Club Name: Little LEGO Tekineer Krew

PORT OF BENTON

Project Title: Hydrogen and Small Modular Reactors Combined Sustainable Energy Model Advisor's Name: Sara La, Boeing Company, Seattle WA

We developed a Sustainable Energy Model and shared our learning and knowledge with kids, communities, industries, universities, and government agencies. We went on a field trip to the Port of Benton, WA and learned that they rented land to businesses, however, businesses were concerned about energy shortage. We researched sustainable energy solutions under the mentorship of our advisor. We found that a combination of new hydrogen plants and small modular reactors (SMR) as suitable solutions to the Port's problems. We then implemented our solutions using LEGO blocks and demonstrated them to the Port and gained their feedback and appreciation.

Hydrogen can be generated from renewables during off-peak hours and later electricity can be generated using fuel cells and fed back into the grid during peak demand. Unlike batteries, hydrogen can be stored in large quantities for longer times. SMR use same concept as traditional nuclear reactors but are modularized, take less space, water, fuel, and materials to build. The combined solution of hydrogen and SMR promise to provide adequate sustainable energy for the Port of Benton as well as for rest of the world.

Goals and Initiatives: Identified Problems, Surveyed Current Technologies, Offered Solutions, and Did Outreach



Problem Identification: Port of Benton field trip was helpful to understand the need for sustainable Energy mode which will help businesses in Tri-Cities. This is our project goal **Industry based Learning**: Visited industries to understand current technology to generate clean Energy







Experimenting

Had fun with LEGO made many energy models and tested various designs **Community outreach** at Robotics events, energy industries and at Washington State University, Tri-Cities





Approach: Research, Brainstorming, Sketches, and Models for Sustainable Solutions

- Our team researched about renewable energy sources for more than 50 hours.
- We brainstormed ideas with our mentor from Boeing for over 70 hours who gave us feedback and suggestions for progress.
- We identified solar, tidal energy; also had thoughts about developing designs and models for using energy emitted from underwater volcanic eruptions.
- We came up with initial designs and made the process fun with LEGO bricks.
- The Boeing Company sponsored our project and helped us in buying supplies like engineering notebooks and LEGO bricks that helped us in developing designs and building structures.



State of the Art: Energy Education through Industry Field Trips

- We identified OCOChem Inc. and sent email to CEO of OCOChem. We received response and got an opportunity for a field trip.
- We learned about OCOchem's electrolyzer device helps to store energy in liquid form.
- Field trip helped us to understand conversion of carbon dioxide into useful products and storage of renewable energy.

Relevance: Identified Energy Insufficiency In Tri-Cities from Port of Benton Field Trip

Port of Benton is a government agency that invited us for a field trip.

We learned that the Port rents out a lot of land to attract businesses to Tri-Cities. However, many businesses are not coming to the Tri-Cities because of energy shortage. This was the problem we identified

We learned about a submarine called the USS Triton that used Nuclear Energy because it helped the Triton to be powered for a long voyage. We learned that there was a nuclear fission reactor at the very end of the submarine. This system had a primary loop where water was heated and then the steam would move on to the secondary loop. Then, the cold water particles will go back to the primary loop where the cold water was again heated. The hot water that entered the secondary loop later spinned a turbine and generated energy.

Accomplishments: Our sustainable Energy Model Design Overview

Prototype: Hydrogen Energy System Prototype LEGO Models

We designed and developed hydrogen production unit based on Proton Electrolyte Membrane Electrolysis Technology and compressor unit based on Hyperbaric technology.

We sketched our own idea based on existing technology and programmed the models so that it was functional.

Risk and Safety: Safety Feature Innovation for Hydrogen Energy Storage System

In addition to leak detection and pressure monitoring system that are in present models, we added bolt loosening sensors. When bolts loosen, the sensor activates and gives a light. This feature will prevent future accidents.

Prototype: Small Modular Reactor Technology Prototype LEGO Model

Small Modular Reactors are smaller in size, safe, leave low carbon footprint, are flexible and have low construction cost. They have a modular design too !!

Further SMR take less space, use less water and materials to build, use less fuel, and follow the same concept as traditional reactors.

Government Agency Outreach: Presentation at the Port of Benton

We presented our sustainable energy solution to about 15 members at the Port of Benton and they had great questions for us. They inspired us and mentioned about a lot of fun STEM energy programs in Tri-Cities. They loved our model !!

Community Outreach: Presentation at the FIRST Robotics Festival

We presented our model and educated many people in the public at FIRST Robotics festival in Washington state. There were about 32 teams and each of them had 20 kids who came to us and learned about alternative energy sources. Indirectly, the concept reached about 500 community members through FIRST Washington social media website (flicker).

Community Outreach: Presentation at the FIRST Washington STEM Night

We presented our model and poster board at the STEM night organized by FIRST Washington.

We met several school board employees, volunteers, and teachers who were very impressed by our model and presentations skills

There were about 40 people at the two hour session. We also explained our concepts to other kids from other parts of Washington State

Public Utility Outreach: Presentation at Energy Northwest

Energy Northwest is a public utility company serving Tri-Cities, WA.

They appreciated our effort and suggested we present our proof of concept to the Washington state legislators.

Since Washington state uses 67% of hydroelectric power, Energy Northwest team suggested that we could also use hydroelectric power concept to power the electrolysis unit for hydrogen production.

Energy Startup Outreach: Presentation at STARS Technology Inc.

STAR technology gave us great feedback. We had good discussion about splitting Methane into Carbon and Hydrogen for generating Hydrogen. They also showed their model and loved our concept. They have invited us to their company in California to present our model and also to perform outreach at their events.

University and Community Outreach: Presentation at the Washington State University, Tri-Cities WA

We approached Washington State University Tri Cities Clean Energy Ambassador Program and demonstrated our sustainable energy model.

There were great questions about the future of hydrogen technology alongside with great positive feedback about our idea.

The ambassador program has accepted our team as a part of their group and has invited us to present at the Undergraduate Symposium at Washington State University Tri-Cites campus.

