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Introduction

This book is a report of my last three years facing an economic analysis of an innovation, a potentially revolutionary innovation, giving room for radical changes to match a new sustainable development with 1. reliability, 2. efficiency and 3. security of energy supply for all industrial sectors of ours countries: extraction of Natural Gas (CH_4) from Natural Gas Hydrates (NGH), the so-called "ice-like solid crystalline compounds", by injection of CO_2, the so-called Hydrate-based Carbon Capture (HbCC) process.

Alongside conventional fossil fuels, notably oil, coal, and natural gas, a new source of natural gas discovered in the last few decades has moved into the focus of interest: the so-called gas hydrates. These are solid crystalline compounds of gas and water molecules in which a guest gas molecule, notably methane (CH_4), is trapped in a cage structure formed by water molecules. Facing the enormous potentially availability of NGH we have to consider it as a potential future energy source for energy demand increases; moreover, the unique properties of NGH make them suitable for several practical applications, such as gas transportation, cold storage, carbon capture and storage, water desalination, energy storage and so on.

The structural impact, accounted for by the economic analysis, of the reflections of the profound transformation of the traditional CH_4 production chain into a sort of sustainable "new primary source", thanks to its extractability from NGH clathrates in ways that would configure a sort of "environmental neutrality", being the same molecule due to the simultaneous injection of CO_2 and, therefore, the storage of CO_2 in a new mode of carbon capture and storage, is believed to be important, potentially able to envisage discontinuity in the evolution of international energy mixes.

The desire to pursue energy policy choices aimed at ensuring maximum consistency with the objectives of sustainability and, more specifically, achieving the best "energy-environmental neutrality", has now become a dogmatic issue, bordering on ideological, in political, academic and institu-

tional debates. At the same time, however, the diffusion and development of energy generation plants initially prefigured as "renewable" are proving more and more clearly to be problematic management, of evident burden (with tax burden significantly diverted to the purposes), of uncertain effectiveness with respect to purposes of satisfying the increasingly growing Energy Demand in the world and, above all, of dubious validity, including environmental ones, in the light of a more widespread and articulated application of Life Cycle Assessment (LCA) and Levelized Cost of Energy (LCOE) methodologies.

The developments in the zonal, national and international energy mixes also highlight new trends, new problems with respect to the apparent polite political choice aimed toward a totally unconditional support for the so-called Renewable Energy Sources (RES), if only due to the fact that the technologies that determine their generative activation are anything but sustainable. Furthermore, the emphasis that today is placed on the frontier of hydrogen development, as a desired source of energy, poses problems of the pragmatic effectiveness of this option. The evolution of the stimuli towards the development of new techniques of Carbon Capture and Storage (CCS) options on natural gas provisions in Steam Reforming (SRM) process for the production of Blue-Hydrogen reproposes the centrality of the natural gas supply in the concrete realization of the structural innovation of the Hydrogen Economy.

Finally, in order to achieve general decarbonization objectives, it becomes very important to experiment with a concrete implementation of technologies capable of extracting NGH and capturing CO_2 at the same time, would determine a real revolution in the world energy scenario.