University of Sussex

# Renewable energy technologies for rural development: Drivers, options and issues

**Jim Watson (and Oliver Johnson)**
Sussex Energy Group, University of Sussex, UK

**UNCTAD Expert Meeting on Green and Renewable Technologies**
**Geneva, 9-11 February 2010**

**Sussex Energy Group**
**SPRU - Science and Technology Policy Research**

Tyndall Centre for Climate Change Research

# Overview

University of Sussex

1. Contexts: Drivers for rural renewables
2. Overview of technological options
3. Key issues and considerations
4. Conclusions

Sussex Energy Group
SPRU - Science and Technology Policy Research

Tyndall Centre for Climate Change Research

# Contexts

## Millenium Development Goals (source: DFID)

University of Sussex

**Goal 1: Eradicate extreme poverty and hunger.** Modern energy services can facilitate economic development; improve access to clean water and cooked food

**Goals 2 and 3: Achieve universal primary education; promote gender equality.** Can reduce time taken by women and children for basic survival and improve access to education

**Goals 4, 5, 6: Reduce child mortality, improve maternal health; combat major diseases.** Energy is a key component of a functioning health system

**Goal 7: Ensure environmental sustainability.** Renewables can help with sustainable resource use and reduce emissions

# Contexts
## Energy access

University of Sussex

- **2.4 billion rely on traditional biomass fuels for cooking in the developing world. Negative impacts:**
  - Time taken to gather woodfuel (several hours per day is common) which reduces opportunity for income generation
  - Indoor air pollution which causes 1.3 million premature deaths each year.
- **Transition to 'modern' fuels such as electricity is happening in some countries – e.g. China's levels of electricity access and car ownership rising fast**
- **But many countries making transition very slowly: ~ 1.6 billion people still do not have access to electricity**

# Contexts
## Electricity access (IEA, 2006)

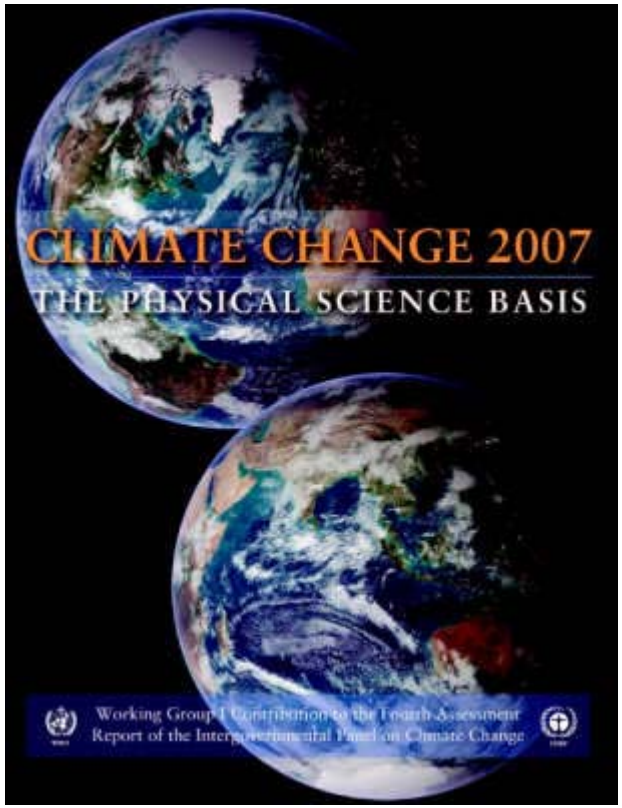
University of Sussex

**Some data from sub-Saharan Africa:**

| | Total | Urban | Rural |
|---|---|---|---|
| Benin | 22% | 51% | 6% |
| Cameroon | 46% | 77% | 17% |
| Kenya | 13% | 52% | 4% |
| Malawi | 8% | 34% | 2% |
| Senegal | 47% | 82% | 19% |

# Contexts
## Climate change

University of Sussex




**“Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level” (IPCC)**

Sussex Energy Group
SPRU - Science and Technology Policy Research

Tyndall Centre for Climate Change Research

# Contexts
## Climate change

University of Sussex

- **Global emissions need to peak by 2015, and reduce by at least 50% by 2050 (compared to 1990 levels)**
- **Key issue of impacts of climate change. These are expected to be most severe for some poorer countries**
- **Also might suffer impacts from others' mitigation efforts (e.g. risks from some first generation biofuels)**
- **Whilst historical responsibility requires developed nations to act first, low carbon development pathways important for all countries**

# Overview of key technologies

University of Sussex

| Energy Source | Domestic Energy | Electricity |
|---|---|---|
| ***Elemental renewables*** | | |
| Solar | | |
| Water | | |
| Wind | | |
| Geothermal | | |
| ***Biological renewables*** | | |
| Energy crops | | |
| Standard crops / by-products | | |
| Forestry and by-products | | |
| Animal by-products | | |

Source: Renewable Energy Association

**Sussex Energy Group**
**SPRU - Science and Technology Policy Research**

Tyndall Centre for Climate Change Research

# Overview of key technologies

University of Sussex

| Energy Source | Domestic Energy | Electricity |
|---|---|---|
| ***Elemental renewables*** | | |
| Solar | Solar pump / cooker | Solar PV |
| Water | | Micro- / pico-hydro |
| Wind | Wind pump | Wind turbine |
| Geothermal | | Geothermal plant |
| ***Biological renewables*** | | |
| Energy crops | | Biomass plant |
| Standard crops / by-products | | Biomass plant |
| Forestry and by-products | Improved cookstoves | Biomass plant |
| Animal by-products | Biogas digester, Improved cookstoves | Biogas digester |

Source: Renewable Energy Association

**Sussex Energy Group**
**SPRU - Science and Technology Policy Research**

Tyndall Centre for Climate Change Research

# Overview of key technologies

University of Sussex

| Energy Source | Domestic Energy | Electricity |
|---|---|---|
| ***Elemental renewables*** | | |
| Solar | **Solar pump / cooker** | Solar PV |
| Water | | / pico-hydro |
| Wind | | d turbine |
| Geothermal | | ermal plant |
| ***Biological renewables*** | | |
| Energy crops | | nass plant |
| Standard crops / by-products | | nass plant |
| Forestry and by-products | | nass plant |
| Animal by-products | | as digester |
| | Improved cookstoves | |

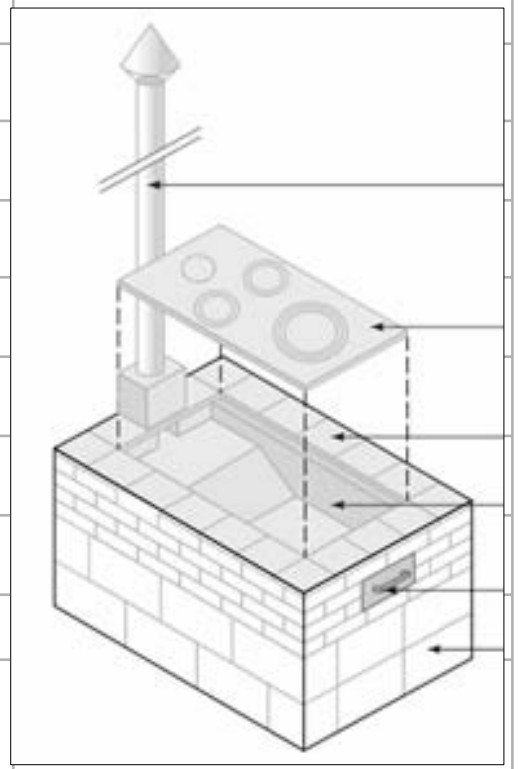
Sussex Energy Group
SPRU - Science and Technology Policy Research

Tyndall Centre for Climate Change Research

# Overview of key technologies

University of Sussex

| Energy Source | Domestic Energy | Electricity |
|---|---|---|
| ***Elemental renewables*** | | |
| Solar | Solar pump / cooker | |
| Water | | |
| Wind | Wind pump | |
| Geothermal | | |
| ***Biological renewables*** | | |
| Energy crops | | |
| Standard crops / by-products | | |
| Forestry and by-products | **Improved cookstoves** | |
| Animal by-products | Biogas digester, **Improved cookstoves** | |



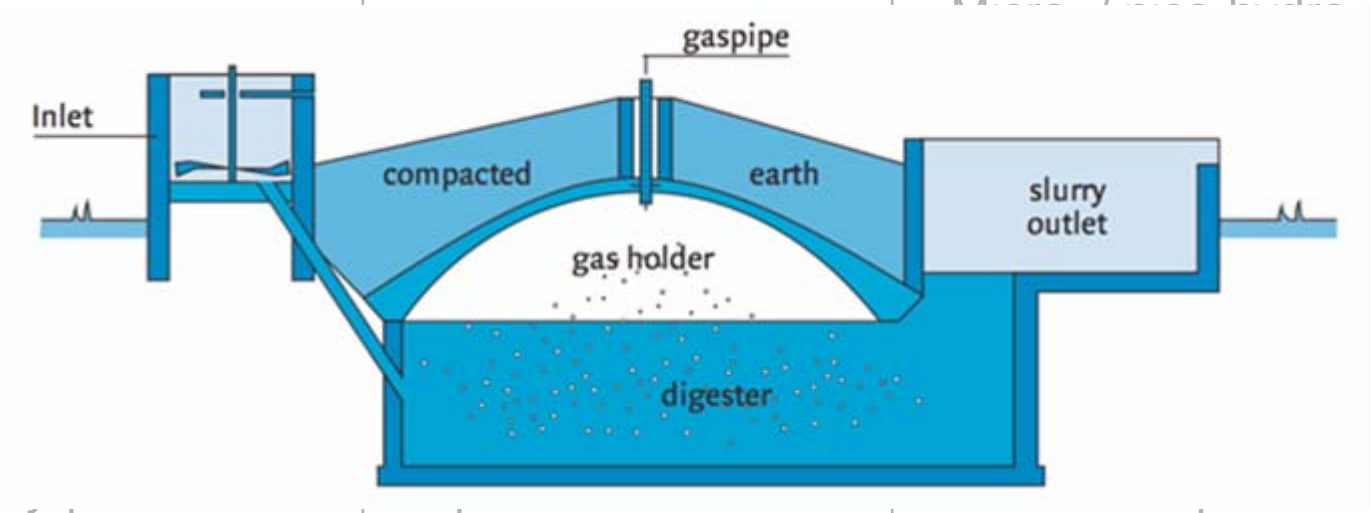
**Sussex Energy Group**
**SPRU - Science and Technology Policy Research**

Tyndall Centre for Climate Change Research

# Overview of key technologies

University of Sussex

| Energy Source | Domestic Energy | Electricity |
|---|---|---|
| ***Elemental renewables*** | | |
| Solar | Solar pump / cooker | Solar PV |
| Water | | |
| Wind | | |
| Geothermal | | |
| ***Biological re*** | | |
| Energy crops | | |
| Standard cro | | |
| Forestry and | | |
| Animal by-products | **Biogas digester,** Improved cookstoves | **Biogas digester** |




**Sussex Energy Group**
**SPRU - Science and Technology Policy Research**

Tyndall Centre for Climate Change Research

# Overview of key technologies

University of Sussex

| Energy Source | Domestic Energy | Electricity |
|---|---|---|
| ***Elemental renewables*** | | |
| Solar | | **Solar PV** |
| Water | | Micro- / pico-hydro |
| Wind | | Wind turbine |
| Geothermal | | Geothermal plant |
| ***Biological renewables*** | | |
| Energy crops | | Biomass plant |
| Standard crops / by-products | | Biomass plant |
| Forestry and by-products | | Biomass plant |
| Animal by-products | | Biogas digester |


**Sussex Energy Group**
**SPRU - Science and Technology Policy Research**

Tyndall Centre for Climate Change Research

# Overview of key technologies

University of Sussex

| Energy Source | Domestic Energy | Electricity |
|---|---|---|
| ***Elemental renewables*** | | |
| Solar | | **Solar PV** |
| Water | | Micro- / pico-hydro |
| Wind | | **Wind turbine** |
| Geothermal | | Geothermal plant |
| ***Biological renewables*** | | |
| Energy crops | | Biomass plant |
| Standard crops / by-products | | Biomass plant |
| Forestry and by-products | | Biomass plant |
| Animal by-products | | Biogas digester |

**Sussex Energy Group**
**SPRU - Science and Technology Policy Research**

Tyndall Centre for Climate Change Research

# Overview of key technologies

University of Sussex

| Energy Source | Domestic Energy | Electricity |
|---|---|---|
| ***Elemen*** | | |
| Solar | | Solar PV |
| Water | | **Micro- / pico-hydro** |
| Wind | | Wind turbine |
| Geothe | | Geothermal plant |
| ***Biologi*** | | |
| Energy | | Biomass plant |
| Standar | | Biomass plant |
| Forestry | | Biomass plant |
| Animal | Improved cookstoves | Biogas digester |

**Sussex Energy Group**
**SPRU - Science and Technology Policy Research**

Tyndall Centre for Climate Change Research

# Overview of key technologies

University of Sussex

| Energy Source | Domestic Energy | Electricity |
|---|---|---|
| ***Elemental re*** | | |
| Solar | | Solar PV |
| Water | | Micro- / pico-hydro |
| Wind | | Wind turbine |
| Geothermal | | **Geothermal plant** |
| ***Biological re*** | | |
| Energy crops | | Biomass plant |
| Standard cro | | Biomass plant |
| Forestry and | | Biomass plant |
| Animal by-products | Biogas digester, Improved cookstoves | Biogas digester |

**Sussex Energy Group**
**SPRU - Science and Technology Policy Research**

Tyndall Centre for Climate Change Research

# Overview of key technologies

University of Sussex

| Energy Source | Domestic Energy | Electricity |
|---|---|---|
| ***Elemental renewables*** | | |
| Solar | Solar pump / cooker | Solar PV |
| Water | | Micro- / pico-hydro |
| Wind | Wind pump | Wind turbine |
| Geothermal | | Geothermal plant |
| ***Biological renewal*** | | |
| Energy crops | | **Biomass plant** |
| Standard crops / by | | **Biomass plant** |
| Forestry and by-pro | | **Biomass plant** |
| Animal by-products | Improved cookstoves | Biogas digester |

**Sussex Energy Group**
**SPRU - Science and Technology Policy Research**

Tyndall Centre for Climate Change Research

# Some key issues
## Barriers to deployment

University of Sussex

- **Deployment of these options goes beyond availability of technology**
- **Costs are often high, therefore financial incentives are required – at least for a transitional period**
- **Lack of standards can inhibit successful diffusion**
- **Policy focus on centralised grid extension can exclude opportunities for rural renewables**
- **May need adaptation to local needs, with input from users in design process. Innovative capabilities crucial**

# Some key issues
## Innovative capabilities

University of Sussex

- **Complementary sources of capabilities: localised innovation and external (e.g. technology transfer)**
- **No ‘one policy fits all’ solution: varies by sector, stage of development etc.**
- **Need new institutional capabilities for innovation, e.g. through joint R,D,D&D or low carbon innovation centres**
- **Access to Intellectual Property Rights ‘necessary but not sufficient’ for technology transfer. Lack of access can slow rate of ‘catching up’ in specific technologies**
- **National and international policy environments (financial incentives, regulations etc) can have a large impact**

**Sussex Energy Group**
**SPRU - Science and Technology Policy Research**

Tyndall Centre
for Climate Change Research

# Our case studies

University of Sussex

| | | | | |
|---|---|---|---|---|
| ***Energy for domestic use*** | | | | |
| | Biogas Sector Partnership | Nepal | Biogas plant | NL / DE govts |
| | Improved Stoves Program | Eritrea | Mixed fuel stove | Eritrea govt |
| | Improved Stoves Program | Guatemala | Wood stove | Guatemala govt / donors |
| ***Electricity*** | | | | |
| | Renewable Energy Development Project | China | Solar PV lighting | IBRD/GEF |
| | Renewable Energy in Rural Markets Project | Argentina | Mixed techs | IBRD/GEF |
| | Market-driven pico-hydro | Lao PDR | Pico-hydro | Consumers |
| | Telecoms base stations | Namibia | Wind turbine | Firms |

**Sussex Energy Group**
**SPRU - Science and Technology Policy Research**

Tyndall Centre for Climate Change Research

# Some key issues
## National policies and incentives

University of Sussex

- **Capacity building and R&D (e.g. for improved cook stoves in Guatemala; solar PV in China)**
- **Subsidies and incentives (e.g. cookstoves in Eritrea required 85% subsidy; microfinance for biogas in Nepal)**
- **Standards and performance guarantees (e.g. biogas plants in Nepal; lack of standards problematic for pico-hydro in Laos)**
- **Promotion of local manufacturers – often to reduce costs and as part of technology adaptation process (e.g. cook stoves; solar PV in China)**

# Some key issues
## International policies

University of Sussex

- **Donor funding essential in many cases we reviewed (e.g. Biogas in Nepal; rural renewables in China). But can market can be sustained when funding is withdrawn?**
- **But need to be flexible and linked to national policies (e.g. Argentia's programme of rural electrification)**
- **Climate funds (e.g. CDM) do not generally reach small scale rural projects. Very few in sub-Saharan Africa.**
- **Project funding needs to be complemented by funding for generic capacity to innovate**
- **Learning can be important – between projects and between countries / contexts**

**Sussex Energy Group**
**SPRU - Science and Technology Policy Research**

Tyndall Centre for Climate Change Research

# Conclusions

University of Sussex

- Strong drivers for rural renewables: address several MDGs; energy access and climate change agendas
- Public financial support very important in most cases, from both national and international sources
- But need to think about mechanisms to sustain demand once support is no longer available
- Local involvement / adaptation of technologies often crucial: e.g. to reduce costs, make designs 'appropriate'
- Capacity building through projects, but also institutions and investments in more generic capabilities

Sussex Energy Group
SPRU - Science and Technology Policy Research

Tyndall Centre for Climate Change Research

University of Sussex

# Thanks

**http://www.sussex.ac.uk/sussexenergygroup/**

**Sussex Energy Group**
**SPRU - Science and Technology Policy Research**

Tyndall Centre
for Climate Change Research