HAC's 2011 sheet o' good stuff

Energy Conversion Factors

Gas	0.0393 GJ/m^3
	51.23 kgCO2e/GJ
Diesel	38.6 GJ/kL
	69.5 kgCO2e/GJ
Electricity WA	0.82 kgCO2e/kWh
	3.6 MJ/kWh
Electricity Vic	1.23 kgCO2e/kWh
	3.6 MJ/kWh

Small-scale solar PV

Approximate cost per Watt installed:
1-20 kW = $5-6/W ; 20-50 kW = $5/W ; 50-100 kW = $4-5/W ; Above 100 kW = $4/W for crystalline, $3-4/W for thin film.
Ground-mount framing adds $2/W in metro areas, $4/W in remote areas;
Output: 1.65 MWh/kW_p per annum (Perth) ;
Area: 7 m^2/kW if flush-mounted on a tilted roof, or 10 m^2/kW if mounted on a horizontal plane

Large-scale solar

Solar PV with single-axis tracking: 2.7 GWh per MW installed per annum (in WA).
$5.8M per MW installed. Note: no rule of thumb for utility-scale solar thermal, highly dependent on technology and location.

Small-scale wind turbines

1 kW microturbine = $16,000 fully installed.
10 kW small wind turbine = $80,000

NGER Thresholds	100 TJ	25 ktCO2e	200 TJ	50 ktCO2e
Diesel	2,591 kL	9,319 kL	5,181 kL	18,638 kL
Gas	2,544,529 m^3	12,417,184 m^3	5,089,059 m^3	24,834,367 m^3
Electricity Vic	27,778 MWh	20,325 MWh	55,556 MWh	40,650 MWh
Electricity WA	27,778 MWh	30,488 MWh	55,556 MWh	60,976 MWh

Anaerobic digesters (case study)

Liquid and kitchen waste 1500 people
30-60 kW system (240,000 kWh/a @90% availability)
Capex: $710,000 installed
Revenue:
Electricity $28,800 @ 12c/kWh
RECs $9,600 @ $40/MWh
Liquid fertilizer $78,855 @ $35/tonne
Waste heat $6,910 @ $0.047/kWh
Plus displaced trade waste costs

Causes of poor power factor

Fluorescent & HID lighting, electric induction heaters, induction motors and solenoids, arc welders, transformers, other induction loads.
Power Factor Correction (PFC) installation costs $2500/50 kVAR (plus building modifications).
kVAR = sqrt(kVA^2-kW^2)
PFC kVAR = target kVAR-present kVAR

Hydrogen fuel cells

Energy content of H_2: 120 MJ/kg LHV
1 Nm^3 H2 = 0.09 kg
A fuel cell produces 16 kWh per kg H_2

ORC Turbines

Recovers around 10% of the energy generated by a diesel or gas power plant. Levelised cost of energy around 15 -20 cents/kWh for a 5 year payback.

PIPES

1. State the PROBLEM,
2. Tell them the IMPLICATIONS.
3. Point out POSSIBILITIES if they didn't have the problem.
4. Give an EXPLANATION of how to solve the problem.
5. Tell them what SOLUTIONS you can offer to help solve it. (how you can implement the solution you've described).

(Source: gihanperera.com)

Pump/fan laws

Flow is proportional to shaft speed. Head is proportional to the square of shaft speed. Power is proportional to the cube of shaft speed.

$$\frac{Q_1}{Q_2} = \left(\frac{N_1}{N_2}\right)$$

$$\frac{H_1}{H_2} = \left(\frac{N_1}{N_2}\right)^2$$

$$\frac{P_1}{P_2} = \left(\frac{N_1}{N_2}\right)^3$$

Wind project costs

Major budget item	$/kW
Feasibility	10
Project development	30
Pre-construction site works	10
Turbine deposits	340
Construction	250
Balance on turbines	1,360
Total	2,000
Annual O&M	43

Another rule of thumb: $1.4 to $2.1M per MW nameplate capacity.

Net Present Value

$$NPV = -A + B\,\frac{\left(1 - \left(\frac{1+a}{1+dr}\right)^{C}\right)}{\left(\frac{1+dr}{1+a} - 1\right)}$$

A = capital cost
B = annual cash flow (+ve for savings/inflow)
C = asset life
a = Consumer Price Index
dr = discount rate
(applies to projects with constant annual cash flow)

Cogeneration

No rule of thumb. Economics highly dependent on fuel price, grid electricity cost, and thermal applications. Feasibility must be studied. First profile electrical load and utility rate structure. Size the plant for 70-80% of on-site electricity consumption to maximize the operating hours. Then look at heating and cooling opportunities to increase overall efficiency. Exhaust temperature of gas-fired co-generation plants are typically 450-600°C.

HAC Smart Solutions for a Carbon Constrained Future

Questions? Love it? Hate it? Contact us...
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