11

Conclusion

11.1 GENERAL CONCLUSION

This book has examined in detail the selection process of biomass materials for the purpose of using them as a source of fuel. In the process, the study has presented an insight into the field of renewable energy, in general, and biomass energy, in particular. This book also provided a mapping process for a number of biomass samples, examining in four different steps the viability of each biomass sample in the initial stage of the first selection process. In addition to this, the book provided full details regarding the construction process of REA1 methodology in three successive chapters. The details related to the survey method results, as well as the results obtained via the application of the methodology have covered fifteen different biomass samples, in addition to the coal used as the main reference sample. Finally, an economic study of biomass energy, in general, and SFS scenario fuel, in particular, has provided a general guideline for a prospective biomass energy commercial enterprise.

11.2 Methodology (REA1) and Applications

Examining the overall subject of renewable energy can certainly provide additional insight into the strength and weakness of this new field of 'commercial' future energy sources. This book has reviewed a large number of research projects in this field that involved different people

with different backgrounds, various institutes, organisations and businesses. It looked at different and sometimes unexpected results and raised large numbers of questions. Consequently, the general conclusion is borne out here as a result of what is carried out and achieved in this book, i.e. a methodology which can work not just for biomass energy sources, but for a variety of renewable sources of energy, as well as for fossil fuels.

The methodology, therefore, can be applied as follows:

1. For any biomass or fossil fuels business, where biomass or fossil fuels selection is vital to their work. The REA1 application can be used either for the selection of fuels on a commercial basis or from a scientific and technical viewpoint, or for both of them at the same time;
2. For the purpose of selection of biomass materials for co-firing purposes;
3. For the purpose of selection in the production of various types of Bio-fuels, including those obtained from pyrolysis and gasification. With minor adjustments, the present methodology can be used as well for other types of renewable energy production process.

11.3 Why Biomass?

What's left is the final closing question, which is frequently asked and discussed during the work on this book and mentioned on a number of occasions, i.e. the summary of why should it

be biomass and not other forms of renewable sources of energy? Again, consider the question: 'Why should biomass energy work better than any other source of energy?' The answer is simple. When a methodology 'made to measure', so to speak, is applied and correctly calculates various factors associated with scientific, technical and business sides of biomass materials, then the result, in practical terms, can be achieved by any commercial business dealing with biomass energy alone and/or co-firing it with different type of fuels (see Section 2.1.5 and Section 2.2). How it is possible to conclude that biomass is the answer to the present increasing demand for global energy when the commercial long term case is still not yet fully proven? At the present time, much work and research across the globe is aimed at just that, i.e. at building the basis of what will be needed (now or later) in order to provide fast, accurate and affordable ways of employing the principles of biomass energy on a large commercial and international scale. The study of the basic principles of biomass energy sources and methods/mechanisms of applying it, made it desirable to put a case forward for a simple but comprehensive approach in the form of a new biomass methodology. As is well known, in any technology, no work is complete without the demonstration of practical application. Thus, Chapter Nine of this book has produced results from the methodology applications followed by Chapter Ten describing and examining the economical approach in general and details of the new bio-fuel in particular. The SFS is a designed hybrid fuel model added by the author at the end of this chapter (Figure 11.1).

11.4 Co-Firing and Power Generating

For biomass energy commercial production to establish itself and become an important source

of energy, i.e. competing at the same level as fossil fuels on the global market, regular awareness programs and support should be launched by international, national and local governments. The support programs should include solutions for co-firing problems and costs, as considered within various parts of this book. In a similar way, comprehensive support and publicity for some of the top biomass energy crops would act as another incentive for the farmers and power generating companies to take part in the above development. Biomass samples and other types of energy crop have been examined and analysed in Chapter Four.

The commercial biomass business is still lagging far behind biomass energy research. This is due to a number of reasons, but possibly the most significant is that biomass energy is not yet fully able to pay off large return dividends for potential investors. Yet, at the same time, large commercial companies do not want to be left behind when it comes to renewable energy in general, and biomass energy in particular, and therefore, they were among the first to start their own research in this field.

The survey method completed in this book has found out that a number of businessmen, engineers, researchers, and technicians (in the field of biomass energy) still believe that there is not enough support at the present time for co-firing methods, as well as for the bio-fuels industries, in general. For this reason, biomass business viability was among one of the most important factors answered and commented upon in the questionnaires. The survey also showed, indirectly, i.e. via face-to-face questions and answers, that co-firing is still one of the most popular and economical method used by the power generating companies, as a first step in introducing biomass materials for the purpose of generating electricity.

11

At the beginning of researching this book, only literature review materials available were the guideline for the BF and S&T methodology sections. By completing the survey method, a new source of data presented itself as a base for obtaining factual results. It is hoped that the above part of the report, which is very much the core in providing the final data in Chapter Eight and Chapter Nine, will play an important role as an example for the power generating companies using co-firing method, in the biomass materials selection process. The result also can be a good source for launching further developments and additional applications within the business, scientific and technical aspects of biomass, in general, and bio-fuels/co-firing, in particular.

11.5 The New Biomass Fuel (SFS)

The approach used throughout the past few years while researching this book is that a new type of biomass fuel should be the end result. This type of fuel should fulfil certain criteria, which present bio-fuels available on the market are still lagging behind. The characteristics of SFS bio-fuel have been investigated in Chapter Ten. Fulfilment of certain conditions, such as price, quality, availability, storage and so on, can be partly made from the number of biomass materials mixed together and the percentage of the mix up recipe needed for the SFS. The number of biomass materials needed for the mix has already been decided upon, i.e. between 4 - 5 samples. However, details of the percentage of the mix-up from each sample (methodology Two, i.e. REA2) would take this book beyond the scope of the present research. SFS can easily be blended with other type of fuels, just as in the case of using it for the co-firing, when biomass materials are blended with coal. The process works in the same way

when using SFS in a liquid and gas forms. Fortunately, the liquefaction of the SFS can be achieved without the use of additional energy, i.e. in the form of heating, such as the method used in pyrolysis.

11.6 The Future of Co-Firing and Biomass Energy

The growth of biomass as a source of energy in a number of countries is developing faster than many expected. For example, from 2003 to 2005, the market growth in biomass was 11.8%, and from 2004 to 2005 a growth of 16.1% in electricity production *(Ballard, 2007)*. These figures of growth have been supported by governments, which consequently, may not reflect a clear picture of how the growth of biomass energy industries would be, if there were no governmental support/intervention related to the biomass market.

Depending on the type of technology used and the type of biomass materials, the cost of producing energy from biomass materials can vary. Also, the type and capacity of the power plant have an important effect on the final cost. Reportedly, co-firing at the present is the most cost effective when it comes to the use of biomass materials *(US Department of Energy, 2009)*. Financial costs for projects which deal with co-firing can be small, in comparison with the cost of other types of renewable energy in that the co-firing ranges from 1 MW to 30 MW of biopower capacity, in which the cost itself can be recovered within two years when low-cost biomass fuels have been used *(US Department of Energy, 2009)*.

Regardless of whether co-firing is the best route for the power generating companies or there are other better routes, when it comes to using biomass as an alternative to co-firing in terms of cost, the future of biomass energy is still in the hands of the investors and, eventually, the

end users. What this means is that a confident market in the shape of stable investment and growing trading are both vital for the future of biomass energy and co-firing. Alongside them are the continuous developments in the scientific and technical aspects, which hopefully, can lead to a better quality fuel at a lower cost. At the same time, environmental protection should be the number one priority, as without this, the whole process of producing a new type of commercial fuel would bring us back to square one.

11.7 Final Results and Final Conclusion

The overall final conclusion for REA1 methodology factors and biomass samples can be summarised in the following points:

1. The study showed that within each factor of BF and S&T within the survey method, the accuracy was around 97%, i.e. an average error of 3%;
2. The study also showed that the average accuracy of BF and S&T sections is 96%, i.e. an average error of 4%;
3. For the methodology as a whole, the study showed that the average accuracy is 95%, i.e. an average error of 5%;
4. For S&T, the most important factor voted for was ‘energy’, while the lowest receiving votes have been given to ‘nitrogen emission’. For BF, ‘business viability’ received the highest number of votes, whiles the factor ‘land & water’ received the lowest number of votes;
5. The highest total fitness for S&T alone is for rapeseed (26%) while the lowest S&T total fitness is for switch grass (6%). For BF, the lowest is for rice and rapeseed meal (~13%),

the highest is for rapeseed (~26%);

6. The methodology results showed that rapeseed has the highest total final fitness (53%), while switch grass and rapeseed meal received the lowest total final fitness (21%);
7. The study has shown that the final top four biomass samples are: rapeseed, sunflower BS, Niger seed and apple tree wood (apple P);
8. From the top four (or five) biomass samples, the book outlined an approach for a new type of hybrid biomass fuel. This type of bio-fuel can be produced without significant impact on the local, national and international market. The SFS bio-fuel can be optimised at a level close to the positive quality of a fossil fuel, such as coal, i.e. the reference sample used in this book.

11.8 Positive Outlook

Visiting biomass businesses, power generating companies and attending conferences and workshops, the author has found a great deal of support and enthusiasm from researchers, businesses and power generating companies who deal, in one way or another, in the field of biomass energy. The general public support, therefore, for a sustainable environmentally friendly fuel is already there. What the general public would like to see is better global co-ordination and more investment in the field of biomass energy.

Some of the institutes and companies visited provided presentations and training on a number of issues related to renewable energy. This in turn has contributed directly and indirectly to the research itself in various positive ways. Consequently, the above has made the next step

of continuing this research in this field, to a more specialised level (i.e. for developing SFS) is vital, rather than allowing it to be left on a shelf, as part of a report, accumulating dust.

1.9 What Next?

Despite all the difficulties and changes which have taken place during four years of research in compiling this book, the work successfully has been completed on time, providing a useful contribution in the form of practical results. These results will benefit everyone who took part in this research, as well as those who are working in the same or related fields.

The details provided in this book should not be forgotten or ignored, especially when the time comes for another decision by the power generating companies to increase further (at a higher percentage - ROC) the usage of selected biomass materials for the purpose of generating electricity.

This book has provided factual figures indicating that the prospect of biomass materials can be part of a wider commercial energy use. This prospect is possible to achieve, worldwide. However, trading biomass energy on 'international' level, similar to present day fossil fuels global trading, can only happen when additional investments, further research and international laws and policy, in this field, are already in place.

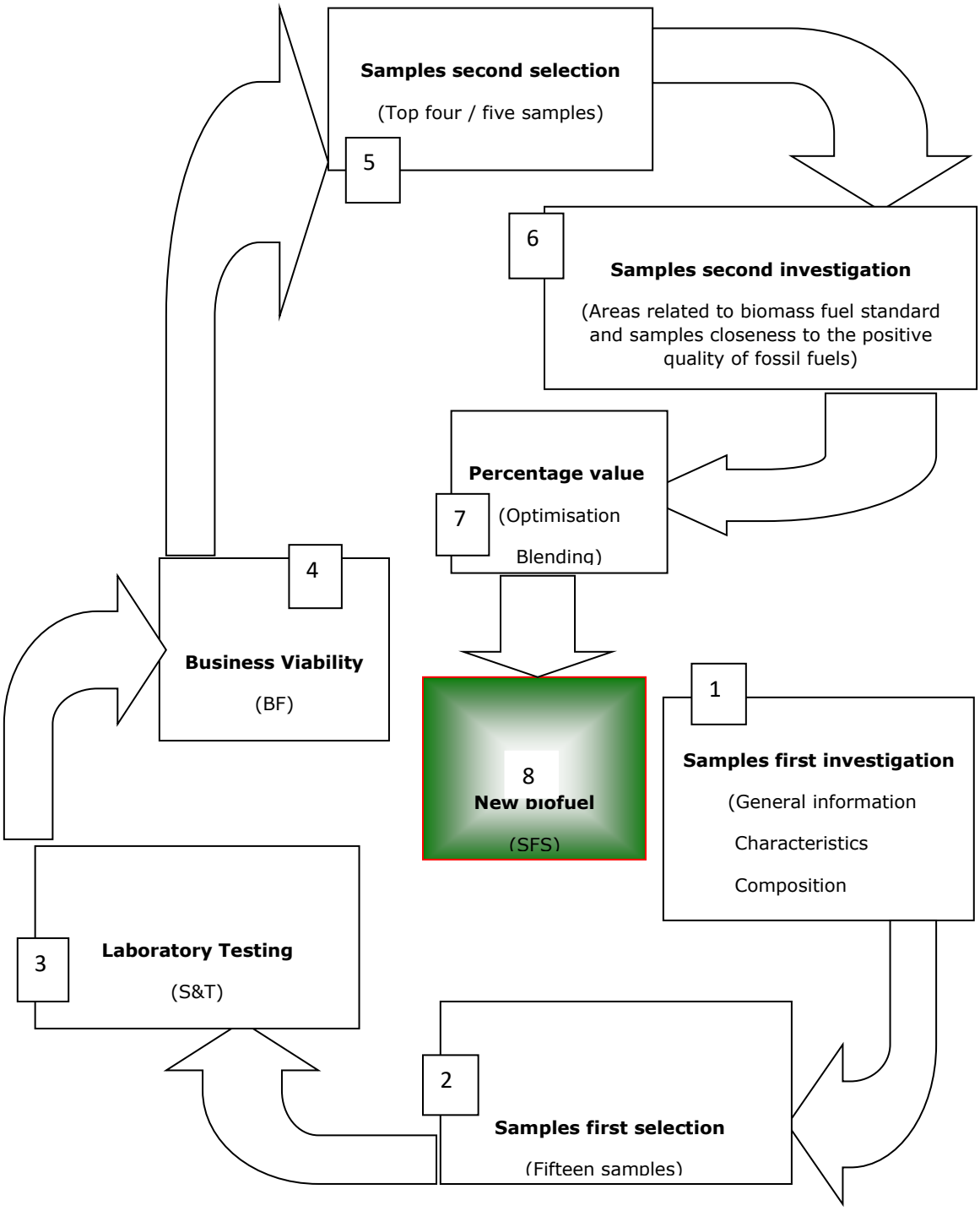

Figure 11.1 Selection model for biomass materials (leading to the production of SFS biofuel)

(Source: Author)

11

11.10 References

Ballard G. (2007) Opportunities for biomass energy programmes – experiences & lessons learned by UNDP in Europe & the CIS. Final report.

US Department of Energy (2009) State energy alternatives - biomass energy. Energy efficiency and renewable energy

http://apps1.eere.energy.gov/states/alternatives/biomass.cfm 26.4.2009