

Health Indicators of **sustainable energy**

in the Context of the Rio+20 UN Conference on Sustainable Development

Initial findings from a WHO Expert Consultation: 17-18 May 2012

Key messages:

Health is a universal indicator of progress in the UN Sustainable Energy for All initiative.¹ The most recent assessment suggests that 3.3 million deaths/year may be due to outdoor air pollution and 3.5 million deaths/year due to indoor smoke. Estimates of air pollution's health burden are far higher today than a decade ago – although better data and methods of analysis may also be a factor. Much air pollution is due to inefficient, poorly used, and badly distributed energy technologies. Improving access to modern energy that emits less pollution, both in the home and the community, can benefit the health of millions of people today and contribute to long-term health by reducing climate change.

- **Monitoring reductions in air pollution-related diseases provides an important bottom-line measure** of the social gains from a shift to more sustainable energy policies.
- **Monitoring progress in transition to low-emission energy technologies, including greater use of renewable energy** and efficient energy distribution, also are important to health.

Some key health-relevant indicators of progress on sustainable energy can include measures for:

- Household access to modern, low-emissions heating/cooking technologies;
- Energy access at community health facilities – particularly for reliable electricity;
- Health burden from air pollution-related diseases and injuries;
- Health equity impacts of energy policies – access of poor and vulnerable populations;
- Clean electricity generation across the energy supply chain – in terms of reduced pollution; greater efficiencies and reliance on renewable energy sources.

1. Linkages between sustainable energy policies and better public health

Improving access to low-emission,² renewable, and modern energy technologies both in the home and the community can benefit health and contribute to long term goals of sustainability. Notably, the inefficient combustion of fossil fuels and biomass for energy purposes is the major cause of climate change. Air pollution, often due to inefficient modes of energy production, distribution, and consumption, is a large and growing cause of environmental health risks. Some indicative statistics:

¹ *Energy for a sustainable future: summary report and recommendations*. New York, United Nations Secretary General's Advisory Committee Group on Energy and Climate Change, 2010.

² Rudimentary biomass/coal stoves typically release high levels of both health-damaging and climate changing pollutants per unit of energy generated, yielding very high household PM_{2.5} concentrations (200- 500 µg/m³). Use of "low-emission" stoves including advanced biomass, biogas, ethanol, or LPG (liquefied petroleum gas) can reduce CO₂ and particulate emissions and thus household PM_{2.5} concentrations – the latter by 90% or more. Mean annual PM_{2.5} concentration at or below the WHO Air Quality Guideline Interim Target-1 of 35 µg/m³ can reduce disease risk from air pollution exposure substantially.

- **Some 3.5 million deaths/year may be due to household air pollution from rudimentary biomass and coal stoves³ – this recent assessment is considerably higher than previous estimates.**⁴ These stoves, used in some 3 billion homes worldwide, emit large proportions of health-harming pollutants in their smoke – including black carbon particles, a short-lived climate change pollutant.
- **Approximately 3.3 million deaths/year may be due to outdoor air pollution³ – with exposures highest in developing cities.**⁵ Building energy use, transport and electric power generation based on the inefficient combustion of coal and diesel fuel are major contributors to outdoor air pollution and climate change emissions.⁶
- **In some developing countries, over one-half of health care facilities have no electricity or lack reliable electricity.**⁷ Health-care facilities depend on access to reliable electricity for functioning at night for operating diagnostic equipment, pumping water, vaccine storage, and managing hazardous waste. Thus, access to reliable electricity can have significant implications for providing health care, especially for reproductive and child health.
- **Some 1.3 billion people lack access to electricity and rely on kerosene lamps and other polluting alternatives for lighting.**⁸ **At the same time, conventional electric grid systems waste a great deal of energy.** About 50% of grid electricity produced may be lost as heat in conventional thermal power plants.⁹ New models for community-based micro-grids, combining use of solar/wind sources with co-generation of heat and power (CHP), can significantly increase access to energy and improve energy efficiencies through the use of cleaner technologies and mixes of renewables and fossil fuels – benefiting air quality, environment and health.¹⁰

Health offers a universal indicator of progress in attaining sustainable energy for all. By measuring indicators of *access* to energy, the idea that people need to have sufficient access to energy to ensure basic conditions of health and livelihoods is highlighted. Measures of *pollution* emitted and the associated *human exposure* reflect present day health impacts from inefficient energy technologies. Measures of energy *efficiencies* and the *renewable/fossil fuel mix* reflect impacts on climate change. These metrics can be used to assess progress in countries at very different starting points in terms of their current mix of energy technologies and consumption patterns.

³ Lim S, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*, 2012, 380(9859):2224-2260.

⁴ *Global health risks. Mortality and burden of disease attributable to selected major risks*. Geneva, World Health Organization, 2009.

⁵ *Outdoor air pollution in cities* [online database]. Geneva, World Health Organization. (http://www.who.int/phe/health_topics/outdoorair/databases/en/index.html).

⁶ Markandya A, Wilkinson P. Electricity generation and health. *Lancet*, 2007, 370(9591):979-90.

⁷ WHO analysis of USAID Demographic Health Survey's Service Provision Assessment (SPA).

⁸ Energy for all. In: *World Energy Outlook 2011*. Paris, Organisation for Economic Co-operation and Development Programme & International Energy Agency, 2011.

⁹ Metz, B et al. eds. *Climate change 2007: Mitigation of climate change. Contribution of Working Group III to the fourth assessment report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge & New York, 2007.

¹⁰ ClimateChange, 2007: Chapter 4.3.5-8 notes: "Up to two-thirds of the primary energy used to generate electricity in conventional thermal power plants is lost in the form of heat.... Switching from condensing steam turbines to CHP (cogeneration) plants produces electricity but captures the excess heat for use by municipalities for district heating, commercial buildings or industrial processes ... A wide variety of fuels is possible including biomass (Kirjavainen et al., 2004)...A well-designed and operated CHP scheme will provide better energy efficiency than a conventional plant, leading to both energy and cost savings (UNEP, 2004; EDUCOGEN, 2001)... Storage is of critical importance if variable low-carbon energy options such as wind and solar are to be better utilized.... Energy storage has a key role for small local systems where reliability is an important feature. ... Renewable-energy systems connected to the grid or used instead of diesel gensets will reduce GHG emissions. (IPCC 4.3.7).

2. Core health indicators that can monitor progress and identify success

Energy access

- Percentage of households with access to affordable, reliable, and cleanly generated electricity ;
- Percentage of households using modern fuels and technologies for all cooking, heating, and lighting activities that meet emissions and safety standards (as proposed by the Partnership for Clean Indoor Air/International Standards Organization (PCIA/ISO) *International Workshop Agreement* on international standards for cookstoves and WHO guidelines on household fuel combustion (in preparation)).¹¹

The above indicators build upon the targets set in the *UN Secretary General's Advisory Group on Energy and Climate Change (AGECC) Report* calling for universal access by 2030—as measured by the percentage of households with access to modern energy.¹² AGECC targets also call for doubling the rate of improvement in energy efficiency and doubling the share of renewable energy in the global energy mix.

Power (electricity) generation

- Proportion of electricity generated with technologies that produce low levels of pollutants that harm health and climate across the energy lifecycle (extraction, generation, and distribution);

Energy for health facilities

- Proportion of health facilities with reliable 24-hour supply of electricity and water;

Attributable health burden

- Rates of adult and child disease burden and injuries (deaths and DALYs)¹³ attributable to household air pollution from the incomplete combustion of biomass fuels and coal for cooking and heating;
- Rates of adult and child disease burden (deaths and DALYs) attributable to outdoor air pollution in both urban and rural settings;

Health and health equity impacts in energy policy

- Whether or not health and health equity impacts (by gender, age, and socio-economic status) are routinely assessed and accounted for in the design and implementation of major energy policies such as through the use of health impact assessments.

3. Expanded indicators

Outdoor air pollution

- Concentrations of outdoor air pollution (now mainly available from routine ground level monitoring sites in large urban areas) supplemented (where available and relevant) by data from emissions inventories and satellite remote-sensing with source apportionment;

Household air pollution (HAP)

¹¹ Safety (including protocols for testing) are also included in the PCIA/ISO *International Workshop Agreement* (IWA): <http://www.pciaonline.org/news/cookstoves-iwa-unanimously-approved>.

¹² *Energy for a sustainable future: summary report and recommendations*. New York, United Nations Secretary General's Advisory Committee Group on Energy and Climate Change, 2010.

¹³ Disability-adjusted life year (DALY) is a quantification of total death, disease and disability expressed in terms of "life years" lost or gained.

- Nationally-representative average HAP concentrations and/or personal exposures;

Disease burden from household air pollution by country and cause of illness

- Building on the WHO's work on comparative risk assessment for global burden of disease and environmental health risks, national level estimates of burden of disease from household air pollution are available, including estimates by cause of illness and death;

4. Added value of these health indicators

Measures of the health burden from both household and outdoor energy-related pollution offers important indicators of progress towards adoption of cleaner fuels and technologies for households in middle- and low-income countries. Regular and reliable provision of electricity to health care facilities is important for their effective operation.

The UN Secretary General's Initiative for *Sustainable Energy for All* on universal modern energy access by 2030 provides the rationale for linking health indicators on energy access directly to the UN AGECC's target at the household level, for ensuring that the health risks from power generation are managed, and that health benefits are maximized. The generation of electricity from low-emission sources is critical to the achievement of greenhouse gas reduction targets and will also carry appreciable population health benefits. Monitoring the use of health impact assessment for alternative energy strategies will reflect the degree to which decision-makers are considering the distribution of energy benefits (and risks) across different populations. Health impact assessments can also provide data on the health costs and benefits of alternative energy strategies/policy investments.

5. Feasibility of data reporting

Mode of energy production/use

Global and national data, by energy mode, is available from the International Energy Agency.¹⁴

Household and community energy access in countries

In terms of household reliance on coal and biomass for cooking, WHO maintains a *Global Household Energy Database*, which includes information for over 150 countries.¹⁵ A greater emphasis is being placed on data collection in the context of the UN Secretary General's initiative. This database is being expanded to include household data on lighting, heating, and access to electricity. In terms of health facilities, limited data on access to power is available from surveys administered by several multilateral agencies; this data has recently been compiled by WHO for about 10 countries in sub-Saharan Africa. However, data collection on health sector energy access needs more precise information about energy modes used, the level of power supply, and the reliability of the power supply. Improvements in survey design and implementation are needed to ensure comparability across different surveys used and to

¹⁴ Note: Country level energy 'use' is described by IEA in terms of its "total primary energy supply (TPES)", which is defined as production + imports - exports - international aviation and international marine bunkers +/- stock changes. In: *Key world energy statistics 2011*. Paris, Organization for Economic Co-operation and Development (OECD)/International Energy Agency (IEA), 2011 (www.iea.org).

¹⁵ *WHO Household energy data base*. Geneva, World Health Organization. (http://www.who.int/indoorair/health_impacts/ie_database/en/index.html).

ensure that surveys undertaken are representative of all health facilities, e.g. at regional, national or sub-national levels.

Outdoor and indoor air pollution emissions

Estimates of volume of CO₂ and air pollutant emissions are typically available at country level (typically by type of fuel as well as by use (e.g. heating, electricity generation, industrial). However, these estimates are based on modelling of emissions inventories that may or may not correctly estimate emissions from various uses and technologies. In particular, making reliable estimates of emissions from biomass burning is challenging in many developing countries where biomass burning is an important source of outdoor and household air pollution and the consequent disease burden.¹⁶ Outdoor emissions may arise for sources like crop-waste burning, household biomass use, charcoal manufacturing, waste incineration (including health-care waste), and brick kilns.

Outdoor and household air pollution concentrations and human exposures

Data available on ambient air pollution concentrations in over 1100 cities are compiled by WHO.¹⁷ Expanded geographic coverage of data for pollution concentrations and emissions is needed.

In terms of exposure to household air pollution, the main source of household air pollution exposure measurements is the *WHO Global Indoor Air Pollution Database*, which was developed in collaboration with the University of California at Berkeley.¹⁸ This database houses the results of HAP monitoring studies in about 250 communities globally, but these data samples are small in comparison to the large variations in risk for populations across Africa, South-East Asia, and Latin America. A new study, soon to be published, has modelled fuel use and housing characteristics to estimate HAP concentrations; however, this work is limited to only one country (i.e. India). This illustrates the potential, but also the enormous need, for expanded, robust monitoring of household air pollution concentrations and personal exposures, including disaggregated data for highest-range exposures and not only averages.

For more accurate indicators of the health impacts from exposure to household air pollution, more comprehensive household surveys would be needed for: types of cooking, heating and lighting fuels and technologies; quality of stove maintenance; and ventilation. Such survey data could then be examined in light of new *WHO Guidelines for Indoor Air Quality for Household Fuel Combustion*¹⁹ and PCIA/ISO standards to better estimate health impacts.

Disease burden from outdoor (urban) air pollution

The *WHO Comparative Risk Assessment in the Global Burden of Disease Study and the Environmental Health Risks* translates outdoor urban air pollution concentrations to estimates of global mortality and morbidity in cities over 100 000. The assessment is based on a large body of research from large, long-term population studies that have identified quantifiable relationships between higher concentrations of fine particulates (PM_{10/2.5}) and premature mortality.²⁰ A recent (2010) estimate of the burden of disease attributable to outdoor air pollution globally – including not only cities, but smaller human

¹⁶ http://www.who.int/hia/green_economy/en/index.html

¹⁷ Outdoor air pollution in cities [online database]. Geneva, World Health Organization, 21 May 2012 (http://www.who.int/phe/health_topics/outdoorair/databases/en/index.html).

¹⁸ Global indoor air pollution data base [online database]. California, World Health Organization and University of California at Berkeley, 5 June 2012 (http://www.who.int/indoorair/health_impacts/databases_iap/en/index.html).

¹⁹ In Press, 2012.

²⁰ *Global health risks: mortality and burden of disease attributable to selected major risk factors*. Geneva, World Health Organization, 2009.

settlements and rural areas – was made as part of a comparative risk assessment coordinated by the Institute of Health Metrics and Evaluation.²¹ In peri-urban and rural areas of developing countries considerable outdoor air pollution emissions may arise not only from household biomass use and other forms of energy production/consumption, but also from the open air burning of waste, various industrial activities, and from forest fires or land clearing. The WHO provides support to countries for carrying out national-level burden of disease assessments based on available exposure data.

Policy

Comprehensive data collection in forms suggested here is not currently available and would require surveys. Reporting on energy policies and investments could feasibly follow formats used for monitoring of health and development in the water sector such as the WHO/UNICEF *Joint Monitoring Programme* (JMP) responsible for monitoring the MDG 7 drinking-water and sanitation target²² as well as the more policy-oriented *UN Water Global Analysis and Assessment of Sanitation and Drinking-water* (GLAAS). It is expected that the Secretary General’s initiative on universal energy access will provide a framework for evaluating major national and international energy policies.

6. Cross-cutting issues for further consideration

Equity

Energy access and associated health impacts are very closely linked to inequities. For instance, the collection of increasingly stressed supplies of biomass takes up valuable time, especially for women and girls. That time spent on collection could be used for income generation or schooling and puts them at risk for injury and violence. Reliance on kerosene lighting presents health risks that extend beyond air pollution alone, including burns, scalds, and poisoning, especially to women and young children. It is critical that data is collected and disaggregated in reports and analyses by the following important groups: gender, age, socioeconomic status, and geography (e.g. urban/rural).

Integration

Improvements in household and community energy access can be synergistic with other priority environmental health interventions, e.g. for water, sanitation, and hygiene.

Climate change

Energy use is the primary driver of climate change. There are very substantial health co-benefits to be gained from measures to mitigate global warming.

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²¹ Lim S, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*, 2012, 380(9859):2224-2260.

²² Targets and indicators for global monitoring after 2015. WHO/UNICEF *Joint Monitoring Programme for Water Supply and Sanitation*.