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RENEWABLES
TRAINING RANGE

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Generation Of Engineers

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Cert No. 24094

RENEWABLES TRAINING RANGE



At Matrix TSL, we are committed to advancing sustainable energy solutions that shape a cleaner, greener future. Our expertise in renewable energy engineering empowers industries and communities to harness the power of nature through innovative, efficient, and reliable teaching solutions.

Whether it's solar, wind, hydro and more, Matrix provides comprehensive teaching solutions tailored to meet the unique learning objectives.



“

“We have used Matrix equipment for several years at Lakes College, ranging from Locktronics to dsPIC systems used with a range of courses / age groups. The kits stand up to day-to-day use and when I have needed support (or spares) I have received accurate timely responses. The kits include workbooks but don't be afraid to take advantage of the versatility and make up your own extension activities. We would recommend the equipment to anyone looking for hands on activities in the classroom to support electrical / electronic engineering.”

Lakes College, United Kingdom

We can fulfill all of your engineering teaching requirements

Contact us to find out more

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MATRIX | LAB

Range Coverage

www.matrixsl.com/learning

<p>Fundamentals of Photovoltaic Energy CPxxxx</p> <p>RE4854</p>	<p>Fundamentals of Wind Energy CPxxxx</p> <p>RE3584</p>	<p>Fundamentals of Hydrogen Fuel Cell Technology CPxxxx</p> <p>RE2339</p>
<p>Fundamentals of Battery Storage Technology CPxxxx</p> <p>RE2986</p>	<p>Advanced Photovoltaic Energy CPxxxx</p> <p>RE3955</p>	<p>Advanced Wind Energy CPxxxx</p> <p>RE9346</p>
<p>Advanced Hydrogen Fuel Cell Technology CPxxxx</p> <p>RE7026</p>	<p>PEM Hydrogen Fuel Cell CPxxxx</p> <p>RE1091</p>	<p>Advanced Thermal Energy CPxxxx</p> <p>RE9584</p>
<p>Advanced Smart Grid Systems CPxxxx</p> <p>RE0226</p>	<p>Biofuel Production CPxxxx</p> <p>RE0870</p>	<p>BioMass Cycle CPxxxx</p> <p>RE9380</p>
<p>Renewable Energy Storage Technology CPxxxx</p> <p>RE1962</p>	<p>Hydropower Energy CPxxxx</p> <p>RE6763</p>	<p>Energy and the Environment CP7122</p> <p>LK7345-2</p>

Range Coverage

<p>Renewable Power Systems CP7128</p> <p>LK6946</p>	<p>Power and Energy Electronics CP3666</p> <p>LK3568</p>	<p>Electrical Machines & MATLAB v2.0 CP8198</p> <p>EM5154</p>
<p>Battery Simulator CP1166</p> <p>EM0843</p>	<p>Three Phase Systems 2.0 CP2980</p> <p>LK6846</p>	<p>Advanced Electrical Machines & Mechanical Drives v2.0 CP6152</p> <p>EM5154</p> <p>Transformer Add On EM4425</p>
<p>Electrical Machines For Installation / Manual Control V2.0 CP3897</p> <p>EM9922</p> <p>EM5154</p>	<p>Electrical Machines Systems 2.0 CP7479</p> <p>EM9922</p> <p>EM5154</p>	



LEARNING CENTRE

Enter the product code on the learning centre to find the curriculum





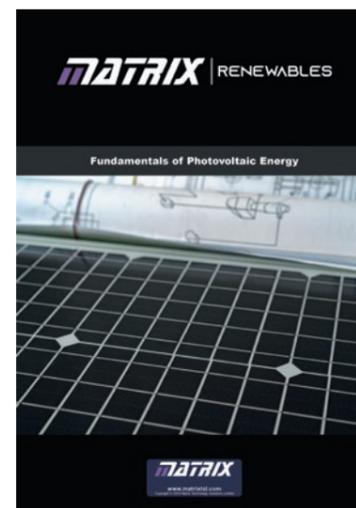
FUNDAMENTAL RENEWABLES TRAINING RANGE

The Fundamental Renewables range gives students the foundation learning required for a range of renewables subjects, teaching them the basics of wind energy, biomass and more. All of the equipment in the fundamental range is provided with comprehensive curriculum, including worksheets and teachers note. The equipment is supplied in storable trays, with the option of a complete solution.

The fundamentals of photovoltaic energy teaching solution introduces the principles of photovoltaics (PV) and demonstrates how solar cells convert light directly into electrical energy. This table top solution includes a plug and play base unit, which enables students to easily set up and conduct a range of investigations.



Accessories kit is essential to use this kit **RE6491**



LEARNING OBJECTIVES & EXPERIMENTS:

- Power dependence on the area of the solar cell
- Power dependence on the angle of incidence
- Power dependence on the level of illumination
- Power dependence on the frequency of the incident light
- Dependence of the solar cell power on temperature
- Determination of efficiency ratio of energy conversion
- Internal resistance of solar cells
- Dark characteristic curve of solar cell
- Inhibiting and conducting direction in illumination and darkness
- IV characteristic and fill factor of the solar cell
- IV characteristic of the solar cell in dependence on the level of illumination
- Shading of solar cells in series connection
- Shading effect of solar cells in parallel connection
- The solar cell as a transmission measure

The fundamentals of wind energy teaching solution explores the fundamentals of wind power generation, helping students to understand the operation of wind power plants. Including both a Savonius and three-blade rotor, this table top solution includes practical experiments demonstrating how factors such as wind speed, wind direction and rotor type, affect power output.



Accessories kit is essential to use this kit **RE6491**

LEARNING OBJECTIVES & EXPERIMENTS:

- Influence of the wind speed
- Start-up wind speed of a wind turbine
- Comparison of the start-up wind speed of a Savonius and a three-blade rotor
- Change the turbine voltage by connecting a consumer
- Examine the wind speed behind the rotor
- Energy balance sheet at a wind turbine
- Calculating the efficiency of a wind turbine
- Storing electric energy
- Energy conversion in a wind turbine
- Examine color wheels using a wind turbine
- Comparison of a Savonius rotor and a three-blade rotor
- Comparison of two, three and four-blade rotors
- Characteristic curves of a wind turbine
- Influence of the wind direction
- Influence of the rotor blade pitch
- Influence of the rotor blade pitch on the start up speed of a wind turbine
- Influence of the blade shape



The fundamentals of hydrogen fuel cell technology teaching solution teaches students the principles of electrolysis and fuel cells. This kit includes PEM fuel cells and all components for a complete solar-hydrogen cycle, including an electrolyser, PEM fuel cell, and solar module. A motor as the electrical load enables realistic, hands-on experiments for effective learning.



RE6786 Hydrogen charger, **RE1200** Hydrogen storage, **RE6491** Accessories kit are essential to use this kit. **RE7460** Ethanol fuel cell is an optional add-on

LEARNING OBJECTIVES & EXPERIMENTS:

- Set up of an electrolyser and the different fuel cells
- Characteristics of an electrolyser
- Operation of an electrolyser
- Characteristics of a PEM-Fuel cell
- Operation of the PEM-Fuel cell
- Faraday and energy efficiency of the electrolyser
- Faraday and energy efficiency of the PEM-fuel cell
- Properties of Ethanol Fuel Cell (optional)
- Powering a motor with the Ethanol Fuel Cell (optional)
- Characteristics of the Ethanol Fuel Cell (optional)

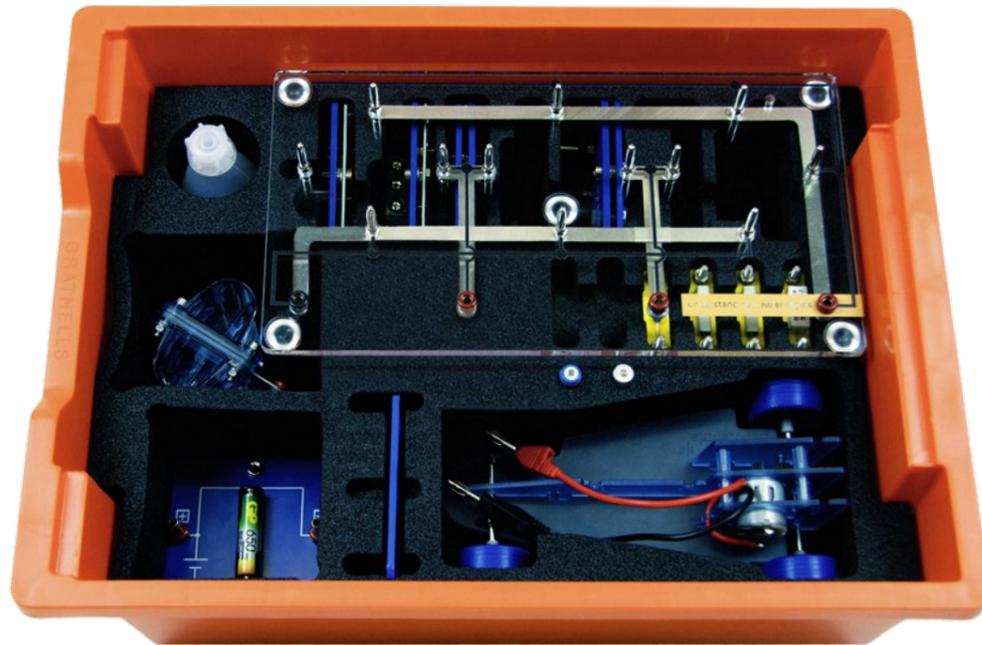


Fundamentals of Battery Storage Technology

RE2986

The fundamentals of battery storage technology teaching solution introduces students to the physical and technical fundamentals, as well as the applications of various battery technologies. Electric mobility is addressed through a model electrical car, allowing students to explore topics such as battery selection, lifespan and charging methods.

The system is optionally expanded with modules for Lithium-Polymer (RE4668) and lead batteries (RE6800).



RE6491 Accessories kit, RE2670 Charger module & RE5945 Battery adapter cable are essential to use this kit. RE4668 Lithium-polymer battery module & RE6800 Lead battery module are optional add-ons

Accessories Kit

RE6491

This accessories kit is essential for all fundamental teaching solutions.

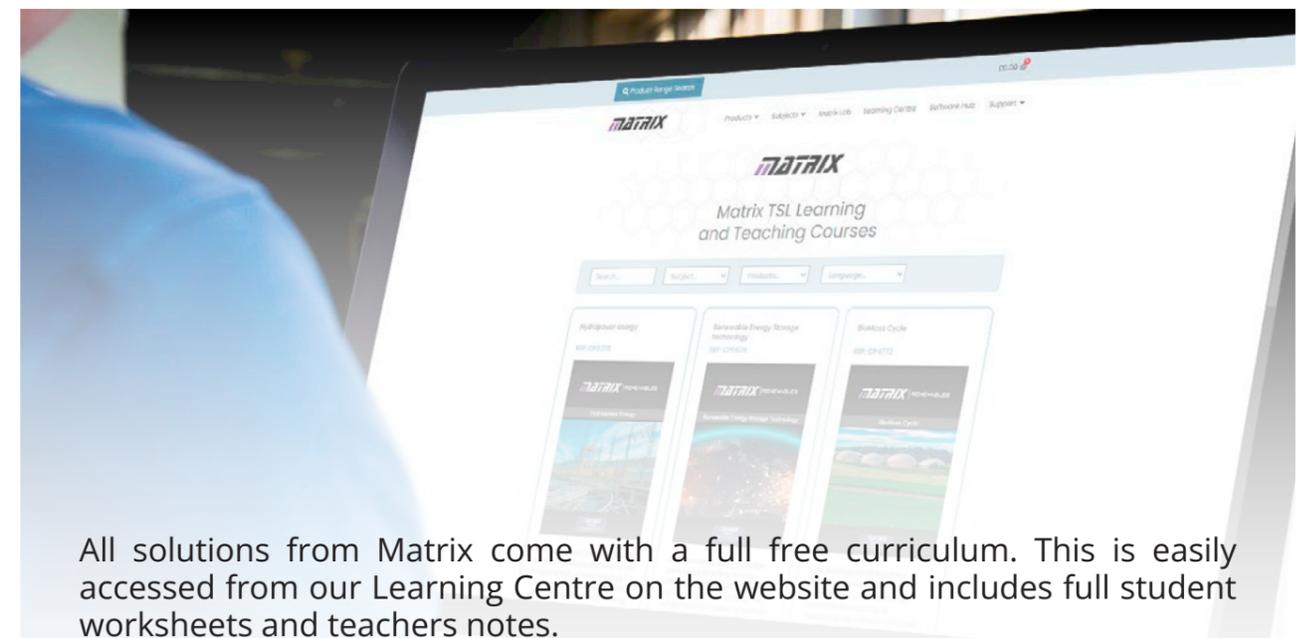
Containing:

- 1x Anemometer
- 3 x Power Module
- 1 x Lamp with clamp
- 8 x Digital multimeter
- 8 x Black test lead - 25cm
- 8 x Red test lead - 25cm
- 1 x Laboratory thermometer



LEARNING OBJECTIVES & EXPERIMENTS:

- Ohm's law
- Series / Parallel connection of resistors
- Nominal voltage and capacity of voltage sources
- Four-terminal sensing
- Internal resistance of voltage sources
- Series connection of voltage sources
- The capacitance of a battery module
- The energy density of battery modules
- The Ri efficiency of a battery module
- The total efficiency of a battery module
- The charging process of a capacitor
- The discharge process of a capacitor
- I-V characteristics of Batteries
- The charging / discharging process of a battery module
- Hydrogen production in the reversible hydrogen fuel cell
- Characteristic curve of the electrolyser
- Hydrogen consumption of a fuel cell
- Characteristic curve of the fuel cell
- The efficiency of the hydrogen fuel cell
- Operation of the electric car with several battery modules
- Operation of the electric car with the reversible fuel cell



All solutions from Matrix come with a full free curriculum. This is easily accessed from our Learning Centre on the website and includes full student worksheets and teachers notes.



LEARNING CENTRE

SCAN TO VISIT LEARNING CENTRE

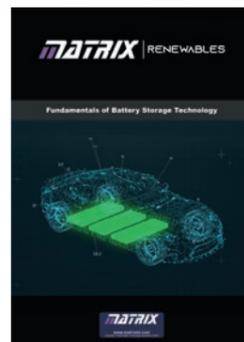
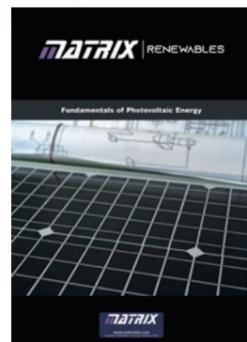
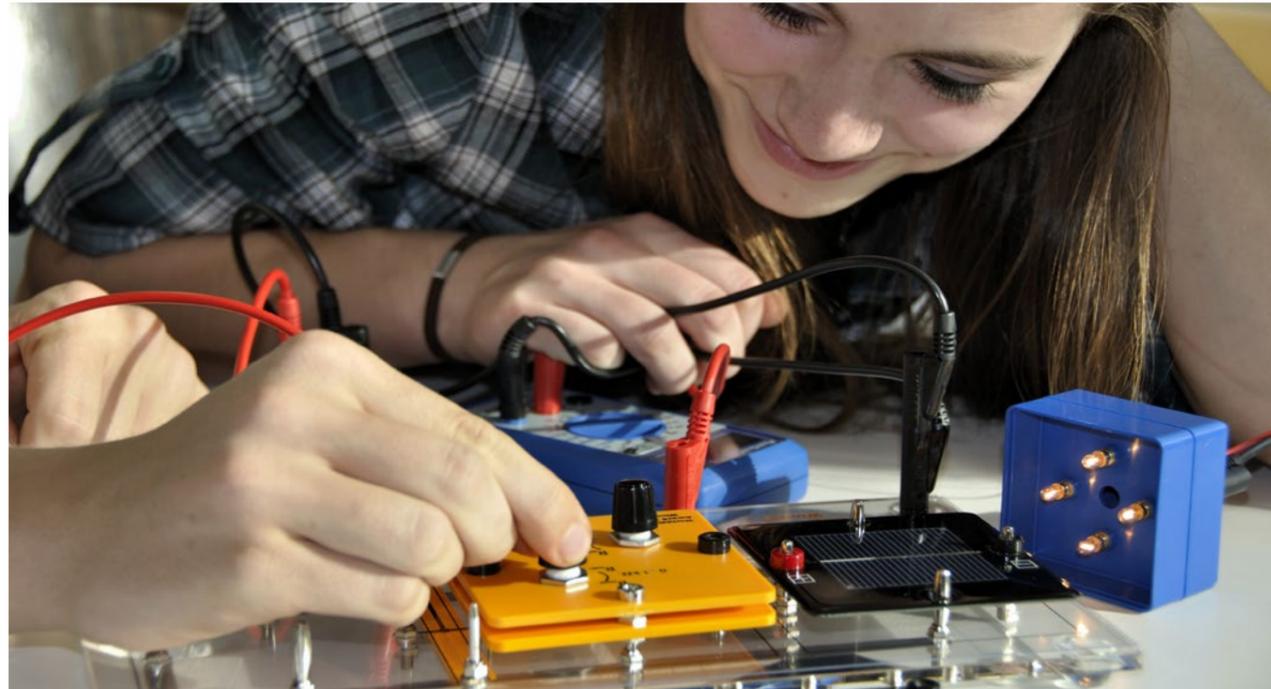


Complete Renewable Energy Training Solution

RE0563

The complete renewable energy training solution, includes a large variety of kits to teach a variety of renewable subjects including:

- Fundamentals of Photovoltaic Energy
- Fundamentals of Wind Energy
- Fundamentals of Hydrogen Fuel Cell Technology
- Fundamentals of Battery storage technology
- Accessories Kit
- Ethanol fuel cell module
- Hydrogen Charger
- Hydrogen Storage
- Lithium-polymer battery module
- Lead battery module
- Charger Module
- Battery adapter cable



Energy and the Environment Solution

LK7345-2

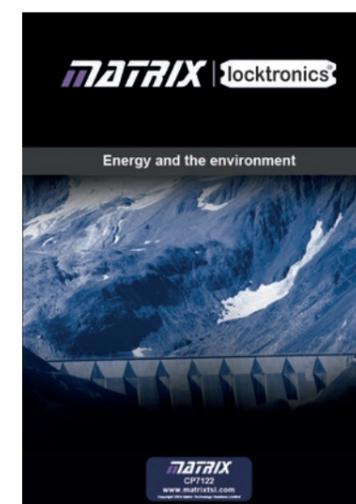
This course provides an introduction to renewable energy generation and energy saving measures through intelligent building control. As such, it addresses the aims of a number of courses in Science and Technology. The curriculum gives students a fundamental understanding of energy and power, joules and watts through an understanding of energy storage and efficiency, and use of intelligent buildings.



ANSI version also available **LK7345-2A**

LEARNING OBJECTIVES & EXPERIMENTS:

- Advantages / disadvantages of renewable energy sources: photovoltaic, wind, wave, hydroelectric
- Solar cells and their operation
- Electricity generators
- Solar heating and energy storage
- Voltage regulation
- Efficiency of a filament lamp and LED lamp
- Insulation and double glazing
- Energy efficient building design using microcontrollers



SCAN TO VISIT
PRODUCT PAGE





ADVANCED RENEWABLES TRAINING RANGE

Our Advanced Renewables range takes student learning to new heights by offering a comprehensive, hands-on educational experience in renewable energy. Designed to develop deeper understanding, this program covers a wide spectrum of renewable energy topics, from solar and wind technologies to emerging trends in sustainable energy solutions. As with the fundamental range, this equipment is supplied with curriculum. The equipment in cases provides a robust, storable solution for academic settings.

Advanced Photovoltaic Energy

RE3955

The advanced photovoltaic energy teaching solution offers students a comprehensive, modular setup to explore the foundational principles of photovoltaics, examine PV system components, and design complex PV systems in a lab environment. The system includes experiments that enable students to investigate the core properties of solar cells, analyse their electrical characteristics, and measure how environmental conditions impact solar cell performance. It also provides in-depth analysis of specific component characteristics, including the switching thresholds of series or shunt regulators, MPP (Maximum Power Point) tracking, PWM (Pulse Width Modulation) regulation, and power generation.



LEARNING OBJECTIVES & EXPERIMENTS:

- Series and parallel connection of solar cells
- Power dependence on the surface area of the solar cell
- Power dependence on the angle of incidence
- Power dependence on level of illumination
- Power dependence on level of illumination under load
- Internal resistance dependence on level of illumination
- Shading effect on solar cells
- Dark characteristic curve of solar cells
- I-V-characteristics, MPP and fill factor of solar cells
- Dependence of the I-V-characteristics of solar cells on level of illumination
- Dependence of the I-V-characteristics of solar cells on temperature
- Characteristic curve of solar modules
- I-V-characteristics of partly shaded solar modules
- Temperature coefficient of solar cells
- Components of an off-grid system
- Possible operating conditions of off-grid systems
- Working principle of shunt and series regulators
- Comparison of PWM and series regulator
- Load characteristic of PWM regulators
- Working principle of a MPP tracker
- Characteristics of a MPP tracker
- Working principle of deep discharge protection
- Working principle of an inverter
- Determination of the output voltage progression at an inverter

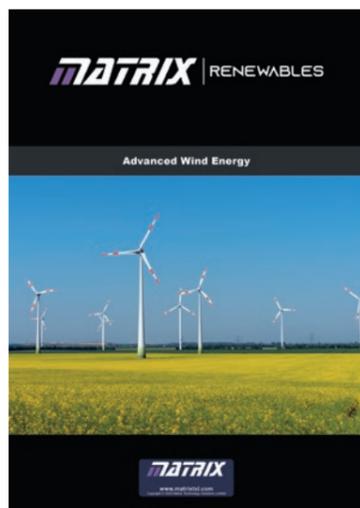
The advanced wind energy teaching solution provides students with a modular setup to explore the core principles of wind energy production, including the basics of wind power, wind tunnel control, and various rotor types. Students study wind turbine characteristics, performance under load, and behaviour under different wind conditions. The system enables students to analyse power conversion in wind turbines, assess and rate turbine performance, examine the effects of wind conditions and loads, and determine optimal operating conditions. The system includes multiple rotor types, such as Savonius rotors, along with variations in blade shape, number, and pitch. Experiments allow students to explore the benefits and limitations of different rotor designs, ultimately validating the efficiency of the three-blade horizontal-axis wind turbine as the most effective design.



The advanced hydrogen fuel cell technology teaching solution offers the 2 current fuel cell technology's for comparison. The Kit is designed to allow students to experiment on the fundamentals of various fuel cell designs. Supplied with a solar module, electrolyser and fuel cell, a solar-hydrogen cycle can be set up and examined. Functionality, efficiency and characteristics of the electrolyser and fuel cell or fuel cell stack are just a few of the topics. In addition to the PEM fuel cells, an ethanol fuel cell is also included, so different technologies can be compared with one another.



RE6786 and RE1200 essential for this kit



LEARNING OBJECTIVES & EXPERIMENTS:

- Examine the wind speed behind the rotor
- Energy balance sheet and efficiency of a wind turbine
- Rotational speed and speed ratio of a wind turbine
- Change the turbine voltage by connecting a consumer
- Influence of a consumer
- Characteristic curves and rotational speed of a wind turbine
- Influence of the wind speed
- Voltage of a wind turbine dependent on the wind speed
- Rotational speed and output dependent on the wind speed
- Voltage dependent on the wind direction
- Influence of the wind direction
- Rotational speed and output dependent on the wind direction
- Influence of the generator model
- u Voltage dependent on the rotor model
- Rotational speed and output dependent on the rotor model
- Influence of the rotor blade shape
- Voltage dependent on the rotor blade shape
- Rotational speed and output dependent on the rotor blade shape
- Influence of the number of rotor blades
- Voltage dependent on the number of blades
- Rotational speed and output dependent on the number of blades
- Voltage dependent on the rotor blade pitch
- Influence of the rotor blade pitch dependent on the rotor blade pitch
- Start-up speed of a wind turbine dependent on the rotor blade pitch
- Rotational speed and output dependent on the rotor blade pitch



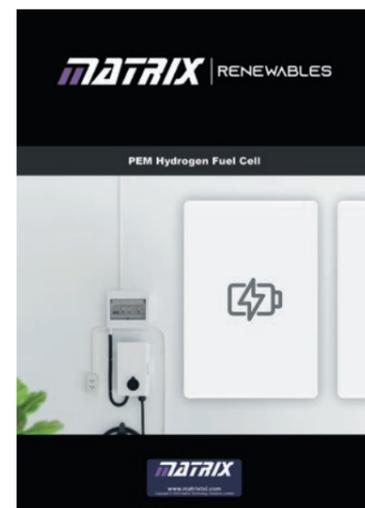
LEARNING OBJECTIVES & EXPERIMENTS:

- Structure of the electrolyser and of the different fuel cells
- Properties of the electrolyser
- Characteristic curve of the electrolyser
- Properties of a PEM fuel cell
- Characteristic of the PEM fuel cell
- Properties of an ethanol fuel cell
- Characteristic of the ethanol fuel cell
- Faraday and energy efficiency of the electrolyser
- Faraday and energy efficiency of the PEM fuel cell
- Parallel and series connection of PEM fuel cells
- Hydrogen storage with the H2 storage technology

PEM Hydrogen Fuel Cell

RE1091

The PEM hydrogen fuel cell teaching solution offers in depth studies of the PEM (Proton Exchange Membrane) fuel cell, also known as a Polymer Electrolyte Membrane fuel cell. This type of fuel cell that converts chemical energy from hydrogen and oxygen into electrical energy, with water and heat as byproducts. Solar module, electrolyser, and fuel cell permit the assembling and examination of a solar-hydrogen cycle. Working principles, efficiency and characteristics curves of electrolyser and fuel cell are just some of the topics covered. The system is supplied with multiple PEM fuel cells allowing both single and stack configuration. A H2 Charger and H2 Storage are included in the kit allowing for the easy generation and storage of hydrogen.



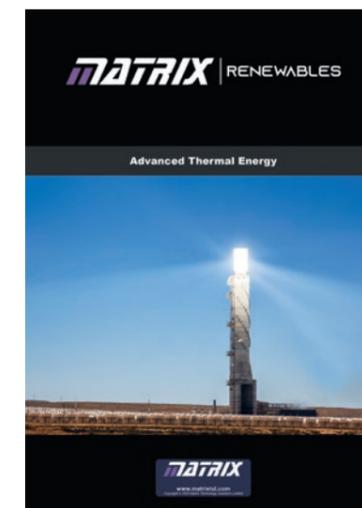
LEARNING OBJECTIVES & EXPERIMENTS:

- What an electrolyser does
- Characteristics of an electrolyser
- Hydrogen production with the H2 Charger
- Hydrogen storage with the H2 Storage technology
- Characteristics of a PEM-fuel cell
- Characteristics of an Ethanol-fuel cell
- Faraday and energy efficiency of the electrolyser
- Faraday and energy efficiency of the PEM-fuel cell
- Parallel and series connection of PEM-fuel cells

Advanced Thermal Energy

RE9584

The advanced thermal energy teaching solution offers students a comprehensive modular setup to explore various solar thermal energy transformation technologies at a laboratory scale. The system includes multiple solar collector types, such as a parabolic reflector and absorber tube, which can be operated with or without the included pump. It also features CSP (Concentrated Solar Power) technology and a Peltier element for direct conversion of thermal energy into electricity. Experiments cover core thermodynamic principles, including heat exchange, heat radiation absorption, and convective heat flow.



LEARNING OBJECTIVES & EXPERIMENTS:

- Absorptivity and reflectivity of different materials
- Focusing of light by a Fresnel lens
- Thermal convection and layering
- Thermal conduction
- Thermal insulation
- Solar thermal collector with pump circulation
- Solar thermal collector with thermosiphon circulation
- Variation of the flow speed
- Collector circuit with heat exchanger
- Collector circuit with paraffin heat reservoir
- Parabolic trough collector with pump cycle
- Defocusing
- Qualitative demonstration of the functional principle
- Investigating the thermoelectric generator
- Quantitative determination of the electrical power

The advanced smart grid systems teaching solution offers students a complete modular setup for gaining an in-depth understanding of complex interactions between renewable energy sources, energy storage, and consumers on a laboratory scale. This system enables students to construct and control a smart grid within a lab environment, featuring both pre-set scenarios and options for custom or user-designed configurations. Included components cover various renewable energy sources, such as wind and photovoltaic modules, as well as energy storage options like lithium-iron-phosphate batteries and fuel cells.



The biofuel production teaching solution offers a hands-on demonstration of the biofuel production process through structured student experiments. This table top solution, includes all necessary components in a portable case. The process begins with selecting resources and initiating fermentation, followed by distillation of the resulting mash using a custom condenser. The produced ethanol is then characterised. To convert the biofuel into usable energy, students can use the included ethanol fuel cell to generate electricity. Beyond bioethanol, the kit also demonstrates biodiesel production via the transesterification of fats, providing a comprehensive exploration of biofuel generation.



RE3357 and a Bunsen burner are essential for this solution

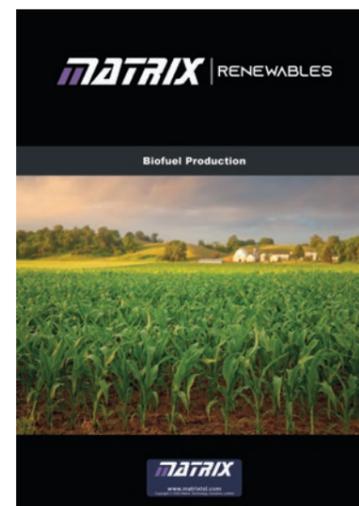
LEARNING OBJECTIVES & EXPERIMENTS:

- Daily power fluctuations of a photovoltaic (PV) power plant
- Daily power fluctuations of a wind power plant
- Energy supply of a building by conventional power plants
- Energy supply of a building by conventional and PV power plants
- Energy supply of a building by conventional and PV power plants with storage
- Voltage behavior and grid stability in a radial distribution system
- Grid stability with PV power plants
- Grid stability with PV power plants depending on consumer load
- Grid stability with PV power plants depending on wire length
- Grid stability with PV power plants and smart transformer stations
- Grid stability with PV power plants and storages
- Grid integration of E-Mobility
- Conductor rope management
- Fundamental experiments:
- **Photovoltaics**
 - IV-Characteristics of solar panels
 - IV-C characteristics depending on illumination
 - IV-Characteristics depending on temperature
 - MPP-Tracking
- **Wind energy**
 - Turbine power dependent on blade shape and pitch angle
 - Turbine power dependent on number of blades
 - Turbine power dependent on wind direction
- **Fuel cell and electrolyser**
 - Functionality of an electrolyser
 - IV-characteristics of an electrolyser
 - Functionality of a fuel cell
 - IV-characteristics of a fuel cell
- **Storage technologies**
 - Charge and discharge characteristics of a capacitor
 - Functionality and charge procedure of a LiFePo battery
 - Operation of fuel cells and electrolyser



LEARNING OBJECTIVES & EXPERIMENTS:

- Production of biodiesel (FAME)
- Extraction of fats from groceries or oil plants
- Differences between cooking oil and FAME
- Fermentation on the basis of different sugars
- Proof of CO₂ by a calcium hydroxide solution
- Link between reaction speed and temperature
- Distillation of fermented mash
- Working principle of the fuel cell
- Recording the characteristic curve of a 15% solution
- Temperature dependence of the power
- Concentration dependence of the power and the characteristic curve



BioFuel Production Accessories

RE3357

The bioFuel production accessories kit, allows set-up independent of location. With the associated support rods and various clamps, the setup for the distillation process is carried out in an intuitive way. For stowing the components a plastic box with insert is included.

Containing:

- 1 x 1700-03 Set of stand rod 2
- 1 x 1700-02 Chain clamp
- 2 x L2-06-012 Test lead black 25 cm
- 2 x L2-06-013 Test lead red 25 cm
- 1 x L2-06-118 Stand base plate
- 2 x L2-06-120 Double clamp
- 1 x L2-06-116 Universal stand clamp



BioMass Cycle

RE9380

The biomass cycle teaching solution enables students to recreate and understand the complete biomass cycle independently, without additional equipment. Using a cultivation box and hydroculture setup, students can observe plant sprouting and growth while analysing water and nutrient consumption across various growth stages. Through a series of experiments, the kit demonstrates both aerobic and anaerobic decomposition of biomass via composting and biogas processes, allowing students to explore the applications of biomass effectively.



MATRIX

Our sales team are available to speak to you

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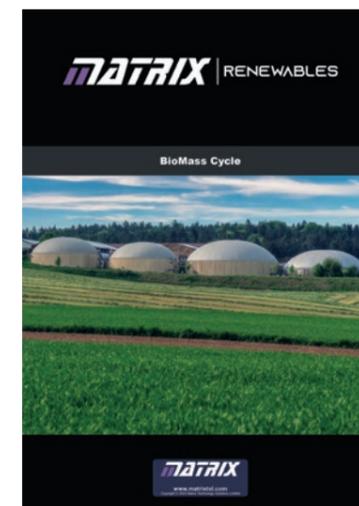
+44 (0) 1422 252 380

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www.matrixtsl.com

LEARNING OBJECTIVES & EXPERIMENTS:

- Germination of plant seeds
- Plant growth in a hydroculture
- Consumption of water and nutrients
- Aerobic degradation of biomass in a compost
- Anaerobic degradation of biomass to form hydrogen
- Anaerobic degradation of biomass to form methane



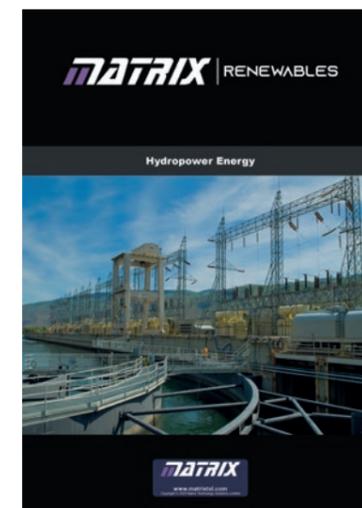
The renewable energy storage technology teaching solution offers students a modular, self-contained platform to study the fundamental principles of storage technology essential for sustainable energy transition. This system allows students to analyse the characteristics of various battery types and assess their optimal applications. It includes a range of battery technologies, such as lead, NiMH, and Lithium-Polymer (LiPo), along with a PEM Fuel Cell Charger Module.



LEARNING OBJECTIVES & EXPERIMENTS:

- Ohm's law
- Series connection of ohmic resistances
- Parallel connection of ohmic resistances
- Start-up and idling behavior of a motor
- Nominal voltage and capacity of voltage sources
- Four-terminal sensing
- Internal resistance of voltage sources
- Series connection of voltage sources
- The capacitance of a battery module
- The energy density of battery modules
- The R_i efficiency of a battery module
- The total efficiency of a battery module
- Temperature-dependent behavior of the lithium-polymer cell
- The charging process of a capacitor
- The discharge process of a capacitor
- I-V characteristics of the single NiMH battery module
- I-V characteristics of the NiZn battery module
- I-V characteristics of the LiFePo battery module
- I-V characteristics of the lead battery module
- module
- I-V characteristics of the lithium-polymer battery module
- I-V characteristics of the triple NiMH battery module
- The charging process of the NiMH battery
- The charging process of the NiZn battery
- The charging process of the LiFePo battery
- The charging process of the lead battery
- The charging process of the lithium-polymer battery
- The discharging process of a battery module
- Hydrogen production in the reversible hydrogen fuel cell
- Characteristic curve of the electrolyzer
- Hydrogen consumption of a fuel cell
- Characteristic curve of the fuel cell
- The efficiency of the hydrogen fuel cell
- Operation of the electric car with several battery modules
- Operation of the electric car with the reversible fuel cell

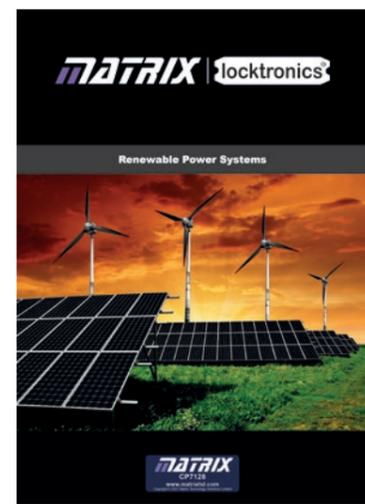
The hydropower energy teaching solution introduces students to the fundamentals of water turbines, The self-contained kit is supplied with fast assembly GARENA linking system allowing quick connection common water taps. The kit is supplied with different types of turbines - from a simple water wheel to a modern, highly efficient Pelton turbine and an electrical generator used to convert water power into electricity.



LEARNING OBJECTIVES & EXPERIMENTS:

- Volume flow, flow velocity and power as a function of the height of fall
- Volume flow, flow velocity and power as a function of the pipe cross-section
- Comparison of the functionality of Pelton turbine, crossflow turbine and waterwheel
- Comparison of the performance of the Pelton turbine, crossflow turbine and waterwheel in dependence to the volume flow and pressure

This kit combines our Locktronics learning system with a solar panel rig and a miniature wind turbine rig that can be used for experiments in Power and Energy electronics. The solar panel rig includes a full-sized solar panel - rated at 120 watts - that generates a reasonable amount of power under classroom/laboratory lighting. The kit also contains a variable speed DC motor coupled to a three-phase generator which produces up to 20 watts of power, replicating an industrial wind turbine. Together the solar panel rig and wind turbine rig can be used to provide varying amounts of energy, with varying voltage and current, in the lab. Students use these accessories with the Locktronics Power and Energy Electronics kit and 3.7V Lithium-ion batteries to conduct a range of experiments in domestic energy systems.



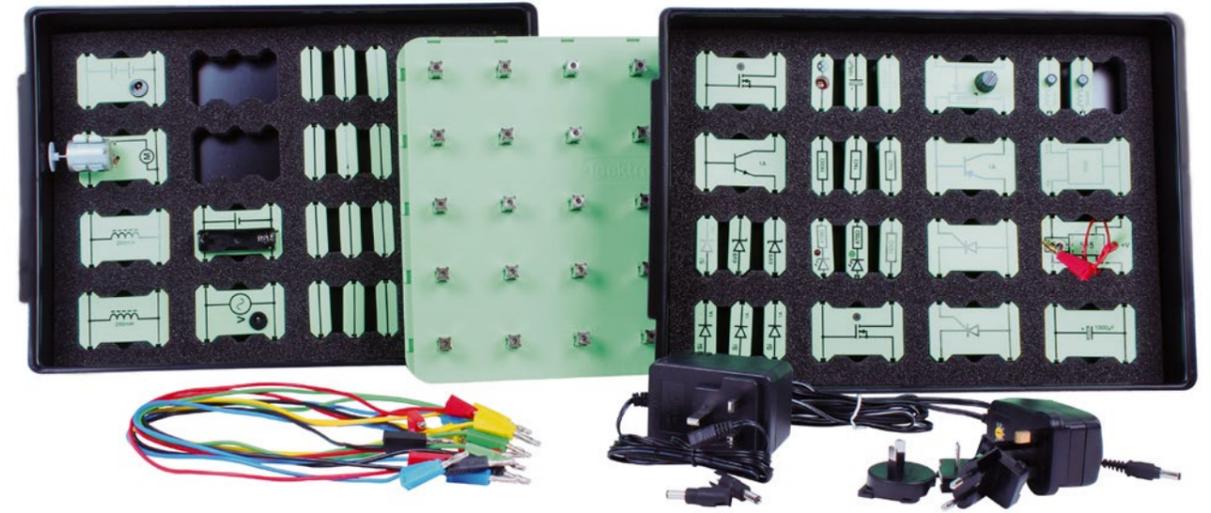
LEARNING OBJECTIVES & EXPERIMENTS:

- Sources of power and energy
- Wind turbine operation and output
- Solar panel operation and output
- Energy conversion - upconverters and downconverters
- Energy efficiency
- Batteries and series parallel configurations
- Lead Acid and Li-ion battery charge and discharge characteristics
- Powerwall technology
- Wind turbines
- Wind turbine power dumping
- Three phase rectification
- Voltage inversion - DC to AC

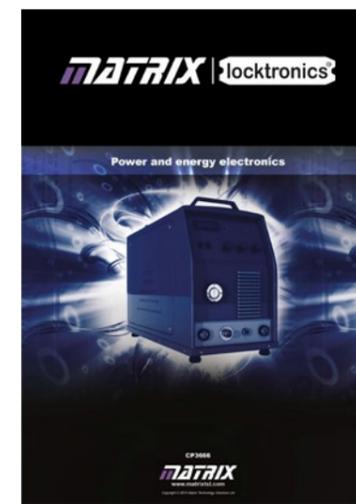
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This kit is suitable for teaching students the technology behind modern power electronics systems which are used to convert one form of electrical energy into another in vehicles, domestic energy systems and a new wave of electronics devices. The kit first explores power components including diodes, BJT, MOSFET, IGBT, SCR, thyristors and triacs and then moves on to showing how these are used in power circuits including rectifiers, converters and inverters. A full suite of worksheets is supplied which guides students through the learning activities.



ANSI version also available LK3568A



LEARNING OBJECTIVES & EXPERIMENTS:

- Diodes, BJT, MOSFET, IGBT, SCR, thyristors and triac components
- Speed control of DC motors
- Half and full wave rectifiers
- Fixed voltage regulators
- Buck and boost converters
- Modern power electronics topologies
- Sources of renewable energy

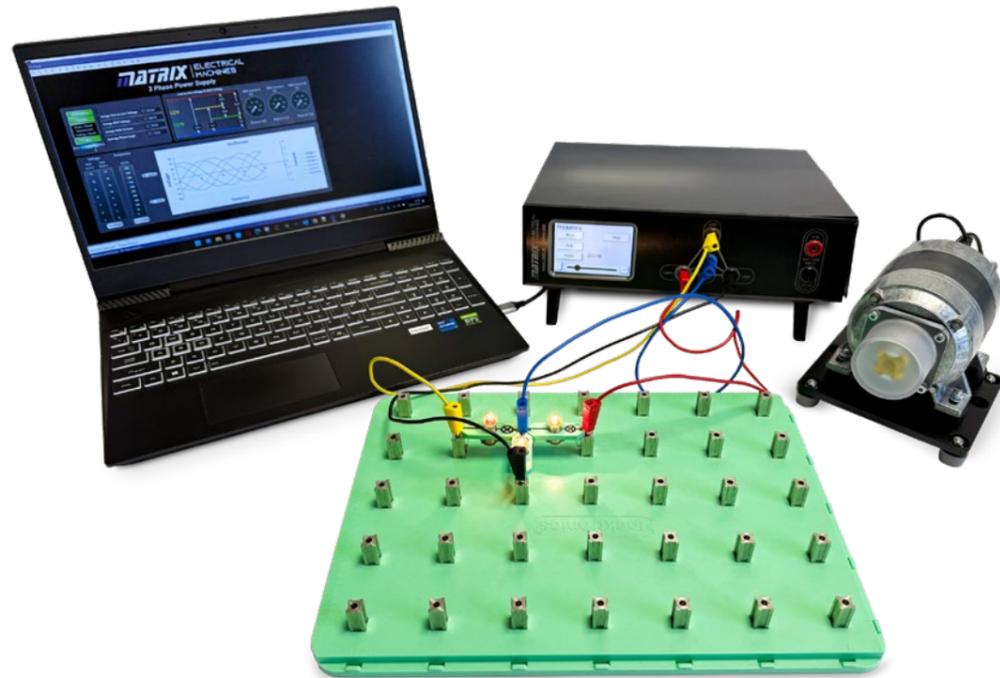
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Three Phase Systems 2.0

LK6846

Three-phase power is widely used in renewable energy systems, especially for large-scale generation and distribution. This kit includes a suite of practical investigations into renewable energy systems, featuring a low-voltage analogue three-phase generator and a low-voltage three-phase motor. Developed as part of the new Renewable Energy and Sustainable Power product range from Matrix, this pack provides the necessary components to set up three-phase systems based on star and delta topologies with balanced and unbalanced loads. Students work through a structured workbook to develop a deeper understanding of three-phase power generation in renewable energy applications. Optional instruments for this kit include a 4-input Pico scope and a current clamp.



LEARNING OBJECTIVES & EXPERIMENTS:

- Three phase circuits – star and delta
- Balanced and unbalanced loads
- Phase relationships in three phase systems
- Phase vectors
- Using a capacitor to create a phase shift for motors
- Three phase rectification – half and full
- Real, reactive and apparent power
- Three phase inductance and reactance
- Power in three phase systems
- Motors in three phase systems
- Using current clamps and PC oscilloscopes
- Power factor correction



Electrical Machines Training System

EM5154

Electrical motors play a crucial role in renewable energy systems, both in power generation and in applications that support clean energy use. This kit includes the digital drive control box, dynamometer and all machine types included in the new electrical machines range. Users will then be able to follow a comprehensive course in Electrical Machines Systems, including parts of the Advanced Electrical Machines systems curriculum.



LEARNING OBJECTIVES & EXPERIMENTS:

- Key motor characteristics, including DC, AC, three phase, brushless, stepper machines and more
- Understanding speed, torque and mass
- Three phase generation
- Phase shift in motors
- Delta configuration of motors
- Motor characteristic comparisons
- Electrical Machines and MATLAB

Transformers Add on is essential to use this kit **EM4425**



Electrical Machines Core Set

EM9922

The core set is a lower-cost introductory set of electrical machines, including the main digital drive control box and dynamometer, alongside a small selection of machines; DC, three phase and brushless DC.



LEARNING OBJECTIVES & EXPERIMENTS:

- Key motor characteristics, including DC, three phase and brushless machines.
- Understanding speed, torque and mass
- Three phase generation
- Delta configuration of motors
- Motor characteristic comparisons

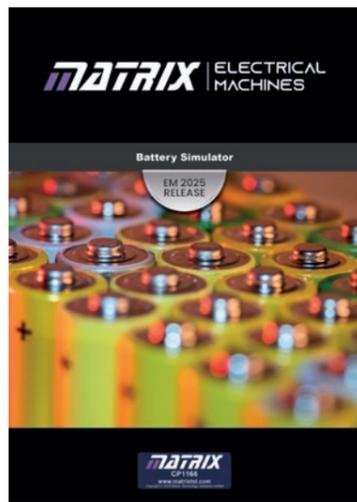


The Battery Simulator Control Box is an innovative educational tool designed to teach the fundamental principles of various battery technologies, including advanced lithium-ion systems. Engineered for hands-on learning, this versatile simulator allows users to explore the characteristics, performance, and safety considerations of different battery types. Ideal for training centres, educational institutions, and industry professionals, it provides a practical and engaging way to deepen understanding of battery technologies that power today's world.



LEARNING OBJECTIVES & EXPERIMENTS:

- Battery chemistries
- Batteries in series and parallel
- Internal resistance of batteries
- Battery capacities
- Battery discharge curves
- Battery discharge behaviour
- Battery charging
- Driving electrical machines with batteries



This add-on allows users to add transformer construction study to the electrical machines system from Matrix. This add-on is used with the Advanced Electrical machines curriculum and with this kit, students can study:

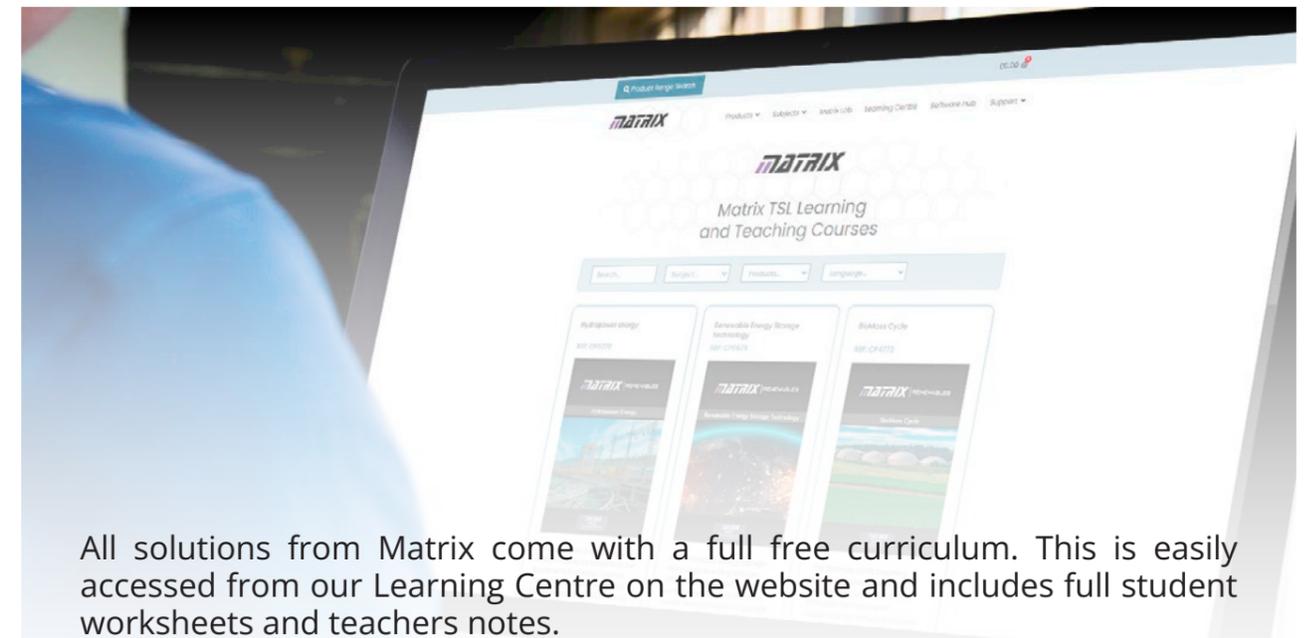
- Open and short circuit characteristics of transformers
- Circuit modelling of transformers using MATLAB or LabVIEW

KEY FEATURES:

- Transformer open circuit test
- Transformer short circuit test



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All solutions from Matrix come with a full free curriculum. This is easily accessed from our Learning Centre on the website and includes full student worksheets and teachers notes.



LEARNING CENTRE

SCAN TO VISIT LEARNING CENTRE



Additional Instruments

Product	Code	Required For
Power Module	RE1480	
Smart Meter	RE9427	
AV Module	RE6661	
Laboratory Thermometer	RE4892	
Lamp with Table Connection	RE1098	
Ethanol Fuel Cell Module	RE7460	RE2339
Hydrogen Charger	RE6786	RE2339, RE7026
Hydrogen Storage	RE1200	RE2339, RE7026
Lithium-polymer Battery Module	RE4668	RE2986
Lead Battery Module	RE6800	RE2986
Charger Module	RE2670	RE2986
Battery Adapter Cable	RE5945	RE2986



RENEWABLES TRAINING RANGE



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