A word about global warming

Pat Naughtin

Like a lot of people, I am currently concerned with the issues of global warming and peak energy. Recently, as I researched some dietary issues, I had to confront the linguistic problems that the leaders of the diet and nutrition industries have chosen to face every day. Their key measuring words, calories, Calories, kilocalories, kiloCalories, and (my favourite) the International Steam Table Calories don't necessarily have fixed and definite definitions and numerical values. The various different calories arose partly because of the temperature dependence of their definitions —a 15 °C calorie is not the same as a 20 °C calorie — and partly because of spelling differences — a Calorie is 1000 times larger than a calorie because of the upper and lower case c — it follows that a Cal is a thousand times larger than a cal, and a kCal is a million times larger than a cal.

Following from these widespread linguistic and numerical confusions, calculation errors are common in the diet and nutrition industries and especially in the communication of diet issues to the public. However, many food industry leaders seem to be unaware that they are facing language and definition issues – rather than measurement problems.

I soon realised that these linguistic problems in the nutrition industries are relatively minor when compared to the linguistic problems on a worldwide climate scale when we consider the issues of global warming, climate change, peak energy and peak oil.

As I searched for the ways people describe energy use, I quickly found lots of different words that are supposed to describe different amounts of energy. See the table on the next page for the 198 energy names that I have collected — so far:

I know that some of these are equivalent to each other; for example, I guess that a kilogram calorie-20 is about the same as a major calorie-20, but since these two names are not supported by any ongoing international agency I can never be sure of this. Nor can I be sure that they have exactly the same definitions as I have no idea who made up these two different measures or how they defined them. I am also aware that some abbreviations might be the same as spelled out unit names but I couldn't guess this from the context.

Sometimes an individual company, or even an individual person, can devise a definition based on their own circumstances at the time. For example, in 1919, the first promoter of the word calorie in the world of human nutrition, Dr Lulu Hunt-Peters, defined her own 'calorie' as *the amount of heat needed to raise the temperature of 4 pounds of water by 1 degree Fahrenheit*.

I am also aware that some of these words in the table on the next page are exactly equivalent to each other. For example, I think that a Rydberg is equivalent to a Kayser, but I doubt that this equivalence would be intuitive to many people, including most of our politicians.

But what is even more concerning is that when converting from one to another, all these different energy words require thousands of conversion factors if energy issues are to be understood at even a basic level. The 198 measures in the table require 39 006 conversion factors to convert from any one measure to any other.

Put simply, we are not able to sensibly discuss any issues related to our use of energy and its effects on global warming. Why? Too many people use too many different words to

describe the amounts of energy relevant to their particular industry or to their particular nation.

Table of energy units and old energy measures

Complete list of SI metric energy units	**Some words currently used as energy measures Old pre-metric, early metric, and cross-bred energy measures**
joule J The single SI metric unit can also be used with the SI metric prefixes to form multiples of the SI unit: **kilojoule kJ** **megajoule MJ** **gigajoule GJ** **terajoule TJ** **petajoule PJ** **exajoule EJ** **zettajoule ZJ** and **yottajoule YJ** Conversion factors needed for 1 unit = 0 Factor to go from one prefix to the next prefix is always 1000	Atomic energy unit, barrel oil equivalent, bboe, billion electron volts, Board of Trade unit, BOE, BOT, brake horsepower-hour, British thermal unit, British thermal unit (16 °C), British thermal unit (4 °C), British thermal unit (international), British thermal unit (ISO), British thermal unit (IT), British thermal unit (mean), British thermal unit (thermal), British thermal unit (thermochemical), British thermal unit-39, British thermal unit-59, British thermal unit-60, British thermal unit-IT, British thermal unit-mean, British thermal unit-th, BThU, BThU-39, BThU-59, BThU-60, BThU-IT, BThU-mean, BThU-th, Btu, Btu-39, Btu-59, Btu-60, Btu-IT, Btu-mean, Btu-th, cal, cal-15, cal-20, cal-mean, calorie, Calorie, calorie (16 °C), calorie (20 °C), calorie (4 °C), calorie (diet kilocalorie), calorie (int.), calorie (IT) (International Steam Table), calorie (mean), calorie (thermochemical), calorie-15, Calorie-15, calorie-20, Calorie-20, calorie-IT, Calorie-IT, calorie-mean, Calorie-mean, calorie-th, Calorie-th, cal-th, Celsius heat unit, Celsius heat unit (int.), Celsius heat unit-IT, Celsius heat unit-mean, Celsius heat unit-th, centigrade heat unit, centigrade heat unit-mean, centigrade heat unit-th, Chu, Chu-IT, Chu-mean, Chu-th, coulomb volt, cubic centimetre atmospheres, cubic foot atmospheres, cubic metre atmospheres, double Rydberg, duty, dutys, dyne centimetres, E-h, electron mass energy equivalent, electron volt, equivalent volt, erg, eV, foot grains, foot pound, foot pound force, foot poundal, ft-lb, ft-lbf, ft-pdl, gigaelectronvolt, gram calorie, gram calorie-15, gram calorie-20, gram calorie-IT, gram calorie-mean, gram calories (mean), gram calorie-th, grand calorie, grand calorie-15, grand calorie-20, grand calorie-IT, grand calorie-mean, grand calorie-th, hartree, Hartree energy, horsepower hours, horsepower hours (metric), inch pound force, Kayser, kcal, kcal-15, kcal-20, kcal-mean, kcal-th, kgfm, kilocalorie, kilocalorie (16 °C), kilocalorie (4 °C), kilocalorie (int.), kilocalorie-15, kilocalorie-20, kilocalorie-IT, kilocalorie-mean, kilocalorie-th, kiloelectronvolt, kilogram calorie, kilogram calorie-15, kilogram calorie-20, kilogram calorie-IT, kilogram calorie-mean, kilogram calories (int.), kilogram calorie-th, kilogram force metre, kiloton TNT equivalent, kilowatt hour, kilowatt minute, kilowatt second, kWh, large calorie, large calorie-15, large calorie-20, large calorie-IT, large calorie (mean), large calorie-th, Latm, latm, litre atmosphere, major calorie, major calorie-15, major calorie-20, major calorie-IT, major calorie-mean, major calorie-th, megaelectronvolt, megaton TNT equivalent, megawatt hours, metric ton oil, metric ton TNT, metric ton coal, micri-erg, natural unit of energy, newton metre, petit calorie, petit calorie-15, petit calorie-20, petit calorie-IT, petit calorie-mean, petit calorie-th, Q unit, quad, quadrillion, Rydberg, small calorie, small calorie-15, small calorie-20, small calorie-IT, small calorie-mean, small calorie-th, therm, therm (EC), therm (EU), therm (UK), therm (US), thermie (16 °C), ton coal equivalent, ton oil equivalent, ton TNT equivalent, tonne coal equivalent, tonne oil equivalent, tonne TNT equivalent, watt hour, watt minute, and watt second. Conversion factors needed for 199 names = 39 402

We cannot have meaningful discussions on issues such as peak oil and global warming if the language we choose is completely muddled by our choice of words.

In the International System of Units (SI), the modern metric system, there is only one unit for energy:

joule

Therefore conversion factors are not necessary — there aren't any.

The **joule** was first established as the international unit for heat and for other forms of energy in 1889. It is the only unit recognised internationally for all forms of energy since then. It is now the only unit for energy in the International System of Units (SI).

Since a joule is a relatively small amount of energy (enough to lift a medium sized apple from the floor on to a metre high bench), it is usual to describe larger amounts using the SI prefixes. Here is the complete list of those in use:

joules, kilojoules, megajoules, gigajoules, terajoules,

petajoules, exajoules, zettajoules, and yottajoules.

Given the nature of this linguistic problem how can we, as a nation, or as a world community, sensibly discuss energy issues when we don't know what other people in other industries and in other nations are talking about?

As an example, let me quote from the Australian Bureau of Statistics (ABS) web page. In '*Detailed Energy Statistics, Australia*' I found that the choices of measuring units made by the ABS make it very difficult for me to compare energy from oil with energy from black or brown coal, with hydroelectric energy, or with energy from petroleum. I quote from the ABS web page:

> *... Non-renewable fuels used to generate electricity include black coal (53,576 kt), brown coal (65,075 kt), and natural gas (291,372 TJ). Hydro-electricity was the main renewable source of electricity, and in 2001-02, 15,567 GWh of hydro-electricity were produced ...*

How can a citizen who is concerned about global warming begin to comprehend the various jargons incorporated in the ABS statistics? More importantly, how can national and world leaders sensibly discuss energy issues when the language of energy measurement is made so unnecessarily complex?

Fortunately, there is an immediate solution to this communication problem and that is contained within the single metric unit, **joule**. As an example of its use, consider the Australian energy use figures, quoted above, lightly edited, sensibly rounded, and expressed in petajoules (PJ):

> *... Non-renewable fuels used to generate electricity include 1600* petajoules (PJ) *from black coal, 1000* PJ *from brown coal, and 290* PJ *from natural gas. Hydro-electricity was the main renewable source of electricity, and in 2001-02, 56* PJ *of hydro-electricity were produced ...*

Expressing energy in joules, whenever energy information is provided, means that conversions are no longer necessary, and all forms of energy are immediately comparable. You don't have to memorise, look up, or calculate with conversion factors because there aren't any.

This measurement muddle is even worse in the USA where they have yet to widely adopt the International System of Units — the modern metric system. In the USA, there are some people still using things like:

toe's (for tons of oil equivalent measured in one or other of the British thermal units)

MMBtu/Mcf (for million million British Thermal Units per million cubic feet)

and using conversion factors like

1 short ton per cubic yard = 0.0330687831 long tons per cubic foot.

I wish the USA well with their metrication transition, but if anyone tells you that the USA will take a leadership role in the peak oil or global warming debates anytime soon — tell 'em they're dreamin'!

We need to understand the issues behind peak oil and global warming and so do our legislators and elected politicians. How can we do this when industries and nations choose to describe energy using incomprehensible numbers and so many undefined measures based on old pre-metric words?

On a similar theme, you might also like to refer to my submission to the:

Australian Government Senate Inquiry

into Australia's future oil supply and alternative transport fuels.

You can directly down load my submission as a pdf from:
http://www.aph.gov.au/SEnate/committee/rrat_ctte/oil_supply/submissions/sub05.pdf

Or see where my submission fits in relation to others, at:
http://www.aph.gov.au/SEnate/committee/rrat_ctte/oil_supply/submissions/sublist.htm

Pat Naughtin helps people understand how to go about their metrication upgrade– quickly and easily – by helping them avoid mistakes that he has made himself, or that he has seen made by others during his more than 35 years of involvement with metrication matters.

Pat specialises in the modern metric system based on the International System of Units (SI), but he is mostly concerned with the processes that people use for themselves, their groups, their businesses, their industries, and their nations as they go about their inevitable metrication process.

Pat Naughtin is a highly knowledgeable metric enthusiast, who is also a writer, professional speaker, editor, and publisher.