Renewable energy resources and reserves

Renewable renewable energy resources can be assessed in the same way as non-renewable mineral energy resources when though of in terms of:

- physical knowledge/certainty
- economic certainty

For example, non-renewable mineral energy stocks reside in the crust of the earth and are estimated to varying degrees of physical certainty by geologists and economic certainty by engineers. By contrast stocks of geothermal energy are estimated amounts of geothermal energy that can be used from the crust, estimated to varying degrees of physical certainty by geologists and economic certainty by engineers. Similarly, renewable stocks of energy from wind and water are the anticipated amounts of energy the earth's climate will provide over time as estimated to varying degrees of certainty by climatologists and hydrologists while engineers assess how much of this energy can be used commercially.

Renewable energy resources can be assessed using a modified McKelvey box in the same way non-renewable energy resources are assessed in relation to physical knowledge and economic certainty (Table 1).

Level of physical knowledge ←

Economic certainty ↑

	Explored			***Unexplored***
	High	**Medium**	**Low**	**Very Low**
Economic Reserves	*Proven*	*Probable*	*Possible*	*NA*
Potential Resources	*Measured*	*Indicated*	*Inferred*	*Hypothetical and Speculative*

Table 1: Generic modified McKelvey box for assessing renewable and non-renewable energy.

For renewable energy resources to be presented using a modified McKelvey box there is a need to understand the basic structure of the McKelvey box in relation to the realities of utilising renewable energy resources. The McKelvey box represents physical knowledge as being measured, indicated and inferred. When a resource becomes economic it is referred to as being proven, probable and possible. Using hydro electricity as an example, where there is technical information regarding the potential to develop a hydro catchment the estimated energy resource could be said to be measured, indicated and inferred depending on the level of research and reliability of information available on the catchment. Where there is a catchment with an existing hydro power generation plant in operation then the estimated energy available for utilisation can be assessed as being proven, probable and possible. Proven reserves could be considered the water measured in the catchment (in simplistic terms: the water behind the dam). Probable reserves could be estimated as the amount of energy expected to be utilised over a set period of time (see selecting a period of time below).

Figure 1: Hydro reserves and resources illustrated.

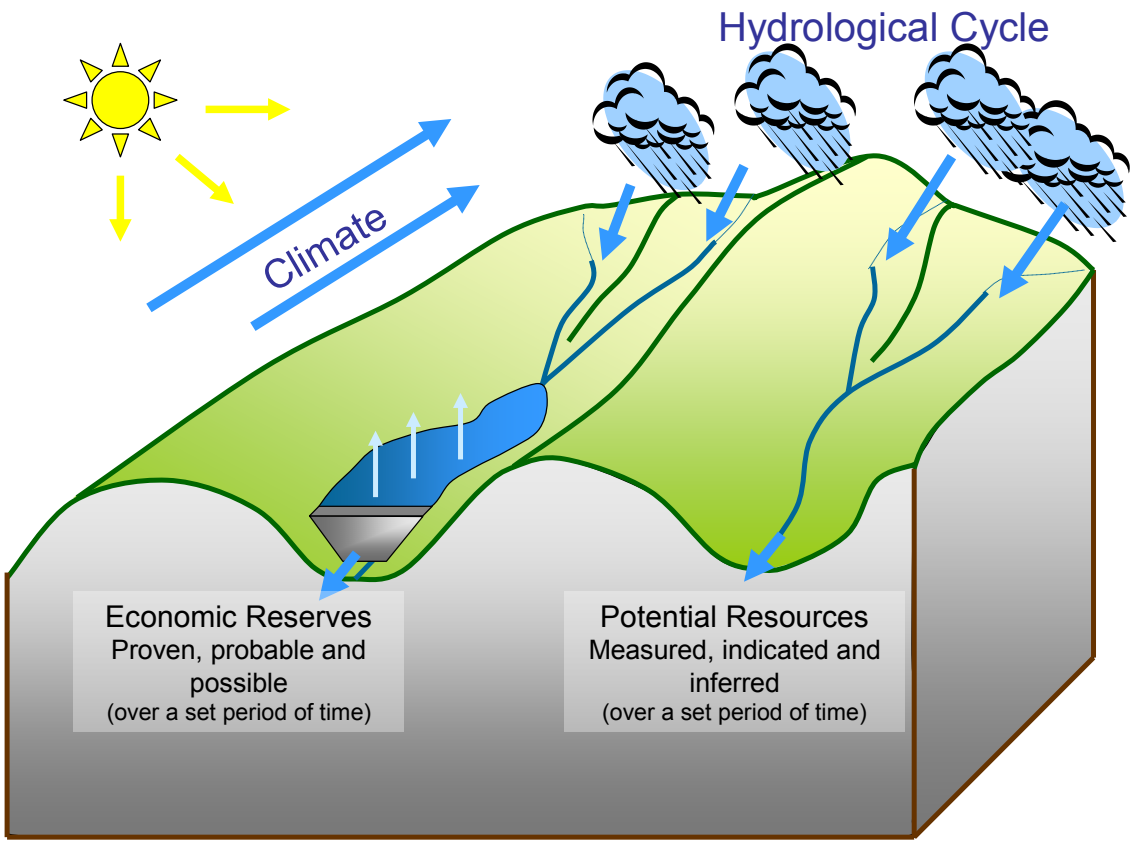


Table 2: Hydro electricity resources as they would appear in a modified McKelvey box.

	Explored			***Unexplored***
	High	**Medium**	**Low**	**Very Low**
Economic Reserves Only includes potential energy from catchments with existing operational hydro electric generation stations and stations under construction.	***Proven*** Potential energy currently available in the catchment (at this present point in time)	***Probable***	***Possible*** Hydro energy expected to be available over the period being assessed.	NA
Potential Resources Includes potential energy from catchments which are not developed for the purposes of hydro electricity generation, but could be developed for such purposes.	***Measured***	***Indicated***	***Inferred*** Hydro energy that would be available over the period being assessed if there were hydro electricity generation.	*Hypothetical and Speculative*

Similarly wind resources could be assessed with a modified McKelvey box and compared with hydro, coal and petroleum energy stocks. Conceptually it is difficult to envisage a 'proven' stock of wind, but it is probable that climate will provide a certain level of wind energy over the lifespan of an individual wind turbine or of a wind farm or some other period of time.

Selecting a period of time

Renewable resources can potentially be utilised indefinitely and for that reason stocks could be assessed as very large, almost infinite by comparison to current exploitation. Such figures are of little analytical value and do not allow comparability with non-renewable energy stocks. Renewable energy stocks are limited over any given timeframe, and for that reason renewable energy resources should be assessed with a specific timeframe in mind.

When selecting a timeframe it is important to ensure the timeframe allows comparability between renewable energy resources and with non-renewable mineral energy resources. Ideally, the timeframe used should also be consistent across different studies allowing comparability between studies.

Timeframes for analysing renewable energy stocks might include:

- lifespans of alternative non-renewable energy resources
- management/planning timeframe
- design life of equipment utilising renewable energy

The selection of a timeframe for assessing renewable energy reserves and resources should relate to the purpose for which renewable energy stocks are being analysed. For the purposes comparing national statistics we recommend a standard timeframe be used, either 30 or 50 years. The reason for this is that the value of additional energy generation from renewable energy beyond 50 years is negligible when discounted, even when using a social discount rate of 4%. Therefore the physical stock assessment can be compared to the monetary valuation of the renewable energy resource.

Renewable Energy McKelvey Box Example

New Zealand's renewable energy resources have been assessed in a number of reports. These reports include:

Hydro Resources of New Zealand (1990)

Geothermal Resources of New Zealand (1993)

Review of New Zealand's Wind Energy Potential to 2015 (2001)

Availabilities and Costs of Renewable Sources of Energy for Generating Electricity and Heat (2002)

In these reports renewable resources are assessed in relation to the certainty of the energy being useable, similar to the way non-renewable energy resources are assessed. For example Hydro Resources of New Zealand assesses potential hydro electric resources using physical knowledge and information regarding economic assurity, which is comparable to the way non-renewable mineral resources are assessed. The Hydro Resources of New Zealand report assesses each hydro catchment in terms of the "level of investigation" and the "potential for development". The level of investigation is rated into five levels, with level 1 being a "map search / desk study", and level 5 being a "preliminary design investigation". The potential for development is assessed in terms of four levels with level 4 being "development appears unlikely" through to level 1 which is "attractive with few apparent problems".

We have adapted the hydro resources of New Zealand (1990) report results into a modified McKelvey box. Hydro reserves are based on the quantity of hydro electricity that is anticipated to be produced over the next 30 years, based on information from the Ministry of

Economic Development's Energy Data File. Resource estimates are based on the Ministry of Commerce's Hydro Resources of New Zealand (1990) report.

Table 3: Modified McKelvey box for New Zealand's Hydro Resources (PJ) over a 30 year period from 2000.

	Identified			Unidentified	
Reserves	Proven 87	Probable 2536	Possible 0	Speculative 2621	Hypothetical 3617
Resources	Measured 0	Indicated 141	Inferred 201		

Table 4: How figures from the Hydro Resources of New Zealand (1990) were adapted into renewable resource estimates.

Potential	Investigation 5	4	3	2	1
1	Measured		Indicated	Inferred	Speculative
2	Inferred	Speculative			
3	Speculative	X	X	X	X
4	X	X	X	X	X

Potential:

- Level 1. Attractive, with few apparent problems
- Level 2. Attractive, but some significant problems
- Level 3. Possible, but with many problems
- Level 4. Development appears unlikely

Investigation

- Level 1. Map search/desk study
- Level 2. Resource identification
- Level 3. Pre-feasibilty study
- Level 4. Feasibility study
- Level 5. Preliminary design investigation

There is potential to develop McKelvey boxes for other renewable energy resources although there are some issues. Other renewable energy reports have similarities to the hydro report, but the treatment of physical knowledge and economic certainty is less clear. The most simple and commonly used assessment of renewable energy resources includes a maximum and minimum level of available energy, which in a simplistic way conveys the level of certainty of the resource being realised if attempts are made to utilise it.

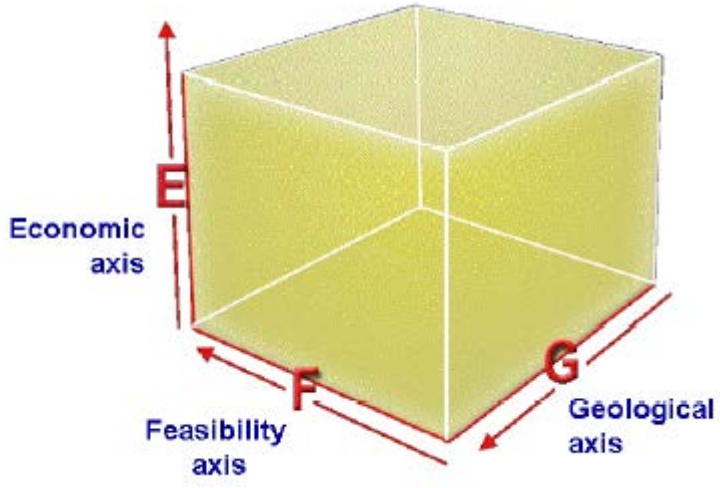
For more information on the above estimates and methodology please contact Jeremy Webb and Kent Hammond:

webbj@un.org

kent.hammond@med.govt.nz

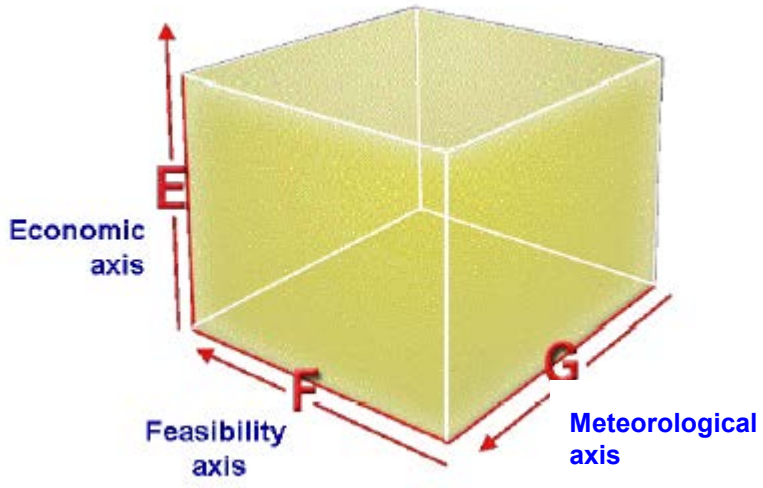
Note (30 August 2006): United Nations has been working on a United Nations Framework Classification for Fossil Energy and Mineral Resources. This has strong similarities with the Modified McKelvey box approach to classifying non-renewable energy resources, although with an additional dimension due to the separation of technical feasibility from economic factors. The adaptation of the United Nations Framework Classification for Fossil Energy and Mineral Resources to renewable wind energy sources has been represented in Figure 2 and Figure 3 below.

Figure 2: United Nations Framework Classification for Fossil Energy and Mineral Resources.



Source: United Nations Framework Classification for Fossil Energy and Mineral Resources

Figure 3: United Nations Framework Classification for Fossil Energy and Mineral Resources adapted for weather related energy sources such as wind energy or solar energy.



Source: Adapted from the United Nations Framework Classification for Fossil Energy and Mineral Resources

For more information on the United Nations Framework Classification for Fossil Energy and Mineral Resources please see:

http://www.unece.org/ie/se/reserves.html