Consultation on the UK ElecTech Sector's R&D and Innovation Landscape

This brief paper is intended to solicit stakeholder views and help focus thoughts ahead of a consultation about the ElecTech roadmap and subsequent report.

The ElecTech Council, with the support of Innovate UK, ran a roadmapping workshop in July 2017 to identify key opportunities and underlying technologies for the ElecTech sector. The roadmapping process so far has delivered a layered understanding of the 'drivers', the 'priority opportunities', the 'technologies' that underpin these and the additional 'enablers' that help it all to come about.

Since the workshop we have been analysing the outputs and will be developing them further to make them suitable for a report to be co-published by UKRI-Innovate UK and BEIS. To this end, we will be running a follow-up consultation workshop on 3rd July 2018 with Innovate UK and BEIS, to ensure that the roadmap report has a good coverage of the technology aspects.

We are getting in touch with you, a key stakeholder with an interest in ElecTech technologies and their application, and would like to get your input on what might be missing. You will be asked to respond to 3 specific questions from a top-down and bottom-up perspective as per the guideline text below.

The roadmapping workshop identified a number of **priority opportunities**. These were a mix of quite technically focussed but broad capabilities and applications areas. In trying to draw out the relevance for ElecTech we have come up with the following representation:

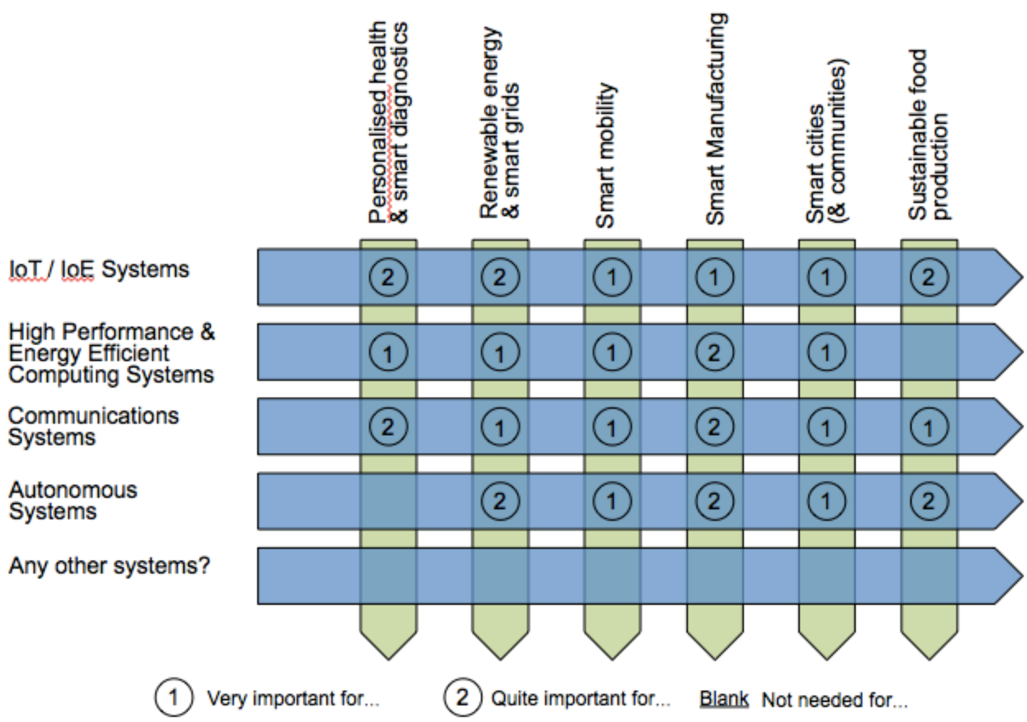

Figure 1: Capabilities vs. Applications

The verticals are **applications**. They are deliberately more specific than generic applications such as health, transport, energy etc as they are to describe applications level challenges for which ElecTech can be a major part of the solution.

The horizontals represent **'system-level capabilities'**. These reflect the technical solutions that the workshop identified as strategic cross cutting capabilities. They are a level above individual technologies themselves (e.g., photonics, electronics) as shown in Figure 2 below. As strategic choices they represent the medium to longer term requirements to deliver on the applications and reflect the corresponding evolving R&D and innovation landscapes.

TOP-DOWN APPROACH

What we would like you to focus on (at this stage) is the horizontal '**system level capabilities'**.

Question 1: *Are there any key 'system level capabilities' not represented in Figure 1? These would need to be similarly broad areas that address multiple applications and rely upon a number of technology areas and underlying technologies (see Figure 2).*

Question 2: *Which applications do you believe any particular capability is key for and to what extent? Note that the degree of importance is indicated at the intersection of capability and application in Figure 1. Please provide views as currently these are illustrative but not validated.*

BOTTOM-UP APPROACH

In further analysing the ways in which ElecTech enables the capabilities, and therefore also the applications, we have come up with the following representation.

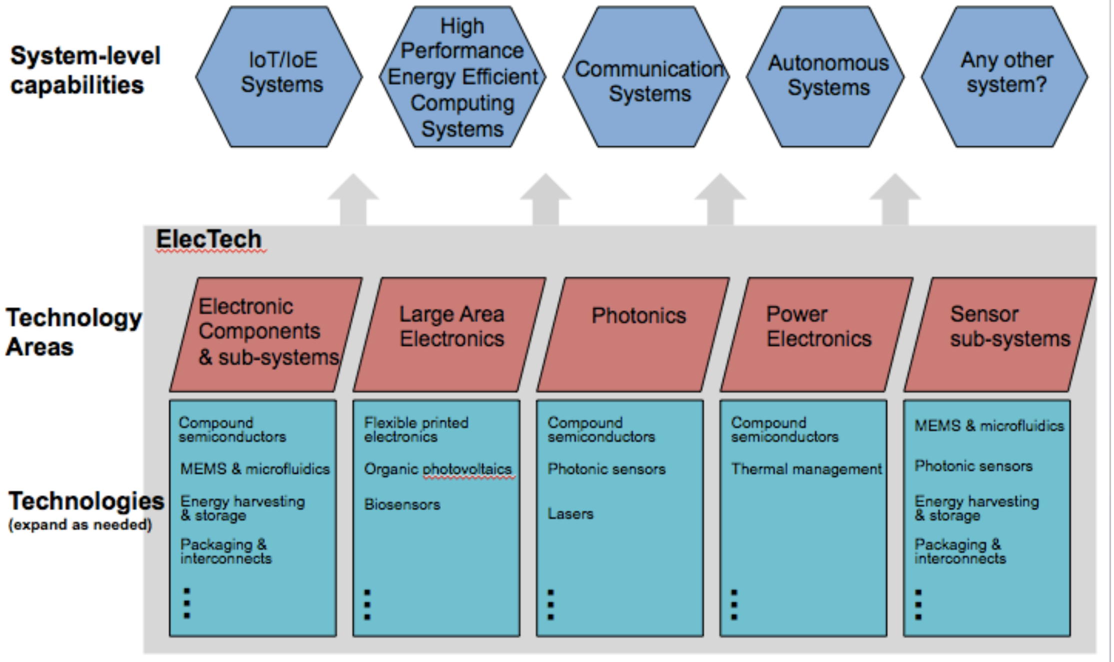

Figure 2: System-level capabilities and underpinning technologies decomposed into layers.

This is more of a bottom-up approach where we wish to be comprehensive in identifying the relevant ElecTech technologies and where they are needed. In the 'technologies' boxes we will list specific device and component level technologies. We are currently mining the roadmap workshop outputs to populate this but wanted to share the structure with you to illustrate approach and also to make clear the distinction between system level capabilities, technology areas and the underlying technologies.

We recognise that in reality the technology blocks are not silos. There are widely applicable component technologies and also intersections of technology areas. For the time being we are noting these by repetition in the illustrative examples within the diagram e.g. compound semiconductors.

Question 3: *Given your domain of expertise can you please let us know which specific technologies you believe are critical to enable the capabilities?*

We will follow up our discussions with you by talking further to technology experts having specialist knowledge and will also use the consultation workshop on 3rd July to explore in more detail expectations on technology evolution, critical take-off points and UK strengths.

We look forward to having a discussion with you on the above so please indicate your availability for a call in the next few weeks.

Appendix

What follows is some indicative descriptions of the various categories mentioned above. These are not exhaustive but should help you understand what each includes. Please feel free to suggest additions.

Applications

Personalised health & smart diagnostics
Cost effective diagnostic sensors and AI driven analytics with significant focus on data security. Patient monitoring inside and outside of the care setting to enable timely intervention and reduce pressure on the healthcare system whilst improving quality of life. Predictive healthcare. Development of new diagnostic modalities.

Renewable energy & smart grids
Need sustainable low carbon energy production that at least initially supplements the base-load. For the UK typical sources will be wind, marine, hydro and geothermal. A focus on all of generation, conversion and storage as well as efficient distribution though smart grids which will rely upon systems integration expertise, power electronics and sensor systems. Smart grids will also support smart mobility and autonomous vehicles.

Smart mobility
Enabling smarter and more sustainable transport systems. Ranges from infrastructure and transport modalities to operational control of transport, particularly within an urban environment. Reduction of congestion and pollution. Coordination of multiple modes of transport. Includes use of autonomous unmanned vehicles and electrification of vehicle power.

Smart manufacturing
Includes Industry 4.0, the application of cyber-physical systems to the automation of manufacturing using IoT, cloud computing and cognitive computing. Also reconfigurable factories for ultra flexible demand driven manufacturing which will rely upon manufacturing processes such as additive layer manufacturing. There will be significant need to integrate supply chains effectively. Will require the use of robotics and extensive smart low cost sensing.

Smart cities (& communities)
The monitoring of a range of assets, transport, services, energy utilities, security access and potentially crowd management in order to make the community operate more cooperatively and efficiently. Resource management, reducing the cost of living, congestion, pollution, improving health outcomes.

Sustainable food production
Enabling intensified and more sustainable production of food, particularly through more efficient agricultural practice e.g. precision application of pesticides and fertilizer, greater automation, remote sensing technologies and

platforms and wireless sensor networks. Opportunities in post-harvest supply chain management and in food processing.

System Level Capabilities

IoT / IoE Systems

The intelligent connection of people, process, data and things. The Internet of Everything (IoE) describes a world where billions of objects have sensors to detect measure and assess their status; all connected over public or private networks using standard and proprietary protocols. Focus covers the end point devices, the communications networks and the computing systems. From cheap to sophisticated nodes with advanced functionalities.

High Performance & Energy Efficient Computing Systems

Everything from power efficiency in embedded systems through to true exascale High Performance Computing architectures where high performance processing and power efficiency are key. Covers architectures, low-energy processor units, system software stack etc.

Communications Systems

Includes Ethernet, RF, 5G, LoRa, LiFi etc (data communication technologies) and ZigBee, IoT, M2M etc (data communication infrastructures). Architectures, point-to-multi-point communications, base stations and network equipment, analogue and digital signal processing.

Autonomous Systems

Broadly classed under 'Unmanned-x-Systems' across different application areas and environments. Includes autonomous vehicles, drones, underwater vehicles, machines and robotics and the systems required to enable their autonomous operation. These are underpinned by electrified propulsion, sensors and sensor fusion, communications, imaging and AI, motors and batteries.

Technology Areas

Please note that technologies may cut across Technology Areas and System-level Capabilities – for example Electronics components and sub-systems can be found in IoT/IoE Systems and Communication Systems; similarly, Compound Semiconductors are applicable to both Photonics and Power Electronics.

Electronic Components & sub-systems

Electronic systems comprise a broad spectrum of technologies that enable advanced functionalities such as computing, sensing, actuation, communication and control incorporated into sophisticated and heterogeneous components and devices integrated into higher level subsystems and systems potentially leading to system of systems. Micro and nano electronic technologies are included in this technology area.

Large Area Electronics

Large area Electronics - including printed, plastic, organic, flexible electronics and related connotations - comprise technologies for the development of components and devices driven by new materials and manufacturing processes. This technology area includes design, development, integration, testing, and manufacturability aspects. Example application areas include photovoltaics, lighting, displays, sensors and intelligent objects.

Photonics

Photonics comprise technologies used in the generation, detection and manipulation (amplification, modulation, processing, switching, steering) of photons. This technology area covers photonic-based technologies for the design and development of sophisticated components, devices and integrated systems including lasers, optics, fibre-optics, and electro-optics in diverse application areas such as manufacturing, healthcare and telecommunications.

Power Electronics

Power electronics is the application of solid-state electronics for the control and conversion of electrical power. Example applications include energy generation and distribution and electrification of vehicles. This technology area includes component technologies, packaging and integration, testing and validation.

Sensor sub-systems

Technologies for the design, development, integration and testing of sensor elements / devices and sensor systems focusing upon the layers of the “sensor stack” which includes:

- Front-end sensor
- Sensor specific digital signal processing
- Communications
- Data processing and fusion