The Re-Energize Undergraduate Research Program in the Third and Final Year

Dr. Dan G. Dimitriu, San Antonio College

Dan G. Dimitriu has been practicing engineering since 1970 and taught engineering courses concurrently for more than 20 years at various institutions. In 2001, he joined San Antonio College full-time as the Coordinator of its Engineering program. He has been involved with several engineering societies and became a member of the Two-year College Division of ASEE in 2002. His research interests are in engineering graphics, 3-D Visualization, fuel cells, plastics, and engineering education.

Mr. Klaus Bartels, San Antonio College

Klaus Bartels is an Adjunct Faculty member at San Antonio College (SAC) in the Mathematics, Architecture, Physics and Engineering Dept. He was born near Buenos Aires, Argentina and immigrated to the U.S. in 1956. He grew up and went to college in the Boston, MA area. He has a B.S.E.E. from Tufts University (1972) and an M.S.E.E. from M.I.T. (1975). He served as a Communications-Electronics Engineer/Officer in the USAF from 1975 to 1999, retiring as a colonel. He worked part time as a Flight Director at the Challenger Learning Center of San Antonio from 2000 to 2009, and has been teaching remedial math and engineering classes at SAC since 2000. He has also been involved in various engineering summer programs at SAC, including instructor for Robotics Camps for 3rd to 5th graders (2012 - 2014), instructor and coordinator for the Early Development of General Engineering program for high school students (2007 - 2015), and faculty adviser for alternative energy Summer Undergraduate Research Programs (2011 - present).

Mr. Steven F Lewis

Steven Lewis served as a training manager for Lockheed and Raytheon corporations around the world and spent a total of 27 years primarily in Colombia, Iran, Saudi Arabia and Mexico. He assumed the leadership role at the Service, Trade, and Industry Center of Alamo Colleges/San Antonio College in 2006 and quickly expanded the scope of the center by launching the Alamo College Green Training Initiative. In order to strengthen the initiative, Mr. Lewis collaborated with the college grant office to submit a successful proposal to the United States Department of Urban Development in 2010 for construction of the William R. Sinkin Eco Centro. He since served as director of Eco Centro while collaborating with Texas State University on the Re-Energize grant and EverGreeen grants in overseeing undergraduate research projects.
Re-Energize Undergraduate Research Program in Its Third and Final Year

Abstract

The Re-Energize Undergraduate Research Program started with the creation of a network of renewable energy education and research labs fully contained and established at each of the four participating member institutions and it evolved into a collaborative effort to share effective new green technology content. Its goal was to impart skills to faculty members of this network in order to strengthen their capacities and arm them with additional resources to support their efforts in recruiting and retaining students, and in particular, minorities and females in STEM programs offered at their institutions.

San Antonio College (SAC) as part of this network worked continuously on developing and implementing new undergraduate research projects related to green technologies for the entire duration of this partnership making a commitment to

1) encourage STEM faculty to attend Re-Energize professional development to learn about and include green energy educational modules into our STEM curriculum;

2) "start-up green lab" on our campus through funding from the collaborating four-year institution so that faculty can conduct classroom demonstrations and students can perform undergraduate research. This initiative diversified and continued our undergraduate research program by including our Eco Centro, a community outreach center for environmental sustainability, into this program;

3) promote additional outreach and educational efforts to support our students and encourage them to seek careers in STEM and green energy-related fields; and

4) participate in on-going evaluation and research efforts related to this program.

Numerous reports demonstrate that undergraduate research programs at four-year institutions have been responsible for increasing retention and graduation of their students. Our previous results indicate that two-year institutions can also initiate successful programs with similar results. The paper will present in detail the conclusion of this valuable partnership between the participating institutions and their plans to continue developing new directions for undergraduate research programs that can be conducted year around. Our experience and recommendations may be used as blueprints to develop similar programs at other institutions of higher learning.
Career Growth Projections for Engineers

Bureau of Labor Statistics (BLS) indicates that demand for engineers will continue to show a steady growth during the 2014-2024 period and expects greater-than-average growth from several individual engineering fields with rates ranging from 23.1% for biomedical engineers to 5.3 % for mechanical engineers [1]. The increasing employment of engineers in service industries, research and development, and consulting is expected to generate most of the employment growth.

The National Science Foundation in a 2015 Survey of Graduate Students and Post-doctorates in science and engineering [2] found that from 2008 to 2013 STEM graduate students in the U.S. who were U.S. citizens or permanent residents rose 3.1%. Of these, 25.8% were Hispanic and 7.8% were African-American.

San Antonio College, being a minority serving institution, has a stated mission to attract and engage minorities on a path toward higher education. A high level of achievement in Science, Technology, Engineering, and Mathematics (STEM) education is essential if the U.S. is to maintain a leading role in space science, aeronautics, cybersecurity, and technology in general. As shown in previous papers, for the last fifteen years SAC has been on a continuously ascending path to attract and retain more students, in particular minorities, into the STEM fields as well as striving to align its engineering program with the engineering programs offered by the surrounding area four-year institutions [3],[4]. At the same time, our engineering faculty made every effort to provide the highest quality education for our students [5],[6].

Two previous ASEE papers [7],[8] described the first two years of a new kind of partnership, called “Re-Energize,” that is expected to help several two-year colleges develop their own research capabilities in renewable energy in collaboration with Texas State University (TxState).

The Re-Energize program established a creative research and development (R&D) and professional development (PD) ecosystem. This ecosystem empowers institutions of higher education who prepare students in engineering and engineering technology in Central Texas to continue to do so with enhanced and focused knowledge, facilities, and student programs. Re-Energize addresses the learning needs of faculty and students via a systems approach and aims to serve as a replicable and scalable national model. This paper presents the results of the
Third Year of the program.

Re-Energize Project: Results of the Third Year (1 Oct 16 to 30 Sep 17)

Objective 2: Provide awareness, training, and financial support to attract and motivate students from the minority institutions to consider education and career opportunities in STEM.

Activity 2.3: Texas State will facilitate a day-long tour for the participating students to Texas State labs and facility with STEM-oriented educational and entertainment programs.

<table>
<thead>
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<th>Year</th>
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<td></td>
<td></td>
<td>13 females (28%)</td>
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</table>

Table 1- SAC Re-Energize Student Participants

Table 1 provides statistics for SAC students that were recruited for and participated in the Re-Energize program over the three years of the grant. In Year 3, there were 46 students, an increase of 24% over Year 2, and 119% over Year 1. The number of female participants was 13, an increase of 63% over Year 2, and 333% over Year 1. In Year 3, 35 of the participants (76%) were underrepresented minorities (URMs) in STEM (females, Hispanics, African-Americans). The number of minorities in Year 3 was 40% more than Year 2 and 119% more than Year 1. The declared majors of the 46 students in Year 3 were: 39 engineering (85%), 3 environmental science (6.5%), 1 physics (2%), 1 computer programming, 1 biology, 1 general science.

On 11 November 2016, one SAC faculty member and 16 students visited Texas State University for a day-long tour of renewable energy demonstration/research laboratories and engineering
manufacturing facilities. TxState faculty and graduate students also provided information on STEM career paths and an update of the Re-Energize program including research and scholarship opportunities.

**Objective 3:** Design and develop a replicable renewable energy laboratory to carry out the training and hands-on activities proposed in the Re-Energize program. A replica of the lab will be established at Eco Centro to operate independently once the training is completed.

**Activity 3.2:** San Antonio College will nominate selected members of STEM faculty and encourage as well as support them to attend the designated Re-Energize professional development activities to learn and adopt green energy educational modules.

In Year 3, one staff member (STEM workshop technician) attended a 3-day Re-Energize training seminar at TxState from 15 – 17 May 2017. During the seminar, TxState faculty, graduate students and industry representatives provided an overview of the Re-Energize program, information on green technology, tours of solar and wind energy labs, as well as information on mentoring and injecting green technology activities into the classroom.

On 18 May 2017, SAC hosted the Re-Energize faculty/staff from TxState and the other partner institutions for a tour of SAC’s Mathematics Engineering Science Achievement (MESA) STEM Center [9] and SAC’s Eco Centro, a community outreach center for environmental sustainability. In addition, SAC Re-Energize students gave presentations and demonstrations of Re-Energize-supported research projects; i.e., hydroponics, solar electric cart, and hydrogen fuel cell prototype vehicle.

In Year 3, SAC faculty continued the use of educational modules/activities that were developed during Year 1 for use in engineering and math classes. These modules/activities improved student awareness and learning in sustainability and renewable energy systems. These modules included renewable energy application problems for use in exams as well as a sustainability team design project. The team project requires students in our Introduction to Engineering classes to modify a builder’s existing new home design to improve its sustainability by reducing its resource consumption and/or improving energy efficiency. After substantial research in “green” technology, materials and practices, student teams developed written design proposals and gave oral presentations on their more sustainable new home designs. These designs included features such as improved insulation, xeriscape landscaping, solar panels, solar roof tiles, higher
efficiency HVAC systems, geothermal systems, sustainable building materials and rain harvesting systems. The detailed requirements/guidelines for this team project are provided in Appendix 1.

**Activity 3.3**: San Antonio College will utilize the funding provided by TxState and designated for the establishment of a start-up green lab (as defined by specific parameters) and follow TxState guidance regarding technical training and support.

**Hydroponics Project**

During Year 3 of the hydroponics project, the focus of activity built upon two years of design and experimentation in order to launch several hydroponic food production units. Design and technology innovation enabled the SAC hydroponic students to share expertise with collaborators at research-based universities including Texas State University, Texas A&M University Kingsville, and Wageningen University in the Netherlands. The SAC project distinguished itself by incorporating low-cost and commonly available materials to achieve growth results similar to those in systems requiring a much higher initial investment.

![Fig. 1 - The hydroponics design team builds low-cost system support structure](image)

During the spring semester of 2017, students from TxState visited the hydroponic laboratory and the corresponding shipping container at SAC. They met with faculty, staff and students at SAC in order to compare advances in hydroponic projects at the respective campuses. The TxState team expressed particular interest in the automation system designed by SAC students that
continually monitors and adjusts contents of the nutrient solution (Figure 1). The TxState team explained its use of fiber optic cables to transmit sunlight from the exterior to the interior of their hydroponic container.

The design team took into account specifications for the hydroponic shipping container that will ultimately expand the project from the laboratory to a commercial production setting. Alamo Colleges supported the hydroponic project’s impending move to the container by providing electrical infrastructure needed to put it into full operation during the summer of 2018. The container now has an independent meter with a conduit connection and live circuitry throughout the interior.

The team took the remote-controlled monitor transport cart designed in Re-Energize Year 2 to a new level by developing a multi-faceted automation system (Figure 2). It monitors ingredient levels of the nutrient solution and makes adjustments when sensors indicate a need.

As Re-Energize Year 3 advanced, the team transitioned from the initial design stage to the implementation stage of the project. Rather than using an off-the-shelf hydroponic system that incorporates one of several types of grow lights on the market, the team engaged in comparative
experimentation involving fluorescent and LED grow lights. Factors taken into consideration included cost, usable light output, heat generation and energy consumption. LED lights proved to advantageous in all categories except cost. Since lower cost fluorescent light fixtures accept LED bulbs, the team is conducting experiments with hybrid light sources that incorporate both technologies. Experimentation to date resulted in healthy plant growth with both systems (Figure 3), with LED offering the advantage of focusing the light spectrum to emphasize spectrum components most beneficial to vegetative growth and flowering.

Fig. 3 – Experiments with fluorescent lighting resulted in healthy basil plants

Design work and experimentation during Re-Energize Years 1 and 2 came to fruition in multiple projects during Year 3. In the hydroponic laboratory, multiple teams of STEM students designed and assembled mounting structures that support multiple layers of plants nourished by a flow of nutrient solution. In accordance with the project’s goal of producing low-cost grow systems made from readily available materials, they assembled most of the support structures from 1.5-inch schedule 40 PVC pipe and fittings.
After completing the support structures, Re-Energize students designed and experimented with both deep water and ebb/flow hydroponic systems (Figure 4). By controlling light access and nutrient contents, students reduced the variables in their experimentation. The success of the initial system designs made it possible to obtain additional materials and scholarship funding from the USDA EverGreen sub-grant under Texas State University, which focuses specifically on undergraduate research in the realm of hydroponic food production.

Students were able to link growth results with the level of useful light emitted by each light source. A Vernier PAR sensor provided accurate readings on the amount of useful light available to plants at varying distances from the light source. That, in turn, allowed students to adjust the distance between light sources and plants in order to achieve optimal plant development.

Other light-related experiments involved adjusting the amount of time plants receive light exposure on any given day. Students adjusted the length of light exposure using a series of timers that they will later incorporate into the full-scale hydroponic container.

Fig. 4 – Ebb/flow experimentation involving multiple edible plants
As the number of hydroponic grow units expanded, students had to step up the level of seed propagation and plant cloning. They initially faced problems with leggy seedlings that lacked the strength to survive when transferred to hydroponic systems. After systematically adjusting the distance between light fixtures and seedlings as well as the number of hours of light exposure per day, students achieved consistently healthy seedlings (Figure 5).

![Image](image_url)

**Fig. 5** – Students achieved these consistently healthy seedlings

The three years of Re-Energize funding made it possible for STEM students to move full cycle from system concept to design, assembly and operation. Engineering students played a key role throughout, but as our systems became operational, there was a need for students from other STEM fields. Additional funding sources make it possible to offer stipends to students majoring in agriculture, biology and environmental science. Perhaps the most promising outcome of the three-year project is that it gave us a foundation of hands-on experience that prepares our students to expand the projects dramatically in 2018. The ultimate goal is for sales of our product to be able cover the cost of operation. Once we achieve that goal, we will have the assurance that undergraduate research can continue without being dependent on additional sources of funding. At the same time, the years of collaboration with research universities positions our graduating
students to transfer to them with STEM-related scholarships. The bonds we formed with those institutions also position us to engage in collaborative undergraduate research for years to come.

**Solar-Electric Vehicle Research Project**

The Year 1 and 2 papers detailed the success of Re-Energize students in converting an old, worn-out gas utility cart into a solar-electric vehicle (figure 6). Three 4-person teams completed this difficult and complex project over two semesters, producing a fully functional solar-electric vehicle. The outstanding achievements of these students was recognized when they and the vehicle were showcased at SAC’s 90th anniversary celebration in November 2015.

![Solar-electric cart](image)

**Fig. 6 - Solar-electric cart**

In Year 3, SAC’S MESA Center used the vehicle at various events at SAC to increase students’ interest in STEM education/careers as well as promote sustainability, renewable energy technology, and the Re-Energize program (figure 7).

![Solar-electric cart](image)

**Fig. 7 - Solar-electric cart being used to promote renewable energy technology and STEM**
Hydrogen Fuel Cell Vehicle Research Project

Late in Year 1, a few of the Re-Energize students involved in the solar electric vehicle project proposed that SAC compete in an international vehicle fuel efficiency contest. After gaining faculty/staff approval, these energetic engineering students (mostly Hispanic) recruited over a dozen other (mostly engineering) students and established the SAC Motorsport Team (figure 8). Their goal was to design and build a prototype hydrogen fuel cell vehicle (HFCV) to compete in the prestigious Shell Eco-marathon Americas tournament (shell.com/ecomarathon - figure 9). Shell Eco-marathon challenges student teams from around the world to design, build, test and drive ultra-energy-efficient vehicles. This project has generated more interest and participation by SAC STEM students than any previous undergraduate research project.

In Year 2 the SAC Motorsport (SMS) Team recruited additional team members (figure 10) and worked hundreds of hours researching, designing, and selecting equipment/materials for the HFCV; i.e., wheels & tires, steering & suspension, frame & body, motor & controller, and the hydrogen fuel cell. The team also worked hard getting equipment/parts donations and raising funds for this extremely complex and expensive project. The team was assisted by five SAC faculty/staff advisors as well as industry contacts, and Texas State University students/faculty. Most students also received stipends under the Re-Energize grant.
During Year 2, the team procured most of the equipment/parts needed to build the vehicle, including the expensive Hydrogen Fuel Cell Stack (HFCS) that provides electrical power for the vehicle. As detailed in the Year 2 paper, four SMS Electrical Team students completed a research project in summer, 2016 which tested the hydrogen fuel cell stack (figure 11) under different operating conditions (i.e., varying gas supply pressure and output load). The objectives of this research project were met; i.e., a better understanding of hydrogen fuel cell stack performance and determining its most efficient operational configuration. This information is critical to maximizing the fuel efficiency of the hydrogen fuel cell vehicle.

During Year 3, the SMS team logged many hundreds of hours (including working during winter and spring school breaks) finalizing the design, ordering remaining equipment and materials, constructing the frame and body, and installing the wheels, steering, motor, hydrogen fuel cell, and electrical equipment (figure 12).
After successful local testing, the vehicle, named “Noventa,” was unveiled and demonstrated at a media-covered public event at SAC on 20 April 2017 (figure 13).
The SAC Motorsport Team, comprised of 13 students and 4 faculty/staff advisors, travelled to Detroit, Michigan to participate in the 11th annual Shell Eco-marathon Americas event from 27 to 30 April 2017 (figure 14). The event drew over 120 high school and college teams from across North and South America with over 1,200 student participants competing in five different categories covering both prototype vehicles and urban concept vehicles. The SMS team’s vehicle was entered in the hydrogen fuel cell prototype vehicle category, the most technically complex category, which had 6 different teams competing. After some repairs and adjustments, the vehicle, unlike many others, passed rigorous safety, mechanical, and electrical inspections by Shell Eco-marathon technicians and engineers (figure 15). The vehicle was cleared to compete on the 0.9-mile oval course set up on blocked-off downtown Detroit streets.

![Fig. 14 – SMS Team at Shell Eco-Marathon](image)

![Fig. 15 – HFCV during technical inspection](image)

The HFCV performed without failure or accidents during multiple competition runs (figure 16).

![Fig. 16 – HFCV during competition runs at Shell Eco-Marathon Americas in Detroit](image)
The vehicle’s fuel efficiency was measured at 66 miles per cubic meter of hydrogen gas, or the equivalent of 829.4 miles per gallon of gasoline. This resulted in the team placing third in the hydrogen fuel cell prototype vehicle category and garnering a $1500 prize (figure 17).

Fig. 17 – SAC Motorsport Team Leaders with Third Place Award

This marquee Re-Energize and SAC undergraduate research project received high praise and recognition within SAC, Alamo Colleges, in the local media, and the community at large. It has provided new knowledge, skills, and experiences to students, which has assisted them in obtaining scholarships, internships, career-related jobs, and future research opportunities. In addition, this project has and will continue to be used at various STEM events in and around SAC to promote sustainability and energy efficiency as well as to help to recruit and retain students in STEM fields/programs (see figure 18).

Lastly, the excitement and success of the HFCV project has inspired a new group of SAC students to join the SAC Motorsport team. Based on knowledge gained from the HFCV project, this new team is designing and building a lighter, more efficient hydrogen fuel cell vehicle to compete at an even higher level at the Shell Eco-marathon Americas competition in 2018.
Collaboration Challenges

As detailed in this report, the Re-Energize program was successful in achieving its goals and included some remarkable student-led achievements. However, there were a number of challenges that had to be overcome in building a successful collaboration between Texas State University (lead institution) and the three community college partners (SAC, Southwest Texas Junior College, and Coastal Bend College) as detailed below:

1. Research activities are not required/important for most community colleges.
2. Faculty are not normally encouraged to be engaged in research activities.
3. Faculty do not receive reduced teaching load for participating as advisors in research activities.
4. Community college administrative systems are not familiar with subcontracts and reporting mechanisms required for research activities.

The above challenges were overcome thanks to dedicated faculty (full and part time) at the partner institutions that were personally motivated to support the Re-Energize program and student research projects. However, future collaborations of this type should include enough
funding to compensate faculty for their time and effort in the form of summer salary or course buyouts. Thanks to programs like Re-Energize, community college students are gaining legitimate research skills and the increasing sophistication of their projects boosts the credibility of undergraduate research projects.

**Conclusions**

In Year 1 of this collaborative effort, SAC ramped up quickly with equipment acquisitions, faculty training, student recruitment, and research team formation and project execution. In Year 2, our student participation in Re-Energize activities increased by 76% (from 21 to 37 students), and we added a fourth “green-energy-trained” faculty member to the program. In addition, Year 2 saw more students involved in Re-Energize-supported undergraduate research projects. These students completed the solar electric cart project and made major progress in the hydroponics and hydrogen fuel cell vehicle projects. In Year 2, SAC also continued the use of educational modules/activities that were developed during Year 1 for use in engineering and math classes.

In the final year (Year 3), SAC continued the activities from Year 2 and was again successful in meeting objectives of the Re-Energize program. Student participation increased by 24% from Year 2 to Year 3 and minority participation increased by 40%. In addition, in Year 3 the two Re-Energize supported research projects, hydroponics and the hydrogen fuel cell vehicle, thanks to the dedicated efforts of dozens of outstanding SAC engineering and science majors, achieved impressive results. We are also proud to note that San Antonio College was not only the largest contributor to the Re-Energize program but also was recognized by Texas State University, the lead institution, as the most outstanding collaborator over the 3-year Re-Energize program. Throughout the 3-year Re-Energize program the excellent collaboration between SAC and TxState resulted in strengthening our capacity to use renewable energy technologies and activities to support efforts to increase recruitment and retention of students, especially minorities and females, in STEM programs offered at our institution. In the future, SAC will continue to use the knowledge and experience gained during the Re-Energize program to further advance STEM education and outreach, especially to underrepresented minority students.
References


3. Forging Stronger Ties between Community Colleges and Four-Year Universities, by Dan G. Dimitriu and Jerry O’Connor, ASEE Conference, Salt Lake City, UT, June 2004

4. Community Colleges Can Help Universities During ABET Accreditation Efforts, by Dan G. Dimitriu and Jerry O’Connor, ASEE Conference, Louisville, KY, June 2010

5. The Need for a Quality Control System for Community College Engineering Education, by Dan G. Dimitriu and Jerry O’Connor, ASEE Conference, Honolulu, Hawaii, June 2007

6. Initiation of an Undergraduate Research Program, by Dan G. Dimitriu and Jerry O’Connor, ASEE Conference, San Antonio, TX, June 2012

7. The Re-Energize Undergraduate Research Program at Our Community College, by Dan G. Dimitriu, Klaus Bartels, Steven F. Lewis, and Bahram Asiabanpour, ASEE Conference, New Orleans, LA, June 2016

8. The Re-Energize Undergraduate Research Program in Its Second Year, by Dan G. Dimitriu, Klaus Bartels, and Steven F. Lewis, ASEE Conference, Columbus, OH, June 2017

9. The Five Years Evolution of a MESA Program, by Dan G. Dimitriu and Jerry O’Connor, ASEE Conference, Atlanta, GA, June 2013
Appendix 1

ENGR 1201 – Team Project #1 — Guidelines
Sustainable New Home Design

☐ Goal: Prepare a proposal for modifying an existing new home design to improve its sustainability by reducing its resource consumption and improving energy efficiency

☐ General Project Requirements:
  o Obtain an existing San Antonio builder’s design, including floor plans and specifications, for a typical, middle income 3 or 4-bedroom new home
  o Select two (min) or three (max) ways to change the home’s design to increase its sustainability and/or reduce resource consumption, yet still be affordable for middle income families
  o Examples of sustainability measures that can be incorporated into the design include:
    ▶ more sustainable building materials
    ▶ more efficient HVAC or water heating systems
    ▶ more efficient appliances
    ▶ alternative energy systems (solar, wind, biofuel, or geothermal)
    ▶ xeriscape landscaping
    ▶ rainwater harvesting
  o Prepare a written report and oral PowerPoint presentation detailing your proposed design

☐ Written and Oral Report Requirements: (Note - much more detail must be provided in the written report. The oral presentation will include the most important aspects of the written report/proposal.)
  o Description of the existing new home design to include:
    ▶ Name of builder, floor plan, dimensions, lot size, primary building materials, total cost
    ▶ Energy efficiency specs. for house (e.g., HVAC, water heater, insulation, appliances)
    ▶ Estimated average annual utilities usage and cost for family of four for electricity, water, and gas (if used in the home)
    ▶ Limitations of current design as regards to sustainability and efficiency
  o Description of each change/improvement you propose for the home to include:
    ▶ Description of the improvement and list of equipment and materials required
    ▶ Description of how the improvement would be implemented and how it would operate
    ▶ Drawings and/or diagrams of the improvement as incorporated into the home design
    ▶ Benefits and limitations of each design change/improvement
    ▶ Additional initial implementation cost and additional annual maintenance cost (if any)
    ▶ Cost analysis including dollar savings per yr. on utilities and payback period in yrs.

☐ Administrative Requirements:
  o Oral presentation:
    - 6 - 12 mins (each person does equal portion; grade reduced if time limit busted)
    - Must use a minimum of 6 PowerPoint ® slides during the presentation
      ▶ Include Title, Overview, and Conclusion slides
  o Written report:
    ▶ 8 to 12 pages typed (double spaced) including title page, references, and diagrams
    ▶ Include a title page with your team name, team logo, title, report date, and typed name of each team member – also, each member must sign by his typed name
    ▶ Include a table of contents page as well as introduction and conclusion paragraphs
    ▶ Use chapter designators/topic titles (Ex: Intro., Existing Design, Improvements, etc.)
    ▶ Add name of person responsible for each paragraph at beginning of each para.
    ▶ Gantt chart for research/design/documenting/acquiring materials/building/selling home
    ▶ Number pages and include a list of references (including title, author, and date)
      ▶ Use the guidelines sheet as a check sheet (✓) and staple it at the end

Last revision: 23 Jan 16

Due Date: __________
Appendix 2

Team Project #1 – Sustainable New Home Design

Grade Sheet

Name: _______________________________ Team: ___________________________ Date: ___________________________

Written Report Grade Sheet:

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<tr>
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<td>Pages properly numbered and topic titles (chapter designators) used</td>
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<tr>
<td>Step-by-step project timeline (Gantt chart) for researching, designing, documenting, acquiring equipment/materials, building, and selling your sustainable home (not a team project Gantt chart)</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Certification from SAC Writing Center of assistance obtained on written or oral report</td>
<td>5 (optional)</td>
<td></td>
</tr>
<tr>
<td>Total:</td>
<td>105</td>
<td></td>
</tr>
</tbody>
</table>

Oral Report Grade Sheet:

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Max. Points</th>
<th>Points Earned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration between 6 and 12 minutes (each individual between 1.5 and 3 minutes)</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Oral delivery (eye contact, voice clarity/strength, enthusiasm, hand gestures, pace)</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Content (understandable, slides readable and not too busy, covered required material)</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Total:</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Overall Project Grade: \( \frac{\text{Written Report Grade} + \text{Oral Report Grade}}{2} \)