City of Utrecht

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Stan4SWAP: Are swappable batteries the last chance to decarbonize light vehicles?

📌 **Wednesday, 26 November 2025**
⏱️ **9:00 - 10:30**

SESSION 1E
Cars and Carbs: Lifting up LEVs

SPEAKERS
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Stan4SWAP

What have standards got to do with it?

Global mission to make decarbonise cities and make them sustainable

R&I provides innovative solutions for sustainable development

Standards support implementation of sustainable innovations

Why Stan4SWAP?

The European Green Deal is calling for deployment of more energy-efficient vehicles

- Transport sector responsible for 25% of GHG and for deterioration of air quality
- Need for new solutions and alternative fuels in all aspects of transportation..
- Need for consideration of decongestion..

AFIR Regulation 2023/1804

- Ensure min. infrastructure to support uptake of alternative fuel vehicles
- Ensure full **interoperability** of infrastructure
- Ensure comprehensive user information and adequate payment options at alternative fuels infrastructure..

Stan4SWAP in a nutshell

Support the **decarbonization of urban mobility** through the development of a robust **standardization roadmap** towards boosting innovation to market for **swappable Battery Systems for L-cat vehicles** deployment

Project Partners

PIAGGIO GROUP · Fraunhofer ISI · HYBA POWER THE FUTURE · CENELEC · VUB · KTM F&E · Swobbee · BMGI Consulting

Project Objectives

Identification

Of needs for **pre-normative research** work in the context of swappable battery systems for light-category vehicles

Prioritizing

Standardization activities towards supporting the deployment of swappable battery systems for L-cat vehicles

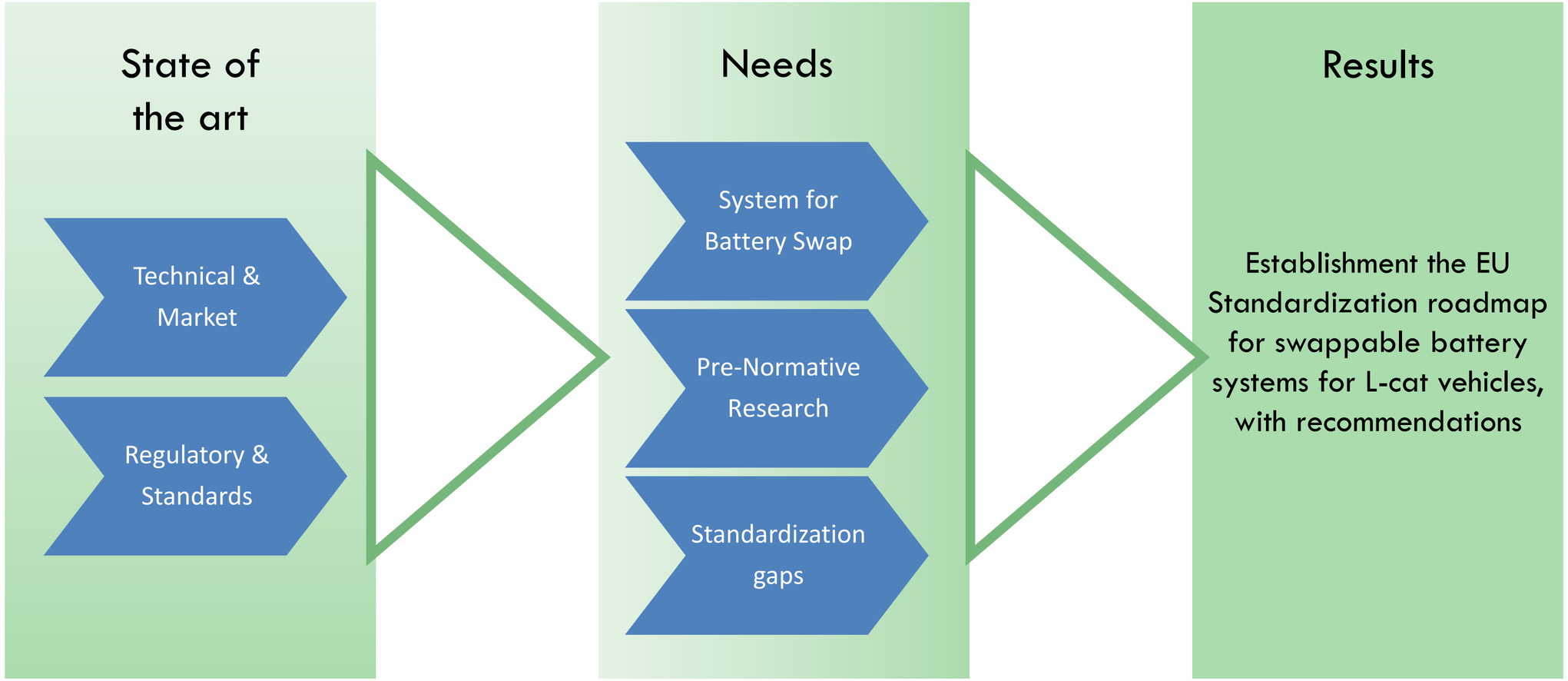
Increase

Stakeholders' engagement establishing an active dialogue between the standardization community, industry and research

Educating

And **raising awareness** about the role of standardization in supporting the decarbonization of mobility and transportation ecosystem

The road to the Stan4SWAP roadmap



The road to the Stan4SWAP roadmap

State of the Art

Technical & Market

Conclusions

- Mature market in Asia, but emerging in Europe and the US
- Multitude of different batteries
  → interoperability issues
- Important safety concerns & operation complexity
  → investment hesitation
- Limited awareness
  → low user push

Regulatory & Standards

Conclusions

- Regulation: Battery Reg., AFIR, Type-Approval of L-category vehicles, Low voltage Directive
- Standardization: Mandated standards, IEC62840: Electric vehicle Battery Swap System + EN, ISO, IEC standards on accessories, battery safety and battery chargers
- NEW INITIATIVE: CEN TC301 WG19
- No over-standardization
- Respond to regulatory, safety and societal needs
- Slow process but democratic and consensus based

The road to the Stan4SWAP roadmap

Needs

System for Battery Swapping

Multi dimensional compilation of needs

Vehicle Needs

- Compatibility and interoperability
- Performance metrics
- Standards for battery and its connecting and vehicle
- Easy handling (incl. weight)
- Robustness towards environmental conditions

Infrastructure Needs

- Adequate network coverage
- Optimized investments costs
- Interoperable hardware
- Harmonization of reg. for operation
- Prevention of incorrect use
- Detection of defects
- Safety requirements

User Needs

- Elimination of range anxiety
- Simple and safe intuitive swapping
- Ergonomic and safe handling of the battery
- Flexible investment costs to lower start investment
- Robust customer support
- Transparent communication

Manufacturing Needs

- Balance innovation, costs and safety
- Interoperability across designs
- Robustness of batteries regarding frequent swaps
- Cost effective production
- Compliance with EU reg. for recycling and sustainability

The road to the Stan4SWAP roadmap

Needs

System for Battery Swapping

Vehicle Needs

- ..

Infrastructure Needs

- ..

User Needs

- ..

Manufacturing Needs

- ..

Conclusions

Benefits of swappable battery systems

- Reduction of emissions in urban areas through electrification
- Swappable battery systems can alleviate range anxiety and enhance usability

Importance of Standardization

- Reduction of emissions in urban areas through electrification
- Swappable battery systems can alleviate range anxiety and enhance usability

Market Success Factors

- Reduction of emissions in urban areas through electrification
- Swappable battery systems can alleviate range anxiety and enhance usability

The road to the Stan4SWAP roadmap

Needs

Pre-Normative Research

Conclusions

- Focused on 4 domains:
  - Battery side
    - Safety feature protocols, monitoring requirements, recycling, repurposing, ..
  - Vehicle side
    - Communication interface batt.-vehicle, mechanical, electrical, ..
  - Charging infrastructure
    - Fire safety, ownership, settlement, installation criteria, common data exchange, ..
  - Interfaces (full system management)
    - Cross operator communication, data fields to be collected, ..

Standardization

Conclusions

- Focus on the same 4 domains (battery, vehicle, charging infrastructure and interfaces)
  - Standardization landscape
  - Related standards
  - Standardization expectation
  - Stakeholders' involvement

The road to the Stan4SWAP roadmap

Scope of the work

Value chain system approach

Main priorities

Interoperability

Compatibility

communication

Time perspective

T1: activities to be launched within 2 years

T2: activities to be launched within 4 years

T3: activities to be launched within 5 years

The road to the Stan4SWAP roadmap

Scope of the work

Three levels of elements

- Battery pack
- Vehicle
- Swapping charging station

Two levels of direct interfaces

- Battery pack - Vehicle
- Battery pack - Swapping charging station

Three levels of communication

- Battery pack - Vehicle
- Battery pack - Swapping charging station
- In support of services

The road to the Stan4SWAP roadmap

A peak to the results

Pre-Normative Research

Standardization

High priority

Battery Level

- Define standards and protocols for safety features
- Define connector for power supply and data communication incl. mechanical fixture
- Define physical properties of SWAP battery (vs. permanently integrated batteries)

- Safety requirements:
  - Streamlined testing/certification for Li-ion thermal runaway & propagation mitigation
  - Clear underwriting guidelines for multi-operator systems
  - Standard safety feature protocols
- Longevity/durability
  - Standardizing durability metrics to ensure consistent performance across swappable batteries
- Degradation rates
  - Establishing unified testing methods to measure and predict degradation to maintain reliability in swapping systems.

The road to the Stan4SWAP roadmap

A peak to the results

Pre-Normative Research

Standardization

High priority

Vehicle Level

- Define connector for power supply and data communication including mechanical fixture
- Define physical and electrical properties of SWAP battery (vs. permanently integrated batteries)
- Define communication protocol for SWAP battery

- Interface: connector (mechanical) vehicle <–> battery
  - Definition of a solid and reliable connection for a swappable battery solution versus permanently integrated batteries,
- Battery mechanical requirements
  - Definition of physical dimensions for a swappable battery solution versus permanently integrated batteries,
- Battery electrical requirements
  - Definition of electrical requirement for a swappable battery solution versus permanently integrated batteries,
- Interface: communication vehicle <–> battery
  - Comparability of data exchange

The road to the Stan4SWAP roadmap

A peak to the results

Pre-Normative Research

Standardization

High priority

Charging station Level

- Fire safety:
  - Advanced fire detection & suppression systems
  - Testing protocols for thermal runaway barriers in multi-battery racks.
- Using swappable batteries as grid assets
  - Control algorithms for “mobile V2G”
  - Market design for aggregator- based use of distributed battery modules.
- Standard installation criteria for swapping stations
  - Load-bearing studies for multi-battery racks
  - Building code alignment, best practices for safe installation

- General installation requirements
- Fire safety for battery systems
  - Harmonized guidance for battery swap fire detection & containment
  - Unified safety assessment for large battery deployments

The road to the Stan4SWAP roadmap

A peak to the results

Pre-Normative Research

Standardization

High priority

Interfaces and full system Level

- System level (swappable ecosystem)
  - Define cybersecure backend with standard communication system and Authorization system
  - Cybersecurity issues regarding authentication

- Smart grid integration
  - Clear aggregator communication standard for swappable battery nodes.
  - Mechanisms for verifying battery ownership, scheduling feed-in, settling payments.
  - Using swappable batteries as grid assets (load balancing, V2G, aggregator-driven “virtual power plants”)
- Location management
  - Harmonized building/permitting codes across regions.

The road to the Stan4SWAP roadmap

The recommendations

- **Improve** and **align** pieces and elements of regulation and policies
- Further **support to PNR** topics towards boosting maturity and meeting standardization “ready TRL” (i.e. Horizon Europe IA), including **support to pilots and demos** at full scale and real use cases/context (i.e. city tests)
- **Launch standardization development**, EN, TS, TR, CWA (i.e. CWA about swappable charging station for L-cat battery system and communication protocols towards validating swap action, SoH of the pack for proper life cycle related allocation, contribution to local grid – storage capacity -, etc…)
- Use and extend **existing standardization** where possible to avoid over complicating
- Consider **additional roles of charging stations** (i.e. new business models – BaaS, battery ownership, pricing contribution of charging station (storage) in support of decentralized grid management, …)
- **Education and Training**, raising awareness about role and relevance of standards, motivating experts to join standardization drafting teams, ….

Thank you for your attention!

POLIS
CITIES AND REGIONS FOR TRANSPORT INNOVATION

City of Utrecht

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