

## **AC 2008-1485: ADDRESSING CONTEMPORARY ISSUES, LIFELONG LEARNING, AND THE IMPACT OF ENGINEERING ON GLOBAL AND SOCIETAL ISSUES IN THE CLASSROOM**

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# Addressing Contemporary Issues, Lifelong Learning, and the Impact of Engineering on Global and Societal Issues in the Classroom

## Abstract

Whenever there is a discussion of outcomes a-k for ABET EC 2000, the outcomes least understood are those involving knowledge of contemporary issues, lifelong learning, and the impact of engineering on global and societal issues. Most faculty believe they understand the intent of these topics, but to identify where these criteria are supported in a curriculum is often difficult. A separate course or seminar is not necessarily the answer as most programs cannot afford the addition of more classroom hours. A simple method of addressing these issues used by the author for the past three years is to have students accomplish short presentations on topics of their choice related to the course. In the last year, explicitly adding a requirement to present on a topic related to contemporary issues and/or the impact of engineering on global and societal issues yielded more focused presentations. Having the students pick their own topics allowed them to pursue something that they find personally interesting and wished to present to the class. For the first two years, additional credit was given to students who have a range of reference materials, especially materials found in the library. This developed research skills beyond that of the worldwide web. Topics were very different and students were not allowed to give a presentation on a topic that had already been given. Many of the presentations naturally addressed topics dealing with contemporary, global or societal issues and this gave the opportunity for further discussion. For the heat transfer class in which this was implemented, topics have included energy production, biomedical applications, safety issues, and the impact of heat transfer on day-to-day living. Students clearly enjoyed the presentations and everyone, including the author, was exposed to topics that might not normally be included in the classroom.

## Introduction

There are many influences on any mechanical engineering program that have greatly impacted the curricular content. None is more profound than the ABET EC 2000. EC 2000 Criterion 3 has become the central core for most programs, as it is the standard for assessment. While traditional evaluation has been in regards to the usual program content such as applying knowledge of mathematics, science and engineering, it is the intangible or “soft” outcomes that have caused the most concern. More specifically, the outcomes most underrepresented in programs are the outcomes that state graduates from engineering programs must have:

- h) the broad education necessary to understand the impact of engineering solutions in a global and societal context
- i) a recognition of the need for, and an ability to engage in life-long learning
- j) a knowledge of contemporary issues.

Recently, while preparing for an ABET evaluation, the mechanical faculty at Baylor University

came face-to-face with the reality that coverage of these “soft” outcomes was lacking in the mechanical engineering program. Faculty meetings on mapping outcomes to specific courses were not able to identify where in the curriculum these topics were present. While not an intentional, primary activity to satisfy the ABET outcomes, it was determined that the PowerPoint presentations used by the author in EGR 4345, Heat Transfer, might partially satisfy these “soft” topics. Topics lists are not given to the students. Presentation skills are not taught. It was anticipated that through the selection of a topic, the preparation for the presentation, and the presentation itself, students could demonstrate the “soft” outcomes which are the focus of this paper. .

Faculty often have difficulty defining what is meant by these “soft” outcomes in the context of their courses. Berg and Nasr of Kettering University highlight the following:

“The general perception among faculty is that these (soft) outcomes are not formally “taught”, nor presented or reviewed, as part of any mechanical engineering course structure or content. Why this is so may be explained on the basis of tradition, lack of time in the course schedule, instructor disinterest, lack of incentive or expertise, or disagreement as to whether they belong in a M.E. course or elsewhere in the general education component of the curriculum.”<sup>1</sup>

This leads to many discussions on interpretations of outcomes and how a particular outcome relates to a specific course or topic area. More often than not, the majority of discussion time is spent trying to decide what the ABET document really meant and what would be required by evaluators. In most faculty discussions of this sort, consensus is difficult to achieve. Even in the literature there are disagreements. Robinson and Sutterer propose outcomes for contemporary issues and global issues.<sup>2</sup> For contemporary issues, they propose that students have “an understanding of how contemporary issues shape and are shaped by mathematics, science, and engineering.” Global for these authors is “an ability to recognize the role of professionals in the global society.” These two objectives are somewhat incomplete. Lord, of the University of San Diego, limited contemporary issues to those within the discipline and further limited contemporary issues to the topic of the course.<sup>3</sup>

There are several common opinions that surface in these discussions. First, most faculty are convinced that their programs give students the broad education necessary for them to understand engineering in the global and societal context. Often it is assumed that the humanities and social science content of programs would provide the global and societal dimension to the core engineering foundation from the technical courses. For example, Needy from the University of Pittsburg details an economics course which includes societal context, an appreciation for life-long learning and contemporary issues.<sup>4</sup> Butner at Mercer University does the same in their economics course.<sup>5</sup> Baylor University requires students to take two courses in religion, the equivalent of two courses in a foreign language, two courses in great texts (historical development of philosophy), one course in ethics and one course in economics, in addition to a course in British Literature or American Constitution. While these courses are excellent in and of themselves, there is little control over the content and how they relate to the outcomes in question. Having these courses in the curriculum obviously contributes to a broad

foundation but necessarily should not be the only source of exposure to these topics for the students.

Second, faculty often say that they know a life-long learner when they see one. So what is a life-long learner? This life-long learner seems to be a student who is motivated to learn without coercion, that is to say, learning for learning's sake. It is the student that does more than is required on a laboratory or assignment. It is that extra graph or extra paragraph discussing a topic area that was not specifically addressed by the assignment. A life-long learner will ask excellent questions in class, read the textbook because they want to know more than is possible to impart in the classroom, and are able to frame a question and seek a solution. As faculty, what is being done to develop these curiosities and what skills are being taught to students which will help them find the answers to their questions? Often faculty think of themselves as models of life-long learners since faculty should be constantly improving their knowledge in their technical field as well as their knowledge of pedagogical techniques. The curiosity faculty have in observing the world is what the faculty are trying to develop in the students.

Third, it is often assumed that students gain knowledge of contemporary issues as part of their engineering education. What is meant by contemporary issues? Engineering students spend little time keeping current in the world news. More specifically, if contemporary issues pertain to the discipline of engineering, students will do little to maintain their knowledge apart from what is discussed in the classroom context. In reality, this topic must be more intentionally interjected into the curriculum to show application of engineering principles.

Two categories of courses come to mind that should adequately support "soft" outcomes. One such course would be a senior capstone design course. Berg and Nasr discuss such a course.<sup>1</sup> It is true that the capstone design course should be the pinnacle of an engineering program, where students are able to integrate all aspects of their education into a challenging project. It is a natural place to discuss topics in the professional context of engineering. Using senior capstone design as the sole assessment of the "soft" outcomes is not sufficient. Other courses most able to address these "soft" outcomes are usually mechanical engineering elective courses. An elective course should be a course students take because they have an interest in learning more about that particular subject. Hence, this is an opportunity to capitalize on life-long learning. Throughout the elective course, students should be exposed to how the knowledge gained in previous courses impacts global and societal issues, as well as contemporary issues. The drawback is that while elective courses should have these elements, there is no requirement for them to accomplish these outcomes. If the course is an elective, it also does not mean that every mechanical engineering student will take the course. This was the argument against using elective courses to satisfy ABET assessment, one which was brought to Baylor University's attention during a recent accreditation visit. One could always try and develop a specific course to add to the program requirements but having a specific course to address these issues is really not the answer. Curriculums are already bursting and requiring students to take such a course at the expense of another "technical course" is often not a possibility. This leads to the necessity of being very intentional in the existing engineering curriculum to address the "soft" outcomes. It involves looking at what is being accomplished in curriculums around the country to address these issues and to take a good, hard look at what is being accomplished in the existing program curriculum that could be used to satisfy the assessment of these outcomes. It is always

preferential to use existing assessment tools, if possible, than to develop more assessment or add additional surveys, etc. to an already crowded course schedule.

Another aspect of the curriculum that demands compliance with ABET is the increasing emphasis on Global awareness that is being described in documents such as the National Academy of Engineering's (NAE) "Educating the Engineer of 2020: Adapting Engineering Education to the New Century" and "The Engineer of 2020: Visions of Engineering in the New Century."<sup>6,7</sup> These documents outline what the NAE considers to be the top challenges facing engineering, ranging from items in the biosciences, to energy, to solving basic needs such as food and water. With the population of the world increasing and resources being scarce, engineers figure prominently in the solution to these challenges. The NAE is not the only organization urging engineering at Baylor University to look globally. Baylor University's Board of Advocates for the School Engineering and Computer Science has made it clear that Baylor graduates must be able to compete in the global area. Their guidance has resulted in new opportunities for engineering students to study abroad in interdisciplinary groups visiting countries such as the Netherlands and China.<sup>8</sup> Once again, these opportunities are not experienced by every student, therefore, assessment of graduates in the "soft" outcomes must be accomplished in courses that all mechanical engineering students must take as part of their graduation requirements.

Another underlying question that one must ask about students is what characteristics should the student possess when they leave the engineering program? Students must be equipped to face the challenges of the workplace. Students must be capable of formulating the right questions and be equipped with the skills to seek the answers. Educated engineers are valuable assets to any establishment because they are equipped with the ability to think and solve problems. It is the desire of most faculty that students think and solve problems on the global scale and that students will impact society for good. This desire is found in most program objectives, and Baylor University is no different. Baylor's Department of Mechanical Engineering has Program Educational Objectives for engineering graduates. The graduates should be able to:

1. Apply their knowledge of mathematics, basic science and engineering science to creatively ring a project from problem statement to final design.
2. Be professionally competent and engaged in life-long learning, serving God in a professional career or by continuing their education in a graduate program.
3. Work in interdisciplinary teams and clearly communicate ideas through a variety of media.
4. Be a responsible professional with a strong sense of Christian vocation, ethics, and integrity that is consistent with a Christian worldview perspective, enabling graduates to become leaders in their churches, communities, professional societies and society as a whole.

Inherent in these objectives are the concepts of life-long learning and the desire for students to make positive contributions to their churches, communities and society as a whole. Being professionally competent involves learning about contemporary issues. The PowerPoint presentations in EGR 4345, Heat Transfer, contribute to this end.

## PowerPoint Presentations

The PowerPoint presentations were initially to serve two purposes. First, the course is taught at 8 am two days a week for an hour and twenty minutes each class period. Because of the long duration, a few minutes break is given to the students approximately half-way through the lecture period. After the break, the presentations are a means of getting students seated and thinking about heat transfer for the remaining class time. Second, it was desired to give the students an opportunity to develop a PowerPoint presentation and to speak to the class, thus developing communication skills.

On the first day of class the presentations are discussed and the students are shown an example presentation by the professor. A schedule is passed around for students to sign up for a specific day to present. Initially it was tried to use a random number generator to select the presentation for that day but the students did not like having to prepare the presentation early in the semester and then not know when they would present. Presentations are not made on days of exams or laboratories. The presentations have been used as part of the heat transfer class for the past three years with good results. The duration of the presentation is to be approximately five minutes in length and must use PowerPoint. Slides must be e-mailed to the professor on the day of the presentation. For the first two years, points were awarded for the presentation with 10 points being given for the preparation of the slides and another 15 points given for the actual presentation (see Attachment A). For the past year, students earned 10 points for the slides and 10 points for the presentation. Another five points were given to how well the topic was addressed (also see Attachment A). The total of 25 points for the presentation is a small part of a 1000 point course total but it is sufficient to insure the presentation had the attention of the students. For the first two years, the only guideline for choosing a subject was that it must have something to do with heat transfer. The third year focused more on the “soft” topics. Students being able to pick their own topic contributed to life-long learning, as they usually picked topics that were interesting to them. Research skills were also encouraged. While some students only used the internet as a reference, others were encouraged to find additional sources. For the first two years, bonus points were given for a technical reference from a library journal (10 points), using an outside book or magazine (other than the ASME magazine) that is not from the web (5 points), or an online technical journal (5 points). A copy of the journal article or other source was shown to the professor on the day of the presentation. For the last year bonus points were awarded for topics and/or presentations that exceptionally illustrate the contemporary, global and societal issues. Other bonus points were awarded for outstanding sources of information and excellence in the oral presentation. Some topic areas listed below:

- A Heat Transfer Model for Fire Fighter’s Protective Clothing
- Autoclaves
- Cerebral Protection
- Dealing with the Heat in Concrete
- Energy from Space
- Heat Transfer During a Fever
- Heat Transfer in Hydraulic Disc Brake Systems
- Acoustic Refrigeration
- The Eden Project and The Greenhouses
- Automotive A/C
- Automotive Cooling Systems
- Heat Shields
- Heat Transfer/Phase Transformations in Laser Annealing of Thin Si Films
- Hair Dryers

- Ocean Surface Cooling Using Wave-Driven Upwelling
- The Benefit of Moisture Wicking Fabrics
- Bridge Deicing
- Gas Turbines
- CPU Water Cooling
- Heat Sinks in Power Amplifiers
- Sweat
- Penguins: Insulation Matters
- Heat Transfer in the Sterilization of Canned Foods
- High Performance Brake Rotors
- Ice Rinks
- Heat Transfer in Dry Storage Spent Fuel Casks
- Space Suits
- Importance of Heat Transfer in Rifle Barrels
- Heat Transfer in Nanofluids
- Determination of the Wind Chill Index
- Cryosurgery Microcracks
- Thermonuclear Rockets
- Solar Power Tower
- Thermal Imaging
- The Curious Temperature-Dependent Sex Determination of Sea Turtle Eggs
- Tissue Temperature Oscillations Model
- Cryogenic Inducement of Osteonecrosis – A Thermal Analysis
- Waste-to-Energy Systems
- Solar Desalination
- Creating an Energy Efficient Home

As can be seen, the topic areas chosen are varied, exposing students to many topics not normally discussed in a heat transfer class. There are topics that deal with global issues such as energy, eco systems, and storage of nuclear waste. Other topics involve biomedical applications or safety issues. Still others are just plain fun topics for students to present. One such presentation was how penguins maintain their body temperature in the arctic environment. While the presentations were limited to five minutes, questions could be asked after the presentation for further discussion. The second year class had 24 students which meant that if each student presented for five minutes, the equivalent of one class period over the semester was dedicated to this activity. Any further discussion in class used additional time. The third year class had 32 students which required even more time. Attachments B and C show examples of student PowerPoint slides.

### **Student Feedback**

A survey on student attitudes towards the presentations was taken the past two years. The students were asked two sets of questions. The first set of questions, seen in Table 1, asks opinions on the presentations from the perspective of someone sitting in the audience. A total of 24 students responded in 2006. A total of 32 students responded in 2007. The second set of questions, Table 2, was directed towards those individuals who had given presentations. The total number of students who responded were 16 students in 2006 and 30 students in 2007. The scale ranged from 1 to 5, with 1 being Strongly Agree and 5 being Strongly Disagree.

For Table 1, average responses were mostly in the Strongly Agree and Agree categories. The presentations were enjoyable and interesting. The lowest responses concerned reinforcing concepts from the class lecture and discussion of their presentations outside the classroom.

For Table 2, the students clearly enjoyed picking their own topics and learning more about their topic area. What was not as clear from the responses was the use of outside references. For the first two years, of the 38 presentations archived for the course, all but three students used the internet. Fourteen students used library journals, five used an outside book reference, and seven used an

online journal. For the last year, out of 32 students, every student used the internet. Additionally, 12 students used journals, and four used books or magazines. More must be done to help students develop research skills.

Table 1 Questions completed by all students about the presentations

The presentations:	Average Response 2006	Average Response 2007
exposed me to new heat transfer applications I had not previously considered.	1.5	1.5
were informative.	1.7	1.8
were interesting.	1.4	1.5
illustrated how heat transfer impacts our environment.	1.8	1.8
illustrated how heat transfer impacts our society.	1.8	1.8
reinforced concepts from the class lectures.	2.0	2.0
were an enjoyable part of the class.	1.3	1.7
prompted further discussion with classmates outside of class.	2.0	2.9

Table 2 Questions completed by students who made presentations

	Average Response 2006	Average Response 2007
I learned a lot about heat transfer from researching this presentation.	1.8	1.9
I mainly used the internet to research this presentation.	2.3	2.0
I used a library reference for this presentation.	2.6	2.8
I enjoyed being able to pick my own topic.	1.4	1.7
I picked a topic about which I was curious to know more.	1.7	2.1

### Student Comments

Student comments speak for themselves. The students also have additional insight into what might be done to enhance this activity in the future.

“I think these presentations are a great way to learn more about the applications of the theories we learn about in class. The presentations are interesting and a great way to explore heat transfer.”

“The presentations have made me notice some heat transfer in things that I would never have thought of. They were very, very interesting.”

“I think the presentations are a great part of this class. It allows us to see the application of many of the concepts in the real world. They are also enjoyable to sit through.”

“It is nice to see real-life applications that I never realized involved heat transfer. It would be beneficial if we could do more projects regarding these presentations. For example, take a piece of

moisture wicking fabric and test it in the lab.”

“I wish we could do more of things like this, take everyday things and apply our engineering skills/knowledge to them.”

“I liked how we related equations from class to real-world topics. Shows the need for the class.”

“It gave scope to the subject and broadened the application understanding of heat transfer in the real world. Yes, time well spent.”

“I think hearing about new and even current heat transfer applications is just as informative as the class material. It helps stimulate your interest when real life applications are shown.”

### **Future Recommendations**

The students overwhelmingly commented to keep the presentations in the course even though the time used for the presentations meant less course material could be presented or fewer example problems accomplished during the year. Emphasizing contemporary, global, and societal issues in the last year’s presentations made it a little more difficult for student to choose a topic. For future offerings, student should be allowed to select a topic in any area of their choice. Other suggestions from the literature are to have students pick topics from trade magazines<sup>3</sup> or to write essays<sup>9</sup>. Since the main focus of the course is not to satisfy these “soft” outcomes, the amount of time allocated these topic areas cannot be significantly increased. In fact, should the size of the class increase further, it may not be possible to devote the time needed for individual presentations and the presentation will have to be withdrawn from the course. It would be advisable to incorporate more of these examples from past presentations into the course and use some of the knowledge gained through the presentations for future class demonstrations or in future class lectures. Improving the assessment survey must also be explored.

### **Summary and Conclusions**

While most faculty agree that the ABET EC 2000 outcomes are necessary for consideration in a mechanical engineering program, few faculty have considered the assessment of the more difficult outcomes concerning life-long learning, contemporary issues, and the impact of engineering in the global and societal context. This paper outlined the use of PowerPoint presentations on heat transfer topics chosen by the students to satisfy these outcomes. Students demonstrated life-long learning skills by selecting a topic and then doing the appropriate research. The variety of topics touched on contemporary issues and also showed heat transfer in a global and societal context. The student reaction to the presentations show that even something as simple as a five minute PowerPoint presentation can have a significant impact on a student’s attitude and motivation toward heat transfer.

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Attachment A

## **EGR 4345 Heat Transfer (2005 -2006)**

### **Presentation Guidelines**

Topics for the presentation must have a heat transfer theme. Discuss the heat transfer modes and the application. The topics can come from the internet however bonus points will be given if the topic is acceptable and is from a magazine or book (not from the web) other than the ASME Mechanical Engineer (5 extra points). An online technical journal that is used for the presentation will receive extra points (5 extra points). Additional extra bonus points (10 extra points) will be given if the topic is from a technical journal from the library (not an online journal) such as the ASME Journal of Heat Transfer. Bonus points will be awarded at the discretion of the professor. A copy of the technical journal articles will be turned in on the day of the presentation. The presentation is worth 15 points and the PowerPoint slides are worth 10 points for a total of 25 points.

Presentations will be:

made on the day for which you signed up. Any exceptions must be coordinated through the professor.

no more than five minutes in length.

informal yet professional.

made using PowerPoint. An electronic copy of the PowerPoint slides will be turned in as part of the presentation on the day the presentation is given.

**PRESENTATION DATE** \_\_\_\_\_

# **EGR 4345 Heat Transfer (2007)**

## **Presentation Guidelines**

Topics for the presentation must be on anything you find interesting that relates to heat transfer in the context of contemporary issues and/or the impact of engineering on global and societal issues. Discuss the heat transfer modes and the application. The presentation is worth 10 points and the PowerPoint slides are worth 10 points for a total of 20 points. The remaining five points will be awarded on how well the presentation illustrates the issues and relates to heat transfer. Topics and/or presentations that exceptionally illustrate the contemporary, global and societal issues may be awarded bonus points. Other bonus points may be awarded for outstanding sources of information and excellence in the oral presentation. Bonus points will be awarded at the discretion of the professor.

Presentations will be:

made on the day for which you signed up. Any exceptions must be coordinated through the professor.

no more than five minutes in length.

informal yet professional.

made using PowerPoint. An electronic copy of the PowerPoint slides will be turned in as part of the presentation on the day of the presentation.

**PRESENTATION DATE** \_\_\_\_\_

## Attachment B



### Bridge Deicing Methods

By Jeremy Reddin

vision



### Why do bridge surfaces form ice before road surfaces?

- Bridges lose heat from both sides while road surfaces retain heat from underneath.
- Bridges made with steel and concrete – high k.

Roads mostly made of asphalt – low k

$k_{\text{steel}}=14-15 \text{ W/mK @ } 300\text{K}$

$k_{\text{concrete}}=1.4 \text{ W/mK @ } 300\text{K}$

$k_{\text{asphalt}}=0.062 \text{ W/mK @ } 300\text{K}$

vision



### Deicing Methods

- Salt
- Hydronics
- Passive Geothermal Deck Heating (Heat Pipe)
- Conductive Concrete Overlay (Resistive Heating)

vision



### Salt

- Applying salt to ice/water lowers the freezing point

No salt added -  $T_f=32^\circ\text{F}$

10% salt solution -  $T_f=20^\circ\text{F}$

20% salt solution -  $T_f=2^\circ\text{F}$

- Disadvantage – very corrosive

vision



### Hydronics

- Heated fluid circulated through tubing embedded in bridge deck
- Opposite of radiator in a car
- Heat sources
  - Boiler
  - Ground source heat pump



vision



### Passive Geothermal Deck Heating (Heat Pipe)

- Working fluid – usually ammonia
- Heat source – geothermal
- Vapor transfers heat to bridge deck

vision

## Passive Geothermal Deck Heating (Heat Pipe)

vision

## Conductive Concrete Overlay

- May be defined as a cement-based composite that contains a certain amount of electronically conductive components to attain stable and relatively high electrical conductivity."
- Electrical resistance generates enough heat to prevent ice formation when connected to a power source
- Concrete mix containing 1.5% of steel fibers and 25% of steel shavings
  - Increases electrical conductivity while maintaining strength
- Provides good thermal power density of  $590 \text{ W/m}^2$

vision

## Any Questions?

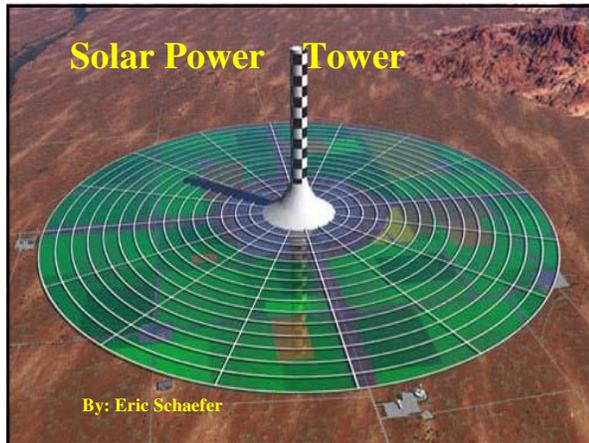
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## Attachment C



### What

- Large scale solar thermal power station
- Utilizes the greenhouse effect to produce emission free energy

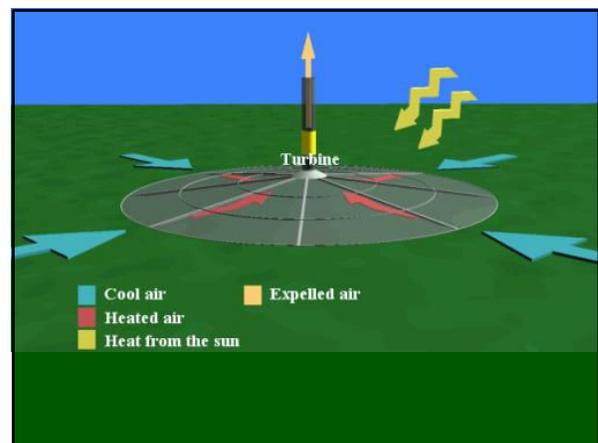


### Construction Materials

- Collector Zone - glass, polycarbonate and polymer
- Tower - reinforced high strength concrete
- Turbines - lightweight alloy materials (still in design stage)

### How

- Sun's radiation heats air and ground below collector zone
- Temp difference btw ground and air of tower causes convection air currents
- $T_{\text{ground}} = T_{\text{air}} + 35^{\circ}\text{C}$
- Air flows, 15m/s, and turns turbines
- Air expelled from top of tower



## Impact

- Power 200,000 Australian households
- Save 900,000 tons of CO<sub>2</sub> annually
- Area under outer edge of collector zone can be used for farming purposes
- Visible from 130km
- 2% Efficient

## Sources

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