# The nexus between energy and health in rural areas

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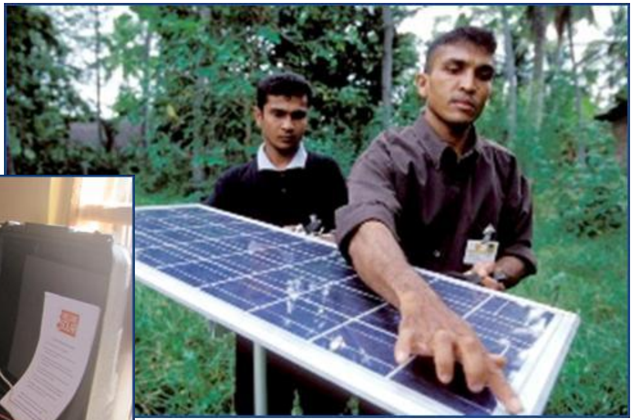
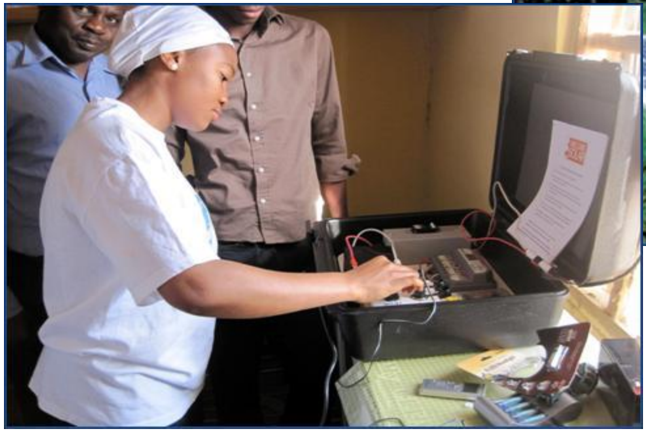
# WHO analysis of health in proposed SDGs : Strong synergies between Energy and Health

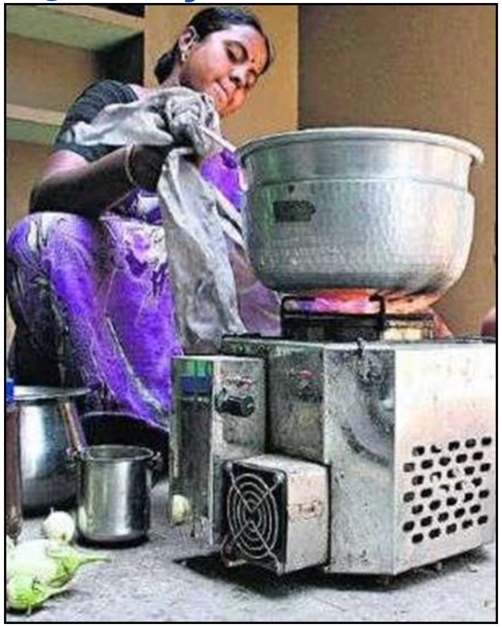
**Indicators:**

- **% of health care facilities with access to clean/sustainable energy**
- **% of households with access to clean** cookstoves and/or clean fuels.
- **Deaths and disease attributed to indoor and outdoor air pollution** (above WHO Air Quality guidelines)

WHO/Hans Everts







# Lessons on energy and health: India's National Program on Improved Chulhas (NPIC) (1985-2002):

Total installations reached 35 million units with more than 60 designs (*Venkataraman 2010*, *Barnet et al. 2012*

*Main issues*:

- Stoves in the field had low performance durability and usage, with some stoves having higher emissions than traditional stoves
- The program made use of subsidies to encourage stove distribution without paying adequate attention to consumer requirements and after-sales service.
- Little formal monitoring, making it difficult to evaluate and develop needed mid-course corrections in design and dissemination

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# The new Indian Biomass Cookstoves Initiative (2009-current)

*Goal*: to reach about 160 million households cooking with biomass and coal cookstoves

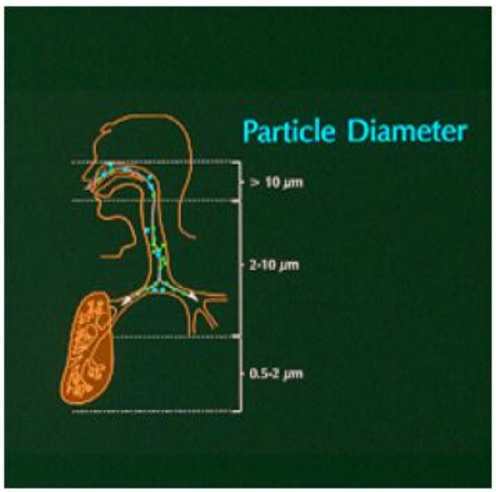
*Technology promoted:*

- Natural draft stoves: rely on natural ventilation for the mixing of the fuel and air;
- Forced draft stoves: use a fan to further improve fuel-air mixing.

The efficiency and overall performance varies considerably between these two technologies.

# Air pollution a link for climate change, health and development

PARTICLE SIZE AND DEPOSITION




$PM_{<10}$ – Coarse

$PM_{<2.5}$ – Fine

$PM_{<1}$ – Ultrafine

*Medgadget .com*

**Particles smaller than 2.5 micrometers are able to penetrate through the lungs and effect the body more systematically leading to cardiovascular disease and can lead to adverse pregnancy outcomes.**

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# Burden of disease from Air Pollution

## the sum is similar to number of tobacco deaths

- Outdoor air pollution → 3.2 million deaths/yr – large proportion urban exposures
- Indoor air pollution → 3,5 million deaths/yr – mostly from inefficient biomass/coal cookstoves

*(Lim S et al, Lancet, 2012)*

**Estimates being reviewed by the WHO release early 2014**

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# New studies:Air Pollution is responsible for a large proportion of major NCDs

## Indoor Air Pollution

~50% of all pneumonia deaths among children under 5

~30% of all COPD (Chronic obstructive pulmonary disease) deaths

~18% of disease & deaths from ischaemic heart disease

## Outdoor Air pollution

~22 % of disease & deaths from ischaemic heart disease

~15 % of deaths from pneumonia in children under 5

~5% of COPD deaths – (from ambient ozone pollution)

**Air pollution also is a factor in: Cancers, Asthma (ozone), Cataracts, Adverse pregnancy outcomes, TB**

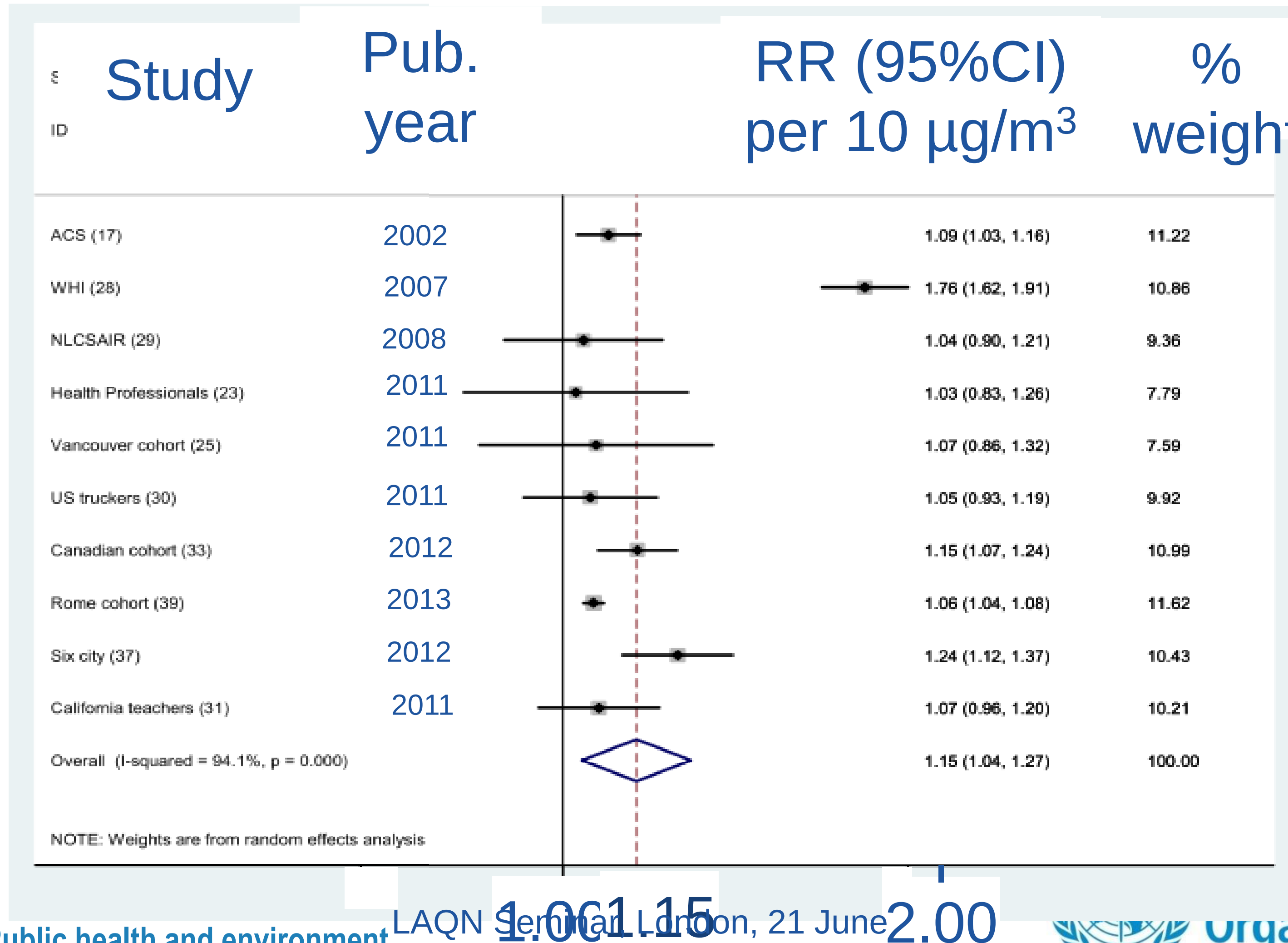
# "Review of evidence on health aspects of air pollution - REVIHAAP", WHO 2013

selected conclusions on PM (A1)

**Confirm and strengthen results form the 2005 WHO Guidelines on Air Quality and Health.**

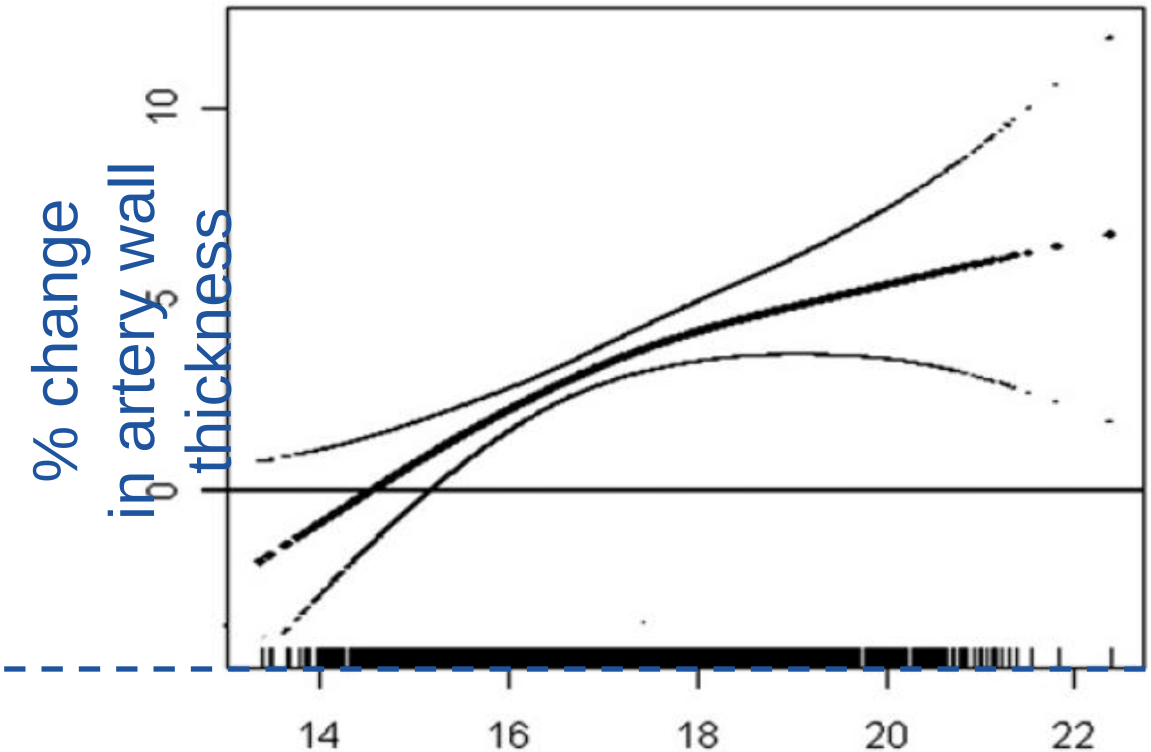
- New studies on **short- and long-term** effects;
- Long-term exposures to $PM_{2.5}$ are a cause of **cardiovascular** mortality and morbidity;
- More insight on **physiological** effects and plausible biological mechanisms linking short- and long-term $PM_{2.5}$ exposure with mortality and morbidity;
- Studies linking long-term exposure to $PM_{2.5}$ to several **new health outcomes (e.g. atherosclerosis, adverse birth outcomes,** childhood respiratory disease).

# Meta-analysis of the association between long-term exposure to **$PM_{2.5}$ and cardiovascular mortality**




Hoek et al, EnvHealth 2013

# **Carotid artery wall thickness** (=risk of atherosclerosis) and long-term $PM_{2.5}$ exposure




AQG

EU LV

Home outdoor $PM_{2.5}$ ($\mu g/m^3$)

Heinz Nixdorf RECALL study, Ruhr region, Germany

Bauer et al, JACC 2010

# WHO's International Agency for Research on Cancer – Sept.2013

Evidence review concludes:

- Air pollution mixture is a carcinogen
- Small particles (PM 10 and PM 2,5) are carcinogenic



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# WHO Indoor Air Quality Guidelines: Household fuel combustion

## To be released early in 2014

## What the new IAQ Guidelines offer?

# What the new IAQGs offer?

The guidelines are designed to provide countries and implementing partners with practical information on the performance and characteristics of household combustion technologies and fuels needed to prevent negative health effects currently attributable to this source of air pollution

Questions addressed:

1. What device and fuel emission rates are required to meet WHO air quality guideline for $PM_{2.5}$ (annual) and for CO (24 hours)?
2. In light of the acknowledged challenges in securing rapid adoption and sustained use of very low emission household energy devices and fuels, what approach should be taken during this transition?
3. Should coal be used as a household fuel?
4. Should kerosene be used as a household fuel?



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# Guidelines: evidence reviewed

- **Fuel use:** Global; for cooking, heating & lighting
- **Emissions:** range of technology & fuel options, how relate to AQG
- **Levels:** HAP and exposure
- **Health impacts of HAP:** risk for pneumonia, COPD, lung cancer, etc., including exposure-response.
- **Burns and poisoning:** risks, burden  and interventions
- **Intervention impacts:** HAP/exposure in routine use
- **Adoption at scale:** barriers and enablers, costs/benefits, finance

→

WHO Recommendations



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# Implementation phase

- Role of standards and testing
- Country focus: integration into action plans
- Field research on health impacts to assess the effectiveness of interventions:
- Which technology (including improved ventilation) work best and is safe
- How behaviour changes may contribute to reducing levels of HAP or exposure
- Role of fuel stacking and how to reach widespread and near-exclusive use of clean fuels/technologies
- Monitoring and evaluation



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# Monitoring and evaluation

- Tracking fuel use trends through the WHO Global Household Energy Database (which collates data on primary household fuel use provides a foundation for improved reporting of indoor air pollution concentrations)

- Extend monitoring to include not only cooking fuels, but also data on lighting and heating information for more refined estimation of health burden.

- Working with national survey networks to harmonize data collection on household energy data collection to better estimate health impacts



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# Household air pollution data base (WHO)

- Data from over 900 household surveys
- Information on fuels and technologies used for cooking, and now also for heating and lighting
- Base for estimates of IAP and related mortality

*(Lim S et al, Lancet, 2012)*

# Outdoor Air Quality Data (WHO)

**1500 cities, but sparse coverage for Africa, Latin America, Middle East**

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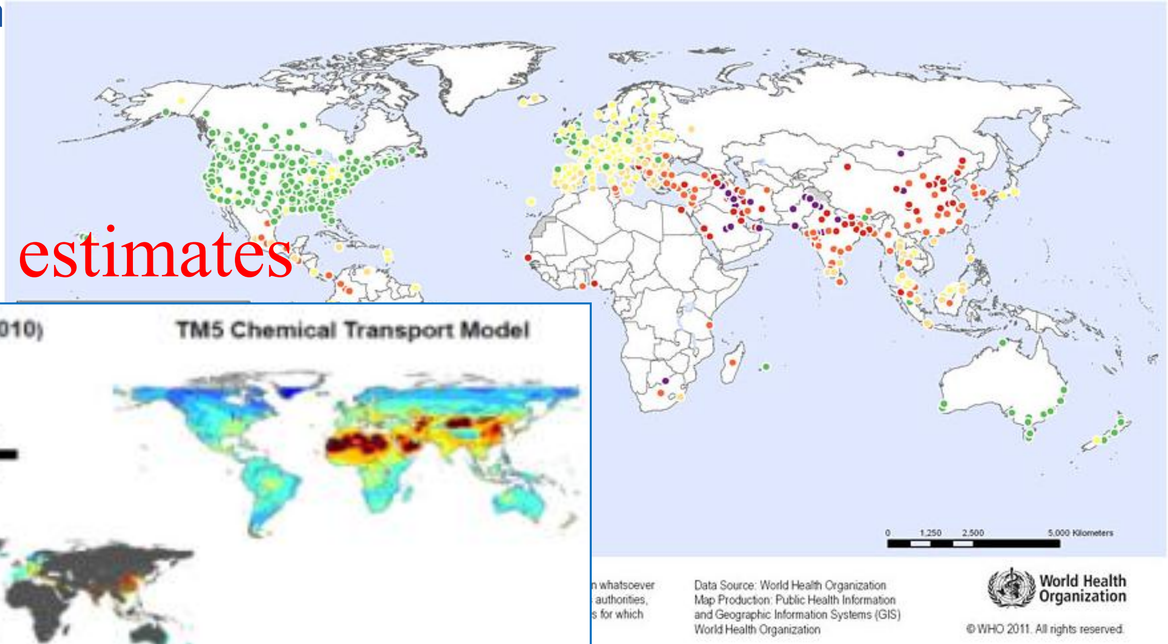
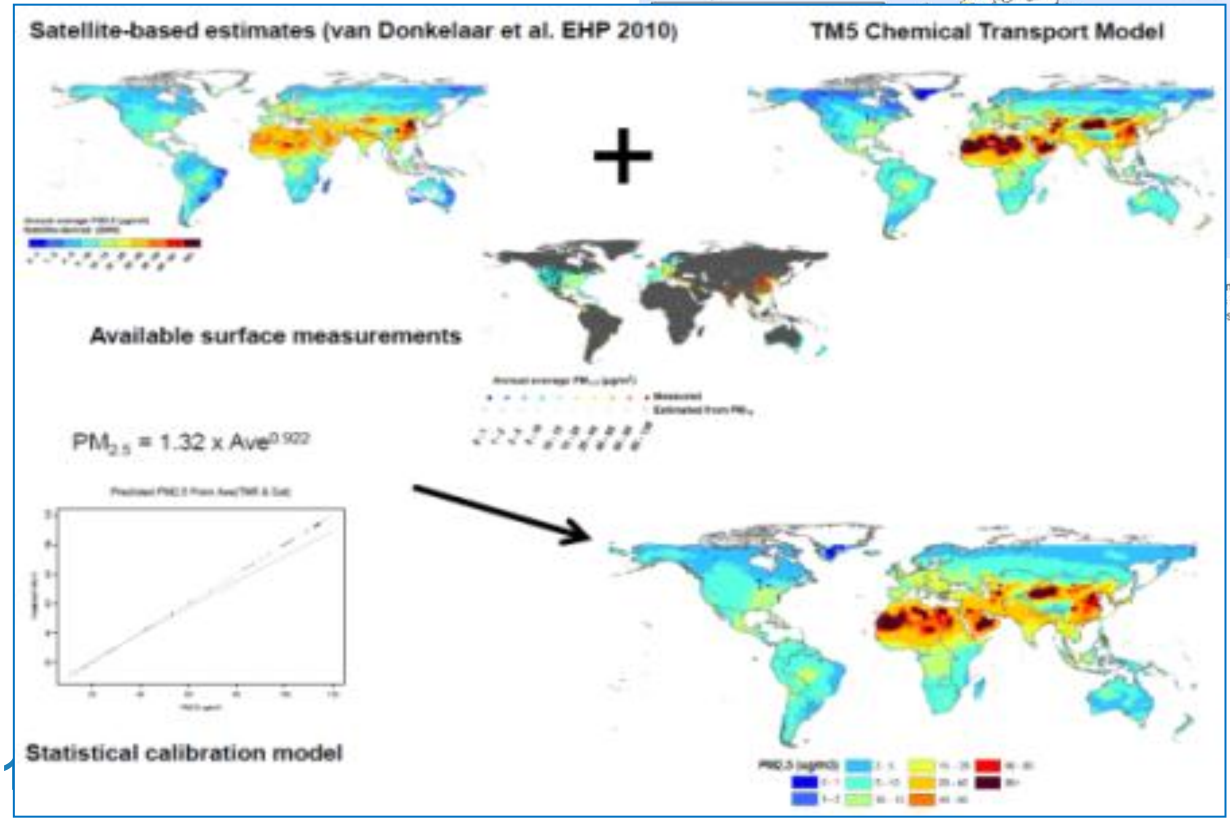



Next: Satellite base estimates



# Powering Health Care

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# Silent "epidemic" of energy poverty – Initial WHO analysis African facilities

| Survey | No. Countries | No Electricity | Unreliable Electricity | No/unreliable electricity | Method |
|---|---|---|---|---|---|
| DHS | 5 | **18-58%** | **15-49%** | - | Nationally representative |
| Global Fund | 4 | - | - | **23-55%** | Geographic Balance/high burden areas |
| WHO SAM/SARA | 5 | - | - | **42-84%** | Mix nationally representative /geographic balance |



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# Need for updated information

| DHS/SPA | Date |
|---|---|
| Ghana | 2002 |
| Rwanda | 2007 |
| Tanzania | 2006 |
| Uganda | 2007 |
| Kenya | 2010 |
| **WHO/SARA** | |
| Zambia | 2010 |
| Tanzania | 2008 |
| Sierra Leone | 2011 |
| **Global Fund** | |
| Burkina Faso | 2007 |
| Ethiopia | 2008 |
| Zambia | 2008 |
| Malawi | 2008 |
| **WHO/SAM** | |
| Rwanda | 2005 |
| Uganda | 2004 |

1. 10 African countries; 14 data points);
2. DHS data nationally representative; others may be more focused on high burden areas
3. Survey questions vague; not harmonized

# Need for better energy information in SARA:

**Continuity of supply/reliability**

**Power Capacity**: No data collected at all.

**Power mode:** Data on generator functionality is collected, but not for other modes (e.g. solar/wind).

| Number | Question | Result | | Skip |
|---|---|---|---|---|
| 410 | Does this facility have any of the following other sources of electricity? | YES | NO | |
| 01 | Fuel operated generator | 1 | 2 | |
| 02 | Battery operated generator | 1 | 2 | |
| 03 | Solar system | 1 | 2 | |
| 04 | Others ______________ (SPECIFY) | 1 | 2 | |
| | CHECK Q410_01 AND Q410_02:<br>GENERATOR ( "YES" CIRCLED FOR EITHER) | NO GENERATOR ("NO" CIRCLED FOR BOTH) | | Q413 |
| 411 | Is the generator functional? | YES .......... 1<br>NO .......... 2<br>DON'T KNOW .......... 98 | | <br>→413<br>→413 |
| 412 | Is there fuel or a charged battery available today? | YES .......... 1<br>NO .......... 2<br>DON'T KNOW .......... 98 | | |

Sample questionnaire:
http://www.who.int/healthinfo/systems/sara_introduction/en/index.html

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# Energy inequalities

**Estimated Electricity Consumption in Hospitals in India, 2008 (USAID)**

| Hospital | No. of Beds | Estimated kWh/Bed/ year | Assumed Electricity Cost per kWh | Estimated Electricity Consumption (Million kWh) | Estimated Electricity Cost (Rs. Millions) |
|---|---|---|---|---|---|
| Government Hospitals -Urban | 328,491* | 750 – 1500 | Rs. 5 | 246 - 492 | 1232 - 2464 |
| Government Hospital - Rural | 154,031* | 150 - 300 | Rs. 4 | 23 - 46 | 92 - 184 |
| Private/NGO Hospitals & Nursing Homes | 500,000** | 1000 – 2000 | Rs. 6 | 500 – 1000 | 3000 – 6000 |
| **Total** | **982,522** | ---- | ----- | **769 - 1538** | **4324 - 8748** |

**India (USAID)**

- Private hospitals used 25% more power per bed than government facilities – disparities can be 10x more in some cases.
- Urban government hospitals used 5x more electricity than rural facilities



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# Infrastructure → Services

| •Energy services | •Possible technologies | •Medical Procedures |
|---|---|---|
| •Lighting | •PV, Wind, Hydro, Diesel | •Delivery, operations and visits at night |
| •Refrigeration | •PV, Wind, Hydro, LPG, Kerosene | •Storage of medicines, vaccines, reagents for basic lab exams |
| •Heat | •Solar, Thermal | •Sterilisation of equipment, cooking |
| •Radio communication | •PV, Wind, Hydro, Diesel, Wind-up | •Consultations and transport logistics |
| •Water pumping | •PV, Wind, Diesel, Hand-pumps | •Water for patient and staff hygiene, staff accommodation, cleaning |
| •Television / VCR | •PV, Wind, Hydro, Diesel | •Education/awareness-raising gatherings |

Source: Adapted from "*IT Power: Use of Renewable Energy in the Rural Health, Water and Education sectors.*" European Commission, 2007



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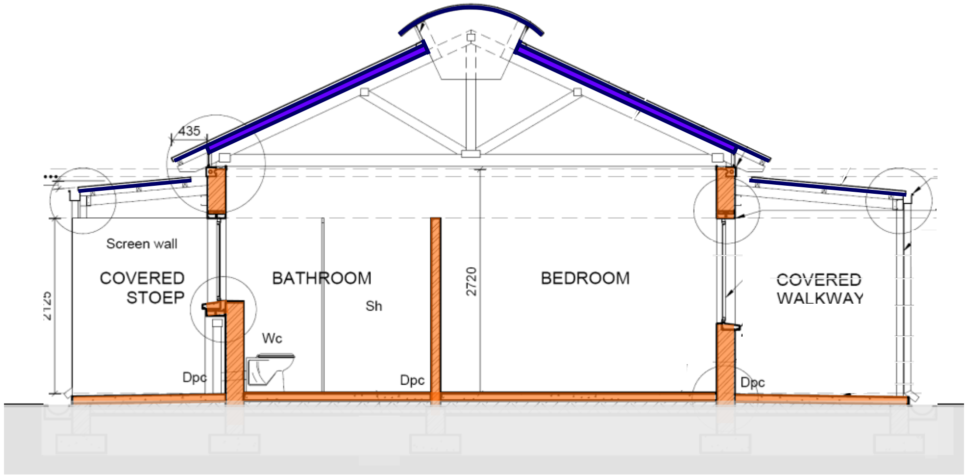
# Energy services → Health **(rarely measured)**

| | |
|---|---|
| **Medical services** | • Prolonged opening hours;<br>• Emergency surgical services;<br>• Obstetric emergency care (avoiding maternal deaths);<br>• Childhood illnesses;<br>• Chronic conditions;<br>• Referrals (communications);<br>• Sterilization ; |
| **Health & Safety** | • Hygiene and cleanliness with lighting and water available;<br>• Security lights for evening hours. |
| **Disease prevention and treatment** | • Improved cold chain for vaccines/blood supply;<br>• Improved testing for HIV and TB;<br>• Evening education with lights/TV/VCR. |
| **Staff & patient wellbeing** | • Staff & patient security<br>• Electricity for staff training/education;<br>• Staff recruitment/job satisfaction to locations w/ electricity and water; |
| **Administration and logistics** | • Administration & communications between health facilities<br>• Improving planning, transport logistics and quality assurance |

Source: **Adapted from:** ***IT Power: Use of Renewable Energy in the Rural Health, Water and Education Sectors.*** European Commission, 2007

# 2. Low-energy design

Excellent models of environmental design exist in developing countries – e.g. China, India, South Africa.




**South Africa: TB ward design, including rooftop and eaves natural ventilation**



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# 3. **Natural ventilation** – making the most of it for energy and health

- Infection control properties under-recognized

**Table 5: Infection risk in 15-minute exposure for an infector in 6m x 6.7m x 2.7m enclosed space**

| Quanta[ix] generation (quanta/min) | Ventilation rate (air changes per hour) (%) 1 | 6 | 18 | 30 |
|---|---|---|---|---|
| 1 | 0.05 | 0.01 | 0.00 | 0.00 |
| 7 | 0.30 | 0.06 | 0.02 | 0.01 |
| 14 | 0.51 | 0.11 | 0.04 | 0.02 |
| 20 | 0.64 | 0.16 | 0.06 | 0.04 |

- Not a panacea – but important to consider – particularly in low-resource settings (WHO, 2009/systematic review)

**Table 4. Estimated air changes per hour (ACH) and ventilation rate for a 7m x 6m x 3m ward**

| Openings | ACH | Ventilation rate (l/s)* |
|---|---|---|
| Open window (100%) + open door | 37 | 1300 |
| Open window (50%) + open door | 28 | 975 |
| Open window (100%) + closed door | 4.2 | 150 |

* L/s (Litres per second) | *Source: (WHO, 2009)*



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# 4. Low-energy appliances


**Vaccine refrigeration needs are projected to increase 8-10 times by 2030. that demand can only be met with greater reliance upon solar technologies.**

*Solar, direct-drive fridge in Viet Nam:.*

*WHO/Path "Project Optimize" renewable energy initiative in three countries: Viet Nam, Tunisia and Senegal.*

# 5. Low energy medical devices


Rapid Diagnostics for HIV/malaria and congenital syphilis & more recently, LED fluorescence TB smear microscopy are just a few examples. (Photo: DFID)

# 6. Water harvesting and grey water reuse

- Saves energy for water pumping/extraction in limited resource settings
- Now mandatory for new buildings in 18 of 28 Indian states.


*Samhavna Clinic, Bhopal, India. – Rainwater from the monsoon season is collected, from the roof, filtered and stored in large underground tanks for use in the summer*

# 7. Health waste management

One-quarter of health waste is hazardous – poor waste management puts poor countries most at risk.

– Waste-energy systems may exact a health penalty (e.g. emissions of dioxins, pollutants)

– Mechanical/thermal treatment (e.g. microwaving/autoclaving) – need more exploration.

**Open health waste incineration pit – Haiti**

**Hydroclave: steam sterilization and grinding/volume reduction - Guyana**



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# 8. Procurement, transport & telehealth, anaesthetic gas containment/reuse

All have health, energy & climate impacts – need to be part of long-term approach to "energy & environmental performance"

# Health Sector Energy Needs are Unique

- **High, constant energy supply**
- **Electricity is a primary need** – but thermal energy also vital in larger facilities
- **Power has to be "failproof"** – it's a matter of life and death
- **Reliable power requires hybrid solutions** (a primary and secondary power source)