

Kyiv, 25 February 2021



Production and use of hydrogen in Ukraine



Recommendations for Ukraine on the Roadmap for production and use of hydrogen in Ukraine

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Role and importance of hydrogen



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- Hydrogen is a renewable and clean source of energy that supports circular economy
- Transition from traditional energy sources to hydrogen supports climate change initiatives
- Investments to hydrogen production, infrastructure and use may become a new booster of economy of Ukraine
 - supporting green post-COVID-19 recovery
 - increasing energy security and efficiency
 - creating new employment opportunities

Purpose of the study



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- This report provides an analysis and a set of recommendations for the Government of Ukraine (GoU) and specifically to the Ministry of Energy of Ukraine
 - Roadmap for production and use of hydrogen in Ukraine
 - Roadmap for the use of hydrogen in Ukraine in road transport
- The report is prepared with the support of the United Nations Economic Commission for Europe (UNECE), as part of its Regular Programme on Technical Cooperation (RPTC)

Scope of the study

production and use of hydrogen in Ukraine



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- Analysis of best international practices and plans for the use of hydrogen
- Analysis of the importance of hydrogen technologies and the potential for their use in Ukraine
 - Use of hydrogen in the energy sector
 - Use of hydrogen in the transport sector
 - Use of hydrogen in the industry sector
 - Use of hydrogen in the natural gas industry
- Analysis of hydrogen production methods and their cost-effectiveness
 - Mass production of hydrogen from natural gas using steam methane reforming (SMR) technology
 - Hydrogen production by electrolysis
 - Other technological options for hydrogen production
 - Economic analysis of various hydrogen production methods

Scope of the study

production and use of hydrogen in Ukraine (continued)



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- Analysis of existing and required infrastructure for hydrogen storage and transportation for domestic use and export opportunities
- Analysis of potential for and experience of manufacturing equipment to produce hydrogen domestically
- Development of a roadmap for the introduction of hydrogen technologies
 - **Actions and measures at the national level**
 - Legislation
 - Institutional arrangements
 - Economic incentives
 - Research and development (R&D)
 - Public awareness
 - Role of Ukraine in development of a regional hydrogen economy

Scope of the study

use of hydrogen in Ukraine in road transport



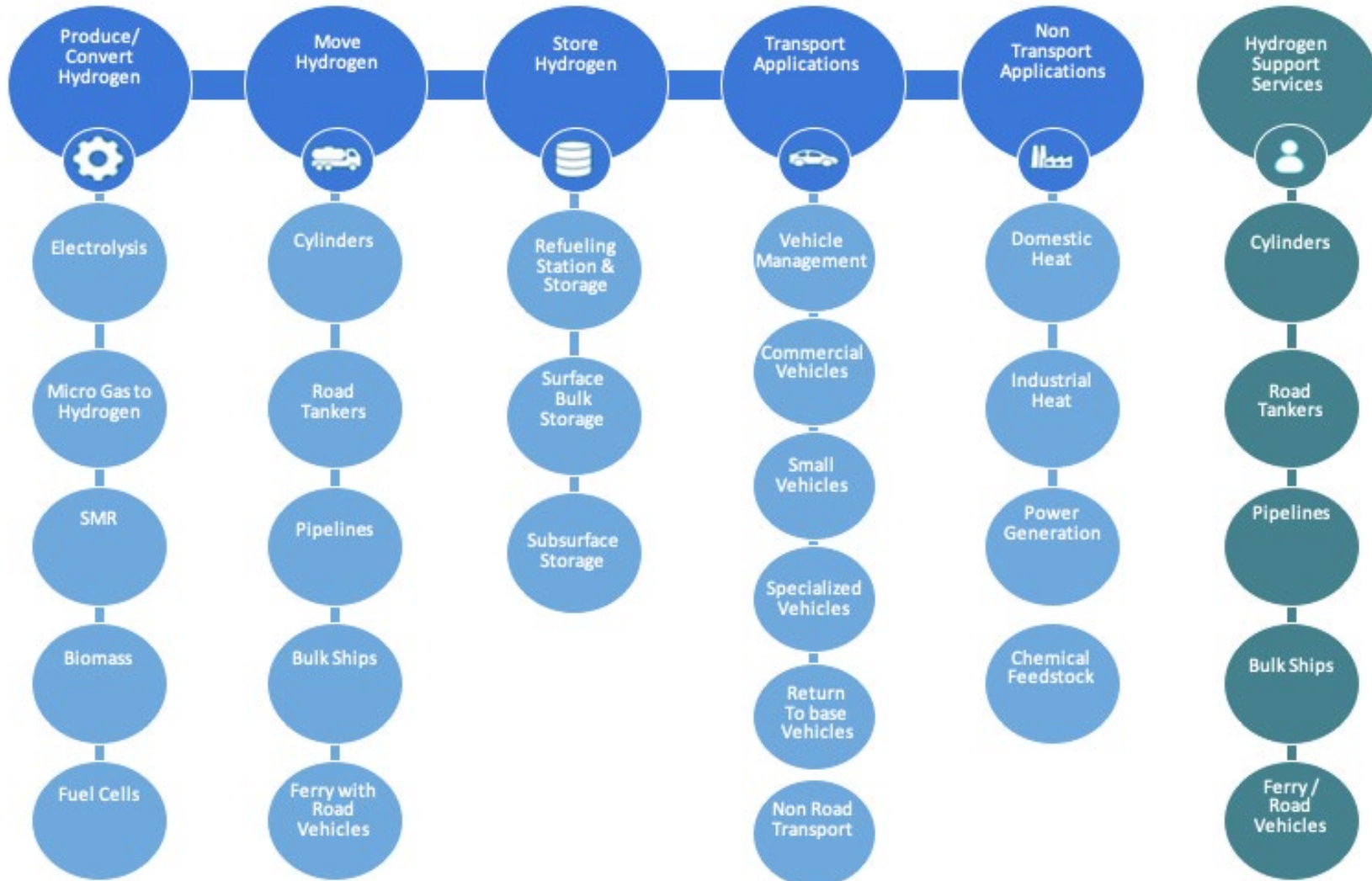
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- Ukraine stakeholder mapping and identification of stakeholders relevant for the use of hydrogen in road transport and their role, type and priority of engagement
- International best practices and existing hydrogen initiatives and projects in road transport, with a focus on urban transport
- Legal and regulatory framework pertinent to the use of hydrogen in road transport in Ukraine
- Economic and financial considerations pertinent to the use of hydrogen in road transport, particularly urban transport
- Recommendations on the use of hydrogen in Ukraine in road transport

Hydrogen supply chain



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4 Pillars

for introduction of hydrogen technologies in Ukraine



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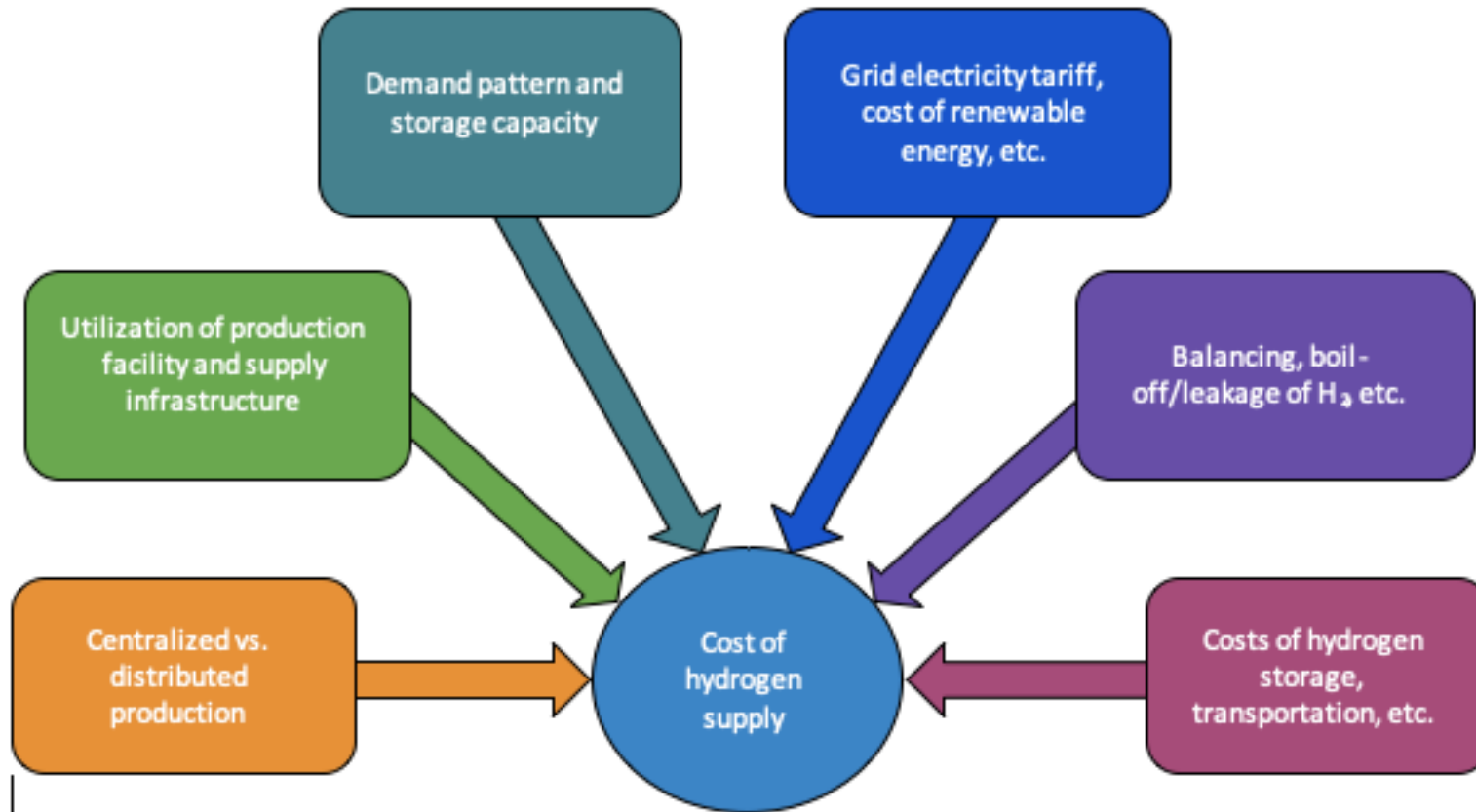
- Transformation of electric power supply and heating systems
 - Electricity sector
 - Residential and non-residential heating
- Transformation of industrial process heat
- Transformation of transport sector
- National gas pipelines system and scaling-up of hydrogen manufacturing, storage and transportation

Economic feasibility of hydrogen

key factors for evaluation



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3 Phases

of transformation



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- Assessment of the Ukrainian economy for “green transition” and launch of the hydrogen economy
- Policies prioritization, hydrogen market and supply chain development and demonstration, scale-up
- Put together a Smart Portfolio of Policies and Strategic hydrogen projects development, regulatory reform, technological development

First phase
(2021-2023)

Second phase
(2024-2026)

Third phase
(2027-2029)

4 Groups of Measures



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- For each of the 3 Phases the proposed measures are split into the following 4 Groups:
 - LEGISLATIVE MEASURES
 - ECONOMIC MEASURES
 - SUPPORT FOR R&D
 - PUBLIC AWARENESS

Key recommendations

HYDROGEN PRODUCTION



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- Research, development, and demonstrations are needed to improve and expand methods of economically producing hydrogen
- Enact policies that foster both technology and market development
- Develop and demonstrate small hydrogen plant based on renewable energy sources with electrolyzer
- Develop advanced nuclear energy methods to produce hydrogen
- Develop methods for large-scale carbon dioxide capture and sequestration

Key recommendations

HYDROGEN DELIVERY



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- Develop a demonstration rollout plan
- Develop a consensus view on total costs of delivery alternatives
- Increase research and development on delivery systems

Key recommendations

HYDROGEN STORAGE



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- Develop a coordinated national programme to advance hydrogen storage materials
- Initiate a programme to support development of high-risk technologies
- Develop a mass production process for hydrogen storage media

Key recommendations

FUEL CELLS



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- Enhance manufacturing capabilities for fuel cells
- Collect more and better information on operating performance at existing demonstration sites

Key recommendations

APPLICATIONS



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- Conduct research and development to address critical challenges to a hydrogen economy
- For the near term, research is needed to address such issues as durability, cost of the fuel cell stack, system integration, system architecture

Key recommendations

EDUCATION AND PUBLIC AWARENESS



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- Establish regional, state, and local networks
- Create a broad coalition to influence Ukrainian energy policy on hydrogen
- Develop a comprehensive public education and outreach programme
- Create a public demonstration hydrogen village
- Commit resources for long-term education of students at all levels

Key advice

to all stakeholders



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- Define clear, long-term, and realistic approaches for reducing carbon emissions in all industry sectors
- Stimulate private investments in hydrogen and fuel cell technologies
 - Acceptance is crucial for any new technology to penetrate the market
 - Most hydrogen related technologies still require more research and product development



Use of hydrogen in Ukraine in road transport



Road transport related input to the Roadmap for production and use of hydrogen in Ukraine

**photograph credit: IRU*

Hydrogen in transport



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- The renewable fuels (in particular H₂) can significantly reduce air pollution and noise emissions produced by public transport
- H₂ buses and refuelling stations are emerging across EU and other countries with essential support from the state and private sector
- H₂ spread is not limited only to road public transport, but also to trains and ships
- There are plenty of projects across EU with proven efficiency, sustainability and positive impact to communities

Stakeholder mapping

H2 road transport



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- The hydrogen supply chain was used to identify stakeholder in H2 transport area
- The production, transportation, storage, transport use and H2 support were considered as key elements
- The following stakeholders were identified as most important for introduction of H2 transport

Stakeholder mapping

H2 road transport



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Name of institution	Type of engagement
Ministry of Energy of Ukraine	<ul style="list-style-type: none">- leading the process production and use of hydrogen in Ukraine- develop a Ukrainian strategy for hydrogen- establishing policies for production of hydrogen in Ukraine
Ministry of Infrastructure of Ukraine	<ul style="list-style-type: none">- create implementation principles and regulation for use of hydrogen in air, railway transport and maritime sector
State Agency on Energy Efficiency and Energy Saving	<ul style="list-style-type: none">- support with alternative fuels policies
State Service of Ukraine on Food Safety and Consumer Protection	<ul style="list-style-type: none">- create implementation principles and regulation for use of hydrogen in agriculture and special purpose vehicles
Ministry of Interior of Ukraine	<ul style="list-style-type: none">- create implementation principles and regulation for use of hydrogen in road transport
Committee on energy, housing and utilities services of the Verkhovna Rada (Parliament of Ukraine)	<ul style="list-style-type: none">- development of primary legislation- high level public support of hydrogen use

Stakeholder mapping

H2 road transport (continued)



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Name of institution	Type of engagement
Development agencies and international finance organizations	<ul style="list-style-type: none">- support with technical assistance- financing of pilot hydrogen projects
Scientific and research institutions	<ul style="list-style-type: none">- research and development, adaptation and localization of hydrogen technology- stimulate the development of studies of hydrogen use and technician and technical training programmes
Non-governmental institutions	<ul style="list-style-type: none">- encouraging partnering and collaboration between GoU, private sector and other stakeholders- stimulate new hydrogen-based start-ups, entrepreneurial activity- facilitate the arrangement of regional events and conferences on use of hydrogen
Private sector	<ul style="list-style-type: none">- create and deliver tangible hydrogen projects (productions, use and infrastructure)
Cities and communities	<ul style="list-style-type: none">- create and stimulate hydrogen transport projects in the regions- support with financing of hydrogen transport projects by local budgets

Economic considerations

H2 road transport



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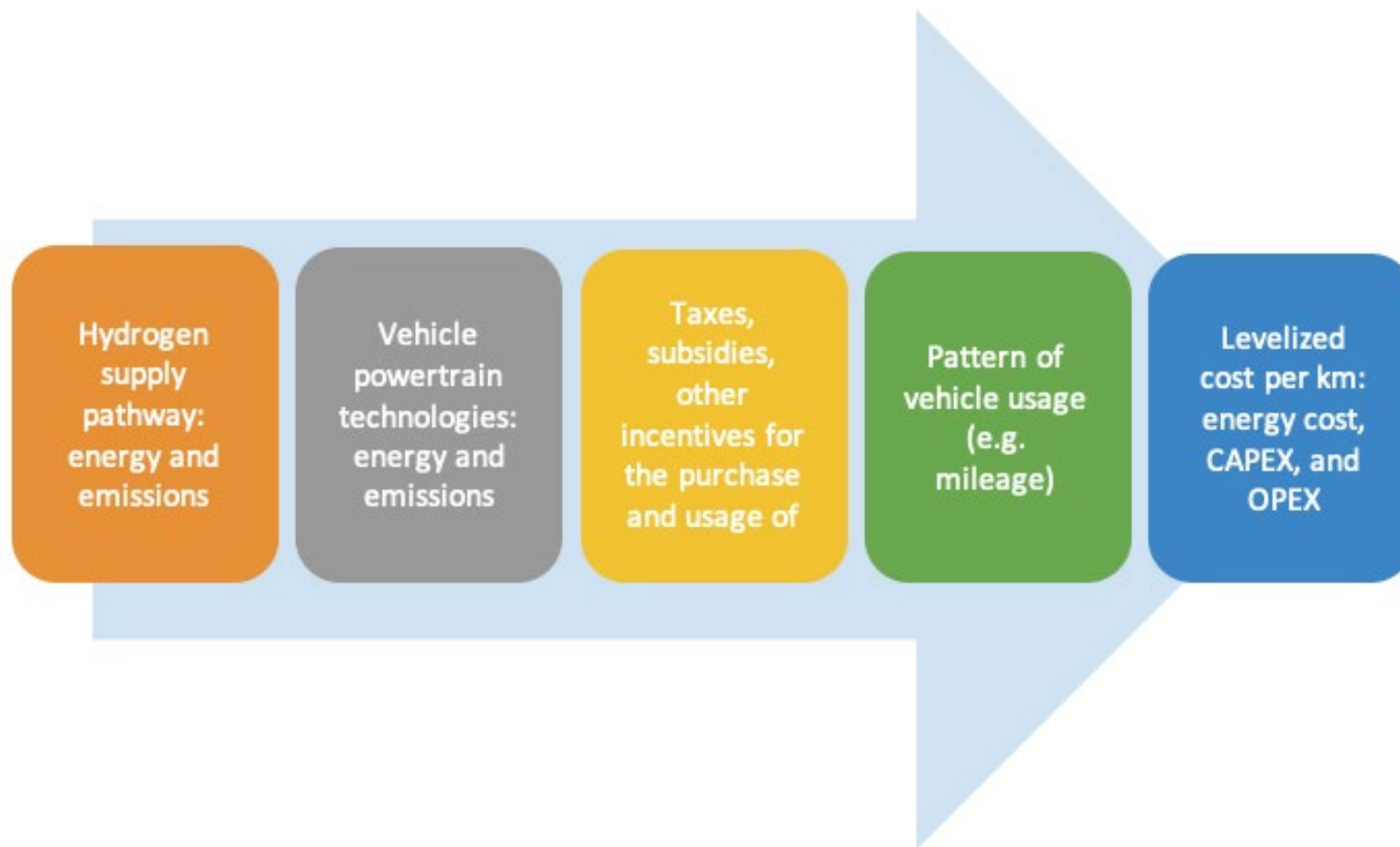
- H2 investment is a new booster rocket for the economy (energy and adjacent sectors)
- Key elements to consider:
 - Capital expenditures (vehicles and essential infrastructure cost)
 - Operational expenditures (mostly H2 price)
- Zero emission impact to be additionally addressed
- The UK and China experience shows competitiveness of H2 road transport, however due to generous subsidies and incentives
- Costs will continue decreasing due to scale of bus fleets and further development of hydrogen technologies

Economic feasibility of hydrogen

TCO evaluation for transport



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Recommendations

H2 road transport



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1. Cooperation with international community

- Ukraine should intensify real cooperation with its international partners
- The strategies and road maps of EU countries to become a basis for concept (strategy) on development of hydrogen economy in Ukraine
- Ukraine to become reliable partner for EU countries implementing H2 framework

Recommendations

H2 road transport



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2. *Strategy and local policies development*

- The GoU to develop appropriate, effective and efficient policy framework to support hydrogen development
- The framework may include concept, strategy, road map, local policies (including sectoral policies) etc.
- Ukraine must use unified and common terminology to speak one language with its international partners
- Ministry of Energy may become a leader for stakeholders 's coordination and new policies drafting
- The Ministry of Infrastructure to take proactive role in H2 transport

Recommendations

H2 road transport



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3. Stimulate hydrogen market via pilot projects and other incentives

- Ukraine needs to replicate successful H2 pilot projects in transport area
- H2 transport manufactures, infrastructure providers, EU hydrogen transport initiatives to be involved into Ukrainian projects
- Cooperation with local Ukrainian municipalities is highly advisable to implement H2 road public transport

Recommendations

H2 road transport



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4. *Improve access to hydrogen*

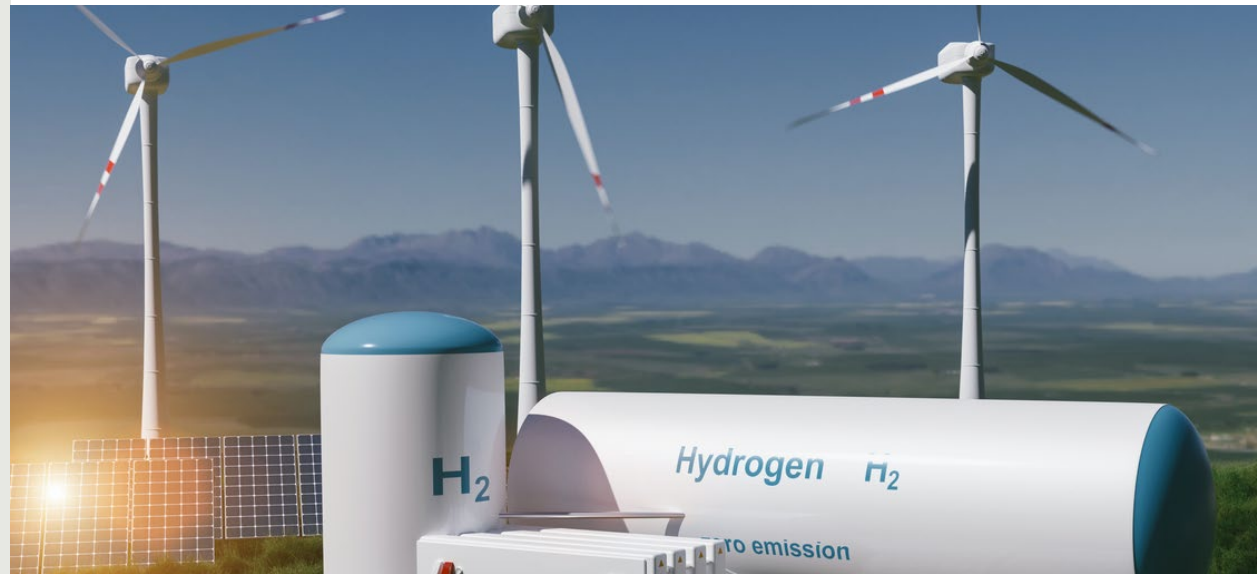
- Access to affordable financing is a key
- The government of Ukraine to cooperate with international financial institutions and investors for H2 projects implementation (via grants, development facilities and loans)
- Complementary policies and incentives to be developed to support H2 projects

Thank you

Stanislav Dubko



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