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ABSTRACT

This module is intended to acquaint students with the basic concepts of net energy in the context of gain, growth, and their interrelationships. The module is presented through the media of filmstrip and cassette tape. Suggestions are provided for discussion to precede the film-tape presentation. One class period is required to complete the module. (Author/RE)

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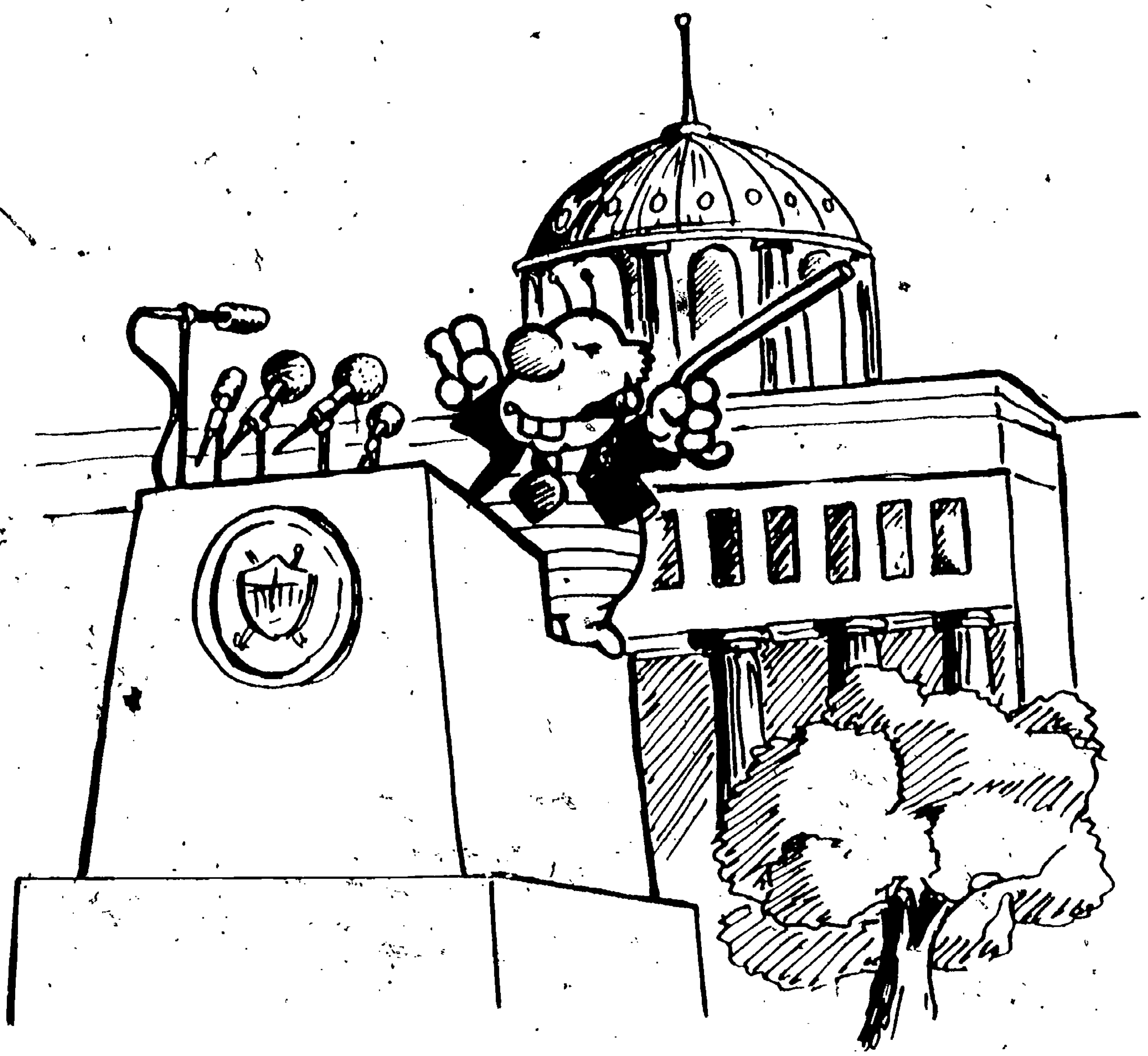
SENATOR WOLS AND PROFESSOR TRAMS MEET THE ENERGY MULTIPLIER

TEACHER'S GUIDE



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SENATOR WOLS AND PROFESSOR TRAMS MEET THE ENERGY MULTIPLIER

By Richard J McLeod

Unit Title: Net Energy

Module Title: Senator WOLS and Professor Trams Meet the Energy Multiplier

Description of the Module: This filmstrip is designed to acquaint the students with the basic concepts of net energy including the concept of gain, growth, and the relationship between the two.

Unit Objectives Met: 1a, 5a, 5b, 5c, 5d

Materials Needed: Filmstrip, cassette, filmstrip projector and cassette player

Module Type: Introduction

Context: General

Time Required: One class period

Mode: Filmstrip

Sample Evaluation Items

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SAMPLE EVALUATION ITEMS

SENATOR WOLS AND PROFESSOR TRAMS MEET THE ENERGY MULTIPLIER

1. Given a gain of 10 and a life expectancy of 30 years, determine:

   a) the total amount of energy that would be delivered by the system if 200 units are needed to build and operate it over its lifetime.

   b) the energy produced by the system each year assuming uniform rate of return.

   c) at what point in time the system would begin to exhibit positive net energy if no other systems were built.

   d) an approximation for the maximum rate of growth if this system is to remain a positive net energy source.

Answer:
a) 2000
b) 66 2/3
c) about 3 years
d) 23.3%

Prior to showing this filmstrip, it might be instructive to discuss with the class their perception of the reality of the energy crisis and actions that they think we should take. It is quite likely that students already are thinking of moving toward a solar energy economy. If so, discuss with them how quickly they think we should move and how much of our total energy needs should be supplied by solar in the future. After showing the filmstrip, you might want to introduce some of the concepts that are developed in Appendix A and Appendix B that will help the students to begin to get a grasp of the concept of limits of growth. These concepts are rather mathematical and so might not be appropriate unless your class, in general, has well developed mathematical skills.

This filmstrip assumes that the students have either seen the filmstrip on "Energy and Doubling Time" or have read the booklet, "Energy and Doubling Time" which introduces the "Red-banded Snarf." As a brief reminder, one Snarf was placed on the entire known world reserve of Ortep at 11:00 a.m. and at 12:00 noon the Ortep was completely gone. The Snarf's doubling time was one minute such that at 11:00 there was one Snarf and at 11:01, two and so forth. Therefore, at 12:00, there would be 2^{60} Snarfs or 1.15×10^{18} Snarfs! If we work backward from 12:00, we would find that ½ of the ortep still remained at 11:59, 3/4 at 11:58 and so forth. In fact, at 11:55, just five minutes before it was all gone, you could easily show that 97% of the ortep still remained. The "Energy and Doubling Time" filmstrip was designed to show this fantastic increase due to doubling. The concept is briefly reviewed in Frames 8 - 12.

<u>Frames 13-15</u>

This begins a different scenario for the snarfs. Here they recognize by 11:15 that they do not have an infinite supply of ortep and must find more. At 11:15, we would have 2^{15} snarfs or 32,768 snarfs -- more than enough to send out a search party.

The key point here is that it takes energy to find energy. In fact, they must take more energy with them in the form of ortep than they can bring back. As we must go further and further to find our energy resources in the form of oil, coal and natural gas, the same thing will happen. The question is when?

Frames 16-18

A snarf professor is introduced as well as the Snarf Senator WOLS. Any resemblance between Senator WOLS and any existing real life politician is purely coincidental.

Frame 19

This is the first time that the concept of gain has been introduced, although it is not labeled. This multiplier has a gain of three. That is, it will produce 3 times as much energy as it takes to build and maintain it. Thus, the energy out divided by the energy in equals 3.

Frame 21

This frame refers to the concept that was developed in the "Energy and Doubling Time" filmstrip. At 11:15, virtually all of the ortep mountain still remained, but at 12:00 it was all gone. Thus at 11:15, less than 45 minutes of ortep would remain.

Frames 22-28

These frames represent a fallacious argument that is prevalent today. In fact, we are only now beginning to think about how much energy must be invested in energy producing systems. That is, the concept of gain is only now becoming important in our thinking. There are even fewer people who are thinking about any limitations on growth. The argument as given by Senator WOLS seems quite reasonable. The faster we grow the more energy we will have. The next few frames show that that is not true.

Frame 32

The rate of pay back is a key factor in the problem. If the pay back were instantaneous, it would indeed be profitable to grow as quickly as possible. However, since the pay back is distributed over a number of years, it is quite possible to invest at a rate that exceeds the pay back rate and achieve a net energy deficit. Remember, that this is not like investing money. The principal cannot be withdrawn. The principal has been, for all practical purposes, lost and only the interest can be recovered.

Frames 32c - 32s

These frames are very difficult and it may be necessary to review them again after the entire filmstrip has been shown. However, an understanding of the development of this chart is critical to the concept.

Frames 36 - 47

Here, we develop the argument that the result would have been a positive energy flow if the gain could have been increased, or if the rate of growth would have been decreased sufficiently. To illustrate that, the rate of growth was decreased by a factor of 4 such that the doubling time was 20 minutes rather than 5 minutes. With this rate of growth, a gain as low as 3 results in a net pay back to society. The remainder of the filmstrip attempts to relate this problem of the sharfs to our own energy problems. When oil and coal were very easy to obtain, the gain for energy systems based on these fuels was extremely high. At one time, for example, so little energy was invested to obtain oil that the energy gain for oil was up in the 100's. That is no longer true. The energy gain now is less than 20. These gains will continue to decrease. Much has been said about converting coal to oil and gas. This process requires a large energy input for conversion. This will further depress the gain of coal. Thus, we must revise our thinking to accommodate the realities of low gain systems. Solar, wind, and other alternatives, in general, fall in the low gain category.

The most important point of the entire filmstrip is that we must begin to think more carefully about the amount of energy that must be invested to get energy. The concept of gain must become an increasingly pivotal concept upon which decisions are made. We as a society cannot afford to permit low gain systems to grow at rates that will exceed their ability to pay back. An understanding of this concept will help us make the right decisions. The module on "Energy Gain" will further develop this concept.