# 2022 WITSA Global Innovation and Tech Excellence Awards
## Nomination Form

The 2022 WITSA Global Innovation and Tech Excellence Awards *(*formerly known as *the Global ICT Excellence Awards*) will be presented to select individuals, academic institutions, corporations, NGOs or governments whose use and applications of digital technologies exhibit exceptional achievement within the following broad categories:

| Private Sector/NGO | Public Sector |
|---|---|
| Digital Opportunity/Inclusion Award | Digital Opportunity/Inclusion Award |
| Smart Cities Award | Smart Cities Award |
| Sustainable Growth/Circular Economy Award | Sustainable Growth/Circular Economy Award |
| Innovative eHealth Solutions Award | Innovative eHealth Solutions Award |
| Public/Private Partnership Award | Public/Private Partnership Award |
| E-Education & Learning Award | E-Education & Learning Award |
| Emerging Digital Solutions Award | Startup Ecosystem Award |

In addition, a *Chairman's Award* will be presented to a nominee selected from the entire pool of candidates from all award categories.

Candidates for these Awards are nominated by ICT experts from around the world who span over 80 countries/economies. The 2022 *WITSA Global ICT Excellence Awards* will take place in conjunction with the September 13-15, 2022 World Congress on IT in Penang, Malaysia (**https://wcit2022.com/**).

## Sustainable Growth/Circular Economy Award

Award #1: Individuals, academic institutions, corporations, or NGOs
Award #2: Government authorities

Award Criteria-There is an urgent need for transition to a more sustainable and circular socio-technical systems - now is the best time when we can witness how the health of the planet is connected to the human well-being and vice versa. The most accepted definition of the sustainability is defined by the Brundtland Commission in 1987; sustainability is seen as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. Circular Economy (CE) can be defined as a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling.

As the UN’s 2030 deadline for change fast approaches, we explore what role the circular economy has to play in mitigating the impacts of climate change and how the technology industry can learn from it. It is a popular idea as it places an emphasis on designing out waste and pollution, thus keeping products in use for longer and facilitating the regeneration of natural systems. Now, as the world faces an imminent climate crisis, the

IT and technology industries are starting to sit up and notice. ICT systems have influenced every aspect of modern life and the CE is no exception. Cutting-edge technologies, such as big data, cloud computing, cyber-physical systems, internet of things, virtual and augmented reality, and blockchain, can play an integral role in the embracing of CE concepts and the rollout of CE programs by governments, organizations, and society as a whole. Many countries are advancing circular electronics initiatives to encourage longer product lifetimes, but legal, policy, and economic support must exist for an open repair environment to motivate consumers to opt for repair over replacement.

This award will recognize Individuals, academic institutions, corporations, NGOs or governments that adopt effective and innovative local, regional or global initiatives that promote local production and use, local renewable energy sources, and adoption of circular and participatory practices for circularity in digital devices, software, internet access and services.

**YOUR NOMINEES (limit three nominations per award category)**. *Please specify whether the nominee(s) are for the private or public sector category*.

Private Sector

Nominee: Hong Kong Applied Science and Technology Research Institute Company Limited

Entry Name: Power supply system for carbon neutral building

**REASONS FOR NOMINATION** (NOTE: It is important that you make a detailed description of the nominee and why you think the nomination is justified. The absence of a detailed summary of qualifications as they *relate* to the above-mentioned award description will make it difficult for the awards committee to make an appropriate assessment of the candidate):

**Applicant background**: Hong Kong Applied Science and Technology Research Institute Company Limited (ASTRI) was founded by the Government of the Hong Kong SAR in 2000 with the mission of enhancing Hong Kong's competitiveness through applied research. Technology Divisions: Trust and AI Technologies; Communications Technologies; IoT Sensing and AI Technologies; and Integrated Circuits and Systems. It is applied across six core areas which are Smart City, Financial Technologies, Intelligent Manufacturing and Re-Industrialisation, Digital Health, Application Specific Integrated Circuits and Metaverse.

**Project background**: the project is a perfect combination of innovated applied technologies and fashion stylish product design of power conversion and protection devices for building energy saving applications. It is an emerging solution to level up the green building energy utilization to achieve carbon neutrality for smart city.

From technology point of view, the DC power supply system is to convert the AC electrical grid of a building to DC with 98%+ efficiency by using 3rd generation semiconductors and advanced control technologies. Besides, the Solid-state DC Circuit Breaker (SDB) ensures a safe electrical disconnection in micro-second range without electric arc in case of a short circuit, shown in fig. 1.

Fig. 1 DC power supply system with SDB

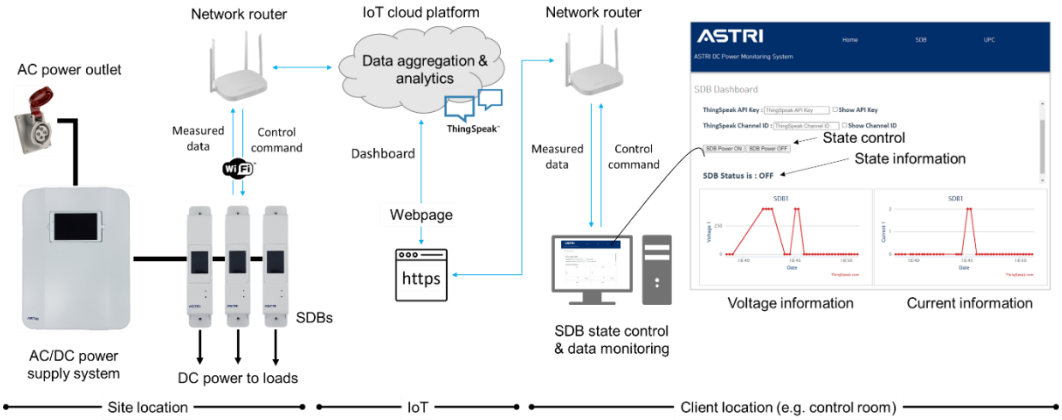



Fig. 2 IoT based DC power supply system

From artistic point of view, the DC power supply system combines technological elements with fashion design successfully. It reforms the public mindset of power supply equipment from classical metallic style to modern humanize appearance and make the power supply infrastructure fit into the modern life.

From IoT point of view, IoT based HMI monitoring system provides smart monitoring and control of DC power system and SDB. It makes the monitoring and control highly efficient and low cost especially when the power system, or the SDB, are installed in remote area where is difficult to reach due to transportation or weather issues, shown in fig.2.

## Innovative Features and Functionalities:

1. Energy saving & carbon emission – It is anticipated that DC building power infrastructure innovation can reduce power consumption by 5% - 20% compared to AC building. About 15% of energy saving is achieved in the field demonstration in EMSD. For some appliances, such as variable frequency drive fan coil, it can achieve ~40% of energy saving compared to AC power.
2. Safety – A Solid State DC Circuit Breaker (SDB) is developed, it is ~x100 times faster in protection than nowadays miniature circuit breaker (MCB) in response to a short circuit event. It minimizes the short circuit current, thus the seriousness of the failure, substantially.
3. Sustainable technology development – The power system can work coherently with the existing sensor-driven energy saving solutions in the market.
4. High efficiency – with 99.9% superior efficiency of the SDB and approached 99% power conversion efficiency of the power supply system.
5. Uninterrupted power supply – seamless power transition technology between grid and battery to cope with power shortage and recovery.
6. IoT based power system – consist of power management, power protection, real-time metering, monitoring, control, and remote configuration / re-configuration functions.

## Global Impact/Potential:

The proposed solution converts the incoming electricity of a home/office from AC voltage to DC voltage and power the appliances connected to the DC voltage grid. The power conversion unit is natural cooled with very low acoustic noise, it is suitable for noise sensitive applications such as indoor. The all-digital SDB bring traditional breakers to a new age and make the LVDC installations possible in redefined DC zones. It provides < 10$\mu$s protection to a short circuit event with almost no arc in the disconnection. It can be configurated in both current rating and trip curve right on the breaker's panel as well as remote via internet.

Upon our best knowledge, we are the 1st in Hong Kong to implement DC Building / Home technologies in actual application in EMSD Headquarters. We are the 1st in Hong Kong to develop the digital DC circuit breaker. In the global scale, we are the one of the few solution providers on digital DC circuit breaker in the world, including ABB from Switzerland, DC Systems (by Schneider Electric) from Netherlands, Atom Power from US, and Amber from US.

## Scalability:

The proposed solution is an upgrade on the power grid side which works coordinately with the energy source/storage side, e.g. renewable source and battery storage, and appliance/load side, e.g. home appliances, personal IoT devices, EV, etc., in smart city development.

1. Huge market potential – Residential and commercial buildings accounted for ~65% of energy consumption in HK in 2018, i.e. 187,398TJ; if there is a 5% electricity reduction in all these building, i.e. 9,370 TJ, it is equivalent to the energy consumption of ~240,000 people in a year. It is a feasible and emerging way to facilitate the carbon neutral target.
2. Low voltage DC grid / microgrid in specific applications – Due to the nature of renewable energy, e.g. solar, and battery storage are in DC voltage format, using those in DC grid is more efficient and less costly as excessive AC-to-DC and DC-to-AC power conversion

processes and losses are eliminated. Suitable applications including EV charging station, telecom base station, and data center with solar power integration as all key appliances (or loads) are DC voltage driven.

3. DC appliances readiness – Appliances such as LED lamp driver, fridge, air-conditioner, fan coil, humidifier, etc. are market available.

## Proven Solution:

Technical verification **–** The presented DC power system consists of:

- 10kW AC/DC stage – It consists of power converters to covert the 220V/50Hz AC incoming voltage to 375V DC voltage for the DC appliances by using five 2kW 5-level modules in interleaved operation. A new multi-phase AC/DC power conversion platform solution, namely Adaptive Multilevel Converter (AMC) was developed. Operating principle has been explained and experimental verification of the AMC has been implemented successfully. The proposed solution was evaluated on a 10kW prototype. The power efficiency at 2% load (i.e. 200W) was increased from 93.4% to 97.2% by the AMC operation. Efficiency was higher than 98.5% from 20% load to 100% load with 98.8% peak efficiency at ~50% load. The PF is ≥0.93 from 10% load and ~0.999 from 50% load to 100% load, shown in fig. 3.
- Solid state DC circuit breaker – It is an optimized design on cost and efficient with a matrix connected low voltage MOSFET for the main branch. The proposed solution guaranteed 99.9% efficiency with a simple copper plate heat sink under natural cooling and 6.6kA/400V DC breaking capacity, shown in fig. 4 and 5. It was confirmed experimentally the proposed breaker guaranteed micro-second range disconnection of 400V DC short circuit without electric arc. It brings the use of DC voltage to a higher safety level, shown in fig. 6.

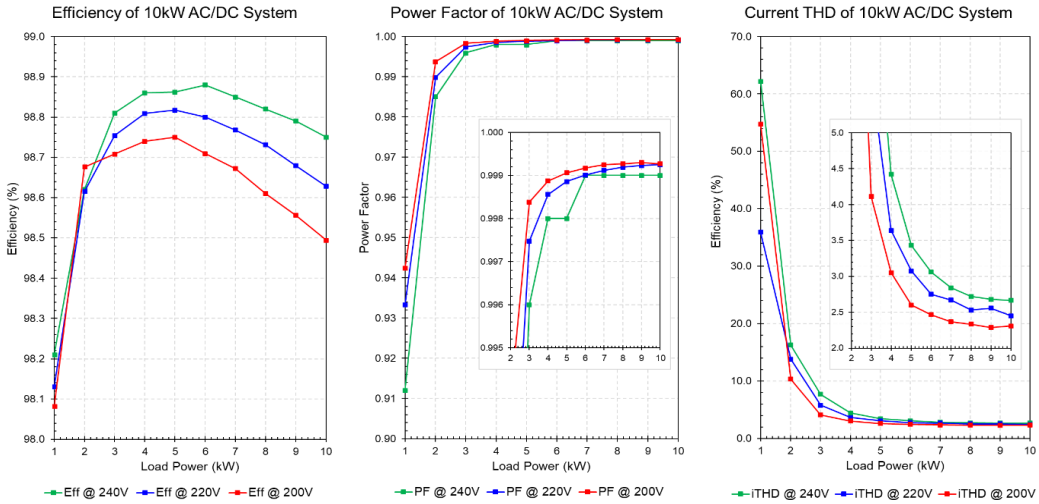
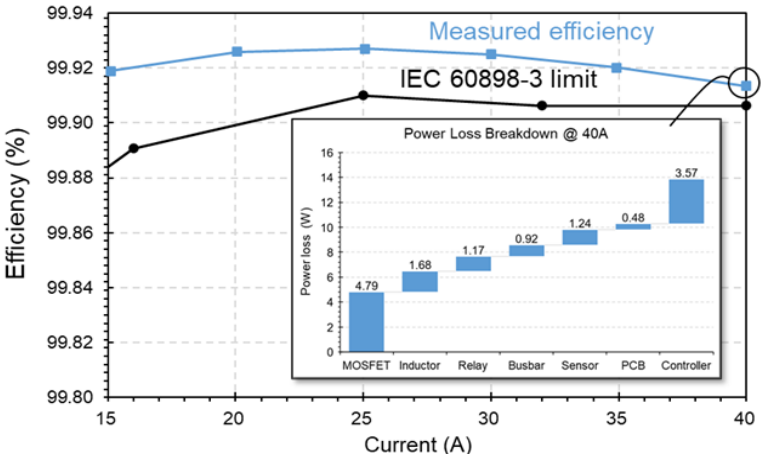



Fig. 3 Measured efficiency, power factor, and iTHD of DC power supply

- Human machine interface (HMI) monitoring system – IoT based HMI monitoring system provides smart monitoring and control of DC power system and SDB. Various parameters, including ON/OFF status, current, voltage, fault information etc., are collected and uploaded to IoT platform in real-time, shown in fig.7. User can monitor the status of power system and circuit breaker in the site location. User can also turn-on/off the breakers and adjust the setting in the client location remotely. It makes the monitoring and control highly efficient and low cost

especially when the power system, or the circuit breaker, are installed in remote area where is difficult to reach due to transportation or weather issues.




| Item | Resistance |
|---|---|
| MOSFET | 2.99mΩ |
| Inductor | 1.05mΩ |
| Relay | 0.73mΩ |
| Busbar | 0.57mΩ |
| Sensor | 0.78mΩ |
| PCB | 0.30mΩ |

Fig. 4 Efficiency and power loss breakdown measurement on the SDB

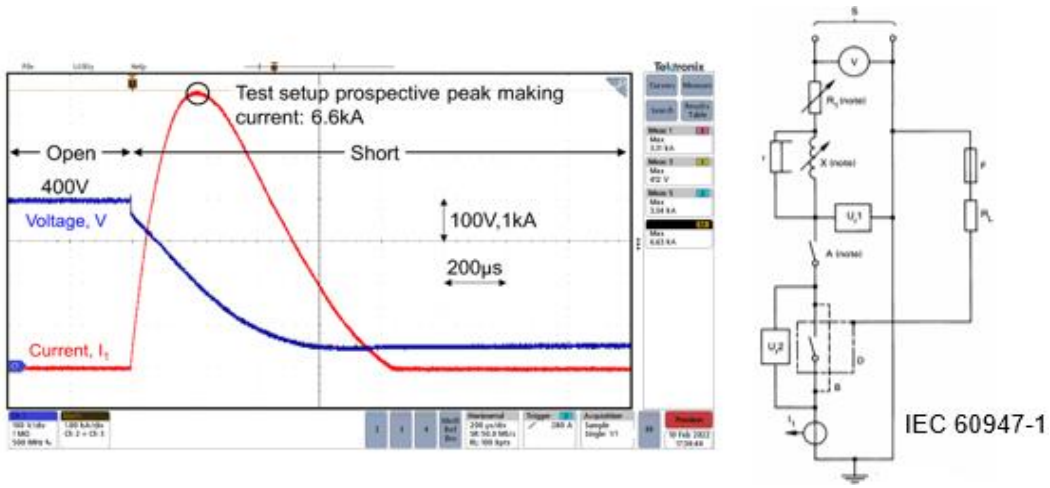



Fig. 5 Circuit breaker breaking capacity test setup and the test waveform (without SDB)

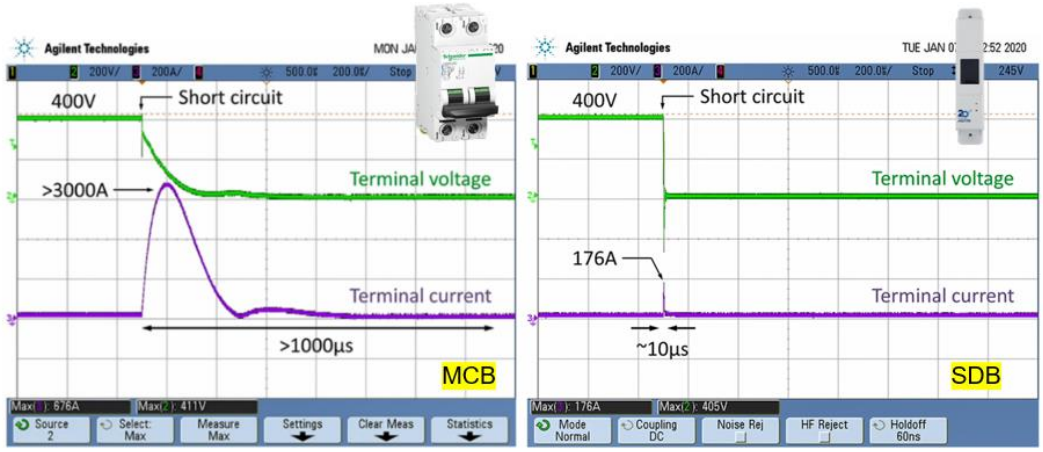



Fig. 6 400V short circuit test results of MCB and SDB

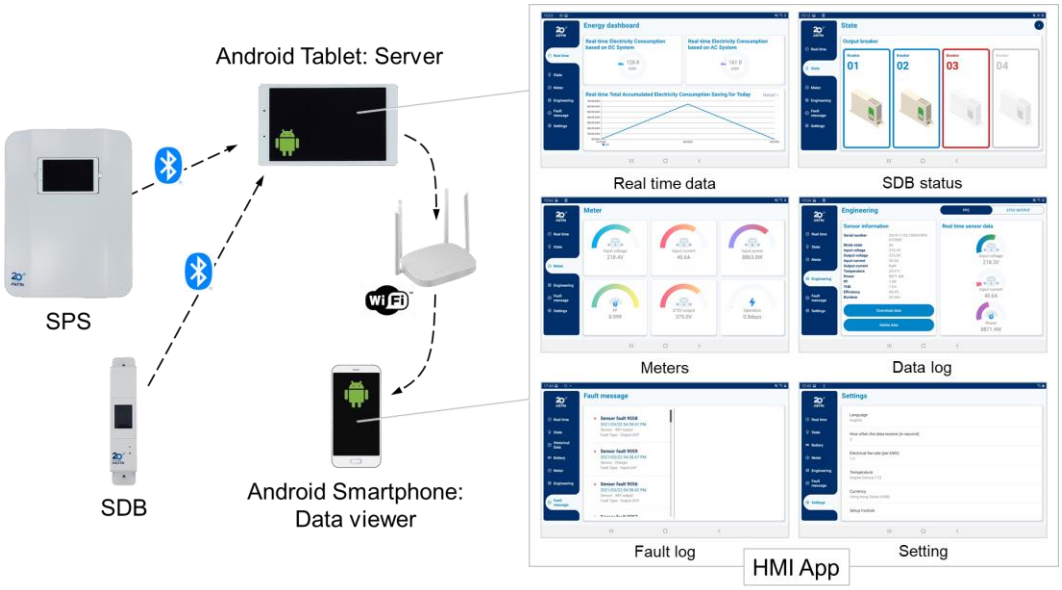



Fig. 7 Communication and monitoring system

## Actual use cases:

The key technologies of presented DC power system have been transferred to a leading circuit breaker manufacturer in China mainland for mass production, shown in fig.8. 2 systems have been installed at Hong Kong Electrical and Mechanical Services Department (EMSD) Headquarters for educational purpose and technology trial. ~15% energy saving is achieved by using the DC powered system as compared with AC powered system and zero failure records since installation, shown in fig. 9. 1 set of system has been installed by Tsinghua Sichuan Energy Internet Research Institute by DC home demonstration, shown in fig. 10.


Fig. 8 DC power supply system installed at customer

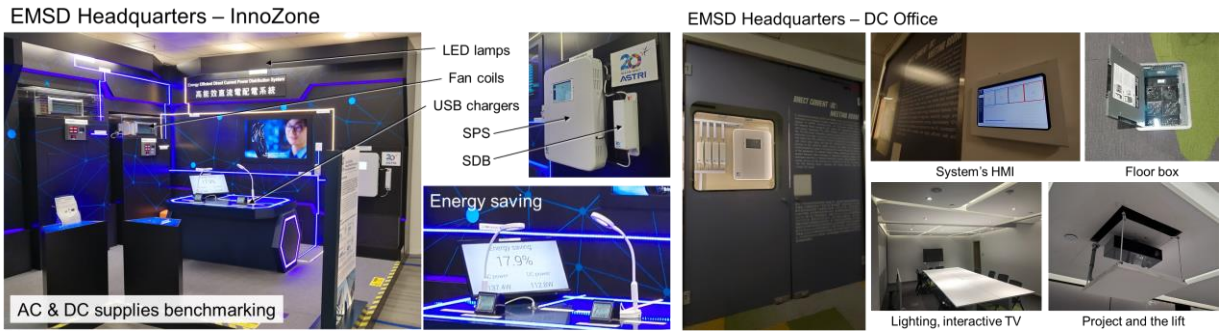



Fig. 9 DC power supply system installed at Hong Kong EMSD

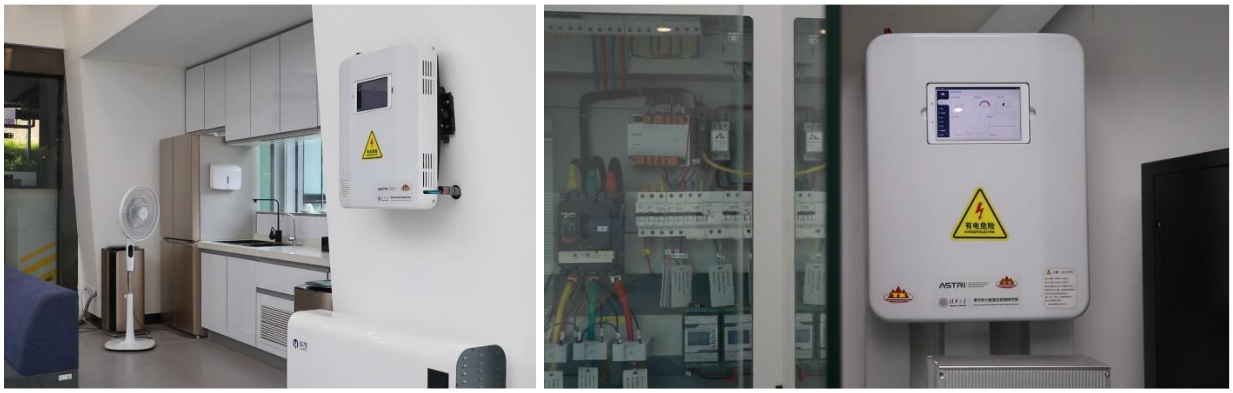


Fig. 10 DC power supply system installed at Tsinghua Sichuan

**SUPPORTING INFORMATION**: Please send any supporting information to the address above, including information from candidate (i.e. excerpt from program description, web site print-out, press release, etc.)

1. Patent, paper, conference
   - Controller for an AC/DC or a DC/AC multi-phase power converter. US11043891 (B1), CN113508521 (A) [**LINK**]
   - Electrical protective device for low-voltage direct current (LVDC) network. US11070045 (B1), CN112840517(A) [**LINK**]
   - An Ultra-efficient and Low-cost Solid-State Circuit Breaker for LVDC Microgrid Applications, IEEE International Conference on DC Microgrids (ICDCM) 2021 [**LINK]**
   - A Single-phase Ultra-wide-efficient Load Range AC/DC Power Conversion Solution for DC Infrastructure Power Supply Applications, IEEE International Conference on DC Microgrids (ICDCM) 2021 [**LINK**]
2. Recognition by public sector and social impact
   - Hong Kong ICT Smart Living (Smart Home) Award 2021 – Silver award [**LINK**]
   - Hong Kong Awards for Industries: Innovation and Creativity 2021 – Certificate of Merit [**LINK**]
   - Innovations Geneva 2021 – Silver award [**LINK**]
3. Arise social awareness
   - RTHK video programme – IP 新機遇：創新直流電技術 (專利發明) [LINK]

- YouTube video - ASTRI – Innovative Direct Current Technologies [**LINK**]
- PHOENIX TV show –《龍行天下》：《綠金》——《政府驅動》[**LINK**]
- 5G DC Building promoted by Hong Kong City University - 每日明報 [**LINK**]
- RTHK radio programme – 太陽底下新鮮事 [**LINK**]

4. Actual use cases
   - The key technologies of presented DC power system have been transferred to a leading switchgear manufacturer in China mainland for mass production
   - DC office at EMSD Headquarters was commenced from Jan/2021
   - DC home demonstration by Tsinghua Sichuan Energy Internet Research Institute

**NOMINEE CONTACT INFORMATION** (for award follow up and coordination)
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