Appendix 7

Recommended Resource Ranking Framework for Renewable Resources

Contents

1. Introduction

This Appendix briefly reviews the terminology that has been used to describe the different levels of resource that are available with a view to ensuring as high a level of consistence as possible. Several versions of the definitions are compared and conclusions are drawn. It is borne in mind that these definitions or similar have been in use for over a decade and that incremental rather than radical change is more likely to be acceptable.

2. Resource Ranking Framework of 1997 Study (Ref. 6)

2.1 Hydro Resource

Theoretical Resource

The full theoretical resource which would have included potential river dam sites was excluded from evaluation.

Technical Resource

Confined to small hydro only without impounded storage and amounts to approximately 76MW capacity with a projected annual output of 360GWh.

Feasible Resource

Technical Resource reduced by elimination of non commercially viable small sites as a function of discount rates.

Practicable Resource

Feasible resource reduced by elimination of particular designated areas, an arbitrary cap on capital cost allowed, and a limited annual rate of development. No reduction is made in relation to planning permissions.

2.2 Onshore Wind

Theoretical Resource

Entire land area covered by wind turbines at a realistic density. Reduced by 2% to allow for availability, 5% for wake losses, 5% for electrical losses.

Feasible Resource

Theoretical resource less physically unsuitable areas: settlements, roads, rivers, lakes, railways, and selected corine land cover classes [beaches …. and buffer zones].

100m along linear features

100m around woodland

400m around settlements

Areas with slope > 10^{o}

6km around airports

100m along power lines

100m around quarries, mines

Ribbon development assumed along all roads except trunk and motorways.

Wind speeds > 7.0m/sec.

Accessible Resource

Feasible less environmentally sensitive areas and archaeological road coastline, lakeshore, river buffering.

Practicable Resource

Accessible less proximity, clustering, network connection, cost build rate constraints.

2.3 Offshore Wind Resource

(not included)

2.4 Biomass

2.4.1 Biomass (Farm)

Dry Wastes – Incineration

Technical Resource

Based on conversion values MJ/Kg. for poultry litter, straw and spent mushroom compost.

Feasible Resource

10% straw, 80% (poultry + spent mushroom compost available).

Practicable Resource

50% of Feasible with likely counties being grouped in terms of minimum sizes of combustion plant.

2.4.2 Biomass (Farm)

Animal Slurry Digestion

Straw*, poultry litter*, Spent Mushroom Compost*.

Technical Resource:

Slurry (cattle 100%, pigs 100%)

Based on numbers/county.

Feasible Resource

10% of cattle slurry, 30% pig slurry.

Practicable Resource

Delete herd sizes < X where power conversion would be suboptimal due to farm size.

2.5 Biomass from Crops and Forestry

2.5.1 Short Rotation Coppice

2.5.2 Forest Residues

2.5.3 Wood Industry Residues

In each case the resources were derived as follows.

2.5.4 Technical Resource

Total amount of energy existing limited only by man’s technical ability to extract energy from the source.

Feasible Resource

The resource which could be exploited i.e. limited by the above technical ability to extract energy from the resource and by basic practical incompatibility.

Practicable Resource

The resource which could be exploited after taking economic, environmental, planning and any other practical constraints into consideration. This is, necessarily, a subjective judgment.

2.6 Municipal & Industrial Waste

2.6.1 Municipal Waste to Energy

Technical Resource

This was calculated per county from the total waste arisings and their calorific value.

Feasible Resource

This was estimated using industry standard data for waste to energy conversion based on 85% of the non recyclable waste being suitable. (Conversion efficiency from thermal to electrical energy is low at 20-25% and the electrical "house load" is assumed to be 15%).

Practicable Resource

This was estimated by assuming that 85,000T/annum is the limiting minimum technical and viable plant size. Growth of waste fuel was assumed at 2% per year to 2020.

2.6.2 Sewage Biogas

Technical Resource

This was estimated per county by assuming that 70% of the sludge solids are organic and have a calorific value of 21-22MJ/Kg.

Feasible Resource

This was estimated assuming that 50% of the volatile organic matter in the sludge is converted to biogas in the digestion process. The resulting gas productions circa $1Nm^3$ gas/Kg organic matter converted (at 65% methane content). Finally a gas engine conversion efficiency to electricity of 25% is taken.

Practicable Resource

Considers only the sewage works where anaerobic digestion is proposed and where annual sludge production exceeds 1000t, dry solids. (The combination of suitable agricultural, industrial, and urban wastes in common plants was not considered).

2.6.3 Landfill Gas

Technical Resource

This was calculated per county from the total waste arisings and their calorific value.

Feasible Resource

This was estimated using industry standard data for landfill gas production. The gas was assumed to contain 55% by volume of methane and production at a rate of $10NM^3$ annum was assumed.

Practicable Resource

It was assumed that an operating landfill capacity of 50,000T/yr. is necessary and the resource was derived by assuming a gas collection efficiency of 50%. The gas engine conversion efficiency to electricity was assumed to be 30%.

2.7 Passive Solar Design

Technical Resource

Not utilised.

Feasible Resource

Assumed to be a function of new build but not utilised.

Practicable Resource

(1) The amount of energy displaced per annum by the adoption of passive solar housing design [1000kWh/house, with 50% of new houses having the capacity to benefit from PSD and continuation of house build rate as per 1991-5] plus [retrospective fitting of double glazing saving 1000kWh/yr. to 4% of pre 1996 stock] on a county basis.

Practicable Resource

(2) The corresponding figures for non domestic buildings were estimated using savings of 5kWh/m^2/yr x total new floor area and 0.8kWh/m^2/yr x total refurbished floor area.

(The savings could be shown in terms of CO_2 reduction and the rate €/TCO_2 estimated). However the quality of input information would need to be much higher for comprehensive and credible analysis of this kind.

2.8 Active Solar Heating

Technical Resource

Not meaningful.

Feasible Resource

(1) (Housing): Estimated on the 1250kWh/yr being produced by 4m2 collector acting on 50% of housing stock growing at new build rate per year (with deductions for flats and pumping losses) on a county basis.

Feasible Resource (2):

Corresponding figures based on the numbers and sizes of swimming pools.

Practicable Resource (1),(2):

These were the feasible resource figures with a small downward correction on housing of 5% due to unsuitability.

(Again the result could be estimated in terms of CO_2 displaced, but it is suggested that the decision is more a quality of life issue than a purely economic one).

2.9 Photovoltaic

Total Resource

This was simply the annual solar energy arriving on the surface of the country.

Technical Resource

This was simply the annual resource that would be available if the country was covered with PV modules, and reflects the conversion efficiency of these elements.

Feasible Resource

Based on mean annual output for typical system multiplied by fraction of building stock.

Practicable Resource

Not utilised.

2.10 Photoconversion

Not utilised

2.11 Tidal Energy (Barrage Option)

Total Resource

(not developed)

Technical Resource

Developed for 46 selected locations.

Feasible Resource

Technical resource reduced due to wave exposure and implied material consumption giving extreme cost/kWh.

Practical Resource

Feasible resource reduced by exclusion of sites with cost/kWh exceeding range of interest.

(The tidal stream option was deleted by reference to cost data arising from U.K. studies).

2.12 Wave Energy (Shoreline)

Theoretical Resource

Estimated for 100m depth contour an annual resource of 105TWh/y.

Feasible Resource

By reference to the coastline this was estimated at an annual resource of 7.5TWh/y with a mean power level of 798MW spread over 105km.

Practicable Resource

This was estimated by deleting quiet areas, poorly serviced areas, islands, highly designated areas and assuming installation of a LIMPET converter. This implied that 17.5km of coast could sustain 160MW of plant with a potential annual output of 1.5TWh if costs could be contained.

2.13 Geothermal Hot Dry Dock

Theoretical Resource

Not featured.

Feasible Resource

Heat flow too low for viability in Ireland.

Practicable Resource

Heat flow too low for viability in Ireland.

2.14 Geothermal Aquifers

Theoretical Resource

Computed to a set of depths for different strata.

Feasible Resource

None for electrical generation due to low temperatures and low permeability.

Practicable Resource

As above.

Direct heat pump utilisation for heating applications possible on small scale.

Table A7.1

Resource Ranking Framework used in 1997 Study

	Resource	Theoretic al	Technical	Feasible	Accessible	Practical
1	Hydro	-	x	x	-	x
2a	Wind Onshore	x	-	x	x	x
2b	Wind Offshore	N/A	N/A	N/A	N/A	N/A
4a	Biomass: Farm Waste : Thermal	-	x	x	-	x
4b	Biomass: Farm Waste : Digestion	-	x	x	-	x
5a	Biomass: Forestry SRC	-	x	x	-	x
5b	Biomass: Wood Industry	-	x	x	-	x
5c	Forest Residue	-	x	x	-	x
6a	Municipal: Waste to Energy	-	x	x	-	x
6b	Municipal: Sewage Digestion	-	x	x	-	x
6c	Municipal: Landfill Gas	-	x	x	-	x
7	Passive Solar	-	-	-	-	x
8	Active Solar	-	-	x	-	x
9	Photovoltaics	x	x	x	-	x
10	Photoconversion	-	-	-	-	-
11	Ocean : Tidal	-	x	x	-	x
12	Ocean: Wave	x	-	x	-	x
13	Geothermal: Hot Rock	-	-	x	-	x
14	Geothermal: Aquifer	-	-	x	-	x

X Heading utilised

- Heading not used

2.15 Discussion

A review of the foregoing 1997 study (Ref. 6) (summarised in Table A7.1) shows that a degree of pragmatism was necessary in estimating particular resource levels to keep within the allowable scope of the project. It should be borne in mind that when estimating at the strategic level, broad indications of the accessible resource are usually sufficient for national planning purposes, and highlight the likely effect of known institutional constraints. Where such constraints are defined only in vague terms the impact on the real accessible resource cannot of course be reliably quantified.

3. Previous SEI Usage

It may be noted that SEI in issuing an enquiry document in respect of dry agricultural residues (June 2003) grouped the following resources in pairs.

- Technical/Theoretical
- Accessible/Feasible
- Practicable

This implies that in the particular cases it was considered that there was no meaningful difference between

- Theoretical and Technical
- Accessible and Feasible

and that all were senior to Practicable. It is doubtful if this accords with the general principles envisaged and the approach is not considered further in this report.

4. Definitions suggested in Client Brief

It is expected that the methodology will utilise resource definitions developed from those used previously for renewables energy including for example:

- Total Resource – the total energy content of the renewable energy in a given time period;
- Technical Resource – the total resource limited by our technical ability to extract energy from it using the best available technology and advanced technologies;
- Practical Resource – the technical resource limited by basic practical production or consumption limits and incompatibilities for example physical features which reduce the land available such as conurbations, roads, lakes etc.
- Accessible Resource – the practical resource additionally limited by institutional restrictions, primarily environmental ones such as designated areas including, national parks, sites of special scientific interest, areas of outstanding natural beauty etc.
- Techno-Economically Achievable Contribution (by a given date) – the accessible resource, limited by the mechanics of implementation and economic factors e.g. build rate for plant cost effectiveness, life cycle cost analysis, energy prices.
- Estimated Market Contribution (by a given date) – the potential resource that can be expected or predicted in practice. It is the Techno-Economically Achievable Contribution limited by market conditions, fiscal policy, support programmes etc.

5. Resource Definitions utilised in Interim Report (2003)

5.1 Theoretical (or Technical) Resource

That gross energy resource theoretically available for a particular technology over a given time period limited only by the occurrence of that particular form of energy. A cost cut off can be applied to the theoretical renewable energy resource to exclude contributions that are well outside the attractive cost range.

5.2 Technical Resource

Total resource limited by the current technical ability to extract energy from it using the best available technology.

5.3 Practicable Resource

Technical Resource limited by basic practical production or consumption limits and incompatibilities e.g. physical features and infrastructure.

5.4 Accessible Resource

The practical resource further limited by institutional restrictions, primarily environmental such as designated areas including national parks, statutory reserves, Special Areas of Conservation, Danger Areas etc.

5.5 Techno-Economically Achievable Contribution (by stated date)

The accessible resource limited by the mechanics of implementation and economic constraints e.g. energy prices, cost effective build rates, life cycle cost analysis.

5.6 Estimated Market Contribution (by stated date)

Techno-economically achievable contribution limited by market conditions, fiscal policy, level of support programmes etc.

6. Directive 2001/77/EC

Promotion of electricity produced from renewable energy sources in the Internal Market.

Neither the above Directive nor its referenced White Paper COM (97) 599 Energy for the Future : Renewable Sources of Energy cite any particular set of resource definitions.

7. Open University Terminology

The following terminology is suggested for describing renewable energy resources (Ref. 11)

7.1 Total Resource

Total energy content of the renewable energy within a given space over a given time (e.g. all the annual energy content in the:

1. Hydro resource in the set of catchments and waterways of Ireland.
2. Wind passing over Ireland up to a particular height.
3. Sustainably Possible Forests and crops on the lands of Ireland.
4. Utilisably possible Agricultural and Human Wastes arising in Ireland.

5. Solar radiation falling on Ireland.

6. Waves passing over a given contour off the coast.

7a. Tidal streams within a given contour off the coast

7b. Tidal levels within the set of coastal bays or estuaries.

8. Geothermal thermal resource (above ambient temperature) to a given depth in the crustal block below Ireland

7.2 Technical Resource

Total resource above constrained by technical ability to extract energy therefrom, reflected by currently available conversion system efficiency (variable).

7.3 Practical Resource

Technical resource above constrained by practical infrastructural, and physical, incompatibilities, e.g. roads, towns, industrial sites, lakes, cliffs, swamps. Power lines, railways, canals, pipelines.

7.4 Accessible Resource:

Practical Resource above constrained by institutional/regulatory deletions that limit energy conversion development e.g. incompatible town and county development planning, zoning, buffer zones, environmental areas, restricted areas, etc. (variable).

7.5 Viable Resource

Accessible Resource above constrained by what is considered financially viable in terms of development cost, size, distance, reward level or other risk (variable).

7.6 Acceptable Resource

Viable resource constrained by residual public acceptance criteria (variable).

8. Heat Utilisation Terminology

In order to extend these definitions to include the heat market the following modifications of the Open University Criteria of Section 7 above are suggested, based on the concept that a resource may form an opportunity to draw heat from a particular energy source or to inject heat from a CO_2 neutral source to the replace heat that would be derived from fossil sources.

8.1 Total Resource

Total potential for supply or substitution by renewable energy demand of a system or process over a given time.

8.2 Technical Resource

Total potential as above but constrained by technical ability to inject energy into a system or process over a given time.

8.3 Practical Resource

Technical resource as above, constrained by practical physical or other incompatibilities.

8.4 Accessible Resource

Practical resource as above but constrained by institutional/regulatory deletions that limit energy inputs e.g. environmental, health and safety, energy policy, planning zonation, by-product management etc.

8.5 Viable Resource

Accessible resource as above, constrained by what is considered viable in terms of development cost scale, reward level of other risk.

8.6 Acceptable Resource

Viable resource as above, constrained by residual public acceptance criteria.

9. Unified Terminology

9.1 Need for a Unified Terminology

To minimise potential confusion it is desirable to develop a unified terminology that is equally applicable to electricity and heat markets (including heat from various sources).

10. Proposed Unified Terminology

10.1 Unconstrained Resource

10.1.1 Theoretical Resource

The gross energy content of the particular form of renewable energy that occurs within a given space over a given time thereby having the potential to displace fossil energy. (Relatively invariant over time).

10.2 Constrained Resources

10.2.1 Technical Resource (Subset of Technical Resource)

Theoretical resource as above, constrained by the efficiency of the currently available technology to respectively extract renewable energy from the resource or inject it to an electricity or heat using system over a given time thereby displacing fossil energy. (Slowly variable over time).

10.2.2 Practicable Resource (Subset of Technical Resource)

Technical resource as above, constrained by practical physical or other incompatibilities e.g. where resource capture or injection systems simply cannot meaningfully be located due to physical interference or other practical reason e.g. crops do not grow on roads (slowly variable over time).

10.2.3 Accessible Resource (Subset of Practicable Resource)

Practicable Resource as above but constrained by manmade, institutional/regulatory deletions that limit energy extraction e.g. environmental, health and safety, energy policy, planning zonation, byproduct management criteria etc. In general not all of the accessible resource may be commercially viable. (variable over time).

10.2.4 Viable Resource (Subset of Accessible Resource)

- **Viable Managed Market Resource**

  Accessible resource as above, constrained by what is considered to be commercially viable at a particular time in the managed or supported market in terms of development cost, scale, resource distribution, market reward level, timing or other risk (variable over time).

- **Viable Open Market Resource**

  Accessible resource as above constrained by what is considered to be commercially viable at a particular time without market support in terms of development cost, resource distribution, market reward level, timing or other risk (variable over time).

10.3 Discussion

- The above combined terminology was offered to SEI for consideration prior to incorporation as input to this final report.
- The term “Theoretical” is used in preference to “Total” or “Gross” to suggest that this unconstrained resource is only academically available. A distinction has to be made between a naturally occurring resource and one that is a by-product of some other process.
- The term “Feasible” resource previously used in 1997 is deleted.
- For strategic planning purposes the “Practicable” resource and those below it are of most interest. This permits issues of accessibility and commercial viability to be considered.
- The “Accessible” resource is intended to capture the effects of all the legalistic constraints that would impact on the practicable resource. The accessible resource breaks down into three levels the first of which is accessible but not commercially viable within the timeframe of interest.
- At the next level it is recognised that two levels of commercial viability can occur. In the managed or supported energy market it is recognised that certain projects can be made viable as an instrument of public policy having regard to wider economic benefits for the community as a whole. Thus supported market viability can exist. The price range will lie between that for best new entrant and an upper limit set at a public policy limit that will achieve the immediate public objective.
- The second level of viability, which is a subset of the above, is the free or open unsupported market viability where the project is inherently viable without support. (See Fig. A7.1). In the electricity market it can be considered as the resource whose generation technologies allow the unit price of power production to fall below that of the Best New Entrant as published by the Commission for Energy Regulation. In the heat market the viable open market resource is the fraction of the resource that can be brought on stream by a particular technology at a unit cost below rival fuels (e.g. gas) that might be used for heating.

(The managed market is by definition a distorted one. It arises primarily because of the commercial inability of a particular renewable source to contribute a politically desirable proportion of its accessible resource under the open market conditions prevailing at the particular time. It therefore needs intervention or “market

management" to create the conditions under which it can contribute. This may arise for a number of reasons e.g. the resource may be inherently diffuse, difficult or expensive to develop, the currently available conversion processes may be relatively inefficient etc. Thus the boundary between the open market (which is rarely completely open) and the managed market is not necessarily a rigid one over time. It is quite possible for a resource that was once viable on the open market to encounter difficulties in supply, rising costs (e.g. environmental costs) or other circumstances that would force movement into the managed market if it is to remain viable. This might be necessary if there was a considerable capital investment or employment tied up in existing generating plant or infrastructure associated with the particular resource or if it was considered to be strategically necessary for a particular period of time).

- The public policy limit price has to be set having regard to the resource cost curves for the particular technology and the sustainability of paying above the Best New Entrant Price to achieve a public objective of supporting a particular resource on a particular scale for a particular period. It has the objective of bringing that resource into the portfolio at an ultimately lower unit price when a developmental phase has been completed. It may also have the objective of tapping a resource because it is available even if the price has to be higher than BNE indefinitely.
- This arrangement broadly parallels the O.U. table but omits 'Acceptable' resource.

11. Conclusion

The resource definitions proposed in Section 10 above can be used for both electricity and heat markets in the context of this and associated reports where resource ranking frameworks for renewable energy resources are required.

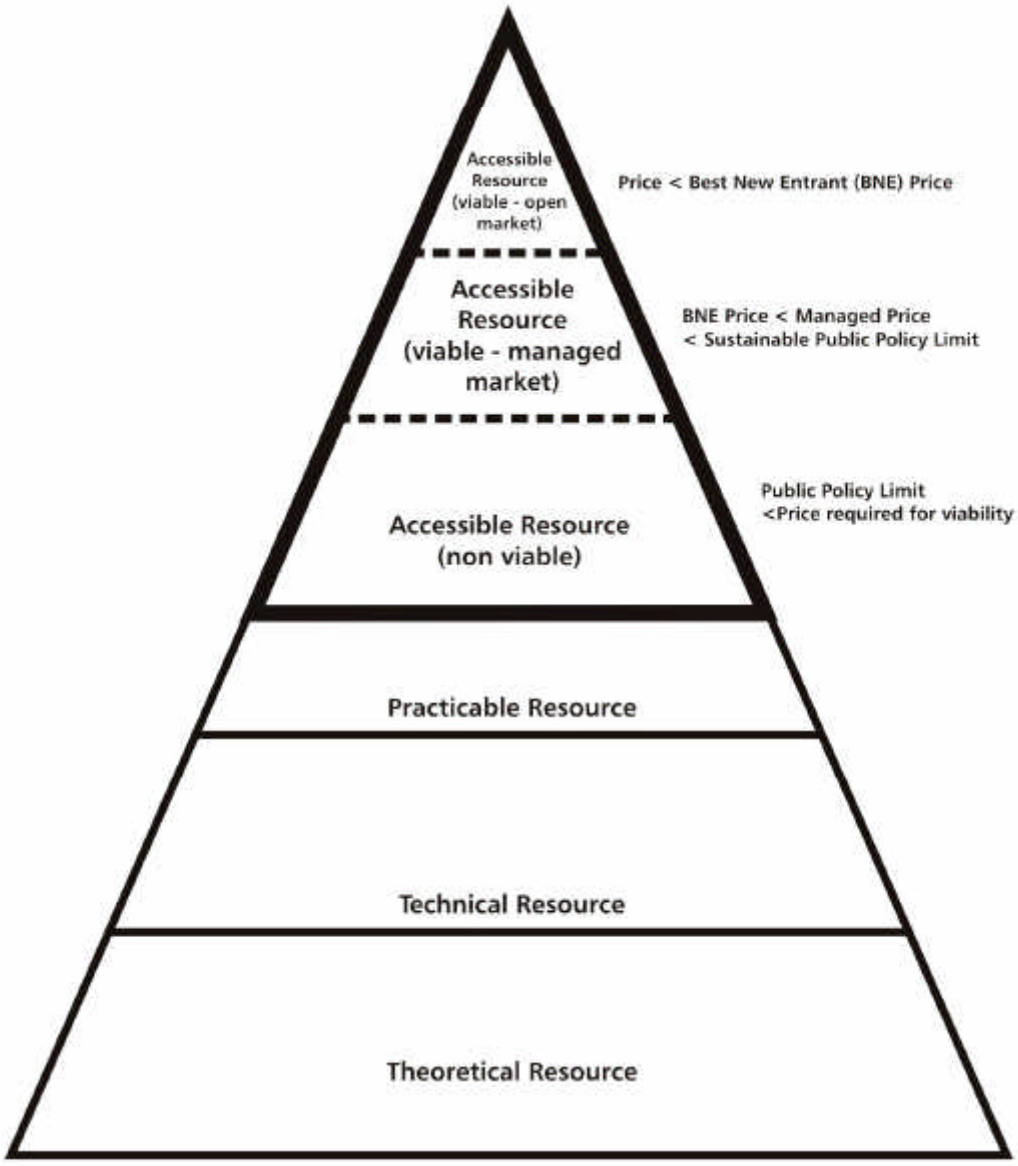

FIG A7.1 Generic Renewable Energy Resource Ranking Diagram (not to scale)