

Energy Research Topics

Intended for senior secondary school students

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(except for Q23 suggested by Bill Holliday and Q24 by Chris Chapman, both of UTS)

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For all questions, answer as best you can with reference to either your home town or Australia. Questions marked 'Very Difficult' are open-ended topics of debate, but no question is easy and many have no definite answers.

Low and Medium Difficulty

- 1) What are the main electricity use appliances in your home? Apportion your annual electricity bill amongst your appliances. You can measure the use of each by timing the spinning disk in your home's electricity meter (if visible in your meter box), or you might like to buy a Mains Power Meter (e.g. Jaycar Product No. MS6115, \$39.95).
- 2) Efficient home lighting – should halogen downlights be prohibited? Can ultrabright LEDs replace them now?
- 3) What are the downsides of Compact Fluorescent Lights (CFLs)? Is their mercury content a concern – should they be collected outside of normal household rubbish? Are they worthwhile?
- 4) Should city office blocks be made to have open-able windows so that air-conditioners could be turned off on suitable days of the year?
- 5) What are the costs and actual output (instantaneous and annual) of a "1 kW" photovoltaic panel system? Is it worthwhile?
- 6) What is the cost of electricity from wind farms? Explain the cost as a breakdown of interest on capital cost (try to find out the approximate costs of civil works, tower, blades, generator, electronics, transmission lines, etc) and running cost. To what extent did the 2% MRET Scheme kick-start wind-farm development in Australia?
- 7) How many birds are killed by wind turbines? Should we have stopped wind farms for the yellow-bellied parrot?
- 8) What potential do wave and/or tidal energy electricity generators have in Australia?
- 9) What solar thermal air-conditioners exist for either offices or homes, capable of cooling a building using the thermal energy in solar irradiation?
- 10) Compare three solar hot water systems for homes. Why are they so expensive? How much thermal energy do they capture, so how much electricity and CO₂ do they save compared to a pure electric hot water system?
- 11) How do solar thermal electricity plants work and what is the cost of electricity from them? Should we build such plants in Australia, and if so, where?

- 12) Compare at least two means of desalinating seawater for a city water supply, with respect to capital cost, electricity or other energy use and CO₂ emissions.
- 13) What are the issues involved with a home owner installing a small wind turbine? Is it worthwhile?
- 14) Does “Earth Hour” – turning off city lights for one hour - save CO₂ emissions from coal-fired power plants?
- 15) Which is the best method for “boosting” a solar hot water system during overcast intervals? Compare the cost and CO₂ emissions for: off-peak electric boost, with and without Green Power; and gas boost, both heating water in the tank or instantaneously heating the water as it flows from the tank.
- 16) The hybrid Toyota Prius uses less fuel but costs more. Compare the Prius with a standard car of similar performance and size, and assess how much the saved CO₂ costs per kg, over the life of the car. Is a Prius worthwhile for a typical family? Rank it against some other basic CO₂ saving measures.
- 17) Quantitatively describe the power flow and approximate costs of an electric bike (choose any type or brand). How much power does a bike need and how much electric power does Australian law allow? Should electric bike use in Australia be encouraged by governments, and if so, how?
- 18) Compare three possible means to provide electric power assistance for a bicycle and decide which is best, or invent your own new method.
- 19) What is the fuel in standard nuclear power reactors? If all of the world’s electricity came from such reactors, how long would the fuel last? Is it worth Australia building such reactors now?
- 20) Is Australia on track to meet its Kyoto target and what will the penalties be if we don’t? Was it right for Australia to get a +8% increase in CO₂ emissions, plus our high land-clearing in 1990 bonus?
- 21) What are the typical costs of retrofitting a rainwater tank system in a home and the implied per kilolitre costs? How does that compare with a desalination plant?
- 22) Why aren’t solely battery-powered electric cars available today? Is it technically possible, now, with cost the only stumbling block? What is the approximate cost in dollars and kg CO₂ per km travelled of a battery-powered car, recharged by Green Power (assuming a typical car life and including battery replacement cost) compared to a similar performance petrol-powered car?
- 23) Compare the energy cost per passenger kilometre assuming a 50 year lifetime of a freeway and private car system and a heavy rail and foldable bicycle (for transport to and from home and destination) system.
- 24) Summarise what the Stern Review on the Economics of Climate Change assesses to be the likely cost of doing nothing about climate change, to the cost of reducing CO₂ emissions to stabilise global temperature this century. Very roughly, if the damage cost from doing nothing could be paid for by a carbon tax, what would it be (in AU\$ per kg of CO₂)?

Very Difficult

- 25) Is it wise to encourage “carbon neutral” homes with on-site electricity production or should renewable energy be concentrated in large farms?
- 26) What fraction of electricity could be provided by wind and solar farms before frequent failures in Australia’s electricity supply resulted?
- 27) What might be the cheapest and best way for Australia to store renewable energy thus enabling an increase in the fraction of our electricity provided by renewable energy?
- 28) Which is better for Australia to store underground – sequestered CO₂ from burning coal or radioactive waste from “burning” uranium?
- 29) How should the world reduce its CO₂ emissions? Should reductions be imposed on countries by some percentage of their recent emissions levels or according to a worldwide per head allowance? Or should an international carbon tax be imposed somehow?