PELMOB

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Intelligent transport systems

Professor Emeritus Dr. Zoran Avramović
AUB, Faculty for Traffic, Communication and Logistic, Budva

Electric vehicles in traffic

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Introduction

- Electric vehicles (eng. EV - Electric Vehicles) are becoming a key part of modern transport systems,
- reduction of harmful gases ,
- energy efficiency and
- sustainable mobility .

Types

- Electric vehicles are divided according to in a way work and drive system :

- 1.1. BEV (Battery Electric Vehicle) – Battery electric vehicles
- They use only electric motor and energy from batteries .
- They don't have an engine with internal combustion (ICE).
- Charging on stations (AC or DC chargers).
- Examples: Tesla Model 3, Nissan Leaf, VW ID.4.
- 1.2. PHEV (Plug-in Hybrid Electric Vehicle) – Plug-in hybrids
- They have electric motor and engine with internal by combustion.
- Short distances they drive on electricity, longer on gasoline / diesel.
- Charging batteries possible connecting on electricity grids.
- Examples : Toyota Prius Plug-in, BMW 330e, Volvo XC60 Recharge.

Types

1.3. HEV (Hybrid Electric Vehicle) – Classic hybrids

- They combine **an electric and a classic motor**, but **are not charged externally** .
- Energy is recovered **during braking (recuperation)** .
- Examples: **Toyota Corolla Hybrid, Honda Insight** .

1.4. FCEV (Fuel Cell Electric Vehicle) – Hydrogen vehicles

- They use **hydrogen fuel cells** to produce electricity.
- **Ecologically clean option** – they emit only **water**.
- Examples: **Toyota Mirai, Hyundai Nexo** .

Advantages of electric vehicles in traffic

- ☑ **Reduced CO_2 emissions** – Electric vehicles do not emit harmful gases if powered by renewable sources.
- ☑ **Lower maintenance costs** – Fewer moving parts compared to internal combustion engines.
- ☑ **Quieter operation** – Less noise in cities, improving quality of life.
- ☑ **More efficient energy consumption** – Electric motors have **higher energy efficiency** (90%) compared to conventional motors (~30%).

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EV Challenges and Limitations

⚠ **Range and autonomy** – Although battery technology is developing, some models still have **limited range** (150–600 km).

⚠ **Charging network** – Insufficiently developed infrastructure in some regions.

⚠ **Charging time** – Fast chargers (DC) can charge the battery to 80% in 30 minutes, while home chargers (AC) can take 6-12 hours.

⚠ **High cost** – EVs are more expensive than conventional cars, but subsidies reduce the difference.

⚠ **Impact on the grid** – Mass charging can strain the power system.

Infrastructure for electric vehicles

Charger types:

•**AC (slow chargers)** – Home chargers, **3-22 kW** (charging in 4-12 h).

•**DC (fast chargers)** – Public stations, **50-350 kW** (charging in 15-60 min).

Chargers in cities:

•**Tesla Supercharger**, **Ionity**, **EVgo**, **ChargePoint**, **GreenWay** – global networks.

•**European regulation**: The EU aims to have **3 million public chargers by 2030** .

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Regulation

European regulations and laws on electric vehicles

🚘 **EU Legislation**

•**Euro 7 standard** - Tightened emission regulations (from 2025).

•**Ban on the sale of new petrol and diesel vehicles in the EU from 2035** .

•**Alternative Fuels Infrastructure Directive (AFID)** – Mandatory installation of charging stations **every 60 km** on motorways.

💰 **Subsidies and incentives**

•**Germany** : Up to **€6,000 in subsidies** for EVs.

•**France** : Up to **€7,000 discount** for purchasing an EV.

•**Serbia** : Up to **€5,000 subsidy** for electric cars.

The future of electric vehicles

🚀 **New technologies** :

- **Solid-State Batteries** – Longer autonomy, shorter charging.
- **Vehicle-to-Grid (V2G)** – EVs as **mobile energy sources** to power the grid.
- **Inductive charging** – Wireless charging via electromagnetic fields.

🌍 **Global trends** :

- It is expected that by **2030,** 50% of new vehicles in the EU will be **electric** .
- Chinese companies like **BYD** and **NIO** are becoming global leaders in the EV industry.

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Practical experiences

- Traffic safety improvement system supported stationary cameras .
- All cameras are connected to the emergency operations center .
- The stationary radar system records speeding and red light violations at intersections.
- Operators in control centers monitor and manage traffic flows on highways .
- The system enables recording and documentation of all violations on highways.

Practical experiences

- Cameras for traffic monitoring and incident detection.
- The system also includes portals along the entire length of the highway, which feature variable traffic signs and information displays for communication with road users.
- As part of ITS, SOS telephones are built in that enable communication with control centers.
- also includes meteorological stations , which are installed in potentially risky locations

Smart attitude

- The stop provides access to data on vehicle arrivals and departures, charging of mobile devices, access to free internet, advertising of products and services on monitors, tourist information, downloading of music and film content, as well as information on meteorological conditions in the city.
- All this is possible thanks to the solar panels located on the stop's canopy, which convert solar energy into electricity.

Modernization

In the modernization of the city and transport, we can select the following projects:

1. Improving traffic safety and smart traffic management,
2. Bus tracking in JGPP,
3. A smart public lighting system that saves electricity,
4. Digitization of the management of green urban areas,
5. Innovations and technologies for the city of the future,
6. Smart bus stop and
7. Smart park.

Adaptive management

Adaptive intersection control refers to the use of advanced algorithms and sensor systems to dynamically control traffic lights in real time. The goal is to optimize traffic flow, reduce congestion, improve safety, and reduce emissions.

- Adaptive intersection management is a state-of-the-art solution in traffic.
- The system consists of cameras and sensors that record the situation at the intersection and send the collected data in real time. The software processes it and finds the optimal solution for safe traffic management.

Advantages

Advantages of adaptive intersection management:

- ☑ Reduction of congestion and congestion
- ☑ More efficient use of existing infrastructure
- ☑ Reduction of travel times
- ☑ Lower CO_2 and fuel emissions
- ☑ Greater safety for road users

Implementation examples:

- **SCOOT (Split Cycle Offset Optimization Technique)** – UK
- **SCATS (Sydney Coordinated Adaptive Traffic System)** – Australia
- **MOVA (Microprocessor Optimized Vehicle Actuation)** – Europe
- **InSync** – USA .

Computer networks in EV

The computer network in electric vehicles enables communication between various **electronic control units (ECUs),** sensors, and actuators, to optimize vehicle control, improve safety, and enable advanced autonomous driving features.

Key components of the EV network:

🚙 **1. Electronic control units (ECU)**

•Main computers that control various vehicle systems

•Examples: battery management (BMS), engine control, infotainment, autonomous driving

Computer networks in EV

2. Types of network protocols

- **CAN (Controller Area Network)** – the primary protocol for exchanging data between ECU units
- **LIN (Local Interconnect Network)** – used for less critical systems, such as seat and window controls
- **Ethernet (Automotive Ethernet)** – used for fast data exchange in advanced EV systems
- **FlexRay** – reliable communication for safety and autonomous driving systems
- **MOST (Media Oriented Systems Transport)** – used for infotainment systems

3. BMS (Battery Management System)

- Monitors and manages the vehicle battery
- Optimizes power consumption and extends battery life
- Communicates with ECU via CAN or Ethernet network

Computer networks in EV

4. Infotainment and connectivity

•Communication with cloud services, navigation and software updates (OTA – Over-the-Air)

•Wireless connections: Wi-Fi, Bluetooth, 5G/V2X communication

🚦 **5. Autonomous and ADAS systems**

•Lidar, radar and cameras send data to the vehicle's central computer

•AI processes information for automatic braking, parking assistance and autonomous driving

Advantages of an integrated network in EVs:

☑ Fast and efficient data exchange between systems
☑ Optimization of energy consumption and performance
☑ Improved security and precise system control
☑ Possibility of remote software updates and predictive diagnostics

Conclusion

ITS represent **the future** of transport.

Their implementation brings numerous benefits, but requires significant resources and meticulous planning.

High initial costs.

A joint effort by governments, the private sector and users is essential.

Integration **of old** systems with new technologies.

Legal and ethical challenges.

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Conclusion

The future of ITS:

- Advancing AIoT, artificial intelligence, and machine learning
- Autonomous vehicles
- Connecting all traffic participants (V2X communication)
- Increasing security
- Greater efficiency
- Sustainable development

Conclusion

Upon completion of the course, we expect students to be able to:

- They manage traffic with the help of ITS;
- They design adaptable traffic light systems, as well as elements of ITS systems;
- They evaluate system effects, create technical reports including EV ;
- They manage EV congestion.

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Thank you for your attention!

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