SWINBURNE UNIVERSITY OF TECHNOLOGY

School of Engineering and Science

Quantification of Greenhouse Gases at Visy Industries using Life Cycle Assessment

February 2001

Submitted for the Degree of Master of Applied Science

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Abstract

Greenhouse gases (GHGs) are vital components of the earth's atmosphere, trapping heat around the earth, maintaining temperatures necessary for human existence. Until the Industrial Revolution, these gases existed in a *natural* equilibrium with the environment. Since that time, anthropogenic activities such as fossil fuel burning and land clearing have increased the quantity of GHGs, such as carbon dioxide (CO_2) and methane (CH_4), in the earth's atmosphere. Evidence indicates that global warming is occurring as a result of the additional accumulation of GHGs in the atmosphere.

International response to climate change resulted in the 1997 development of the Kyoto Protocol. If the Protocol is ratified, developed countries will be legally bound to reduce their GHG emissions in accordance with negotiated emission reduction targets. At the beginning of the year 2001, the Protocol was still to be ratified.

With the possibility of future GHG emission restrictions, some Australian companies have started quantifying their GHG emission levels. One such company is Visy Industries, the largest privately owned paper packaging manufacturing company in the world. Visy's core business is the manufacture of cardboard boxes from recycled paper. As part of its future operations, a kraft pulp and paper mill is presently being built in New South Wales, Australia.

The environmental decision support tool, Life Cycle Assessment (LCA), was used to quantify Visy's CO_2 and CH_4 emissions across the entire life cycle of the Visy paper recycling and virgin papermaking processes. Commercially defined LCA models were developed for both papermaking processes.

GHG emissions estimated by each model were compared and the effect of different energy sources, technologies and manufacturing processes on CO_2 and CH_4 emissions were assessed. The majority of emissions in the two Visy papermaking models were due to fossil fuel derived energy sources and the decomposition of wood fibre in Solid Waste Disposal Sites (SWDSs). Results were used to propose appropriate GHG reduction strategies and business opportunities.

GHG reduction strategies included increasing the use of renewable energy, reducing the volume of solid waste rejects sent to SWDS, incinerating solid waste rejects with energy recovery and sourcing steam from third party providers. Proposed GHG business opportunities included increasing the production of Greenpower from the pulp and paper mill for sale to the grid.

This thesis is an example of the practical application of current GHG knowledge and LCA methodology that was undertaken in an environment where technical, political and commercial guidelines at both a national and international level were still evolving. Nevertheless, the thesis is not a critical review of LCA methodology.

The LCA *support* tool was able to quantify CO_2 and CH_4 emissions across the life cycle of the Visy recycling and virgin papermaking processes. The chosen functional unit, the assumptions and exemptions made, and the placement of the system boundaries, were found to be critical to the Visy LCA results.

Acknowledgments

The author wishes to sincerely thank the following people:

Mr Richard Pratt, Chairman of Visy Industries and Mr Ned Colo, CEO, Visy Paper, for their support and encouragement of the research.

Mr Ron Dawson (Visy Group Research and Development Manager) and Mr Ron Hardwick (Visy Group Technical Consultant) for providing invaluable support and encouragement throughout the entire project. They freely gave their time and knowledge of the Visy papermaking processes, provided access to Visy data and operations, and patiently answered the many questions the author always had.

Ms Julia Lamborn and Dr Graeme Frecker for their guidance and patience during the writing up of this thesis. Their constructive and challenging questions not only made discussions lively and stimulating, but also kept the author continuously focused on the goals of the research. For the rest of her life, the author will forever ask the question 'what am I trying to say' whenever pen is put to paper. Discussions over coffee will be greatly missed!

Finally, the author wishes to acknowledge her family, for their patience and total support. A special thank you must go to my husband Philip, for his interest in the research, supplies of endless cups of tea, encouragement and constant reminders that there is life after writing a thesis. Hopefully, he can now start planning weekends away!

Declaration

I hereby declare that this thesis contains no material that has been accepted for the award of any other degree or diploma in any University or College of Advanced Education in Australia or in other countries.

To the best of my knowledge, all material previously published or written by another person has been referenced in the text of the thesis.

The conception of an initial LCA framework for both the Visy paper recycling and virgin processes was a joint collaboration between Energetics Pty. Ltd and me. This collaboration resulted in the production of two Visy internal documents (Energetics Pty Ltd & Wiegard 1998a & 1998b). I was solely responsible for all subsequent research and modelling.

Jean Wiegard

February 2001

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Abbreviations used throughout this thesis

AGO	Australian Greenhouse Office
CAMFor	Carbon Accounting Model for Forests
CBA	Cost Benefit Analysis
CERs	Certified Emission Reductions
CFCs	Chlorofluorocarbons
CNG	Compressed Natural Gas
CO_2(e)	Carbon dioxide equivalent
COP	Conference of the Parties
CSIRO	Commonwealth Scientific and Industrial Research Organization
DOC	Degradable Organic Carbon
DOC_F	Dissimilated Degradable Organic Carbon
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMS	Environment Management System
EPA	Environment Protection Agency
ESAA	Electricity Supply Association of Australia
FCCC	Framework Convention on Climate Change
GCO	Greenhouse Challenge Office
GCV	Gross Calorific Value
GHG	Greenhouse Gas
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
LCA	Life Cycle Assessment

LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
LFG	Landfill Gas
LPG	Liquid Petroleum Gas
MRF	Material Recovery Facility
NGS	National Greenhouse Strategy
NGGI	National Greenhouse Gas Inventory
NOAA	National Oceanic and Atmospheric Administration
OCC	Old Cardboard Cartons
RECs	Renewable Energy Certificates
SETAC	Society of Environmental Toxicology and Chemistry
SWDS	Solid Waste Disposal Site
t	tonne
TAPPI	Technical Association of the Pulp and Paper Industry
UNEP	United Nations Environment Program
UNFCC	United Nations Framework Convention on Climate Change
WCED	World Commission on Environment and Development
WCP	World Climate Program
WMO	World Meteorological Organization
WWTP	Waste Water Treatment Plant