VIA VTRUX (Fleet)	$79,000	$71,500	40 gas	23	85	—	$76	
	Porsche Panamera	$96,100	$91,348	16-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

Only ONE moving part!

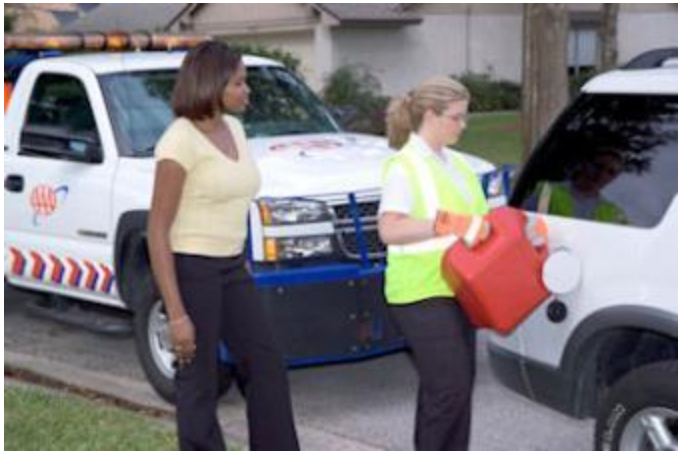
- Electricity less than 30% cost of gas
- Maintenance 10% of a gas car



Public Charging – only a security blanket

Only Provides comfort & security

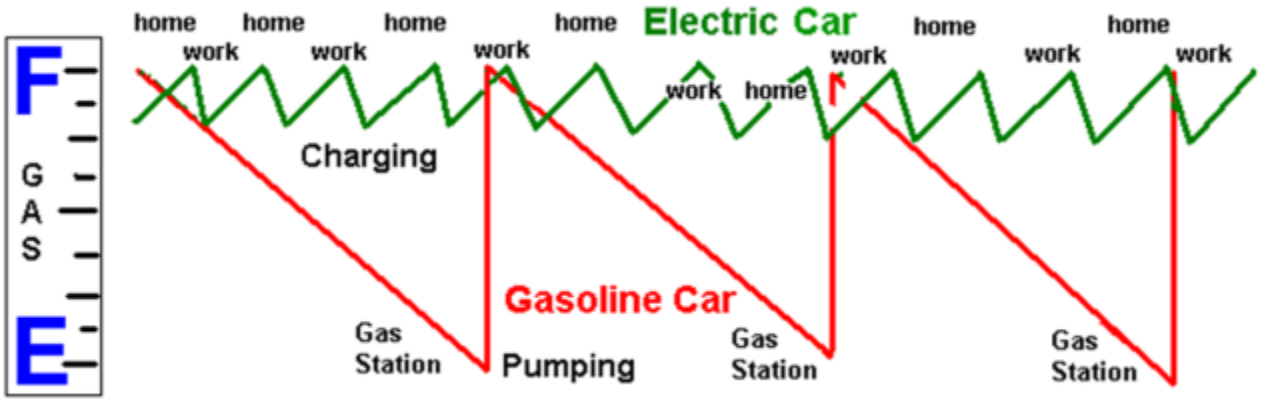
… like a spare gas can



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

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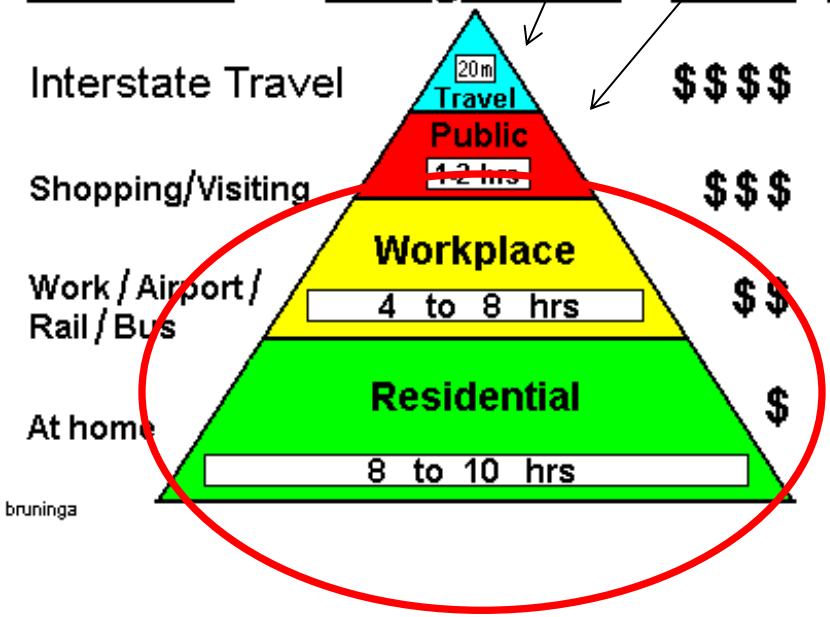
Charge at Home (and at work)

0.3% of the need

Public Charging is like looking for $10 gas!



Location	Charge Time	Price	Level	Cost	Driver?	Speed?
Interstate Travel		$$$$	L3	$10,000	Waiting...	20 min
Shopping/Visiting		$$$	L2/3	$2,000	Parked	10 Sec*
Work / Airport / Rail / Bus		$$	L1	$ 25	Parked	10 Sec*
At home		$	L1	$ 25	Sleeping	10 Sec*

* connect/disconnect time

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

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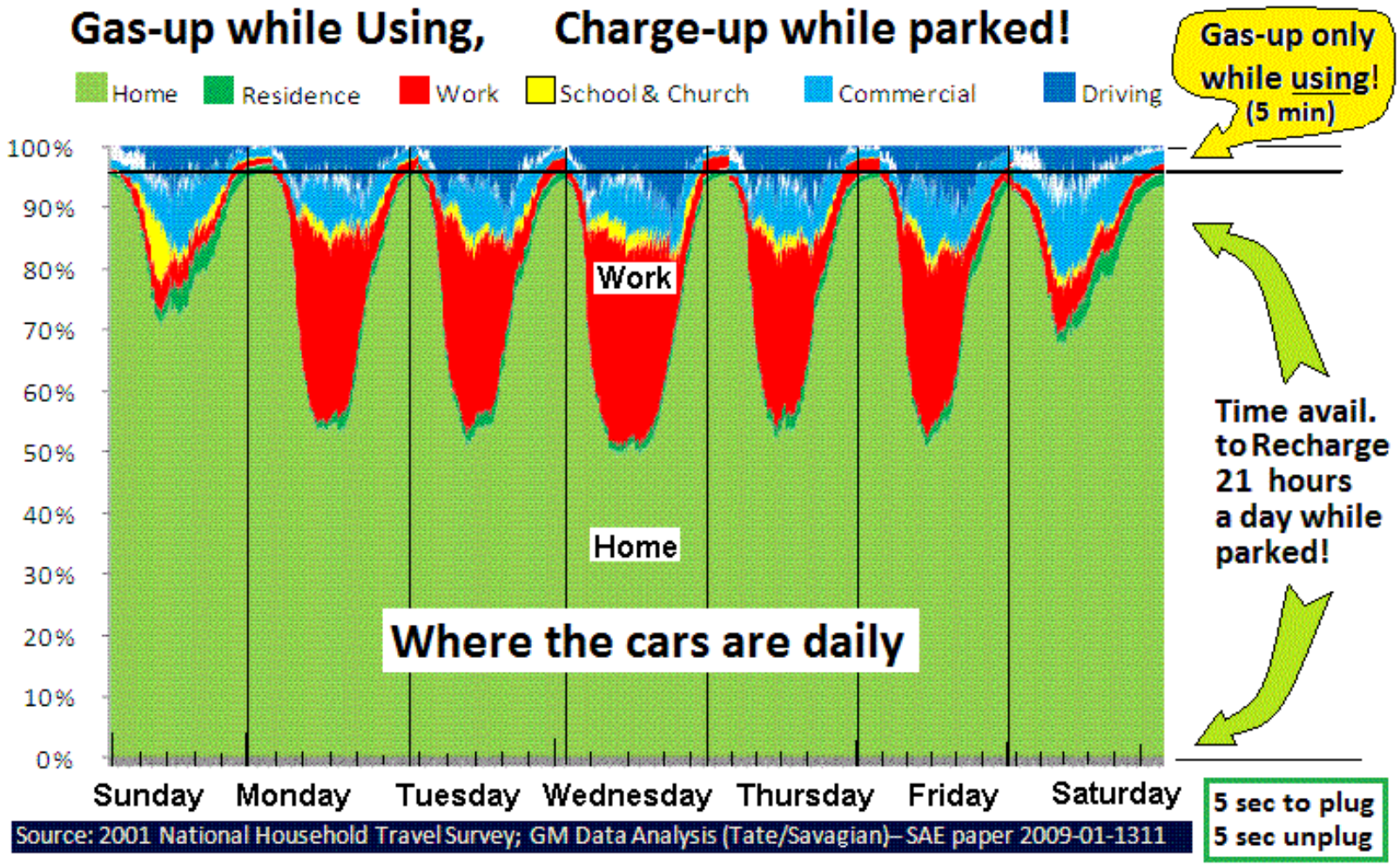
Charging While Parked (21 hrs/day)



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Our Legacy experience

Oh the Horror!

People see this

And think $50

Reality with EV's is

20¢/hr

$1 a day

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Charging Load at 120v:

1 Coffee Pot = Level 1 EV charging

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

SAME = LOAD

We dont want free electricity, we want to pay for it, and simply be allowed to plugin!

Pay $20/mo
For 20mi commute

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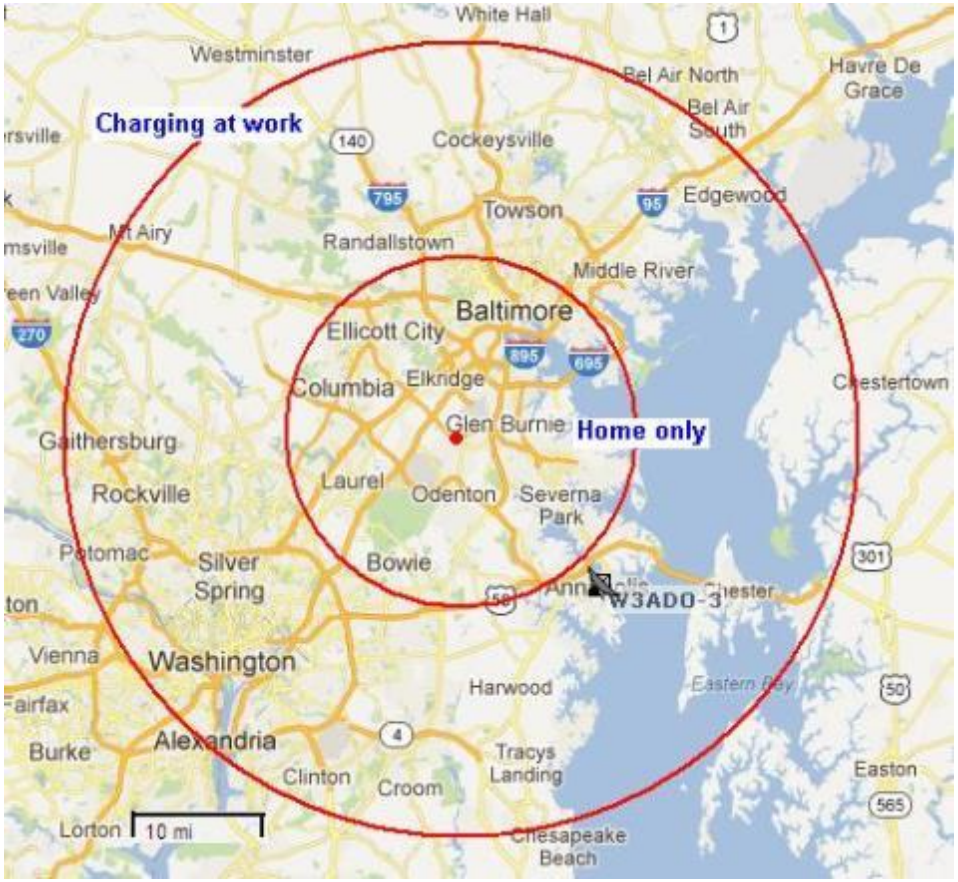
Plug-in at work (double range, quadruple area)

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

Charge L1 at work/home = 64 mi range

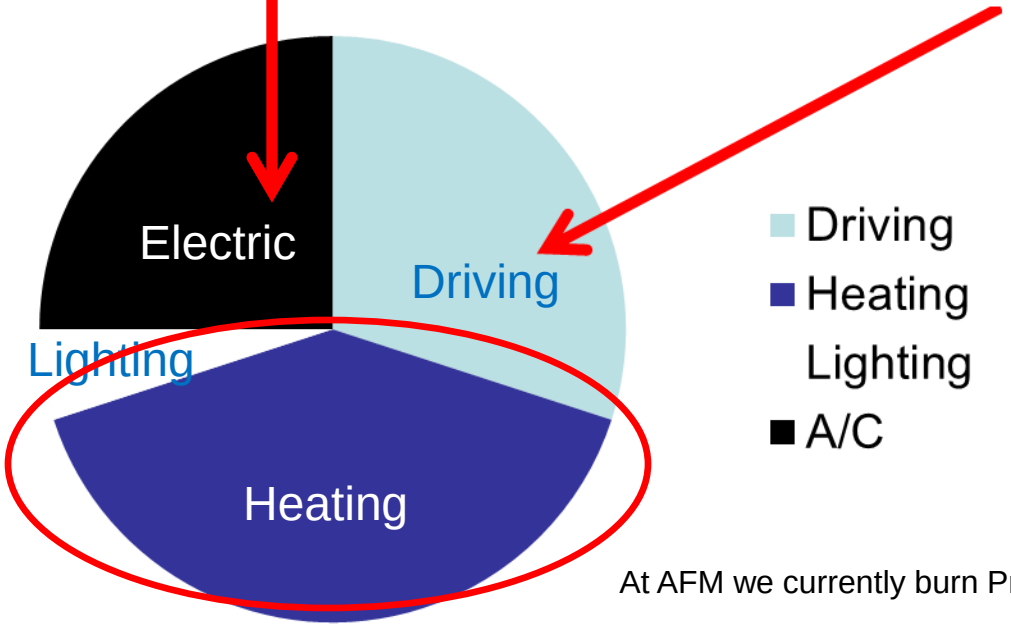


Big Picture!

Fossil Burning Costs

Solar Power for Electricity

Electric Vehicle Support



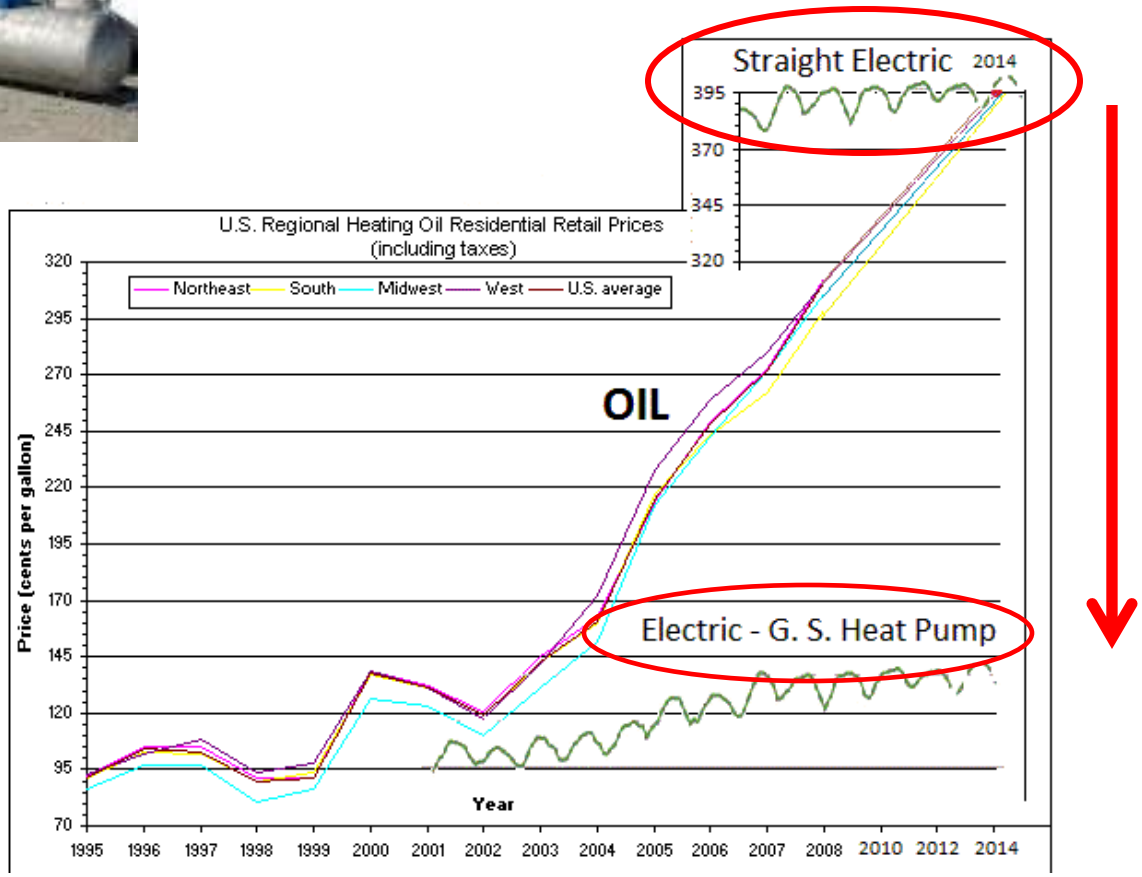
We include EV's because about half of our easily-fixed energy is spent *driving*

At AFM we currently burn Propane for heat

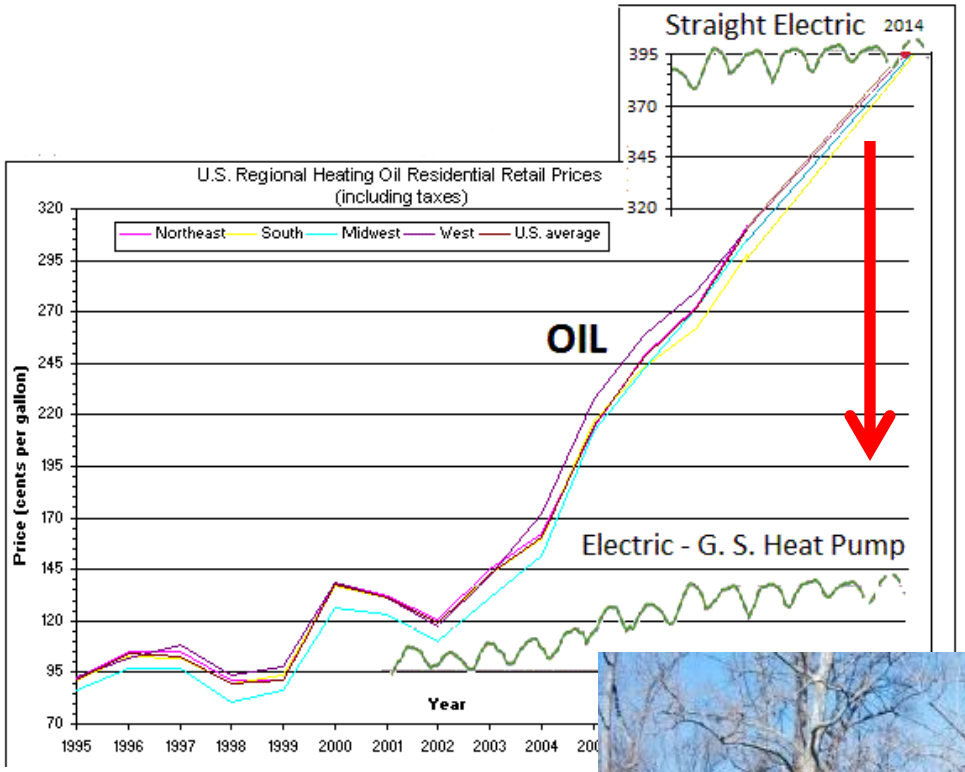
Heating Costs – Oil, Propane…

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

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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!