

Innovative Conservation and Production of Energy: A review

Daniel R. Rousse ^{a,*}, George J. Nasr ^b, Sylvain F. Turcotte ^c, and Stéphane Lassue ^d

^a Department of applied sciences, Université du Québec à Chicoutimi, Chicoutimi, G7H 2B1, Canada

^c Faculty of Engineering, Lebanese University, Roumieh, Lebanon

^b Centre Études Internationales et Mondialisation, Université du Québec à Montréal, Montréal, H3C 3P8, Canada

^d LAMTI, Faculté des Sciences Appliquées de l'Université d'Artois, Technoparc FUTURA 62400 Béthune Cedex, France

Abstract

Over the course of the past century, the rate of human population growth has increased unrelentingly and today the modern society, all over the world, long for ever higher standards of living. As a result, human populations have been placing ever more demand on the earth's resources, leading to increased demands in energy. At the same time, the availability of the resource which has been the corner stone of the industrialized world is compromised as hydrocarbons reserves are already threaten by the actual demand.

In this context, some argue that eventually a major world crisis is unavoidable, some admit that rough times are forecasted, and others just think nothing will change. However that may be, the amount of energy that our world is using will have to be adjusted to the difference between the amount produced by alternative renewable sources plus that coming from diminishing traditional sources.

As a consequence, conservation and production energy technologies are absolutely going to increase in importance over the next centuries.

While economic and political issues are fundamental to explain the rise of one or more technologies compare to others, the format of the paper and the scope of the conference do not allow discussing these critical aspects of the question. Hence, the paper, will then describe the state of the art in upcoming innovative technologies that pertain to either conservation or production of energy.

Keywords: : Review paper, energy production, energy conservation, renewable energy.

1. Introduction

Energy is a mainstay of today's world. But as the population grows and because all countries strive for higher standards of living, the amount of energy required to sustain the 21st century way of living in developed and developing countries is ever increasing. However, as for many other resources on the planet, the availability of non renewable energy sources is rapidly decreasing.

Therefore, nowadays it is generally accepted that to restrict the impact of an upcoming energy crisis, the solution will be twofold: first, the amount of energy used per capita in OECD countries will have to be reduced and second, to the best extent possible, renewable energy sources will have to be used.

The solution will necessarily involve political and economical decisions. However, the purpose of this paper is to present an overview of the technological issues. Both conservation, that will enable to reduce the amount of energy used for a specific task, and innovative

production of energy, that will partly – if not eventually chiefly – replace traditional fossil fuels, will be overlooked in this paper.

Nevertheless, the time horizon of this overview is unfortunately very limited as environmental, social, and economical conditions vary drastically one year to another in the first decade of the century. Moreover, new technologies blossom at a very fast growing pace and one that may emerge today as very promising could vanish tomorrow, eclipsed by a novel technology more suited to the global environment.

The review is necessarily incomplete as novelties emerge every month and because of space limitations. However, it is hoped that the reader will at least learn about several novelties that will help making this world a little better.

The paper first tries to examine the overall energy situation with a realistic viewpoint to avoid the traditional alarmist discourse pitfall. Then, the generation of energy will be treated before the paper gets onto conservation issues.

* Corresponding author. Tel.: (418) 657-4428 Fax: (418) 833-1113; E-mail: Daniel.Rousse@uquebec.ca

2. Global energy snapshot

Global energy consumption in the last 50 years has increased constantly and is expected to grow over the next half century. Figure 1 shows, in Mtoe, that the world total final consumption doubled from 1971 until 2006

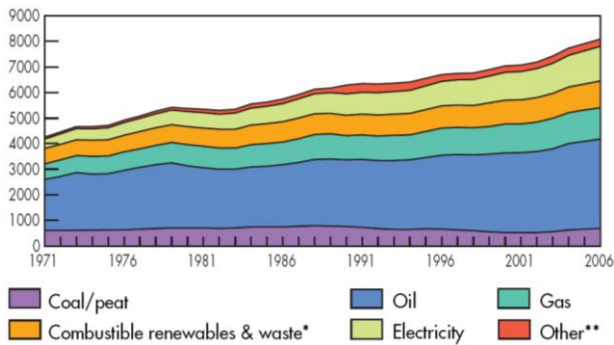


Figure 1: Evolution from 1971 to 2006 of world total final consumption by fuel (Mtoe) []

This figure also indicates that more than 2/3 of this consumption is either coal, gas or oil. Recent world energy statistics [] also indicate that if people from Asia (2,12 Gpeople, 0,63 TPES/cap) would suddenly use as much energy as an average OECD citizen (4,70 TPES/cap), the world consumption would instantly double. Hence, as the energy demands increases by about 120 Mtoe/yr, as this rate is expected to increase, as nonrenewable sources are quickly depleted and because they induce a dramatic impact on CO₂ emissions, there is an urgent need for alternatives. (Note that the "Other" category in Figure 1 represents about 3,4% of the total consumption and that it includes geothermal, solar, wind, heat, etc.)

2. Production

In this section, production techniques for energy are overviewed. First, for each topic a short description of at least one innovation is provided among the sometimes numerous alternatives. Then, what could possibly be forecasted for the coming years is presented. The review starts with non-renewables than switches to other sources.

2.1. Coal

2.1.1. What it is today

Text

2.1.2. Some possible future

Text

2.1. Gas

2.1.1. What it is today

Text

2.1.2. Some possible future

Text

2.1. Oil

2.1.1. What it is today

Text

2.1.2. Some possible future

Text

3. Conservation

In this section, attention is focused on technologies that improve the overall efficiencies of existing equipments, systems or processes.

2.1. Energy efficiency

2.1.1. What it is today

Text

2.1.2. Some possible future

Text

2.1. HVAC controls

2.1.1. What it is today

Text

2.1.2. Some possible future

Text

2.1. Electricity conservation

2.1.1. What it is today

Text

2.1.2. Some possible future

Text

2.1. Heat recovery

2.1.1. What it is today

Text

2.1.2. Some possible future

Text

2.1. Pinch technology

2.1.1. *What it is today*

Text

2.1.2. *Some possible future*

Text

2.1. Geothermal recovery

2.1.1. *What it is today*

Text

2.1.2. *Some possible future*

Text

2.1. Energy storage, transmission, distribution

2.1.1. *What it is today*

Text

2.1.2. *Some possible future*

Text

2.1. Cogeneration

2.1.1. *What it is today*

Text

2.1.2. *Some possible future*

Text

2.1. Photovoltaic

2.1.1. *What it is today*

Text

2.1.2. *Some possible future*

Text

2.1. Solar thermal

2.1.1. *What it is today*

Text

2.1.2. *Some possible future*

Text

2.1. Wind power

2.1.1. *What it is today*

Text

2.1.2. *Some possible future*

Text

2.1. Waste-to-energy

2.1.1. *What it is today*

Text

2.1.2. *Some possible future*

Text

2.1. Biofuels

2.1.1. *What it is today*

Text

2.1.2. *Some possible future*

Text

2.1. Biomass

2.1.1. *What it is today*

Text

2.1.2. *Some possible future*

Text

2.1. Hydrogen

2.1.1. *What it is today*

Text

2.1.2. *Some possible future*

Text

2.1. Fuel cells

2.1.1. *What it is today*

Text

2.1.2. *Some possible future*

Text

X. Conclusion

Despite major efforts to reduce energy consumption, within the next decade, global energy needs are undoubtedly expected to grow, with fossil fuels remaining the dominant source, with dramatic worldwide impact on up CO₂ emissions. China and India are the emerging energy giants in this unsustainable future. Their unprecedented pace of economic development will require ever more energy and will transform the global energy system by dint of their sheer size in their growing weight in international fossil fuel trade. Yet it will transform living standards for billions.

“The problems of energy security and climate change are global and require global solutions. The challenge for all countries is to put in motion a transition to a more secure, lowercarbon energy system, without undermining economic and social development.”[WEO2007]. And the aforementioned global solutions are indeed more socio-economical than technological.