

UPDATE AND EXPAND THE SCOPE OF BIOSYSTEMS ENGINEERING PROGRAMS OF STUDY PLACING EMPHASIS ON THE AREA OF BIO-FUELS, BIO- MATERIALS AND QUALITY OF PRODUCT IN MALTA

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Abstract

Malta has limited freshwater and land resources, a high population density and poor soil fertility making the country complete dependent on imports to satisfy national food requirements. The Institute for Prospective Technological Studies of the Joint Research Centre issued a report in 2003 in which it specifically states that Malta has a rather small territory, and notes that there is no potential for production of feedstock for either biodiesel (rapeseed or sunflower) or for bioethanol (wheat, sugar beet, maize or potatoes) production. Malta has no refineries, natural gas, gas network or interconnections. Malta is practically totally dependent upon imported fossil fuels for its energy needs. Coal for electricity generation used to be imported until the 1990s but was stopped for environmental reasons. Since Malta has negligible potential of agriculture-based biofuels production potential and is dependent on importation of fuel to meet its energy needs, there exists a strong motivator to find means to increase fuel diversity and to use renewable and indigenous energy sources.

The Malta Council for Science and Technology (2002) identified biotechnology as one of its priorities, specifically the need for Malta to develop the application of biotechnology to several areas including bio-fuels. The scarce availability of arable land and the limited supply of fresh water resources make the cultivation of crops for biomass production not a feasible or sustainable option. Industrial and domestic waste is the only substantial source of biomass. Malta is keen to exploit its potential biomass availability particularly in view of its total dependence on imported fuels and the environmental benefits of renewable energy sources. In this respect, Government policy is as follows:

- to reduce the quantity of waste and to encourage higher levels of reuse;
- to increase recycling and composting;
- further development of energy recovery technologies (anaerobic digestion);
- safe disposal of residues that cannot be otherwise managed.

Material recovery and composting is given a higher ranking than energy recovery in this strategy. The strategy envisages composting of biodegradable waste to reduce landfilling as far as possible. The industrial and municipal waste streams will be directed towards reuse and composting rather than biofuel production, with the exception of waste oil. One company (case study presented in Annex I) is collecting waste cooking oil and converted to biodiesel (Cassar G and A Sammut 2007).

Recently, interest in the production of biofuels using marine resources such as algae as raw material has also been expressed. Research is also underway to determine the feasibility of utilizing biomass from waste water to produce biogas during the treatment process to generate electricity.

The State of the Environment report (MEPA 2006) notes that in 2003 over 63% of the primary energy is used for power generation. The remaining oil consumption is mainly used for transportation (85%) and only a minor share is used for other purposes (15%). Heavy fuel oil and light distillate are used for power generation. Transport fuel consists of petroleum products and a small percentage of biodiesel (0.52%) (1.5 million litres of biodiesel).

The main centre for research in Malta is the University of Malta. In the past, people wishing to pursue PhD training or a research career had to go abroad. Huge efforts have been invested in the recent past to improve the research environment and increase opportunities. However, most specialists work alone, and rely on overseas colleagues for knowledge (Habeck, 2004). Past lack of investment in research and the small size of the research community have led to poor performance in terms of biotechnology publications per capita. However, citations per biotech publication are well above the EU average, suggesting that there is expertise in Malta and support from the new RTDI programme may provide the potential for Malta to contribute to the future growth of European knowledge in the field, especially through joint research with other European countries (Senker 2007).

There is no doubt that Malta can serve as a live test-bed for trials of a range of new technologies and / or system innovations. Europe is currently priming itself to make the transition to the bio-economy through the introduction of emerging technologies relating to the environment, energy and agriculture. Malta's small size and innovation-enthusiastic population makes the testing of such technologies particularly viable. Recently, a German consortium has shown interest in considering Malta as a location for a research institute that would focus on developing a strain of the jatropha plant which provides high yields of oil that can be used as a biofuel. The research will focus in developing high yielding hybrids adapted to our semi arid conditions. The shortage of arable land means that Malta and Gozo would never grow enough jatropha for processing, but it could produce hybrid seeds to sell for cultivation in Mediterranean countries.

At the undergraduate level, the Faculty of Engineering offers a very restricted list of credit options on the subject matter. Study Unit MME4109 – Nano and Biomaterials (5ECTS), has the objective to provide a balanced, insightful view of biomaterials where the classes of materials used in medicine will be outlined together with their applications in medicine, biology and artificial organs. Although biofuels and biomaterials are not main areas of degree specialization, engineering students have an opportunity to further develop these topics during their final year compulsory research projects. These projects are open-ended problems for which the aims and objectives must be defined, a programme of work delineated and then carried out in a structured way. The type of work, design, experimental, simulation analysis, etc will depend on the project specification and may concentrate more on one area than another or be multi-disciplined according to the knowledge gained by the student during the previous years of the course. However all projects are expected to have an element of design, implementation and testing. The project presentation and project report should demonstrate how well the student has achieved the intentions behind the work in relation to the project specification. The research interests of the department of Mechanical Engineering include the following:

- Pressure vessel design & structural integrity;
- Biomechanics;
- Heat Transfer;
- Internal Combustion Engine Simulation;
- Electronic Engine Controls;
- Wind Energy;
- Solar Energy;
- Environmental Engineering.

Further to the Faculty of Engineering, the University of Malta has also an Institute for Energy Technology. The aims of this Institute are to assist in the development of national energy plans through studies in the use of new and renewable energy sources and methods of energy conservation. It is also intended that the Institute should organise and participate in teaching programmes and research projects in the field of energy technology. Other objectives include the dissemination of appropriate methods and techniques relevant to the Institute's areas of interest and to design equipment adapted to local conditions.

This is carried out mainly by:

- analysis studies on the use of energy;
- determination of feasible measures to conserve energy;
- applications of renewable sources of energy;
- originating and participating in teaching and research projects;
- collaborating with other universities, industries and international bodies.

In June 2007 the first Maltese energy agency was set up: The Malta Intelligent Energy Management Agency (MIEMA). This agency brings together a wide array of public institutions and includes the University of Malta. MIEMA intends to foster and conduct research in the field, through collaboration with the University of Malta.

Activities programmed for the next three years include:

- Energy planning
- Green certificates
- Energy certification of buildings
- Energy saving on public lighting
- Studies to address the energy needs of industrial parks and micro-enterprises
- Studies to address the energy needs of tourism establishments
- Promotion of the use of biofuels and related projects (e.g., marine algae project)
- Dissemination of information about renewables at local and national levels.

ANNEX I

Case Study: Biofuels Production - Edible Oil Refining Co. Ltd. MALTA

Edible Oil Refining Co. Ltd. (EORC) started operations in the early 1950s and up to 1993 enjoyed a quasi-monopoly in vegetable oils in the Maltese internal market. With the liberalization process, the company started to gradually lose market share. In 2000 EORC embarked on a pilot project on the production of biodiesel from vegetable oils and fats. The company estimated that based on the total market sales of some 9,000 tons of material and taking into account European recovery statistics, the residual amount being disposed in the waste stream was some 3600 tons of fats and oils. During the trial period spanning over a 3 year period the company carried out in-house trials on its fleet to ensure that optimum product would be developed prior to its launch on the market. In 2004, EORC launched its biodiesel and sold some 150,000 litres, and surpassed 1.7 million litres in 2006. This process is the only source of indigenous production of biofuels in Malta, utilizing waste cooking oil which otherwise would have been dumped into the domestic sewers.

EORC implemented the following measures to recover cooking oils from the waste stream:

1. The catering sector was incentivized by offering up to 33% rebate in fresh oil for those clients returning used cooking oil.
2. A number of strategic partnerships were struck between EORC and key entities including:
 - (i) Malta Tourism Authority (MTA) where an audit trail and accountable system for all establishments processing and disposing of oils and fats were established. The document was also integrated and formed part of the licensing renewal conditions issued by the MTA.
 - (ii) Wasteserve Ltd. for the use of biodiesel by government entities and corporations and the launch of a household collection scheme.
 - (iii) Malta Hotels and Restaurants Association (MHRA) where members of MHRA were given special terms for the return of used oil.

To address quality issues in the production of biodiesel EORC together with the University of Malta (Department of Engineering) set up a testing and evaluation process to test the biodiesel produced. The Malta Standards Authority on its part also defined the quality norms for biodiesel to be sold in Malta.

Marketing and Raising Consumer Awareness

In marketing the product and to increase public awareness EORC implemented various measures. These included:

1. An agreement reached with Enemalta on the retailing of fuels for transport in licensed service stations.
2. Appointment of Malta's largest independent fuel distributor as its agent in the market for industry.
3. Setting up a sales team and invested in an educational programme through the ministry responsible for the environment.
4. Opening up of a dialogue channel with the Malta Resources Authority (the authority regulating the fuel sector in Malta) and reaching an agreement on the form and manner in which biodiesel could be sold in the absence of a liberalized market
5. Sending diesel mechanics overseas to get educated in bio diesel and its role

6. Hosting three national seminars where the general audience, as well as specific audiences (engineers and key stakeholders such as station owners) were targeted. Foreign speakers were also invited to attend during these seminars.
7. Joining Government's campaign on the "Clean the world";
8. Launching a mass media and public relations campaign.
9. A promotional and educational campaign was set up in schools where audio visual aids were used to support the project and its benefits. This included in station promotions where franchise girls in bio wear gave promotional material to young children. Consumers were educated on the use and application of biodiesel from an individual perspective as well as the environmental benefits associated with its use.

Government Incentives

Government on its part de-taxed biodiesel, and legislated its incorporation with fossil diesel at a maximum of 5% in line with the EU directive on the promotion of biofuels for road transport. Government also established a green procurement policy.

Project's Recognition, Key Outcomes and Results

Bio diesel can today be sourced from 46% of the stations in Malta and Gozo. The project is mopping up some 1200 tons of waste material produced locally which would have otherwise been thrown in the waste stream.

During 2005, total production of 100% biodiesel was around 1.492 Mlitres, of which 60% was used for transport purposes, and 40% for industrial use. The total amount of biodiesel sold for the transport sector was of 0.895 Mlitres. This increased compared to 0.18 Mlitres of biodiesel for road transport in 2004.

The project has also reached international acclaim when in 2005 it placed second in the BBC world challenge – (an international competition where 78 countries competed with 476 environmental projects) and sponsored by BBC World, Shell and Newsweek. The project was also featured in the Newsweek magazine and on BBC World.

The company has also attracted the participation in the world record breaking circumnavigation attempt being carried out in March / April 2007 and powered exclusively with 100% bio diesel. This will include the refuelling with biodiesel in Malta

The key issues which have contributed to the success of the project have been

- Research
- Product development
- Testing and road worthiness
- Education
- Marketing
- Promotion
- Institutional support and legislative modification.

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