12 Renewable Energy for Sustainable Development

Mohamed Salama, Mutasim Nour, Adel Haloub and Yara Al Jundi

Learning outcomes

By the end of this chapter the reader should be able to:

- Compare the different types of renewable energy technologies (RETs)
- Appreciate the importance of RETs for sustainable development
- Discuss the key features of a Biofuel Refinery Plant Project as an example of sustainable development projects in the energy sector.
- Understand how to conduct a feasibility study to build a waste-to-energy (WTE) incineration plant as an example of sustainable recycling project.

Introduction

This chapter aims to introduce the reader in general, and project managers in particular, to the basic concepts and applications of renewable energy (RE) with emphasis on the various renewable energy technologies (RTEs), emerging as an alternative to traditional energy sources, in an applied, practical and project-focused context. The chapter builds on academic research-based cases studies conducted by the authors.

The first case relates to a real-life project which will be the first advanced biofuels refinery to be built in the Middle Eastb with an estimated cost of $700m and commercial operation date in 2022. The financial close date is scheduled for the end of Q4, 2018, and it is expected to have a lower cost of production compared to European and US refineries.

The second case study concerns the feasibility study to build a waste-to-energy (WTE) incineration plant in Dubai. It provides project managers with useful

insight into the details of this vital initiation stage for this type of project, based on a real-life data set, in an applied research context.

The details of both cases can be found on: https://www.goodfellowpublishers.com/sustprojman.

The first few sections of the chapter set up the scene for the case studies by presenting brief definitions of the basic concepts of RE and various RETs in the context of sustainable development. Then at the start of each case study, a brief introduction to the specifics of the case is presented.

Sustainable development

According to Gupta et al. (2002), using the techniques of risk assessment and environmental impact assessment, can help to identify, mitigate or eliminate unsustainable aspects to some degree. In order to achieve sustainable economic development along with sustainability in the energy sector, many problems lie in energy production and consumption; such as low efficiency, shortage of resources, high emissions and lack of the effective management system Zhang et al. (2011), To achieve stable and sustainable energy that does not affect the environment, the renewable energy sources must be developed (Wargacki et al., 2012). Adoption of renewable energy will help many countries to decrease their dependence on fuel imports and reduce their foreign exchange bills (Moller et al., 2014; Prakasham et al., 2014). Therefore, renewable energy and biofuel, the focus of this section, can play a vital role in reducing environmental pollution and mitigate the energy crisis (Huang et al., 2010; Kumar, 2013).

Renewable energy

The concept of renewable energy or sustainable energy can be defined initially as any source of energy that derives directly or indirectly from solar energy. This kind of energy will be available as long as the sun continues to shine; with an estimated life of the main stage of the sun being 4 to 5 billion years. With this broad definition, almost all the energy that the world uses it today, including fossil fuels can be considered a form of solar energy. However, oil, gas, wood and coal are the most familiar forms of energy that gathered, stored and transferred by natural processes. In other words, renewable energy can be defined as "*forms of solar energy that are available and replenished in timescale no longer than a human lifetime*" (Ahmed, 1994).

There are many options of renewable energy technologies; some are still under development, have entered commercial markets or have achieved sizable market penetration. While others, such as photovoltaics, are used but have limited application till these days. Table 12.1 shows some of these technologies.

Table 12.1: Types of renewable energy technologies based on the end use application

Resource	Technology	End Use Application			
		Electricity	Industry	Building	Transport
Solar	Photovoltaics - Flat Plate	×			
	Photovoltaics - Concentrator	×			
	Solar Thermal Parabolic Trough	×	×		
	Solar Thermal Dish/Stirling	×			
	Solar Thermal Central Receiver	×	×		
	Solar Ponds	×	×	×	
	Passive Heating			×	
	Active Heating			×	
	Daylighting			×	
Wind	Horizontal Axis Turbine	×			
	Vertical Axis Turbine	×			
Biomass	Direct Combustion	×	×	×	
	Gasification/Pyrolysis	×	×		×
	Anaerobic Digestion	×	×	×	
	Fermentation				×
Geothermal	Dry Steam	×			
	Flash Steam	×			
	Binary Cycle	×			
	Heat Pump			×	
	Direct Use		×	×	
Hydropower	Conventional	×			
	Pumped Storage	×			
	Micro-hydro	×			
Ocean	Tidal Energy	×			
	Thermal Energy Conversion				

Types of renewable energy

Photovoltaic (PV)

A photovoltaic installation converts sunlight into electricity. It is composed of multiple PV cells. There are two categories of PV devices: the first is the flat-plates that utilize the whole of the solar radiation including direct insolation and diffuse (scattered) sunlight; and the second is the concentrator systems that use lenses to focus radiation onto a highly effective PV cell and use direct sunlight.

Solar thermal – electric

Solar thermal technologies collect the sun's radiant energy to create a high-temperature heat source that can be converted into electricity via a number of thermodynamic conversion cycles.