

December 2007

Greenhouse gas abatement programs in Melbourne's north 2007



NORTH Link/NIETL and RMIT University
GREENHOUSE CHALLENGE SUPPORT PROGRAM FINAL REPORT

NORTH Link/NIETL

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Foreword

NORTH Link/NIETL and RMIT University are pleased to announce the successful completion of the student projects on emission reduction, related capacity building, awareness raising and promotional activities for Greenhouse Challenge Plus members in Melbourne's north within the 2007 Greenhouse Challenge Support program.

We present this final report to the Australian Greenhouse Office on behalf of the northern region of Melbourne and are once again delighted with the results achieved in this fourth year of the program.

NORTH Link/NIETL is confident that the results achieved not only fully meet the requirements set, but have also exceeded expectations of energy and greenhouse-gas emission reduction.

The project has resulted in an increased number of enthusiastic advocates for emission reduction activities, including in particular:

- The thirteen companies that have hosted student projects in 2007, in addition to the thirty one companies involved in the 2004, 2005 and 2006 programs, now have a much higher commitment to energy reduction
- Eleven final year Bachelor of Engineering students, ten undergraduate students from other disciplines (Social Science, Business and Industrial Design), and four Master of Engineering students (further to the 46 students involved over the previous three years) possess the skills, ability, willingness and commitment to identify, research, cost and implement energy reduction measures for their future employers. These students will undoubtedly carry these skills forward to their full-time employment upon graduation and convince many more businesses to undertake energy reduction measures

Acknowledgements

The completion of such a project within such a short period of time would not have been possible without the efforts of many, including:

Students

The eleven final year Bachelor of Mechanical Engineering students, the three Bachelor of Business students, the three Bachelor of Industrial Design students, the four Bachelor of Social Science students, and the four Master of Engineering (Sustainable Energy) students from RMIT University who worked so enthusiastically to complete the projects and who presented their findings with such flair and confidence at the public presentation to industry.

Companies

The thirteen companies which hosted the energy-reduction research projects for students and who provided the support and mentoring that helped achieve the outstanding results documented in this report. The forty companies who participated in the outreach support strategy program.

RMIT University

RMIT University staff from the School of Aerospace, Mechanical and Manufacturing Engineering who assisted in the development and implementation of the program especially:

- Dr John Andrews, Project Leader and Senior Lecturer
- Dr Andrea Bunting, Lecturer
- Professor Aleksandar Subic, Discipline Director
- Professor Aliakbar Akbarzadeh, Research Group Leader
- Ms Anne Badenhorst, Director Community & Regional Projects

The assistance of Biddiyut Paul, a PhD student in the school, and Bhaumik Dholakiya who has just completed the Master of Engineering (Sustainable Energy) degree at RMIT, in the preparation of this final report is also gratefully acknowledged.

Australian Greenhouse Office

Our appreciation is extended to the Australian Greenhouse Office for providing the funding that has made the program possible, and in particular to Ross Carter, Assistant Secretary, Industry Partnerships Branch AGO, John Wyatt and David Liversidge, Senior Advisers, Greenhouse Challenge Plus Program AGO, for their assistance in the industry seminar and administration of the program.

Mick Butera
Executive Director
NORTH Link/NIETL

Executive Summary

NORTH Link/NIETL and RMIT University have been actively engaged in greenhouse emission reduction activities, in partnership with the Australian Greenhouse Office, since 1998 and have achieved many successes over that period.

In December 2006, NORTH Link/NIETL was again contracted by the Australian Greenhouse Office to provide assistance to Greenhouse Challenge member businesses in the northern region of Melbourne, following on from the success of the similar programs in 2004, 2005 and 2006.

The School of Aerospace, Mechanical and Manufacturing Engineering at RMIT University was subsequently engaged to assist NORTH Link/NIETL in setting up and supervising undergraduate student projects involving fourth year Bachelor of Engineering (Mechanical and Aerospace) students, and postgraduate Master of Engineering (Sustainable Energy) students working with selected firms, on the technical and financial evaluation of the implementation of identified emission-reduction measures.

In addition this year, with the assistance of internal funding support from RMIT's Design the Future program, a number of undergraduate students from other disciplines, namely Business, Social Science and Industrial Design, were invited to join undergraduate engineering students multidisciplinary projects with selected firms.

Hence in total this year, twenty-five RMIT students from four different disciplines have conducted projects with thirteen firms located in Melbourne's north. The participating students comprised of eleven final-year Bachelor of Mechanical Engineering students, three final-year Bachelor of Business students, three final-year Bachelor Industrial Design students, four final-year Bachelor of Social Science students, and four Master of Engineering (Sustainable Energy) students. Overall, the research conducted by the students has been a great success with all participating firms set to make large energy savings as well as cutting greenhouse gas emissions.

If all the measures recommended by the twenty-one RMIT Bachelor of Engineering, Business, Industrial Design and Social Science students, and four Master of Engineering (Sustainable Energy) students involved are implemented, the thirteen firms in this year's program could cut their collective annual greenhouse gas emissions by a massive 46 000 tonnes of carbon dioxide equivalent.

However, it must be noted that in some cases (such as RMIT Property Services, VicUrban and Moreland Energy Foundation Ltd) the estimated emission reductions assume application of the measures studied in typical units on a much more widespread scale and in other cases the measures involved do have a very long payback period (for example, VicUrban and Foster's Group).

If these cases are not counted, the total potential emission reduction is reduced to 27 000 tonnes per year, still a very sizeable reduction.

At the same time, the firms remaining will cut their energy bills by nearly \$1 million per year, for a total capital investment of just over \$4 million.

The emission reductions of the 2007 program have thus considerably exceeded even last year's record achievements, when participating businesses were presented with opportunities to cut their annual greenhouse gas emissions by some 12 000 tonnes.

In view of the continued success of the program in achieving emission reductions, financial savings to firms and raising awareness and expertise among students in this area, it is therefore recommended that:

A similar program involving undergraduate and postgraduate student projects on emission reduction be provided again in 2008 to assist additional firms to achieve best practice in energy efficiency and low-emission production and more importantly, to create a "movement" and critical mass of firms in the northern region of Melbourne that are proactive in emission-reduction activities.

Executive Summary (continued)

| Company | Project | Students | Projected emission reduction (tonnes/y) | Annual savings in fuel bills (\$'000) | Capital costs (\$'000) | Payback period (years) |
|---------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|---------------------------------------|------------------------|------------------------|
| Caterpillar | Follow-up of energy efficiency opportunities identified in energy audit; solar lighting for external environment | Darrel Wolter (B Mech Eng) | 2 073 | 95 | 168 | 2 |
| City of Darebin | Cogeneration at Northcote Aquatic and Recreation Centre | Andrew Tran (B Mech Eng) | 1 900 | 68 | 550 | 8 |
| Edlyn Foods | Energy-efficient design for new food factory | Inge Sarunic (M. Eng Sustainable Energy) and Christoph Begert (M. Eng Sustainable Energy) | 640 | 47 | 172 | 4 |
| Foster's Group | Solar thermal steam production and additional insulation | Robert Leo (B Mech Eng) Colin Toohey (B Mech Eng) | 7 200 | 470 | 21 400 | >40 years |
| Honda Australia | Follow-up energy-efficiency opportunities identified in earlier audit | Karthikeyan Balasubramaniam (M Eng Sustainable Energy) | 34 | na | na | na |
| Hotel Sofitel* | Energy audit of building and follow up, including window films, working with BAS system and energy educational program for staff | Shane Bartlett (Bachelor of Engineering); Mei Soon (Bachelor of Business); Pui Sze (Bonnie) So (Bachelor of Design) | 1 500 | 76 | 244 | 3 |
| Moreland Energy Foundation Limited* | "Take Action" project, working on reducing emissions associated with water heating in residential buildings | Mark Salera (Bachelor of Engineering); Arief Rabik (Bachelor of Social Science - Environment); Shaun van Oorde-Grainger (Bachelor of Design) | 6 600 | na | na | na |
| Orica | Energy audit of chlor-alkali plant and follow-up; investigation of use of hydrogen currently vented to atmosphere in fuel cells to supply electricity and heat | Andrew O'Dea (B Mech Eng) | 16 000 | 500 | 3 000 | 6 |
| Rio Tinto | Building energy management, including window films, energy-efficient lighting, passive-solar conservation features. Link to ISO140001 certification | Brett Heron (B Mech Eng) | 300 | 21 | 90 | 5 |
| RMIT University (Property Services)* | Reducing emissions from energy use in selected RMIT buildings | Luke Zha (Bachelor of Engineering); How Seong (Gideon) Ng (Bachelor of Business); Mark Whiting (Bachelor of Design) | 4 000 | 200 | 200 | 1 |
| South Pacific Tyres* | Energy audit and follow up opportunities; including addressing workplace practices associated with energy usage. | Tim Slingsby (Bachelor of Engineering); Bexx Steel (Bachelor of Social Science - Environment); Zoe Paisley (Bachelor of Social Science - Environment) | 4 400 | 175 | 23 | 0.2 |
| VicUrban* | Sustainable energy opportunities in new fringe suburban development | Ben Criddle (Bachelor of Engineering); Yong Kuorwel (Bachelor of Social Science - Environment); Chee Yuen Kong (Bachelor of Business) | 1 000 | 170 | 3 600 | 20 |
| Yarra Trams | Energy saving through regenerative braking on trams | Ricardo Figari (M. Eng (Sustainable Energy)) | na | na | na | na |
| TOTALS | | | 45 647 | 1 822 | 29 447 | |
| TOTAL without long payback periods** and omitting widespread implementation*** | | | 26 847 | 982 | 4 247 | |

Notes

Na: Not available

* Multidisciplinary project

** Foster's Group and VicUrban omitted

*** RMIT Property Services and Moreland Energy Foundation Ltd omitted

1 Introduction

Following the successes of its 2004, 2005 and 2006 Greenhouse Challenge Support Programs, NORTH Link/NIETL was again contracted in December 2006 by the Australian Greenhouse Office to assist selected firms in the northern region of Melbourne that were signed up to the Commonwealth Government's Greenhouse Challenge Plus program, in the achievement of their greenhouse-gas emission reduction targets during 2007.

The School of Aerospace, Mechanical and Manufacturing Engineering at RMIT University was engaged by NORTH Link/NIETL to set up and supervise student projects involving fourth-year Bachelor of Engineering (Mechanical and Aerospace) students and postgraduate Master of Engineering (Sustainable Energy) students working with selected firms, on the technical and financial evaluation and implementation of identified emission-reduction measures. As part of this work:

- Two seminars were to be held to:
 - Introduce firms, students and RMIT staff to the program
 - Allow students to present their findings and outcomes to invited representatives from Greenhouse Challenge firms in the northern region of Melbourne
- Student reports and findings were to be presented to firms as part of the final report to the Australian Greenhouse Office for wider dissemination

In addition this year, with the assistance of internal funding support from RMIT's Design the Future program, a number of undergraduate students from other disciplines, namely Business, Social Science and Industrial Design, were invited to join undergraduate engineering students to undertake multidisciplinary projects with selected firms.

The agreed activities and outcomes to be delivered by RMIT University were as follows:

| Activity/Outcome | Date of completion |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Establishing undergraduate engineering student projects involving students working with selected northern-region Greenhouse Challenge, on the technical and financial evaluation and implementation of identified greenhouse-gas emission-reduction measures | 19 March 2007 |
| Project Proposal, including definition of project scope, activities, and Gantt chart project schedule (15% marks – S1) | Friday 23 March 2007 (end of week 4, semester 1) |
| Seminar/training session 1: <ul style="list-style-type: none"> • For all potential and agreed participants in the student project program – students, RMIT academic staff supervisors and company representatives • Provide background information on greenhouse issues and the Greenhouse Challenge program • Outline projects to be conducted and procedures • Deal with queries from participants | Friday 30 March 2007, 8-10 am (date to be confirmed) |
| Progress report: draft to date of summary report, including introduction, methodology, findings to date (incorporating literature review), actual progress compared to planner and projections to completion (15% of total marks – S1) | Friday 4 May 2007 (end of week 9) (NB later than in MIET2117 course guide) |
| Summary report: submission of summary report to go to company (note this will replace the Project Introduction as defined in the course guide for this course) (40% of marks – S1) | Friday 22 June 2007 |
| Seminar/training session 2: <ul style="list-style-type: none"> • For all participants in the student project program, plus targeted/interested representatives from other firms • Overview and update on greenhouse issues, the Greenhouse Challenge program • Short presentation of individual project outcomes by students, including (30% of total marks – S1) (replaces poster presentation) • Presentation by RMIT Program Leader on overall outcomes of the student project component of the program, including: <ul style="list-style-type: none"> – Overall abatement achieved by the projects to date and future abatement predicted – Potential for transferring actions/projects to other organisations and situations – Examples of interesting technical and other issues that arose and achievements in addressing these – Commentary on significant greenhouse abatement actions more generally • Open discussion on lessons learnt from this program, greenhouse issues and future opportunities for abatement | Friday 20 July 2007 (date to be confirmed) |
| Thesis progress report (10% of marks – S2) | 10 August 2007 (end of week 4 semester 2) |
| Final project report in the form of a thesis for RMIT assessment (60% of marks – S2) | 5 October 2007 (end of week 11, semester 2) |
| Oral presentation and examination (30% of marks – S2) | 22 – 26 October 2007, during week 14, semester 2 |

The present report describes the activities conducted within and the outcomes from the NORTH Link – RMIT Greenhouse Challenge Support program in 2007 conducted by RMIT.

2 Student Projects on Emission Reduction

2.1 Setting up the projects

Selection of the firms to host student projects on emission reduction was accomplished as follows:

- Letters were sent to Greenhouse Challenge firms in the northern region of Melbourne from NORTH Link/NIETL's database inviting them to host a student research project on emission reduction
- These letters were then followed up with personal phone calls to chief executives or their nominees by Mick Butera, Executive Director of NORTH Link/NIETL, and Dr John Andrews of RMIT, to explain the program and encourage participation
- Dr Andrews and in some cases Dr Andrea Bunting, then visited all the short-listed firms to explain what would be involved in hosting a project and gaining provisional agreement for their participation in the program
- The list of thirteen firms was then finalised and a letter sent by NORTH Link/NIETL to the firms for countersigning by the CEO, formally agreeing to host a student project

RMIT Mechanical, Manufacturing and Aerospace Engineering students have a choice as to topic selection for their final year project. The Greenhouse Challenge option was in competition with a range of other opportunities. In total there are over 100 students undertaking their final projects this year. The final year students to be involved in the Greenhouse Challenge Support Program were thus selected through the following procedures:

- A presentation by Dr Andrews of the opportunity at RMIT, in an information session to all (then) third year students in October 2006
- Advertisement of the opportunity at RMIT in February 2007
- Lecturers contacting students to encourage them to participate
- Eleven B. Eng. students signed up to be involved with Greenhouse Challenge projects
- Students were asked to sign confidentiality agreements so that no information confidential to their host firms is released in their project reports, while safeguarding their right to complete their theses for examination

In 2007, postgraduate students undertaking the Master of Engineering (Sustainable Energy) program by coursework at RMIT were also given the opportunity to conduct course projects with firms in the Greenhouse Challenge Support program. Four mature-age students enthusiastically took up this option.

In the multidisciplinary project running this year as part of the overall program, three final-year Bachelor of Business students, three final-year Bachelor Industrial Design students, four final-year Bachelor of Social Science students, also chose to do their final year projects within the Greenhouse Challenge Support program.

Thus in total 25 students participated in this year's program, the largest number to date.

Students were assigned to particular companies taking into account so far as possible the preferences they expressed. Each of the thirteen firms was then visited by Dr John Andrews with the assigned student(s) and Dr Andrea Bunting in the case of the multidisciplinary projects, to introduce them to their company supervisor and agree on the ongoing working arrangements.

The final year project component of the Bachelor of Mechanical Engineering and Bachelor of Aerospace Engineering at RMIT requires the submission of two milestone reports, with a final thesis due at the end of September. A special deadline of 30 June was set for the Greenhouse Challenge students for completion of an overview report on their research and submission to the participating company and the Australian Greenhouse Office. Students also committed to giving a presentation on their report at the final seminar held at RMIT at the beginning of semester 2 in July 2007. Students, however, continued their work with their companies until September to complete their theses giving a more detailed report on the research work done. The Master of Engineering (Sustainable Energy) students undertook their projects as part of the course Sustainable Energy Systems and Design in semester 1 of the year. Their work on the program finished at the end of this semester in late June 2007. The work on the multidisciplinary projects by the students from Business, Social Science and Industrial Design was also for one semester only, in line with the requirements of their respective courses and thus also was finalised by the end of June 2007. The B. Eng students involved in the multidisciplinary projects, however, continued their investigations until the end of semester 2 in October 2007.

The main RMIT staff involved with the program this year were Dr John Andrews (Program Leader and Senior Lecturer), Dr Andrea Bunting (Lecturer), Energy Group and Professor Aleksandar Subic (Mechanical and Automotive Discipline Leader). In addition, Ms Friederika Kaider from the School of Management, Mr Malte Wagenfeld from the School of Architecture and Design and Dr Ruth Lane from the School of Global Studies, Social Science and Planning participated in the multidisciplinary project component of the overall program.

2 Student Projects on Emission Reduction (continued)

2.2 Projects Initiated

Specifically the following projects were initiated within the program, involving twenty five students working with thirteen firms from the northern region of Melbourne:

| Company | Project | Students |
|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Caterpillar | Follow-up of energy efficiency opportunities identified in energy audit; solar lighting for external environment | Darrel Wolter (B Mech Eng) |
| City of Darebin | Cogeneration at Northcote Aquatic and Recreation Centre | Andrew Tran (B Mech Eng) |
| Edlyn Foods | Energy-efficient design for new food factory | Inge Sarunic (M. Eng Sustainable Energy) and Christoph Begert (M. Eng Sustainable Energy) |
| Foster's Group | Solar thermal steam production and additional insulation | Robert Leo (B Mech Eng) Colin Toohey (B Mech Eng) |
| Honda Australia | Follow-up energy-efficiency opportunities identified in earlier audit | Karthikeyan Balasubramaniam (M Eng Sustainable Energy) |
| Hotel Sofitel* | Energy audit of building and follow up, including window films, working with BAS system, and energy educational program for staff | Shane Bartlett (Bachelor of Engineering); Mei Soon (Bachelor of Business); Pui Sze (Bonnie) So (Bachelor of Design) |
| Moreland Energy Foundation Limited* | "Take Action" project, working on reducing emissions associated with water heating in residential buildings | Mark Salera (Bachelor of Engineering); Arief Rabik (Bachelor of Social Science - Environment); Shaun van Oorde-Grainger (Bachelor of Design) |
| Orica | Energy audit of chlor-alkali plant and follow-up; investigation of use of hydrogen currently vented to atmosphere in fuel cells to supply electricity and heat | Andrew O'Dea (B Mech Eng) |
| Rio Tinto | Building energy management, including window films, energy-efficient lighting, passive-solar conservation features. Link to ISO140001 certification | Brett Heron (B Mech Eng) |
| RMIT University (Property Services)* | Reducing emissions from energy use in selected RMIT buildings | Luke Zha (Bachelor of Engineering); How Seong (Gideon) Ng (Bachelor of Business); Mark Whiting (Bachelor of Design) |
| South Pacific Tyres* | Energy audit and follow up opportunities; including addressing workplace practices associated with energy usage | Tim Slingsby (Bachelor of Engineering); Bexx Steel (Bachelor of Social Science - Environment); Zoe Paisley (Bachelor of Social Science - Environment) |
| VicUrban* | Sustainable energy opportunities in new fringe suburban development | Ben Criddle (Bachelor of Engineering); Yong Kuorwel (Bachelor of Social Science - Environment); Chee Yuen Kong (Bachelor of Business) |
| Yarra Trams | Energy saving through regenerative braking on trams | Ricardo Figari (M. Eng (Sustainable Energy)) |

*The projects with Hotel Sofitel, RMIT Property Services, South Pacific Tyres, VicUrban and Moreland Energy Foundation Ltd (asterisked in the above table) involved multidisciplinary teams of students.

The first seminar in the student project component of the program was held on Tuesday 3 April 2007 in RMIT's Renewable Energy Centre on the Bundoora East campus. This seminar provided an update on the climate change issue internationally and nationally, and an overview of the student project component of the overall program. It also allowed students and company representatives to meet as a whole group and swap ideas and contacts.

The invitation to this seminar is included in Appendix B.

2.3 Student Presentations to Companies

All twenty-five of the projects have been completed as required in the contract with NORTH Link.

The students made five-minute PowerPoint presentations on their projects and the main findings, including the emission reductions identified and the financial assessment of those measures, at a seminar held at RMIT on Friday 20 July 2007. The invitation and agenda for this seminar are included in Appendix B. The seminar was very successful, attended by over thirty representatives of Greenhouse Challenge Plus firms in the northern region of Melbourne, along with ten RMIT staff, plus the twenty-five students involved in projects. Mr Ross Carter, Assistant Secretary Industry Programs Partnerships Branch AGO, Mr John Wyatt and Mr David Liversidge, Senior Advisers, Greenhouse Challenge Plus Program AGO and Mr Gerry Neylan, Chairperson of NORTH Link also attended. After each student presentation, their company supervisor gave a short comment on the company's experience with the program and their intentions with regard to implementation of the recommended emission-reduction measures. All spoke in a very positive way about the benefits of their project and commitments to putting into practice the recommendations. Dr Andrews offered comments and suggestions on the transferability of the findings to other firms.

A CD-ROM containing electronic copies of these PowerPoint presentations has been provided to the Australian Greenhouse Office.

2.4 Findings from Research Projects

The main findings from each of the research projects are presented in the following table. The estimated reduction in annual greenhouse gas emissions for each measure investigated is presented, together with its capital cost, estimated annual savings and simple payback period.

| Company | Project | Students | Projected emission reduction (tonnes/y) | Annual savings in fuel bills (\$'000) | Capital costs (\$'000) | Payback period (years) |
|---------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|---------------------------------------|------------------------|------------------------|
| Caterpillar | Follow-up of energy efficiency opportunities identified in energy audit; solar lighting for external environment | Darrel Wolter (B Mech Eng) | 2 073 | 95 | 168 | 2 |
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| Honda Australia | Follow-up energy-efficiency opportunities identified in earlier audit | Karthikeyan Balasubramaniam (M Eng Sustainable Energy) | 34 | na | na | na |
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| Orica | Energy audit of chlor-alkali plant and follow-up; investigation of use of hydrogen currently vented to atmosphere in fuel cells to supply electricity and heat | Andrew O'Dea (B Mech Eng) | 16 000 | 500 | 3 000 | 6 |
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| Yarra Trams | Energy saving through regenerative braking on trams | Ricardo Figari (M. Eng (Sustainable Energy)) | na | na | na | na |
| TOTALS | | | 45 647 | 1 822 | 29 447 | |
| TOTAL without long payback periods** and omitting widespread implementation*** | | | 26 847 | 982 | 4 247 | |

Notes

Na: Not available

* Multidisciplinary project

** Foster's Group and VicUrban omitted

*** RMIT Property Services and Moreland Energy Foundation Ltd omitted

2 Student Projects on Emission Reduction (continued)

Overall, the research conducted by the students this year has been a great success with all participating firms set to make large energy savings as well as reducing their greenhouse gas emissions.

If all the measures recommended by the twenty-one RMIT Bachelor of Engineering, Business, Industrial Design and Social Science students, and four Master of Engineering (Sustainable Energy) students involved are implemented, the thirteen firms in this year's program could cut their collective annual greenhouse gas emissions by a massive 46 000 tonnes of carbon dioxide equivalent.

However, it must be noted that in some cases (such as RMIT Property Services, VicUrban, and Moreland Energy Foundation Ltd) the estimated emission reductions assume application of the measures studied in typical units on a much more widespread scale and in other cases the measures involved do have a very long payback period (for example, VicUrban and Foster's Group).

If these cases are not counted, the total potential emission reduction is reduced to 27 000 tonnes per year, still a very sizeable reduction.

At the same time, the firms remaining will cut their energy bills by nearly \$1 million per year, for a total capital investment of just over \$4 million. Most of the measures have payback periods of less than five years and some with very short paybacks.

The emission reductions of the 2007 program have thus considerably exceeded even last year's record achievements, when participating businesses were presented with opportunities to cut their annual greenhouse gas emissions by some 12 000 tonnes. Interestingly, however, the collective fuel bill savings this year - \$1.8 million/year for all the firms and measures, and just under \$1 million/year for the reduced list omitting long payback measures and those requiring widespread implementation beyond the unit studied - were lower than the total projected savings of \$3 million/year from all the measures last year. Hence, on average the financial savings per tonne of emission reduction this year were much lower than those in 2007. One explanation for this is that the single largest emission reduction this year, at Orica, saved electricity at a relatively low unit price. In addition, one of the major financial savings last year, at The Age Print Centre, involved substantial material and operational cost reductions over and above the reductions in energy costs.

A short summary of each research project is provided in Appendix A, including the project aims, company profile, method, emission reduction and financial analysis.

2.5 Overview Reports on Research Projects

A CD ROM containing a set of overview reports on all the student research projects has also been forwarded to the Australian Greenhouse Office. These reports will be in a form suitable for and have all the necessary approvals for public dissemination.

2.6 Company Comments on the Program

The following are comments on the program from some of the industry supervisors involved this year:

“I wish to thank RMIT and NORTH Link for allowing the Sofitel Hotel Melbourne to place these students in their final studies with us. We have been in awe at the enthusiasm with which they have approached their commitment. Being a manager, I have tried to push them in a direction that was to my satisfaction and found that their own professionalism allowed me to learn from the students. I wish them all well in their futures and I will continue to keep in touch with them as they progress through their careers.”

Peter Barbour, Chief Engineer, Hotel Sofitel Melbourne

“It was a pleasure hosting Andrew this year. A number of us older folks got a buzz from his enthusiasm. He was not a demanding student, was able enough to efficiently use the resources available to him. His presentations and reports were of an excellent standard and generated a credible level of discussion. You may be aware that we are intending to proceed to a feasibility study for the PEM fuel cell opportunity. Orica's participation in the Greenhouse Challenge has provided us with the information and context to push forward with this investigation.”

Kenneth R Richards, Chemicals, Orica Australia Pty Ltd

“The Moreland Energy Foundation Ltd welcomed the opportunity to participate in the 2007 Greenhouse Challenge program. The RMIT students involved came with enthusiasm and capacity to undertake initial investigation as part of a broader research program into cost effective measures to improve the efficiency of domestic hot water systems. The students prepared an impressive report which assessed potential measures and identified key potential areas for further investigation. The program provides important experience for students in applying their academic knowledge in real world situations whilst providing a practical benefit for our organisation. We look forward to participating in the future.”

Bruce Thompson, Business Program Director, Moreland Energy Foundation Ltd

In addition, we are pleased to report that Armstrong World Industries, a company that has participated in the RMIT-NORTH Link Greenhouse Challenge program by hosting student projects in two previous years, won one of the prestigious Greenhouse Challenge Plus Awards given by the Australian Government in 2007. At the award ceremony in Canberra on Monday 17th September, 2007 Mike Jenkins, Armstrong's Vice President - Southern Asia/Pacific, said the company was thrilled to win the award:

“The reduction of Greenhouse Gas Emissions is a crucial part of the lifecycle approach we take in the manufacture of our products. Armstrong was introduced to the Greenhouse Challenge Plus Program in 2000. We recognised that the Program fitted our strategic intent to ensure we leave the smallest environmental footprint as a result of our operations, while complimenting our process optimisation initiatives.”

3 Conclusions and Recommendations

The student project component of this program has once again provided the participating engineering students, and this year students from three other disciplines – Social Science, Business and Industrial Design – with highly valuable and practical career skills in improving the energy and cost efficiency of industrial processes and equipment, and in energy auditing, that will definitely enhance their employment prospects.

It has helped create a culture of environmental stewardship amongst both the students and within the participating firms that have hosted projects, making all parties more aware of the cost saving potential of greenhouse gas emission reduction measures. These effects will continue beyond the life of the program and will help achieve its capacity-building objective.

Overall, the program has provided the students with a great learning opportunity, through working directly with firms to identify new and practical energy-saving measures. The firms have also benefited from the new ideas and cost free research capacity, cutting their fuel bills and meeting their greenhouse emission reduction targets.

The thirteen firms will also cut their carbon dioxide emissions by some 46 000 tonnes each year, if they implement all the measures proposed. Omitting long payback measures and assumed implementation beyond the units studied, reduces the total potential reduction to 27 000 tonnes/year. Most firms indicated a high probability of implementation of the measures at the final seminar in the program.

Again, not counting long payback measures and more widespread implementation, the participating Greenhouse Challenge firms based in Melbourne's north have the potential to achieve annual savings of around \$1 million upon implementation of the recommendations made by the students involved in the program. The total capital investment needed to implement these emission reduction measures would be just over \$4 million so the package as a whole has provided a very attractive financial outcome for participating firms.

It is therefore recommended that:

A similar program involving engineering student projects on emission reduction be provided again in 2008 to assist additional firms to achieve best practice in energy efficiency and low-emission production, and more importantly, to create a "movement" and critical mass of firms, in the northern region of Melbourne, proactive in emission reduction activities.

Appendix A: Summaries of Student Research Projects

The following projects were conducted in 2007. Summaries of each project follow this table.

| Company | Topic | Students |
|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Caterpillar | Follow-up of energy efficiency opportunities identified in energy audit; solar lighting for external environment | Darrel Wolter (B Mech Eng) |
| City of Darebin | Cogeneration at Northcote Aquatic and Recreation Centre | Andrew Tran (B Mech Eng) |
| Edlyn Foods | Energy-efficient design for new food factory | Inge Sarunic (M. Eng Sustainable Energy) and Christoph Begert (M. Eng Sustainable Energy) |
| Foster's Group | Solar thermal steam production and additional insulation | Robert Leo (B Mech Eng) Colin Toohey (B Mech Eng) |
| Honda Australia | Follow-up energy-efficiency opportunities identified in earlier audit | Karthikeyan Balasubramaniam (M Eng Sustainable Energy) |
| Hotel Sofitel* | Energy audit of building and follow up, including window films, working with BAS system and energy educational program for staff | Shane Bartlett (Bachelor of Engineering); Mei Soon (Bachelor of Business); Pui Sze (Bonnie) So (Bachelor of Design) |
| Moreland Energy Foundation Limited* | "Take Action" project, working on reducing emissions associated with water heating in residential buildings | Mark Salera (Bachelor of Engineering); Arief Rabik (Bachelor of Social Science - Environment); Shaun van Oorde-Grainger (Bachelor of Design) |
| Orica | Energy audit of chlor-alkali plant and follow-up; investigation of use of hydrogen currently vented to atmosphere in fuel cells to supply electricity and heat | Andrew O'Dea (B Mech Eng) |
| Rio Tinto | Building energy management, including window films, energy-efficient lighting, passive-solar conservation features. Link to ISO140001 certification | Brett Heron (B Mech Eng) |
| RMIT University (Property Services)* | Reducing emissions from energy use in selected RMIT buildings | Luke Zha (Bachelor of Engineering); How Seong (Gideon) Ng (Bachelor of Business); Mark Whiting (Bachelor of Design) |
| South Pacific Tyres* | Energy audit and follow up opportunities; including addressing workplace practices associated with energy usage. | Tim Slingsby (Bachelor of Engineering); Bexx Steel (Bachelor of Social Science - Environment); Zoe Paisley (Bachelor of Social Science - Environment) |
| VicUrban* | Sustainable energy opportunities in new fringe suburban development | Ben Criddle (Bachelor of Engineering); Yong Kuorwel (Bachelor of Social Science - Environment); Chee Yuen Kong (Bachelor of Business) |
| Yarra Trams | Energy saving through regenerative braking on trams | Ricardo Figari (M. Eng (Sustainable Energy)) |

Note

* Multidisciplinary project

Greenhouse Gas Reduction at Caterpillar Australia

COMPANY: Caterpillar Australia

RESEARCHER: Darrel Wolter

Project aims

- To reduce the greenhouse gas emissions at Caterpillar Australia's Melbourne site
- Conduct an energy audit and identify those areas where improvements can be made to reduce energy consumption and greenhouse gas emissions
- Evaluate viable alternatives in those areas in terms of potential reductions in energy use and greenhouse gas emissions and net economic benefits
- Produce a report recommending preferred options to Caterpillar for implementation

Brief company profile

- Caterpillar of Australia Pty Ltd is a wholly owned subsidiary of Caterpillar Inc. and operates a manufacturing facility at its Tullamarine site
- Caterpillar commenced operations at this site in 1957
- The site also includes Caterpillar Logistics Services in the form of a parts distribution center, covers an area of 32 000 m² which stocks 132 000 different parts to support more than 15 000 Caterpillar machines operating in the region. The site houses approximately 400 personnel, which include support services such as human resources, marketing, services engineering, information systems, finance and training. Truck bodies and attachments are also manufactured at the site in the Manufacturing workshop, which covers an area of 28 000 m² and employs 220 personnel working in three shifts
- Caterpillar Australia supplies 80% of their product market throughout Australia, New Zealand and South East Asia

Emission reduction measures investigated

- The study focussed on reducing greenhouse emissions through more efficient lighting methods, replacement of CRT computer monitors with LCD monitors and by replacing the existing gas hot water boiler in the change block with a more energy efficient alternative and the installation of a wind turbine on site

Method

- Conduct an energy audit to identify areas where greenhouse gas emissions can be reduced
- Conduct a comprehensive literature review to investigate the various types of energy efficient monitors, lighting, solar hot water systems, and solar powered lighting systems
- Conduct a product review of existing products and compare for suitability
- Conduct a cost analysis and assessment of greenhouse gas emissions to assess the most suitable products for reducing greenhouse emissions
- Complete a lifecycle cost analysis, and provide recommendations for the most suitable methods for reducing greenhouse emissions

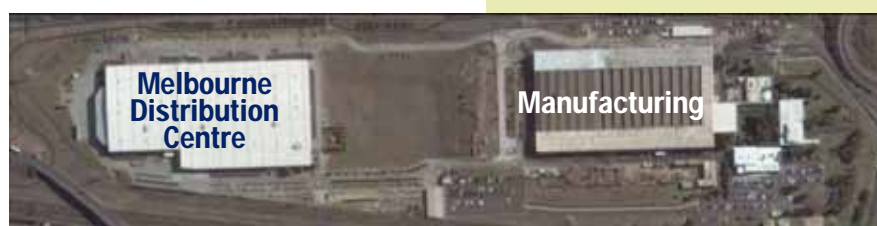
Potential emission reduction

- Replacement of outside lights with standalone solar lighting and a more energy efficient lamp will save 160 tonnes CO₂-e
- Replacement of halogen lights with megaman micro fluoro will save 16 tonnes CO₂-e
- Replacement of T8 fluoro with T5 fluoro will save 32 tonnes CO₂-e
- Replacement of 400 watt metal halide lamps with 250 watt metal halide lamps will save 1 803 tonnes CO₂-e
- Replace CRT monitors with LCD monitors will save 19 tonnes CO₂-e
- Replace hot water boiler and space heat with solar and gas heating will save 43 tonnes CO₂-e
- The total potential reduction in greenhouse emissions is 2 073 tonnes CO₂-e annually

Financial benefits

- If all potential emission reduction methods were implemented there would be an annual saving of over \$95 000 in fuel bills. With an initial capital cost of just over \$168 000 there would be a payback period of just 2 years

By replacing car park, road and path lighting with a stand-alone photovoltaic lighting system and installing a solar hot water system, Caterpillar Australia can reduce greenhouse gas emissions by 2 075 tonnes/year and save over \$95 000 on annual electricity bills



Cogeneration at Northcote Aquatic and Recreation Centre

COMPANY: City of Darebin
RESEARCHER: Andrew Tran

Installation of a suitable cogeneration system at Northcote Aquatic and Recreation Centre will save around 1 900 tonnes of emissions per year for Darebin City Council. The annual electricity bill saving would be \$68 000



Source: Sustainability Victoria

Project aims

- Assist Darebin City Council to achieve 20% reduction of greenhouse gas emissions compared to 1995 levels by the year 2010
- Investigate use of cogeneration to supply electricity and heat at Northcote Aquatic and Recreation Centre to reduce overall emissions and yield net economic benefits

Brief company profile

- Darebin City Council is responsible for an area of around 52 square kilometres, making it one of the largest local government councils in Melbourne
- The council is an active participant in the Cities for Climate Protection program
- The council also has been responsible for community awareness activities like 'Sustainability Street', which broadly aimed to encourage people in reducing water and energy usage for the environment
- The Northcote Aquatic and Recreation Centre, run by the City of Darebin, has an Olympic-size pool, a number of other pools, a gymnasium and range of other sporting facilities
- The Centre is planning to increase its capacity by some 50% over the next few years

Emission reduction measures investigated

- A cogeneration system to meet the electricity and heating demand of the aquatic and recreational centre

Method

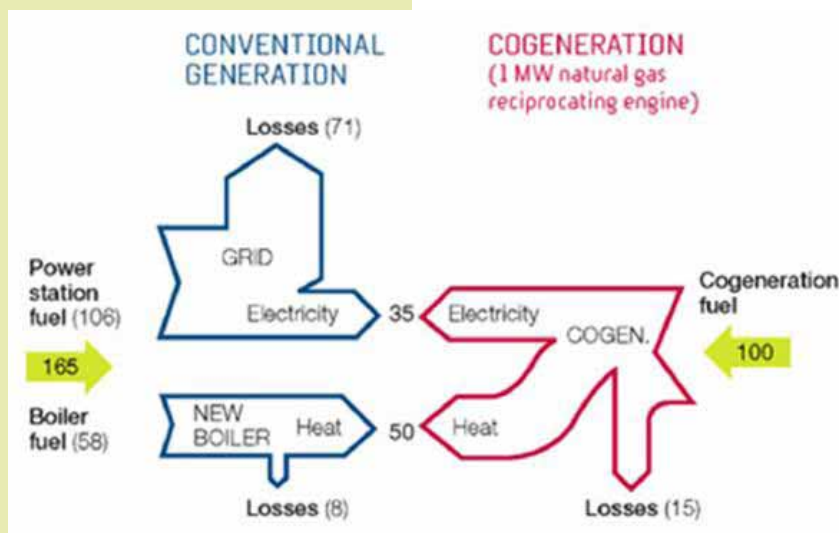
- Obtain data such as gas and electricity usage, current greenhouse gas emissions and cater for growth in customers in forthcoming years at the centre
- Analyse existing blueprints and drawings in order to scope out possible physical location of new cogeneration unit
- Design and select an appropriate cogeneration system
- Calculate the reduction in greenhouse gas emissions per annum
- Calculate the payback period for the council if they chose to invest in cogeneration

Potential emission reduction

- By installing a suitable cogeneration system for both heating and power supply, the Northcote Aquatic and Recreation Centre can potentially reduce its emissions by around 1 900 tonnes of CO₂-e per annum
- This reduction of emissions arises largely because of the sole reliance on natural gas in the cogeneration system, instead of conventional grid electricity plus natural gas just for heating

Financial payback/net benefits

- The initial capital cost of the entire cogeneration system is in the order of \$550 000
- Darebin City council can save approximately \$68 000 per annum if the aquatic centre no longer relies on the electricity from the grid
- Payback period for the investment on greenhouse gas reduction initiatives is 8 years





Make it the Best

Energy-efficient design for new food factory

COMPANY: Edlyn Foods

RESEARCHERS: Inge Sarunic and Christoph Begert

Project aims

- Make recommendations for a design of a sustainable energy system to meet the identified energy-related services for a new warehouse, factory and office facility
- Assess the economic, environmental and social benefits and costs, so that a decision can be made whether to proceed with implementation
- Consider a visionary demonstration of sustainable technologies for the future
- Provide financially attractive sustainable solutions
- Achieve a minimum of 40% energy saving, a 50% greenhouse gas emission saving and reduce waste

Brief company profile

- Edlyn Toppings and Cordials was established in Melbourne more than 65 years ago as a manufacturer of fondants and fruit peels
- Purchased by the Donnelly family and became Edlyn Foods in 1989
- Operating out of its manufacturing facility located in Tullamarine, Victoria, the key product groups now include toppings and syrups, fruit juices, cordials and drink bases, vinegar, bakery premixes, and dessert preparations
- The company has had a continual growth and its products are distributed to all Australian states and select export markets
- The company has around 30 employees

Emission reduction measures investigated

- Passive solar conservation design of factory
- Power factor correction
- Cogeneration
- Electricity generation from renewables: solar photovoltaic cells, wind power, hydrogen fuel cells
- Forklift operations:
 - change layout to minimise travel
 - Fuel cell or CNG forklifts
 - Pumping products from bulk storage to process

- More energy-efficient lighting: LEDs, T5 fluoros, voltage controllers, light level and movement sensors, more natural lighting. 'fluoro-solar' lighting
- Improved waste management

Method

- Map out the processes, the energy and resource use for current situation
- Determine expected future expansion
- Determine the design parameters
- Identify waste reduction measures, energy efficient production methods or equipment
- Identify factory layout and building fabric for energy efficiency
- Identify methods for producing/conserving energy on site
- Recommend preferred options

Potential emission reduction

- With implementation of recommended measures 640 tonnes/y CO₂-e

Financial benefits

- Capital cost – \$172 000
- Annual cost savings – \$47 000
- Payback period – 4 years

Measures such as passive-solar conservation building design, energy-efficient lighting and improved waste-management can cut emissions in Edlyn Foods new factory by over 600 tonnes/year



Solar thermal steam production and additional insulation

COMPANY: Foster's Group

RESEARCHERS: Robert Leo and Colin Toohey

By installing evacuated tube or concentrating parabolic trough collectors to supply just over a third of the steam requirements on site and reduce the load on the boiler system, the Foster's Group could cut emissions by around 7 200 tonnes CO₂-e per annum, with a financial saving in gas bills of \$470 000/year



Source: Foster's Group



Source: Industrial Solar Tech



Source: Build It Solar

Project aims

- To analyse the end uses of the steam required at Foster's Abbotsford brewery
- To evaluate the use of solar thermal systems for supplying some of this steam
- To identify other sources of heat loss on site and investigate ways to reduce these issues
- To compare the options investigated in terms of the greenhouse gas emissions and net economic benefit
- To recommend preferred options for implementation

Brief company profile

- Foster's Group operates a multi-beverage business producing and distributing some of Australia's leading drinks brands, including an international wine portfolio
- Foster's products are sold in more than 155 countries
- Foster's facilities include the Abbotsford Brewery located Abbotsford, Victoria
- This brewery was established in 1907 as Carlton and United Breweries
- There are approximately 550 staff at the Abbotsford site

Emission reduction measures investigated

- Heat loss from pipes and storage tanks
- Investigation of evacuated tube and concentrating parabolic trough solar thermal technologies for steam production

Method

- Analysis of the production and end uses of the steam at the Abbotsford site
- Identify energy-saving opportunities
- Investigate what solar thermal technologies are available for steam production
- Review technologies on solar thermal technologies

to see if they can be used and implemented efficiently at the Abbotsford Site

- Use data available for solar radiation and temperatures of Melbourne to model the solar collector outputs
- Estimate steam or hot water production from the solar thermal collectors and hence the potential reduction in natural gas required for the production of steam
- Recommend possible solar thermal systems steam production at the Abbotsford site

Potential emission reduction

Solar thermal steam production

- With implementation of the evacuated tube or concentrating parabolic trough collectors to supply just over a third of the steam requirements on site and reduce the load on the boiler system, around 7 200 tonnes CO₂-e per annum can be saved

Insulation of feedwater tanks

- With implementation of the insulation on the feedwater tanks to reduce heat losses, a saving of around 0.6 tonnes CO₂-e per annum can be obtained

Financial payback/net benefits

Evacuated tube collectors

- Capital cost of \$21 400 000 (sized for 26 000 tonnes of steam per hour)
- Potential annual savings from reduced consumption - \$470 000 per annum
- Payback period: more than forty years at current gas prices, but would fall with increases in real gas price

Parabolic trough collectors

- Payback period also more than forty years at current gas prices

Energy-efficiency opportunities at Honda Australia

COMPANY: Honda Australia

RESEARCHER: Karthikeyan Balasubramaniam

Project aims

- To reduce natural gas used for space heating by Dravo heaters in a warehouse area
- To assess the emission reduction and economic benefits of preferred options

Brief company profile

- Honda Australia's facility at Tullamarine, Victoria, services Honda dealerships throughout Australia and provides a spare parts service

Emission reduction measures investigated

- Installation of ducts to improve distribution of heat from Dravo gas heaters
- Recirculation of hot air within the warehouse space and reducing the external air input
- Install sky coat insulation
- Install a new more energy-efficient heating and cooling system
- Keeping loading bay doors closed more of the time

Method

- Analysis of gas usage for warehouse heating
- Observation of usage of warehouse
- Data collection on energy use
- Formulation and evaluation of options for emission reduction

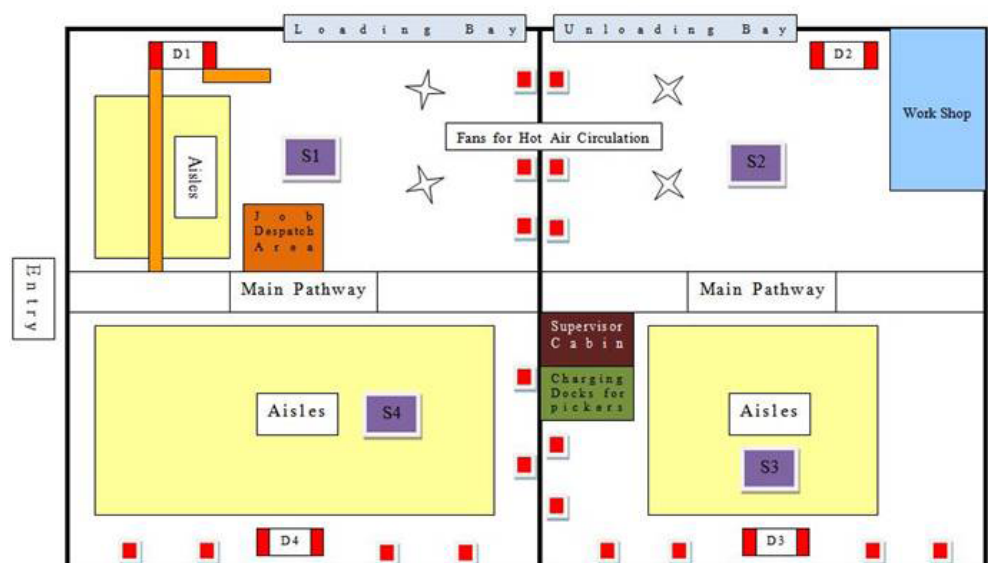
Potential emission reduction

- Implementation of measures leading to a 10% reduction in gas usage for factory heating would save 34 tonnes CO₂-e per year

Financial payback/net benefits

- To be assessed

Implementing emission reduction measures such as ducting for Dravo gas heaters and reducing heat loss through access doors can reduce emissions of Honda Australia by 34 tonnes/year





SOFITEL
ACCOR HOTELS & RESORTS

Energy audit at Hotel Sofitel, Melbourne

COMPANY: Hotel Sofitel

RESEARCHERS: Shane Bartlett, Mei Soon and Pui Sze So

Implementation of window film, CFL lights, LED lights, use of the 'Ozone laundry systems' and a staff awareness program can cut Hotel Sofitel's annual emissions by more than 1 500 tonnes and save over \$76 000 per annum



Project aims

- Reduce annual energy consumption and greenhouse gas emissions by 5%
- Conduct an energy audit and identify wasteful practices
- Initiate an awareness program for staff and guests
- Recommend preferred emission-reduction measures for implementation

Brief company profile

- The Sofitel Melbourne is a 5-star hotel located on Collins Street
- The hotel has 363 rooms located on levels 36 to level 50
- Located on level 35 are the hotel's restaurants and cafes
- The Sofitel Melbourne is part of the ACCOR group

Emission reduction measures investigated

- Placement of film on the hotel windows to reduce unwanted heat input
- Replacement of all incandescent lights with compact fluorescent lights, and 35W Titan halogen lamps with 5W light emitting diodes
- Implementation of the 'Ozone Laundry System'
- The creation of an awareness program to inform staff and guests of ways to reduce energy usage and cut greenhouse gas emissions

Method

- Conduct a comprehensive literature review to investigate the various types of energy efficient lighting, window film technology and methods to reduce energy in the laundry
- Conduct a survey with hotel staff to determine the level of awareness of the climate change issue and potential solutions
- Conduct an energy audit
- Conduct a trial of window film in a guest room to determine the savings in HVAC usage
- Complete a trial of light emitting diodes instead of halogen lights in the hotel foyer
- Determine the most efficient compact fluorescent light to replace incandescent lights throughout the hotel
- Complete a review of methods to improve the efficiency of the hotel laundry system
- Estimate the potential greenhouse gas reductions and financial benefits of all these measures

Potential emission reduction

- With implementation of window film, compact fluorescent lights to replace incandescent lights, LED lights rather than energy-efficient T5 lights, use of ozone in the laundry washing machines and the implementation of an awareness program, a total of more than 1 500 tonnes of CO₂-e can be saved per annum

Financial payback/net benefits

- Capital cost of \$243 500 for the implementation of all the greenhouse reducing initiatives
- A saving of \$76 500 per year can be achieved for the Sofitel Melbourne for the life of the initiatives
- A reduction of 11% in CO₂-e per year will be realised with the use of window film, replacement lights, upgrade of the laundry system and the use of an awareness program such as "Green Tip of the Week" for staff and guests of the Sofitel Melbourne

"Take Action" project, working on reducing emissions associated with air conditioning and hot water in residential buildings

COMPANY: Moreland Energy Foundation Limited

RESEARCHERS: Mark Salera, Arief Rabik and Shaun van Oorde-Grainger

Project aims

- Prevent an increase in energy consumption and greenhouse gas emissions generated from hot water systems in medium-density apartments in the Moreland area
- Analyse potential replacement electric peak hot water systems with solar, gas or heat pump water heaters from the perspective of environmental impact, installation and economics for medium-density apartments
- Estimate potential greenhouse gas reductions and operational cost savings
- Review socioeconomic challenges associated with implementation of energy-efficient hot water systems

Brief company profile

- The Moreland Energy Foundation Ltd (MEFL) is an independent not-for-profit organisation established by the Moreland City Council
- MEFL's main aim is to reduce greenhouse gas emissions across the Moreland community, working with households, businesses, schools and community groups
- The 'Take Action' project addresses the two major causes of greenhouse gas emissions and electricity usage in Australian households: space heating/cooling and water heating

Emission reduction measures investigated

- Replacement of existing electric peak storage hot water systems with solar (with gas boosting), gas instantaneous or heat pump hot water systems
- Installation of pipe and tank insulation throughout a unit
- Replacement of older-style shower head with a low-flow shower head
- Managing operation times to minimise tank standing thermal losses

Method

- Conduct product review, technical and cost analysis of energy-efficient hot water systems compared with electric peak storage hot water systems

- Calculate the potential financial and emission savings with the application of insulation, a low-flow shower head and system operation time management
- Outline challenges and strategies in the replacement of hot water systems in medium-density apartments

Potential emission reduction

- Replacement of existing electric peak storage hot water systems with a solar-gas unit would cut emissions for a typical medium-density apartment block by around 73 tonne/y
- Pipe insulation reduces emission by approximately 1 - 1.2 tonne CO₂-e per apartment building per annum
- Tank insulation reduces emission by about 1.1 - 1.7 tonne CO₂-e per apartment building per annum
- A low-flow shower head reduces emission by about 7 tonne CO₂-e per apartment building per annum
- Managing system operation times reduces emissions by 0.7 - 1.1 tonne per apartment building per annum
- With a 10% adoption of these measures in Moreland, the emission reduction would be 6600 tonne/year

Financial payback/net benefits

- Solar (with gas boosting) system installation provides the best reduction in operational cost, - approximately 89% less than an electric peak hot water system (with an annual operational cost of \$390)
- Gas instantaneous and heat pump hot water systems respectively yield a 70% and 65% reduction in operational costs compared to an electric peak storage system
- Capital cost of tank insulation \$138 (\$38 with a do-it-yourself - DIY - installation)
- DIY payback period for tank insulation between 0.7 and 1.1 years
- Capital cost of low flow shower head \$217 (\$117 with a DIY installation), giving payback period of one year using a plumber, and DIY payback period of 0.5 years

Measures such as installation of solar-gas hot water systems, pipe and tank insulation, low-flow shower heads and managing system operating times can reduce emissions in medium-density apartments



Source: solahart.com.au



Use of hydrogen to supply electricity and heat for steam production at a chlor-alkali plant

COMPANY: Orica

RESEARCHER: Andrew O'Dea

Installation of a PEM fuel cell power plant for utilising hydrogen currently vented to the atmosphere at Orica's Chlor-alkali plant can reduce emissions around 16 000 tonnes per year (that is, by 15%) and cut annual electricity bills by over half a million dollars



A Pratt and Whitney hydrogen gas turbine



A PEM fuel cell. Source: Nedstack



Project aims

- Conduct an energy audit of the plant to identify the magnitude of energy usage and wastage
- Investigate the use of hydrogen currently vented to the atmosphere to reduce energy use and hence reduce carbon dioxide gas emissions
- Investigate other possible energy saving and efficiency improvement measures that could be implemented at the plant
- Report on the findings of the investigation

Brief company profile

- The Chlor-alkali plant of Orica, located in Laverton, Victoria, is one of the major producers of chlorine and caustic soda in Australia
- Orica has joined the Australian Government's Greenhouse Challenge program with the aim of reducing their greenhouse gas emission

Emission reduction measures investigated

- Use of currently-vented hydrogen gas for zero-emission on-site electricity generation using a PEM fuel cell
- Use of vented hydrogen gas for zero-emission on-site electricity generation using a gas turbine generator
- Use of vented hydrogen gas for boiler firing
- Optimisation of the cooling tower outlet water temperature and refrigeration plant efficiency
- Insulation of heat exchanger
- Insulation of a boiler economiser

Method

- Conduct a plant energy audit
- Identify best areas for emission reduction
- Investigate options for the reduction of grid-electricity and natural gas consumption.
- Evaluate emission reduction and economic benefits of the preferred options

Potential emission reduction

- A Nedstack PEM fuel cell (1.5 MW) would yield a reduction in carbon dioxide emissions of around 16 000 tonnes per year or 15% of the plant's total emissions
- A hydrogen gas turbine generator would give a reduction in carbon dioxide emissions of 11 000 tonnes per year
- A boiler economiser and heat exchanger insulation combined could reduce emissions by 18 tonnes per year

Financial payback/net benefits

PEM fuel cell:

- The Nedstack PEM fuel cell would cost with in the order of \$3 million, and would reduce yearly electricity costs by over \$500 000 based on the current electricity cost
- Simple payback period is less than 6 years

Gas turbine generator:

- Capital investment on a Pratt and Whitney gas turbine generator would be \$1.55 million
- The electricity cost would be reduced by nearly \$300 000 per year
- Payback period is less than 6 years

Boiler economiser and heat exchanger insulation:

- Total investment on economiser and insulation would be around \$43 000
- Total saving would be \$10 500
- Payback period is 4 years

RIO TINTO

An investigation into energy efficiency at Rio Tinto's Technology and Innovation facility

COMPANY: Rio Tinto Technology and Innovation

RESEARCHER: Brett Heron

Project aims

- Identify potential energy efficiency improvement opportunities at Rio Tinto's Technology and Innovation facility at Bundoora, Victoria
- Quantify the potential energy use, greenhouse gas and operating cost reductions that could be achieved from the energy efficiency improvement opportunities
- Recommend preferred opportunities for implementation

Brief company profile

- Rio Tinto owns and operates mining, mineral processing and smelting operations in Australia and internationally. Its Technology and Innovation facility at Bundoora provides research, consultancy and other support services to the company

Emission reduction measures investigated

- Raising staff awareness about energy efficiency opportunities
- Reducing energy consumption for heating, ventilation and air conditioning by changing set points according to the season
- Introducing more energy-efficient lighting and installing motion and light sensors
- Meeting a portion of total electricity demand from purchased 'green power' or on-site renewable energy systems

Method

- Review of previous energy audits
- Definition of options for emission reduction, use of cost-abatement curves and selection of those for detailed study
- Quantification of potential emission reduction and economic costs and benefits

Potential emission reduction

- With implementation of the recommended solutions, site emissions can be reduced by over 300 tonnes/year or 15% of the total annual greenhouse gas emissions

Financial payback/net benefits

| Opportunity | \$ - Savings [\$ /yr] | Cost [\$] | Payback period [years] | GHG-emission savings /year [TCO2/y] |
|---------------------------------------|-----------------------|---------------|------------------------|-------------------------------------|
| Implementing energy awareness program | 6 000 | minimal | immediate | 90 |
| Replacement of incandescent globes | 1 000 | 1 000 - 2 000 | 1 - 2 | 15 |
| HVAC modifications | 5 800 | minimal | immediate | 75 |
| T% lamp replacements | 8 500 | 85 000 | 10 | 133 |
| Total | 21 300 | -90 000 | | 313 |

Rio Tinto Technology and Innovation Centre can reduce emissions by over 300 tonnes/year by introducing more energy efficient lighting, raising staff awareness and purchasing green power or installing onsite renewable energy systems. The potential annual electricity bill saving would be over \$21 000



Reducing emissions from energy use in RMIT buildings

COMPANY: RMIT University (Property Services)

RESEARCHERS: Luke Zha, How Seong Ng and Mark Whiting

Window less computer room and optimisation of natural lighting and power management of computers in RMIT computer labs and library can reduce emissions by 4 000 tonnes/year and save \$200 000 in electricity bills annually



Building 8 level 7

CURRENT



PROPOSED



Project aims

- Conduct an energy audit to identify the standout opportunities for greenhouse gas reduction
- Recommend economically and environmentally sustainable methods to reduce the energy consumption through optimisation of usage and improvements in efficiency
- Recommend channels of communication to create user awareness

Brief company profile

- RMIT University provides higher education for over 63 000 students locally and more internationally with over 100 partner institutions worldwide
- RMIT Property Services has the responsibility to operate, maintain and enhance the university's 116 buildings over eight sites across Melbourne

Emission reduction measures investigated

- Optimisation of natural and artificial lighting and power management of computers
- Indirect influence of these recommendations on the supporting Heating Ventilation and Air Conditioning (HVAC) systems

- Analysis of the benefits of centralised computing for RMIT networks
- Future potential for improving thermodynamic efficiency of server rooms

Method

- Conduct a literature review of various current and upcoming technologies in building sustainability and computing
- Conduct a benchmarking study on Council House 2 to gain insight into current practice
- Conduct energy audit and investigate the operational regime of computing services on various campuses across RMIT
- Liaise with RMIT Property Services to focus project aims based on company needs
- Review options and recommend solutions to provide the maximum benefit over cost with consideration of the triple bottom line

Potential emission reduction

- The cumulative emission reduction from measures recommended for a typical windowless 30 person computer room, most common throughout the university, was calculated to be approximately 0.5 tonne CO₂-e per m² per annum
- For an estimated 20 000 m² of computer labs throughout RMIT, and application of the measures to 40% of this total area, the total emission reduction would be 4 000 tonnes CO₂-e per year

Financial payback/net benefits

- Payback on initial investment for windowless rooms is likely to be within a single year
- Net present value for the life of the project with implementation of measures to improve the use of natural lighting is shown to be positive
- For a typical windowless 30 person computer room, financial savings can be expected in the order of \$26 per m² per annum
- For an estimated 20 000 m² of computer labs throughout RMIT, the total financial saving would be around \$200 000 per annum

Energy audit at South Pacific Tyres

COMPANY: South Pacific Tyres

RESEARCHERS: Tim Slingsby, Bexx Steel and Zoe Paisley

Project aims

- To investigate options for reducing energy usage, and thus greenhouse gas emissions and energy costs, at South Pacific Tyres, Somerton

Brief company profile

- South Pacific Tyres is a large tyre production plant situated on the Hume Highway in Somerton and are actively taking part in the Greenhouse Challenge Plus program
- The Somerton plant was first commissioned by B.F Goodrich in 1959, and became part of South Pacific Tyres in 1987 when a joint venture between Pacific Dunlop Tyres and Goodyear Tyres was formed. In January 2006, the company became completely owned by Goodyear
- South Pacific Tyres is the largest tyre manufacturer in Australia, and employs approximately 500 workers, 400 in production and 100 in management

Emission reduction measures investigated

- Improved start up - shut down procedure to reduce idle machine time
 - Train staff and workers to use current switches for each shift
 - Centralise switches of three production areas in focus
 - Centralise switches for all production areas
- Installation of metering units
 - Metering units for three focus production areas
 - Metering units for three focus areas of production with computer monitoring
 - Metering units for entire factory with computer monitoring

Method

- Information gathering through bills, process plans, interviews, inspections and other means
- Analysis of annual energy use and greenhouse gas emissions by production area

- Formulation of options to reduce emissions
- Evaluation of options to identify preferred ones

Potential emission reduction

- Implementation of option 3 for improved start up – shut down procedure and metering would yield an estimated reduction of some 4 400 tonnes CO₂-e per year.

Financial payback/net benefits

- Annual savings from option 3 for improved start up – shut down procedure and metering would be around \$175 000 / year
- Capital cost - \$23 000
- Payback period: 2 months

Improving start up and shut down procedures for machines and installing a metering system at South Pacific Tyres can reduce emissions by over 4 000 tonnes/year, and give financial savings of around \$175 000 per year



Sustainable energy opportunities in new fringe suburban development

COMPANY: VicUrban

RESEARCHERS: Ben Criddle, Yong Kuorwel and Chee Yuen Kong

Installation of wind turbines on 10% of the houses in a new residential development can result in an annual emission reduction of 1 000 tonnes and savings of \$175 000/year



Source: www.hushenergy.com.au



www.vicurban.com.au



Project aims

- Research the feasibility of small-scale wind turbine and solar PV renewable energy systems for the urban development at Officer (near Pakenham in the outer south-east of Melbourne)
- Estimate potential greenhouse gas reductions through such systems
- Seek a multidisciplinary solution with respect to technical design, finance, economics and urban planning
- Make recommendations to VicUrban regarding implementation of renewable energy in the Officer urban development

Brief company profile

- VicUrban is an agency of the Victorian Government responsible for the development of sustainable communities in Victoria, including Docklands and Aurora
- VicUrban has a five-element charter focussing on commercial success, community well-being, housing affordability, urban design excellence, and environmental leadership

Emission reduction measures investigated

- Reduction of the dependence on coal, gas and hydro produced electricity through the installation and use of zero-emission wind turbine and solar photovoltaic renewable energy systems

Method

- Research historical wind speed, solar radiation and general atmospheric data and use trends to predict values for a one year (2007-8) study period
- Select wind and solar PV renewable energy systems based on a number of criteria, including performance,

reliability, country of design and manufacture, cost effectiveness and availability

- Generate estimates for electricity productions for renewable energy systems for study period based on predicted wind speed, solar radiation and general atmospheric data
- Use estimates of performance to conduct financial analysis, including estimation of financial benefits available for residents under various regulatory and electricity pricing environments
- Evaluate the effect of future regulatory trends, and developments in technology

Potential emission reduction

- Installation of a 2 kW solar PV on each home, would yield potential savings of 2.8 tonnes CO₂-e /system
- Installation of 5 m O'Connor Hush Wind Turbines, would yield potential savings of 3.4 tonnes CO₂-e /turbine
- If 10% of the 3 000 houses in the whole residential development were fitted with aerogenerators of this kind, the total emission reduction would be just over 1 000 tonnes/year

Financial payback/net benefits

2 kW Solar PV System

- Capital cost of \$12 086/system
- Potential annual savings of \$927/system
- Potential payback period of 12 years

5m Hush Wind Turbine

- Capital cost of \$12 086/system
- Potential annual savings of \$563/turbine
- Potential payback period of 20 years
- For 10% of houses in the overall development fitted with aerogenerators of this type, the total capital cost would be \$3.6 million, and the total annual savings \$170 000/year

Energy saving through regenerative braking on trams

COMPANY: Yarra Trams
RESEARCHER: Ricardo Figari

Project aims

- Conduct a preliminary investigation into the potential energy and greenhouse gas reduction from full utilisation of regenerative braking on Melbourne's trams

Brief company profile

- Yarra Trams operate on Melbourne's tram network and are active participants in the Greenhouse Challenge Plus program
- The company consists of eight depots, 31 major routes, 1 800 staff and a fleet of 474 trams. In 2002/2003, over 141 million passenger trips were by tram rides in Melbourne

Emission reduction measures investigated

- Full tapping of the potential for energy savings through the use of regenerative braking on Melbourne's trams

Method

- Analysis of current situation regarding use of regenerative braking on Melbourne's trams
- Development of a theoretical model of the potential savings from regenerative braking on a typical tram line section, taking into account most probable distribution of trams on the section and actual positions of electricity supply substations
- Use of empirical data on current drawn by trams on this line section from an earlier study as an input to the model
- In this way, it was possible to determine how efficient a transport mode was and therefore what emissions were generated by the provision of the transport service
- Direct measurement of tram emissions
- In this method, tram-specific energy use was measured, using a data-logger, and therefore emissions calculated as the tram undertook provision of a transport service
- The detailed nature of this form of analysis provides insights into tram energy use and potentially guides improvement options

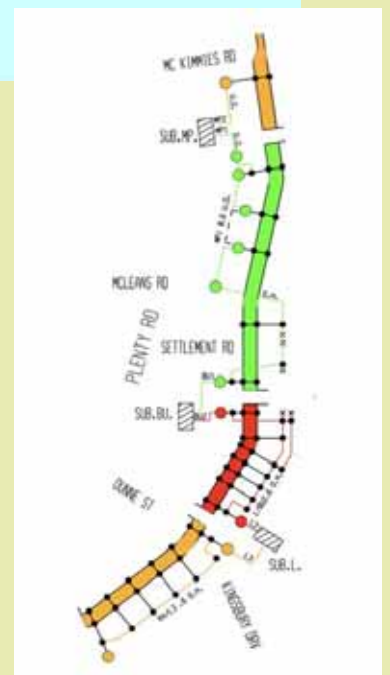
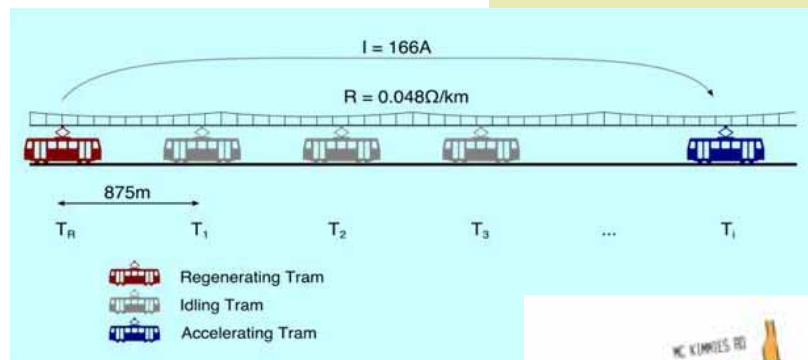
Potential emission reduction

- Preliminary estimates suggest a saving of some 50 tonnes CO₂-e / y for the Bundoora line if all the energy fed back into the network while regenerative braking is being applied could be utilised

Financial payback/net benefits

- Costs of equipment to ensure a high degree of utilisation of energy from regenerative braking yet to be determined

Yarra Trams can reduce greenhouse emissions by implementing regenerative braking systems on their tram fleet



Appendix B: Seminar Invitations and Agendas



INVITATION TO “Saving the environment, saving \$”

Greenhouse Challenge Plus Support Program 2007

Final year RMIT Bachelor of Engineering and Master of Engineering (Sustainable Energy) students, together this year with a number of Bachelor of Business, Social Science and Design students, will be completing a total of 12 projects with leading firms in the northern region of Melbourne during 2007.

The Australian Greenhouse Office, sponsors of the program, NORTH Link/NIETL and RMIT University have great pleasure in inviting you to join us to meet the participating firms and students and more importantly, to learn how it is possible to save \$ in reduced energy costs and at the same time reduce greenhouse gas emissions to the environment.

Time: 8.00am – 9.30am, Tuesday 3rd April 2007

Location: Building 251, room 251.03.34

RMIT University (Bundoora East Campus)

enter off Ormond Bld, right turn from Plenty Rd heading north, at end of tram tracks (opposite McKimmies Rd going left. Take first left on Ormond Bld, then check with Security for directions). See map attached.

Agenda

| | |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8.00 am | Welcomes <i>Mick Butera, Executive Director, NORTH Link/NIETL</i> <i>Professor Aleks Subic, Discipline Director, School of Aerospace, Mechanical and Manufacturing Engineering, RMIT University</i> |
| 8.15am | “Outcomes of the 2006 RMIT-NORTH Link Greenhouse Challenge Plus program, and introduction to 2007 program” <i>Dr John Andrews, Greenhouse Challenge Program Leader, RMIT University</i> <i>Dr Andrea Bunting, Coordinator, Multidisciplinary Greenhouse Projects, RMIT University</i> |
| 8.45am | Firms hosting greenhouse projects for 2007 and participating students |
| 8.45am - 9.10am | Tour of RMIT University's Renewable Energy Laboratory and Centre <i>Prof Aliakbar Akbarzadeh and Dr John Andrews</i> |
| 9.30am | Close |





Industry – Student Projects Presentations

Greenhouse Challenge Plus

| | |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Date: | 8.00am – 11.00am, Friday, 20 July 2007 |
| Venue: | Cafeteria, Building 251, RMIT University, Bundoora East Campus Plenty Rd, Bundoora 3083 (See map attached) Entrance to campus off Plenty Rd, Cafeteria and parking area marked |

Why you should attend and what you will learn

- Innovative strategies and practical measures identified from within seventeen projects with eleven organisations all designed to reduce energy costs and emissions
- Update on the Greenhouse Challenge Plus programme from the Australian Greenhouse Office (AGO).

Case studies on greenhouse and energy reduction projects will be presented from:

Caterpillar, City of Darebin, Foster’s Group, Honda Australia, Orica, Rio Tinto, Hotel Sofitel, RMIT Property Services, South Pacific Tyres, VicUrban, Moreland Energy Foundation Limited, Edlyn Foods and Yarra Trams

Students where drawn from the following areas of study:

Eleven final-year Bachelor of Engineering students, four Master of Engineering (Sustainable Energy) students, three Bachelor of Business, three Bachelor of Design, and three bachelor of Social Science – Environment, from RMIT University.

Presentations on each of the energy reduction measures investigated with the thirteen companies will be provided plus the opportunity for questions and discussion. **This will provide your organisation with a great opportunity to obtain new ideas on energy cost cutting and greenhouse gas abatement. A short tour of RMIT’s solar-hydrogen and solar-desalination facilities will conclude the morning.**

This seminar is hosted by RMIT University. It is part of an initiative by NORTH Link/NIETL in partnership with Greenhouse Challenge Plus to reduce greenhouse gas emissions in industry.

Agenda

| | |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7.45 - 8.00am | Refreshments |
| 8.00 am | Welcome and introduction <i>Mick Butera, Executive Director, NORTH Link/NIETL</i> |
| 8.05 am | Student - Industry Project Presentations <i>Chaired by Dr John Andrews, Senior Lecturer/Program Leader and Dr Andrea Bunting, Lecturer, RMIT University</i> |
| 10.30 am | <i>Professor Aleksandar Subic, School of Aerospace, Mechanical and Manufacturing Engineering, RMIT University</i> <i>John Wyatt, Senior Adviser, Greenhouse Challenge Plus</i> |
| 11 – 11.30am | Tour of renewable-energy hydrogen and solar desalination facilities. |



RSVP to Mick Butera by 18/7/07 on 03 9479 3337 or m.butera@latrobe.edu.au

