ENERGY POLICIES AND PRACTICE IN RELATION TO CONTROLLED ENVIRONMENTS. THE NORTH AMERICAN POSITION: LIGHTING TECHNOLOGIES FOR ENERGY LIMITED ENVIRONMENTS

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Controlled environment agriculture is, by its nature, energy limited. An extreme example of this limitation is the use of controlled environments for life support in space or on planetary surfaces. In the United States, the National Aeronautics and Space Administration (NASA) has identified lighting as a critical technology. The critical elements in crop lighting systems are the electrical conversion, the spectral quality, and the distribution. The electrical conversion of common sources ranges from 15% for light emitting diodes (LEDs) to 35% for high-pressure sodium lamps. New technologies such as plasma sources, microwave/sulphur lamps, may reach 50% in the near future. The spectral quality of these sources, however, must be tailored to the crop to maximise productivity. The low electrical conversion efficiency of LEDs when combined with their ability to produce highly efficient photosynthetic wavelengths, blue and red, increases the overall efficiency of LED systems. In addition, the longer wavelength red LEDs are more electrically efficient and have been shown to have greater productivity in crop production due to the early elongation and higher light interception. The ability to provide an area source with LEDs and to dissipate the waste heat from that large area is an added benefit to their application in closed systems. High pressure sodium lamps, although the most electrically efficient source currently available, are difficult to manage in a closed system due to the large thermal load, a spectrum deficient in blue, and the complicated luminaire required for uniform distribution. New sources such as the microwave/sulphur lamp offer unique capabilities in electrical conversion efficiency, highly efficient spectral quality, and “point” source configuration for simplified luminaire design. The transport and distribution from high intensity sources can be efficiently designed using optical fibres or light pipes with high transmission efficiencies. Uniform distribution can be effected using holographic diffusers, developed for the computer industry, to provide an efficient coupling to the closed environment. The application to life support and space experiments of these critical elements will be briefly presented during the panel discussion.