RENEWABLE ENERGY TRAINER

Our most advanced training platform, for your most advanced experiments.

Horizon Educational

- ✓ Explores the cutting-edge science behind renewable energy engineering
- ✓ Features dozens of customizable expansion modules
- ✓ Built with durable, high-strength materials for long-lasting quality

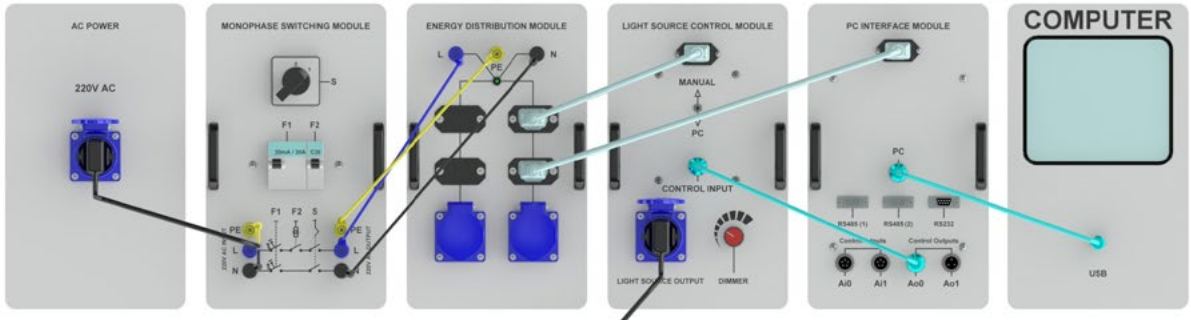
HRET-01

Professional-Grade Photovoltaic Training

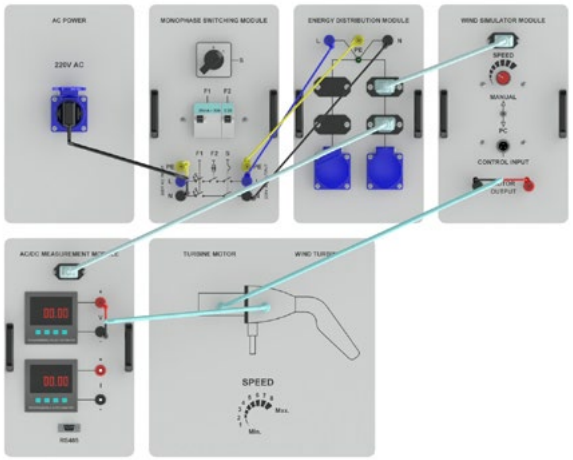
If you expect the best from your students, make sure they train on the best equipment. Whether you're a high school instructor with vocational/technical students or you've got engineering or trade students at a university or technical college, our extensive curriculum and wide variety of expansion modules ensures that the Renewable Energy Trainer can be customized to the perfect fit for your photovoltaic lab.

Features include:

- ✓ More than 20 different available modules
- ✓ Fuse protection for some modules
- ✓ Software adjustment for wind and solar simulation and linear potentiometer module
- ✓ Data acquisition and real-time graphs
- ✓ Software simulations and circuit diagrams
- ✓ Full curricular support for all experiments
- ✓ NABCEP-aligned activities



Weather-Independent Wind Power

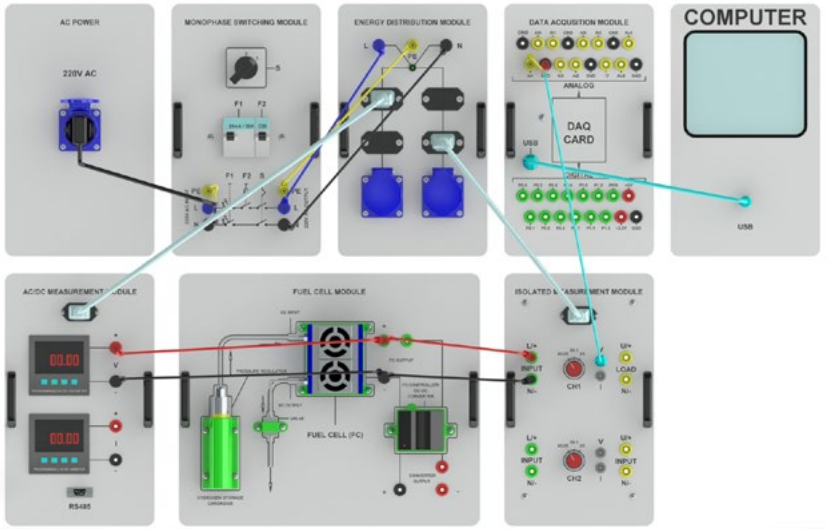


You can run wind energy experiments in your lab whatever the weather's like outside. Adding the Wind Simulator module allows your students to analyze the output of your turbine even when the actual wind isn't cooperating.

Students can explore:

- ✓ Wind velocity and turbine voltage
- ✓ Loaded vs non-loaded turbine operation
- ✓ Turbine output as measured by isolated measurement modules
- ✓ DAQ (Data Acquisition Module) to gather data via personal computers

Smart Grid Electronics with Hydrogen



When the wind doesn't blow and the sun doesn't shine, hydrogen provides an energy storage solution to keep renewable power going. Add the Fuel Cell module and your students can experiment with a completely renewable power grid.

Students can explore:

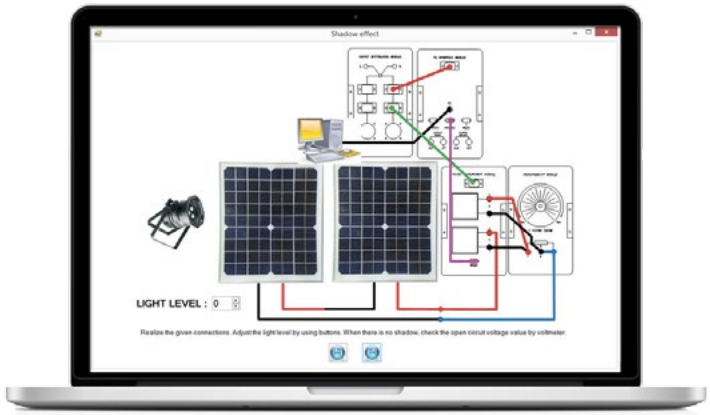
- ✓ Wind and solar-powered hydrogen generation
- ✓ Fuel cell backups for solar and wind systems
- ✓ Hydrogen storage solutions

Computer-controlled Simulation

From adjusting the settings on individual modules to gathering and analyzing data from your experiments, the software included with the Renewable Energy Trainer ensures that your students have the ability to observe, gather and control every aspect of their experiments.

Use software to:

- ✓ Walkthrough connecting new modules
- ✓ Alter simulation parameters
- ✓ Record and export experimental data



Curriculum

Our extensive curriculum provides experiments and activities for every module, at levels ranging from high school to technical college and university. You can choose to explore solar, wind, and hydrogen power over a full semester, or select a few experiments to supplement existing activities.

Covered material includes:

- ✓ Introductory explanation of each module
- ✓ Solar, wind, and hydrogen experiments
- ✓ Renewable energy online book exploring concepts on fuel cell, solar and wind technologies
- ✓ Student's worksheets for classroom experimentation
- ✓ Teacher's support material included

Modules' Specifications

RES - 001

Mobile Stand Module

Made of professional-grade materials, the mobile module can securely hold up to 18 different modules.

Its smooth rolling casters provide easy mobility across different floor surfaces.

Dimensions: 150 (h) x 110 (w) x 60 (d) cm

Weight: 34 kg

RES - 003

Light Angle Adjustable Solar Panel

The Light Angle Adjustable Solar Panel comes with 2 polycrystalline solar panels and a halogen spotlight to simulate sun light. The brightness of the halogen spotlight can be adjusted using a dimmer or the included simulation software. With 3 different tilt adjustments, the module simulates: daylight - sunrise to sunset, seasons of the year, position of the country in the world.

Halogen spotlight
Power: 400W
Power supply: 230 V
Solar module:
Voltage per photovoltaic module: 21.5 V
Short-circuit current: 640 mA
Maximum power: 10 Wp
Weight: 33 kg
Dimensions: 150 (h) x 85 (w) x 60 (d) cm
Weight: 3.5 kg

RES - 002A

Wind turbine module

Driven by an 100W DC motor.

Power: 150W

Connection terminals: 4 mm safety sockets

Weight: 4.9 kg

RES - 002B

Wind Simulator Module

The module is for adjusting of wind turbine speed by potentiometer or by software.

Power: 160 W

Power supply: 230 V

Connection terminals: 4 mm safety sockets

Dimensions: 300mmx205mm x148mm (HxWxD)

Weight: 3.2 kg

RES - 002C

Wind Turbine Charge Control Module

Industrial wind charge controller according to the needs of battery. Converts AC output of wind turbine to DC voltage for charging battery. If wind speed is over-limit, forces angular velocity of wind turbine to be reduced.

Rated battery voltage: 12 V

Wind generator braking voltage: 15/30 V

Connection terminals: 4 mm safety sockets

Dimensions: 300mmx205mm x148mm (HxWxD)

Weight: 2.8 kg

RES - 004

Linear Potentiometer Module

For general use purposes of resistive load applications.

0-1 Kohm adjustable

Adjustable manually

Connection terminals: 4 mm safety sockets

Dimensions: 300mmx205mm x148mm (HxWxD)

Weight: 2.8 kg

RES - 005

Electronic Potentiometer Module

For general use purposes of resistive load applications.

0-1 Kohm adjustable (By 1 ohm steps)

Adjustable manually or by software

In sweep mode, resistor values and time steps are adjustable

LCD monitor

Connection terminals: 4 mm safety sockets

Dimensions: 300mmx205mm x148mm (HxWxD)

Weight: 4.4 kg

Modules' Specifications

RES - 006

Solar Panel Simulator Module

The solar panel simulator module is for realistic solar module emulations.

Adjustable output voltage: 4-22 V
Maximum short-circuit current: 2 A
Light intensity adjustable from 20% ... 100%
Bypass diode connectable
Short-circuit proof
Power: 40 W
Displays: Voltmeter 0-20V (analog), ammeter 0 ... 5A (analog)
Power supply: 230 V
Dimensions: 300mmx205mm x148mm (HxWxD)
Weight: 3.4 kg
Fuse protection

RES - 007

Accumulator Module

The Solar Accumulator module is equipped with a maintenance-free and fully-enclosed lead accumulator permitting use at any location.

Voltage: 12 V
Capacity: 7 Ah
Re-chargable
Overcurrent protection
Connection terminals: 4 mm safety sockets
Dimensions: 300mmx205mm x148mm (HxWxD)
Weight: 4.5 kg
Fuse protection

RES - 008

Analog Measurement Module

For general use purposes;

1 industrial ammeter,
1 industrial voltmeter.

Voltmeter: 0-30V
Ammeter: 0-5A
Connection terminals: 4 mm safety sockets
Dimensions: 300mmx205mm x148mm (HxWxD)
Weight: 2.4 kg

RES - 009

220V Lamp Module

The lamp module allows for study and comparison of energy saving light bulb and LED light bulb. This allows for a variety of power-consumption scenarios to be investigated.

Energy saving light bulb: 15 W
LED: 5 W
Operating voltage: 230 V
Dimensions: 300mmx205mm x148mm (HxWxD)
Weight: 2.4 kg
Fuse protection

RES - 010

12V Lamp Module

The lamp module allows for study and comparison of halogen and LED lights. The bulbs are of the same brightness and each can be activated individually. This allows for a variety of power-consumption scenarios to be investigated.

Halogen lamps 50W
LEDs 3W
Operating voltage: 12V
Dimensions: 300mmx205mm x148mm (HxWxD)
Weight: 2.4 kg
Fuse protection

RES - 011

Isolated Measurement Module

For adapting and transferring high amplitude signals to data acquisition module or other purposes.

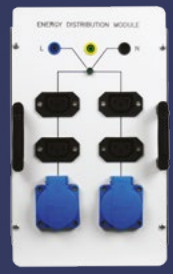
Measuring signals in range of 0-500V without disturbing signals (isolated)
Connection terminals: 4 mm safety sockets and BNC
Dimensions: 300mmx205mm x148mm (HxWxD)
Weight: 2.8 kg
Power supply: 230 V
Fuse protection

RES - 012

Monophase Switching Module

For general use purposes especially grid voltage applications; Industrial switch, 1 industrial residual current circuit breaker, 1 industrial circuit breaker. This module also prevents students from having electric shock hazard.

Mains supply 230 V/10 A
Automatic cut-off 10A
Main switch
Residual current circuit breaker
Output: 4mm safety sockets
Dimensions: 300mmx205mm x148mm (HxWxD)
Weight: 2.4 kg



RES - 013

Energy Distribution Module

For distributing energy to multiple modules with different type plugs.

4 mm safety sockets
IEC sockets
Plugs
Dimensions: 300mmx205mm x148mm (HxWxD)
Weight: 2.5 kg

RES - 015

AC Energy Analyzer Module

The AC energy analyzer is a stand-alone device monitoring over twenty-five parameters. The meter also has built in Modbus RTU communications via a RS485 interface.

Power supply: 230V
Current inputs (settable on device): 1A or 5 A 50Hz
Measurement accuracy: ± 1%
Connection terminals: 4 mm safety sockets
Dimensions: 300mmx205mm x148mm (HxWxD)
Weight: 3.7 kg
Fuse protection

RES - 016

PC Interface Module

Communication module of PC to control all software controlled modules.

2 independent analog signal outputs (0-5V)
1 connection terminal for USB communication with PC
2 RS485 communication ports (For measurement tool modules communication)
1 RS232 communication port (For various experiment modules communication)
Dimensions: 300mmx205mm x148mm (HxWxD)
Weight: 2.8 kg
Fuse protection
Power supply: 230V

Modules' Specifications

RES - 017

AC-DC Measurement Module

To be used in general measurements; 1 Industrial Ammeter, 1 Industrial Voltmeter. All data can be shared with a computer via RS485 port and by using PC Interface Module. All data can be illustrated and recorded on PC by using graphical software.

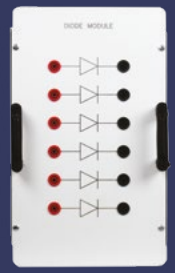
Maximum voltage: 500 V
Measurement accuracy: 2%
Dimensions: 300mmx205mm x148mm (HxWxD)
Weight : 2.8 kg
Power supply: 230 V
Fuse protection

RES - 018

Data Acquisition Module

For general use purposes of acquiring analog/digital data from different modules/outputs.

8 analog inputs (12 bit, 10 kS/s)
2 static analog outputs (12 bit)
12 digital input/output
32 bit counter
Compatible with: LabVIEW, LabWindows and Visual Studio.NET
Acquired data can be evaluated by MATLAB
Connection terminals: 4 mm safety sockets
Dimensions: 300mmx205mm x148mm (HxWxD)
Weight: 2.8 kg



RES - 019

Diode Module

Diode module is to be used as bypass diode or blocking diode applications.

6 diodes
Connection terminals: 4 mm safety sockets
Dimensions: 300mmx205mm x148mm (HxWxD)
Weight: 2.4 kg

RES - 020

On-Grid Inverter Module

Modern solar power systems using grid-connected inverters to feed electric power into the mains. The mains inverter has a monitoring LED.

Max. input current: 20 A
Input voltage range: 22 - 60V
Output voltage: 230V / 50Hz
Output power: 260 W
Connection terminals: 4 mm safety sockets
Dimensions: 300mmx205mm x148mm (HxWxD)
Weight: 3.2 kg

RES - 022

Solar Charge Regulator Module

The solar charge controller monitors the charge level of the accumulator and protects this against excessive and deep depletion.

Input voltage: Automatic 12/24 V switching
Charge/discharge current: 20 A
Connection terminals for: Solar generator, Solar accumulator, DC load
Connection terminals: 4 mm safety sockets
Dimensions: 300mmx205mm x148mm (HxWxD)
Weight: 2.4 kg

RES - 027

Hydrogen Module

Showing main components and general process steps of a fuel cell electricity production module.

Power: 30 W
Rated performance: 8.4V at 3.6A
Hydrogen pressure: 0.45-0.55 Bar
Flow rate at max output: 0.42L/min
Efficiency of system: 40% at full power
Connection terminals: 4 mm safety sockets
Dimensions: 300mmx360mm x148mm (HxWxD)
Weight: 5.4 kg

RES - 028

Light Source Control Module

This module is designed to control light intensity manually. It can also control light intensity via PC interface.

Power supply: 230V
Dimensions: 300mmx205mm x148mm (HxWxD)
Weight: 3.2 kg
Fuse protection

RES - 021

Off-Grid Inverter Module

The module consists of a commercially available off-grid inverter which generates an output voltage of 230 V AC from an input voltage of 12 V.

On/off switch
LED display of operating status
Acoustic alarm to signal warnings
Output voltage: sinusoidal 230 V +/- 5%
Power: 300 VA
Efficiency: 93%
Safety functions:
Cut out for excess battery voltage
Over temperature and overload protection
Short-circuit protection
Pole reversal protection
Connection terminals: 4 mm safety sockets
Dimensions: 300mmx205mm x148mm (HxWxD)
Weight: 3.2 kg

+ ACCESSORIES

RES - 029

Static Module Stand

Made of durable aluminium, The Static Module Stand is designed to store up to 16 spare modules.

Dimensions: 173mmx91mm x61mm
Weight: 20 kg

+ ACCESSORIES

RES - 023 **Monitor Holder**

Monitor holder is designed to hold a LCD monitor to the mobile support.

RES - 024 **LCD Monitor**

LCD Monitor is ideal for screen projection of the software to the entire classroom, so students and teachers can better visualize the software simulation user interface.

RES - 025 **Cable Holder**

Cable Holder is designed to easily store and organize different cables. It is connected to the Static Module Stand, having capacity to hold more than 40 cables.

RES - 026 **Cable Set (40 Piece)**

Flexible safety measurement cables with 4mm safety plugs, colored in blue, black, red, and yellow

RES - 030

AC Power Module

Additional module to provide AC energy to the system.

Experiment - Module Matrix

Experiment	Module
SOLAR ENERGY EXPERIMENTS	
2.1. Photovoltaic Panel Experiments.	
2.1.1. Photovoltaic Panel Open Circuit Voltage Measurement.	RES-001, RES-003, RES-012, RES-013, RES-014, RES-017, RES-025, RES-026
2.1.2. Photovoltaic Panel Short Circuit Current Measurement.	RES-001, RES-003, RES-012, RES-013, RES-014, RES - 017
2.1.3. Determining Photovoltaic Panel Current Voltage Characteristics.	RES-001, RES-003, RES - 004 RES-012, RES-013, RES - 014, RES-017, RES-025, RES-026
2.1.4. Examining the Non-Loaded Output Voltage of the Photovoltaic Panel Depending on Daily Solar Movement	RES-001, RES-003, RES-012, RES-013, RES-014, RES-017, RES-025, RES-026
2.1.5. Examining the Loaded Output Voltage of the Photovoltaic Panel Depending on Daily Solar Movement	RES-001, RES-003, RES-004, RES-012, RES-013, RES - 014, RES-017, RES-025, RES-026
2.1.6. Examining the Non-Loaded Output Voltage of the Photovoltaic Panel Depending on Seasonal Changes	RES-001, RES-003, RES-012, RES-013, RES-014, RES-017, RES-025, RES-026
2.1.7. Examining the Loaded Output Voltage of the Photovoltaic Panel Depending on Seasonal Changes.	RES-001, RES-003, RES-004, RES-012, RES-013, RES - 014, RES-017, RES-025, RES-026
2.1.8. Examining the Series Connection in Photovoltaic Panels.	RES-001, RES-003, RES-004, RES-012, RES-013, RES-014, RES-017, RES-025, RES-026
2.1.9. Examining the Parallel Connection in Photovoltaic Panels.	RES-001, RES-003, RES-004, RES-012, RES-013, RES-014, RES-017, RES-025, RES-026
2.1.10.Examining the Photovoltaic Panel Simulator	RES-001, RES-012, RES-013, RES-006, RES-025, RES-026
2.1.11. Examining the Effect of Shadow on Photovoltaic Panels	RES-001, RES-003, RES-004, RES-012, RES-013, RES-014, RES-017, RES-025, RES-026
2.1.12. Examining the Effect of Bypass Diodes on Photovoltaic Panels.	RES-001, RES-003, RES-004, RES-012, RES-013, RES-014, RES-017, RES-019, RES-025, RES-026
2.1.13. Examining the Effect of Mismatching on Photovoltaic Panels	RES-001, RES-003, RES-012, RES-013, RES-014, RES-017, RES-025, RES-026
2.1.14 Examining the Effect of Blocking Diodes on Photovoltaic Panels.	RES-001, RES-003, RES-007, RES-012, RES-013, RES-014, RES-017, RES-019, RES-025, RES-026
2.1.15.Examining the Photovoltaic Panel Emulator	RES-001, RES-003, RES-012, RES-013, RES-025, RES-026
2.2. Photovoltaic System Experiments	
2.2.1. Direct Loading of the Photovoltaic Panel	RES-001, RES-003, RES-010, RES-012, RES-013, RES-014, RES-017, RES-025, RES-026
2.2.2. Engaging the Off-Grid Inverter (No-Load Operation).	RES-001, RES-003, RES-0007, RES-011, RES-012, RES-013, RES-021, RES-022, RES-025, RES-026
2.2.3. Setting up the Basic Photovoltaic System (DC Load).	RES-001, RES-003, RES-007, RES-010, RES-012, RES-013, RES-014, RES-017, RES-022, RES-025, RES-026

Experiment	Module
2.2.4. Setting up the Basic Photovoltaic System (AC Load).	RES-001, RES-003, RES-007, RES-009, RES-011, RES-012, RES-013, RES-014, RES-017, RES-021, RES-022, RES-025, RES-026
2.2.5. Examining the OFF_GRID Inverter Output Signal By Using the DAQ Module.	RES-001, RES-003, RES-007, RES-009, RES-011, RES-012, RES-013, RES-014, RES-017, RES-018, RES-021, RES-022, RES-025, RES-026
2.2.6. Measuring the OFF_GRID Inverter Output Signal By Using an Energy Analyser.	RES-001, RES-003, RES-009, RES-012, RES-013, RES-014, RES-015, RES-025, RES-026
2.2.7. Measuring the Energy Received from the OFF_GRID Inverter.	RES-001, RES-003, RES-007, RES-009, RES-012, RES-013, RES-014, RES-021, RES-022, RES-025, RES-026, RES-030
2.2.8. Measuring the OFF_GRID Inverter Output Power and Efficiency	RES-001, RES-009, RES-012, RES-013, RES-017, RES-021, RES-025, RES-026
2.2.9. OFF_GRID Inverter SCADA Application.	RES-001, RES-003, RES-007, RES-009, RES-012, RES-013, RES-014, RES-021, RES-022, RES-025, RES-026, RES-030
2.2.10.Examining the ON_GRID Inverter.	RES-001, RES-003, RES-007, RES-012, RES-013, RES-020, RES-022, RES-025, RES-026
WIND ENERGY EXPERIMENTS	
3.1. Examining the Relationship Between Wind Velocity and Wind Turbine Output Voltage (Non-Loaded Operation)	RES-001, RES-002a, RES-002b, RES-002c, RES-012, RES-013, RES-017, RES-025, RES-026
3.2. Examining the Relationship Between Wind Velocity and Wind Turbine Output Voltage (Loaded Operation)	RES-001, RES-002a, RES-002b, RES-002c RES-010, RES-012, RES-013, RES-017, RES-025, RES-026
3.3. Examining the Wind Turbine Output Voltage.	RES-001, RES-002a, RES-002b, RES-002c RES-011, RES-012, RES-013, RES-017, RES-025, RES-026
3.4. Examining the Wind Turbine Output Voltage By Using a DAQ Module.	RES-001, RES-002a, RES-002b, RES-002c, RES-011, RES-012, RES-013, RES-017, RES-018, RES-025, RES-026
3.5. Examining the Wind Energy System..	RES-001, RES-002a, RES-002b, RES-002c, RES-007, RES-012, RES-013, RES-017, RES-025, RES-026
HYDROGEN FUEL CELL EXPERIMENTS	
4.1. Examining the Hydrogen Fuel Cell Output Current with Oscilloscope	RES-001, RES-011, RES-012, RES-013, RES-017, RES-025, RES-026, RES-027, RES-028
4.2. Examining the Hydrogen Fuel Cell Output Current with DAQ Module	RES-001, RES-011, RES-012, RES-013, RES-017, RES-018, RES-025, RES-026, RES-027, RES-028
4.3. Plot U-I curve and understand the behaviour of the fuel cell system	RES-001, RES-011, RES-012, RES-013, RES-017, RES-025, RES-026, RES-027, RES-028
4.4. Calculate the efficiency of the hydrogen system	RES-001, RES-011, RES-012, RES-013, RES-017, RES-018, RES-025, RES-026, RES-027, RES-028