Can you make money while saving the planet ?

A description of practical issues between you and a profit from a 1MW (preferably) renewable scheme.

Recent changes/developments

Political

- The current review of government policy. Who will pay who this time ?
- Large scale PV subsidies effectively dropped
- Technical
- Useful IET conference on large scale renewables next month

IET conference 8-9th February 2011

- Title: Connecting Renewable energy to the Grid
- Almost entirely about large scale projects
- The highlights are listed on the next slide

IET conference 8-9th February 2011- Some of the highlights

- Solution oriented technical on offshore substations, smart grids, HVDC, tidal power technology, grid optimisation & power quality
- Analysis of key regulatory and consent issues
- Practical presentations on design issues, cost, interconnection, power arbitage

Separating the corn from the chaff (lobbyists?)

- This IET event has exiting technical developments. However one could question the economics. Massive schemes safeguard existing players.
- For an opposite view look at the Micro Power Council.
- For a look at small schemes which appear successful in reducing costs look at the Thameswey website

Somewhere in the middle

I am going to cover some of the practical issues which arise to build and connect an embedded generator of about 1MVA. Many of the issues are similar to those which come up in larger or smaller schemes. This approach will suit any generation but obviously renewables are the flavour of the month

Making distribution networks two way streets?

- For decades distribution sent power almost solely from large sources e.g.‘Bulk Supply Points’
- Dispersed generation needs networks to collect/harvest and deliver power
- Existing networks were not intended for both
- Similar issues apply to allsize schemes

What you might want to sell

- Intermittent renewables – usually wind or hydro
- Renewable organics usually from some form of waste typically sewage, chicken manure,wood chip, food preparation
- CHP on sites with regular heat demand – hospitals, sheltered housing, indoor pools
- Short term reserve services from standby generators
- Triad management

Typical generation costs

- Hydro power or wind vary a lot as the scale changes on smaller schemes. Say£1000/kW
- Gas engine -say £300/kW plus fuel processing giving £500/kW
- Modifying Standby diesel generator for short term reserve or triad management Say £30/kW

A really neat renewable scheme

This rather attractive scheme graces the garden of a tea room. This small induction generator probably pays for itself as an attraction. A couple of kW on a good day

Typical Timescales

- Project definition, funding and land perhaps two years
- Planning permission – can be one year to infinity
- Electricity network quotation five months
- Electricity network connection – a few months to a few years
- Commercial negotiations on power export several months
- Construction time six months

Why most generators must have the a 'grid' connection

- Access to markets to sell electricity
- Access to buy energy when unable to meet site demand.
- Purchase of reliability. Typically this allows us to build a facility with only one generator. This can give a big reduction in capital cost.

Cost elements in the ‘transport’ charge.

- The National Grid or transmission charges. For embedded generation these are in the distribution charges.
- The distribution companies (DNO) connection charges
- DNO ongoing capacity charges
- The costs incurred by the generator to meet the DNO’s technical requirements

Technical reasons for costs 1

- ‘Wires’. The obvious costs of the network and the connection to it – metering, governance, capital, maintenance
- Impact on feeder voltage profiles and fault levels
- Extra protection schemes such as ROCOF & neutral displacement protection

Circle diagram for a 11kV line. A 700 kW 830kVA, load 10 miles from a 33/11kV busbar gives 7% volt drop. Similarly 700kW generated 10 miles away from the 33/11kV busbar can give 7% rise at 11kV where connected. Losses 50kW

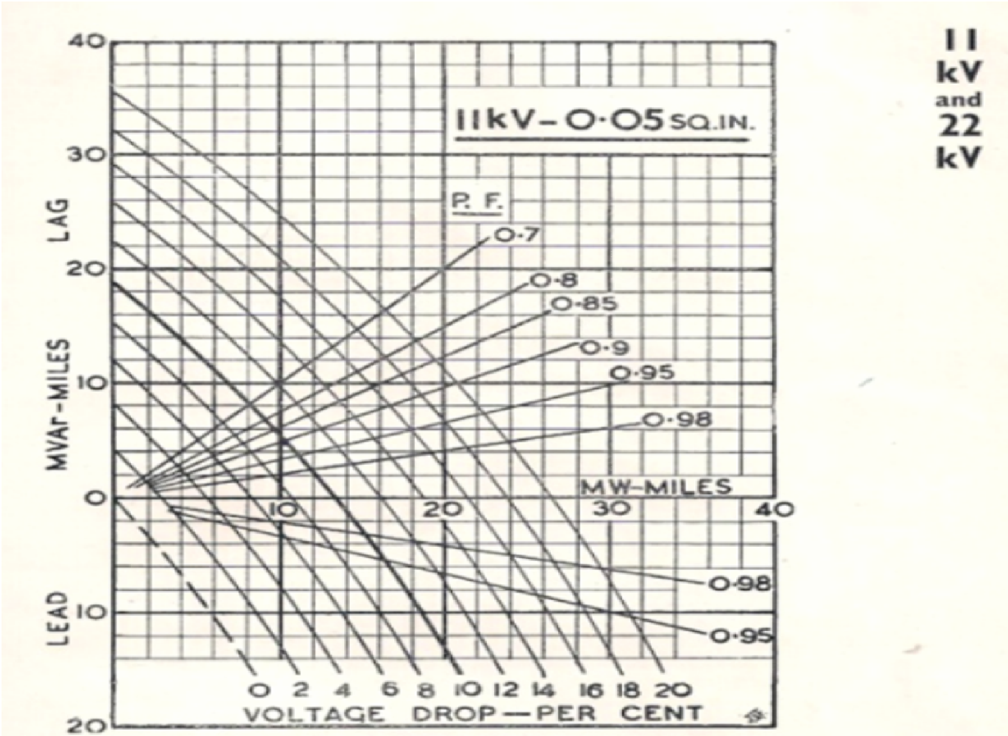

Fig. 15.—Voltage-drop chart for 11-kV line, 0·05 sq. in. copper conductors.

Technical reasons for costs 2

- Lower utilisation of transmission system. Throughput is reduced. Lower number of kWh over which to spread balancing costs. We still want the system to deliver power when the embedded generation is off line.
- This is particularly important for intermittent generation such as seasonal or wind energy

Technical reasons for costs 3

- UK losses-about 6% on distribution, 1.5 % transmission
- Distribution losses are higher in rural areas
- Transmission losses are higher in the south west
- At heavy load times losses at difficult parts of networks can be double the average

Technical reasons for costs 4

- Loss factors used in estimating bills are prepared by the ENA using profiles for different customer groups. Fair charges will need much better metering systems. Smart meters might deliver this
- The introduction of ‘smart meters’ will hugely increase metering charges. It remains to be seem if this is justified

The transmission element

- I have taken a very simplified approach
- According to the 06/07 annual accounts for NGC UK transmission, NGC carried 350TWh for an income of £2012m in 2007 i.e. NGC receives 0.66p per kW hour. With three years inflation to 2010 say 0.73p per kWh
- When purchasing the charge is about 0.2p per kWh dearer in the south west and about 0.2p per kWh cheaper in the North East . The reverse should apply when you sell. However you might find that your supplier takes a large slice. As a small generator you are in a fairly weak position to negotiate

Distribution costs

- As far as practical in 1948 the distribution areas were set up to give similar costs so figures from a fairly average one will be of the right order of magnitude for most areas. I am using the old Southern Electricity's area 06/07 figures
- Sterling prices of materials, transport and labour used on new distribution assets are rising quite dramatically
- Connection costs could increase double RPI inflation rates

The distribution element and some rough assumptions

- In 2007 Southern Electricity received £425m for carrying 33.9TWH. i.e. 1.25p per kWh
- NGC 'Exit' Charges are included in this figure so a reduction of say 5% is necessary to avoid double counting. This gives a figure of 1.19p per kWh. As explained later, embedded generation will incur similar costs or higher ones
- Add 2 years inflation less OFGEM restriction – say 9% gives 1.3pence per kWh

The connection charge 1

- Connection charges vary with location. Advance payment is often required
- A typical connection charge for a 1MVA generator at 11kV is likely to be over £50K,
- There are many locations where a 1MVA generator is not acceptable at 11kV. Expect 33kV connections to start at over £250k
- You will have to pay a sum for a quote. OFGEM have introduced temporary limits
- To use the connection you pay a monthly capacity charge of about £1/kVA/month.

Connection Charges 2
Financial risks

- The quotation may be months in production and the connection years in construction
- I have seen budget figures multiply by five when firm quotes were obtained
- Without a connection agreement early in your project you are taking a serious gamble. When the quote comes it may kill the job

Connection charges 3
More risks and a stab at p/kWh

- DNOs may find wayleaves unobtainable
- Their network may not be able to absorb power where you want. A front end study is essential. It is advisable to allow a lead time of a year for quite modest schemes
- A £50k fee for a 1000kVA capacity is roughly equivalent to 0.07p/kWh if you have no restrictions on available energy. Low plant utilisation will make this number soar as it does the capacity charge

Energy sales to finance the connection charge

- Number of kWh per annum from a one MVA generator = 1000 X 0.9 X 0.8 X8760=6307200 where 0.9 = power factor and 0.8 = annual load factor
- Capital charge is say £50000
- At 12% the charge is £6000pa
- Cost per kWh = 6000X 100p/6307200 =0.095p per kWh

The total cost of power transportation per kWh today

- NGC 0.73p/kWh – higher in the SW
- DNO 1.3p/kWh
- Capacity charge if load factor 0.3 – 0.4p/kWh
- Funding connection charge. Say 0.1p/kWh
- Total cost 2.5p/ kWh and +/- 0.2 p/kWh depending on where you are relative to the NGC zonal charges.

A guess at the price of power transportation in say 5 years

- The distribution cost will probably increase about 40% to 1.8pkWh
- The NGC cost will increase to 1p/kWh
- Sunk connection cost i.e.0.1p/kWh
- The average charges total about 2.9p/kWh at todays prices.
- Southwest has high zonal prices charges, say a total of 3.1p/kWh

Future transportation costs – A summary - 1

- As embedded generation increases, the DNO will have to stiffen the network to accept it.
- This will need more conductivity in the networks to reduce voltage issues
- That, and the generation will precipitate a need for higher rated switchgear
- Vastly improved communications and protection arrangements will be needed
- A high proportion of distribution assets are old. Replacement programmes will be substantial.
- How much renewal cost should be allotted to dispersed generation is a debatable point

Future transportation costs –A summary 2

- Grid connections using BSPs will remain to ensure continuity of supply. Incidentally NGC usually demands 40 year contracts for new BSPs
- Some studies expect distribution costs to rise 40% when embedded generation meets a high portion of demand. It now looks nearer 90%.
- If NGC connect a large quantity of wind power their costs must rise. Connection charges will not cover the 'deep' costs or the higher system operational costs. I would consider a rise to 1p/kWh within about a decade as perfectly possible

Avoiding power transportation costs

As the proportion of embedded generation increases so will the pressure to avoid subsidies in power transportation. Therefore:-

- Look at any wheeze such as selling over the fence to neighbours or in cooperatives
- Consider using ‘private wires’
- Enter partnerships with local authorities
- Use power on site whenever possible
- Locate/design plant to reduce connection charges
- Think at the front end. Moving power is expensive and will get dearer.

Addendum – Supply Arrangements

The previous slides do not include any explanation of why we have different supply arrangements.

The following may be useful for small low voltage schemes.

The theoretical advantages and disadvantages are often lost in the standardisation necessary to build practical networks so it is an over simplification.

Single phase 230 volts

Usually used for domestic and small commercial premises. Needs two wires but a third one to use as an earth may be found on some supplies. Often limited to 100amperes or less by the utility if you are using power and usually less for generators.

Advantages. Doesn't need as many wires and insulation as other arrangements. Only needs two wires on the 11kV coming to the local transformer.

Disadvantages. Uses lots of copper and single phase rotating machines are quite dear. They need big currents to start. Only a limited range available

Single phase 460 volts

Can be found at in some rural areas. Needs three wires and occasionally a fourth if an earth wire is provided. The biggest size of supply is usually about 100 amperes

Advantages. Allows double what can be done on 230volts. Only needs two wires on the 11kV supplying the local transformers.

Disadvantages Uses lots of copper and single phase machines need high currents to start. Machines are expensive or not even available from some vendors

Three phase 400 volts nominal

Available to high currents in many locations, particularly urban ones.

Advantages Saves copper as it only needs about 60% as much copper as single phase. Large efficient machines are available at relatively low prices

Disadvantages Needs 4 wires and possibly an earth wire at low voltage. Needs three wires at 11kV Using more wires requires more insulation. Sometimes connections in rural networks are very expensive.