Homework 3 Solar Power for Africa

Graf et al. (Graf, D.; Monnerie, N.; Roeb, M.; Schmitz, M.; Sattler, C.; Economic comparison of solar hydrogen generation by means of thermochemical cycles and electrolysis *Int. J. Hydrogen Energy* 33 4511-4519 (2008).) compare three sources of hydrogen, iron oxide redox reaction; a hybrid sulfur cycle; and electrolysis using solar energy from a heliostat field.

a) Look at the Graf et al. paper and draw a sketch of each of the three cycles showing roughly what the processes involve.

b) Graf proposes the use of a Brayton-cycle helium turbine for solar electricity production using the same heliostat field that is used for the hydrogen cycles. Comment on this choice. List a few options and their advantages for solar electricity production.

c) By Graf's assessment the hybrid sulfur cycle is slightly better than the other options, (5.4 Euro per kg) versus 2.1 to 6.8 Euro/kg for electrolysis (depending on the cost of electricity) and 3.5 to 12.8 Euro per kg for the metal oxide cycle (depending on the cost of the metal oxide). Both electrolysis and the sulfur cycle require electricity to produce hydrogen. Make a table of plus and minus for the costs and other aspects of the three cycles and the difficulty of implementation (this doesn't have to be extensive). Graf hasn't considered startup/shutdown for the processes which needs to be done each day unless he included a heat storage method. Consider in this the safety of startup/shutdown for the processes.

d) Comment on Graf's overall cost estimate from you experience in plant design/senior project. That is, briefly critique his paper in a similar manner that you would critique a senior project.

e) One assumption of Graf is that a hydrogen economny is the only path forward. Give an assessment of this assumption. Compare the attractiveness of an electricity/battery-based future to a hydrogen-based future (including fuel cells). Which is simpler to implement; which will yield a better lifestyle. Given the current state of the climate, which of these could more feasibly be implemented in the next 10-15 years to replace hydrocarbon fuels in industry and for consumers? This can be a table listing positive and negatives.