Beyond Oil and Gas: The Methanol Economy

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Preface

Humankind, for its continued existence, requires not only such essentials as food, clean water, shelter, and clothing materials, but also large amounts of energy. Ever since cavemen succeeded in kindling fire, our ancestors have used a variety of sources for heating and cooking, ranging initially from wood and vegetation followed by peat moss and other carbon-based fuels. Since the industrial revolution, the major source of energy was coal to which, during the twentieth century, oil and natural gas were added. The latter resources – termed "fossil fuels" – were formed by Nature over eons, but once combusted they are not renewable on our human time scale and are thus increasingly depleted by overuse. Our readily accessible oil and gas reserves may not last much past the twenty-first century, while coal reserve may be available for another century or two. We need, therefore, to find new ways and resources for the future.

This book discusses a new approach based on what we call the "Methanol Economy®". The production of methanol directly from still-available fossil fuel sources, and the recycling of carbon dioxide via hydrogenative reductions, are – we believe – feasible and convenient ways to store energy generated from all possible sources including, alternative energy sources (solar, hydro, wind, geothermal, etc.) and atomic energy. In the short term, new efficient production of methanol not only from still-available natural gas resources (without going through the syn-gas route) but also by the hydrogenative conversion of carbon dioxide from industrial exhausts, offer feasible new routes. In the long term, recycling of the carbon dioxide captured from the air itself will be possible. Air, in contrast to oil and gas resources, is available to everybody on Earth, and its CO_2 content represent an inexhaustible recyclable carbon resource. Methanol produced from this CO_2 (using any energy source to produce the required hydrogen from water), is an excellent fuel on its own for internal combustion engines or fuel cells of the future. It can be also readily converted, via its dehydration to ethylene and propylene, into synthetic hydrocarbons and their products. Consequently, it can free mankind's dependence on our diminishing oil and natural gas (even coal) resources. At the same time, by being able to recycle excess CO_2 we can mitigate or eliminate a major source of global climate change – that is, warming of the Earth – caused by human activities.

We are fully aware that to solve our outlined problems for the future, including energy storage and transportation, non-oil- and gas-based fuels and raw materials for the production of synthetic hydrocarbons and their products (to which we are accustomed in our everyday life) and new approaches are needed. Much has been said about the future in view of our diminishing and non-renewable fossil fuel resources. The outlined "Methanol Economy" is one of the feasible and achievable solutions, which deserves serious further consideration and development. We hope that this book will call more attention to this approach, and spur future activities in the area.

Los Angeles, December 2005

George A. Olah
Alain Goeppert
G. K. Surya Prakash

Acronyms, Units and Abbreviations

Acronyms

AFC	Alkaline Fuel Cell
BP	British Petroleum
BWR	Boiling Water Reactor
CEA	Commissariat à l'Energie Atomique (France)
CEC	California Energy Commission
CIA	Central Intelligence Agency
DMFC	Direct Methanol Fuel Cell
DOE	Department of Energy (United States)
EDF	Electricité de France
EIA	Energy Information Administration (DOE)
EPA	Environmental Protection Agency (United States)
EU	European Union
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IAEA	International Atomic Energy Agency
ICE	Internal Combustion Engine
IEA	International Energy Agency
IGCC	Integrated Gasification Combined Cycle
IPCC	International Panel on Climate Change
ITER	International Thermonuclear Experimental Reactor
LNG	Liquefied Natural Gas
MCFC	Molten Carbonate Fuel Cell
NRC	National Research Council (United States)
NREL	National Renewable Energy Laboratory (United States)
OECD	Organization for Economic Cooperation and Development
OPEC	Organization of Petroleum Exporting Countries
ORNL	Oak Ridge National Laboratory
OTEC	Ocean Thermal Energy Conversion
PAFC	Phosphoric Acid Fuel Cell
PEMFC	Proton Exchange Membrane Fuel Cell
PFBC	Pressurized Fluidized Bed Combustion
PV	Photovoltaics

PWR	Pressurized Water Reactor
R/P	Reserve/Production ratio
SUV	Sport Utility Vehicle
TPES	Total Primary Energy Supply
UNO	United Nations Organization
UNSCEAR	United Nations Scientific Committee on Effects of Atomic Radiation
URFC	Unitized Regenerative Fuel Cell
USCB	United States Census Bureau
USGS	United States Geological Survey
WCD	World Commission on Dams
WCI	World Coal Institute
WEC	World Energy Council
ZEV	Zero Emission Vehicle

Units and Abbreviations

b and bbl	barrel
Btu	British thermal unit
°C	degree Celsius
cal	calorie
g	gram
h	hour
ha	hectare
kWh	kilowatt-hour
m	meter
Mb	megabarrel (10^6 barrels)
ppm	parts per million
toe	tonne oil equivalent
s	second
Sv	Sievert
t	metric tonne
W	watt