

Keeping the lights on while transitioning off fossil fuels

North American Electric Reliability Council NERC

Institute of Electrical and Electronic Engineers IEEE

Loss Of Load Expectation Working Group (partial group shown below)

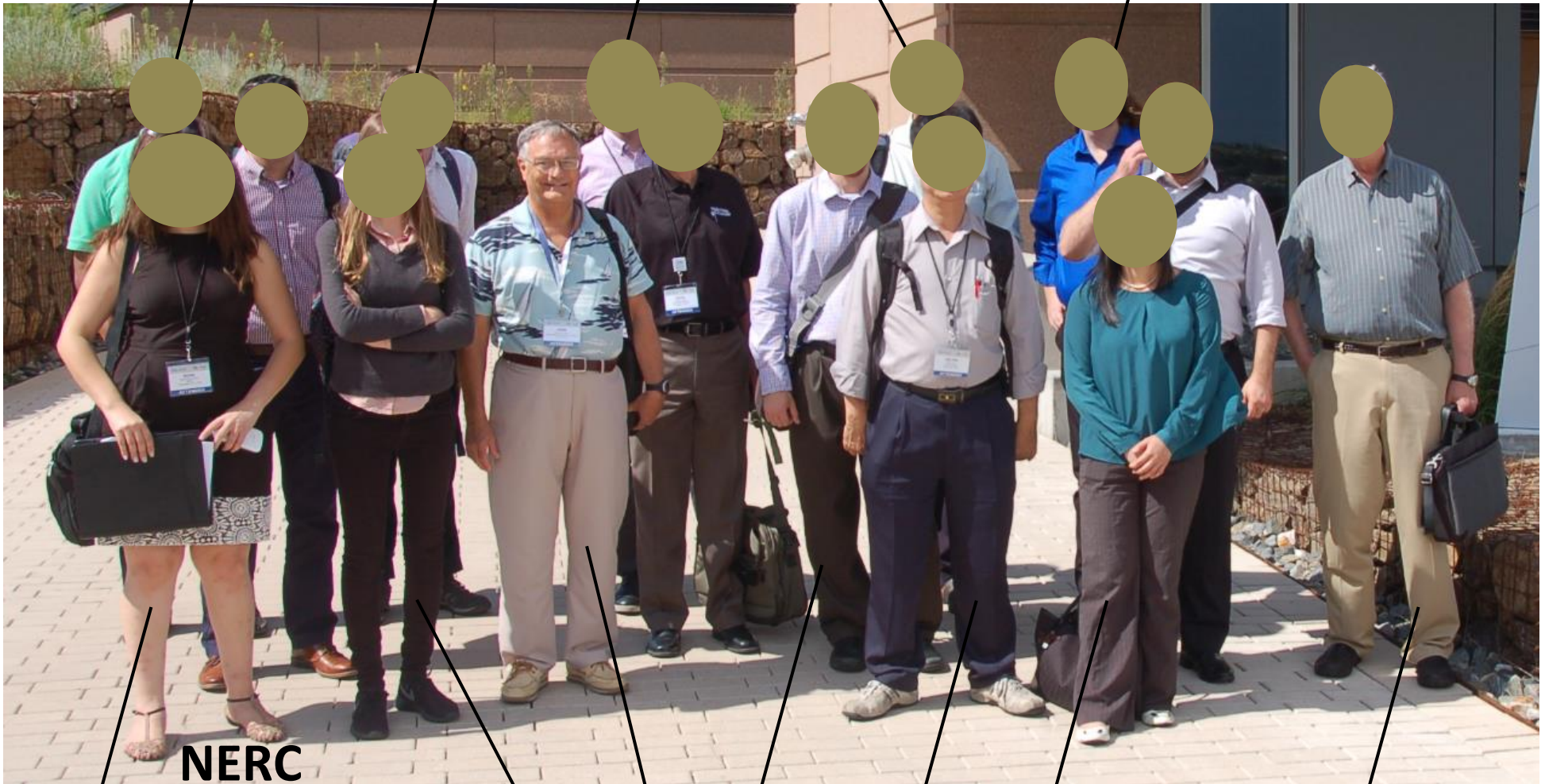
SouthEasternUS

UK

UK

NREL

CaliforniaPUC



NERC

NAmerElecRelCouncil

UK

Gene(Tx)

NorthEasternUS

PacificNW

IEEE Loss of Load Working Group runs network simulations
 looking for instances the future power supply is insufficient.

DIRECT SOLUTION

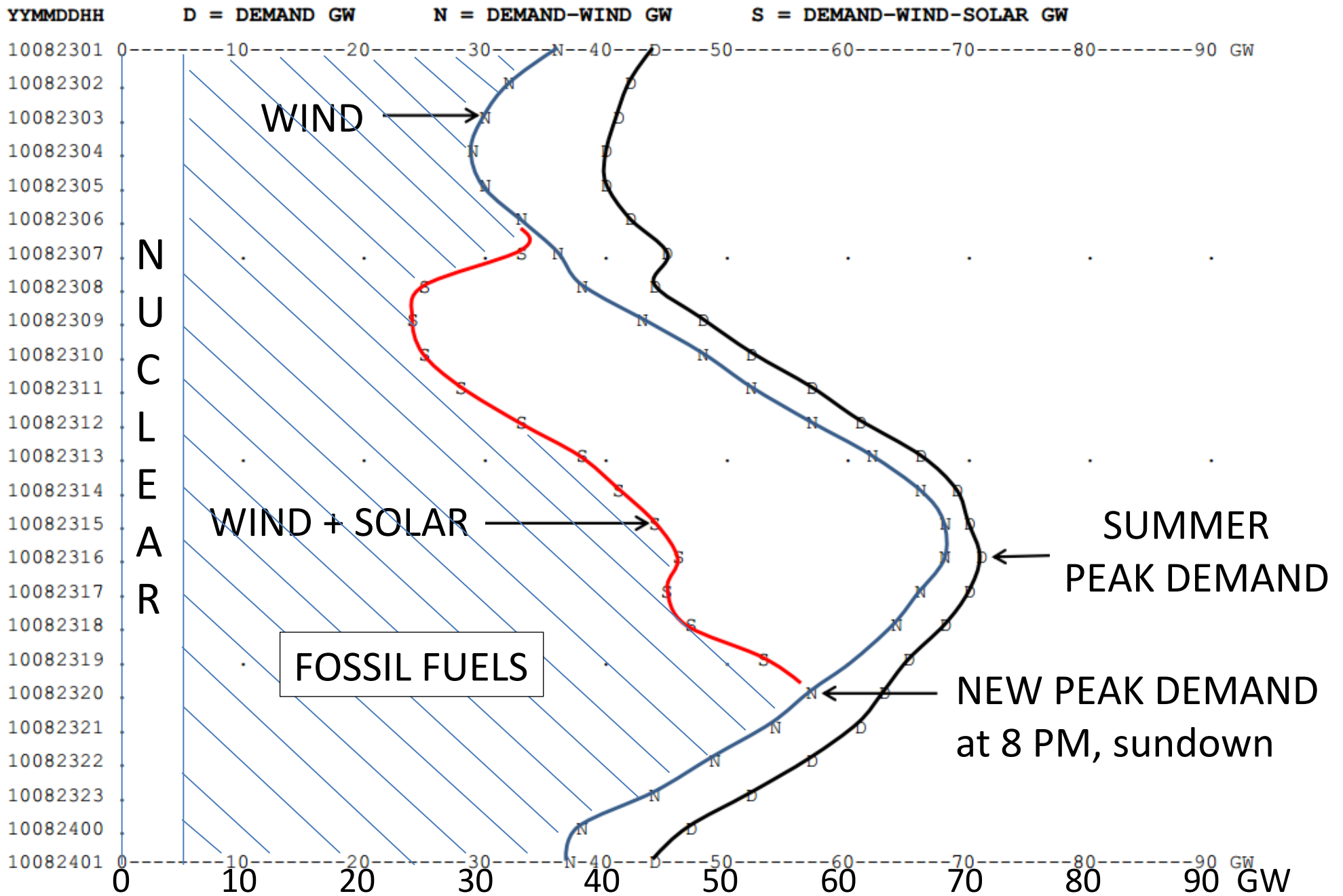
LOLH	LOLE	ALLR	
0.595133	0.100009	0.095285	<- target
MWHEUE	MWHTOTAL	puEUEppm	
27.55358	1880818.	14.64978	

MONTECARLO SEQUENTIAL SOLUTION

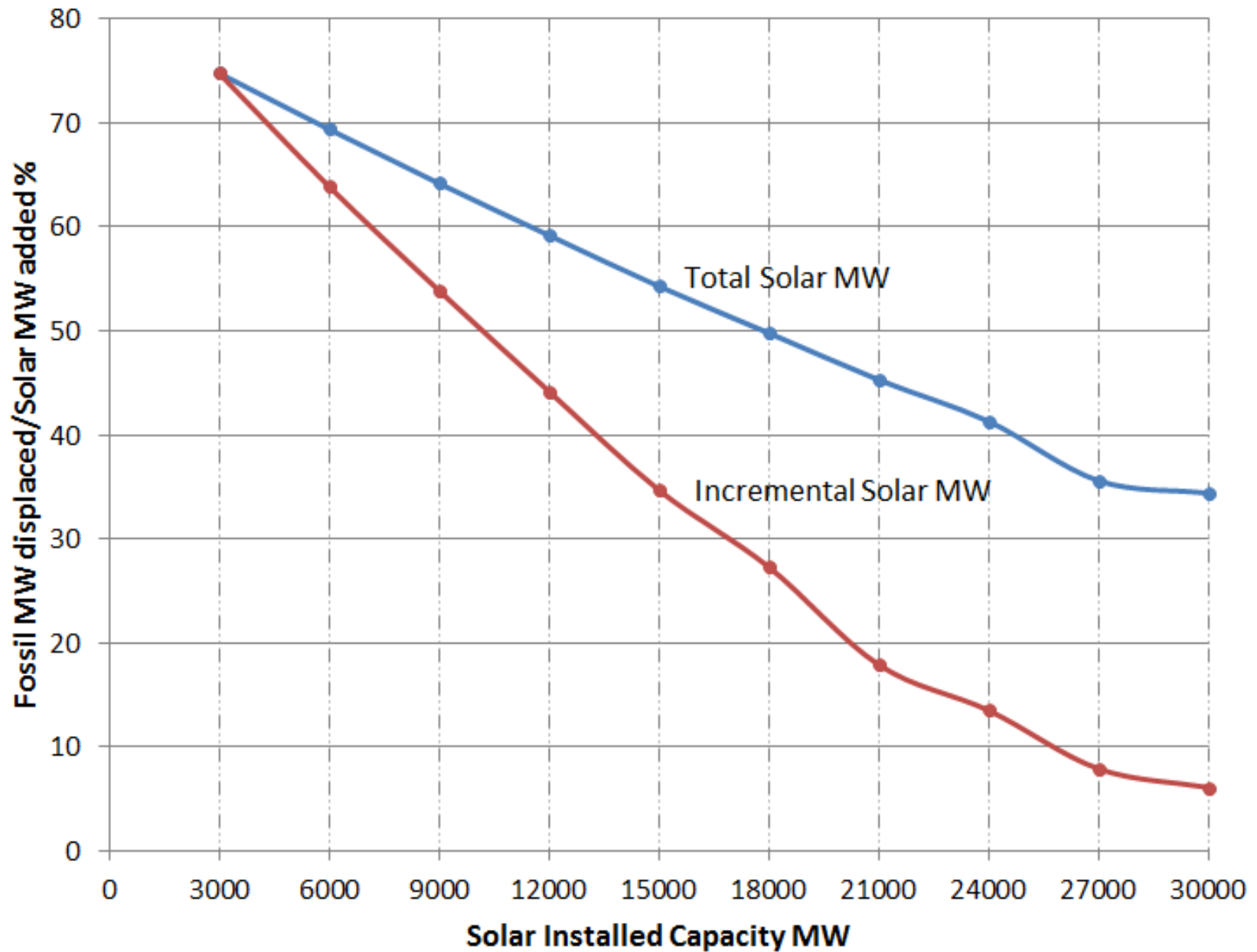
YRS	LOLH	LOLE	ALOLP	MWHEUE
1000.	0.887000	0.115000	0.015000	35.108
10000.	0.586300	0.102900	0.013900	27.959
100000.	0.575800	0.101980	0.013740	25.367

LOLE = Loss Of Load Expectation in days per year is the sum of the daily probabilities of not meeting the demand each day for a year

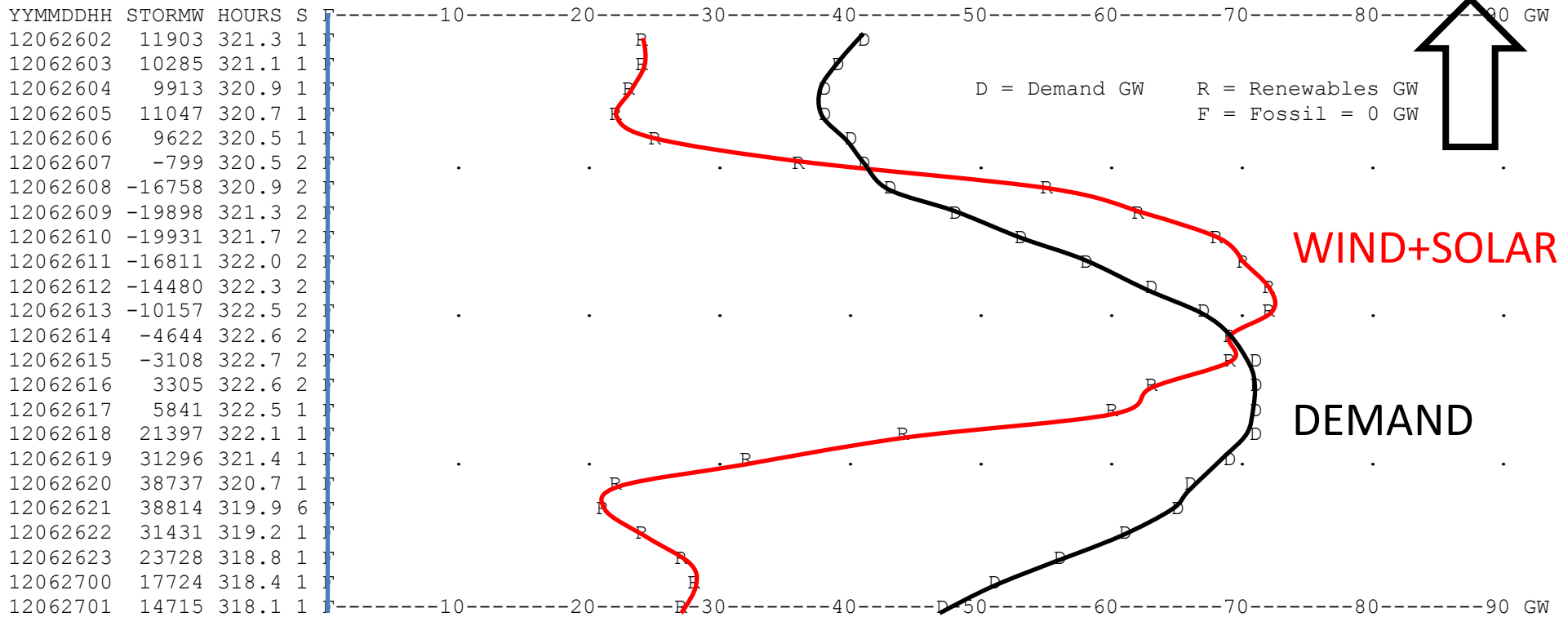
ERCOT 2010 HISTORICAL PEAK DEMAND DAY WITH 24 GW WIND + 30 GW SOLAR



Solar's Effectiveness In Displacng Fossil Fuel Capacity While Holding LOLE Constant 0.1 days/year



68 GW wind + 76 GW solar – 69.264 GW fossil (12.523 GW remains) + 50 GW storage for 330 hours (~14 days) to achieve zero fossil fuel generation, storage cost=~\$6600bn



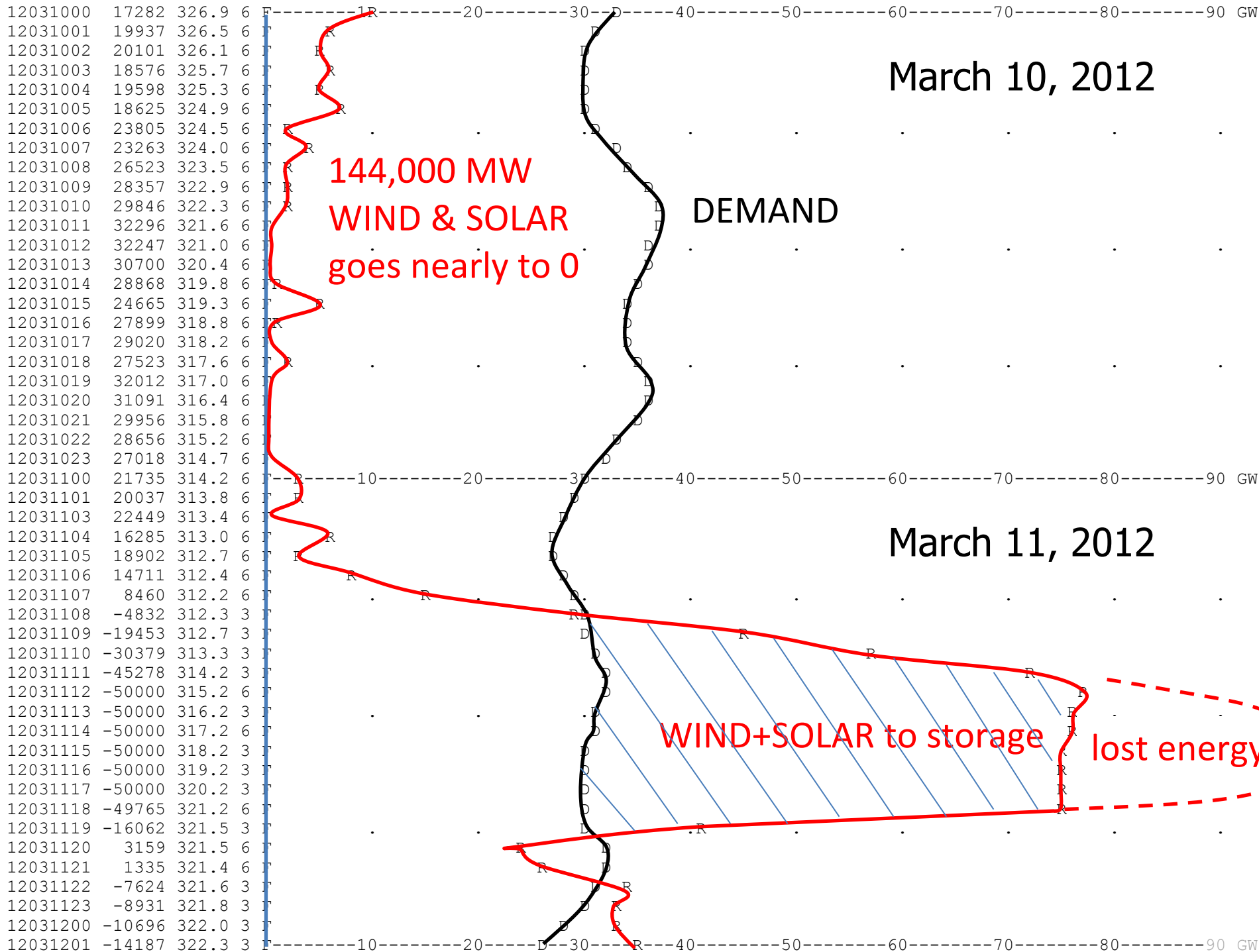
NUCL BASE: 13.064% OF SYS ENGY 100.000% CAP FACT 5150. MW PMAX

RENEWABLE: 110.873% OF THE TOTAL SYSTEM ENERGY
(WIND+SOLAR) 20.918% OF THE RENEWABLE ENERGY IS LOST

RENEWABLE: -23.937% OF SYS ENGY LOST

 1036948. GWH 100.000% OF SYS ENGY IS NON FOSSIL
 0. GWH 0.000% OF SYS ENGY IS FOSSIL FUELS
 1036948. GWH 100.000% TOTAL (3 years)

LOAD RAMP UP 1027 MW/MIN ON 11020718 YYMMDDHH
 LOAD RAMP DOWN 939 MW/MIN ON 12030508 YYMMDDHH
 MINIMUM DEMAND -44850 MW ON 12122815 YYMMDDHH
 STORAGE: 49755 MAXIMUM DISCHARGE (+) MW -50000 MAXIMUM CHARGING (-) MW
 16500000 MAXIMUM CHARGE ENERGY MWH 330.0 MAXIMUM CHARGE ENERGY HR 4.7 MINIMUM CHARGE ENERGY HR



Why all the fuss about getting off fossil fuels?

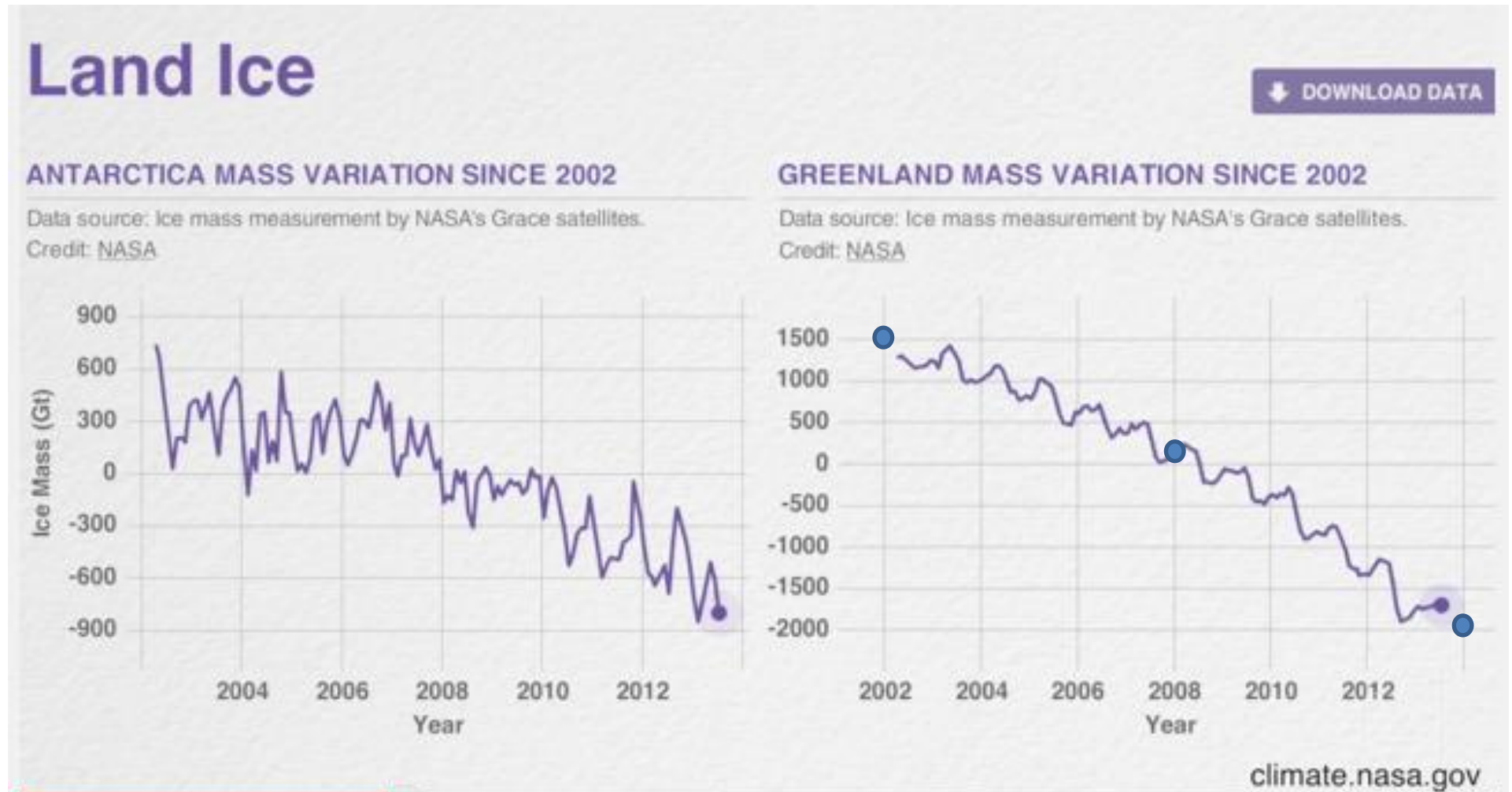
Ocean acidification – since 2007 baby oysters cannot grow in the acidic ocean waters in the Pacific Northwest. See the pictures:



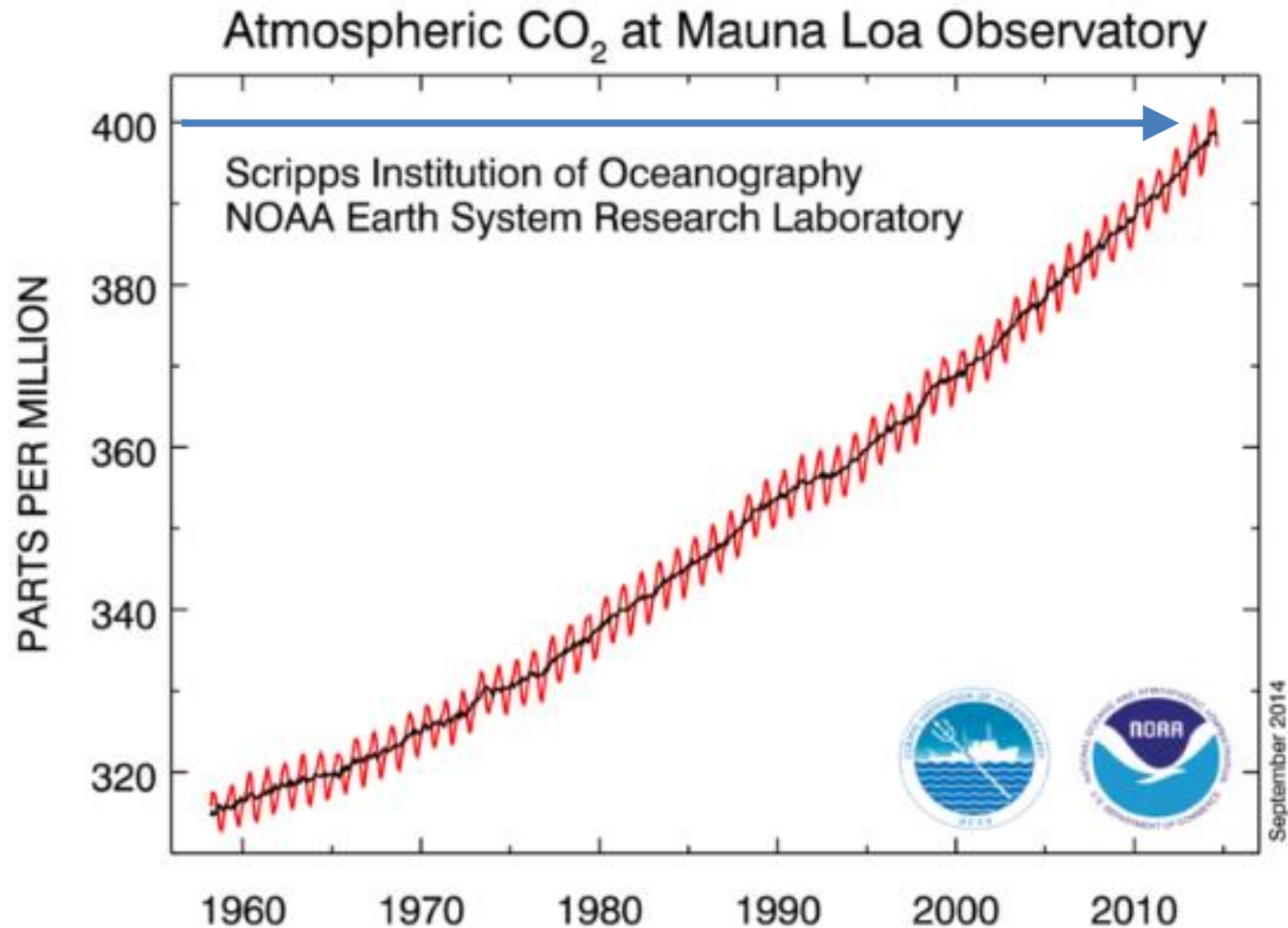
Ocean acidification is the most dangerous near term CO₂ problem.

<http://www.sciencedaily.com/releases/2015/08/150817085455.htm>

Ocean rise from the melting of Greenland's and Antarctica's Ice:
Greenland's acceleration since 1994 is a constant 8.2% per year.



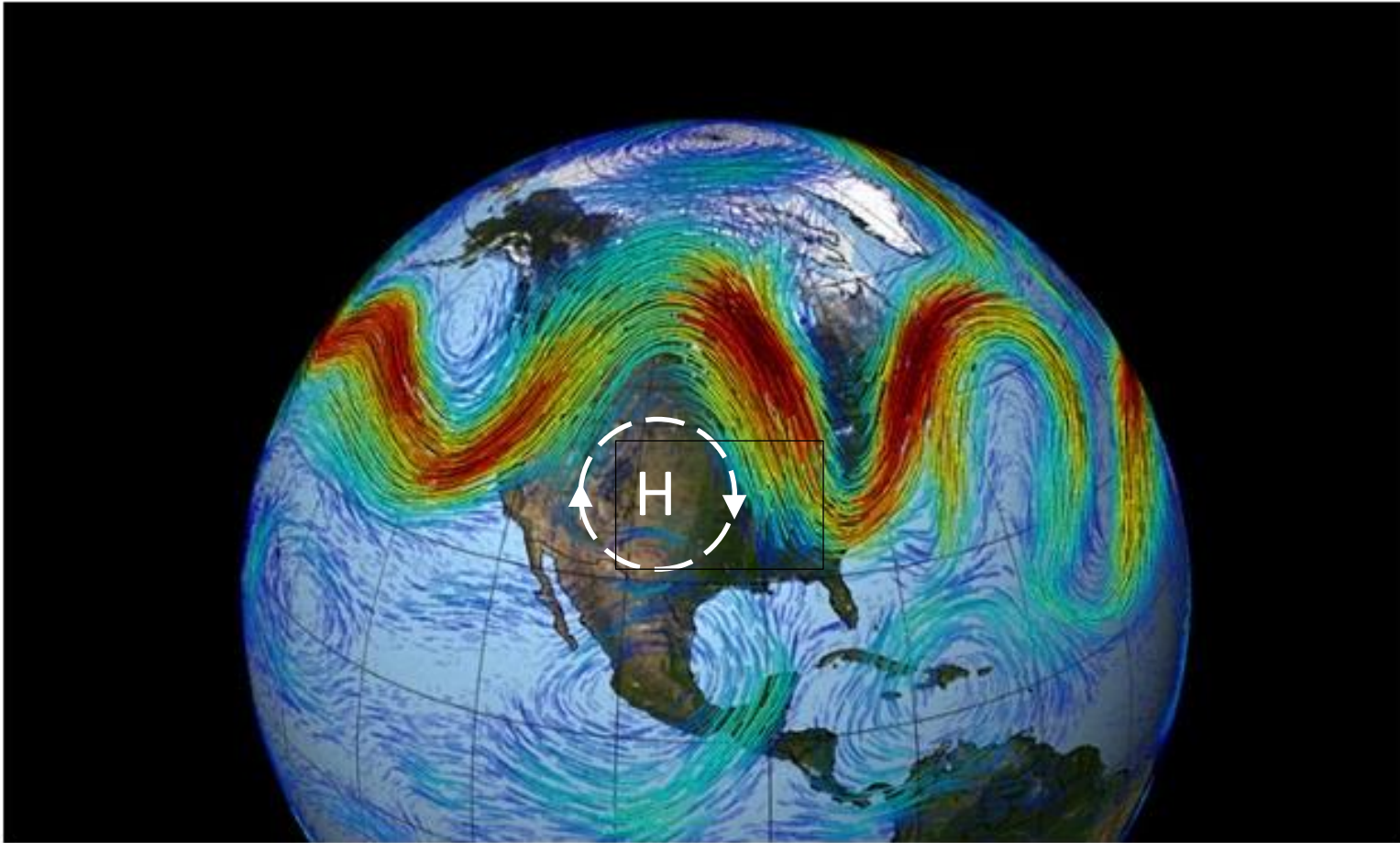
At this rate, Greenland's Ice is completely gone by 2100 which results in a 20 foot ocean rise. <http://egpreston.com/GreenlandIcemelt3.xls>



400 ppm is a point of no return because of positive feedbacks. If we stopped fossil fuels today the curve would still continue upward at a small slope. We are just now entering into uncharted waters.

The Jet Stream is swinging farther north - south in a zig zag pattern.

A new study investigates how changes to atmospheric winds are making weather more extreme



Are summer high pressure systems parked over Texas the result of a warming atmosphere? Possibly this is the new normal.

Conclusions:

- ERCOT cannot afford a 100% renewables plan because of the high cost of storage.
- Without storage or with much smaller amounts of storage, ERCOT can only accommodate about 40% renewable energy before the system becomes inoperable.
- Austin's solar investments made now will decline in capacity value in the future as more solar is added in ERCOT.
- The Austin Community Climate Plan has a target date of 2050 for 100% conversion off fossil fuels which is too slow in my opinion for solving the CO₂ problem. <https://austintexas.gov/climate>

Recommendations:

- Base load the bio plant for additional CO₂ reduction credits.
- Account for nuclear and bio energy as non CO₂ sources separately from wind and solar as non CO₂ sources.
- Microgrids at homes and businesses will allow ERCOT to send a signal to curtail load sometimes and more importantly increase load when there is an excess of renewable power on the grid.
- Austin's LOLE will increase when Decker Plant is shut down and substantial new transmission is likely needed. This should be carefully studied to avoid having a high risk for future blackouts.
- The 100% conversion off fossil fuels needs to be accelerated because zero CO₂ is needed worldwide today, not tomorrow. Wind and solar plans alone are not enough.