5 RENEWABLE ENERGY TECHNOLOGIES FOR COOLING AND ICE MAKING

This chapter reviews the general economic aspects of different energy options in relation to their scale. The concept of life cycle cost, and its relevance for stand alone renewable energy generation are discussed. An IEA publication [5] and an Ecofys publication [6] were used as a background for this chapter.

5.1 RENEWABLE ENERGY GENERATION EQUIPMENT COSTS

This section provides an overview of the typical costs of different types of stand-alone energy equipment in general. It must be noted that equipment prices, in what is still a small and immature market in many countries, can be highly variable, depending on the country and location, the source and quality of equipment and the taxes or subsidies applied. Therefore, table 8 gives only indicative costs for a limited range of 'typical' equipment.

Equipment	**Size range**	**Cost Guidelines**
PV modules	50 Wp or greater	$4–7/Wp
PV lighting systems	50 Wp or greater	$8–20/Wp
	<50 Wp	$15–30/Wp
PV water–pumping systems	100–1 000 Wp	$10–15/Wp
Micro-hydro: electro-mechanical equipment	30–300 kW at heads >50 m	$400–600/kW
	30–300 kW at heads 10–50 m	$600–1 200/kW
Micro-hydro: complete installations	30–300 kW at heads >50 m	$1 500–2 000/kW
	30–300 kW at heads 10–50 m	$2 000–4 000/kW
Wind–generator and battery unit	0.1 to 10 kW at 10m/s wind-speed	$2–5/W
Solar absorption ice making	0,21 kW (5 kWh/day)	$20k-60k/kW*

table 1: Indicative costs of renewable energy systems (adapted from: IEA lessons learnt [5])

*when locally produced in large series, the ISAAC solar icemaker can be locally produced at 4-5,000 US$ [3].

In general each energy technology has a certain range of average energy demands which it is most cost-effective in supplying.

Future cost reductions are foreseen as the technologies and markets develop. For example, the price of PV modules has reduced from $20/Wp to around $5/Wp in the period 1980–1997.

The broad picture can be described as follows (see table 8):

- For on–off domestic power supplies for cooling, a battery-based supply charged by PV or wind is likely to be the most cost-effective. If occasional power peaks occur, a back-up generator can be considered.
- For a number of domestic supplies, e.g. for a small village, the economic choice lies between individual battery-based units (Solar Home Systems or commercial battery charging) and a centralised scheme with PV plant, diesel generator or micro-hydro.
- For remote water cooling, the choice is between solar, wind and diesel systems.
- For electrifying larger ice plants where hundreds of kW are required, the choice is principally between micro-hydro, diesel and extending the grid.

Continuous power:	**1 W**	**10 W**	**100 W**	**1 kW**	**10 kW**
PV–battery	■	■	■	■	
Wind–battery	■	■	■	■	
Hydro-electric turbine			■	■	■
Diesel generator with battery			■	■	
Solar thermal* ice making			■	■	
Diesel generator				■	■
Wind diesel				■	■
Grid extension					■

table 2: Indication of typical economic power ranges for energy systems (adapted from IEA lessons learnt [5]).

*based on local large scale production of ISAAC ice making systems (US$4,000-5,000 per system [3])

5.2 COST OF LIFE–CYCLE

However important (and often decisive), the initial cost is only one element in the overall economics of a system. An economic assessment is required to determine which system from a number of choices will give the best value for money in the longer run.

The economics of renewable-energy technologies are rather different to those of conventional small power systems:

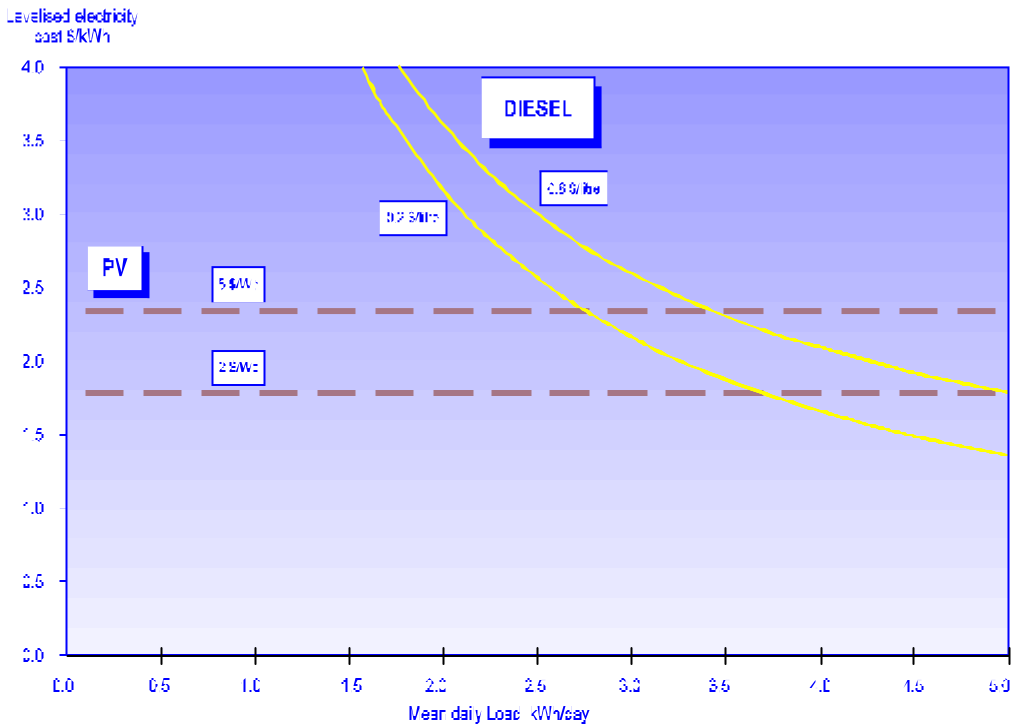
1- The capital cost of the equipment is relatively high, especially for larger plants.
2- The running costs are generally low and there are no fuel costs.
3- The output of the system depends the resources available (differs per location).
4- The output of the system depends on the load pattern.
5- The reliability is high.

High (upfront) fixed cost and low variable cost mean that a high occupancy rate is needed to get the maximum out of the system, especially if the application can only just compete with its conventional alternative.

5.3 Economic comparisons

Some energy technologies prove to be more cost-effective in different situations. In general, it is the average amount of energy required per day that dictates the choice of system. In the following examples, life–cycle costing has been used to compare the *levelised* cost of energy supplied by different technologies over their lifetime, as a function of the daily energy required.

Figure 7: Economic comparison of PV vs. a diesel generator (Real costs, 5 year battery replacement). (source IAE lessons learnt [5])



5.3.1 Opportunities for Cost Reduction

Opportunities exist to reduce the cost of RE electricity in the near future:

- A steady decline in RE technology costs (esp PV), especially module costs and selected components linked to PV systems on the international market will help reduce the cost. In addition there will be further improvements in component efficiencies. On the other hand, PV itself will remain costly because it is mostly produced in industrialized countries and will have to be imported.
- Cost reductions possible through the use of locally made and/or locally assembled components (provided they are of satisfactory quality), as well as the economies of scale in procurement, sales and servicing that enlarged customer bases can provide.

- Better knowledge about renewable energy resources in general, better forecasting of availability of the power supply.
- A strong RE industry together with appropriate policy incentives increases the likelihood of attracting low-cost capital and lowering duty and taxes (or even tax exemption) for the expansion of sustainable new energy models.

5.4 Economics and real life

Although economic analyses have a key role to play in selecting energy technologies and planning projects, two further issues affect the overall economic outlook:

1. Social, technical and personal factors affect an entrepreneur's purchasing decisions;
2. Political and macro economical factors will influence the purchasing decision.

5.4.1 Real-life decisions

Entrepreneurs may do carry out a life–cycle cost analysis before deciding to make a purchase. If they do, other influential factors play a major role:

- The up-front cost: even when life–cycle costing proves RE to be the cheapest alternative, the initial investment might be a barrier in some cases.
- The extent to which the demand pattern (over the year) and availability of resources match.
- The existing local experience (usually this is with a diesel generator) and confidence in the performance and reliability of the technology will influence the choice of the entrepreneur.
- The convenience and portability of the system (esp. mobile applications).
- The ease and speed with which the system can be installed and running: no trench digging for cabling, no cumbersome connections to the grid, unreliability of the grid etc.
- The ease of maintenance and independence of fuel.