"Summary of article by Bruce Hannon: Energy, Labor, and the Conserver Society" in Frontier Issues in Economic Thought, Volume 1: A Survey of Ecological Economics. Island Press: Washington DC, 1995. pp. 222-224

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There are two paths that America can adopt with respect to future energy use. On the one hand, we can optimistically increase our per capita energy use, relying on new technologies, energy price controls, and statesmanship to postpone shortages. On the other hand, we can be more realistic and become more of a conserver society that recognizes the limited availability of low-cost energy. A conserver society would need to forecast energy shortages and consider the technological, social and economic problems that would be associated with substituting renewable capital and labor for labor when shortages of nonrenewables arise.

## THE RELATIONSHIP OF ENERGY, WAGES, AND EMPLOYMENT

The use of the three basic inputs in the production process - capital, labor, and energy - are determined by a combination of market forces and regulations in the form of price controls, taxes and subsidies. The ratio of the prices of any two inputs represents the ratio of their marginal productivities; the lower the relative marginal productivity of a commodity, the more widely it is consumed. Between 1935 and 1970, as industrial workers' wages rose faster than the price of industrial electricity, electricity was substituted for labor. Unemployment did not increase during this time period because of an increase in total economic activity that created as many jobs as were lost due to the substitution of electricity for labor. However, steady employment could have been insured during this period even with zero economic growth if the price of energy had been raised relative to the wage rate. This is apparent between 1970 and 1975, when the real wage rate, and hence the ratio of wages to the price of electricity, fell; although the level of economic activity dropped, the level of employment still rose as labor was substituted for energy during this period due to the relative price changes. A reduction in energy use may, however, mean less material wealth, so "the principal problem of the conserver society becomes one of providing and maintaining an equitable distribution of reduced energy and material flows"(47)

Since 1950, labor and capital have not been substituted for one another, but electricity has been substituted for capital. Evidence of this is seen in the increase in centralized production facilities that conserve labor and capital, but are energy intensive.

## THE CONSTRAINTS OF ENERGY

A conserver society will increase the use of labor and capital and reduce energy use. The efficient use of energy should be guided by two important physical rules: the Second Law of

Thermodynamics, and the concept of net energy. The Second Law suggests that a given quantity of energy has a higher quality (in terms of its ability to do mechanical work) at higher temperatures than at lower ones. The concept of net energy suggests that it is more economic to transmit high-quality energy than low-quality energy. These two physical laws should constrain the planners of a conserver society, requiring them to match the quantity and quality exchanges of energy. To achieve maximum efficiency, energy exchanges should be organized in a cascading manner, so that the output of one process becomes the input of another. Raising the relative price of energy will result in more intensive use of energy and the development of energy conserving communities.

As a first step the conserver society must work towards reducing total energy use. Care must be taken to ensure that changes resulting in reduced energy use at one point do not result in compensating increases at another. Such increases might occur, for example, if reducing energy use results in income increases that then increase energy demand when they are spent. The main issue facing conserver society planners is therefore to identify "specific changes in the present economy (that) will reduce energy demand and increase employment, under conditions of income equilibrium."(48) One way that this issue has been approached is by comparing high-energy-using decisions with low-energy-using alternatives while incorporating re-spending effects, to determine the energy and employment changes caused by substitutions. Based on these calculations the job potential per unit of energy saved for each conservation project can be determined by dividing the net change in employment demand by the net change in energy demand.

## RELATING ENERGY AND JOBS

Aggregate behavior of the US economy in 1974 indicates that 930,000 new jobs were created for every quadrillion Btu reduction in energy use. Given that present US energy use is about 80 quadrillion Btu, it would therefore be possible to reduce unemployment by up to 4 million people (i.e., full employment) by reducing energy use approximately 5 to 10 percent. In some cases jobs are lost when energy is expended. For example, in the short run about 75,000 jobs are lost for every new quad of primary energy that is transformed into electricity. This is because increasing energy purchases require a corresponding reduction in costs, which must be brought about by reducing the demand for labor. More jobs are lost due to reduced labor demand than are created by the increased electricity generation.

## STRATEGIES FOR CONSERVERS

Energy conservation policy must be approached on a case by case basis. For this purpose, a series of calculations outlined in this article could be used to establish priorities. Examples of ways to increase employment and reduce energy use include shifting from personal autos to buses, trains, and bicycles, or from bulk materials trucking to retail transport. However, not all shifts towards lower energy use will generate employment.

Another option is to promote lower energy use through a tax on energy at the point of production based on the energy content. This will result in increasing prices for goods and services, with greater price increases resulting for the more energy intensive commodities. Consumers would

then shift from energy-intensive commodities to relatively labor-intensive ones. This tax would result in lower energy consumption at home and in industry, but the increased revenues generated for the government will create their own energy demands when they are spent. The government could use this additional income to reduce the personal income tax on individuals, or to subsidize energy conserving capital investments in the economy. Another way to promote energy efficiency is through rationing, which focuses on the finiteness of the energy supply, and which is a more precise method of controlling energy flows in the economy than taxation

It is only through government intervention, not individual voluntary action, that a culture of conservation can be developed. It is possible to achieve declining energy use without compromising the issues of equity and full employment.