SELF –ASSESSMENT QUIZ

INTRODUCTION

1. The Japanese photovoltaic market (and industry) became the clear world leader in the 1990s. Describe the conditions that lead to that situation and discuss how those conditions apply today in the context of a global recession, limitation on GHG emissions and peaked fossil fuels.
2. In the 2000s, the German PV market became the new world leader through the mechanism of feed-in-tariffs. Discuss the pros and cons of the German incentives to the PV market.
3. The mid-2000s was characterized by the polysilicon bubble. Describe the conditions that lead to that situation and its consequences.
4. How does the feed-in-tariff mechanism work? [Incentive to electricity production vs equipment. Who pays the bill?]
5. The Spanish feed-in-tariff law lead to a new bubble in the PV market in 2008. Describe the events and discuss the lessons learnt.
6. How does the current credit crunch affect the PV market globally?
7. Briefly describe the microgeneration law in Portugal.

SOLAR RADIATION

8. How much radiation reaches the surface of the Earth during one year? [Solar constant: $1366 W/m^2$]
9. Define solar declination. How does it vary during the year?
10. List the atmospheric effects on the solar radiation.
11. Define air mass.
12. Explain the differences between photon flux, power density and spectral irradiance.
13. Discuss the limitations of insolation models and the main sources of errors.
14. Describe the different concepts for solar tracking and briefly discuss the corresponding potential gain with respect to fixed modules.
15. Define ground cover ratio. Discuss how it varies with different tracking concepts.

FUNDAMENTALS

16. What is the effect of temperature on an intrinsic semiconductor?
17. What happens to a silicon crystal when one introduces a V-group impurity such as phosphorous? And a III-group impurity such as boron?
18. When a photon with energy E shines on a semiconductor with bandgap $E_g<E$, what happens to the energy of the photon? [And if $E_g>E$?]
19. Define absorption coefficient.
20. Describe the 3 main recombination mechanisms in a semiconductor.
21. Explain the creation of the electric field in a pn junction.
22. Describe qualitatively the collection probability across a solar cell. How does it depend on the surface recombination rate and the bulk material diffusion length?
23. What is the difference between quantum efficiency and spectral response? How are they related?
24. What is the difference between external and internal quantum efficiency?

25. What does the variation of the quantum efficiency with wavelength tells us about the different parts of a solar cell?
26. Describe how a spectral response of a 'real' solar cell differs from the spectral response of an ideal solar cell. How is it possible to have a response above zero for wavelengths above the bandgap?
27. Draw the equivalent circuit of a solar cell, including parasitic resistances.
28. Write down the IV characteristic equation of a solar cell. How does it differ from the IV characteristic of a diode?
29. Given an IV curve for a solar cell, identify the Voc, Isc, Pmax and calculate efficiency and fill factor.
30. Define the efficiency of a solar cell. Under what conditions it is usually measured?
31. What does the Isc of a solar cell depend on? And the Voc?
32. Define the characteristic resistance of a solar cell. Why is it relevant?
33. How does the series resistance affect the IV curve of a solar cell? And the shunt resistance?
34. What is the effect of irradiation intensity on the IV curve of a solar cell? And the effect of temperature?
35. What are the sources of optical losses in a solar cell? How can they be reduced?
36. How can one reduce the recombination losses in a solar cell?

PV TECHNOLOGIES

37. List the different forms of crystalline silicon available for photovoltaics.
38. Describe the Czochralski process for the growth of monocrystalline silicon.
39. Describe the cast method for the growth of multicrystalline silicon.
40. Discuss the relevance of sheet or ribbon silicon for the growth of multicrystalline silicon for PV application. Enumerate some of the techniques to produce silicon ribbons.
41. Describe the typical manufacturing steps of a silicon solar cell.
42. Briefly discuss the existing and potential material bottlenecks for the silicon solar cell industry.
43. Discuss the main differences between crystalline silicon and thin film solar cells.
44. What are the most relevant manufacturing advantages of CdTe solar cells with respect to crystalline silicon solar cells? What are the drawbacks?
45. Define energy payback time.
46. Define energy yield. Discuss how it varies for the different solar cell technologies.
47. Discuss the main issues regarding materials availability for the most common solar cell technologies.
48. Identify the pros and cons of the most common solar cell technologies.

PV SYSTEMS

49. How many solar cells are there in a typical crystalline silicon solar module? Why?
50. What is the role of a blocking diode in a solar module? Describe an alternative approach to solve the same goal.
51. What happens to the performance of a string of solar cells when one is not illuminated? How do you overcome that problem?
52. How does the IV curve of a solar module vary with temperature? And with irradiance?
53. Define Normal Operating Cell Temperature (NOCT). How does one use that concept to determine the solar cell temperature for a given irradiance?

54. Enumerate the main degradation mechanisms for an electrochemical battery.
55. What are the main losses in the charging/discharging process of a battery?
56. How does the rate of discharge of a battery affect the amount of useful energy one may extract from it? Why?
57. What is the effect of temperature on the storing capacity of a battery?
58. What is the depth of discharge of a battery? How does it affect the lifetime of a battery?
59. What is the role of a charge controller in a PV system?
60. What is the use of a maximum power tracker? How does it work?
61. How does an inverter work?
62. Define the European Efficiency of an inverter. Why is it relevant?
63. Discuss the economic viability of a stand-alone PV system for a small rural application (compare it with a small diesel generator)? What are the most relevant parameters that determine its viability?
64. Discuss the pros and cons of the most significant deployment strategies for rural PV electrification.
65. Determine the capacity of a battery for a stand-alone PV system given the depth of discharge, the required autonomy and the load.
66. Why is the panel inclination in a stand-alone system usually chosen steeper than in a grid-connected one?
67. List some of the ‘rules’ that ought to be considered for a small stand-alone PV system in a remote location.
68. Determine the solar array (kWp) required for a solar pump, given the volume required, the pump head and the average daily solar irradiation.

BUILDING INTEGRATED PV SYSTEMS

69. Discuss the specific issues related to designing building integrated PV systems.
70. What is an “AC module”? Discuss its main advantages and drawbacks.
71. Discuss the specific issues related to designing PV systems for public spaces.

CONCENTRATION PHOTOVOLTAICS

72. How does the efficiency of a solar cell depend on the concentration level?
73. For a given solar cell, what determines the optimum concentration level?
74. What is a luminescent concentrator? How does it work?
75. Discuss the most relevant design options of a concentrator PV system.