

International Institute for Carbon-Neutral Energy Research



Hydrogen Storage Revised Roadmap (Revised version (tentative))

May 2017



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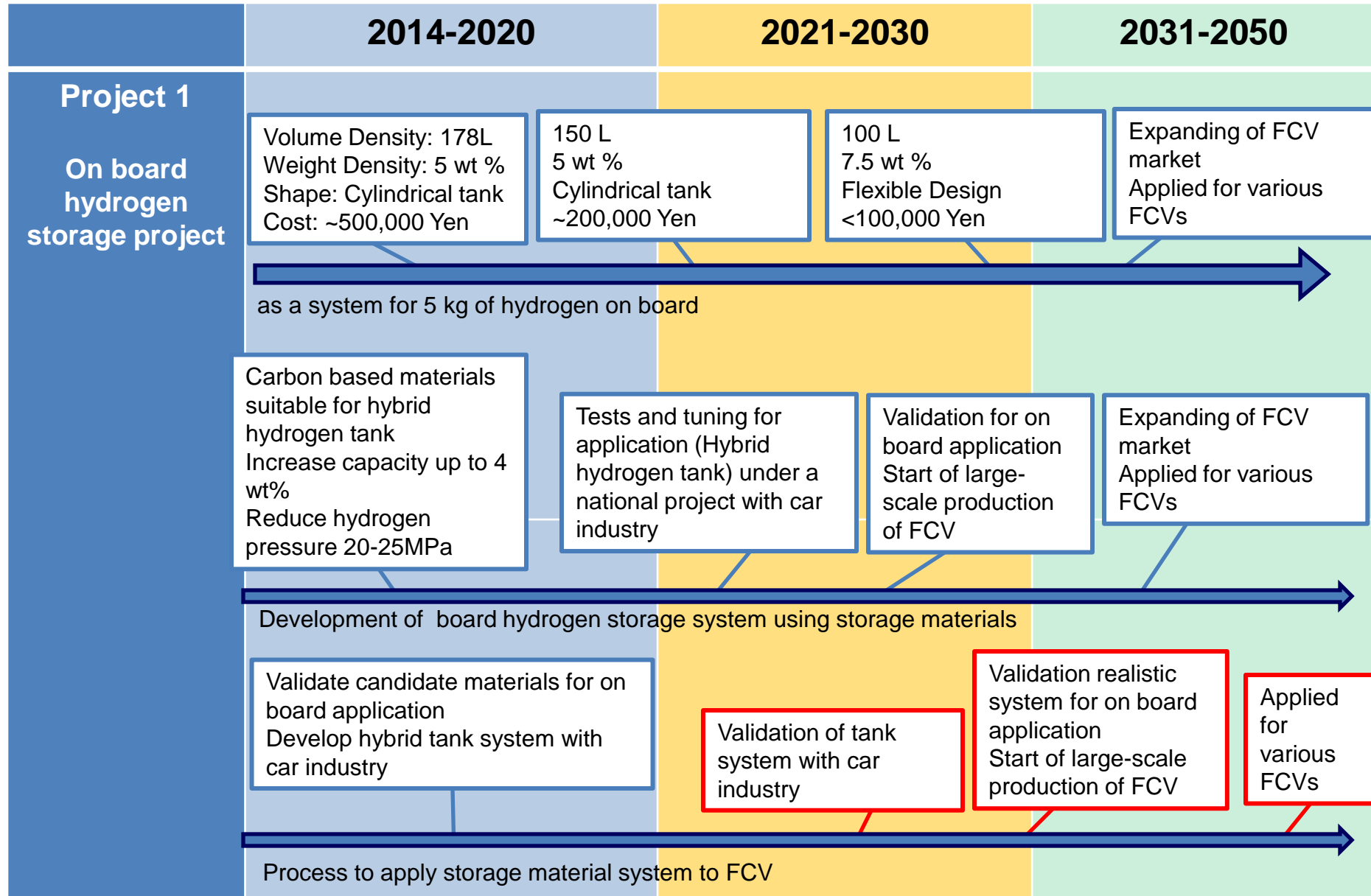
Division Objectives

- Research and develop new carrier materials for hydrogen mobile and stationary storage as well as for hydrogen delivery.
- For mobile storage the material based storage system must meet the needs of hydrogen fuel cell vehicles (HFCV) in terms of volume, weight percent hydrogen, cost, flexibility in tank design, fast charging and discharging, and durability with high well to wheel energy efficiency. Other mobile applications may have similar needs.
- Material based stationary hydrogen storage applications must be more safe, **compact**, cost effective and energy efficient than conventional pressurized gaseous hydrogen storage or uniquely meet particular requirements of specific stationary applications **especially those require free from legal restrictions.**

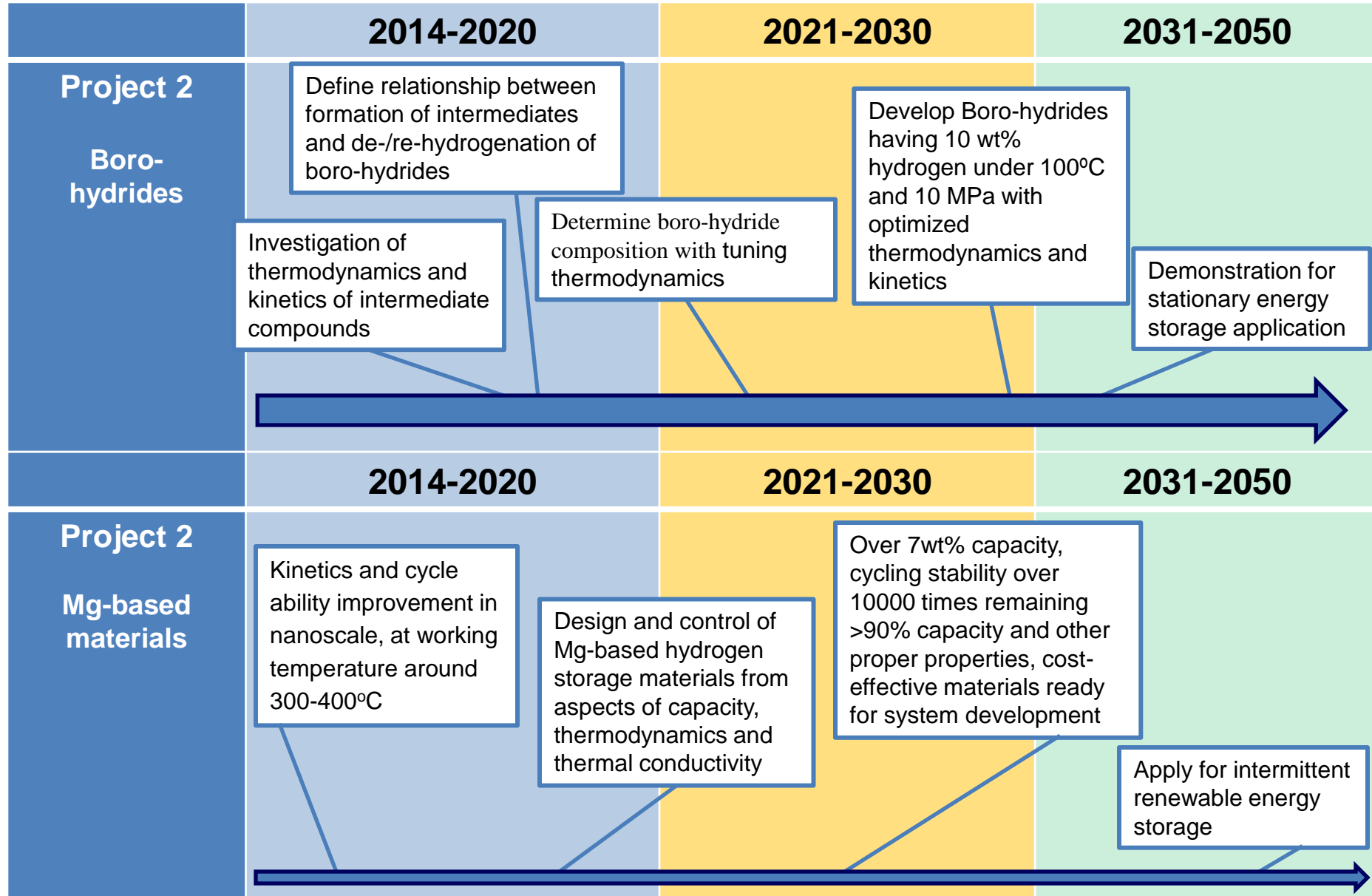
Division Projects, Objectives, Research Efforts

Projects	Objective	Research Efforts	Expected application	Researchers
Project 1 On board hydrogen storage project	Development of light-weight hydrogen storage materials and tank system for on board (FCV) application	Validation of candidate materials such as carbon based materials and fabrication of tank system with car industry	FCV/NEDO	E. Akiba, H. W. Li, H. Shao (+ pos-doc, students)
Project 2 Stationary hydrogen storage using borohydrides / Mg-based materials	Fundamental research of light-weight hydrogen storage materials	Fundamental research on intermediates of decomposition reaction of borohydride and development of novel Mg-based materials	H2 stationary storage, H2 for energy storage	H. W. Li, H. Shao, E. Akiba (+students)
Project 3 Project for application of HPT	Development of materials for mobile and stationary applications using HPT technique	Improvement of hydrogen storage behavior of metallic hydrides for accommodation of fluctuating H2 production from renewable energy	H2 on board application, H2 stationary storage, H2 for energy storage	Z. Horita, K. Edalati, H. Emami, J. Matsuda (+students)

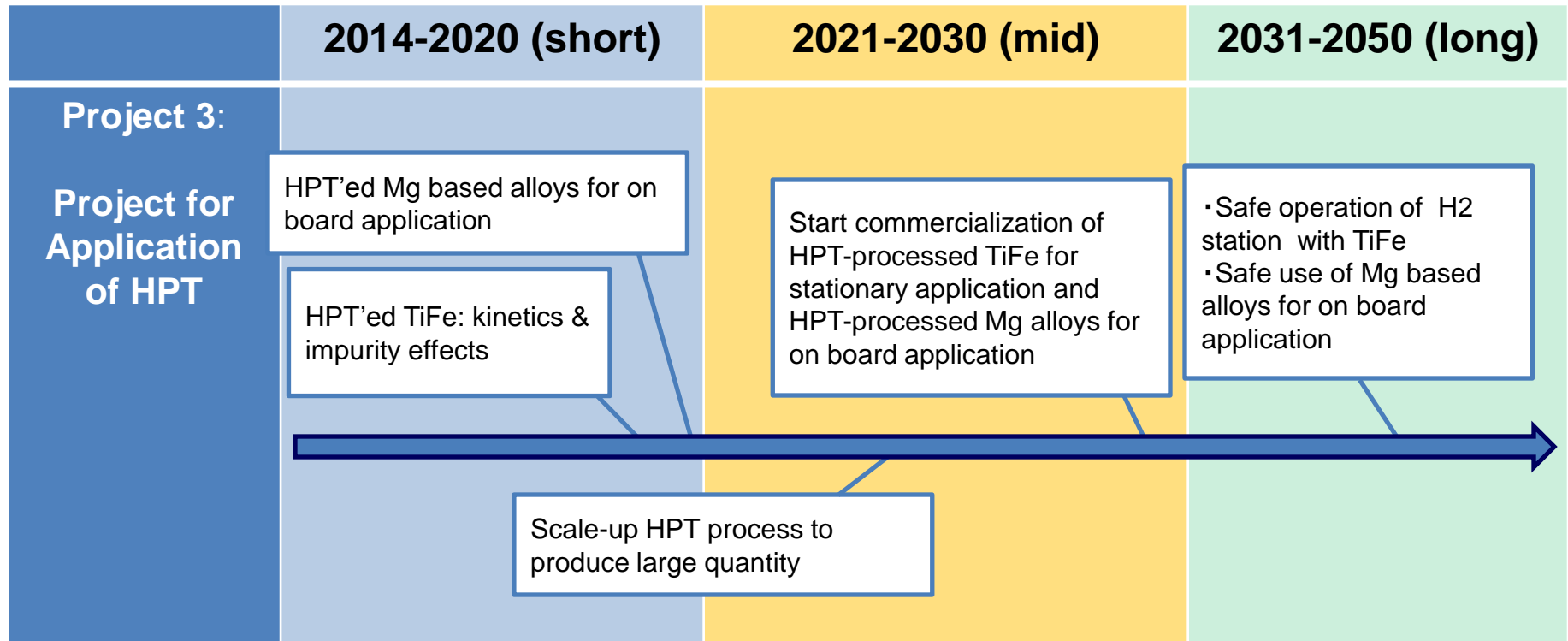
On board hydrogen storage project



Stationary hydrogen storage using boro-hydrides / Mg-based materials



Project for Application of HPT



Ultimate targets

Current Benchmarks

	Ultimate targets	Current Benchmarks
<p>Project 1</p> <p>On board hydrogen storage project</p>	<ul style="list-style-type: none"> • 100 L • 7.5 wt % • Flexible Design • <100,000 Yen as a system for 5 kg of hydrogen on board 	<ul style="list-style-type: none"> • Using Ti-based BCC alloy developed by Akiba@AIST and Iba@Toyota, TOYOTA developed hybrid tank technology (2.2 wt% under 20-25 MPa as system and 2.8 wt% at RT under 20-25 MPa as material)
<p>Project 2</p> <p>Stationary hydrogen storage using boro-hydrides / Mg-based materials</p>	<ul style="list-style-type: none"> • Borohydrides: as materials 10 wt% H₂ uptake at 100°C under 10 MPa • Mg-based materials with > 7 wt% capacity, cycle ability over 10000 times remaining >90% capacity, cost-effective for intermittent renewable energy storage • Competitive cost 	<ul style="list-style-type: none"> • LiBH₄ combined with MgH₂ with addition of TiCl₃ developed by J. Vajo @ HRL Laboratories (USA) (10 wt% @ 400°C under 10 MPa) • McPhy Energy Company developed Mg-based materials with ca. 5 wt% capacity, absorption in 5 min, no significant capacity loss within 4000 cycles. • TOSHIBA developed H2One™ using metal hydride without legal restrictions and proved the system is cost effective.
<p>Project 3</p> <p>Project for application of HPT</p>	<ul style="list-style-type: none"> • Start commercialization of HPT-processed TiFe for stationary application to accommodate fluctuating H₂ production from renewable energy • Safe use of Mg based alloys for on board application 	<ul style="list-style-type: none"> • TiFe activated by HPT processing at room temperature in air and it is not deactivated even after exposure to air. (hydrogen content 1.7wt%) , developed by Edalati, Matsuda, Iwaoka, Toh, Akiba and Horita in hydrogen storage group.