V3 Power Ltd. Hands-on STEM Workshops for Schools and Colleges.

The six different workshops can be mixed and matched to suit timetables and/or content preferences, however we recommend they are done as per the three x two hour ‘sessions’ outlined below and overleaf. These sessions can then be run individually or in combination.

Workshop Title	**Time**	**Description**	**Learning outcomes**
Generator (stator)	90 mins	Manufacturing the stator by winding copper coils and connecting together into three phases	• Faraday’s law of induction • Rates of change • Single vs three phase electricity generation • Cogging (iron vs air cores) • Insulators and conductors • I^2R Resistance heating/losses • Alternator design theory • Use of screwdrivers • Use of spanners
Generator (magnet rotors)	30 mins	Assembling the two magnet rotors by placing magnets into form	• Closed magnetic circuits and the concept of flux • Pros and cons of rare earth magnets • Axial flux vs radial flux generator design considerations • Geopolitical impact of renewables • Embodied energy of systems • Safely handling powerful magnets

Workshop Title	Time	Description	Learning outcomes
Electrical system	30 mins	Explanation of the different components of a wind turbine electrical system	● Electrical power P = I * V ● Three-phase brake switch ● Converting AC to DC using rectifiers ● Charge controllers to divert excess power into dump loads ● Inverters for off grid or grid-tie applications ● Importance of correct fuse ratings & effective earthing ● Battery design, options and maintenance ● Wire sizing and system voltage
Testing	90 mins	Testing the wind turbine in the classroom using a fan (or outside if appropriate)	● Demonstrating effect of varying magnetic strength ● Demonstrating effect of differing number of turns in coils ● Demonstrating effect of altering blade angle of attack ● Using different resistances to explore load matching ● Data acquisition using the Arduino platform ● Use of multimeters

Workshop Title	Time	Description	Learning outcomes
Blades	60 mins	Manufacturing the wind turbine blades by carving them from wooden planks	● Blade theory ● Fluid dynamics (drag force, aerofoils, lift force) ● Transferring theoretical optimums into manufacturing realities ● Transferring designs into the real world through accurate measuring and marking ● Safe and effective use of spokeshave and plane ● Safe and effective use of drill
Assembly	60 mins	Putting together the blade hub, generator & bearing	● Significance of the “air-gap” between magnet poles ● High wind overspeed protection (‘furling’ & other methods) ● Importance of maintenance ● Importance of dynamic and rotational balancing ● Use of multimeters ● Use of spanners

Key Stage 4 Science National Curriculum Relevance

Energy

- energy changes in a system doing work using an electric current
- power as the rate of transfer of energy
- conservation of energy in a closed system
- calculating energy efficiency for any energy transfers
- renewable and non-renewable energy sources used on Earth, changes in how these are used.

Electricity

- exploring current, resistance and voltage relationships for different circuit elements ; including their graphical representations
- power transfer related to p.d. and current, or current and resistance

Magnetism and electromagnetism

- exploring the magnetic fields of permanent and induced magnets
- magnetic effects of currents, how solenoids enhance the effect

Vocabulary, units, symbols and nomenclature