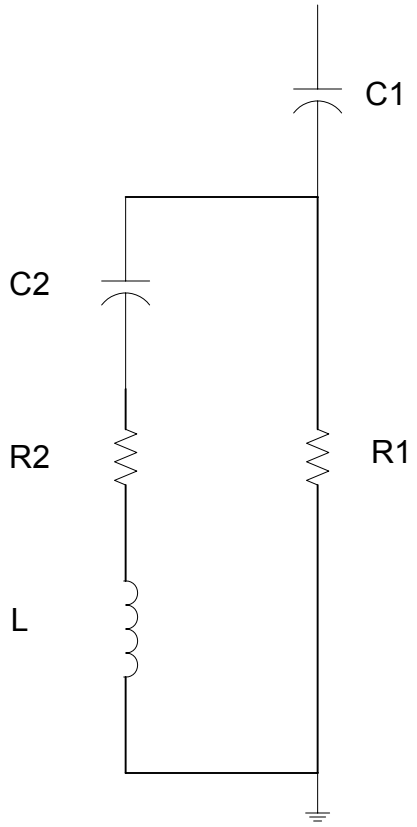
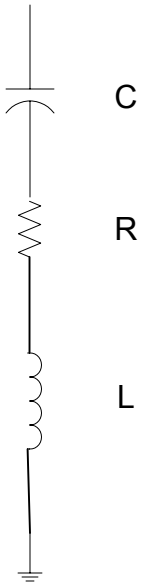
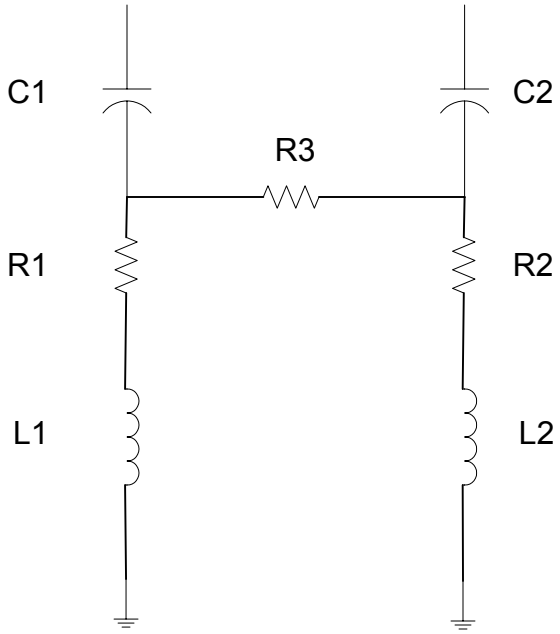
C Filter

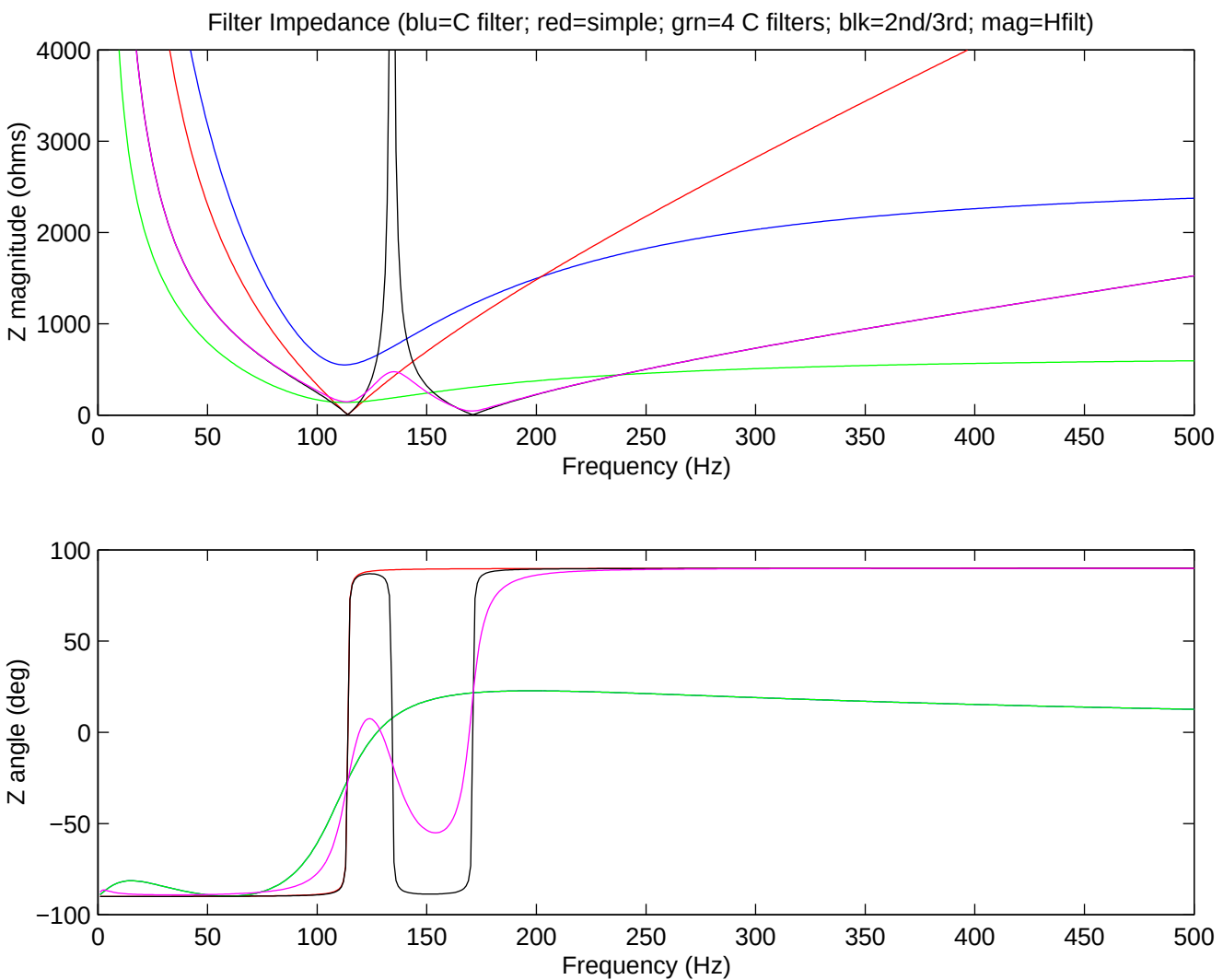


Simple Filter



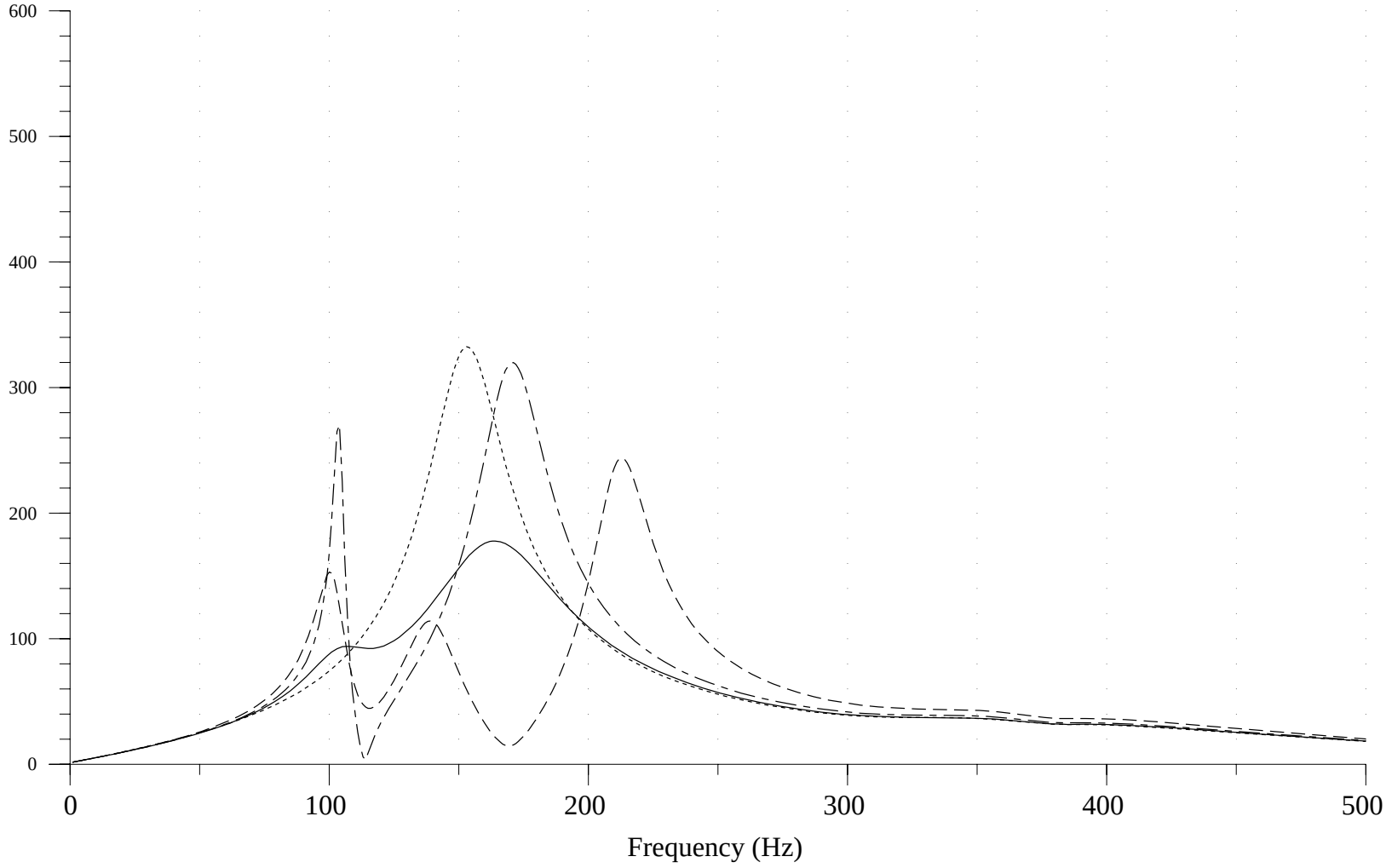
H Filter




Filter Impedance (blu=C filter; red=simple; grn=4 C filters; blk=2nd/3rd; mag=Hfilt)
Z magnitude (ohms)
4000
3000
2000
1000
0
0
50
100
150
200
250
300
350
400
450
500
Frequency (Hz)
Z angle (deg)
100
50
0
−50
−100
0
50
100
150
200
250
300
350
400
450
500
Frequency (Hz)

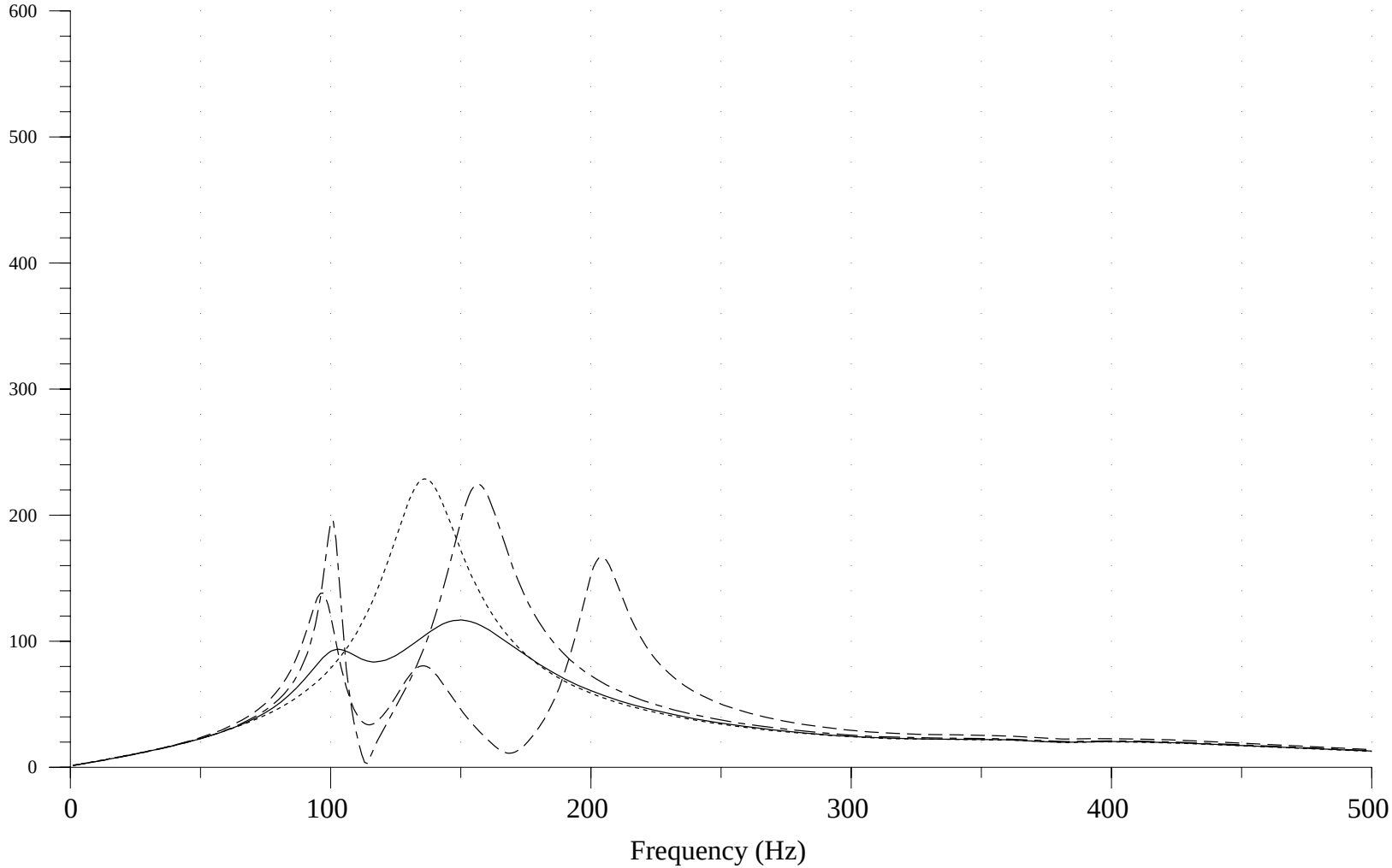
Norwalk 345 kV Positive-Sequence Driving Point Impedance (ohms)
Norwalk - Plumtree Cable and East Devon - Beseck Line Out, Load 40%

C filters___, None...., Simple filters_._., H filters_ _



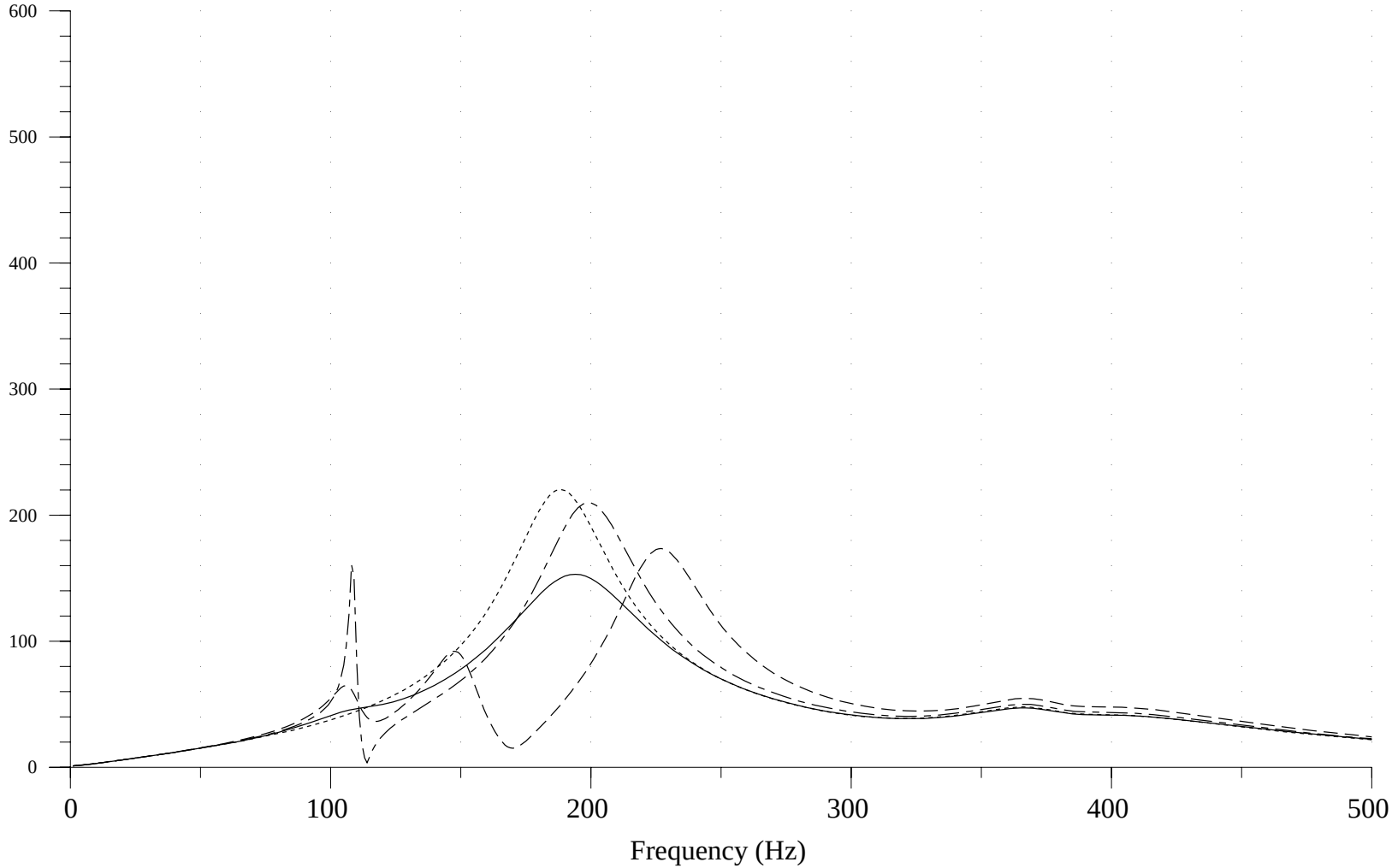
Norwalk 345 kV Positive-Sequence Driving Point Impedance (ohms)
E. Devon - Beseck Line and Plumtree - Long Mountain Line Out, Load 40%

C filters___, None...., Simple filters_._., H filters_ _



Norwalk 345 kV Positive-Sequence Driving Point Impedance (ohms)
Norwalk - Plumtree Cable Out, Load 40%

C filters___, None...., Simple filters_._., H filters_ _



Comparison of maximum TOVs for Case 5 (24 mile) with and without C filters
for >650 cases as in Table 8 of GE report in App. D of ROC Report

	Including Rocky River 115 kV		**Excluding Rocky River 115 kV**	
	2 CY	6 CY	2 CY	6 CY
without C filters	1.66	1.66	1.66	1.47
with C filters	1.54	1.54	1.35	1.31

C filters were placed at Plumtree, Norwalk, Singer, and E. Devon 345 kV
4x50 MVAR filters tuned at 1.9 pu of 60 Hz
4x50 MVAR shunt reactors at filter locations

Main Design Issues
* damping resistor needs to be rated to absorb high energy
* 2.4 Henry reactor may have to be iron-core reactor (saturable) rather than the typical air-core reactor
* component ratings depend on severity of and cumulative duty from repeated disturbances, steady-state harmonics, Geomagnetically Induced Currents (GIC), margin for unknowns

GE Energy
Feb. 14, 2005