Low Carbon Projects

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Previous articles in this series, across several issues of D&T Practice, explored the theme of renewable energy as an excellent way to link together STEM subjects and stimulate cross-curricular project work. The Paris Climate Summit (COP21) in December 2015 will hopefully achieve a binding climate agreement, covering both developed and developing countries, and keep the large-scale use of renewable energy sources high up the political agenda. This article describes renewable energy projects in which I've been involved, and summarises new developments and educational resources. This theme is highly relevant to both emergency preparedness and averting climate change.

A short history of solar technologies

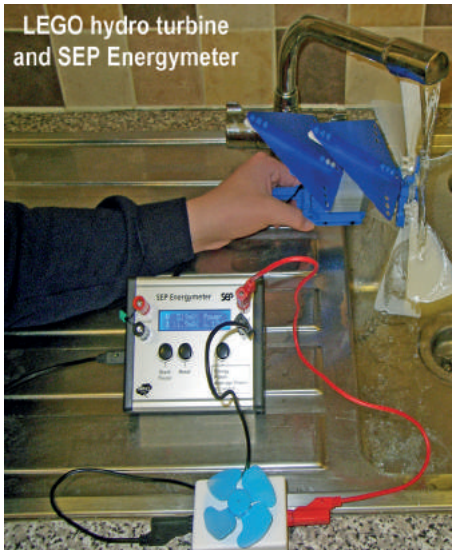
For the past few years I've been using solar photovoltaic (PV) modules and universal batteries from Voltaic Systems, for recharging my notebook computer and mobile phone, and for powering LEGO® MINDSTORMS® robots and other motorised LEGO creations. Voltaic Systems is a portable power company based in Brooklyn, New York. Their durable and versatile products can be ordered via their website, or from eBay or Amazon. LEGO MINDSTORMS projects can also be powered using Dexter Industries' dSolar 4W System, which includes a 9V ~500mA PV panel, power cord and adaptor.

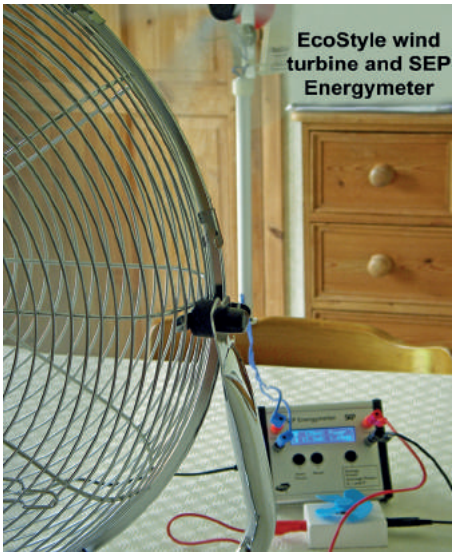
In September 2013, I challenged myself to run LEGO Education's 9688 NXT Solar Station Activity in my back garden, with the NXT powered by two dSolar 9V panels, and my computer powered by Voltaic Systems' 17W panel and V72 universal laptop battery. The activity ran very successfully, with the computer logging and displaying the power (in watts) generated by the Solar Station's PV panel as its orientation was automatically adjusted to maximise its output.

The LEGO MINDSTORMS Education EV3 robotics system has now superseded the NXT system. LEGO Education have recently released their 2005576 Science Activity Pack (developed in collaboration with Germany's Fraunhofer Institute) to supplement the EV3 software. This activity pack comprises 14 physical science experiments utilizing the data-logging capabilities of the EV3 hardware and software, as well as the 9688 Renewable Energy Add-on Set and the 9749 NXT Temperature Sensor (see D&T Practice 06.2010 and 1:2014).

Primary WeDo

I've been running LEGO WeDo sessions at a local primary school in Shrewsbury for the past six years. Earlier this year, I started running an after-school STEM Club there, and on the morning of 20th March I helped many of the school's pupils safely view the partial solar eclipse, using shade 14 welder's glass. I'm now teaching the Year 6 pupils a mini-course on Renewable Energy during class time, using many of the practical activities and resources I've described in previous articles in this series.





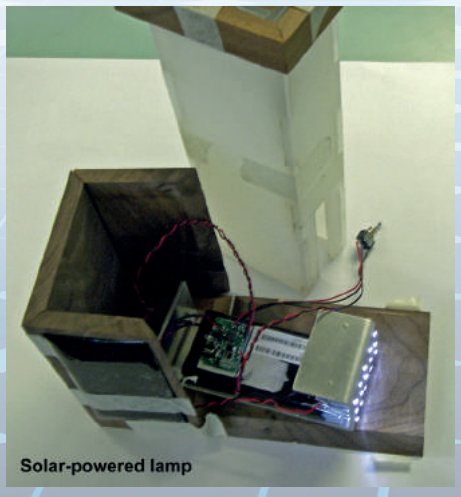
New meters

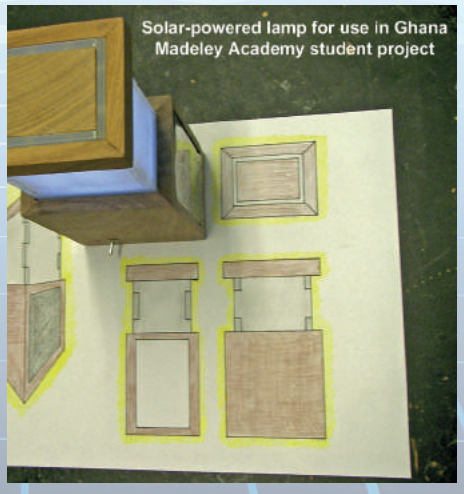
A new USB version of the successful SEP Energymeter is now available from Mindsets. The improved SEP 044 specification includes a log memory of 2500 samples and a log sample period of 1, 2 or 4 seconds. The meter can be powered over USB or using a 5V mains adaptor (included), and can be used without a computer. When a supply and a load are plugged into it, it displays the values of the power and the energy transferred. The display is automatically adjusted to show suitable units and an appropriate number of decimal places, so it can deal with a very wide range of values (e.g. from 100 nanojoules up to 1.75 megajoules). I managed to obtain one just in time to use with my EcoStyle Wind Turbine Kit, in my KS2 Renewable Energy mini-course. I'm finding it much more reliable and easy to use than the LEGO Energy Meter supplied in the 9688 Renewable Energy Add-on Set. (The middle two wires in the 4-wire LEGO Power Functions ribbon cable are the ones that need to be connected to the terminals of the SEP Energymeter.)

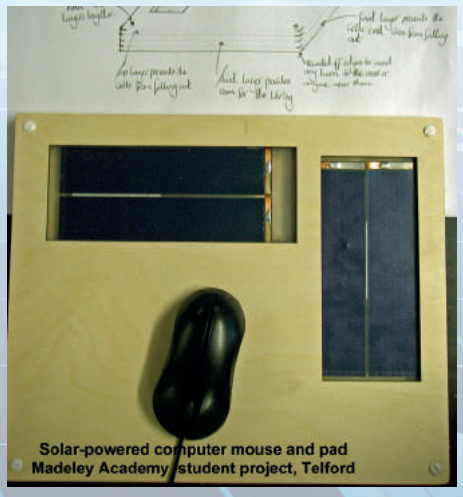
Solar-Active

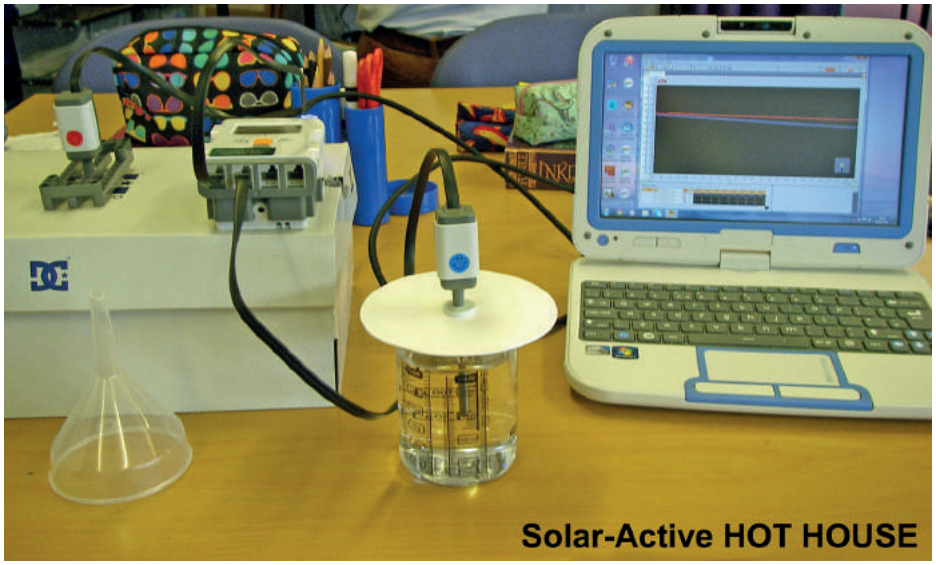
Last year, I was contacted by Jonathan Boyle, Deputy Head at Madeley Academy in Telford, for help in advising one of his 6th form students on her A Level D&T project to design and assemble a solar-powered lamp for use during power cuts in Ghana (her ancestral homeland). The excellent progress she made on her project inspired another student to design and construct a solar-powered computer mouse for his A-level project. His wooden mouse pad incorporates two flexible photovoltaic (PV) cells, from Solar-Active, which have significant output in diffuse light conditions. The PV component is an amorphous silicon thin film triple-junction cell. (The flexible cells have optimum terminal configuration and are also suitable for integration in clothing.)

Solar-Active has pioneered an educational approach, based on its flexible solar cells, that combines education, invention and enterprise. This makes learning and teaching enjoyable, and fosters enthusiasm and proficiency in STEM subjects. The approach promotes collaborative problem solving and









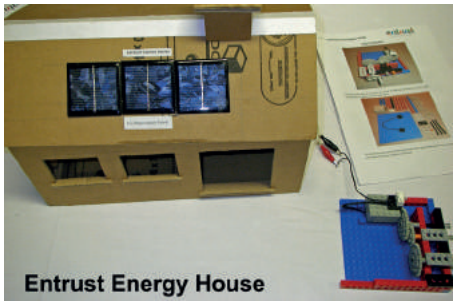
focuses on students learning through 'trial & improvement'. It also encourages them to develop the skills required in the rapidly growing renewable energy industry, to enhance their employment opportunities.

Renewable resources

Hot house

Solar-Active's HOT HOUSE is a new science resource to encourage students to investigate heat energy and acoustic science concepts. It's designed for conducting practical enquiries to cover curriculum outcomes, e.g.:

1. Assess ability to plan and implement an investigation.
2. Gain knowledge and understanding about heat energy and effects of insulation materials.
3. Develop mathematical knowledge through evaluating the outcomes.



4. Select from a range of materials, based on their carbon emissions and other properties.
5. Evaluate associated economic and environmental implications.
6. Make decisions based on the evaluation of evidence and arguments.

The resource includes a curriculum guide, worksheet, PowerPoint slides, and environmentally friendly non-itch and non-toxic insulation materials. Students construct a model house, using a small box or plastic food container. External wall designs are provided electronically or students can design their own. A thermometer is required and a 250ml Pyrex beaker. Students record heat loss over a period of time to compare recycled cotton/denim insulation, shredded paper, and other eco insulation materials. A data logger can be used. The activity can be completed in a single or double period, with follow-up work plotting bar charts to compare results. I'm using HOT HOUSE as one of the practical activities in my KS2 Renewable Energy mini-course.

Solar-Active (in collaboration with UK-ISES) offers workshops that give teachers and students a better understanding of ecological and carbon footprint calculations and how to address climate change issues.

Practical Action

Practical Action has produced some excellent digital resources (suitable for Key Stages 2 to 5) on renewable energy in developing countries, which can be downloaded from its website. The material draws from its renewable energy work in developing countries around the world. The free resources include posters, complete lessons, hands-on challenges and homework or extension activities. Energy access is a key element in lifting people out of poverty. In remote locations, small-scale renewable energy technologies which can be used include micro-hydro, solar, wind and biogas. Technical briefs on a wide range of such technologies can be downloaded from the Practical Action website.

Other projects

For the past five years I've been involved in planning and educational outreach for the proposed Shrewsbury Hydro scheme. A short video describing the proposed scheme has been produced by pupils of Shrewsbury High School and Shrewsbury Sixth Form College and can be accessed as Shrewsbury Hydro 2011 on YouTube or via the Shrewsbury Hydro website's home page (see links below).

Ansari XPRIZE has announced a $20 million global competition (NRG COSIA Carbon XPRIZE) to develop breakthrough technologies to convert CO2 emissions from power plants and industrial facilities into valuable products (building materials, alternative fuels, etc.) that we use every day.

Conclusion

G8 leaders have reaffirmed their commitment to cutting levels of greenhouse gases and agreeing a climate change deal in 2015. This is high on the agenda of a G8 Foreign Ministers meeting this autumn. Leaders of the world's most developed countries said they would continue to work with parties at the United Nations to ensure global warming does not exceed dangerous levels:

> "We recognise climate change as a contributing factor in increased economic and security risks globally. The G8 has agreed to consider means to better respond to this challenge and its associated risks, recalling that international climate policy and sustainable economic development are mutually reinforcing.
>
> "We remain strongly committed to addressing the urgent need to reduce greenhouse gas emissions significantly by 2020 and to pursue our low carbon path afterwards, with a view to doing our part to limit effectively the increase in global temperature below 2ºC above pre-industrial levels, consistent with science."

Pope Francis has released an unprecedented encyclical on climate change and the environment. The 180-page document calls on rich nations to pay their "grave social debt" to poorer countries.

The energy sector is one of the fastest growing sectors in the UK economy, with well-paid career opportunities. Interesting, low-cost projects/activities in renewable energy, conservation and recycling (the topic for this autumn's FIRST LEGO League 'Trash Trek' Challenge) can help fulfil National Curriculum requirements in Science, D&T and Computing.

Acknowledgements

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Further Reading

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Maskell, K. Modelling Climate Change. Gatsby SEP. 2009 [ISBN 978-1-901351-83-5]

Maslin, M. Climate Change: A very short introduction. Oxford. 2014 [ISBN 978-0-19-871904-5]

Trimby, P. Solar Water Heating: A DIY guide (6th edition). CAT. 2008 [ISBN 978-1-902175-60-7]

Hot Links

Carbon XPRIZE: http://carbon.xprize.org

Centre for Alternative Technology: www.cat.org.uk a

ClearDome Solar Thermal: www.cleardomesolar.com

Dexter Industries: www.dexterindustries.com

dSolar 4W System: www.youtube.com/watch?v=Bix0BfMdjn4

EcoStyle kits: www.ecostyle.co.uk

Earthscan: www.routledge.com/sustainability/

Entrust - Inspiring Futures: www.entrust-ed.co.uk

FLL Trash Trek Challenge: www.firstlegoleague.org/challenge/2015trashtrek

Gatsby SEP: www.nationalstemcentre.org.uk/sep

Inno-therm: www.inno-therm.com/education/

Instruments Direct: www.inds.co.uk/energy/index.htm

Low Carbon Partnership: www.ourplanet.org.uk

Mindsets: www.mindsetsonline.co.uk

Practical Action renewable energy: http://practicalaction.org/renewable-energy-resources

Practical Action technical briefs: http://practicalaction.org/technical-briefs-schools-energy

Renewable Energy Centre: www.therenewableenergycentre.co.uk

Renewable Energy UK: www.reuk.co.uk/education.htm

Shrewsbury Hydro: http://shrewsburyhydro.co.uk

Solar-Active: www.new.solar-active.com

Solar Spark: www.thesolarspark.co.uk

UK-ISES: www.uk-ises.org

Voltaic Systems: www.voltaicsystems.com

Zero Carbon Britain: http://zerocarbonbritain.org/