LEITAT
managing technologies

ADVANCED COATING SYSTEM TO OPTIMISE HYDROGEN TRANSPORT AND STORAGE SAFETY

3rd CHINESE-SPANISH JOINT CALL FOR R&D&I PROJECTS 2021

Content

1. Funding agencies
2. Project description
3. Participating entities
4. Call conditions
5. Submission process

1. Funding Agencies

3rd CHINESE-SPANISH JOINT CALL FOR R&D&I PROJECTS 2021

2. Project Description

- The development of energy production technologies using renewable resources that are more efficient, safe and cost-effective is crucial to tackle climate change.

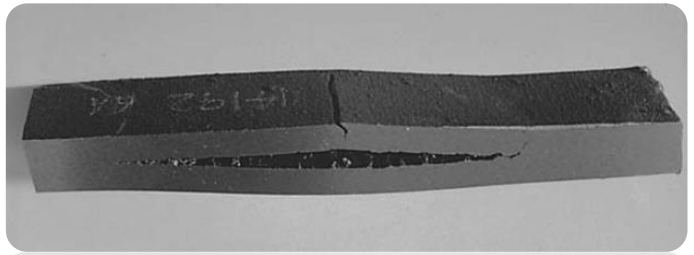
- Renewable hydrogen production is a valid proposal to achieve the clean energy production targets that the European community is setting for the next 5 years.

- In this project we intend to respond to the demand for safety in transport and storage as well as to initiate a relationship at the level of industrial collaboration with the Chinese industry and market.

Specific project objectives

- The project is in the line of finding a coating for storage tanks that improves the state of the art regarding corrosion problems (embrittlement, blistering, decarburisation, etc.) caused by the diffusion of atomic hydrogen through metallic structures and the consequent associated safety problem.

- Specifically, the project proposes research on the basis of consolidated technologies, such as electroless Ni/P and ceramics, a new coating technology in new non-aqueous media (ionic liquids), as well as synergic combinations of the different technologies that provide a significant improvement in terms of safety in the transport and storage of hydrogen.



Hydrogen blistering

Type of steel	*Note*
Normalized and carbon steels	Embrittlement to be assessed if Rm>950 MPa.
Stainless steels	Some of them can be sensible to embrittlement (ex. : 304)
Quenched and tempered steels	**More used** (ex.: 34CrMo4); Embrittlement to be assessed if Rm>950 MPa.

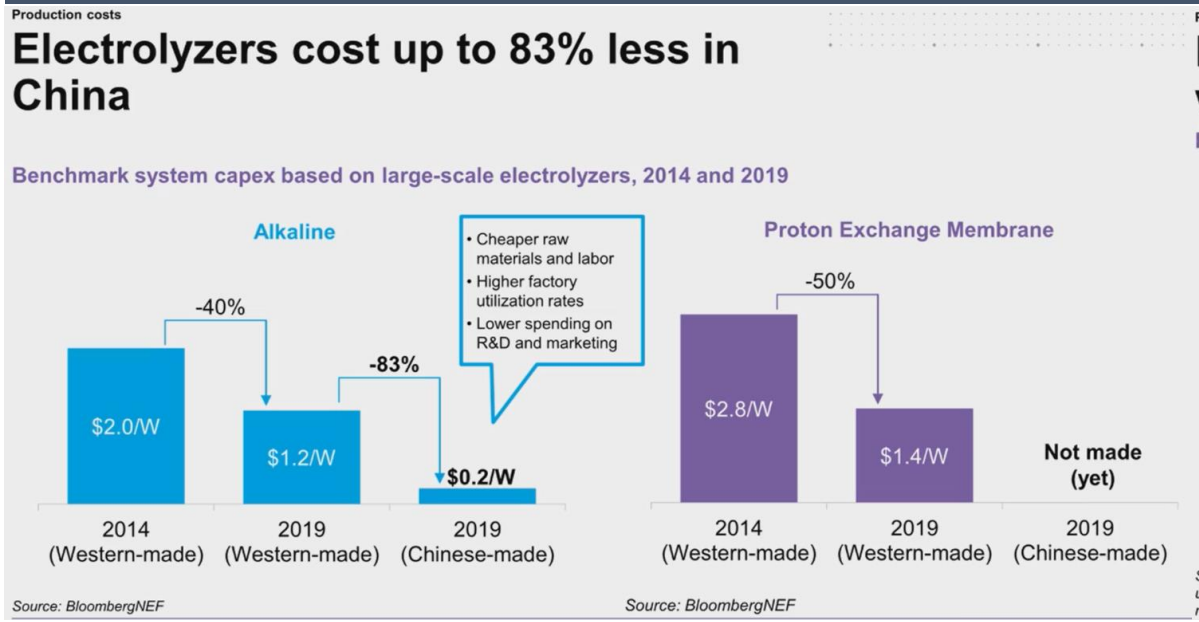
Table 1 : steels acceptable for hydrogen pressure storage (ISO 11114-1)

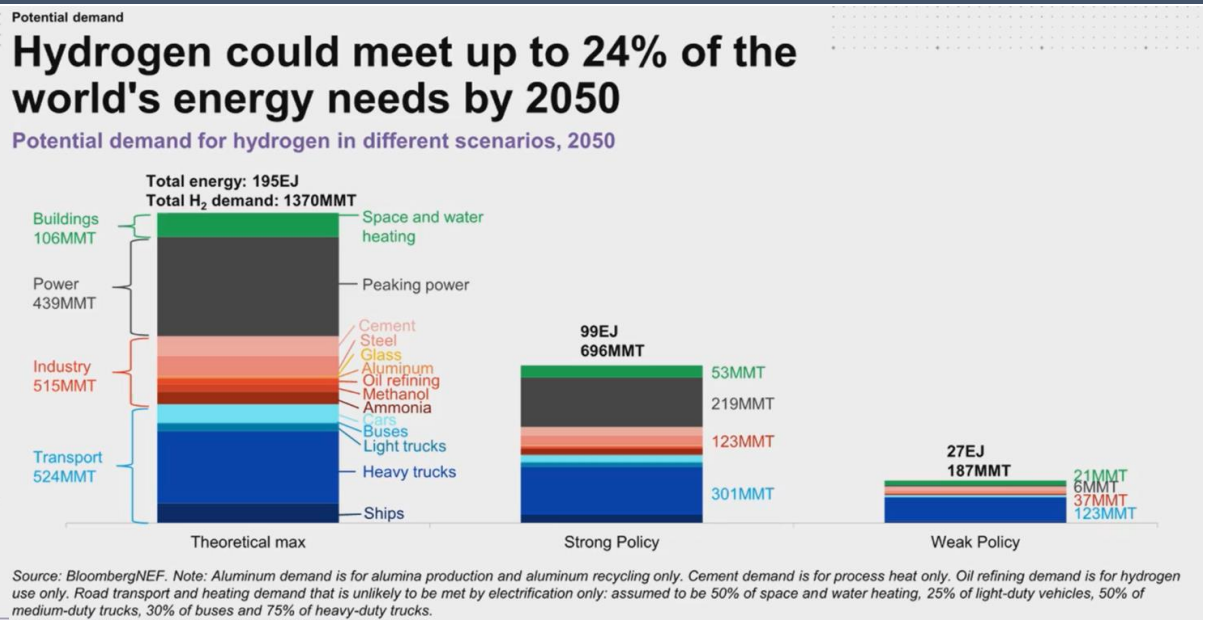
2. Project Description

Description of the technology benefit/appraisal of the technology for the business

- The hydrogen market is a growing market. It has been identified as one of the most promising solutions to meet the "zero emissions" challenge proposed by the European Union for 2050.
- China's foray into hydrogen production has made it not only the world's leading producer of hydrogen, but has also managed to bring the cost of production down to prices that make the expansion of its use feasible, until now limited precisely because of the high production costs.

"Hydrogen today appears to have a tailwind, with the opportunity to successfully build on this unprecedented momentum"





2. Project Description

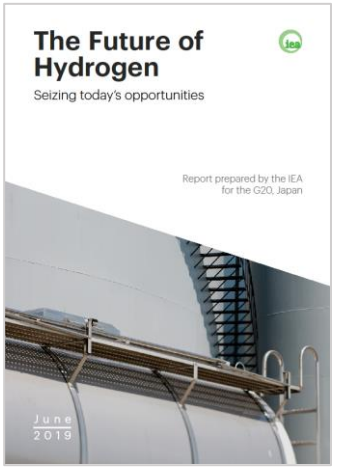
Description of the technology benefit/appraisal of the technology for the business

- Hydrogen demand keep on growing due to its high potential. A new market in expansion that brings with it new needs.

- The future and the opportunities of hydrogen in transport industry has become real.

  US *- 2019 Annual Evaluation of Fuel Cell Electric Vehicle Deployment & Hydrogen Fuel Station Network Development*

  EU *- FUEL CELLS AND HYDROGEN JOINT UNDERTAKING*



Hydrogen Roadmap Europe | The role of Hydrogen | ARB Report | FCHJU

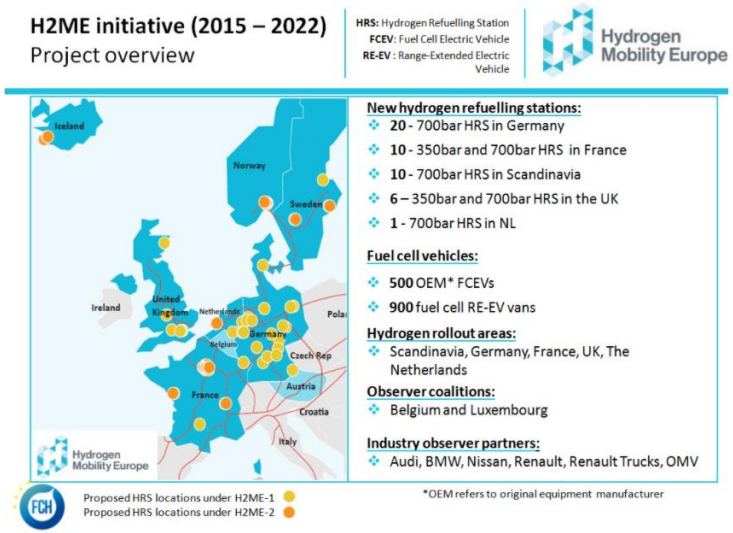


Figure 39. Hydrogen demand for primary chemical production for existing applications under current trends

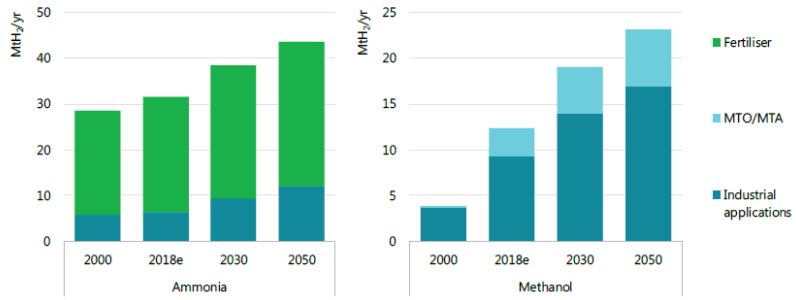
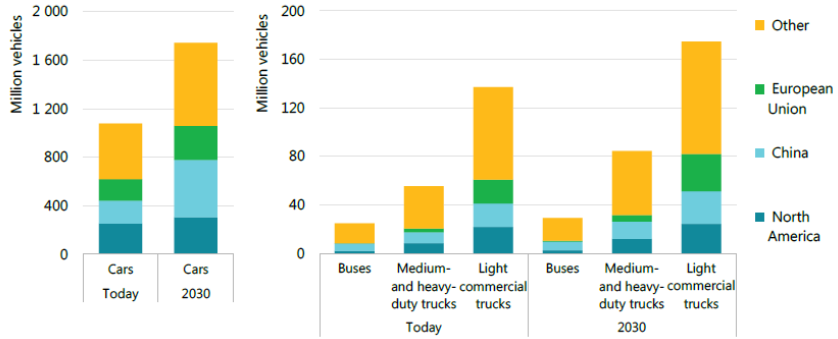
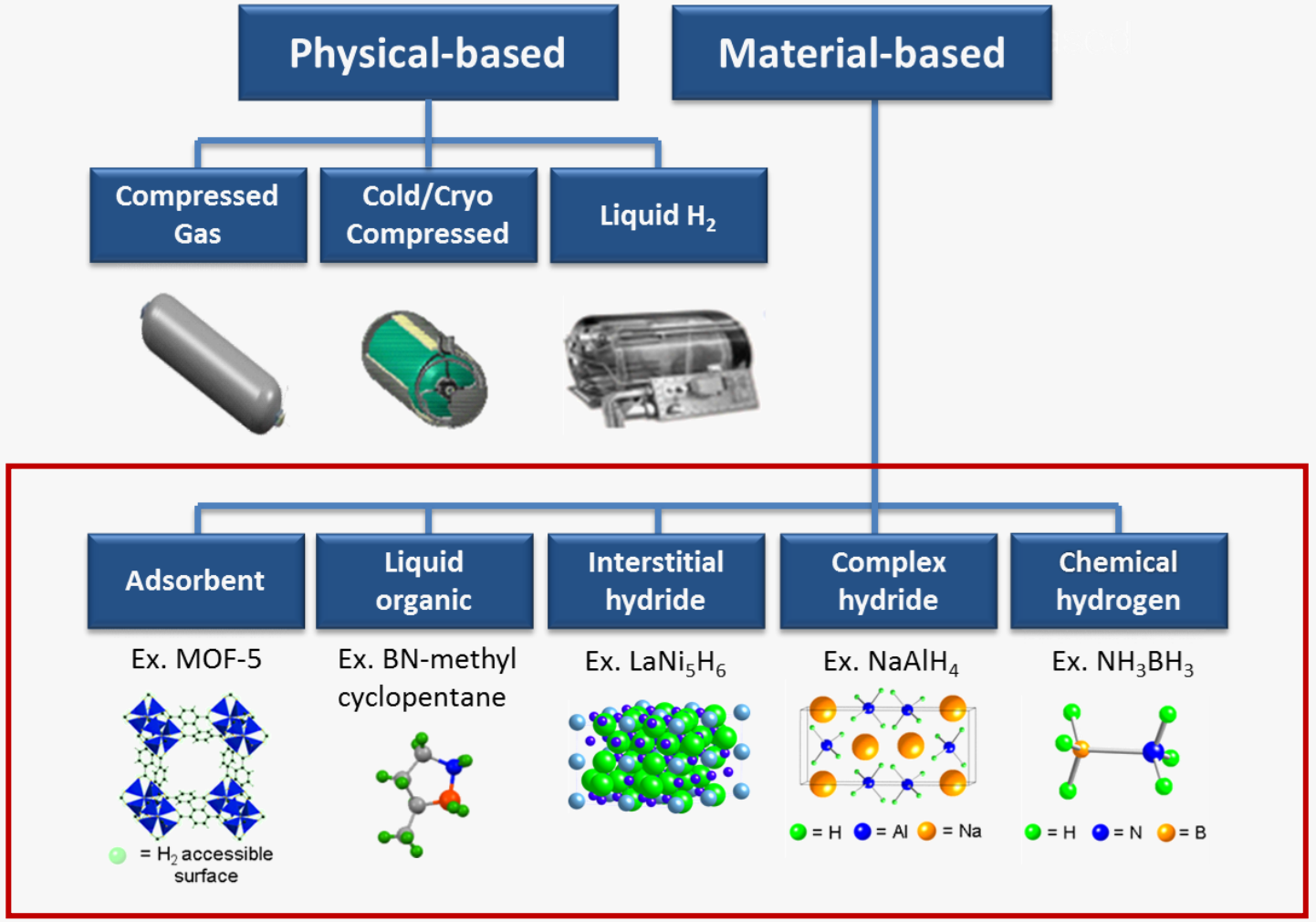


Figure 52. Road vehicle fleet growth to 2030 under current trends



2. Project Description

HOW IS HYDROGEN STORED?



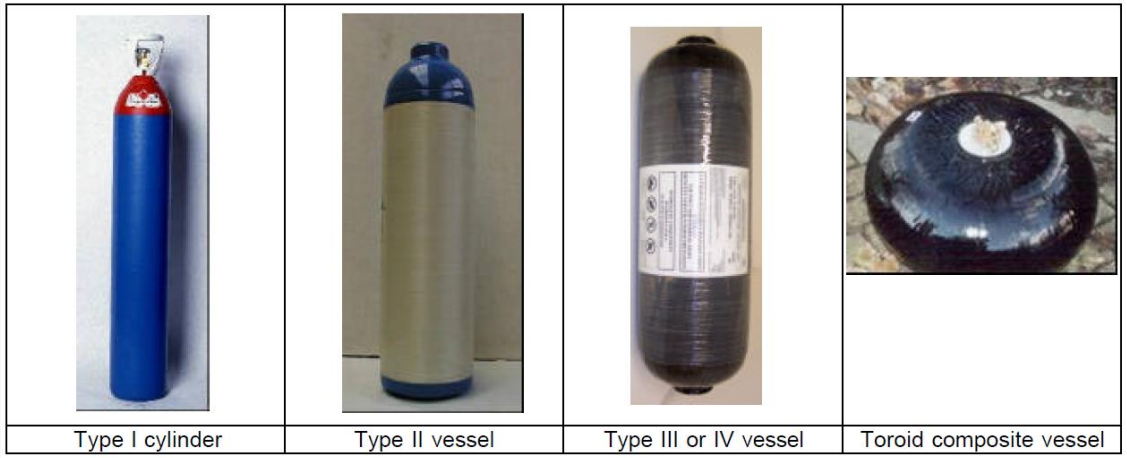
- Low TRL
- Not yet technologically mature approach

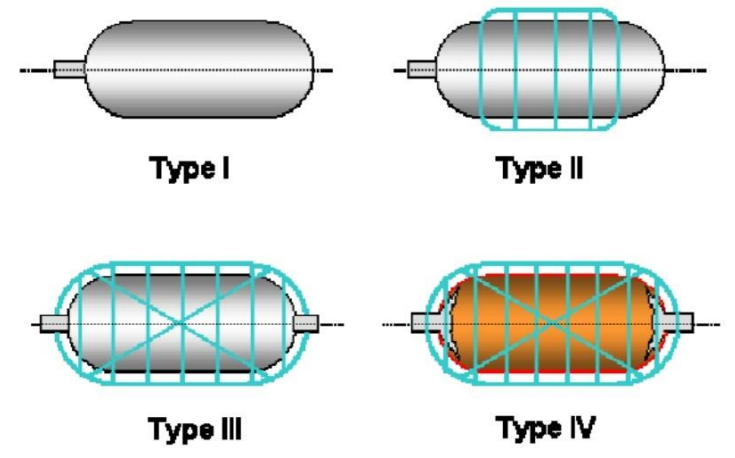
2. Project Description

HYDROGEN HIGH PRESSURE TANKS STORAGES

The pressure vessels are generally cylinders, but composite vessels can also be polymorph or toroid.

- **Type I**: Pressure vessel made of metal (175 bar).
- **Type II**: Pressure vessel made of a thick metallic liner hoop wrapped with a fiber-resin composite (700 bar – 1000 bar).
- **Type III**: Pressure vessel made of a metallic liner fully-wrapped with a fiber-resin composite (700 bar).
- **Type IV**: Pressure vessel made of polymeric liner fully-wrapped with a fiber-resin composite.
  The port is metallic and integrated in the structure (700 bar).





Barral 2006

Mitchler 2007

Mitchler 2012

Vieira-Faria

Type III

Type IV

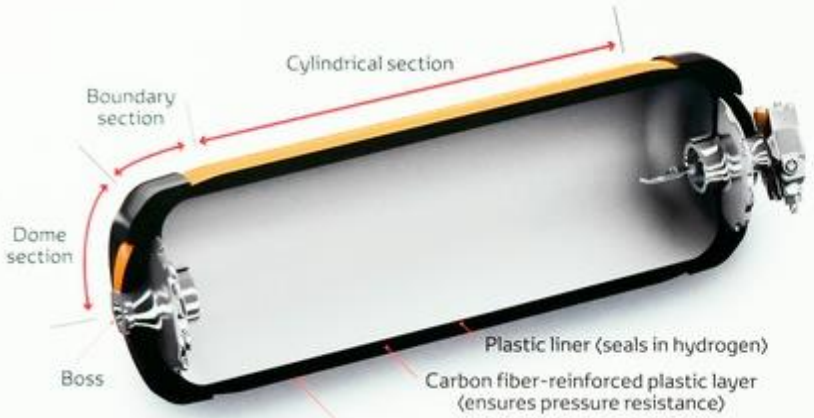
Tank storage density *1

*1 Hydrogen storage mass per tank weight

Lighter weight achieved through innovations of carbon fiber reinforced plastic layer structure

World top level *2

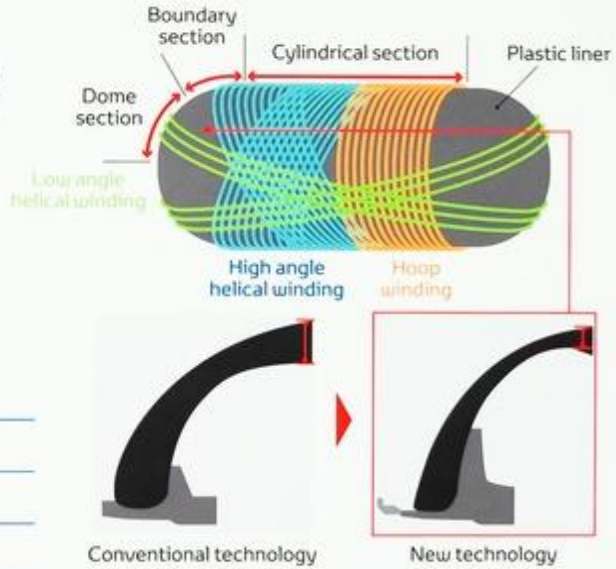
Tank storage density of 5.7 wt% achieved, a world top level *2



High-pressure hydrogen tank

Nominal working pressure	70 MPa (700 bar)
Tank storage density	5.7 wt% (world top level *2)
Tank internal volume	122.4 L (front tank: 60.0 L, rear tank: 62.4 L)
Hydrogen storage mass	Approx. 5.0 kg

Innovations to the plastic liner configuration and efficient layering pattern resulted in a reduction of approximately 40% in the amount of carbon fiber used



*2 November 2014, Toyota data

Type II

HYDROGEN HIGH PRESSURE TANKS STORAGES

2. Project Description

HYDROGEN BARRIERS

It is necessary to suppress the embrittlement and the surface corrosion of the steels by protective layers. e.g. low permeability metallic films and ceramic thin films.

- Electroless/plating Ni coatings offer much better resistance against hydrogen
- Greater success has been reported for intermetallic coatings, such as aluminides and titanium ceramic coatings

- Corrosion and hydrogen penetration properties of electro- and electroless depositions

W. Sha*, C.J. Murphy, J. Quinn; *School of Civil Engineering, The Queen' s University of Belfast, Belfast BT7 1NN, UK; (1999)*

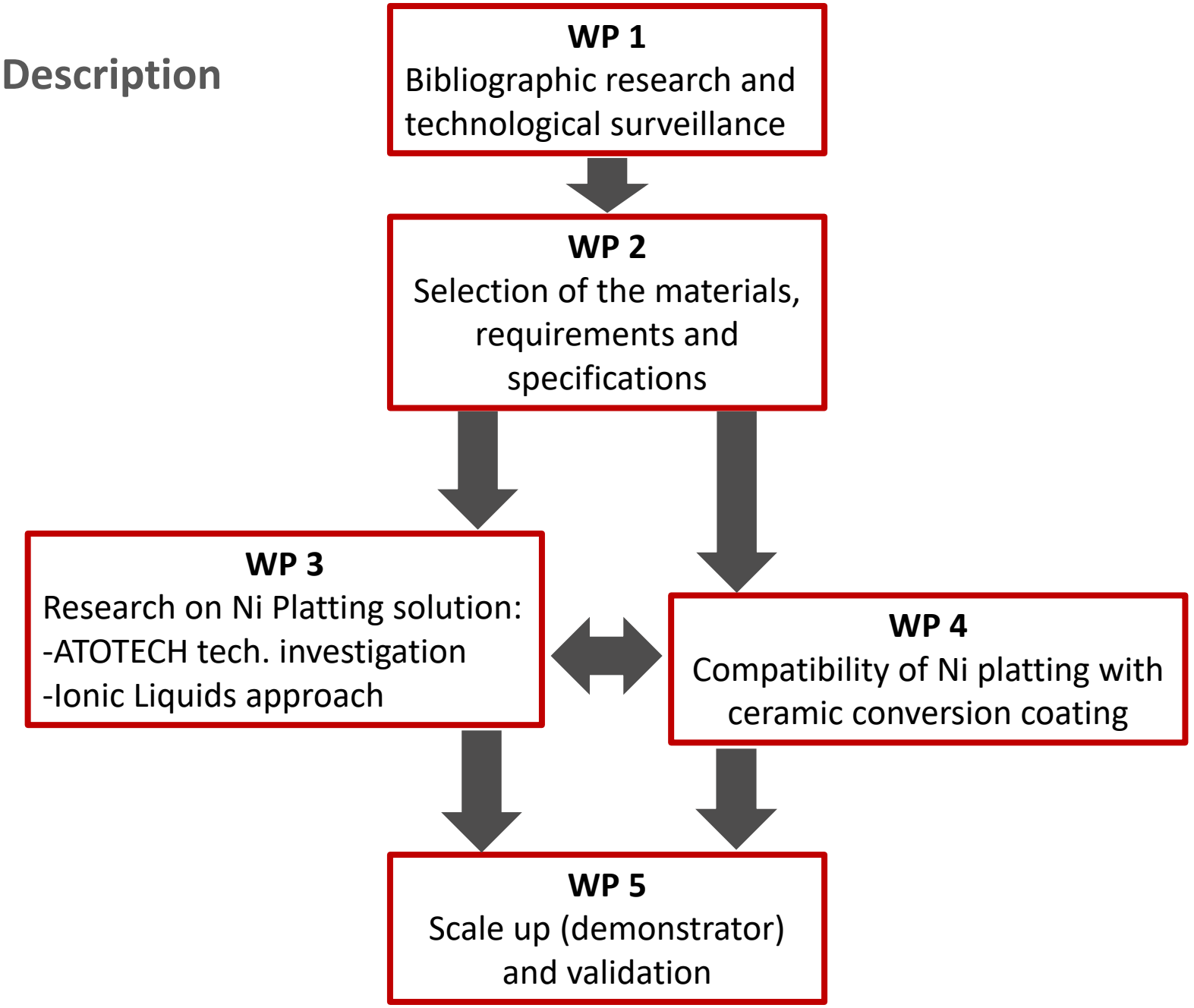
- Hydrogen embrittlement of high strength steel electroplated with zinc–cobalt alloys

E.M.K. Hillier, M.J. Robinson; School of Industrial & Manufacturing Science, Cranfield University, Building 39, Bedford MK43 0AL, UK (2003).

- Tritium/hydrogen barrier development

G.W. Hollenberg a, E.P. Simonen a, G. Kalinin b, A. Terlain c apacific Northwest Laboratory, Richland, WA 99352, USA bITER Team, Garehing, Germany °CEA, Saclay, France

2. Project Description



3. Participating entities

a) Spanish Consortium

A leading specialty chemicals technology company, delivering chemistry, equipment, service, and software to support diverse end-markets such as smartphones and other consumer electronics, communication infrastructure, and computing, as well as numerous industrial and consumer applications such as automotive, heavy machinery, and household appliances. Website: https://www.atotech.com/

ELHCO has the experience and the technical knowledge to perform a variety of surface finishing processes, with the highest quality standards. These processes are Electroless (Chemical) Nickel-Phosphorus, Electroless (Chemical) Nickel-Phosphorus-Teflon, Zinc-Nickel Plating, Electrolytic Nickel Plating, Gold-Cobalt Plating, Tin Plating, Silver Plating, Copper Plating, Anodizing, Chemical Conversion Coating on Aluminium and Passivation of Corrosion Resistant Steels. Website: https://elhco.com/en/

b) Spanish consortium role

Role 1: Formulator of electroless metallic coatings (Ni/P) of metallic parts.

Role 2: Applicator of electroless metallic coatings (Ni/P) for metal parts at industrial scale.

Leitat, founded in 1906, aims at Managing Technologies to create and transfer Social, Environmental, Economic and Industrial sustainable value for companies and entities through research and technology processes. Website: https://projects.leitat.org/ https://www.leitat.org/english/

3. Participating entities

a) Chinese consortium

PENDING

End User

- Hydrogen tanks manufacturer
- Hydrogen distributor
- Hydrogen producer

JITRI
JIANGSU INDUSTRIAL TECHNOLOGY RESEARCH INSTITUTE

Jiangsu Industrial Technology Research Institute (JITRI). It is a centre aimed at building a sustainable innovation ecosystem in Jiangsu Province, linking innovation resources from domestic and international academia to demand drivers in the manufacturing industry by establishing independent research institutes to act as engines of transformational research.
Website: http://en.jitri.org/

3. Participating entities

Chinese consortium role

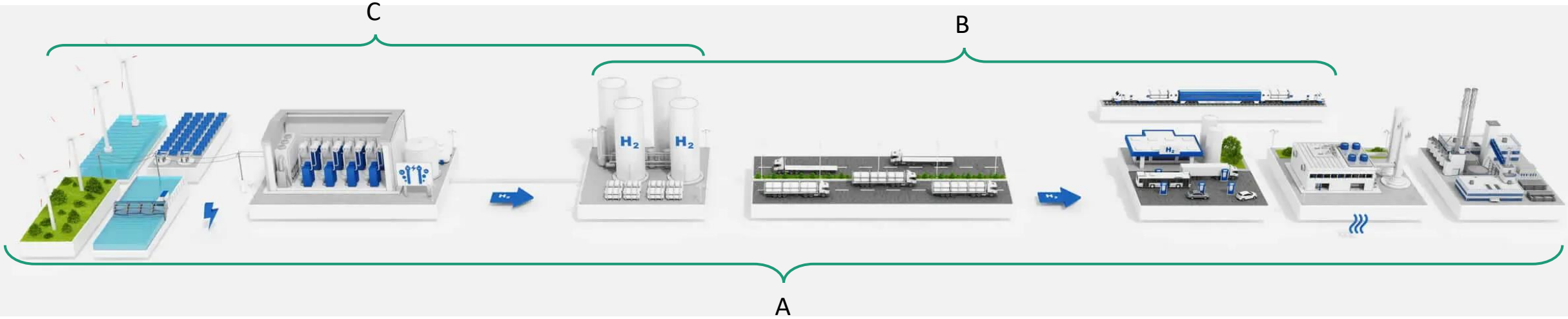
Validate the coatings researched by the Spanish consortium companies and LEITAT and collaborate in the research and development of these coatings.

The selected company should be interested in developing a new and improved tank concept for storing and transporting H_2 to improve capacity and safety.

Option A:
Tank manufacturer

Option B:
Hydrogen distributor

Option C:
Hydrogen producer



4. Call Conditions

Proposal Requirements

Industry-driven and market-oriented R&D project, joint technological co-operation projects between companies, research organizations, academia in China and industrial partners (start-ups, SMEs and large companies), in Spain consisting in the development or substantial improvement of new products, processes or services will be considered.

- Duration from 24 to 36 months.

a) Financial Conditions for Chinese Entities

Financing from the Key National Program of MOST

- Grant up to 3 Million RMB (340.000€).
- No minimum or maximum budget specified.
- No ratio between grant and total budget identified
- No country can have more than the 70% of the total budget.

MOST contact

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E-mail: fengc@most.cn
Website: https://service.most.gov.cn/

5. Submission process

a) Bilateral Call Chineka

Submission Steps

September 2021

Deadline International Phase:
- Application Form
- Consortium Agreement (draft)
- Gantt Chart

January 2022

Eligibility feed-back to applicants

March 2022

Deadline National Phase:
- CDTI – Spanish Partner
- MOST Chinese Partner
  - ✓Signed Consortium agreement

June 2022 –

Label Concession
- Project Signature
- Project Start

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