# Overview on Electric 2&3 Wheelers in Asia and Thailand Charging and Battery Swapping Regulations

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CHARGING INFRASTRUCTURE & BATTERY SWAPPING IN KENYA REPORT REVIEW
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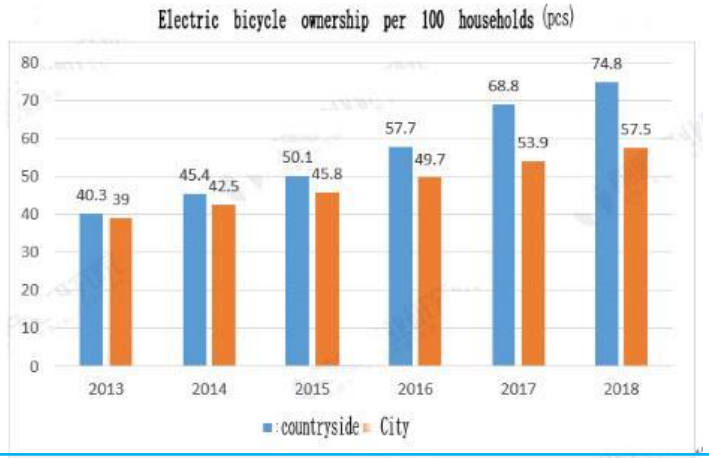
# Electric 2&3 wheelers in Asia

## China

- More than 300 million electric 2-wheelers – large percentage using lead-acid batteries
- In 2020, China produced 113.1 million units of two-wheelers. Of these, exports accounted for the largest proportion, 59.2%; while domestic sales accounted for 40.8% of production
- At the same time China produced a total of 33.9 million units of electric two-wheelers, with most of the production done by more than 100 OEMs China's electric two-wheelers are mainly sold domestically (95.1%), with a small amount for exports (4.9%)

| Some differences between 1999 and 2019 standard | | | |
|---|---|---|---|
| Numbers | Item | 2019 Standard | 1999 Sstandard |
| 1 | Max Speed | < 25KM/H | < 20KM/H |
| 2 | Vehicle Weight | < 55KG | < 40KG |
| 3 | Engine Power | < 400W | < 240W |
| 4 | Battery Voltage | < 48V | < 36V |




Source: various sources compiled by TAILG, 2020; China's Electric Two-wheeler Growth Opportunities (2021) Frost and Sullivan; Statista Research Department

# Electric 2&3 wheelers in Asia

India

Electric 2-Wheelers

- 830,000 electric 2-wheelers
- 152K+ e-2Ws sold in FY19-20 (20% growth from previous year)
- e-2W Policies & Regulations that has fueled growth:
  - FAME II subsidies – max INR 20K per vehicle (only LIBs, top speed > 40kmph; Range > 60kms)
  - No registration and license for e-2Ws with speed less than25kmph
- 80+ e-2W OEMs in India



Electric 3-Wheelers

- 2.5 million electric 3-wheelers
- 90K+ e-3Ws sold in FY19-20 (25% growth from previous year)
- e-3W Policies & Regulations that has fueled growth:
  - FAME II subsidy – max INR 50K per vehicle (only LIBs, Range > 80kms)
  - INR 30K subsidy for retrofitting
  - No permits required for e- Rickshaw (top speed < 25 kmph)
- 100+ e-3W OEMs in India

Source: JMK Research, 2020; pManifold 2020

# Electric 2&3 wheelers in Asia

Southeast Asia

- In Vietnam, there are already 1.35 million registered electric 2 wheelers as of June 2020
- In Malaysia and Thailand, there are 2,000 and 2,300 registered electric 2 wheelers in 2020 respectively
- In Indonesia 3,000 in 2018 electric 2-wheelers
- In the Philippines there are 4,318 registered electric 3-wheelers
- No comprehensive information on OEMs, but at least 50
- Standards and policies are being developed

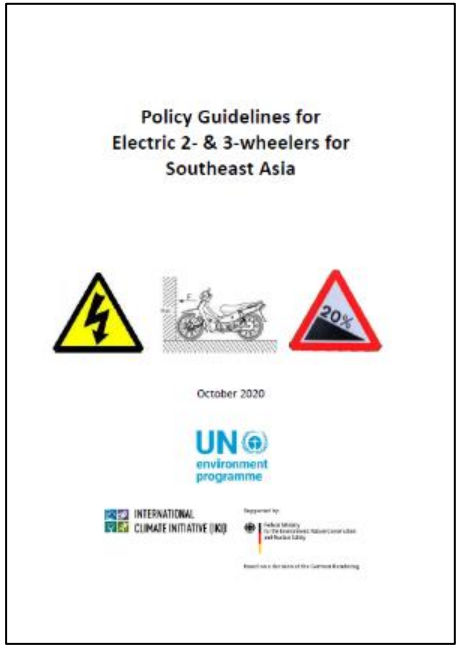


Source: UNEP, 2020. Policy Guidelines for Electric 2- & 3-wheelers for Southeast Asia

# Policy Guidelines for Electric 2- & 3-wheelers for Southeast Asia

Developed to address gap in policies supporting electric 2&3 wheelers, in close coordination with the EV Associations in Malaysia, the Philippines, Singapore, Thailand, and the network in Vietnam

- Guidelines include technical regulations and policy recommendations on:
  - Vehicle tax rationalization – rationalize taxes and fees, reducing them on lighter and more efficient vehicles, and increasing them on larger, less efficient ones
  - Insurance rationalization – in some cases, such as the 25-50kph 2-wheelers, it may even make sense to have universal basic insurance covered by the government using the extra funds extracted from the premiums of the faster, heavier vehicles such as ICE four-wheelers
  - Manufacturing support – not only for 4-wheelers!
  - Public transport integration – enhance commuter's experience
  - Electric 2&3 wheeler infrastructure integration – enhance safety
  - Public awareness and education




Available:
https://cleanairsolutions.asia/wp-content/uploads/ASEAN-E2-E3Vs-Policy-Guidelines.pdf

UN environment programme 50 1972-2022

# Update on Thai EV Charging and Swapping Guidelines

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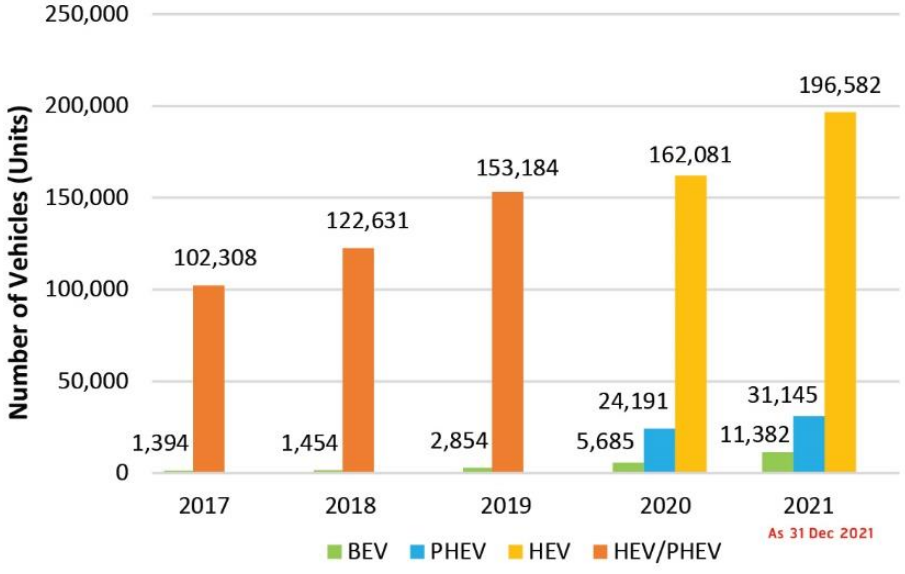
# Current Status of xEV Accumulated Registration in Thailand

## Accumulated Number of xEV Registration
จำนวนยานยนต์ไฟฟ้าสะสม

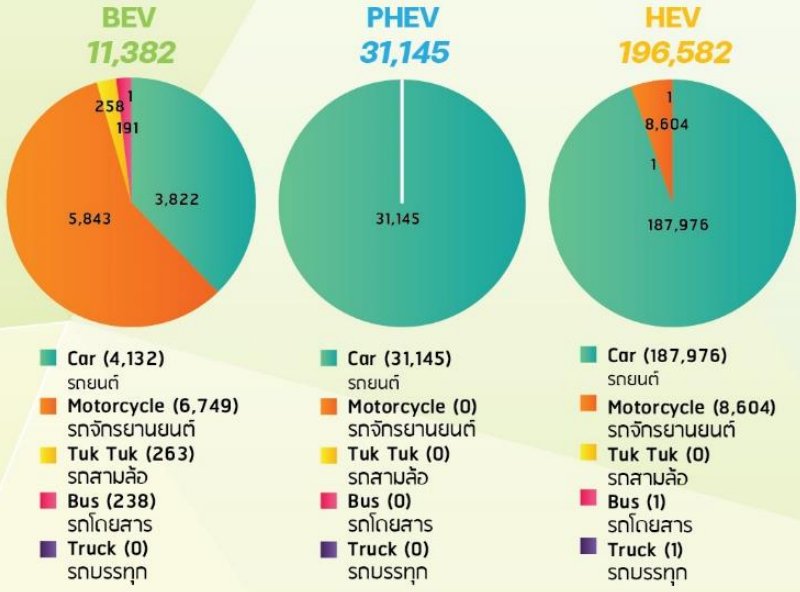
Between 2017-2021
ระหว่างปี 2560-2564




Source: Electric Vehicle Association of Thailand

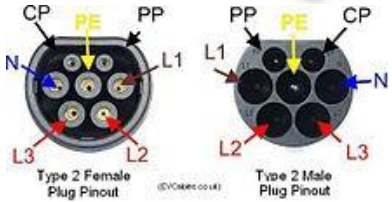
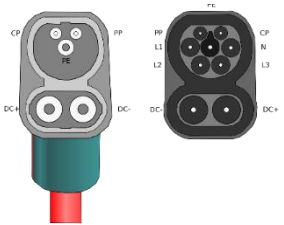
## Accumulated Number of xEV Registration in 2021
จำนวนยานยนต์ไฟฟ้าสะสม

As of 31 Dec 2021
ณ วันที่ 31 ธ.ค. 2564



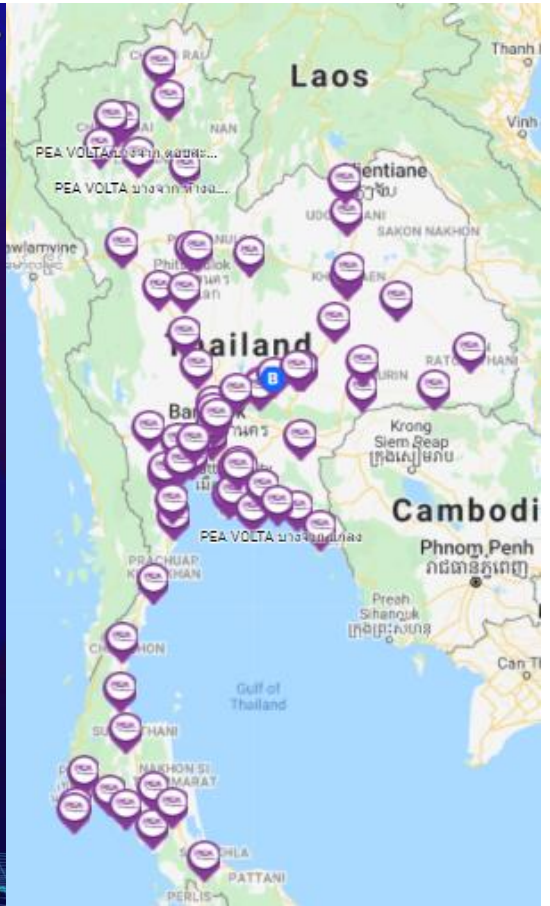
# Sockets and Inlet Standard

Thailand Industrial Standards Institute

<table>
<tr><th>Vehicles</th><th>AC Charger</th><th>DC Charger</th><th>Vehicles</th></tr>
<tr><td>Electric Bus</td><td rowspan="2">IEC 62196-2 Configuration Type 2<br>  <br>  <br><br>Phase: Single / Three<br>Rated Current: 70A (Single phase) / 63A (Three phase)<br>Rated Voltage: 480 V<br>Capacity: Up to 22 kW (Mode 2)<br>Up to 43 kW (maximum)</td><td>IEC 62196-3 Configuration FF<br>  <br>Rated Current: Up to 200 A<br>Rated Voltage: ≥ 500 V DC<br>Communication Protocol: PLC</td><td>Electric Bus</td></tr>
<tr><td>Electric Passenger Car</td><td>  <br></td><td>Electric Passenger Car</td></tr>
</table>

# Total Number of Charging Stations in Thailand


| Service Providers ผู้ให้บริการ | Number of Locations จำนวนแห่ง | AC Normal Chargers | DC Fast Chargers | All Total Chargers |
|---|---|---|---|---|
| MEA | 417 | 1,062 | 571 | 1,633 |
| | 68 | 48 | 32 | 80 |
| evolt | 49 | 79 | 23 | 102 |
| ChargeNow | 42 | 110 | 1 | 111 |
| PEA VOLTA | 32 | 36 | 111 | 147 |
| EV STATION | 30 | 38 | 10 | 48 |
| | 15 | 24 | 5 | 29 |
| ElecX | 14 | 16 | 21 | 37 |
| SHARGE | 14 | 65 | 0 | 65 |
| PUMP CHARGE | 6 | 18 | 0 | 18 |
| EVen | 4 | 7 | 0 | 7 |
| onion | 2 | 8 | 0 | 8 |
| TOTAL | 693 | 1,511 | 774 | 2,285 |

# ELECTRIC MOPEDS AND MOTORCYCLES - REMOVABLE RECHARGEABLE ELECTRICAL ENERGY STORAGE SYSTEM TISI 3316-2564

# ELECTRIC MOPEDS AND MOTORCYCLES – REMOVABLE RECHARGEABLE ELECTRICAL ENERGY STORAGE SYSTEM

## 1. Scope for TISI 3316-2564

Cover “Rechargeable Electrical Energy Storage System [REESS]” for electric mopeds and motorcycle which can be taken out from vehicle for off-board charging

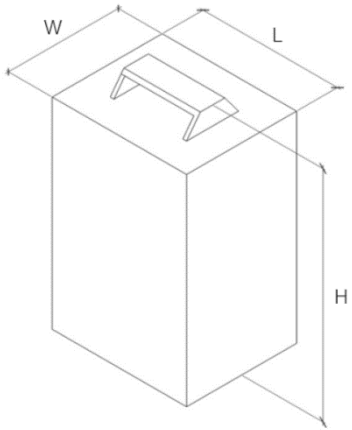
## 2. Definition

- Rechargeable Electrical Energy Storage System [RESS] for electric propulsion
- State Of Charge [SOC] as % of battery capacity
- Nominal voltage indicated in battery cell or pack
- Battery energy as Joule or Watt-hour
- Rated battery energy under condition indicated by manufacturer
- Capacity indicated in battery cell or pack
- Rated capacity under condition indicated by manufacturer

## 3. Category [by voltage]

- 48 V [in the range of 48 V - 52V]
- 60 V [in the range of 60 V - 66V]
- 72 V [in the range of 72 V - 72V]

## 4. dimension of battery




❑ **voltage 48 V และ 60 V**

| Side | L | H | W |
|---|---|---|---|
| mm | 160 | 180 | 300 |

❑ **แบบแรงดัน 72 V**

| Side | L | H | W |
|---|---|---|---|
| mm | 180 | 220 | 300 |

**Note:** Width [W] Length [L] Height [H], mm = millimeter

# TISI 3316-2564

## 5. General characteristics

➢ **Inspection:** visual

- Voltage of battery: 48 V, 60V และ 72 V
- Capacity of battery: ≥ 1,000 Wh
- Pin-Socket consisting of
  - Pin for electricity transmission
  - Pin for data communication

**note:** voltage calculated from battery cell voltage x number of cell in series

➢ **Inspection:** Connecting to battery control unit

- While in use or charging, battery must communicate
  - Temperature of important components
  - Voltage
  - State of charge [SOC]

**note:** Protocol according to manufacturer

## 6. Symbol & label

1. Name of product
2. Category [according to voltage in section 3]
3. Capacity [Ampere-hour, Ah]
4. Voltage [Volt, V]
5. Type of battery cell
6. Manufacturing date and code for battery
7. Name of manufacturer
   [Showing location or trademark]

## 7. Testing

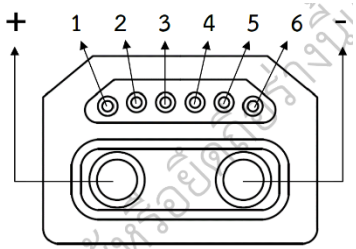
- Measuring device with resolution 1 millimeter
- Method for measurement
  - Width [W] measured from left to right [maximum width]
  - Length [L] measured from front to back [maximum length]
  - Height [H] measured from bottom to top [maximum height]

**note:** dimension from section 4

# Pin-Socket of battery for electric moped/motorcycle

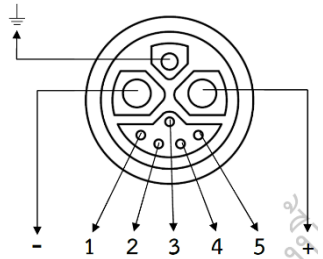
➢ Pin-Socket should support communication channel like CANBUS or RS485

## Example of pin-socket #1




✚ battery anode
- battery cathode
1 RS485A or CAN H
2 RS485B or CAN L
3 Unused [spare]
4 Unused [spare]
5 RS485B or CAN L
6 RS485A or CAN H

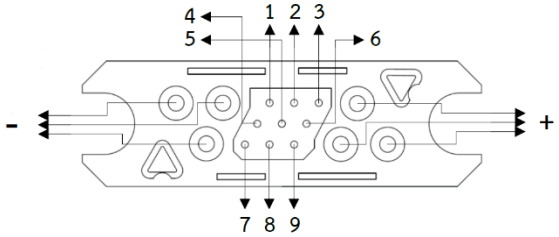
## Example of pin-socket #2




✚ battery anode
- battery cathode
⏚ ground
1 CAN L
2 Unused [spare]
3 Unused [spare]
4 Unused [spare]
5 CAN H

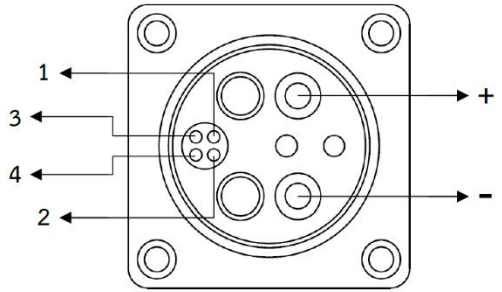
+ -: **electricity**
1-9: **data communication**

## Example of pin-socket #3




✚ battery anode
- battery cathode
⏚ ground
1 RS485A
2 CAN G
3 RS485A
4 5 6 ground
7 RS485B
8 CAN L
9 RS485B

## Example of pin-socket #4




✚ battery anode
- Battery cathode
1 RS485A or CAN H
2 RS485B or CAN L
3 Unused [spare]
4 Unused [spare]

**note:** CANBUS is communication protocol designed for vehicle
RS485 is communication protocol designed for digital data in series

# TISI 62840
# Electric Vehicle Battery Swap System
# [Part 1: General and Guidance]

**Note:** This TISI is directly reprinted from IEC TS 62840-1 (2016)

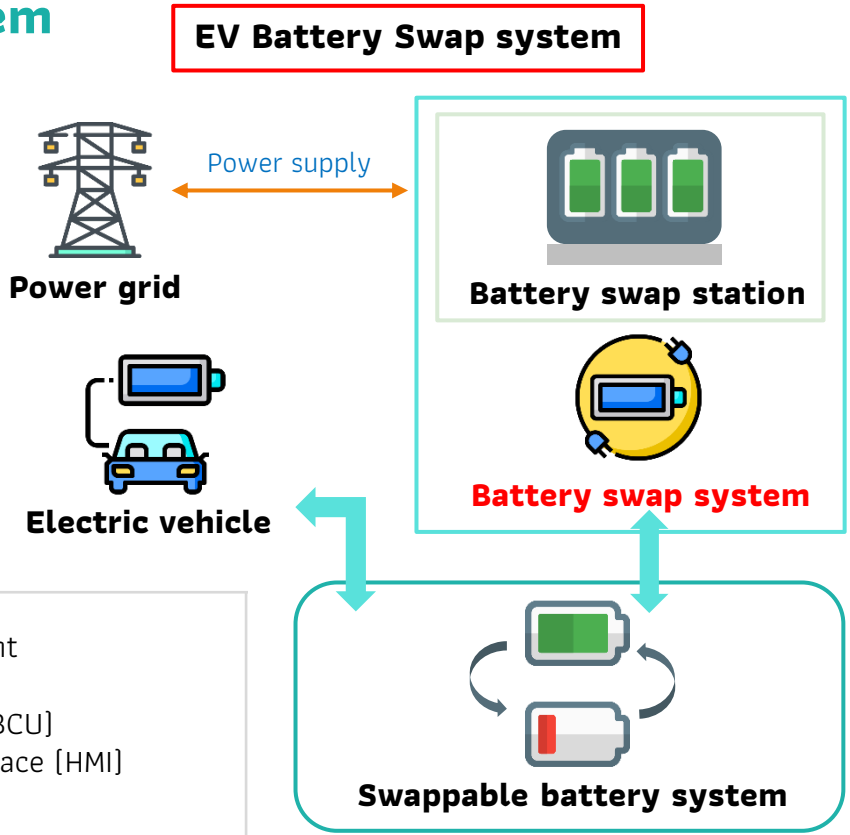
# Electric Vehicle Battery Swap System [Part 1: General and Guidance]

## 1. Scope

IEC 62840 gives the general overview for battery swap system (BSS) of electric road vehicles (EVs). The BSS is connected to the supply network at standard supply voltages according to IEC 60038 with a rated voltage up to 1,000 V AC and 1,500 V DC.

## 2. Terms and definitions

- Electric road vehicle
- Battery swap system
- Supporting system
- Battery swap station (BSS)
- battery pack
- Swappable battery station (SBS)
- Battery system
- SBS Coupler
- SBS Charger
- Charging rack
- Storage rack
- Transferring equipment
- Swap equipment
- Battery control unit (BCU)
- Human machine interface (HMI)



# System overview

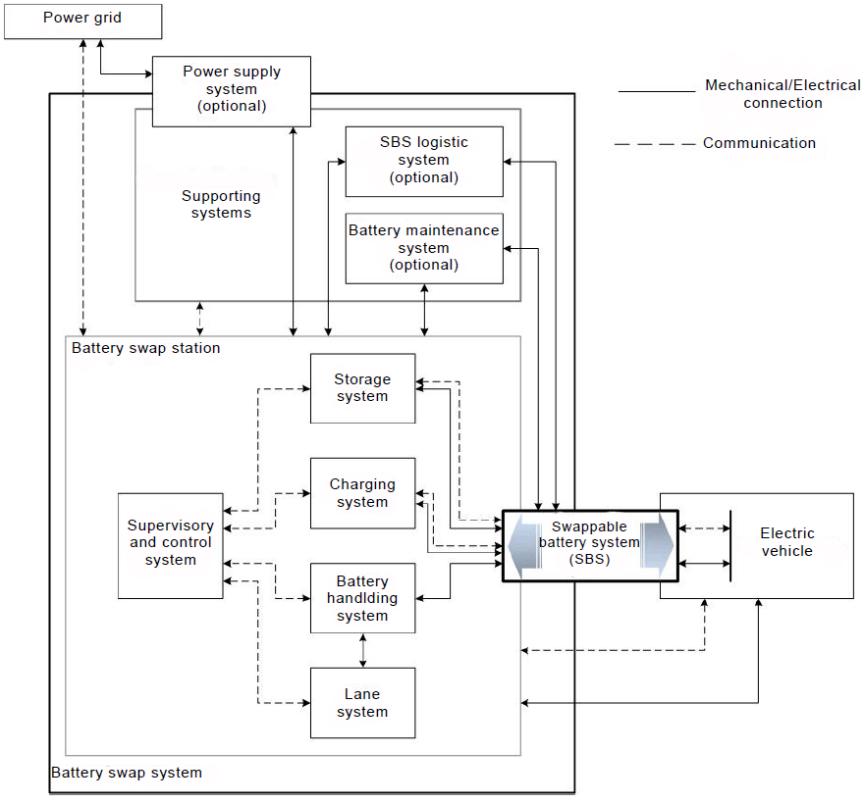
## 3. Battery swap system (BSS)

- **BSSs** provide quick, safe and reliable swapping.
- **EV BSS** consists of:
  - Battery swap system (BSS)
  - Supporting system
  - Swappable battery system (SBS)
  - Power supply system

## 4. Battery swap station (BSS)

- **BSSs** provide system functions.
- **EV BSS** consists of systems:
  - A lane system
  - A battery handling system
  - A storage system
  - A charging system
  - A supervisory and control system

**EV battery swap station**



# System overview

## 4.1 A lane system

➢ System is used to transfer position the EV to the designated location to get ready for battery handling.

- The lane system may provide functions such as:
  - EV verification
  - EV validation
  - EV cleaning
  - EV positioning
  - EV locking and unlocking

**Note:** The lane may include a cleaning station for the purposes of cleaning EV/battery parts before the swap process starts.

## 4.2 Battery handling system

➢ System consists of swap and transferring equipments.

- The system may provide functions such as:
  - Locking/unlocking
  - Mounting/un-mounting
  - Transferring

## 4.3 A storage system

➢ System is used to store the SBS safety.

- The system consists of:
  - A storagee rack
  - An equipment to communicate with supervisory and control system

## 4.4 Charging system

➢ System is used to charge the SBS safety.

- The system consists of:
  - SBS charger [s]
  - Charging racks and communicated equipments

## 4.5 Supervisory and control system

➢ System monitors and controls all BSS processes .

- The system consists of:
  - Communication units
  - A data process module
  - Data acquisition units
  - A data storage module
  - A remote-control module
  - HMI[1]

**Note:** [1] Human machine interface [HMI]

TISI. 62840 # 1-2563, IEC TS 62840-1 [2016]

# System overview

## 5. Supporting systems (Optional)

- Systems consist of equipment which assists in completing the battery swap process.

- Supporting systems may include:
  - A SBS logistic system
  - A battery maintenance system

## 6. Swappable battery system (SBS)

- SBS can be mounted or unmounted separately by the battery handling system.

## 7. Power supply system

- Power supply system supplies electric power to the BSS and the supporting systems.

## 8. Interfaces

- Interfaces in an EV battery swap can be divided into internal and external interfaces.

## 8. Zones

The battery swap system is divided into 4 separates zones with different accessibility patterns:

- **Vehicle lane zone**
  - The vehicle lane zone provides access for the EV to the BSS and the battery swap zone.

- **Battery swap zone**
  - The battery swap zone defines where automatic/semi-automatic devices are mounting/unmounting SBS to and from the EVs.

- **Battery storage zone**
  - The battery storage zone defines where SBS are stored, and munipulated by automatic/semi-automatic devices.

- **Battery charging zone**
  - The battery charging zone defines where SBS are charged. Battery storage and charging zone can be the same physical location.



TISI. 62840 # 1-2563, IEC TS 62840-1 [2016]

# Classification

## 1. General

- The BSS is classified as follows:
  - According to automation level
  - According to SBS mounting level
  - According to the swappable EV category

## 2. Automation level

- **Full-automatic**
  - The full-automatic battery swap process is operated by the automatic electrical/mechanical systems, without any human labor.
- **Semi-automatic**
  - The semi-automatic battery swap process is initiated and controlled by human operator while assisted by the electrical/mechanical systems equipped with sensors or other automatic devices.
- **Manual mode**
  - The manual battery swap process is initiated, operated and controlled by human operators.

## 3. SBS swapping direction

- The physical direction is classified as follows:
  - Side-swapping
  - Bottom-swapping
  - Top-swapping
  - Front-swapping
  - Rear-swapping
  - Multiple-direction

## 4. EV categories

- EV categories according to ISO 3833[2] or UNECE R100[3] are classified as follows:
  - M1, swapping for passenger car
  - M2, M3, N1, N2, N3, swapping for commercial vehicle.

## 5. Environmental conditions

- The battery swap system can be classified according to its suitability for use in severe environmental conditions other than those specified in this specification, if declared so by the manufacturer.

**Note:** [2] ISO 3833 [Road vehicles-Types-Terms and definitions]
[3] UNECE R100 [Uniform provisions concerning the approvall of vehicles]

TISI. 62840 # 1-2563, IEC TS 62840-1 [2016]

# TISI 62840
# Electric Vehicle Battery Swap System
# [Part 2: Safety Requirements]

**Note:** This TISI is directly reprinted from IEC TS 62840-2 (2016)

# Electric Vehicle Battery Swap System
## [Part 2: Safety Requirements]

## 1. Scope

This part of IEC 62840 provides the safety requirement for a battery swap system [BSS]. The BSS is intended to be connected to the supply network. The power supply is up to 1,000 V AC and 1,500 V DC, in accordance with IEC 60038.

**Note:** This standard also applies to BSS supplied from on-site storage systems [e.g., buffer batteries].

- Aspects covered in this standard:
  - Safety requirements of the BSS and/or its system
  - Security requirements for communication
  - Electromagnetic compatibility [EMC]
  - Signs and instructions
  - Protection against electric shock and other hazards

**Note:** This standard is applicable to BSS for EV equipped with one or more SBS.

## 2. Terms and definitions

➢ The terms and definitions given in IEC 62840-1.

- Hazard
- Operator
- Direct contact
- Indirect contact
- Live part
- Risk
- Real time
- Alternating current [AC]
- Direct current [DC]
- Residual current device [RCD]

## 3. General

- Standard nominal voltage according to IEC 60038
- The BSS shall be designed and constructed for reliable and risk of danger to the human, equipment and surroundings.
- The relevant requirements specified by this standard, IEC 62840-1, and IEC 61851-21-2[4].
- The electrical and communication interface characteristics of BSS will be specified in another part of the IEC 62840.

**Note:** [4] 61851-21-2 [EMC requirements for off board electric vehicle charging systems] under consideration

# Safety requirements

## 1. General

- The BSS shall be in accordance with safety standard as follows:
  - IEC 60204-1 [Electrical equipment of machines]
  - IEC 61511-1 [Safety instrumented systems]
  - ISO 13849-1 [Parts of control systems]

## 2. Lane system

- **Vehicle lane**
  - At the entrance to the lane, the EV information shall be identified and fed into the supervisor and control system.

## 3. Battery handling system

- **Battery handling system**:
  - Interlock protecting guarding
  - Interlock with the lane
  - Battery handling process

## 4. Storage system

- **Battery storage**
  - Temperature or critical components
  - Electrical malfunction
  - Locking state

## 5. Charging system

- **SBS charger**
  - The SBS charger shall meet inherent parameters of the battery which are specified by the battery manufacturer.
- **Charger connection**
  - The charging process should be enabled only if the SBS coupler between the charging rack and the SBS is reliably connected.
- **Charging rack**
  - If The SBS is stored in the charging rack, requirement of storage system shall be applied.
- **Communication and monitoring**
  - The parameters shall be provided by BCU[5] and charger controller.

**Note:** [5] Battery control unit (BCU)

TISI. 62840 # 2-2563, IEC 62840-2 (2016)

# Safety requirements

## 6. Swappable battery system

- The batteries in BSS shall be constructed according to relevant standard [e.g., ISO 12405-1[6]].
- The SBS system shall have a standard and guarantee safe.

## 7. Supervisory and control system

- The systems shall communicate with the charging system. The exchange information includes:
  - Charging status
  - Battery states
  - Fault alert
  - Other information

## 8. Power supply system

- Crucial systems include:
  - Supervisory and control system
  - Charging system [For battery monitoring only]
  - Battery handling system [For moving into a safety only]

## 9. Supporting system

- **Battery maintenance system**
  - Forecast and maintenance the cells.
  - Check and test the consistency of cells.
  - Store and analyze the data during maintenance.
  - Communicate with control system.
- **SBS logistic system**
  - The system should have an anti-vibration device and thermal management unit and guarantee the safety of SBS during transferring according to the manufacturer's requirements.

## 10. Communication

- **Data security**
  - Any communication shall avoid unauthorized access and ensure data integrity.
- **Transmission of safety related massages**
  - Where the functional safety is affected, communication shall follow the requirements of IEC 61784-2[7].

**Note:** [6] ISO 12405-1 [Electrically propelled road vehicles: High-power applications]
[7] IEC 61784-2 [Industrial communication networks]

# Safety requirements

## 11. Protecting against electrical shock

- **General requirements**
  - IEC 60204-1 [Electrical equipment of machines]
  - IEC 61140 [Protection against electric shock]
  - IEC 60364-7-722 [Low-voltage electrical installations]
  - IEC 61851-23 [Electric vehicle conductive charging system]
- **Protection against direct contact**
  - IP degrees for the enclosures.
  - IP degrees for coupler
  - Bidirectional energy transfer
- **Stored energy – discharge of capacitors**
  - For systems with voltage > 60 V, the requirement shall be fulfilled:
    - Conductive and protective part ≤ 60 V DC, or the stored energy < 0.2 J.
    - IEC 60364-4-41 [Low-voltage electrical installations]
    - Rigid barriers/enclosures with sufficient mechanical robustness and durability.
- **Fault protection**
  - Automatic disconnection of supply
  - Double or reinforced insulation
  - Electrical separator for the supply
  - Extra low voltage [SELV and PELV]
- **Productive conductor**
  - IEC 60364-5-54

  [Electrical installations of buildings]
- **Supplementary measures**
  - Additional protection
  - Manual/automatic reset
  - Protection of persons against electric shock
- **Telecommunication network**
  - IEC 60950-1:2005/AMD1:2009/AMD2:2013

  [Information technology equipment – Safety]

**Note:** IEC 60950-1:2005/AMD1:2009/AMD2:2013 is applicable to mains-powered or battery-powered information technology equipment, with a rated voltage not exceeding 600 V.

# Safety requirements

## 12. Equipment constructional requirement

- **General**
  - IEC 61439-1
    [Low-voltage switchgear and control gear assemblies]
- **Characteristics of mechanical switching devices**
  - Switch and switch-disconnector [IEC 60947-3]
  - Contractor [IEC 60947-4-1]
  - Circuit breaker [IEC 60898-1]
  - Relays [IEC 61810-1]
  - Metering [IEC 62052-11]
- **Clearances and creepage distances**
  - IEC 60664-1:2007, 4.5.5.6
    [Insulation coordination for equipment within low-voltage systems]
- **Strength of materials and parts**
  - Mechanical impact [IEC 62262]
  - Environmental conditions
    - Protection against corrosion [IEC 61439-1:2011]
- **Properties of insulating materials**
  - Verification of thermal stability of enclosure
  - Resistance to fire [Glow wire]
  - Ball pressure test
  - Resistance of tracking
  - Resistance of ultra-violet [UV] radiation

## 13. Electromagnetic compatibility

- **EMC of the BSS**
  - IEC 61000 series[8]
    [Electromagnetic compatibility, EMC]
  - IEC 61851-21-2
    [EMC requirements for off board electric vehicle charging systems]
- **Functional safety of related to EMC**
  - IEC 61508-1
    [electrical/electronic/programmable electronic safety-related systems]
  - IEC 61000-6-7
    [Electromagnetic compatibility]

**Note:** [8] IEC 61000 series consists of 79 documents. It contains specifications for Electromagnetic compatibility [emission standards, immunity, installation, testing and measurement techniques…]

# Safety requirements

## 14. Marking and instructions

- **General**
  - The equipment shall be marked with ratings or other information to denote severe or unusual environmental of use.
- **Marking of equipment**
  - Name, initials, and trademark
  - Equipment reference
  - Serial number or catalogue number
  - Date of manufacture
  - Rated voltage in V
  - Rated frequency in Hz
  - Rated current in A
  - Number of phases
  - IP degrees [Degree of protection]
  - “Indoor Use Only”, or equivalent
  - All Class II equipment, the symbol shall clearly appear in the markings.
  - The marking All necessary information
  - Minimal contact information

## 15. Legibility

- The markings required by this standard shall be legible with normal or corrected vision, durable and visible during use.

## 16. Signal and waring devices

- It is essential that these signals:
  - Be emitted before the hazardous event.
  - Be unambiguous.
  - Be clearly perceived from all signal used.
  - Be clearly recognized by the operator.
- The information shall prescribe regular checking of warning devices according to instructions.
- Written warning should be drawn up in the language[s] of the country.
- Marking shall comply with recognized standards.

**Note:** Please keep in mind that this presentation just provides one example of safety standard requirements. An audience should read the Thai Industrial Standard book for further information.



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# Thank you