Preface

Air, water, and energy are essential ingredients of human life. The energy needed to sustain human life is quite modest: 2000 kilocalories per day (0.1 kilogram of oil equivalent) which was the daily energy consumed from food by human beings in the Neolithic era. Today it is 5 times higher in the least developed and 50 times higher in the high-income countries. With a world population of more than 7 billion people enormous amount of energy are required: approximately 13 billion tons equivalent of oil per year.

Up to the 18th century most of the energy used was wood from native forests and crop residues as the main source of heat for cooking and heating ("traditional renewables").

In the 19th century with the invention of the Watt engine and its use for electricity generation the importance of coal increased substantially replacing traditional fuels. Electricity generated in hydropower plants contributed also since 1880. The use of traditional energy sources became restricted to rural areas and less developed countries.

By the end of the 19th century, the use of oil increased and the advent of the automobile made oil the dominant fuel of the 20th century. Natural gas usually associated with oil production contributed to the gradual phasing of coal.

The growth of energy consumption in the 20th century was spectacular and much faster than population growth: from 1850 to 2020, the world population increased 6 times (1.238 billion people to 7.760 billion). Energy consumption grew 28 times (from 486 million to 13.527 billion): 83.7 from fossil fuels and 16.3% from "new renewables" (biomass, wind, solar, geothermal) hydro and nuclear.

The drivers of these changes were technological developments, costs, and access to energy particularly oil which was determined in a large scale by the policies of OPEC (Organization of Petroleum Exporting Countries) formed by the

main oil producers in the world the most important being Saudi Arabia, United Arabia Emirates, Kuwait, Iraq, Iran, Nigeria, and Venezuela. Environmental considerations were also very important

In Brazil, petroleum derivatives always represented a large share of energy consumption – approximately 40% – due to the fact that since the middle of the 20th century the Government privileged road transportation.

Today Brazil is a highly motorized country (392 cars/1,000 people compared to 816 cars/1,000 people in the US) but its railway system 5 times smaller than the US system (0.147 km/1,000 people compared to 0.752 in the US.

In 1975, local oil production was very small, and gasoline and diesel oil imports posed an enormous burden on the economy representing roughly one-half of the earnings from exports. At the same time, the sugarcane industry was facing a serious crisis due to declining prices of sugar in the international market. The Government decided to stimulate through subsidies, the production of large amounts of ethanol from sugarcane, which was known to be a good replacement for gasoline. It was thus launched the ETHANOL PROGRAM.

Today approximately 30 billion litres of ethanol per year from sugarcane are produced in Brazil replacing, at competitive prices, approximately one-half of the gasoline that would otherwise be in use. In addition to that, bagasse from sugarcane contributes with 9% of the electricity production of the country.

The ETHANOL PROGRAM led to the development of the important industrial of the production of refineries. The productivity of ethanol production threefold in 50 years and "cradle to grave" analysis showed that ethanol from sugarcane produced carbon emissions substantially smaller than gasoline.

As we enter the 21st century further efforts in replacing fossil fuels at the world level are becoming an urgent task due to the increased concerns on the consequences of global warming.

There are many options for that transition such as the use of "green hydrogen" long life batteries for electric vehicles, carbon capture and storage and others. Government policies can favor any of them through subsidies and/or reallocation of government funds. The successful Brazilian ETHANOL PROGRAM is an excellent example of how to it.

This book by Luís Cortez and Frank Rosillo-Calle describes the origins of the PROGRAM its development, the several challenges faced and how they were successively met. It will be very helpful to people working on the new frontier of a sustainable energy future.

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