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Novel energy saving technologies evaluation tool

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ABSTRACT

The lead-time for the development of a new energy technology, from the initial idea to the commercial application, can take many years. The reduction of this time has been the main objective of the EC DGTREN, who have funded two related recent projects, EMINENT and EMINENT2 (Early Market Introduction of New Energy Technologies). These projects were implemented to identify and accelerate the introduction and implementation of leading edge European technology in the field of energy saving into the market place. The principal features included the production of a software tool and an integrated database of new technologies and sectoral energy supplies and demands. The software tool has the capability to analyse the potential impact of new and underdeveloped energy technologies in different sectors emerging from different countries. In addition, the software tool has been used to perform case studies which have been used to illustrate the new technologies.

1. Introduction

Leading research centres and laboratories throughout the world are developing novel energy-related concepts and prototypes. They could lead to significant economic and social benefits. The problem is in identifying them, evaluating their practicality and speeding up the time of getting them into the market.

The lead-time for development of an early stage energy technology (EST), from first idea to commercial application can take many years. A tool was developed enabling evaluation of ESTs within different national and economic contexts Klemeš et al. (2007). No similar tool has been reported. It provides a rapid appraisal of the geographic potential and a reduction in market lead-time of the promising ESTs. Being a universal tool for analysing the energy technologies, EMINENT is now being used for screening emerging technologies.

Similar challenges have been taken in America, and Japan, e.g. Alberta Energy Technologies (2007), Energy and Environment Technologies Development Projects (2003), NEDO (2008).

During the previous project – EMINENT l launched by EC DG TREN – a unique expert network for systematic evaluation and rapid dissemination of early stage energy technologies was established (Jansen et al., 2004). Also an energy technology evaluation tool was developed, which enables evaluation of early stage energy technologies within different national and economic contexts (Klemeš et al., 2005a; Klemeš et al., 2005b). No other similar tool has been reported so far.

2. Description of the EMINENT tool

Each technology passes several steps (Fig. 1)—paper idea, laboratory experiments, pilot plant, demonstration plant and commercial stage during which the efforts and resources get the peak and then decline. The EMINENT tool is mainly analysing technologies which are in paper-to-demo stages. However, it includes the information about the mature, commercial technologies which are used as reference technologies.

Abbreviations: ATR, autothermal reforming; CHP, combined heat and power; EOR/EGR, enhanced oil recovery/enhanced gas recovery; EST, early stage technology; EUA, EU emission allowance; FC, fuel cells; LV, low voltage; MCFC, molten carbonate fuel cells; NG, natural gas; Np, number of units; Pdem, requested capacity; PEMFC, proton exchange membrane fuel cell; Pout, size (capacity) of the technology available; Pout,max, maximum size (capacity) of the technology available; Pout,min, minimum size (capacity) of the technology available; PV, photovoltaics; ZENG, Zero Emission Norwegian Gas; μCHP, micro-scale combined heat and power unit.

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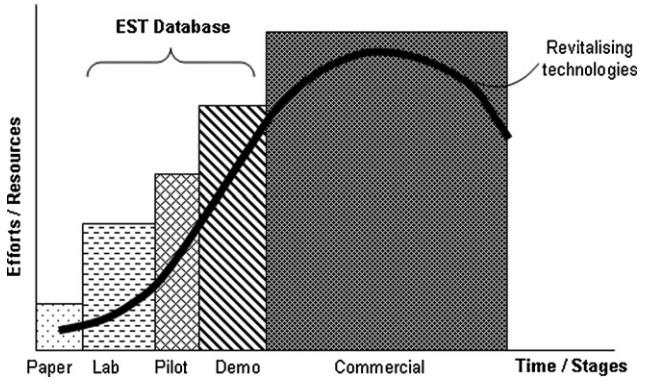

Fig. 1. Stages of technology development.

The following technologies have been analysed so far:

(i) renewable electricity generation;
(ii) renewable heating and cooling technologies;
(iii) production and distribution of liquid and gaseous biofuels;
(iv) eco-buildings;
(v) poly-generation;
(vi) energy demand management and renewable energy supply in high performance communities;
(vii) alternative motor fuels.

Some of them are described in more details in the previous contribution (Klemeš et al., 2006):

- HTU® process in which several types of biomass can be directly converted to a heavy crude-type of oil, similar in composition and characteristics to natural crude oil but with somewhat higher oxygen contents (Koppejan, 2005).
- Biomass gasification methanol synthesis system. Though the parts of the technology – biomass gasification and integrated combined cycle – are quite developed, the concept of biomass-to-electricity and methanol systems based on biomass gasification is quite novel and promising. The paper analyses the potential advantages and discussed the problems still to be overcome (Klemeš et al., 2005a; Klemeš et al., 2005b).
- Transportation of electricity by ship, a 'paper' idea at this stage. Based on the results of this study it is envisaged that more work needs to be done to increase the energy density of the electrolytic fluid to lower transportation cost (de Meij-Braber et al., 2003).
- Integrating renewable sources of energy into an existing combined heat and power system (Pavlas et al., 2006). This study investigated the case of a complex integration of an up-to-date energy production plant for heating rates up to 50 MW. It was focused on the modernization of a strategic hospital that has large requirement for heat. The consumption of electrical energy for health care facilities as hospitals, spas, nursing homes, etc. was not very changeable by various seasons, and therefore had potential for CHP using renewables.

EMINENT2 builds on the previous expertise (EMINENT, 2008). The developed tool and EST databases are being developed with practical recommendations in technological and political domains on the implementation of the promising ESTs.

As the availability and price of primary energy resources and the geographical conditions, demand and price differs significantly worldwide, it is needed to evaluate the impact of ESTs within a national energy supply system.

The resource manager describes details of resources available in the country, modifies and enters the new data, selects the data for technology assessment.

Seven types of energy resources can be handled by the tool: electricity, fuels, geothermal, hydro energy, ocean tidal energy, wave energy and wind energy. The overall concept implemented in the tool is shown in Fig. 2. Any energy supply system consists of a number of components, such as pre-treatment systems, transportation and storage systems, conversion processes, distribution and energy storage systems. As can be seen from Fig. 2, the EMINENT tool analyses energy conversion process ESTs, as they constitute the core of any energy supply system.

The EMINENT software tool developed has the aim to design possible energy supply chains and to rank them based on shadow prices for fossil energy use and CO_2 emission as indicated by the user. It consists of integrated resource manager, demand manager, EST manager, databases on resources, demand and EST as well as the analysis tool (Fig. 3).

A software tool was developed enabling the evaluation of ESTs within different national and economic contexts as no similar tool existed. The aim of EMINENT tool is to evaluate the market potential of energy-related ESTs in various energy supply chains, and their performance in terms of:

(i) CO_2 emissions,
(ii) costs of energy supply,
(iii) use of primary fossil energy and
(iv) in different subsectors of society.

Technology developers and financial supporters are frequently not aware of the application potential and the market attractiveness across countries and society sectors. The EMINENT project consequently provides insight into the future market attractiveness and can accelerate the development of technologies which benefits research and development efforts as they can be targeted more effectively.

The EMINENT tool which evaluates given ESTs makes use of three databases:

- Sectoral energy demand per country, this is information regarding the number of consumers per sector, type of demand, typical quality of the energy required and the consumption and installed capacity per end-user.
- Resource availability and prices per country.
- ESTs and other already commercial technologies, which includes key information on new energy technologies currently under development, and proven energy technologies available and in use.

Fig. 4 shows implementation of the interface of the main components in EMINENT.

Resource manager modifies, enters and selects data on resources in a country (electricity, fuels, geothermal, hydro, ocean tidal, wave and wind energy).

Demand manager describes energy demands per subsector in a country, modifies and enters new data, selects data for the technology assessment.

Technology manager contains key data for existing technologies and ESTs.

User input:

(i) The sectoral energy demands to which EST applied is to be evaluated.