

## Summary of Proposal

Host institution name	Kyushu University
Head of host institution	Setsuo Arikawa (President, Kyushu University)
Center director	Petros Sofronis
Administrative director	Takaaki Kurasaki
Title of center project	Carbon-Neutral Energy Research Institute: The Grand Highway for a Carbon-Neutral Energy Fueled World
Center name	International Institute for Carbon-Neutral Energy Research, Kyushu University
Project Summary	To provide sufficient energy for future generation requires a holistic approach to energy production, storage and usage that utilizes renewable resources, is sustainable and leaves no carbon footprint. Success requires rapid technological breakthroughs of unprecedented magnitude in numerous disciplines. The proposed Carbon-Neutral Energy Research Institute based on hydrogen seeks to determine the fundamental nature of these barriers and to discover solutions to overcoming them. Challenges facing implementation include production of sufficient quantities of hydrogen, delivery and storage of the hydrogen and capture and sequestration of any CO <sub>2</sub> generated during the production process. The Institute at Kyushu University along with the satellite institute at the University of Illinois will provide the facilities and environment needed to foster the inter- and multi-disciplinary research between national and international scientists. The leadership and management system of this Institute constitutes a paradigm shift for Japanese research centers that will transform our research enterprise.
Research fields	<u>Research field:</u> Multi/Inter-disciplinary research that involves chemistry, physics, materials science, mechanics, geo-science, oceanic science, and biomimetics <u>Significance of the proposed project:</u> The impact of global warming, the rising cost of fossil fuels as well as the anticipated decline in supply provide societal, economic and technology driving forces for developing an alternate energy source or carrier. Hydrogen gas is a potential energy carrier that could address these issues provided that technologies are developed for producing a sufficient hydrogen supply that utilizes an energy source that either does not involve generation of CO <sub>2</sub> (e.g., solar or nuclear) or includes strategies for capturing and sequestering in the ocean or geologically or converting the CO <sub>2</sub> to a more useful form.  The importance of the proposed Institute is that it will help to develop science-driven technological solutions to enable the realization of a hydrogen-based energy economy (society) that is sustainable and environmentally friendly. The research agenda of the Institute addresses specifically the scientific barriers/challenges for efficient and low cost hydrogen production; hydrogen storage; design of hydrogen tolerant materials; efficient and reliable fuel cells; material conversion; and carbon capture, ocean sequestration and geological sequestration as well as energy-efficient conversion to more useful forms.
Research objectives	The overarching objective of the Institute is to establish the fundamental science underlying the technology of innovative, safe, and reliable systems for the production, storage and utilization of hydrogen, as well as for separation of CO <sub>2</sub> , carbon oceanic and geological sequestration and conversion to more usable forms. To reach this objective requires establishing a fundamental-science understanding at the atomic level of such phenomena as adsorption, absorption, dissolution, diffusion, reaction

	<p>characterizing interaction of hydrogen and CO<sub>2</sub> and materials in the framework of multi-phase fluid and solid systems. The research objectives toward a carbon-neutral energy fuelled society are summarized as follows:</p> <ul style="list-style-type: none"> <li>• Development of innovative and sustainable hydrogen production processes such as photocatalytic water splitting.</li> <li>• Development of hydrogen-embrittlement resistant structural materials for the design of a safe and reliable hydrogen infrastructure.</li> <li>• Development of next generation fuel cells through novel materials and devices.</li> <li>• Development of novel hydrogen storage materials with a storage capacity larger than 6wt% H<sub>2</sub>.</li> <li>• Development of high efficiency waste-free material transformation processes.</li> <li>• Development of low-energy carbon separation and concentration processes</li> <li>• To inform and educate the public about the scientific benefits of CO<sub>2</sub> sequestration technologies and of transitioning to a carbon-neutral energy fuelled economy (society).</li> </ul>
Outline of management	<p>The research culture and management style of the Institute are intended to be a model for restructuring the Kyushu University on the basis of the Director's academic experience in the US and the general input from prestigious international research universities and laboratories.</p> <p>The Institute is established as an organization directly under the president of the Kyushu University. The structure of the organization is such that the Institute Director has the authority to make decisions regarding the planning and operation of the research activities, the formation and composition of the research program areas, and the budget implementation related to the management of the Institute. On all these matters the director consults the <u>Steering Committee</u> that is headed by the director and its members (science advisors) are the program area leaders of the Institute.</p> <p>A vital component of the Institute is the <u>External Advisory Committee</u> which is composed of national and international leaders in the field. This Committee reviews all aspects of the Institute annually, including the leadership and management, the research progress being made in each program area, and the plans for any initiatives.</p> <p>The Director is assisted by the <u>Associate Director</u> for the management of the Institute' research activities. The Office of the Director is supported by the <u>Administrative Director</u>, head of the office of the Institute's <u>Management Department</u> whose purpose is to provide administrative support to the research personnel of the Institute. The official language of the Institute's Management Department is English.</p> <p>The Director of the Institute, Professor P. Sofronis, is a faculty member at the University of Illinois at Urbana-Champaign. A satellite office will be established at Illinois to serve as the hub for collaborations in the US and to strengthen international research activities.</p>
Researchers and other center staffs	<p>We plan to have 30 Principal Investigators (11 researchers from overseas), 130 researchers (54 researchers from overseas), and a total of 204 research scientists by the end of 2013.</p> <p>Main Principal Investigators: P. Sofronis, Y. Murakami, T. Katsuki, Y. Naruta, T. Ishihara, C. Adachi, A. Takahara, S. Ogoh, K. Kusakabe, Z. Horita, N. Nakashima, Kazunari Sasaki, E. Akiba, M. Okada, T. Yanagi, B.P.Somerday, L. Schlapbach, R. Ritchie, H. L. Tuller, L. J. Gauckler, J. A. Kilner, P. Chen, C. A. Chen.</p> <p>Partnering institutions for collaborative research are: Tohoku University (JPN), University of Tokyo (JPN), National Institute of Advanced Industrial Science and Technology (JPN), University of Illinois (USA), University of California, Berkeley (USA), Massachusetts Institute of Technology (USA), Sandia National Laboratories (USA), Imperial College of London (UK), Swiss Federal Institute of Technology Zurich (SUI), Tsinghua University (China), and Dalian Institute of Chemical Physics (China).</p>

<p>Outline of research environment</p>	<p>To drive the research mission and to ensure each program area has the needed expertise, the Director along with the Principal Investigators will invite periodically scientists and engineers from around the world to submit a white paper addressing how they could contribute to critical mission issues. The Director may seek input from the members of the External Advisory Committee as to the merits and value of these white papers to the overall mission of the Institute. This approach will ensure that the research environment remains dynamic and staffed with scientists and engineers that have the needed expertise.</p> <p>The Director will organize a program review meeting on an annual basis and, in addition to the members of the External Advisory Committee, will invite leading scientists and engineers in each of the thematic areas to review the entire program, including the leadership and management of the overall Institute. The Principal Investigators of each funded program will present the achievements of their program, describe synergistic activities with other members of the Institute and with partnering institutions, and conclude with planned future activities. The program review committee will provide a written evaluation of the achievements and future plans of each effort. The Director, in consultation with the External Advisory Committee and Steering Committee, will use these evaluations to determine future funding for each program and theme. The Institute will organize international conferences, symposia, and specialized workshops to engage the scientific community from academia, industry, and national laboratories and to inform the society on the benefits of a carbon-neutral energy fueled world.</p> <p>To facilitate research at the Institute, the Kyushu University will build a new facility with equipment for cutting edge research</p>
<p>Outline of indicators for evaluating the Institute's global standing</p>	<p>The Institute's visibility and global standing will be measured by i) the quality and impact of the Journal publications, especially joint publications; ii) invited, keynote, and plenary lectures at international conferences; iv) symposia organization in international conferences by Institute researchers; v) trend setting workshops and symposia that attract participation of national agencies such as MEXT, JSPS, US NSF, US DOE, European Commission; vi) participation of the Institute's researchers in international conferences; vii) invitations to the Institute's researchers for participation in government panels and national laboratory efforts; viii) patents and technology accomplishments.</p> <p>Lastly, an indicator of the Institute's international outreach will be the number of international visitors and international researchers in residence at Kyushu for an extended period of time.</p>
<p>Securing research funding</p>	<p>Amount of the research funding won by the main Principal Investigators over the past five years is over 21.5M dollars per annum on average. Similar level of funding is expected for the coming years.</p>
<p>Summary of host institution's commitment</p>	<p>The university's strategic vision is summarized in: "position the university as a center of global research and education" and "promote the development of new academic fields by pursuing multi/inter-disciplinary research through fostering an academic environment that attracts excellent researchers." In this framework, the Kyushu University will embrace and support the Institute with all its resources. More specifically, the Kyushu University will enthusiastically: i) assist to establish the Institute's administrative structure for research and budget implementation; ii) work with departmental units to accommodate participating researchers in the Institute; iii) revise the internal system so that English is the language for international affairs, and iv) re-examine the personnel compensation system.</p>