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## Energy and Environment Pillar

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# Environmentally Powered Smart Sensor Nodes in a Mesh Network Topology for Air Quality Diagnostic

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### Background & Objective

Air pollution is a major problem that has been recognised throughout the world for hundreds of years. In the middle ages, the burning of coal in cities released increasing amounts of smoke and sulphur dioxide to the atmosphere. In the late 18th century, the Industrial Revolution, beginning in the UK, led to escalation in pollutant emissions based around the use of coal by both homes and industry.Pollutant emissions continued to grow through the 19th and early 20th centuries leading to poor Air Quality (AQ). In more recent times, pollution from motor vehicles has become the most recognised AQ issue. Present pollution monitoring is revealing that if we don't act swiftly then vehicle pollution could harm our environment and reduce the quality of life for future generations. The number of cars, both in Qatar and in most countries around the world, is currently steadily increasing, and a speed up in technological development is required to combat the pollution problem. Poor AQ has negative effects on the environment and thus on our wellbeing. Air pollution from transport vehicles includes emissions of carbon monoxide, particulates, nitrogen oxides and dioxide, hydrocarbons and so on. Whilst much attention has been directed towards poor outdoors AQ we sometimes forget that we spend up to 90% of our time indoors. Consequently, keeping the air which we breathe at home clean is crucial, particularly for vulnerable people including babies, children, pregnant women and the unborn babies, the elderly, and those suffering from respiratory or allergic diseases such as asthma. Although in the majority of homes the indoor AQ (IAQ) is fairly good, CO, $SO_2$, $NO_2$ etc… are just some of the indoor air pollutants which can give cause for concern. The level of indoor air pollutants depends on factors such as outdoor air pollutants, construction materials and interior finishing, poorly-designed air conditioning and ventilation

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systems, and households and furniture (via outgassing from fabrics, paints, pets, etc.). Over-ventilation, as often thought, does not solve the problem. Nevertheless, this illusory solution is not adequate in the hot climate of the Gulf region as it leads to unacceptable levels in power demand. Sustaining economic and social growth is impossible without a holistic environmental vision that places environmental preservation for Qatar's future generations at the forefront. The QNV2030 aim to strike a balance between developmental needs (human, society, economy) and the protection of its natural environment, whether land, sea or air. Echoing international initiatives, Qatar has recently undertaken relentless intensive steps in an attempt to address the problem of AQ. The QNV2030 associated Qatar National Development Strategy 2011–2016 (QNDS 2011–2016), through a set of well-defined recommendations, stresses on the need to address the issues of environment and air pollution. To meet these needs, in this extended abstract we present SERENO (SEnsor and REceiver Node), a renewable energy-harvested sensor node that intelligently monitors air quality continuously without human intervention. This paper discusses the challenges of designing an autonomous system powered by ambient energy harvesting. Preliminary results demonstrate that, the presented platform could effectively report and trace air quality levels in a sort of set and forget scenario using a mesh network topology to cover as large as possible area deploying from tens to thousand nodes.

## Methods

The advances in low power electronics and in electrochemical sensors have enabled the development of low cost and power efficient air quality monitoring systems (dedicated to specific target gas and analysis) suitable for even stringent environments and disruptive locations, where air quality assessment is required without human intervention. Environmental energy harvesting technologies has been developed to maximize wireless sensor systems' lifetime and minimize energy consumption by adopting ultra-low power electronics (i.e. ultra-low power controller, low-power AO and CMOS switches). The use of virtually no-power consumed sensors (e.g. electrochemical sensors connected to signal conditioning electronics with supply current around 1 uA) coupled with wireless communication, working on the principle duty cycling (i.e. the device remains in low power SLEEP mode for almost 100% of the time) helps in maximizing the power efficiency and lifetime of the system. It makes the system operative only to perform designated tasks i.e. sensor warm-up, sampling, data processing and wireless data transmission or communication. The top view diagram of the renewable energy harvested system for air quality monitoring named SERENO is given below. Fig. 1 shows the 6 sensors operative on the PCB. The general description of the proposed system is described below.