Problem 1: Electrical resistance heating

While a heat engine is at best around 50% efficient at turning heat to mechanical work, electrical generators are as much as 99% efficient at turning mechanical work to electrical energy. Does that mean efficiency in generators is a non-issue? Decide this by calculating the amount of power put out as heat in a typical power plant generator.

A. Modern generators can convert > 500 MW of power. What is their rate of heat production? Give it in W and, for a visual comparison, as the equivalent number of space heaters radiating heat onto the generator. You can assume one space heater is about 1500 W.

B. In a heat engine or turbine, the waste heat remains in the working fluid and is carried away with the exhaust gas. In a generator, the waste heat is produced by resistive heating in the coils of the generator’s wiring. The generator does act in fact like a really big space heater. Based on your answer in A, is this a problem? What are possible solutions, if so? (Think in part B before Googling anything .. that’s C).

C. Browse around to see what modern generators actually do, and see if that is consistent with your strategies in B. This interesting website, sort of a Craigslist for power generation systems, has details on individual generating systems.

http://www.powerplantsonline.com/steamturbinegenerator.cfm