Energy literacy:

A provisional guide to developing a local conservation curriculum

Even those that are resistant to the blandishments of the advertisements in the mass media have no chance of maintaining equipment in good condition if it is unrepairable and designed for rapid renewal. It is explained to us that such a policy increases the Gross National Product, but ecologists consider it to be a scandalous squandering of the wealth inherent in human work, in matter and in energy. (Labeyrie (1971))

1 Objective

To provide guidance to develop a conservation management CURRICULUM which integrates local sustainable social, economic, and environmental improvements *(ISSEE)*. This will centre on the themes of *making connections between people and ecosystems* and *being with others in time and place.* The curriculum will be based on local community/neighbourhood models of sustainable development presented in an historical and ecological context.

2 Perspective of cultural ecology

2.1 What is Energy Literacy?

Energy literacy is an understanding of the nature and role of energy in the universe, and in our lives. Energy literacy is also the ability to apply these understandings to answer questions and solve problems for living sustainably.

An energy-literate person:

- can trace energy flows and think in terms of energy systems
- knows how much energy he or she uses, for what, and where the energy comes from
- can assess the credibility of information about energy
- can communicate about energy and energy-use in meaningful ways
- is able to make informed energy and energy-use decisions based on an understanding of impacts and consequences
- continues to learn about energy throughout his or her life

Energy Literacy is a part of social and natural science literacy Therefore, a comprehensive study of energy must be interdisciplinary and involve learning about systems thinking. Energy issues cannot be understood and problems cannot be solved by using only a natural science or engineering approach. Energy issues often require an understanding of citizenship, history, economics, sociology, psychology and politics in addition to science, maths and technology.

Just as both social and natural science are a part of energy literacy, energy literacy is an essential part of being literate in the social and natural sciences.

2.2 Why Does Energy Literacy Matter?

Energy literacy is essential to understand the interactions between industrial systems, ecological systems, and societal needs. Material and energy flows driven by human production and consumption are traced throughout the economy and their ecological consequences characterized. A more sustainable relationship between industrial and ecological systems is guided by conservation of non-renewable resources, pollution prevention, and inter-generational and inter-societal equity.

- A better understanding of energy can:
- lead to informed decisions
- improve the security of a nation
- promote economic development
- lead to sustainable energy-use

- reduce environmental risks and negative impacts
- help individuals and organizations save money
- if understood and applied, energy literacy will help individuals and communities make informed energy decisions.

Without a basic understanding of energy, energy sources, generation, use and conservation strategies, individuals and communities cannot make informed decisions on topics ranging from smart energy use at home and consumer choices to national and international energy policy. Current national and global issues such as the fossil fuel supply and climate change highlight the need for energy education.

2.3 How is Energy Literacy Taught?

Energy is an inherently interdisciplinary topic. Concepts fundamental to understanding energy arise in nearly all, if not all academic disciplines. This guide is intended to be used across disciplines. Both an integrated and systems-based approach to understanding energy are strongly encouraged.

Used in formal educational environments, this guide provides direction without adding new concepts to the educator's curriculum. This guide is not a curriculum. The Essential Principles and Fundamental Concepts offer a framework upon which curricula can be based without prescribing when, where or how content is to be delivered.

This document as a guide which includes, but is not limited to, formal and informal energy education, standards development, curriculum design, development and educator training.

Development of this guide began at a workshop sponsored by the US Department of Energy (DOE) and the American Association for the Advancement of Science (AAAS) in 2010. Multiple federal agencies, non-governmental organizations, and numerous individuals contributed to the development through an extensive review and comment process. Discussion and information gathered at AAAS, WestEd and DOE-sponsored Energy Literacy workshops in the spring of 2011 contributed substantially to the refinement of the guide. It was adopted and developed as a guide to the creation of conservation management curricula by a group of teachers associated with the European Conservation Management System Consortium.

3 Making a Community Educational Model

3.1 Energy and material cycles

When biomass is produced through photosynthesis, the amount can be measured in terms of the energy of primary production. Areas very important to the production of biomass on Earth are tropical rain forests with 2,000 $g/m^2/yr$; algal beds and reefs with 2000 $g/m^2/yr$; swamps and marshes with 2,500 $g/m^2/yr$; river estuaries with 1,800 $g/m^2/yr$; temperate forests with 1,200 $g/m^2/yr$ and cultivated lands with 600 $g/m^2/yr$. The least amount of biomass production occurs in the desert and frozen areas of the Earth.

Food webs describe the flow of energy through the system, basically who eats whom and how often. Different levels exist, such as producers (usually plants), primary consumers (herbivores *i.e.* who eat plants), secondary consumers (who eat herbivores), and so on. The food web used to be called the food chain, but the amount of cross-links makes the whole thing more properly resemble a web than a simple linear chain. The structure of a food web also affects the stability of the system. Conservation management of habitats and species essentially involves the diversion of energy flows to particular organisms or groups of organisms. This immediately connects the concepts of 'energy' and 'food. In the face of human population growth and famine it also highlights the need to produce integrated local and global conservation plans to maximise food production with the lowest non-food energy inputs.

Most of the links in the food web are weak, meaning that the consumer doesn't depend excessively on what it consumes. As long as the links are weak, no species will be greatly affected by a predator or prey whose population changes. Strong links means that species are greatly affected by changes in the populations of species they're linked to; if there are many strong links in the system, drastic changes in one species spread through the system along the strong links, destabilizing it.

Human needs such as shelter and transportation are satisfied by the flow of materials through our communities. While materials may provide multiple benefits, there are social, environmental, and economic costs associated with the extraction, processing, manufacturing, use, and disposal of these materials that may be reduced by improving the efficiency of material use in our communities. In this study, the efficiency of material flows is based on the community's ability to maximize the services provided per unit of mass of materials. The efficiency of material flows can be improved by reducing the mass of materials used to meet the needs of communities as long as the reduced flows still provide the same services and the change does not introduce greater social, economic and environmental costs elsewhere.

Sources of energy and supplies of minerals occupy a special place among the various natural resources exploited by humans. They are both essentially nonrenewable' even where they have a biological origin, as in the case of fossil fuels or of certain metal-bearing deposits. They thus form a stock which is undergoing more or less rapid exhaustion according to the size of the various geological deposits and the speed with which contemporary technological civilization is exploiting them.

However, there is a fundamental difference between the sources of energy that are potentially contained in fossil or nuclear fuels and the supply of mineral elements. In accordance with the laws of thermodynamics the energy contained in oil and coal or in uranium-235 is unavoidably lost in any useful form after combustion or fission, Mineral elements, on the other hand, do not disappear after use, whether they are metals or any other inorganic substance: iron remains iron (even when oxidized it only changes its chemical state), glass remains glass, and so on. We have even invented synthetic organic materials like plastics that resist almost any form of biogeochemical degradation!

Unlike raw materials from mineral sources, therefore, energy resources are essentially a limiting factor in our industrial civilization. The energy can be neither recovered nor recycled after use. In contrast to that, the exhaustion of high-grade metal-bearing deposits would not be particularly worrying to us if there were an inexhaustible and virtually cost-free source of energy available. With such a source it would then be feasible to extract important metals from rocks in parts of the lithosphere where they are widespread but in very low concentrations. In practice, the consumption of energy involved in isolating the copper in granites, for example, is so great that it precludes any such undertaking in the climate of the current energy crisis.

Although our personal energy source for survival (plant derived biological molecules) has not changed much since… we started eating, there have been revolutionary changes in how we procure food. While human energy was initially what drove the procurement of food (hunting and gathering, early agriculture and husbandry), we are now increasingly dependent on fossil energy sources to do the grueling labor of growing, harvesting, and distributing our food. This shift to more energy intensive agriculture implies a series of tradeoffs which are best characterized as The Good, The Bad, and The Ugly. The Good is the many benefits we as a society have reaped from the modern food system including cheaper food in terms of time, economic, and resource inputs. The negative environmental effects of resource intensive food production are represented by The Bad. And The Ugly is the paradox resulting from the good and bad tradeoffs in the food system exemplified here in food waste, which is only one example of the ambiguous outcomes of the modern food system.

An analysis of the way ecosystems function soon shows that the flow of energy and the cycle of matter cannot be dissociated from each other. Before going very far into the study of resources, therefore, ecological models will be used to look in more detail at the manner in which energy and matter are transported through anthropoecosystems (a term covering the various human societies with ever-increasing cultural levels that have succeeded each other through the ages).

3.2 Making a Local Community Action Plan.

First define the community!

Community can be approached as descriptive category or set of variables (see below). In practice the two are entwined and often difficult to separate, but may be explored initially in three different ways:

As sharing place.

Territorial or place community can be seen as where people have something in common, and this shared element is understood geographically. Another way of naming this is as 'locality'. This approach to community has spawned a rich literature – first in 'community studies' and more recently in locality studies (often focusing on spatial divisions of labour). Examples of a shared place are local government political compartments and new commercial/residential developments.

As sharing interest.

In interest or 'elective' communities people share a common characteristic other than place. They are linked together by factors such as religious belief, sexual orientation, occupation or ethnic origin. In this way we may talk about the 'gay community', the 'Catholic community' or the 'Chinese community'. Development in what might be called the sociology of identity and selfhood have played an important role in 'opening out the conceptual space within which non-place forms of community can be understood' 'Elective groups' and 'intentional communities' (ranging from cyber-communities to car-boot enthusiasts) are a key feature of contemporary life

As sharing communion.

In its weakest form we can approach this as a sense of attachment to a place, group or idea (in other words, whether there is a 'spirit of community'). In its strongest form 'communion' entails a profound meeting or encounter – not just with other people, but also with God and creation. One example here would be the Christian communion of saints – the spiritual union between each Christian and Christ (and hence between every Christian).

At the heart of communities are special people - the builders. They are the living, active centre. They live the dialogical life. Builders both express and symbolize relation, and in some sense animate community. There are some parallels here with the role of informal educators who are part of local networks. However, in contrast with that role, builders take on a significant leadership role.

Then define the energy system!

The first examples of this type of analysis applied to the study of a particular human society or activity date back to the beginning of the 1960s. However, the credit for having systematized the method belongs to H. T. Odum who used basic flow-charts to describe the functioning of a natural ecosystem, Silver Springs in Florida.

Prehuman cultural ecology

The whole history of the relationship between humanity and the biosphere is marked by two quite fundamental changes: the appearance of agriculture during Neolithic times and the advent of modern industrial civilization in the nineteenth century. It is important, therefore, to analyse the flow of energy and the cycle of matter in two types of human ecosystem: one dominated by agriculture and the other by industrial processes. The ecological models to be used for those analyses will have as their basis the diagram shown in Figure 2.1, which illustrates the functioning of a natural ecosystem not exploited in any way by humans.

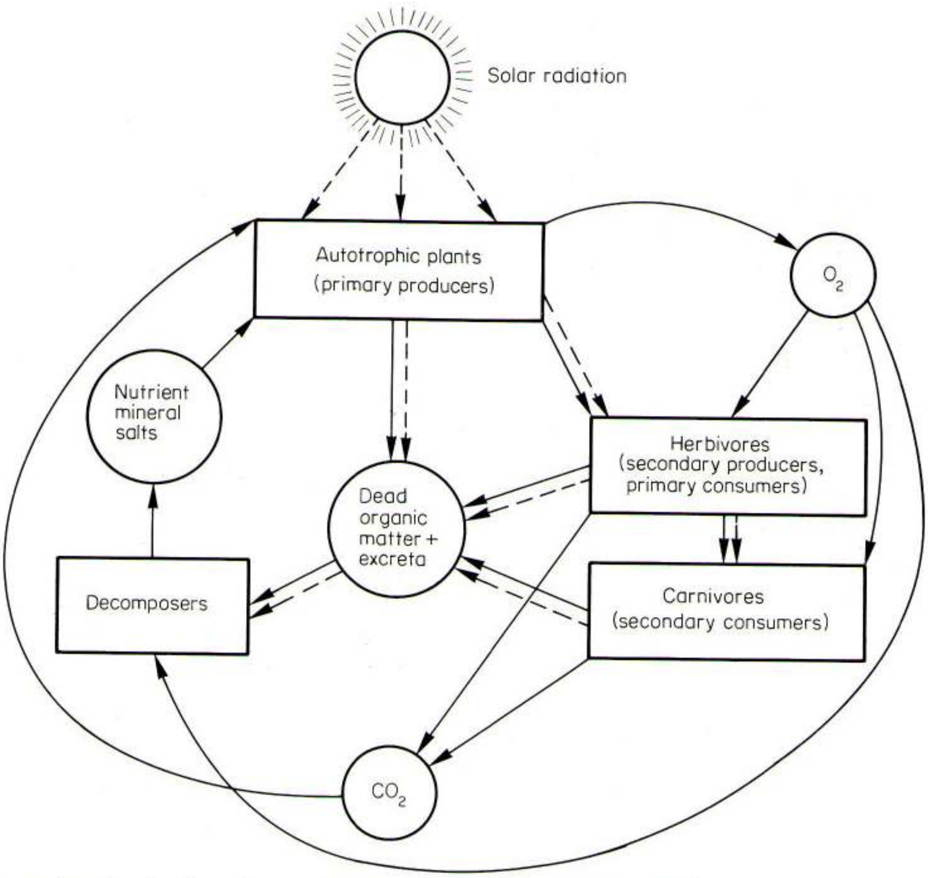


Diagram showing the flow of energy (broken lines) and the cycle of matter (continuous lines) in an ecosystem not exploited by humans

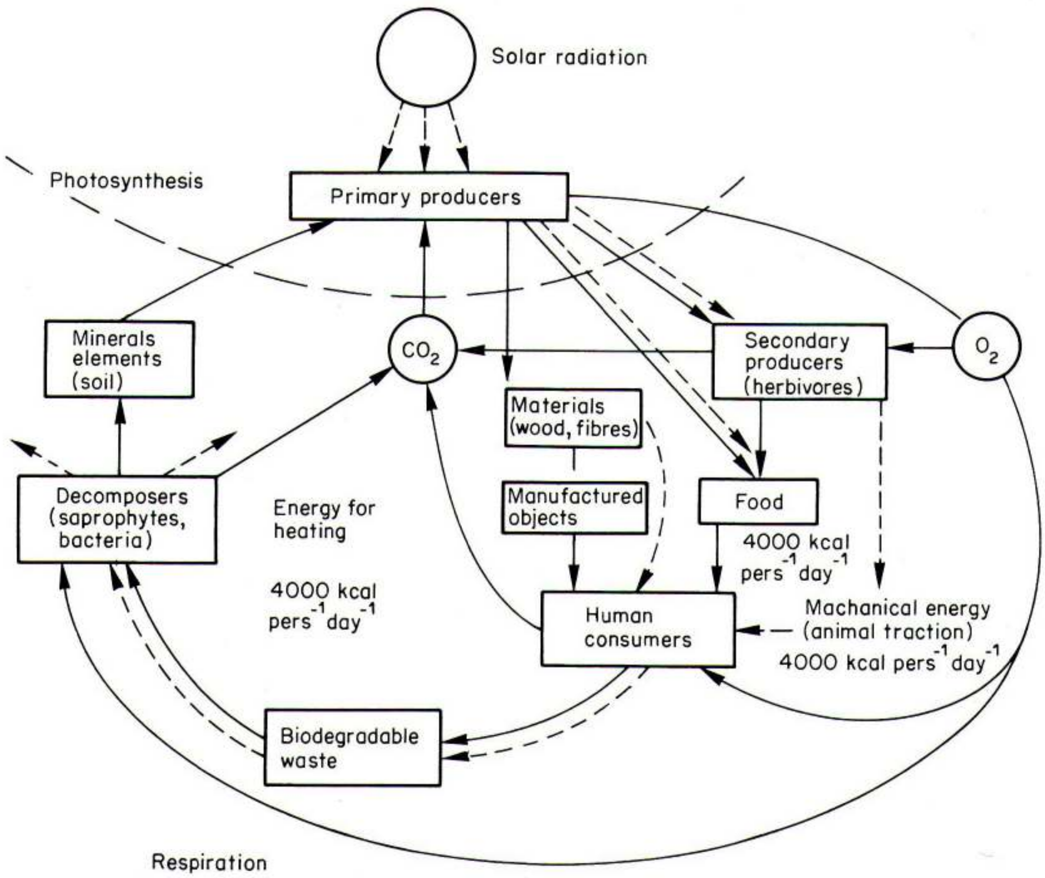


Diagram showing the flow of energy (broken lines) and cycle of matter (continuous lines) in a Neolithic civilization. (From Ramade, 1978a, p. 116)

In a primitive rural civilization of the Neolithic type, the only energy source available to humankind was solar radiation (Figure 2.2). The energy intake per capita in such societies depended entirely on photosynthetic conversion and was therefore determined by the amount of land under cultivation or used for rearing animals. The only fuel used for heating, cooking of food and primitive metallurgy was wood (using about 4000 kcal of energy per day per individual) and the only available source of mechanical work depended on animal traction (using approximately the same amount of energy). The amount of work performed by humans themselves would correspond to energy supplied by the individual's food intake (3000-4000 kcal per day per individual). The total of these three quantities shows that each individual in a Neolithic society would dispose of around 10 000-12 000 kcal of energy per day. The proportion of solar energy used by humans could not be increased beyond a certain limit fixed by the maximum area of land per capita that could be exploited with the modest techniques available. We can conclude that the overall energy equilibrium in the ecosphere was not upset by Neolithic civilization: some 4000 kcal per m2 per day of solar energy reached the Earth's surface and a similar amount was radiated into space in the form of heat. With the low population densities of those times, only a minute proportion of that energy was under the control of human society.

Neither was the cycle of matter affected by such a primitive civilization. The only waste produced by human activity was fermentable organic matter and the various materials used (that is, wood, plant fibres, even certain metals like iron) were subject to more or less short-term degradation by micro-organisms and other biogeochemical agents. As a result, there was no accumulation of waste products because all the matter used by humans was mineralized and dispersed in the environment in such a way as to ensure the recycling of elements, especially in cultivated soils. The Neolithic human ecosystem thus functioned in a way very similar to that of a natural ecosystem, in relation both to the flow of energy and to the cycle of matter.

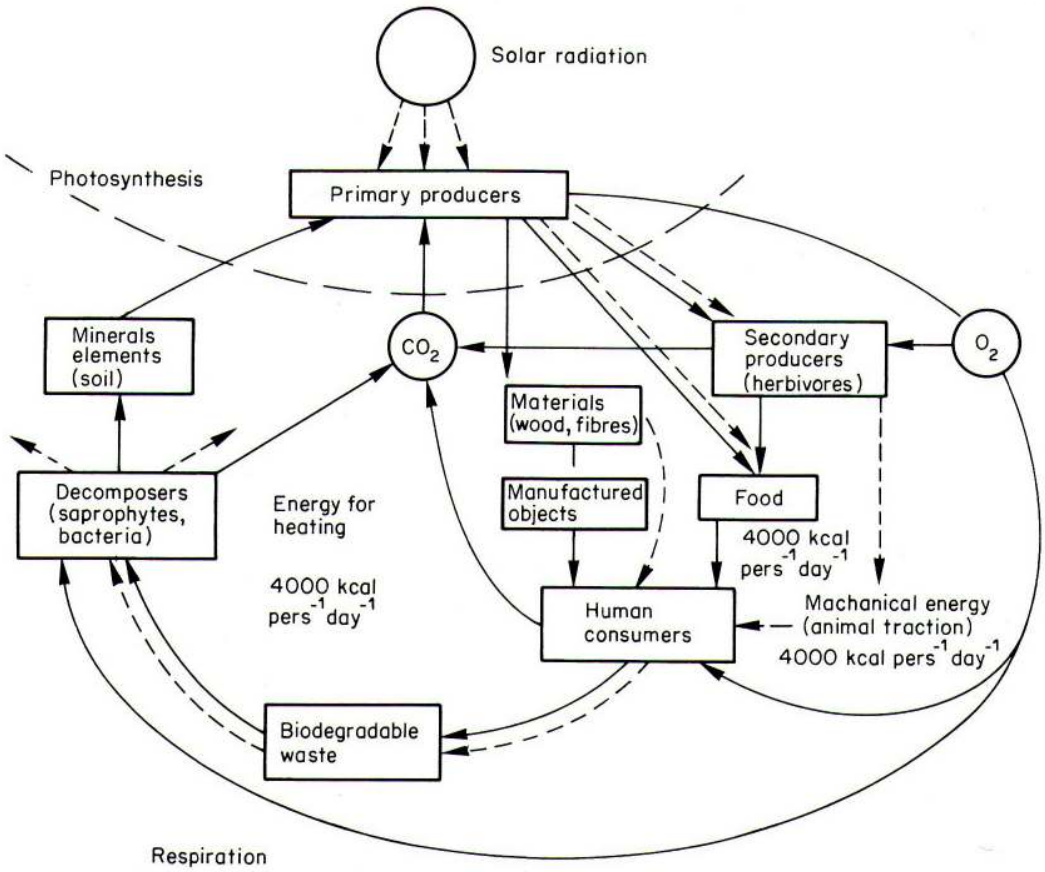


Diagram showing the flow of energy (broken lines) and cycle of matter (continuous lines) in a Neolithic civilization. (From Ramade, 1978a, p. 116)

Industrial human ecology

Our present industrial civilization offers a contrast: the relationship between humankind and the ecosphere as regards energy flow has been profoundly changed both in degree and kind by our massive recourse to fossil fuels (Figure 2.3). Current world consumption is more than 10'° t.c.e. (tonnes of coal equivalent) per year, mostly in the form of the various organic fossils (coal, lignite, oil and natural gas).

The following table compares the energy flow in various ecological and technological systems. Examination of the figures shows that the present consumption of fossil fuels corresponds to an energy flow of 0.44 kcal per m2 per day (assuming the energy to be uniformly distributed over the whole surface of the ecosphere) whereas the amount of solar radiation taken up by agricultural production is only 0.3 kcal per m2 per day (also assuming uniform distribution). Another point to notice is that the consumption of fossil fuels in a large modern, city is equivalent to an energy flow of as much as 4000 kcal per m2 per day: a value greater than the average incoming flux of solar energy (3400 kcal per m2 per day).

The following table shows how consumption has increased through the ages. Today, the energy consumption per capita has reached very high levels and can exceed 300 000 kcal per day in certain regions of Western Europe and North America (the value of 230 000 kcal per person per day was an estimate of the mean consumption in the USA in 1970).

Comparison of energy flows in various ecological and technological systems
(From H. T. Odum, 1971)

System	Energy flow (kcal m^{-2} day^{-1})
Incident solar radiation	
Solar energy flux at the surface of the ecosphere	5110
Solar energy flux available to green plants	3400
Maximum converted by photosynthesis	170
Primary production	
In a tropical rain forest	131
Gross primary production of the biosphere	6
Primary production of world agriculture (related to the total cultivated area: 8.9% of the continental surfaces)	0.3*
Systems of consumers	
Respiration in a tropical rain forest	131
Neolithic village (100 m^2 per inhabitant)	30
World consumption of fossil fuels (related to the surface area of the ecosphere)	0.44*
Consumption of fossil fuels in the USA (related to the total surface area without Alaska)	7.95*
Animal community (oyster colony)	57
Consumption of fossil fuels in a large modern city	4000

* Figures updated to 1979.

In primitive rural civilizations, humans could be said to have lived on the 'interest' from their energy stock produced by cultivated plants and forests. This 'interest', 'trapped' by photosynthesis and consumed by humans through primary plant production, represented only a small fraction of the total incident solar radiation. In complete contrast, today's technological societies are living on their energy 'capital'. The next table shows that the proportion of individual energy consumption arising directly from solar radiation (i.e. the food needed by humans plus animal traction) has continually fallen since Neolithic times and, from the end of the eighteenth century, has formed only a minor part of the overall consumption: fossil fuels have become the preponderant source of energy.

Growth of daily energy consumption per capita *throughout human history* (from E. Cook, 1975)

Period and type of civilization	Energy consumption (kcal per s^{-1} day^{-1}) Food*	Domestic consumption	Industry and agriculture	Transport	Total
10^6 years ago— early Palaeolithic	2 000				2 000
10^5 years ago— middle Palaeolithic	3 000	2 000			5 000
10^4 years ago— early Neolithic	4 000	4 000	4 000		12 000
600 years ago— end of Middle Ages (N.W. Europe)	6 000	12 000	7 000	1 000	26 000
100 years ago— early industrial society	7 000	32 000	24 000	14 000	77 000
AD 1970— technological society	10 000	66 000	91 000	63 000	230 000

* These quantities are the energy content of the plant food needed to produce the meat and dairy products consumed by humans.

As a result, present technological society is slowly but surely exhausting our energy capital existing in the form of fossil fuels derived from the carbon content of the lithosphere. The stock of such fuels represents, in the last analysis, an accumulation of solar energy throughout geological periods after transformation to biochemical energy by fossilized plants. Our present massive dependence on oil, if prolonged for several decades, will lead to the exhaustion in less than a century of a quantity of fossil hydrocarbons that has taken more than 100 million years to form!

The development of nuclear energy also represents consumption from a stock and not from a flow. It is based on the utilization of 'capital' in the form of fissile material which collected when the planetary system condensed some 4700 million years ago. The use of fast breeder reactors instead of conventional ones will merely delay the eventual exhaustion of fissile and fertile materials in the Earth's crust.

The massive use of fossil fuels is causing a considerable amount of ecological disturbance. The ejection of tens of thousands of millions of tonnes of C02 gas per year into the atmosphere could modify terrestrial climates by increasing the greenhouse effect. More generally, the cycle of matter is being completely disrupted, as has been shown by a great deal of research into cases like the biogeochemical carbon cycle just referred to. It has been established, for instance, that the atmospheric concentration of C02, a perfectly stable gas over millions of years, has increased from 280 p.p.m.1 at the beginning of the industrial era to 335 p.p.m. today, with a current annual increase of 1 p.p.m. In a similar way, there is increasing disruption of the nitrogen and phosphorus cycles produced by the massive use of chemical fertilizers. In fact, it is no exaggeration to say that modern industrial society has considerably upset the whole cycle of matter in the biosphere. On the one hand, there is the discharge of various toxic substances into the environment, particularly into water, which decreases or even destroys its self-purifying capabilities. At the same time, there is also an increasing quantity of persistent and even indestructible material being dispersed throughout the world: non-corrosible metals, plastics, chlorinated hydrocarbon pesticides, long-lived radioactive elements and so on. As a result of all this, we are taking part in a linear process with, at one extremity, resources of raw materials in shorter and shorter supply and, at the other, an ever-growing mass of non-biodegradable waste products. The formidable problems of pollution that we face are nevertheless the very consequences of the way modern technological society functions in that no account is taken of ecological models. Pollution itself, which is due to a disruption of the cycle of matter, leads to a very considerable wastage of natural resources, not only because those responsible for industrial activity generally reject all forms of recycling but also because the pollutants contaminating soils and water destroy biological resources even before they can be utilized.

Consumer societies

In fact, the apparent prosperity of industrial countries is in a large measure artificial if the plundering of scarce and non-renewable natural resources on which it is based is taken into account.

Yet the inefficient use of energy and the wastage of raw materials is completely in line with even the most trivial activities in what is called the 'consumer society': a society that persuades people to discard many everyday objects (made, for instance, from plastics, i.e. from oil) not only when they are just a little worn but even when they are slightly outdated. Such waste has been implicitly established and almost institutionalised in Western countries since the beginning of industrial production and it has brought a 'throw-away' state of mind to our civilization that is well summed up in the phrase 'no deposit, no return'. Worse still, limited resistance to wear is in many cases deliberately incorporated into the manufacturing process, whether it is of a small tool or of a motor car.

Finally define the community action plan!

The primary objectives of a local action plan focussing on the community use energy and its impact as greenhouse gas emissions are as follows:

1. Raise local awareness and understanding of the social, environmental, and economic benefits of reducing greenhouse gas emissions (GHGs) on a local and global scale
2. Identify and quantify GHGs emitted by the community from 1990 to present, and project future emissions values to 2050 based on historic and future trends
3. Identify and quantify the community's emissions reductions accomplishments since 1990
4. Identify a politically and economically feasible GHG emissions reduction target for the community to achieve by 2020
5. Identify strategies to reduce GHG emissions generated within the community in the categories of transportation, residential, commercial, industrial, municipal solid waste sectors, the municipal government, that meet specified reduction targets.

Most countries are facing a gap between the knowledge and skills needed for future success and the current education system, which is usually designed to impart a fixed body of examinable knowledge rather than initiate a lifelong journey of creative thinking and agile learning. Recognizing this challenge, numerous organizations—ranging from governments to private foundations to multinational corporations—are undertaking ambitious initiatives to define the 21st century skills students need; develop visions, standards, and supports to facilitate 21st century teaching and learning; and provide teachers and students with information and communication technologies equipment and training.

A school presenting its findings to the community it serves is an example of education in action. The presentation format outlined in Appendix 1 was in fact designed for community education/action in local social issues. The main area of enquiry is for pupils to be able to develop positive approaches to learning, their own confidence and the ability to work in a group, through a creative cross curricular project that encourages them to think about different subjects and make a link on how they can relate each subject to their own environment of their local community. The project will give pupils the opportunity to enjoy and achieve by allowing engagement in creative practice as well as being involved in the planning of their own learning. The project aims to encourage motivation by showing how learning can be fun. It will also look at how to increase attainment levels and encourage pupils to make a positive contribution to their own local community.

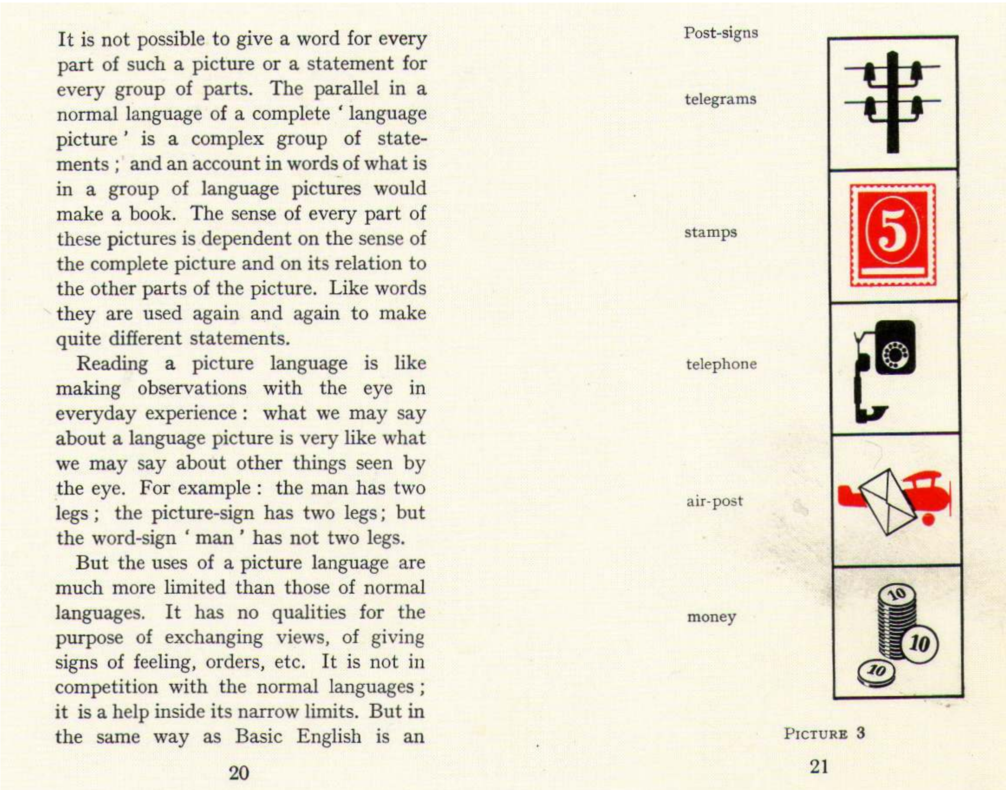
Human society has, and will continue to develop rules and regulations to help minimize negative consequences. As new information comes to light and new technologies are developed, energy policy is re-evaluated. Individuals and communities will have to make decisions. This guide outlines the understandings necessary for these decisions to be informed.

Appendix 1

Modelling and presenting the curriculum

A suggested format for presenting the ISSEE curriculum is inspired by Otto Neurath's promotion of a new visual form of encyclopedic integration of knowledge in the 1930s. Insisting on the need for absolute clarity of communication, he developed an innovative pictographic form of scientific expression to help achieve this, an 'international picture language'. It was based on a graphic design system: ISOTYPE, an acronym for 'International System Of TYpographic Picture Education' (Fig 1).

Fig 1 Pages from 'International Picture Language' by Otto Neurath, (1936)


It is not possible to give a word for every part of such a picture or a statement for every group of parts. The parallel in a normal language of a complete 'language picture' is a complex group of statements; and an account in words of what is in a group of language pictures would make a book. The sense of every part of these pictures is dependent on the sense of the complete picture and on its relation to the other parts of the picture. Like words they are used again and again to make quite different statements.

Reading a picture language is like making observations with the eye in everyday experience: what we may say about a language picture is very like what we may say about other things seen by the eye. For example: the man has two legs; the picture-sign has two legs; but the word-sign 'man' has not two legs.

But the uses of a picture language are much more limited than those of normal languages. It has no qualities for the purpose of exchanging views, of giving signs of feeling, orders, etc. It is not in competition with the normal languages; it is a help inside its narrow limits. But in the same way as Basic English is an

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Post-signs

telegrams

stamps

telephone

air-post

money

PICTURE 3

21

His starting point for the ISOTYPE project was the 'Museum for Society and Economy' founded in Vienna in 1924. Vienna during the interwar period can be regarded as a laboratory of modernity for an ambitious socialist experiment in enhancing housing and general living conditions for the working classes. ISOTYPE was developed to visualize social and economic relations especially for uneducated persons and to facilitate their understanding of complex data of municiple planning and public health. It was developed from the point of view of a specific socialist conception of adult education and sought to enhance scientific arguments by means of an 'education by the eye'. The Museum for Society and Economy was curated as a poster-information hub to inform the public about social issues and their solution.

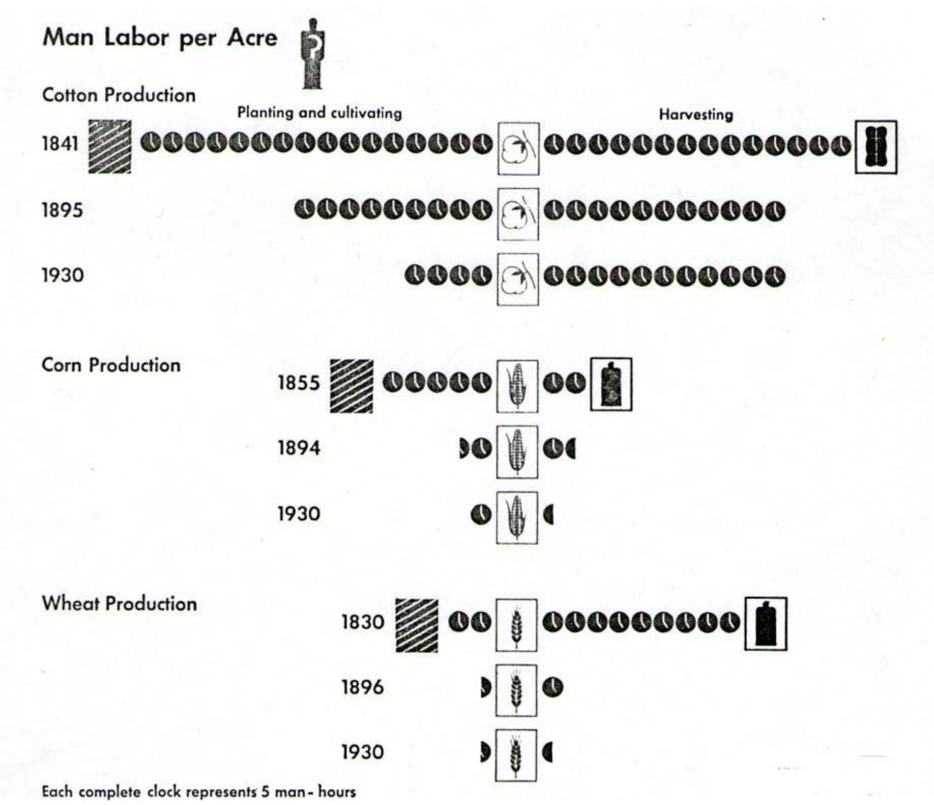
To achieve this aim, Neurath used what we now call visual education with the objective of creating a 'helping language' consisting of sets of internationally standardized graphic symbols to 'be of use in an international encyclopaedia of common knowledge'. Neurath's interest in the unity of science and the relationship of science to society was not merely theoretical. He insisted on the need for practical means that would compel public interest in the application of the social sciences for the good of society. His question was: how can scientists, as social engineers, help to optimise the political and economic issues of their time? The answer was based on a simple premise, that general living conditions could be improved, he believed, if they could be measured objectively, using measures based on a strictly scientific foundation of empirical observation and logical analysis. We would now call these 'performance indicators' to asses the outcomes of policies for making environmental improvements. His project was deeply embedded in the socialist struggle for a new society. He vigorously expressed his ideas on questions of how to represent scientific results and how to transfer this knowledge into society. A picture language of this sort is very important '... because pictures, whose details are clear to everybody, are free from the limits of language: they are international' He said, WORDS MAKE DIVISION, PICTURES MAKE CONNECTION ...

The educational importance of pictographs lies in the simple and inevitable sequence of reactions they produce;

First, they attract the eye by their unique appearance.
Second, they arouse curiosity- the desire to know what they mean.
Third, they satisfy this curiosity by telling a clear and concise story.
Fourth, they impress upon the student a permanent and definite 'visual memory of the ideas represented.

Numerous tests have shown that Neurath pictorgaphs (Fig 2) enable learners to grasp quite complicated ideas and put to use ideas that often remain vague and unproductive when presented by texts or by mathematical graphs alone.

Fig 2 Effect of mechanisation on agricultural production in the United States.



The upper pictograph shows how the increased use of machines has enabled about the same number of workers to farm 75% more land in 1930 than 1890. Below you see how machines have reduced hours of labour in the production *of cotton corn (maize) and wheat. Cotton, which still requires much hand labour, shows the least change. All thes figures are typical except thos for cotton in 1830, which are based on operations near Corpus Christi, Texas. In some regions planting and cultivating takes many man hours per acre. (Data from US Department of Agriculture, Misc Publication No 157)*

What Neurath had created is a picture language which is unique in its ability to visualise idas and relationships in the social sciences. By its very nature this visual language does more that merely give informatnion. It sugests to the student new and clearer ways of thinking for herself. The year of Neurath's death, in 1945 , saw the electronic information revolution on its way. ENIAC, the first full scale electronic computer, was built as a general-purpose machine, thus heralding the information age in which computers would not only transform the storage and the distribution of information, but transform communication itself with new ways in which we perceive information and how we interact with the data universe. Neurath was conceptually way ahead of this technological transformation.

Modern computer interface culture uses iconic signs in abundance. Computer screens and the World Wide Web present an orgy of pictorial signs that may be interpreted as a kind of a helping language as envisioned by Neurath.
The software programs listed here are just a few of many available concept mapping software programs that are designed to help users brainstorm, plan, organize, visualize, create and share graphic organizers, diagrams and flowcharts.

Software	Description	License	Platform
'Inspiration'	Create graphic organizers & idea maps	Commercial	Mac/PC
'Kidspiration'	Categorize and organize ideas for writing	Commercial	'''Mac/PC
'Cmap Tools'	Construct, navigate & share concept maps	Free	Mac/PC
'Smartdraw'	Draw diagrams, graphs and concept maps	Free	PC
'Concept Draw'	Draw diagrams, flowcharts, mind maps	Commercial/Trial	Mac/PC
'FreeMind'	Create mind mapping using Java	Free	Mac/PC
'Power Point'	Create concept maps using the chart feature	Commercial	Mac/PC

The varied capabilities of a concept mapping tool include, but are not limited to the following:

- visually represent concepts and their relationships through linking ideas, pictures, symbols and text;
- Rapid Fire™ feature helps students to get their thoughts down quickly;
- video and sound files such as QuickTime™ movies and MP3 files can be imported into diagrams, using different colors, shapes, fonts and patterns to group and classify, manage notes, organize ideas with the aid of the arrange tool and the checklist feature;
- diagrams can be converted into a hierarchical outline view, drag and drop features, toolbars, templates that offer custom frameworks for gathering and organizing ideas in the subject areas;
- in-built dictionary and thesaurus;
- diagrams can be imported into word processing documents, presentation software slides, HTML and web pages;

- concept mapping tools can be used across the curriculum and in varied grade levels.

The motive for producing conservation curricular is to encourage human managerial behaviours that reduce our environmental impact on the planet. There is widespread agreement that solutions to environmental problems must involve the public at the levels of community and neighbourhood and that there are many possible routes for accomplishing this task. Individuals can garden, bicycle, install solar hot water panels, switch to non-consumptive recreational activities like playing cards and canoeing, and support organizations, policies, and political candidates that offer promising solutions. Organizations can sponsor campaigns, promote policies, coordinate a process to identify indicators, conduct research on the most effective strategies, and provide feedback on changes. Businesses can offer technical solutions to enhance efficiency and convenience, making conservation behaviours more attractive. There is no shortage of possible avenues, but the sense that we are short on time and resources compels people to seek the most effective strategies to engage people in enduring conservation behaviours. Thus, discussions about changing human behaviour generate questions about predictors of behaviour, how behaviour can be changed, and the most effective education or communication strategies that promote behaviour change and measure it in the context of human needs for materials and energy being part of the ecology of planet Earth.

Appendix 2

Historical perspective of energy use?

Natural ecosystems are highly integrated webs of producers (who convert sunlight into food energy), consumers (including herbivores and carnivores) and decomposers (bacteria and fungi) that convert waste into nutrients. Natural ecosystems can serve as a model for industrial systems to better utilize renewable energy sources and eliminate waste through remanufacturing, reuse and recycling

Producers in a food chain like plants, algae and cyanobacteria capture energy from the Sun, and nearly all organisms rely on this energy for survival. Energy flow through most food chains begins with this captured solar energy. Some of this energy is used by organisms at each level of the food chain, much is lost as heat, and a small portion is passed down the food chain as one organism eats another.

Over time, humans have developed an understanding of energy that has allowed them to harness it for uses well beyond basic survival.

The first major advance in human understanding of energy was the mastery of fire. The use of fire to cook food and heat dwellings, using wood as the fuel, dates back at least 400,000 years. The burning of wood and other forms of biomass eventually led to ovens for making pottery, and the refining of metals from ore. The first evidence of coal being burned as a fuel dates back approximately 2400 years.

After the advent of fire, human use of energy per capita remained nearly constant until the Industrial Revolution of the 19th century. This is despite the fact that, shortly after mastering fire, humans learned to use energy from the sun, wind, water, and animals for endeavours such as transportation, heating cooling and agriculture.

The invention of the steam engine was at the centre of the Industrial Revolution. It converted the chemical energy stored in wood or coal into motion energy. The steam engine was widely used to solve the urgent problem of pumping water out of coal mines. As improved by James Watt, Scottish inventor and mechanical engineer, it was soon used to move coal, drive the manufacturing of machinery, and power locomotives, ships and even the first automobiles. It was during this time that coal replaced wood as the major fuel supply for industrialized society. Coal remained the major fuel supply until the middle of the 20th century when it was overtaken by oil.

The next major energy revolution was the ability to generate electricity and transmit it over large distances. During the first half of the 19th century British physicist, Michael Faraday demonstrated that electricity would flow in a wire exposed to a changing magnetic field, now known as Faraday's Law. Humans then understood how to generate electricity. In the 1880's, Nikola Tesla, a Serbian born electrical engineer designed alternating current (AC) motors and transformers that made long distance transmission of electricity possible. Humans could now generate electricity on a large scale, at a single location, and then transmit that electricity efficiently to many different locations. Electricity generated at Niagara Falls, for example, could now be used by customers all over the region.

Although hydropower, largely in the form of water wheels, has been in use by human society for centuries, hydroelectricity is a more recent phenomenon. The first hydroelectric power plants were built at the end of the 19th century and by the middle of the 20th century were a major source of electricity. As of 2010, hydropower produced more than 15% of the world's electricity.

Like hydropower, humans have been using energy from wind to power human endeavors for centuries, but have only recently begun harnessing wind energy to generate electricity. Wind energy propelled boats along the Nile River as early as 5000 B.C. By 200 B.C., simple windmills in China were pumping water, while vertical-axis windmills with woven reed sails were grinding grain in Persia and the Middle East. Windmills designed to generate electricity, or wind turbines, appeared in Denmark as early as 1890. Currently, wind provides almost 2% of the world's electricity.

In the 20th century, Einstein's Theories of Relativity and the new science of quantum mechanics brought with them an understanding of the nature of matter and energy that gave rise to countless new technologies. Among these technologies were the nuclear power plant and the solar or photovoltaic cell. Both of these technologies emerged as practical sources of electricity in the 1950's. Nuclear energy quickly caught on as a means of generating electricity. Today, nuclear energy generates almost 15% of the world's electricity. Solar energy provides less than 1% of the world's electricity. Solar is the only primary human energy source that generates electricity without relying on Faraday's Law. Particles of light provide the energy for the flow of electrons directly.

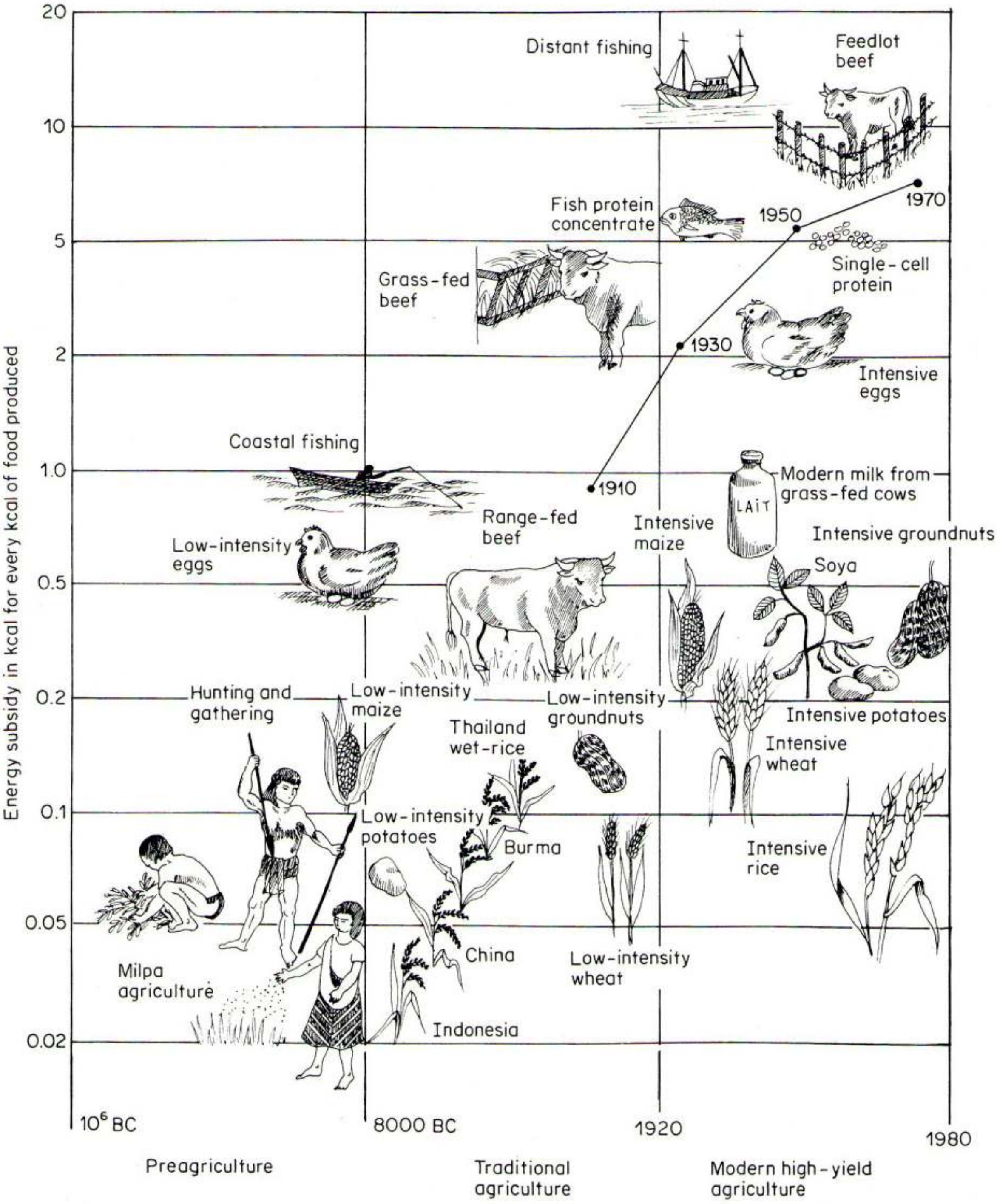
Humans have also managed to harness the geothermal energy of the earth to produce electricity. The first geothermal power plant was built in 1911 in Larderello, Italy. Geothermal energy is a result of the continuous radioactive decay of unstable elements beneath the earth's surface and gravitational energy associated with the earth's mass. The radioactive decay and gravitational energy produce heat that makes its way to the surface of the earth, often in the form of hot water or steam.

Modern biofuels are another way humans have found to harness energy for use beyond basic survival. Biofuels are plant materials and animal waste used as fuel. For example, ethanol is a plant-based fuel used more and more commonly in vehicles, usually in conjunction with petroleum based fuels.

Although humans have found many different sources of energy to power their endeavors, fossil fuels remain the major source by a wide margin. The three primary fossil fuel sources are coal, oil and natural gas. Oil has been the major fuel supply for industrialized society since the middle of the 20th century and provides more of the energy used by humans than any other source. Coal is second on this list followed closely by natural gas. Together they accounted for more than 85% of the world's energy use in 2004.

Industrialization and the rise in access to energy resources have taken place at very disparate rates in different countries around the world. For example, as of 2006, there were 1.6 billion people on earth with no access to electricity.

As with any human endeavour, the harnessing of energy resources and the production of electricity has and will have impacts and consequences, both good and bad. Awareness of the energy used to grow, process, package and transport food, or the energy used to treat water supplies and waste water is important if society is to minimize waste and maximize efficiency. These are just a few examples of the many energy issues that people can become informed about.



Changes in the energy input for various food crops with the evolution of agricultural techniques. The curve shows how the energy subsidy per kcal of food produced has grown in the USA due to the introduction of increasing use of fossil fuels. (From Steinhart and Steinhart, in Ehrlich *et al.*, 1977, p. 349)

References and links

Population growth and energy production

http://www.energybulletin.net/node/48677

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Francois Remade ISBN 0 471 90104 0

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