International Transport Forum

EXPERT WORKSHOP

Mapping standards for low- and zero-emission electric heavy duty vehicles

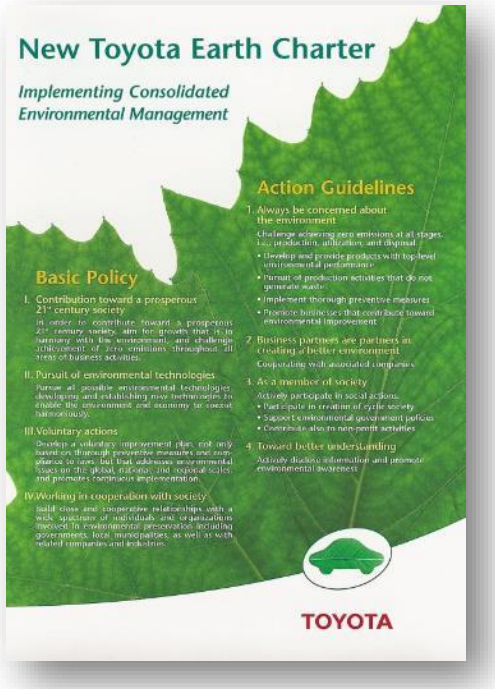
17-18 February 2020 – Paris, France

Toyota's Vision and involvement in HD standardization

17/02/2020

Vincent Mattelaer – Senior Engineer – R&D Powertrain

Toyota Earth Charter led to two technologies

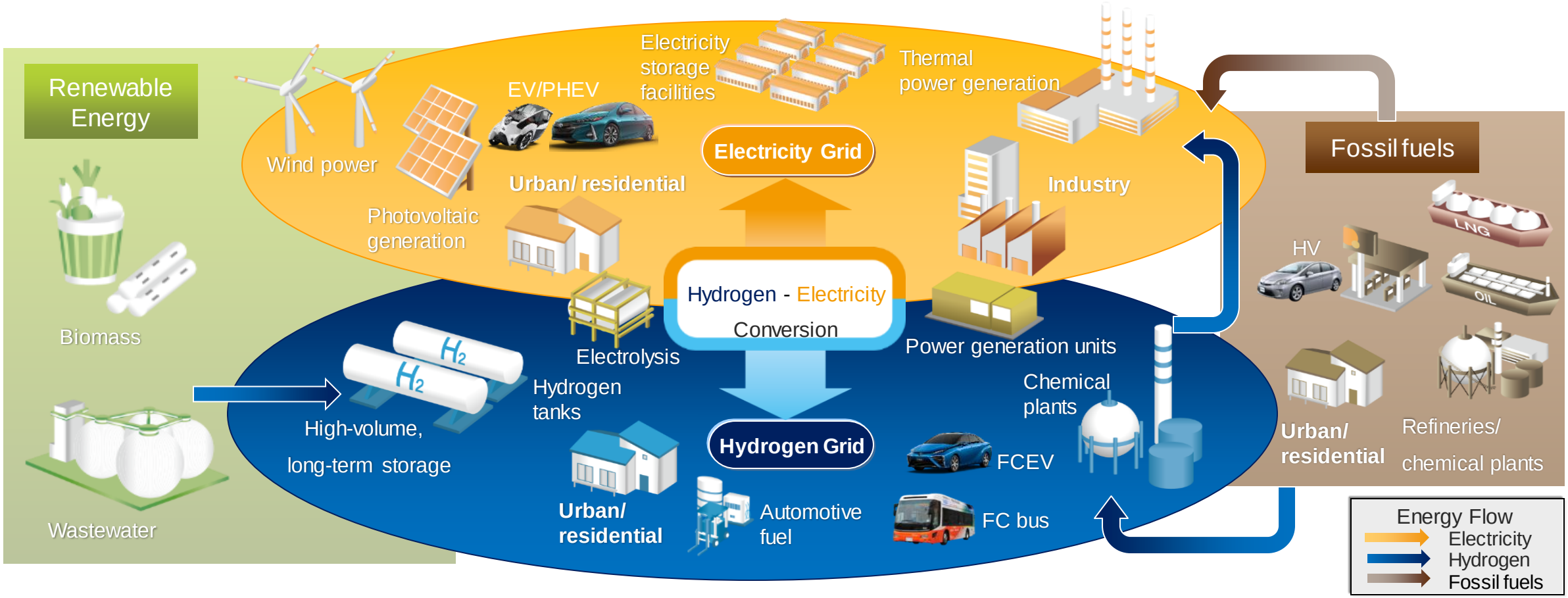


Toyota Earth Charter
(1992)

Prius at Tokyo Auto Show
(1995)

FCEV-1
(1996)

Future Vision: HyGrid (Hybrid Hydrogen – Electricity Grid)



Source: HyGrid Study Group HP

TOYOTA

Toyota's challenging environmental targets

CHALLENGE 1

New vehicle Zero CO_2 Emissions Challenge

CHALLENGE 2

Life Cycle Zero CO_2 Emissions Challenge

CHALLENGE 3

Plant Zero CO_2 Emissions Challenge

CHALLENGE 4

Challenge of Minimizing and Optimizing Water Usage

CHALLENGE 5

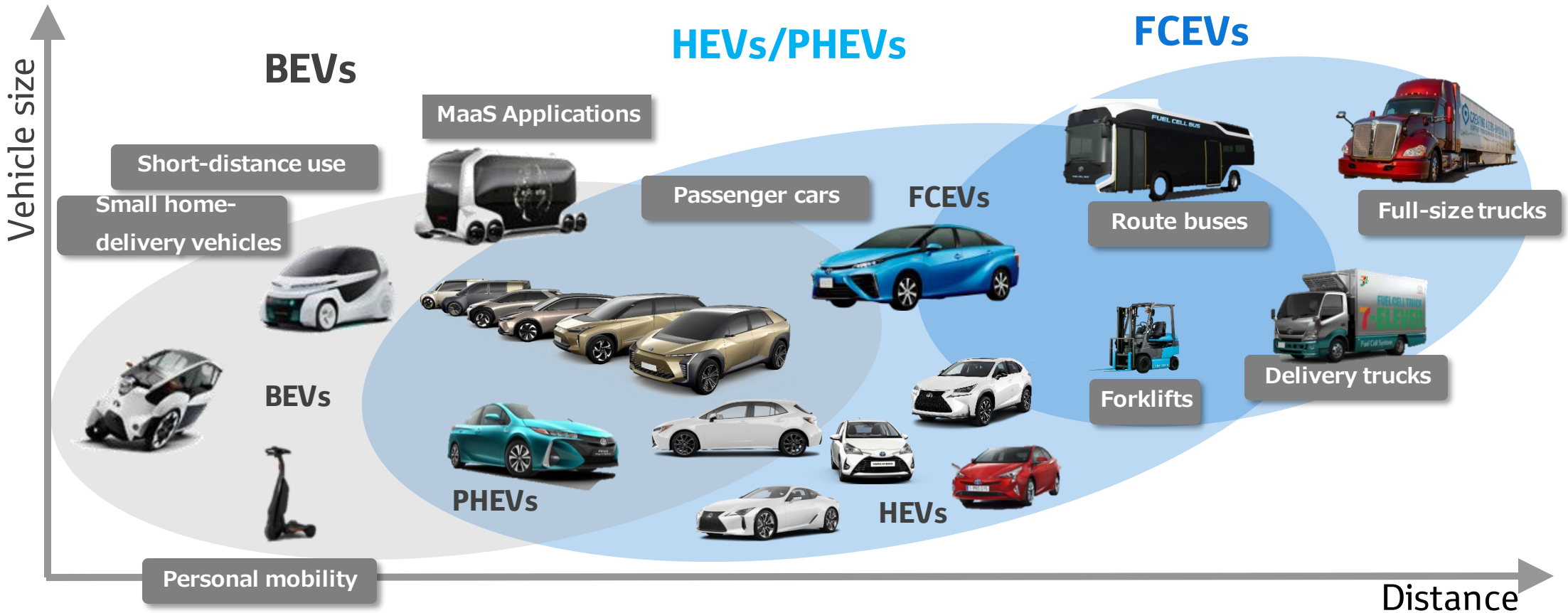
Challenge of Establishing a Recycling-based Society and Systems

CHALLENGE 6

Challenge of Establishing a Future Society in Harmony with Nature

TOYOTA

Diversification of HEV, PEHV, BEV, and FCEV



TOYOTA

Toyota's core technology for electrified vehicles

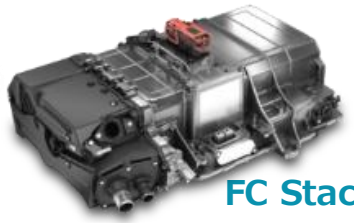
Electrified vehicles core technology


Battery


Motor


Power Control Unit

+


FC Stack

+


High-pressure Hydrogen Tank

FCEV


Charger

BEV


Charger

+


Engine

PHEV


Engine

HEV

TOYOTA

FC stack cost reduction

TOYOTA

Increase H_2 demand through diversification

Passenger Vehicles

Performance improvement and cost reduction

Commercial Vehicles

Substantial hydrogen consumption

Increase demand

H
HYDROGEN

FC technologies

Industrial use

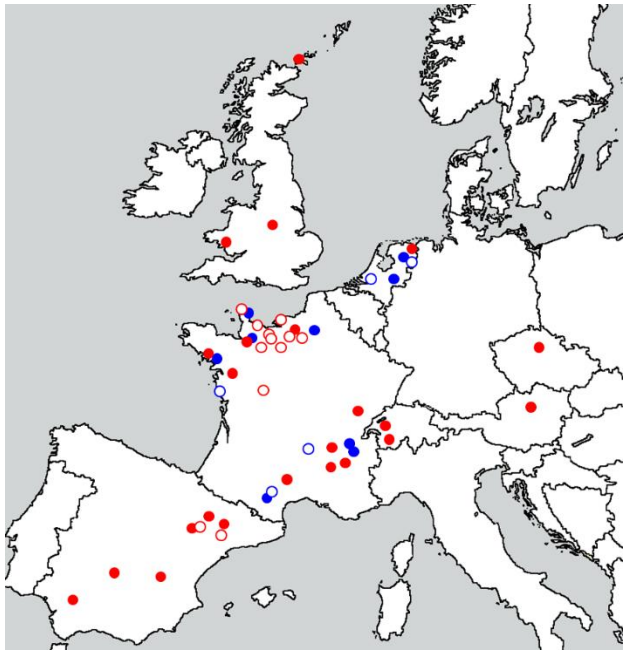
Contribution to infrastructure development

TOYOTA

Non-standardized stations

Closed stations

Including 29 bus stations.
(CHIC, CUTE)



Current and future
non-standard stations

(Mainly 350 bar)

TOYOTA

Standards for stations

1. One standard for connections

   ISO 17268
   EN/ISO 17268

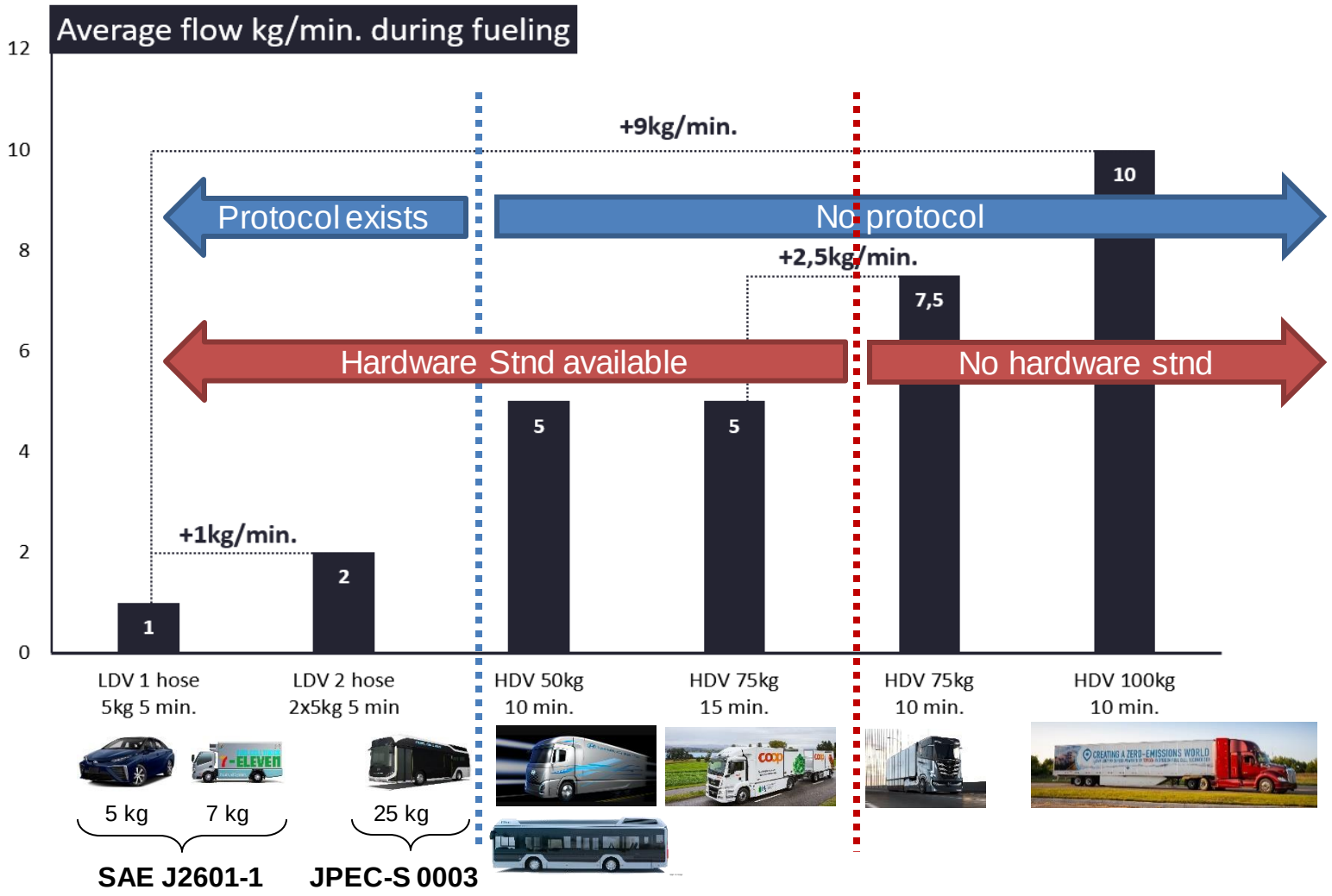
2. One standard for hydrogen quality

   ISO 14687
   EN 17124

3. One (?) standard for hydrogen fuelling protocol

   SAE J2601
   JPEC-S 0003

Standard for refuelling protocol.



TOYOTA

Toyota's participation in PRHYDE project

PRHYDE-Protocol for heavy-duty hydrogen refuelling

Call Identifier FCH-04-2-2019:
Refuelling Protocols for Medium and Heavy-Duty Vehicles

01 JAN 2020 - 31 DEC 2021

Project partners

PRHYDE
Protocol for heavy-duty Hydrogen refuelling

No.	Participant organisation name	Short name	Country
1	Ludwig-Bölkow-Systemtechnik GmbH (Coordinator)	LBST	DE
2	Zentrum für BrennstoffzellenTechnik GmbH	ZBT	DE
3	Air Liquide SA	AL	FR
4	Engie Lab CRIGEN	ENGIE	FR
5	Toyota Motor Europe NV	TME	BE
6	ITM Power (Trading) Limited	ITM	UK
7	NEL Hydrogen AS	NEL	DK
8	Shell Deutschland Oil GmbH	SHELL	DE
9	Commissariat à l'énergie atomique et aux énergies alternatives	CEA	FR
10	Nikola Motor Company	Nikola	USA

Third linked partners: MAN and Toyota North America

Objective of PRHYDE (1/3)

PRHYDE
Protocol for heavy-duty Hydrogen refuelling

- Determine relevant requirements for HDV fuelling:
  - to driving range,
  - fuelling time,
  - tank sizes,
  - average kg/fill,
  - SoC, and
  - customer impact, particularly taking the commercial boundary conditions of typical HDV operators into account

Objective of PRHYDE (2/3)

PRHYDE
Protocol for heavy-duty Hydrogen refuelling

- Determine limitations and gaps of current fuelling hardware capability (for HDV):
  - Capability of state-of-the-art nozzle and receptacle to achieve the flow required for HDV and potential gaps
  - Capability of state-of-the-art vehicle data collection and communication hardware to achieve sufficiently reliable data collection and communication of vehicle data to station and potential gaps
  - Consider how a potential HDV fuelling protocol is to navigate and transition from current state-of-the-art component capability to a future required capability/norm

Objective of PRHYDE (3/3)

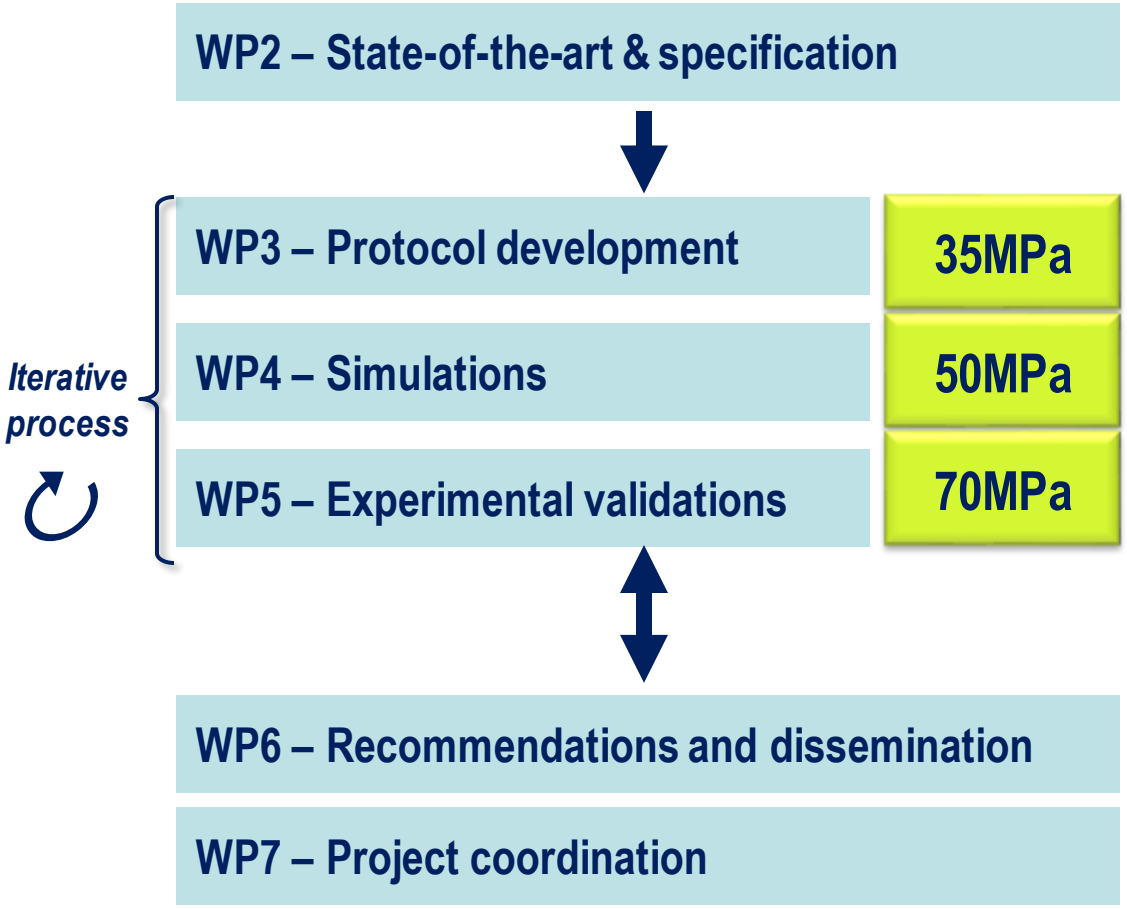
PRHYDE
Protocol for heavy-duty Hydrogen refuelling

- Develop concept(s) for HDV fuelling protocol(s)
- Validate the impact of HDV fuelling protocol(s) concept(s) on achieving key metrics (temperature and pressure) on the vehicle side
  - through tank refuelling simulation with simplified model and CFD approaches
  - through experimental validations on fuelling of tank(s) at station(s).
- Formulate recommendations (outcome of project) for HDV fuelling protocol(s) for use in relevant standardization forums – with the aim of eventually achieving standardization.

CFD: Computational Fluid Dynamics

Work plan

PRHYDE
Protocol for heavy-duty Hydrogen refuelling



WP2: Defining state-of-the-art on protocols, vehicles and component capabilities, gap analysis of current protocols, Specifying (new) tank categories, boundary conditions (flow temperature, connections etc.) target fueling times and quantities for the three pressure levels

Outcome: A detailed specification guiding the following protocol development and test efforts

WP3: Develop protocol approaches for the three pressure levels

Outcome: Protocol approaches for simulations (WP3) and test (WP4)

WP4: Modeling and Simulations of tank systems/categories to determine flow/temperature/pressure aspects

Outcome: Simulation results in order to assess impact of different protocol approaches

WP5: Experimental validation of protocol approaches at HRS(s)

Outcome: Validation of technical feasibility of protocol approaches

WP6: Formulate recommendations for standardization forums and dissemination

Outcome: Specific recommendations that can help create international standards on HDV hydrogen fueling

Welcome to participate to the 1st workshop on 24/03/2020

PRHYDE
Protocol for heavy-duty Hydrogen refuelling

Website: www.PRHYDE.eu

E-Mail: info@PRHYDE.eu

Location:

Hydrogen Europe offices
Avenue de la Toison d'Or 56-60
1060 Brussels

- HRS suppliers and HRS operators;
- Medium and heavy-duty vehicle manufacturers (not limited to road vehicles);
- Component suppliers (e.g. tank, nozzle/receptacle) as appropriate;
- Notified Bodies or hydrogen refueling station authorizers;
- National and international organizations promoting and supporting the use of hydrogen in the transport sector.

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Thank you

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