CAETS

International Council of Academies of Engineering and Technological Sciences, Inc.

Pathways to Sustainability in the Energy, Mobility and Health Care Sectors

A Statement by the International Council of Academies of Engineering and Technological Sciences, Inc. (CAETS)
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Introduction

The 2015 CAETS Convocation, held in New Delhi October 13-14, 2015, covered a wide range of issues related to sustainable pathways for energy, mobility and health care engineering. More than 230 participants from more than 25 countries attended the Convocation, including nearly 30 young engineers from various parts of the world. The participants noted that the sustainable pathways are those in which human needs are met equitably by minimizing harm to the environment and working to ensure that future generations will be able to meet their energy, mobility and health care needs.

The sustainability of future systems depends greatly on introducing technological and engineering innovation in engineering, mobility and health care. This statement describes the issues identified by Convocation participants related to sustainable pathways for energy, mobility and health care systems.

CAETS is the International Council of Academies of Engineering and Technological Sciences, Inc. It consists of those national academies of engineering and technological sciences that have satisfied an agreed set of criteria for membership. It was established in 1978 and was incorporated as a charitable non-profit corporation in the District of Columbia (US) in 2000. Its Articles of Incorporation, Bylaws and Operating Procedures set down its objectives and governance arrangements. These documents and its membership and achievements are posted on the CAETS website, www.caets.org.

Energy

- Energy has a pronounced role as a driver for the sustained growth of sectors such as buildings and transportation. Increased environmental limitations of the current options are the main motivating factors for the search for sustainable energy pathways that cut across engineering discipline boundaries. The **transition to achieve a lower carbon regime** in these sectors requires systematic national-level efforts to account for energy and emissions, setting targets and timeframes for lower GHG emissions, technology review and selection of appropriate options, incentivizing emission reduction initiatives, and assessing their positive impact on businesses and markets.
- **Use of coal for energy** will continue to increase in countries such as China, India, Russia, the United Kingdom, and South Africa under any foreseeable scenario because of its abundance and low cost. However, the development of cleaner process options such as dry beneficiation, ultra-supercritical combustion, pre- and post-combustion carbon capture, and coal gasification/liquefaction will change the landscape for coal-based power generation. These cleaner options deserve to be included in the climate mitigation portfolio. In addition, the high CO_2 capture cost scenario may also lead to a significant reduction in coal use for energy by 2050. From an engineering perspective, the priority objective for coal-based energy should be successful scale up and large-scale demonstration of clean coal process options, in order to establish their techno-economic performance.
- Developments related to **establishing unconventional gases as energy sources** are generating major social concerns in various parts of the world. With a chemical composition similar to natural gas, unconventional gases are drawn from locations such as compact rocks or coal beds and include shale gas, coal bed methane and methane hydrates. At a 2015 conference organized by the Australian Academy of Technical Sciences and Engineering, a consortium of engineering academies from Australia, Argentina, Canada, China, Germany, South Africa, Switzerland and the United Kingdom examined issues related to using unconventional gases as energy sources. The CAETS Convocation participants appreciated this initiative, which involved basic and social scientists, engineers and economists.
- The electricity, transport and heating sectors are **interconnected** from an energy management perspective. Developing relevant energy scenarios under various application modes can form a strong basis for long-term decision making on future energy efficient options in such interconnected sectors. The recent German experience has demonstrated the importance of devising commercially viable alternatives for interconnected sectors.
- The application of photonics, encompassing gamma rays to radiowaves of the electromagnetic spectrum in energy, mobility and health care sectors, attracted the attention of the Convocation participants. Taking inspiration from nature, bio- and photonic technologies comprise a completely new energy source that can be controlled by light-matter interaction for achieving enhanced solar energy conversion efficiency and specialized applications in photo dynamic therapeutics and optogenetics.

Mobility

- The major challenges of the road transportation sector include achieving acceptable levels of decarbonization, developing energy-efficient vehicle engines, and improving the reliability and safety of traffic and navigation systems. From an engineering perspective, developing effective **interacting platforms** for transportation vehicles by **employing digital forces** such as cloud computing, mobile technologies, big data mining and robotics is a priority area. In emerging economies, the major challenge is to provide vehicles that satisfy international safety and emission standards at an affordable cost.
- Worldwide traffic volume and loadings on **road and rail bridges** continue to increase; they have surpassed the volumes and loadings estimated when the bridges were constructed. In addition, environmental, community and safety requirements related to road and rail bridges have become more stringent. Virtual mobility of traffic across bridges while minimizing the carbon footprint have become the main defining factors. Rehabilitation and restoration of overstressed bridges require **novel retrofit technologies** with automated

damage observation systems. A life cycle approach covering all phases of bridge development, operation and maintenance, and dismantling is most essential for developing new engineering options.

- **A modal shift** from road to rail transportation has to be one of the important themes for development of future rail systems to be equipped with super passenger and cargo handling platforms. The emphasis for new material development has to be based on lighter, stronger and more energy-efficient components and systems, multi-functionality, and minimal life cycle costs.
- **The urban mobility crisis** in developing countries stems mainly from deficiencies in traffic management, lack of timely structural adjustments, and tolerance of inequity. A larger perspective has to be taken in these cases to minimize wasteful consumerism and carbon footprints, and respect spatial justice for various transport modes. From an engineering perspective, options such as seamless connectivity through multi-modal transportation, as well as electrification and the ability to regenerate power and store electricity onboard to achieve faster rail and road transportation are of high priority.

Healthcare

- Advances made in electronics, mechanical engineering, computer sciences and communication engineering have led to significant progress in medical and healthcare sciences and engineering in developed countries over the last few decades. A systematic approach to **healthcare informatics** can greatly enhance the quality and efficiency of health care systems – particularly while handling public health emergencies in developing countries. **Systems engineering** approaches are vital to effective redesign of obsolete healthcare systems.
- From a biomedical engineering perspective, recent advances in **nano- and point-of-care diagnostics** and remote-sensing neonatal monitoring systems have shown the multidisciplinary collaborative strengths of medical specialists, biologists, physicists, chemists and engineers. The biomedical device field will continue to grow rapidly with innovations in reliable diagnostics, less traumatic therapies, internal/external sensors for pre- and post-treatment responses, surgical interventions through **image-guided robotics,** and allied areas.
- **Regenerative engineering,** which combines tissue engineering, material science, cell physics and developmental biology, will play a major part in developing next-generation biomedical devices for diagnosing and analyzing hearing and visual impairments, assessing the severity of communicable and non-communicable diseases, and enhancing efficacy of transformational healthcare systems.
- Engineering and healthcare sciences traditionally have been distinct disciplines in their respective silos. The expert discussions at the CAETS Convocation established that the silos are converging fairly rapidly, with innovations emanating from cross-fertilization of ideas and concepts. The application of analytics and communication engineering concepts will have a positive influence on this continued convergence.

The deliberations at the 2015 CAETS Convocation established that achieving long-term sustainability in a business-as-usual mode is impossible in the energy, mobility and healthcare sectors. Higher investments are needed for R&D and technology demonstrations in all of these sectors, particularly for options that are close to commercial maturity and for those requiring scale up to a larger scale. Commitment from policy makers, concerned stakeholders, the academic community and market leaders are vital for achieving public and market acceptability. Prototyping and technology transfer methodologies have to be path-breaking. Open access information sharing among the CAETS member academies in these sectors will create an environment that enables innovations to be adopted in countries with emerging economies.

CAETS Member Academies

National Academy of Engineering (ANI) Argentina
www.acadning.org.ar

Australian Academy of Technological Sciences and Engineering (ATSE) *www.atse.org.au*

Royal Belgian Academy Council of Applied Sciences (BACAS) *www.kvab.be*

Canadian Academy of Engineering (CAE)
www.cae-acg.ca

Chinese Academy of Engineering (CAE)
www.cae.cn

Croatian Academy of Engineering (HATZ)
www.hatz.hr

Engineering Academy of the Czech Republic (EA CR)
www.eacr.cz

Danish Academy of Technical Sciences (ATV)
www.atv.dk

Technology Academy Finland (TAF)
www.technologyacademy.fi

National Academy of Technologies of France (NATF)
www.academie-technologies.fr

German Academy of Science and Engineering (acatech)
www.acatech.de

Hungarian Academy of Engineering (HAE)
www.mernokakademia.hu

Indian National Academy of Engineering (INAE)
www.inae.org

The Engineering Academy of Japan (EAJ)
www.eaj.or.jp

The National Academy of Engineering of Korea (NAEK)
www.naek.or.kr

Academy of Engineering (AI), Mexico
www.ai.org.mx

Netherlands Academy of Technology and Innovation (AcTI.nl) *www.acti-nl.org*

Norwegian Academy of Technological Sciences (NTVA)
www.ntva.no

Slovenian Academy of Engineering (IAS)
www.ias.si

South African Academy of Engineering (SAAE)
www.saae.co.za

Real Academia de Ingenieria (RAI), Spain
www.raing.es

Royal Swedish Academy of Engineering Sciences (IVA)
www.iva.se

Swiss Academy of Engineering Sciences (SATW)
www.satw.ch

Royal Academy of Engineering (RAEng), United Kingdom
www.raeng.org.uk

National Academy of Engineering (NAE), United States
www.nae.edu

National Academy of Engineering of Uruguay (ANI)
www.aniu.org.uy

International Council of Academies of Engineering and Technological Sciences, Inc. (CAETS)

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Internet: www.caets.org
E-mail: caets@nae.edu

William C. Salmon, Secretary/Treasurer
3004 The Mall
Williamsburg, Virginia 23185 USA
Mobile: (1) 703-527-5782

CAETS Records
National Academy of Engineering
2101 Constitution Avenue, NW
Washington, D.C. 20418 USA