1 Introduction

Access to adequate, reliable, sustainable and affordable modern energy services is crucial for socioeconomic development. Such energy access facilitates basic household comforts, reduces drudgery and promotes poverty reduction, and contributes to rural development, health and well-being, education, food security and gender empowerment, among other benefits. The *Sustainable Energy for All (SE4All)* initiative aims to achieve by 2030: universal access to modern energy services for households, productive uses and community applications; doubling the global rate of improvement in energy efficiency; and doubling the share of renewable energy in the global energy mix. Although household access to modern energy has received increasing attention over the past decade, access to energy for community and productive uses has not been highlighted as prominently nor tracked as closely.

This study focuses on health facilities as an important subset of community institutions where access to adequate, reliable and sustainable energy requires particular attention. Energy in health facilities is a critical enabler of universal access to health services. Without energy, many life-saving interventions cannot be undertaken – creating a barrier to the attainment of universal health coverage as well as key health-related Millennium Development Goals (MDGs). Many rural health facilities suffer from acute shortages of energy to power basic services such as lighting, communications, refrigeration, diagnostics and medical devices required for safe childbirth and treatment of illness or injury. District health facilities often lack reliable power for essential laboratory and medical equipment. Many hospitals also operate with only intermittent grid electricity provision or suffer from chronic electricity failures that interrupt support systems such as lights, water and temperature control in laboratories and critical care and surgery units. Such electricity outages also can damage medical and diagnostic devices.

At the same time, power production and energy consumption in homes, workplaces and community service sites, including health facilities, cause multiple environmental health risks (Wilkinson & Markandya, 2007; Wilkinson et al., 2007). WHO estimates that household air pollution from biomass and coal cookstoves causes millions of deaths each year (World Health Organization, 2008a). Such pollution is a contributing factor in nearly half of the pneumonia deaths among children under the age of 5, and among adults it is a leading cause of chronic lung disease, cardiovascular disease and some cancers (World Health Organization, 2009a; Lim et al., 2012). Cookstove pollution is also a risk in the institutional kitchens of schools and health facilities where coal or biomass stoves are used. Meanwhile, poorly designed electrical installations, common in countries with weak building regulation codes, increase risk of fire, electrocution and other safety issues.

The widespread use of kerosene for lighting in health facilities poses health risks in terms of high indoor air pollution emissions as well as safety issues similar to those in households (Mills, 2012). Well-documented kerosene hazards include poisonings, fires and explosions. Studies of kerosene used for cooking or lighting provide evidence that kerosene particulate emissions may impair lung function and increase risks of tuberculosis, asthma and cancer (Lam et al., 2012a). Chronic exposure to pollution from kerosene lamps is thus a concern for health workers as well as households (Mills, 2012; Lam et al., 2012a).

In terms of power generation, stand-alone diesel generators, a common backup and off-grid source of light and power, emit higher concentrations of CO_2 and particulates per unit of power generation than conventional grid power sources (Natural Resources Canada, 2008; Ani & Emetu, 2013; Edenhofer et al., 2011; Gilmore et al., 2010).[i] Globally, both stand-alone generators and kerosene lamps are significant sources of particles of black carbon, a short-lived climate pollutant whose contribution to total carbon emissions is particularly significant in developing countries. This is a growing concern to climate scientists in light of the widespread use of such generators for electrification in off-grid areas (Lam et al., 2012b; Scientific Advisory Panel, 2013).[ii]

Conventional large-scale coal- and oil-powered electricity generation is, however, also extremely energy-inefficient, due to the large loss of heat energy in electricity production and transmission (Sims, et al., 2007). Systems for more efficient co-generation of heat and power, which harness heat that otherwise would be wasted for building thermal needs, are becoming increasingly popular in developed countries, including in health facilities that can afford the capital investment (World Health Organization, 2011; Carbon Trust, 2013).

More energy-efficient design and construction of health facilities can generate further energy cost-savings as well as health co-benefits. For instance, improved use of natural ventilation in health facilities can help reduce transmission of airborne infectious diseases such as tuberculosis (Atkinson, et al., 2009). More generally, climate-adapted and energy-efficient building design helps reduce risks to vulnerable patients and health workers from heat stress, cold exposure, allergies and asthma (World Health Organization, 2011).

Energy is frequently required for pumping water, and thus for safe drinking-water access. Health care facilities are high-risk settings where basic water, sanitation and hygiene (WASH) services are prerequisites to effectively treat and prevent disease. Standard minimum water requirements in health facilities are 5 litres per patient consultation and 40–60 litres per inpatient per day, with 100 litres required for a basic surgical operation (World Health Organization, 2008).

In low and middle-income countries, WASH services in many health facilities are often extremely limited. Of the 66,101 facilities sampled from 54 countries in a recent analysis, 38% did not have access to an improved water source.[iii] Facilities in sub-Saharan Africa had the least access among all regions. In addition, 35% of facilities did not have water and soap for handwashing (World Health Organization, In Press). Inadequate WASH facilities compromises the ability to safely provide basic, routine health services, such as child delivery. It also can increase the risk of infection transmission among health workers, patients and

i Gilmore et al. reported that municipal back-up diesel generators used to supplement power in urban areas during peak demand periods emitted 1.4 grams/kWh of $PM_{2.5}$, causing measurable health impacts on ambient air quality. Filtering generator exhaust or shifting to cleaner fuels can reduce emissions by 85–99%.

ii The Scientific Advisory Panel report of the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants notes: "The kerosene lamps commonly used in households in South Asia, Africa, and parts of Latin America have been confirmed to be a major source of indoor black carbon air pollution in these regions. Controlling this source would not only reduce air pollution, but also bring regional and global climate benefits. … . New information [also] shows that diesel generators are an important source of black carbon emissions in countries where public power supply lags behind electricity demand (e.g. India, Nepal and Nigeria). New evidence confirms that reducing black carbon emissions from diesel engines (both generators and vehicles) and some types of cook stoves provides clear climate benefits."

iii An improved drinking-water source is defined by WHO as a water source protected from outside contamination onsite or within 500 meters of the facility, and including: pipe water, public taps, standpipes, boreholes, protected springs and rainwater collection.

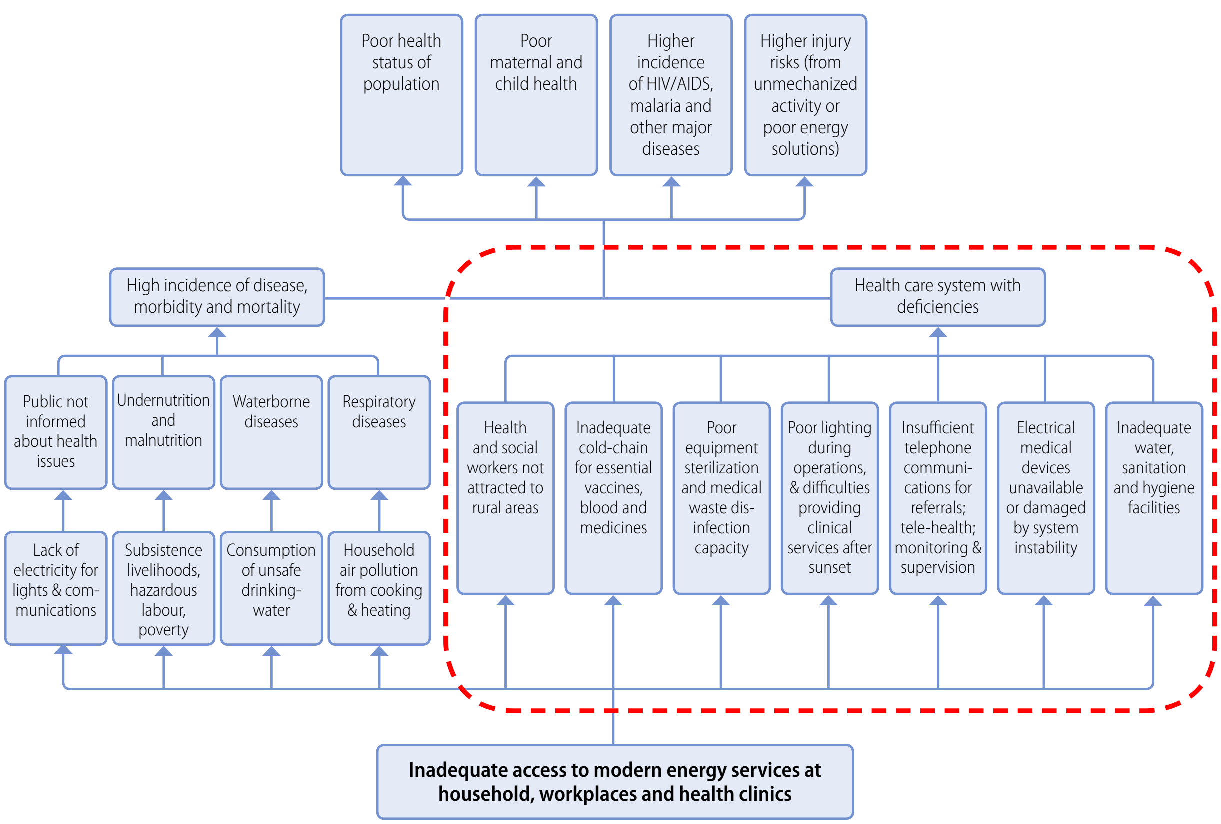
visitors. And lack of safe drinking-water access is the leading risk factor for diarrhoeal disease, one of the biggest killers of children under 5 years old (World Health Organization, 2008a).

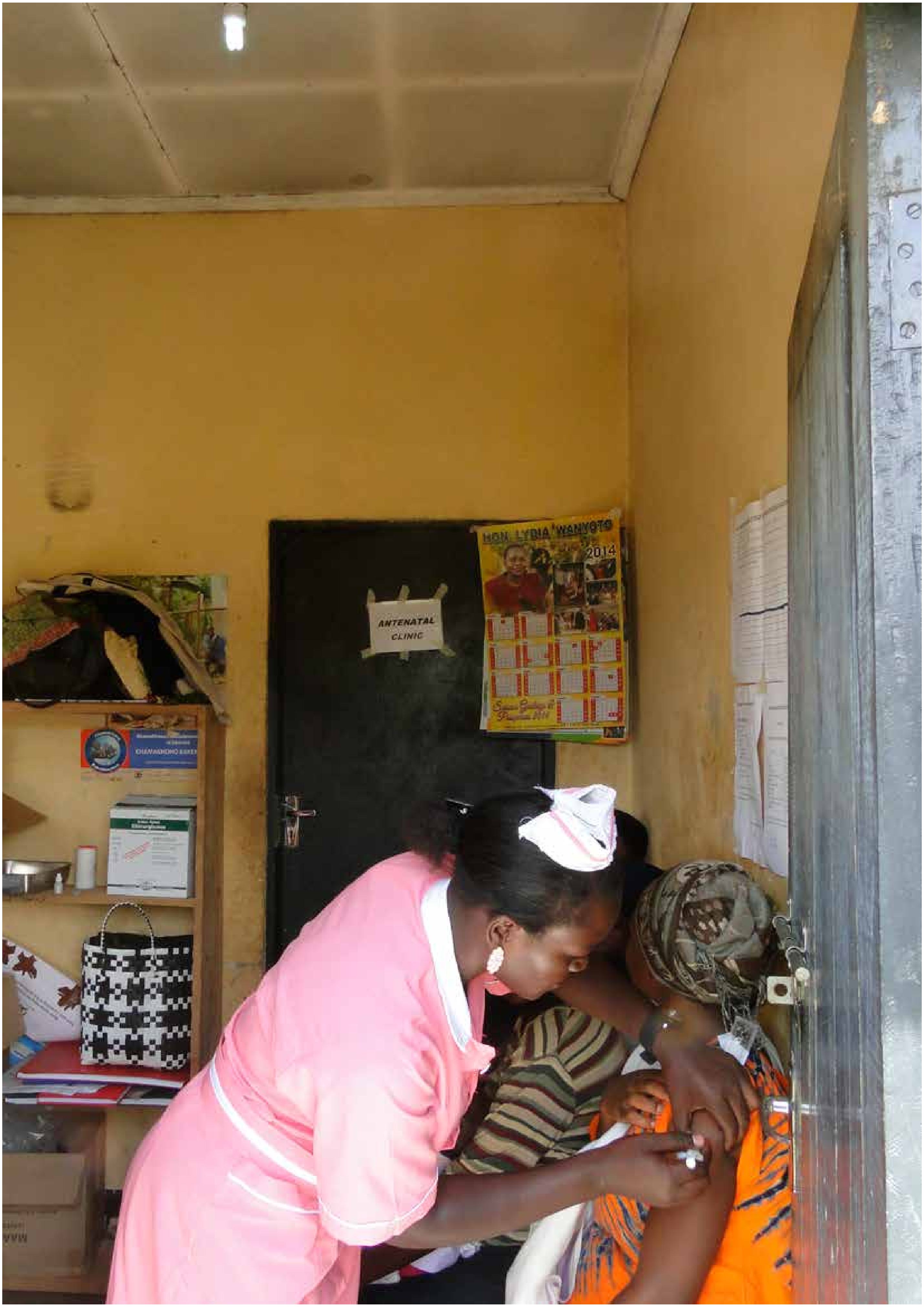
Fig. 1 notes some of the broader linkages between access to clean, sustainable energy and public health generally, as well as in relation to health care facilities.

This report examines the energy needs of health facilities, available evidence of effects of inadequate energy supply on delivery of health services, and approaches for strengthening data availability on access to energy in health facilities.

The discussion is organized as follows. **Chapter 2** examines how adequate access to energy in health facilities is an enabler of universal access to health care, and presents available data on the status of energy access in health facilities in the developing country context. **Chapter 3** examines the diverse energy needs of health facilities based on infrastructure requirements and the health services they deliver. **Chapter 4** looks at trends in electricity supply options among on-grid and off-grid health facilities in energy-constrained countries, including renewable and energy-efficient solutions. **Chapter 5** highlights the need for improved measurement of electricity access in health facilities based on key characteristics (attributes) of electricity demand and supply. **Chapter 6** considers an improved metric for measuring electricity access to capture the key attributes of electricity supply. **Chapter 7** suggests next steps for improving the measurement and monitoring of electricity access in health facilities. Further analytic work is needed to explore how and where electricity access can best enhance delivery of health services and deliver improved health outcomes. These efforts ultimately aim to draw greater attention to the need to catalyze increased investment for improving electricity supply in health facilities.

Fig. 1. Impact of energy access on public health

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