Brief for GSDR 2015

The centrality of electricity supply for global sustainable development

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Introduction

Humanity faces many challenges in the field of sustainable development. Regardless of how sustainability is defined one subject that is very much underrepresented is the importance of electricity at the point of consumption. Electricity is the lifeblood of all modern societies, yet its continual flow is taken for granted. It is only when there is a power cut that we start to appreciate and realise how dependent our daily living standards are on the continuity of its supply. There are many things that can cause an interruption in supply, which can be either caused by humans or nature. In the UK many interruptions of the supply are localised, of a very short duration, are looked at as a minor glitch, and of bearable consequence. But when there is a widespread blackout due to a major incident, then the media and policy makers become vocal and responses are initiated to make the system more robust.

Scientific debate

Currently, about half the world population lives in urban areas, and it is estimated that by 2050 the global urban population is expected to approach 6.4 billion, (Gea, 2012 Section 5.2.2). This makes the robustness of the urban electricity system and the continuation of electricity supply, critical to the future resilience of cities and to the continuation of the standard of living of the population.

In the developed world all electricity generation systems are centralised, with consumers accessing the system via a national grid. Any failure in the national grid system can have far reaching indirect consequences at a very long distance from the actual point of failure, i.e. a failure chain can ensue. "*A **failure chain** is a set of linked failures spanning critical assets in multiple infrastructure systems in the city. As an example – loss of an electricity substation may stop a water treatment plant from functioning; this may stop a hospital from functioning; and this in turn may mean that much of the city's kidney dialysis capability (say) is lost. This failure chain would therefore span energy, water and healthcare systems*." (UNISDR, IBM, & AECOM, 2014). As the urban population grows an electrical failure will have increasing and more devastating secondary impacts on the daily lives of more and more people.

Interesting Facts
• By 2050 the global urban population is expected to approach 6.4 billion • *Solar radiation reaching the Earth's surface amounts to 3.9 million EJ/yr. (GEA, 2012)* • *There are 1.4 billion people without access to electricity. (GEA, 2012)* • *Only 35% of the energy input to the power stations is delivered as electricity to the end user.(Allen, Hammond, & McManus, 2008)* • *Only 3.9% of the 4127 papers analysed from academic literature connected to the field of disaster , had key words connected to electricity.(M. Kinn & Abbot, 2014a)*

A literature search was carried out to ascertain how important electricity was to academic fields associated with disasters. It was concluded that electricity was very much under-represented in the literature (M. Kinn & Abbot, 2014a). This led to further research to ascertain how a city is affected by an extended blackout. In

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the absence of academic work, a report about the reconstruction of New York after Hurricane Sandy in 2010 (DRAP, 2013), was used as a basis for a case study. The case study together with some cases about the total loss of electrical power to intensive care units (Nates, 2004), formed the basis of an input paper to the UNISDR Global Assessment Report 2015, (M. Kinn & Abbot, 2014b). What this paper highlights is the weaknesses and vulnerability of the basic functionality of modern cities due to the loss of electricity.

In many countries the national transmission and distribution systems need massive capital investment and operate on a very low capacity margin. Therefore by introducing distributed systems into the domestic, office and very-light industrial sectors, this will reduce the pressures on the centralised system as well as provide all the advantages that direct current voltage (DC) systems offer.

Every year billions of US dollars are lost in economic activity due to power cuts. (Balducci, 2002). This would be much reduced if the topology for the electricity system is of a distributed nature. The importance of the use of solar lighting was highlighted in the Lighting Africa Conference of 2010 (World-Bank, 2011). Just a few extra hours of light per day can increase economic activity and enhance education by giving everyone the ability to study at night. If just one solar light can make so much difference to a family and to a single person business how much more so if the cooking, food storage and heating activities can be provided via solar DC electricity.

If sustainability means that the level of living standards people expect today should be available in 100 years' time for our descendants, then we must fundamentally change the way electricity is supplied for consumption in the built environment. This can be achieved by using a decentralised DC system that will offer each building energy independence with energy security. By doing this mankind enhances its ability to maintain its ability to consume electricity for all daily activities thus maintaining a high standard of living.

While it is appreciated that technically there needs to be more improvements in the availability and development of DC voltage appliances, this is only due to a lack of focus about the need for this. The international community has to see, providing distributed energy systems all around the world, as a priority. This priority must be placed on the UN's agenda and governments all around the world must provide funding and research opportunities for DC voltage systems. This priority will draw-in private investment capital to develop the much needed low power DC consumer units.

Advantages of DC electrical systems

If DC electricity is used as the sole means of electrical supply then there will be the advantage of the elimination of the ubiquitous alternating current (AC) transformer's in each appliance, which can be up to 25 per household (Calwell & Reeder, 2002, p.7) and when micro-generators are used, the need for an expensive inverter is eliminated. Their elimination reduces the amount of energy lost in multiple conversions and therefore for a given peak load requirement, smaller DC micro generators will be needed, and therefore the cost for the system will be smaller (M. C. Kinn, 2011, p.109). Or for the same outlay a larger DC micro-generation system can be installed thus increasing the energy supply. DC electrical applications have less parts then their AC equivalence, therefore their mean-time-to-failure is lower, and in operation DC motors, fans, compressors, etc. are much quieter (M. C. Kinn, 2011, pp.113-114). By eliminating transformers, and increasing their mean-time-to-failure, their life cycle carbon footprint should be smaller than that of an AC equivalent application. Another advantage of DC only appliances is, their physical size is smaller and therefore the amount of materials needed to manufacture them is less.

Issues for further consideration

The following issues are suggested for consideration by policymakers:

- Promote research into the field of fully decentralised low powered DC autonomous systems
- Make it a priority that the direct and indirect effects of the loss of electricity in all power outage situations are recorded, understood, and papers are written so that the effects of the impact of the blackout becomes part of any disaster risk reduction plan.
- Distributed electrical systems should be included in any city resilience plane.
- Interdisciplinary research must include the fields of engineering like electrical, and mechanical engineers, in order to bridge the gap between the Social Science community and the Engineering community.

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