Research Assessment Exercise 2020
Impact Overview Statement

University: The University of Hong Kong
Unit of Assessment (UoA): 12 electrical & electronic engineering
Total number of eligible staff of the university in the UoA: 28

(1) Context

Research in our Electrical and Electronic Engineering (EEE) Department comprises a balanced mixed of theoretical, analytical and experimental work, with particular emphasis on theme-based interdisciplinary collaboration within the strategic priorities of HKU. Since the 1990s, C.C. Chan (FREng) and Felix Wu (FIEEE) have established the Department as an international leader in electric vehicles and power systems. Present leadership under David Hill (FAA), Ron Hui (FREng), Victor Li (FIEEE) and K.T. Chau (FIEEE) have propelled the Department to new heights in emerging areas of smart grids, power electronics and information & communication technologies (ICT). The Department is a modern one in teaching and research, but still maintained a long-standing tradition of international excellence; for instance, 43% of our academics are ranked as top 1% highly cited scholars in 2018 by Clarivate Analytics. We are the only EEE department with 3 large-scale competitive Theme-based Research Scheme projects granted by the HK Research Grants Council (with successful rate <7%). Other examples of global impacts are reflected by the media's recognitions of C.C. Chan as "Father of Electric Vehicles in Asia" and Ron Hui as "Father of Planar Wireless Charging Technology". The beneficiaries of our research can be broadly grouped into power industry, lighting industry, wireless charging industry, government and professional organizations, R&D communities and the public. For this RAE, we submit 2 impact case studies: Case 1 – "Reliable Electrical Energy Systems" and Case 2 –"Power Electronics as an Enabling Technology for Sustainability".

(2) Approach to impact

Our research directives to staff members are set in accordance with HKU's research strategies of the four "I"s principle of **I**nnovation, **I**nternationalization, **I**nterdisciplinarity and **I**mpacts (with the first 3 **I**'s leading to impacts) such that conducted research works would be led to achieving maximum academic and non-academic impacts. Notable beneficiaries of our research include Electric Power Research Institute (EPRI) USA, State Grid of China, China Southern Power Grid [Case 1], Qualcomm, ConvenientPower, and United Technologies Global [Case 2].

(a) Engagement and Collaboration with Industry: Colleagues are encouraged to work closely with local and overseas industry, and collaborative research with 79 (38 HK, 31 Mainland China, and 10 overseas) companies and organizations occurred over the RAE period. Many such works are interdisciplinary in nature, including those in the areas of power systems, economics and policies [Case 1] as well as power electronics and lighting science [Case 2].

(b) Intellectual Property Generation and Knowledge Transfer: For this RAE period, over 221 patents were filed on our research inventions in over 20 countries, including China, USA, EU and Japan. A significant portion of these patents (64 patents) have been licensed to industry with product installations in 20 countries [Case 2]. Also, 5 startup companies have been founded.

(c) Influencing Policies of Governments and Regulatory Bodies: Members (K.T. Chau and S.C. Tan) served in the Electrical Safety and Advisory Committee and Accreditation Advisory Board of HKSAR Government and assisted in its review of existing and adoption of new regulations. Felix Wu and David Hill advised China Light and Power on advanced metering infrastructure as its Smart Grid Advisory Panel members [Case 1]. Ron Hui was Deputy Chair of the Lighting Association, China. Related policies, standards and regulations of these bodies are adequately informed of the scientific findings derived from our research outputs.

(d) Public STEM Education and Engagement: School visits to promote EEE and regular media releases to announce new discoveries and breakthroughs are frequently conducted**.**

(3) Strategy and plans

Our strategy on achieving high impacts were accomplished through various channels including:

- Deliberate and proactive linking up/fostering interactions between staff members with industry to seek possible sponsorships or collaborative research programs.
- Support and encouragement were provided to colleagues to sit on international regulatory boards and government advisory boards.
- Creation of 3 international collaborations with Imperial College London, Cologne University of Applied Sciences, and University of Sydney through 2 theme-based projects [Cases 1 & 2].

Some emerging technologies that can potentially impact industries for the next RAE have been identified. These topics include:

Power Systems and Smart Grid Technologies: This comprises the joint efforts of our power systems team (5 staff), power electronics team (5 staff) and ICT team (3 staff) on developing technologies, strategies, policies for the dynamically evolving smart grids.

Energy-Related Emerging Topics: We shall continue to pioneer wireless power technologies into new fields such as omnidirectional wireless power transfer. New research on harvesting energy from sea and fresh water is a major endeavor in the coming years. Lighting systems with lifetime exceeding 10 years are on the horizon based on our current research.

(4) Relationship to case studies

Case 1 on "Reliable Electrical Energy Systems" demonstrates how our research in power systems and smart grids have impacted major power companies and national institutes in HK, China and USA in terms of technology, advice, technical guidance and policy for achieving improved system reliability through: 1) smart dispatch and operation, 2) security and recovery tools, and 3) demand analytics.

Case 2 on "Power Electronics as an Enabling Technology for Sustainability" highlights: 1) how our wireless power research has influenced recent international standard revision and product development, and clarified key engineering principles for both academia and industry; 2) how our lighting research led to technology transfer and commercialization in over 20 countries, and its wide-spread product installations; and 3) our invention of the world's first and only electric springs that can provide demand-side response within the time frame of milliseconds.

Power Industry: The significant stakeholders of our research are those from power industry including utilities in HK, Mainland China and the USA through the provision of consultancy, international workshops, commissioned research and collaborative research [Cases 1 & 2].

Lighting Industry and R&D Community: Commercial transfers of patented "sustainable" lighting technologies in over 20 countries and a startup company integrating lighting and IoT technology [Case 2] and through the world's first LED System Theory, our work is now commonly used as essential tools for the design and optimization of LED systems [Case 2].

Wireless Charging Industry: We have introduced to the community the classification of all near-field inductive wireless power transfer into either "maximum power transfer" or "maximum energy efficiency" principle, and pioneered the "maximum energy efficiency tracking" principle, which now influenced international wireless charging standards [Case 2]. We organized the IEEE Wireless Power Workshop in 2018 in Montreal.

Governments, Professional and Regulatory Bodies: We offered professional seminars on smart grids, wireless power transfer, and sustainable lighting for HKIE and IEEE (HK) [Cases 1 & 2]. Colleagues sit on boards of HKSAR Government and Lighting Association of China.

The Public: To raise the profile of engineering among the general public, the Department has embraced opportunities in disseminating our inventions and discoveries through various media. Our Sustainable Lighting Workshop held in 2017 and Renewable Energy & Feed-In-Tariff Workshops in 2018 and 2019, each attracted over hundreds of professional engineers.