



# Intel International Science and Engineering Fair (ISEF)

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## USAID Science for Development Award 2014 Winners

11 young scientists  
\$40,000 in awards

Brilliant solutions for development



USA



Indonesia



Egypt



Sri Lanka



Ukraine



**USAID**  
FROM THE AMERICAN PEOPLE

# 2014 ISEF USAID Science for Development Awards at a Glance

## Winners

**Muhtaza Aziziya Syafiq & Anjani Rahma Putri**, Indonesia  
Global Refrigerant Box

**W.A. Namal Udara Piyasiri**, Sri Lanka  
Versatile Field Construction Machine for Paddy Cultivation

**Alon Millet**, USA  
Cellulose Binding Domains: Novel Implications in Ag. & Biofuel Production

**Dhuvarakesh Karthikeyan**, USA  
MFCs Reloaded: A Novel Bio-Augmented Design to Enhance MFC Efficiency

## Honorable Mentions

**Hoda Mamdouh Shoman, Sara Erat Mohamed, & Mona El Sayed Moawad**, Egypt  
Vacuum Evaporator for Water Purification

**Anjali Vasisht**, USA  
IoT (Internet of Things) Connected Air Quality Monitor to Detect and Measure Particulate Matter [Air Pollution] Concentration

**Mykhailo Lytovchenko**, Ukraine  
Wave-Powered Desalinator

**Donely Gunn**, USA  
Wind Turbines for a Developing World

*Please note that abstracts are written by the pre-college student of the winning project and to preserve the integrity of their work, the language has not been modified.*

# Winning Abstracts



Intel International Science and Engineering Fair (ISEF) Winners  
USAID Science for Development Award

# Winning Abstract

## Muhtaza Aziziya Syafiq & Anjani Rahma Putri



Indonesia

*Global Refrigerant Box*

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**Abstract:** Day by day there is an increasing need of coolers to preserve food stuff and fruits in rural areas, like Musi Banyuasin regency, South Sumatera. Commonly, refrigeration systems in society use electricity. This becomes a problem, because of the limited power supply in rural areas. The alternative solution is using Green Refrigerant Box (GRB) by utilizing gelam wood as activated carbon adsorbent and modified vacuum pump as a substitution of electricity. The first step is designing and assembling GRB using clean cans, hose, copper and plastic box. Then it will be continued with working of the system using 300 gram mass of activated carbon adsorbent and 100 ml, 300 ml, 400 ml volume of ethanol. The data show that for variation of 300 gram mass of activated carbon and 100 ml volume of ethanol produce decreasing of temperature until 6 degrees C for 4 hours 10 minutes pumping time. For Variation of 300 gram mass of activated carbon and 300 ml volume of ethanol produce decreasing of temperature until 5.5 degrees C for 2 hours 20 minutes pumping time. For variation of 300 gram mass of activated carbon and 400 ml volume of ethanol produce decreasing of temperature until 6 degrees C for 3 hours 10 minutes pumping time. So, the optimum parameter is using 300 gram mass of activated carbon adsorbent and 300 ml volume of ethanol. It could decrease the temperature until 5.5 degrees C from 28 degrees C (room temperature) for the shortest time of pumping time.

# Winning Abstract

**W.A. Namal Udara Piyasiri**



Sri Lanka

*Versatile Field Construction Machine for Paddy Cultivation*

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**Abstract:** Many accessories and machinery have introduced for various agriculture based activities, yet nobody has introduced a machine for bund reforming with ability to plough in paddy field. Up to now the bund reforming and ploughing were considered as a strenuous task. After introducing this new machine, it will be an easy task for the farmers in paddy cultivation, since it could be done with less labor and less time. With less labor and time, eventually the cost will be brought down. This machine is to be connected to a tractor. For the work of bund reforming and plough one operator will be sufficient. Amount of mud, angle and width of the ridge can be adjusted by configuring settings of the machine. Changing the settings during operation is also possible. Hence with this invention the time and labor of the farmers can be vastly saved.

# Winning Abstract

**Alon Millet**



USA

*Cellulose Binding Domains: Novel Implications in Ag. & Biofuel Production*

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**Abstract:** Recent exponential increases in the world population have necessitated advances in agricultural methodology and greater efficiency for alternative energy technology. Cellulose binding domain (CBD), the non-catalytic domain of a novel family of carbohydrate-binding hydrolases, has the potential to address both issues. CBD-treated *V. radiata*, the common mung bean, were grown over an 8 day period with a 12h photoperiod. Data indicated CBD increased the mass of sprouts as well as the concentration of free glucose ( $p < 0.05$ ), effecting a six-fold increase in total free glucose at the highest concentration ( $p < 0.05$ ). In plants treated with CBD, length, diameter, and material stiffness increased ( $p < 0.05$ ) and root hair frequency decreased ( $p < 0.05$ ). CBD demonstrated countertoxic effects in a silver nitrate model, increasing the mass of the plant when exposed to the toxin ( $p < 0.05$ ). SEM demonstrated microfibrils of treated plants to be qualitatively more rough and amorphous; TEM determined the presence of secondary cell wall in treated plants and its absence in untreated plants. Toluidine blue-O stain elucidated the composition of the cell wall, with unlignified middle lamella, lignified tracheary elements and lignified sclerenchyma increasing in a dose-response fashion ( $p < 0.05$ ). Multiple-dose administration of CBD rendered a heightened response than single-dose across all assays ( $p < 0.05$ ) except root hair prevalence, which significantly decreased ( $p < 0.05$ ). The data suggests that CBD may be interfering with intermicrofibrillar interactions, increasing amorphousness of the cell wall and allowing for accelerated growth and development under turgor pressure. The data indicates that CBD application represents a promising avenue for increasing agricultural yield and biofuel efficiency.

# Winning Abstract

**Dhuvarakesh Karthikeyan**



USA

*MFCs Reloaded: A Novel Bio-Augmented Design to Enhance MFC Efficiency*

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**Abstract:** Scientists are currently pressed with the problems of conjuring up clean energy, clean drinking water, and waste management in a sustainable way so that we do not drink our planet's resources dry. Instead of attacking these problems as separate ideas, through the incorporation of a Microbial Fuel Cell (MFC), they can be brought under a single roof and tackled as a single, more comprehensive challenge. MFCs work by using bacteria to metabolize the waste at the anode and they produce electrons and protons as by products. The electrons form a current and recombine at the cathode with oxygen and two protons to form water. However, the innate flaws in its design are holding the MFC back from large-scale implementation. The two-chamber MFC is inefficient due to high internal resistance and the single-chamber MFC has both low lifespan and is not cost-efficient. The same way by which researchers were inspired by nature in the pursuit for artificial photosynthesis, I used nature's model to successfully design a more efficient MFC to reduce internal resistance, increase longevity, and increase the surface area to volume ratio of the system. The design increased the power production of the system by a factor of 60%, which overshoot the expected 10-20% increase in power production by a huge margin. By using the extent at which the design changes were set in place as a function of power production, as well as a matrix of meticulous controls, I was able to conclusively determine that it was indeed the modifications in design, and not any adverse effect that lead to an increase in power production. The next step would be determining and overcoming obstacles regarding scaling up the idea before implementation can begin in developing nations and integrated into developed nations.

# Honorable Mention Abstracts



Intel International Science and Engineering Fair (ISEF) Winners  
USAID Science for Development Award



# Honorable Mention

**Hoda Mamdouh Shoman, Sara Erat Mohamed & Mona El Sayed Moawad**



Egypt

*Vacuum Evaporator for Water Purification*

**Abstract:** The world is heading towards an energy crisis due to the huge consumption of energy in many fields including, but not restricted to, distillation techniques. Thermal distillation technique, in particular, has a lot of strengths as it is one of the few practical ways to remove heavy metals and other salts that carbon filters cannot remove. However, it has a critical shortcoming that it is one of the most expensive home water treatment techniques, costing \$0.25 to \$0.35 worth of electrical energy per gallon of distilled water produced - depending on local electricity costs. Research shows that there other alternative solutions such as the Vacuum Evaporator. Our hypothesis depends on the fact that any liquid boils when its vapor pressure equals the atmospheric pressure surrounding it. In our system the atmospheric pressure is decreased until it is equal to the water vapor pressure thus reducing the boiling point of the water used. Consequently, this process will consume lower energy than thermal distillation techniques by 22% which was verified through our prototype testing process. This process has different economic, industrial and environmental applications. First, it is used to separate crude oil into more fractions for specific uses. Second, water is distilled to remove impurities, such as salt from seawater. Third, liquid chemicals for diverse uses are often distilled after synthesis to remove impurities and unreacted starting materials. Finally, distillation of fermented solutions has been used since ancient times to produce distilled beverages with higher alcohol content. The premises where distillation is carried out, especially distillation of alcohol are known as a distillery.

# Honorable Mention

**Anjali Vasisht**



USA

*IoT (Internet of Things) Connected Air Quality Monitor to Detect and Measure Particulate Matter [Air Pollution] Concentration*

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**Abstract:** Air pollution is a major worldwide concern. Particulate Matter (PM) pollutant equal or smaller than 10 micron can get lodged into the lungs causing respiratory problems. Monitoring equipment used by professional agencies is too expensive for households. Therefore there is a need of a low cost personal device which detects air pollutants and alerts the user of any unsafe levels. To address the need, I designed and constructed a device labeled PIQA. PIQA consists of a low cost sensor which detects PM concentration and sends low digital pulses to a microcontroller's sampling program. PIQA is calibrated against ambient air monitors of a local Clean Air Agency. Their Air Quality Index calculator is used to decide high, medium and low thresholds. The microcontroller's software is updated for threshold detection logic. When PM concentration levels exceed programmed thresholds, visual and auditory alerts are raised through different LEDs and buzzer alarm. The data is forwarded to an Internet of Things (IoT) host server to be logged and monitored remotely through connected computers and mobile devices. When subjected to different test conditions, PIQA detected average PM concentrations in the range from 91 (units pcs/0.01cf) in a room with purifier, to 2661 outdoors. Due to low cost, millions around the globe can afford such device for their personal use as well as stream real-time air quality data to the web. Such data when mined should greatly enhance the global monitored footprint and alert governments and environmental agencies about any pollution hotspots.

# Honorable Mention

## Mykhailo Lytovchenko



Ukraine

*Wave-Powered Desalinator*

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**Abstract:** The lack of drinking water in the near future is one of the key problems that appeared before humanity in 21st century. Therefore, the best way to obtain fresh drinking water is desalination of seawater. Most of methods are very energy-consuming. I became interested if wave energy can be used for effective work of desalination equipment. The purpose of my research was to find possible engineering solution to this problem. My converter consists of frame with working chambers and drive shaft. Originality of my conception is construction of working chambers and location of valves. When maximum of a wave passes the device, the valve closes and empty chamber moves up due to the Archimedes' principle. When the minimum of a wave is in, filled chamber moves down by the gravity force. The imbalance of the system rotates the whole installation. The rotation is passed on a high-pressure pump. Due to pressure from salt water on a membrane filter manufactures some amount of drinking water. Remaining salt water is accumulated in the water tower and used to produce electricity on a hydro-turbine. In laboratory and field tests I made and successfully tested different experimental modules, including test on the river Dnieper in real-life conditions. Preliminary assessment of construction cost with conversion rate 1.5 m<sup>3</sup>/day is in range \$15,000 in serial production. And also I can create more than 0,5MWh electricity per month in comfortable form. Payback (compared with diesel generator) is 1 year! As a result, the tests and preliminary calculations show that proposed device can be effectively used in coastal, island and other territory to obtain sufficient amounts of fresh water and electricity. And thanks to the modular design of the plant capacity can be increased up to several MW.

# Honorable Mention

## Donely Gunn



USA

*Wind Turbines for a Developing World*

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**Abstract:** The purpose of this project was to optimize a vertical axis wind turbine that was capable of charging small electronics, specifically cell phones, in underdeveloped countries. I chose to test the solidity of the NACA 0018 airfoil and a savonius type wind turbine. The wind turbines were all created in AutoCAD 2013 and then 3-D printed. A wind tunnel was designed and constructed that allowed the wind turbines to be compared in constant conditions. I measured the wind turbines power output at different wind speeds using an anemometer and a pulley system. The results show that the savonius type wind turbine had the lower starting torque and the steepest power slope, which made it the best of the tested wind turbine designs. I designed a wind turbine device that is able to charge a set of batteries then charge cell phones. Further research will attempt to optimize the current phone charging device and test different blade designs.