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Mr. Chairman, Thank you for inviting me to testify. My name is Robert Harriss and I am president of the Houston Advanced Research Center (HARC), a nonprofit organization dedicated to moving knowledge to action to improve human well-being and the environment at the regional scale. As an institution, HARC does not take positions nor engage in advocacy, so the opinions expressed here are my own.

For the record, I have been involved with energy, environment, and related sustainability issues as researcher, educator, and science administrator serving universities, NSF, NASA, the National Center for Atmospheric Research, and the Houston Advanced Research Center for the past 43 years of my professional career.

My testimony today draws heavily on the work of the Board on Sustainability and Sustainability Roundtable at the National Academy of Sciences/National Research Council. The National Academy Press publication titled *"Our Common Journey: A Transition Toward Sustainability"*, published in 1999, provided a new foundation for thinking about pathways to more sustainable futures. The continuing leadership of Robert W. Kates, recipient of the National Medal of Science, William C. Clarke of Harvard University, William Merrell at Texas A&M-Galveston, and many others, continues to reveal and refine new insights and pathways for advancing the well-being of both our nation and the global environment.

THE URBAN AGE

The Greater Houston and Upper Texas Coast region, our nation, and Planet Earth are nearing critical tipping points that will result in declining economic prosperity, dramatic environmental degradation, and other serious threats to human well-being. Prospects for today's children, and especially our region's vulnerable populations, hinge upon more aggressive and effective leadership in advancing the science, engineering, and policies necessary to achieving more sustainable futures.

The United States has demonstrated an extraordinarily successful capacity for discovery and innovation in developing new technologies, innovation processes, and public policies that serve commercial and national security purposes. In little more than a century our nation has moved from an agricultural, to an industrial, to an urban age. Remarkably, today our top 100 metropolitan areas take up only 12 percent of the land in the United States, but account for 68 percent of our population and 75 percent of the U.S. Gross

Domestic Product. The urbanization of America and other advanced nations, combined with the increasing role of cyberspace as the primary infrastructure stimulating economic globalization, positions cities as the primary platforms for addressing the major challenges facing the world today.

Cities are essential sources of opportunities for social advancement and the creation of wealth, globalization, and creativity. But many cities are also dysfunctional both environmentally and socially. They are large consumers of resources, reservoirs of poverty, and concentrated sources of pollution. The Houston metro area reflects the complexity, opportunities, and challenges that we face in the urban age.

URBAN SUSTAINABILITY: AN *EMERGING FIELD* OF "USE-INSPIRED" RESEARCH, EDUCATION, AND INNOVATION

Sustainability science is a new paradigm that aspires to integrate research and knowledge from the natural, social, medical, engineering, and policy sciences and to inform decision making and stimulate innovation. It is defined by the practical problems it addresses, specifically the problems of sustainable development. It is focused on scientific understanding of strongly interacting human and environmental systems. Sustainability science is generally place-based; at metropolitan and regional scales where complexity is comprehensible and integration is possible, innovation and management happen, and local culture is understood.

Present systems for governing and implementing R&D encourage good research that is anchored in single (or closely related) disciplines and is either fundamental (e.g., university R&D) or specific to commercial products (e.g., industrial R&D). The essence of sustainability science, engineering, and policy is synthesis and integration of knowledge and treating policies and projects as opportunities to learn. Relative to conventional science less emphasis is needed on elite researchers making discoveries and more on connecting diverse stakeholders in a sustained collaborative dialogue on an important shared problem. The outcome of a sustainability process and project is to increase stakeholder options and make choices among them. HARC is committed to the goal of being an effective, trusted bridging organization dedicated to solving sustainability issues in the Greater Houston and Upper Texas Coast region.

THE NEED FOR A NATIONAL NETWORK OF URBAN SUSTAINABILITY CENTERS

America has several times solved complex issues through the implementation of a distributed network of centers that could facilitate a knowledge dialogue aimed at use-inspired research and education. The development of industrial age agriculture benefited from the Land Grant College program. NASA's network of regional research and engineering centers has been successful at integrating university and private sector researchers into national space technology R&D programs. There is an urgent need to provide an institutional framework appropriate to solving the many sustainability issues facing the major metropolitan regions of this nation. Regional urban sustainability centers

would catalyze, facilitate, and support the integration process necessary to creating use-inspired solutions to the grand challenges facing American cities—shaping the transition to a renewable energy future, adaptation to climate change, sustaining biodiversity and ecosystems services, reducing vulnerabilities to pollution and natural disasters, etc.

A TRANSITION TOWARDS SUSTAINABLE ENERGY SERVICES

Long-term sustainable development must be based on clean, affordable, and renewable energy services. Today's most critical sustainability issues like global climate change, energy security, and urban air quality can be directly connected to energy systems. Current efforts to design a transition towards future sustainable energy services will fail because many of the objectives related to public goods (e.g., national security) and externalities (e.g., air pollution) that are not currently priced in markets. A fundamental transition in energy systems would also be subject to "market failures" derived from abuse of monopoly power, lack of information, perverse incentives, short-term planning horizons, and other factors.

A transition beyond business-as-usual toward energy systems that support socially, environmentally, and economically sustainable energy is possible. Many technologies and scenarios are available that could meet the requirements of lower costs of delivering energy services, lower energy intensity of economic activity, lower emissions intensity of economic activity, and enhanced resilience to climate surprise. Conventional R&D is necessary but not sufficient to achieve the goal of sustainable energy services. Creating usable knowledge that informs the design of sustainable energy services requires solution-driven research and innovation and must consider the place and scale of operation. Regional urban sustainability centers would catalyze, facilitate, and integrate the dialogue between stakeholders in civil society, business, and government through which scientists and engineers learn what users need and users learn what scientists and engineers can offer. As America's energy capital, Houston would be the ideal setting to assemble the expertise necessary to develop the goals and institutional framework for a national network of regional urban sustainability centers focused initially on the transition towards sustainable energy services.

THE NEED TO MOVE QUICKLY TO SCALE

Energy will be our most important technological and social challenge in the 21st century. America's metropolitan regions are likely to grow by a further 100 million people in this century. By 2030, fully half of the American built infrastructure in place will have been constructed since 2000. Our current federal technology and environment R&D programs will not drive a transformational change in the design process or implementation of a transition to sustainable energy services. There is an urgent need to move quickly to scale and to maintain a long-term commitment to funding sustainable energy programs by both public and private sectors. This commitment is essential, given the long lead times required for transformational changes in both technology and human capital.

In summary, I suggest that urban centers are the focus of our sustainability problem and they should be the source of innovative solutions. We should employ models of innovation based on collaboration and facilitated by organizations capable of bridging from basic research to application. The first challenge to be addressed by this network of urban sustainability centers should be development of systems for sustainable energy services.