



**Sub-Saharan  
Africa**

# **ACCES TO ENERGY**

SOURCE: IEA, World Energy Outlook 2012

Table 2: Electricity access in 2010 - Africa

# Urban-Rural electricity access

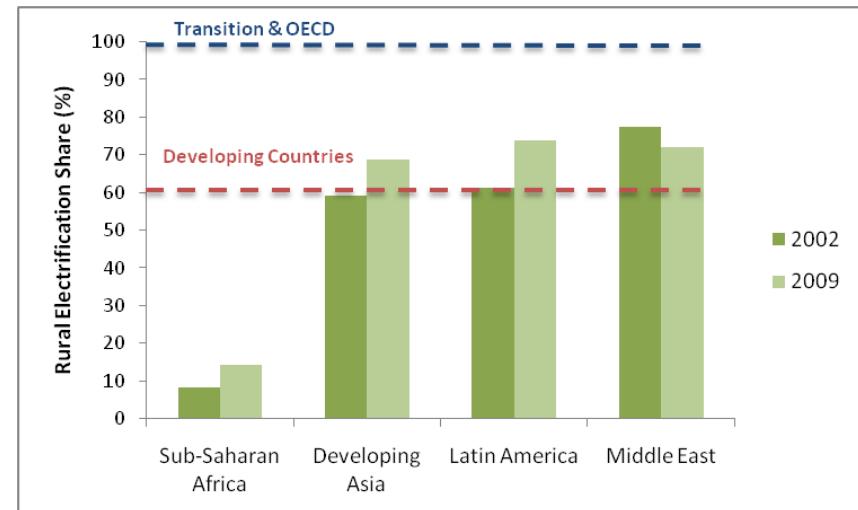
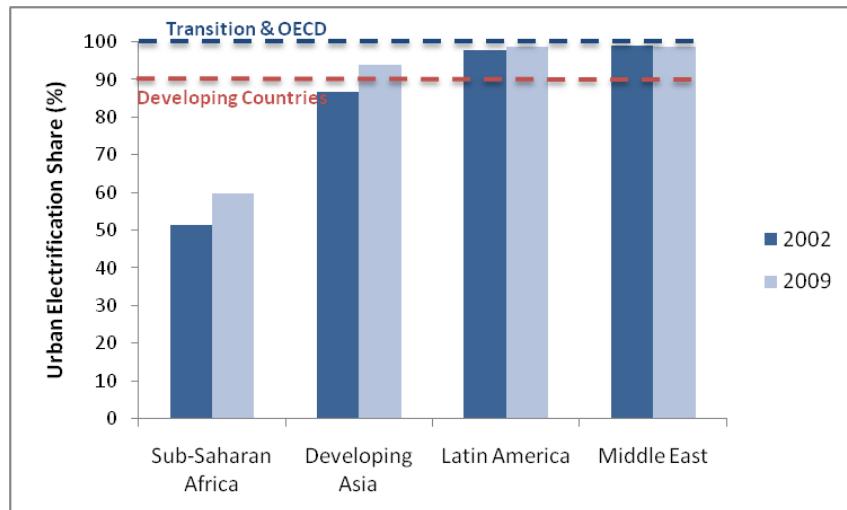
*In Sub-Saharan Africa the urban electricity access rates are low, but the rural rates are far lower*

Region	Population without electricity millions	Electrification rate %	Urban electrification rate %	Rural electrification rate %
<b>Sub-Saharan Africa</b>	<b>589</b>	<b>31.8</b>	<b>64.2</b>	<b>12.9</b>
<i>Angola</i>	11	40	63	8
<i>Benin</i>	7	28	57	7
<i>Botswana</i>	1.1	45	68	10
<i>Burkina Faso</i>	13	15	28	10
<i>Cameroon</i>	10	49	73	14
<i>Congo, Rep</i>	2.4	37	54	10
<i>Cote d'Ivoire</i>	9	59	85	32
<i>DR of Congo</i>	58	15	37	4
<i>Eritrea</i>	4	32	86	17
<i>Ethiopia</i>	65	23	85	11
<i>Gabon</i>	0.6	60	64	34
<i>Ghana</i>	10	61	85	35
<i>Kenya</i>	34	18	65	5
<i>Lesotho</i>	1.7	17	43	7
<i>Madagascar</i>	17	17	40	8
<i>Malawi</i>	13	9	35	2
<i>Mauritius</i>	0.01	99	100	99
<i>Mozambique</i>	20	15	36	2
<i>Namibia</i>	1.2	44	78	23
<i>Nigeria</i>	79	50	78	23
<i>Senegal</i>	6	54	83	32
<i>South Africa</i>	12	76	88	56
<i>Sudan</i>	28	36	48	28
<i>Tanzania</i>	38	15	46	4
<i>Togo</i>	5	28	54	8
<i>Uganda</i>	29	9	46	3
<i>Zambia</i>	11	19	48	2
<i>Zimbabwe</i>	8	37	79	11
<i>Other Africa</i>	96	13	35	4
<b>North Africa</b>	<b>1</b>	<b>99.4</b>	<b>100</b>	<b>98.7</b>
<i>Algeria</i>	0.2	99.3	100	98
<i>Egypt</i>	0.3	99.6	100	99
<i>Libya</i>	0.0	99.8	100	99
<i>Morocco</i>	0.4	98.9	100	97
<i>Tunisia</i>	0.1	99.5	100	99
<b>Africa</b>	<b>590</b>	<b>42.9</b>	<b>72.1</b>	<b>23.6</b>

Page

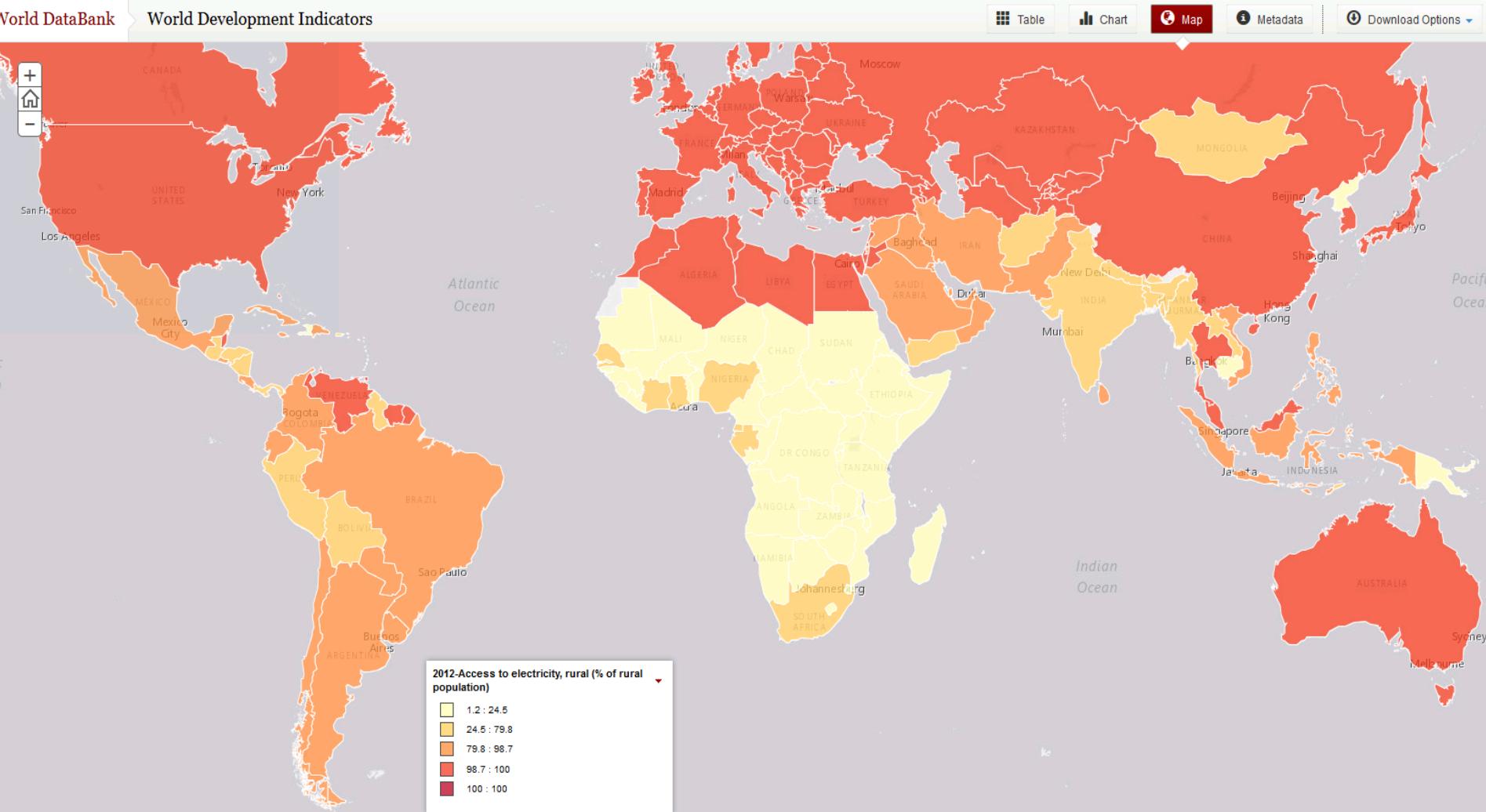
# Trends and current status of electrification: reach out of grid extension

Evolution of electrification share for (a) urban and (b) rural areas (2002-2009)



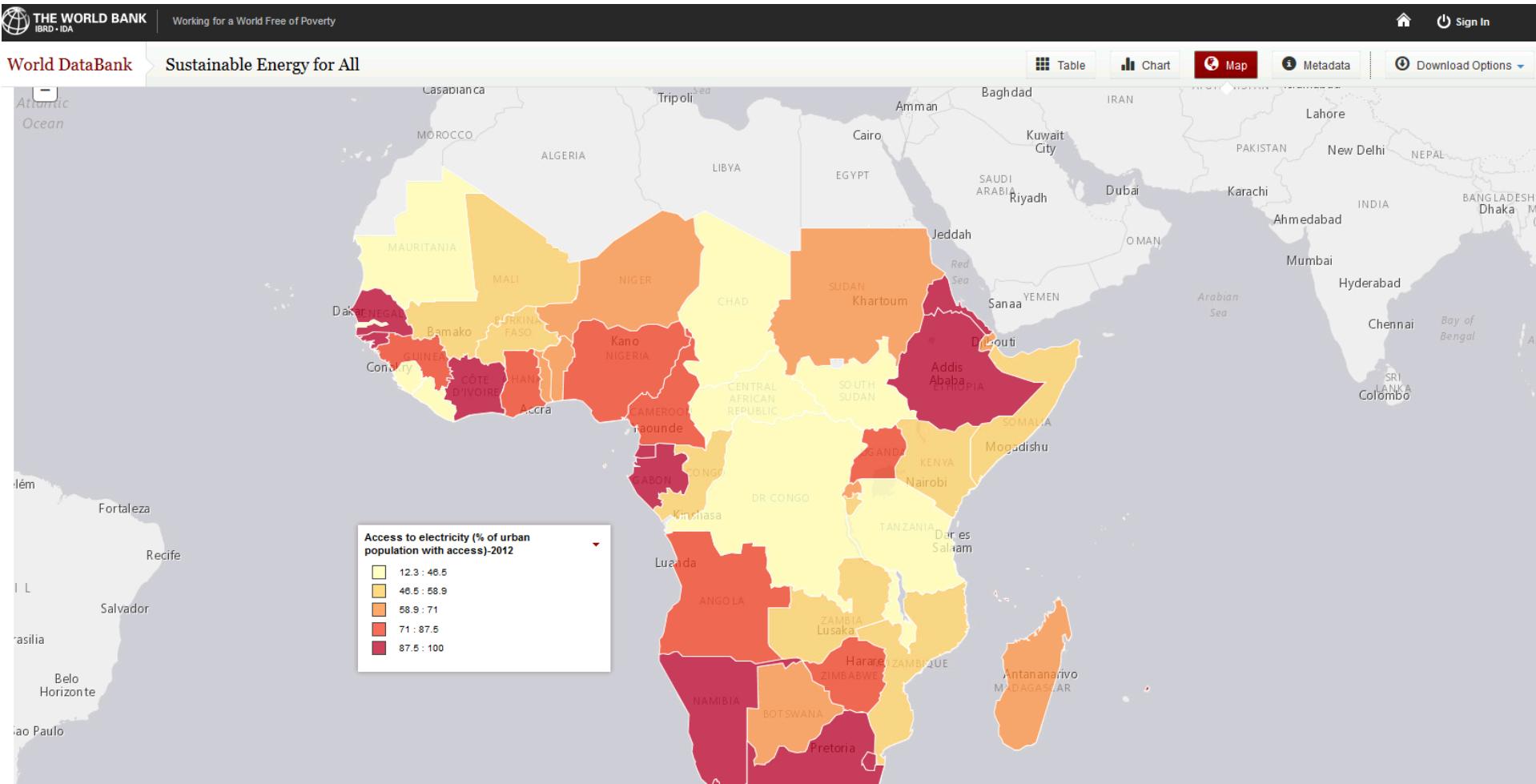
Source: Data compiled from IEA, World Energy Outlook 2010

# Rural electricity access – Global status





# Urban electricity access rate in Africa



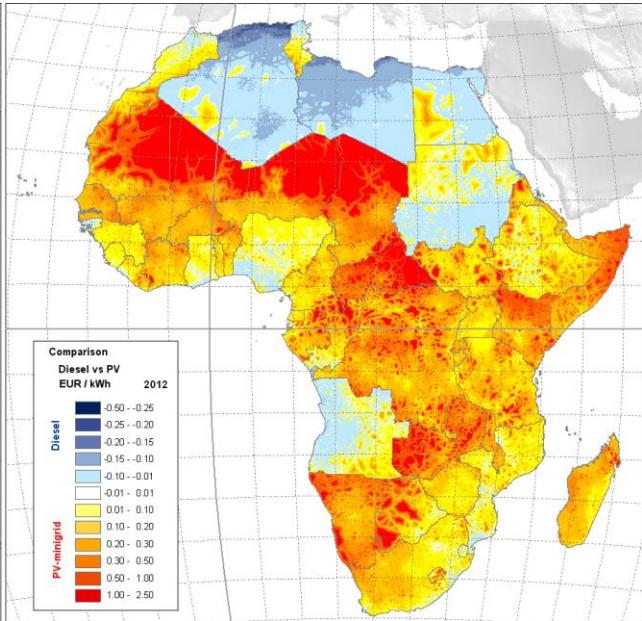
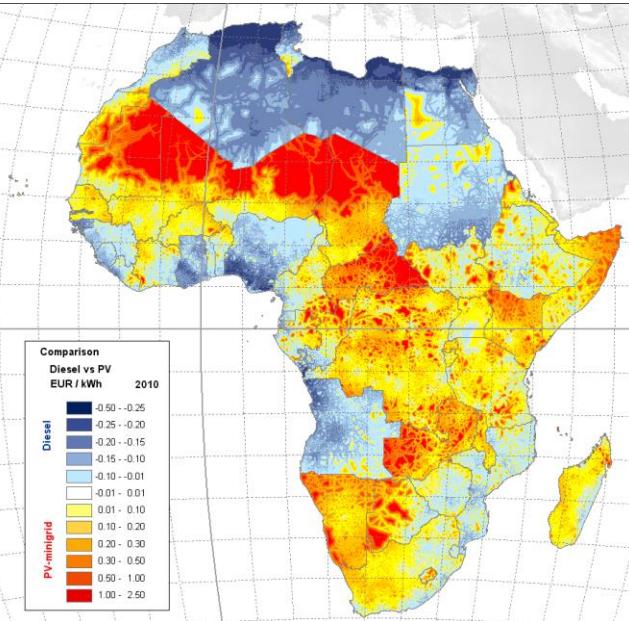
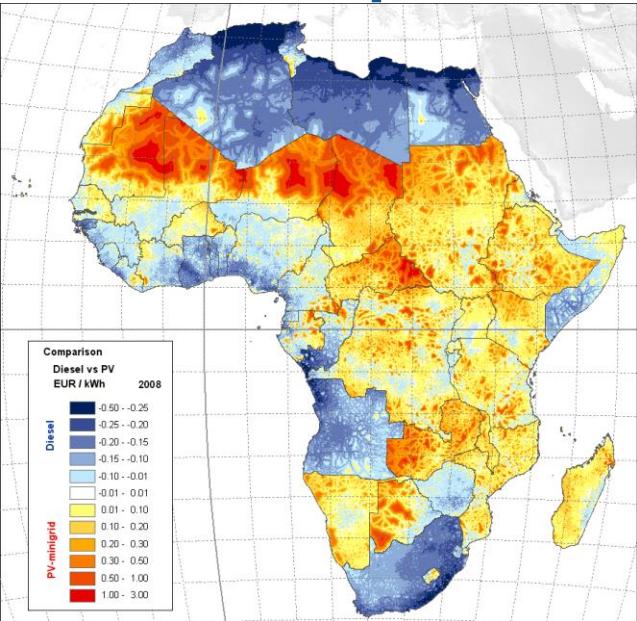
Source: Sustainable Energy for All. Click on a metadata icon for original source information to be used for citation.

Disclaimer: This map was produced by Staff of the World Bank. The boundaries, colors, denominations and any other information shown on this map do not imply, on the part of The World Bank Group, any judgment on the legal status of any territory, or any endorsement or acceptance of such boundaries.



# Electricity access model for Africa

## Follow the dynamic technology and fuel cost development





## Changes introduced

- New important rural electrification technology (mini hydro)
  - Mostly competitive in areas where the other analysed technologies are not affordable

- New diesel cost data from GIZ

- New network lines close to realisation (mainly in case study countries)

Assumptions on the 15kWp PV system

1/3 energy consumption during day and 2/3 during night.

Operation maintenance costs 2.5 %/year of the PV array.

PV lifetime: 20 years

Battery lifetime: 5 years (required battery size changes with PV output)

Discount rate: 5 %

	PV module cost	Rest of the system	Battery price	O & M costs
Analysis based on 2010 data	2500€/kWp	1000€/kWp	1.5€/Ah	2.5 %/year of PV array
Analysis based on 2012 data	1100€/kWp	800€/kWp	1.5€/Ah	2.5 %/year of PV array

# The engine behind



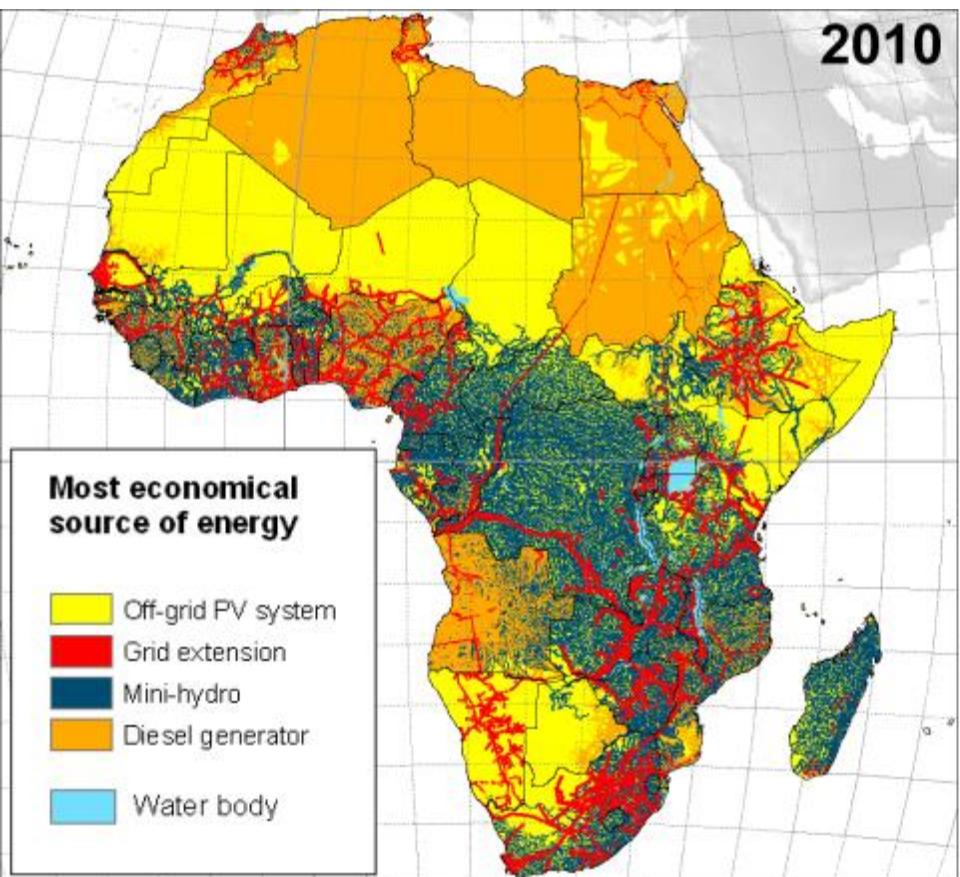
## DATA

	Social/demographic data: <i>Distribution of the demand, consumption pattern, level of service, willingness to pay,...</i>	Theoretical potential (Resource) <i>Solar, wind, biomass, electricity transmission network,...</i>	Technical potential (Technical data) <i>Configuration, sizing, performance, efficiencies, accessibility...</i>	Economic potential (Economic data) <i>Discount rate, costs, O&amp;M, legislation...</i>
PV	Population 	Solar irradiation 		Electricity cost delivered by PV 
DIESEL	Consumption pattern (1/3 daytime, 2/3 evening-night) 	System size (PV and battery) Performance Life time Efficiency, losses 	Investment costs O&M costs Discount rate 	Electricity cost delivered by diesel 

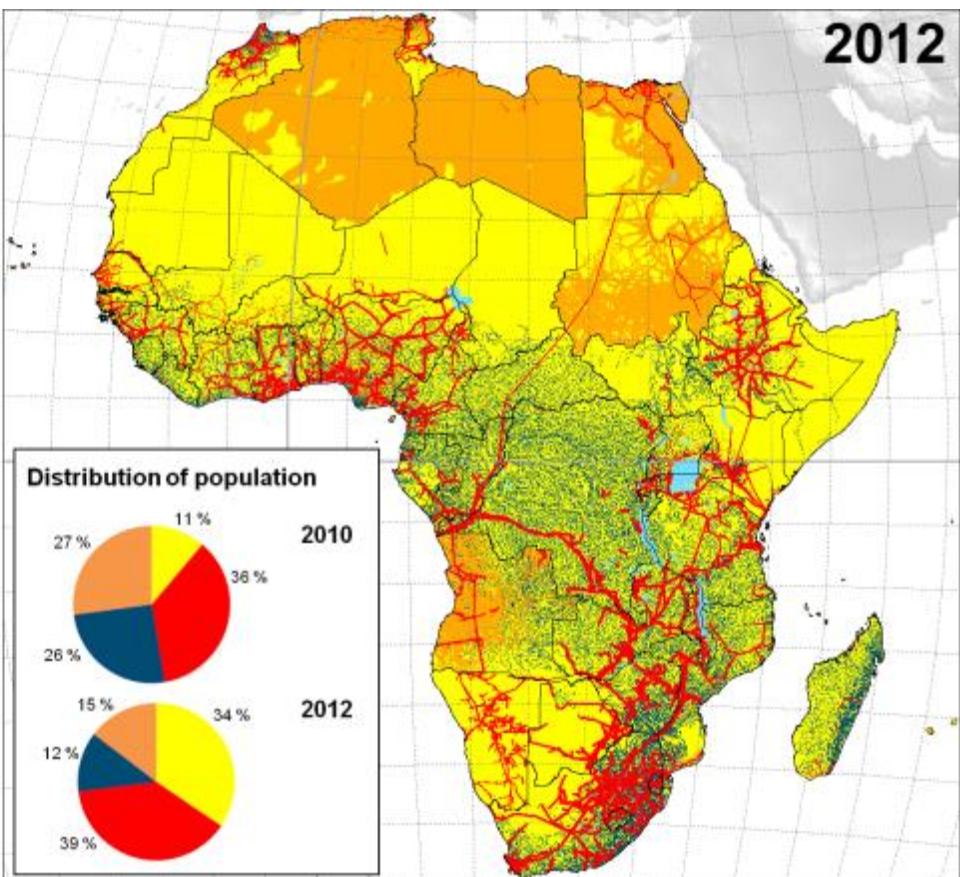
IN BLUE COLOR: NUMBERS

IN RED COLOR: MAPS

# RE planning: technology competitiveness

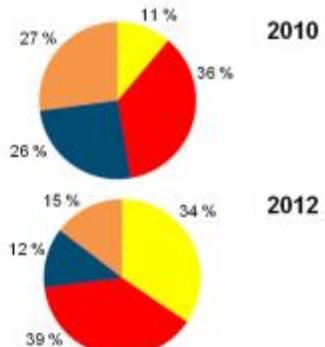


2010



2012

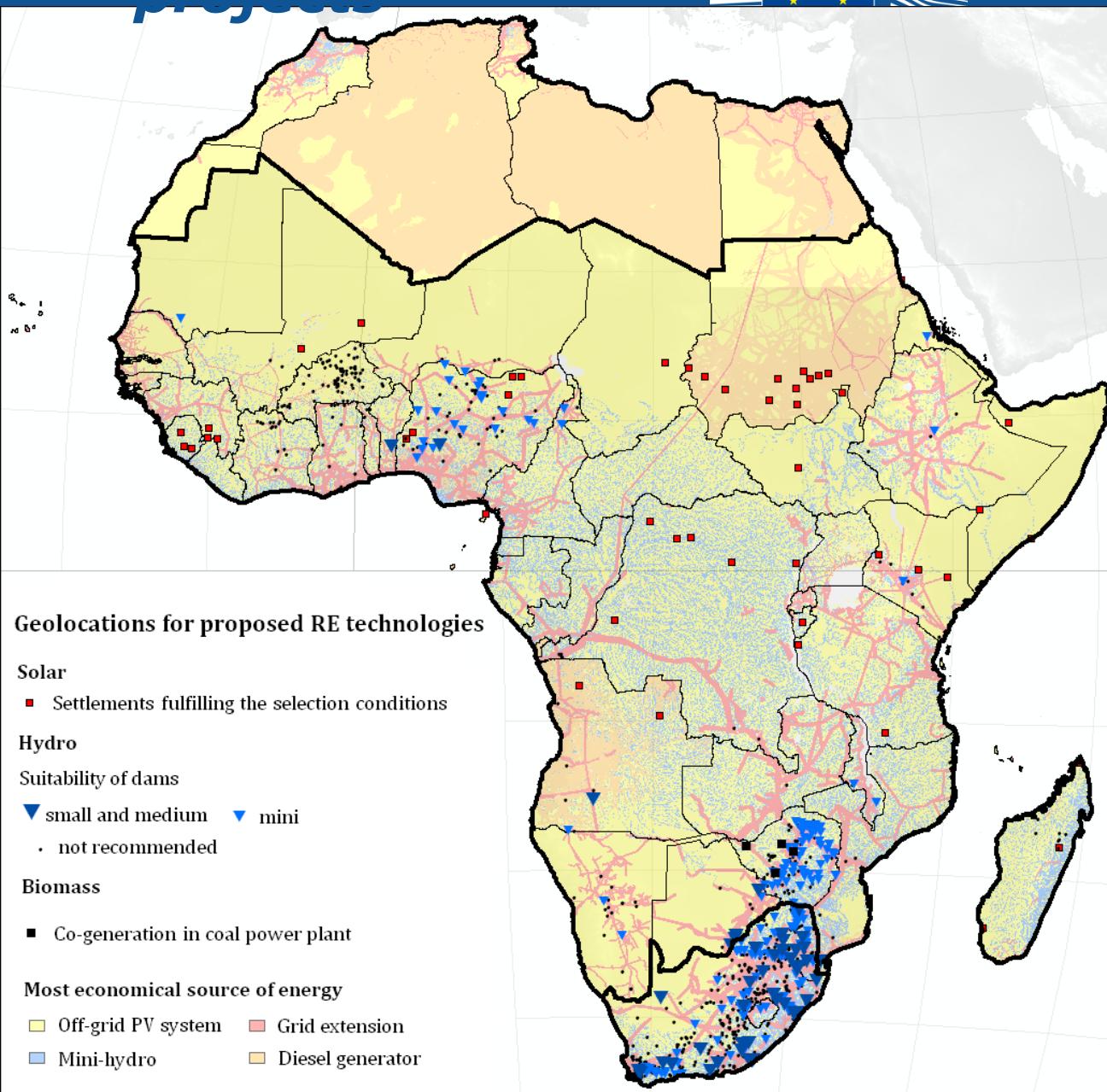
Distribution of population





# **IDENTIFYING INVESTMENT OPPORTUNITIES BASED ON AFRETEP TOOLS**

# • Analysis of potential sites for renewables

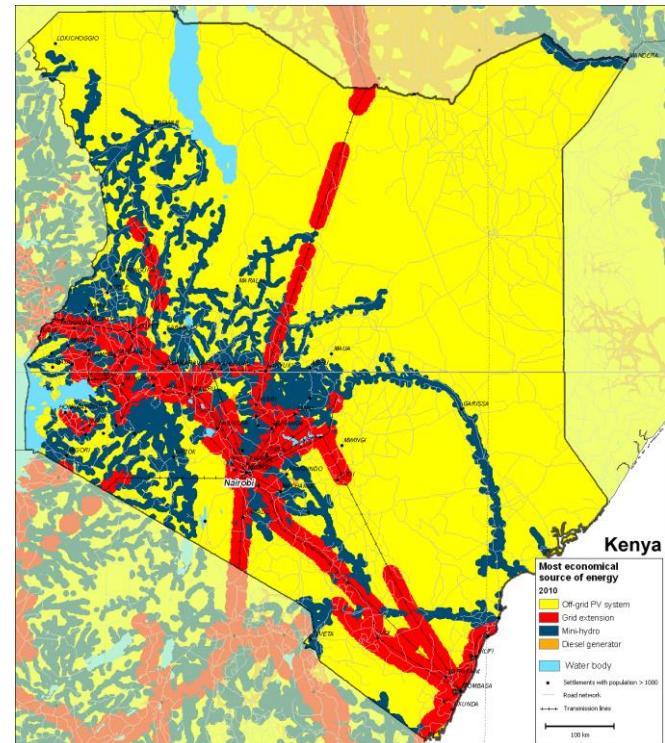
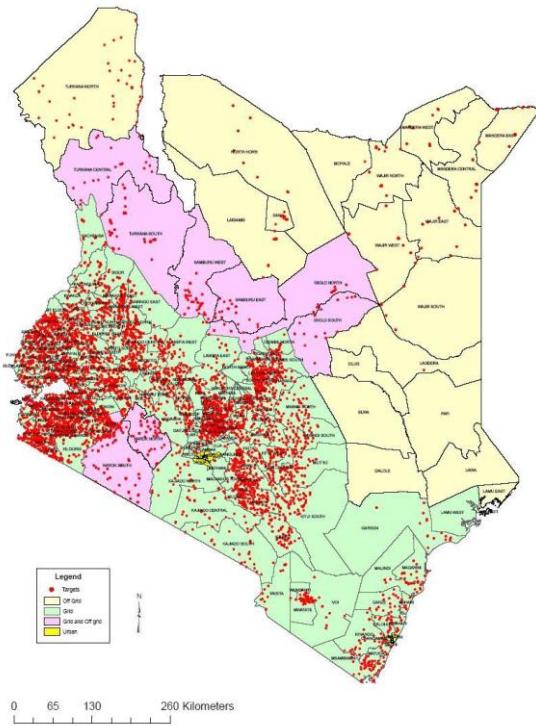


- Identifies "low-hanging fruit" sites
- Combines data on
  - **settlements far from grid**
  - **non-power dams**
  - **sugarcane production close to coal power plants (for co-generation)**
- Could provide electricity for 109 million people
- Nature Energy, 2016/09/19/online

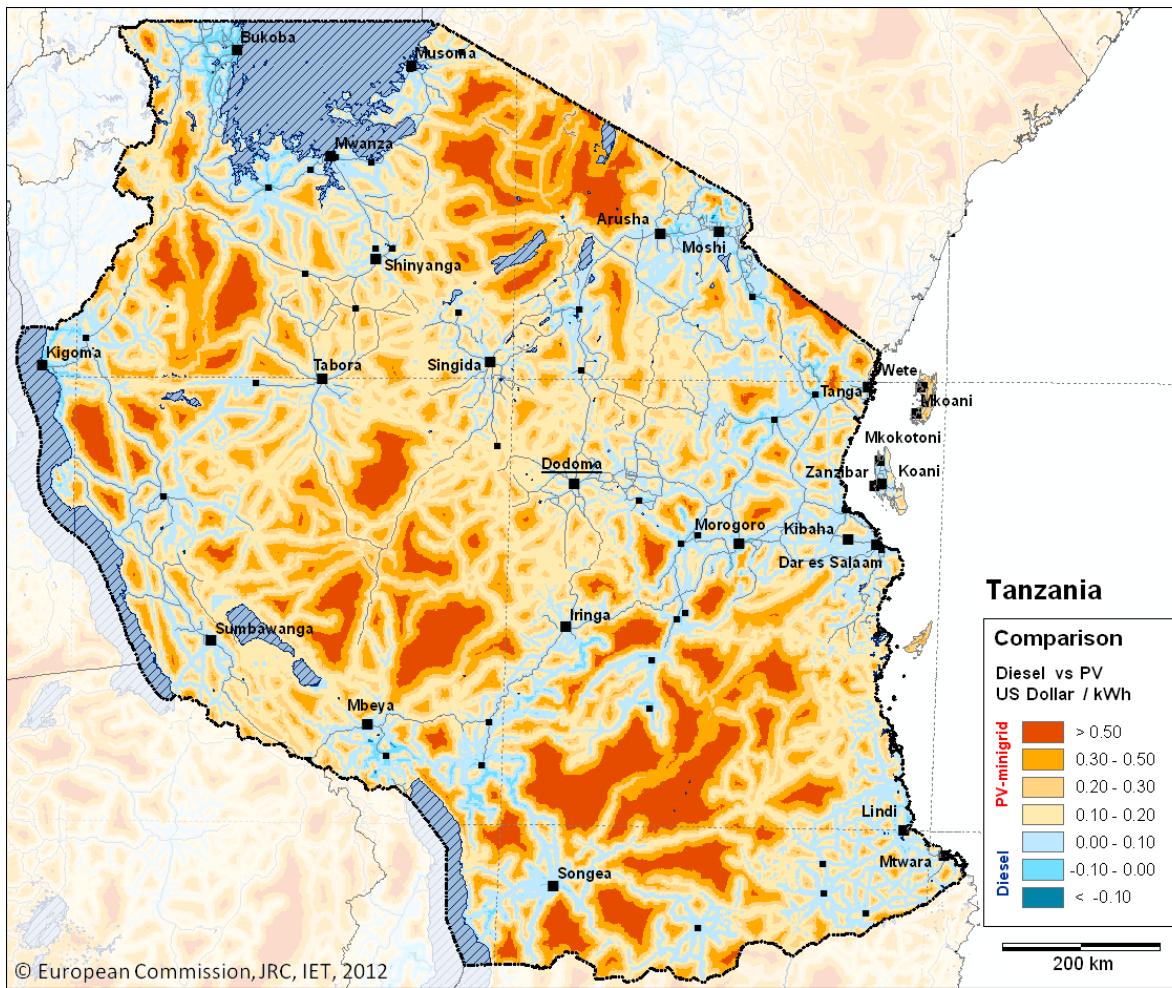


# CASE STUDY COUNTRIES FOR ELECTRICITY ACCESS

# Comparison between results of rural electrification master plan and AFRETEP methods



# Tanzania



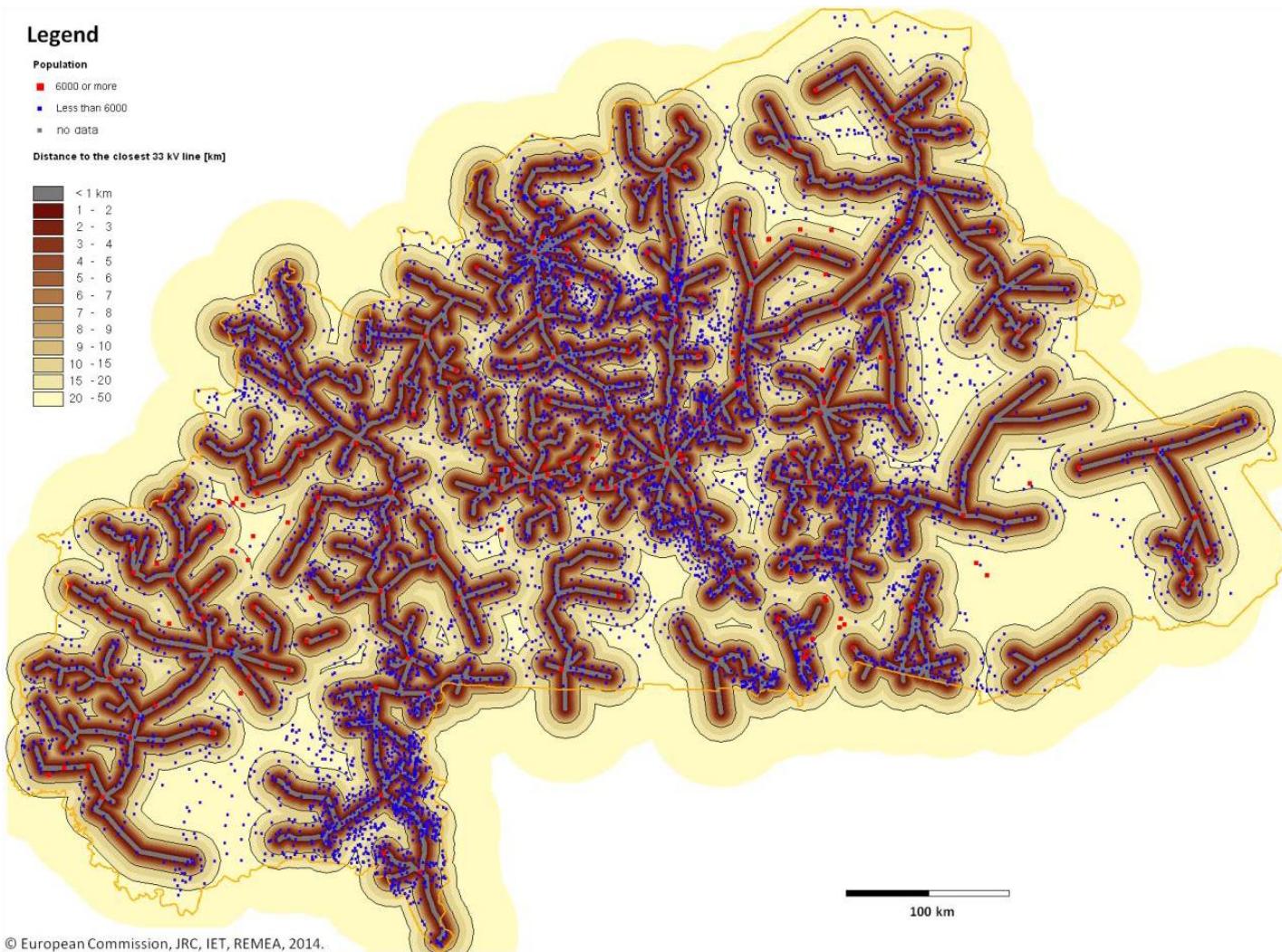
# Burkina Faso

## Legend

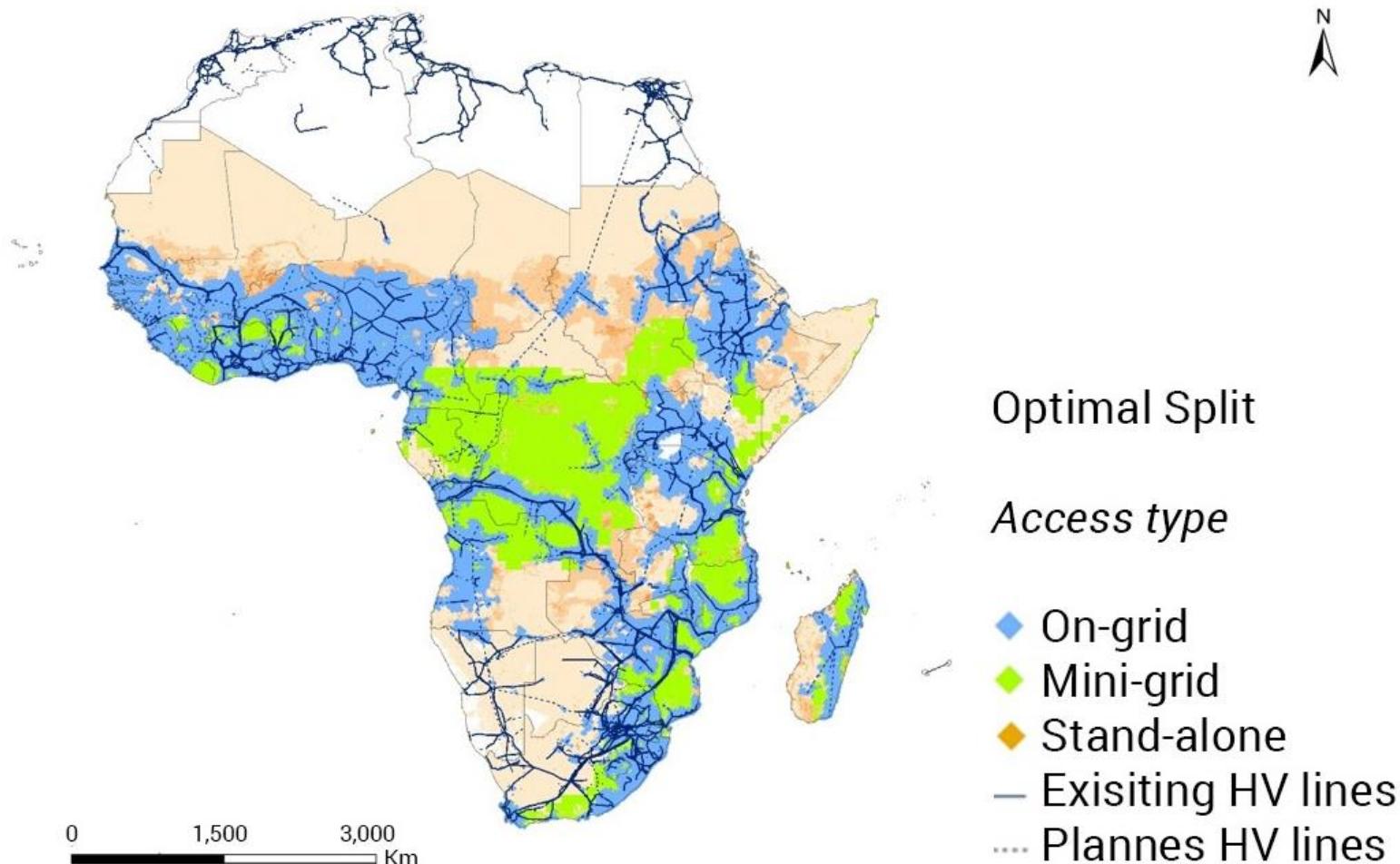
### Population

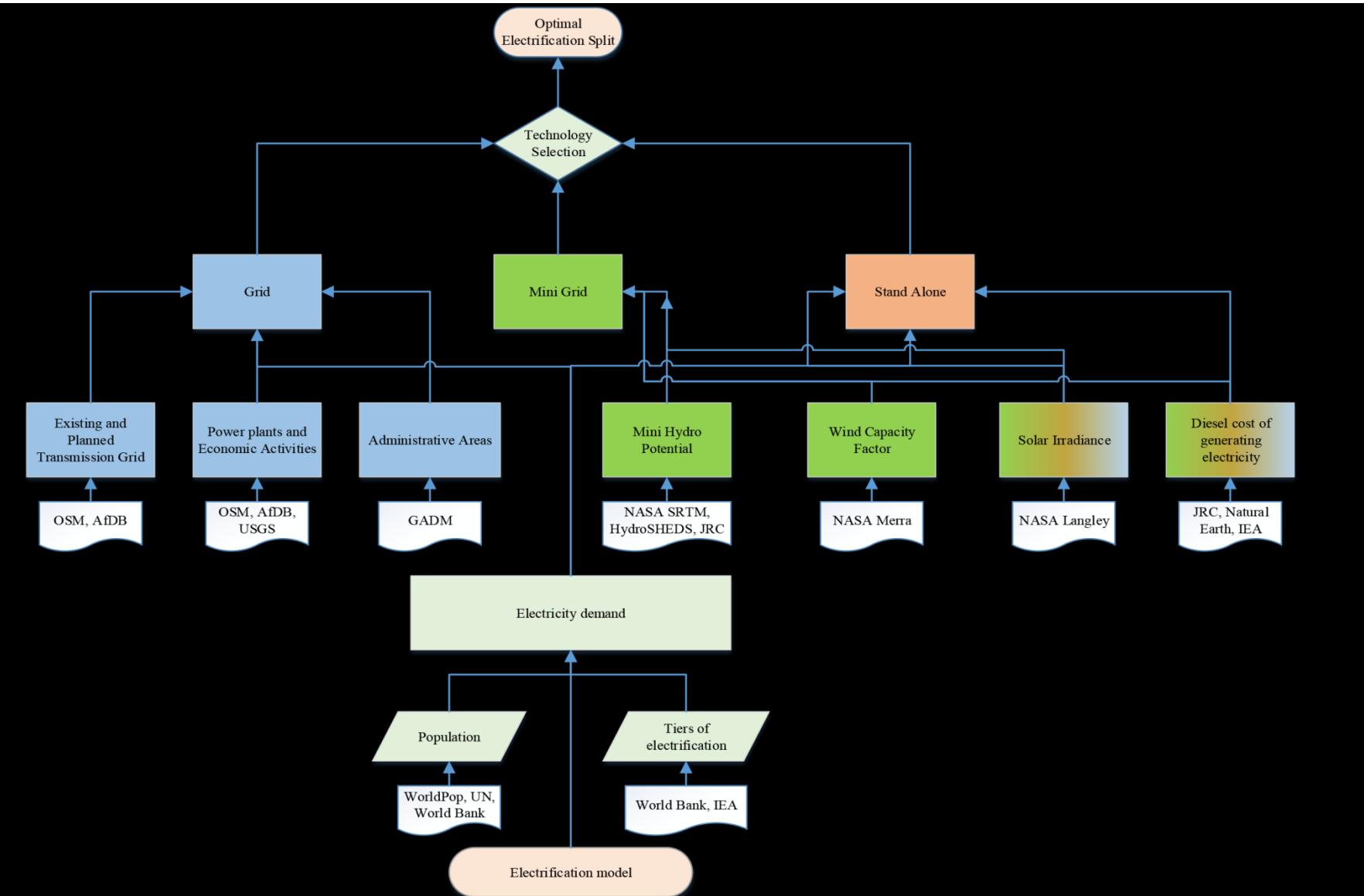
- 6000 or more
- Less than 6000
- no data

### Distance to the closest 33 kV line [km]



# UN has similar approach



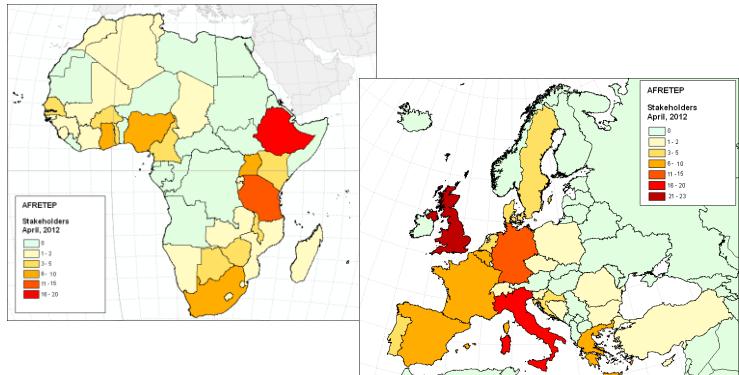


# Network and capacity building



## AFRETEP Platform

Newsletters  
News  
Forums

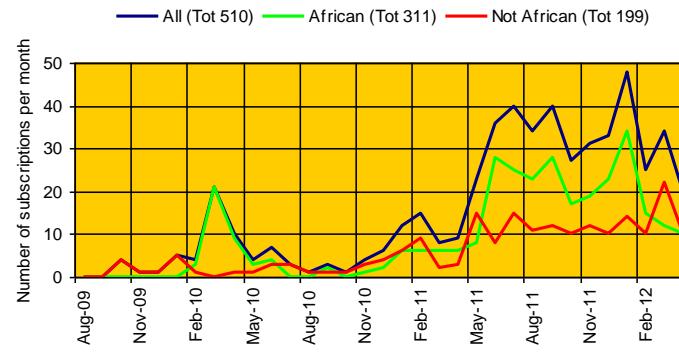


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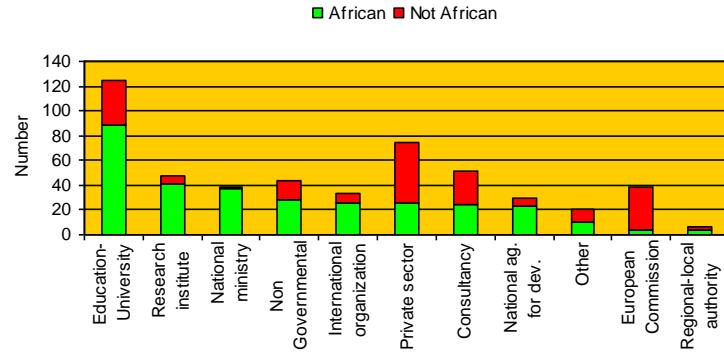
19

10/19/2017

## Members subscription trend



561 members (330 Africans)



19

# Network and capacity building

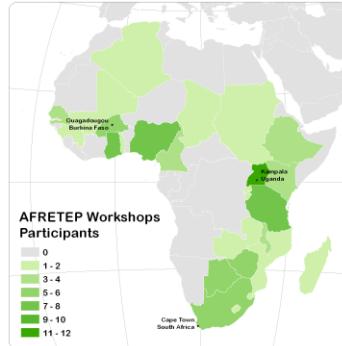


## Workshops

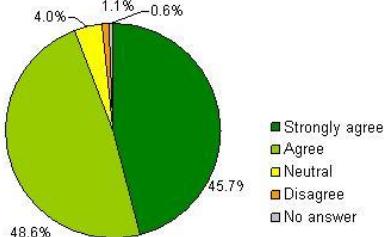
- Kampala (October 3<sup>rd</sup>-7<sup>th</sup>, 2011)
- Burkina Faso (November 7<sup>th</sup>-11<sup>th</sup>, 2011)
- Cape Town (February 20<sup>th</sup>-24<sup>th</sup>, 2012)



96 participants from 30 different countries



Overall evaluation of the trainers



## Web-streaming

A screenshot of a web-streaming interface. It shows a video feed of a man speaking, a sidebar with text about PV hybrid mini-grid systems, a list of speakers, and social media sharing options. The interface is branded with the European Commission and ECN-EBC logos.

[Link](#) [Link](#)

## AFRETEP reportage



[Play](#)

## 2 Forum (WP4)

### JRC involvement in AEEP Forum



After 2 years of preparations the AEEP Forum in May 2012 brought together over 250 representatives from government, civil society, research and the private sector.

Participants came from 13 different EU member states and 29 African countries

#### Research stakeholders: Key findings

- Build **strong partnerships** between industry and research institutions for applied research in energy.
- Make better use of European research capacities for **technology transfer** and **skills development** in Africa
- Policy-making should be better supported by socio-economic research

JRC acts as a European Focal point for the research stakeholder group.

The JRC assisted in mobilizing the presence of the scientific community both from Africa and Europe and supported the Partnership Dialogue Facility.

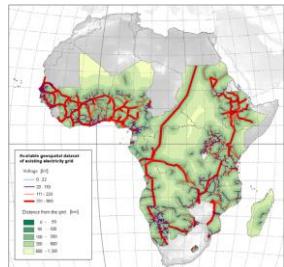


# 3 Presentations & papers (WP2 & WP3)

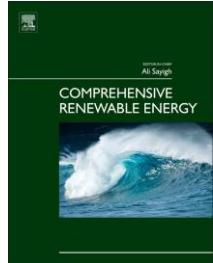
## Data collection of RE Available GIS database:

population, populated places, infrastructure, grid network, diesel prices, PV based electricity costs, travel distances, etc.

Example



## Criteria establishment: grid extension vs. off-grid technologies.



**Book chapter:** Comprehensive Renewable Energy 1.07  
Finance mechanisms and incentives for Photovoltaic Technologies in Developing Countries.



## 25<sup>th</sup> EUPVSEC & 27<sup>th</sup> EUPVSEC

Environmental Research Letters.

9300+ downloads in 2 years



Dear Dr Sandor Stabio  
Congratulations, we are very pleased to tell you that your article 'Ticape: solutions in rural Africa mapping electrification costs of distributed solar and diesel generation versus grid extension' has been selected to appear in the [Highlights of 2011](#) from Environmental Research Letters (ERL).

**Submit your research**

**3.049** 2010 Impact Factor

**Publish for free**

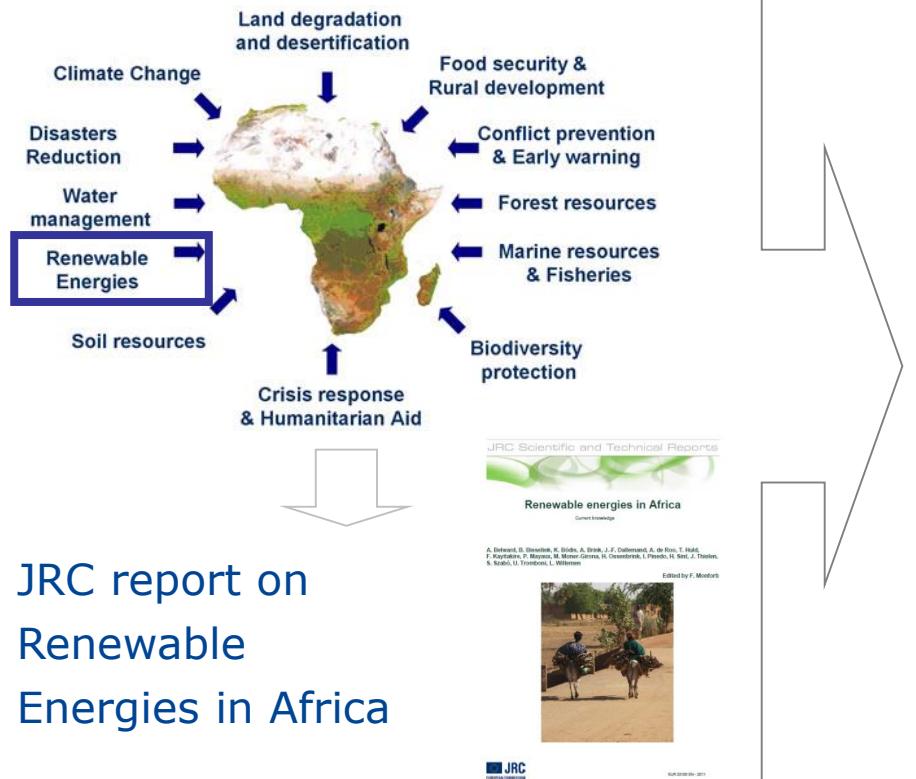
Cross your institution have an open access fund? Find out more and maybe you could [choose ERL and receive free of charge](#).

## Additional information requested by:

- Renewable Energy Technologies Programme ICS-UNIDO, AREA Science Park
- Center for Global Development Washington International Development Group Department of Urban Studies and Planning Massachusetts Institute of Technology Alstom power hydro
- SMA Solar Technology AG
- google
- WIP
- ERRA
- Helios-systems Spain
- Freelance Copy UK
- VP Scientific affairs, Renewable Energy Global Innovations , Canada
- Japan Bank for International Cooperation KTH Royal Institute of Technology/Industrial Engineering and Management/Dept of Energy Technology / Energy Systems Analysis

# 3 Presentations & papers (WP2 & WP3)

## ACP Observatory, JRC



"Just recently, the European Commission's Joint Research Centre has published a very interesting report on "Renewable Energies in Africa". This study provides an analysis and a mapping of the potential and available resources for solar, wind, biomass and hydropower across the African continent. Such an overarching approach allows for each region of Africa to estimate the best choice or mix of renewable resources, taking fully into account sustainability and environmental criteria. **This data could serve to set up national renewable energy action plans"**

José Manuel Durão Barroso  
 President of the European Commission  
 Speech, EU Sustainable Energy For all Summit,  
 Brussels April 16<sup>th</sup> 2012

**The JRC has been active in many thematic field of research (forest monitoring, water management etc) but not in energy. Due to the project it became a core component in the JRC's Africa research.**

JRC Scientific and Technical Reports



## Renewable energies in Africa

Current knowledge

A. Belward, B. Bisselink, K. Bodis, A. Brink, J.-F. Dallemand, A. de Roo, T. Huld,  
F. Kayitakire, P. Mayaux, M. Moner-Girona, H. Ossenbrink, I. Pinedo, H. Sint, J. Thielem,  
S. Szabo, U. Tromboni, L. Willemen

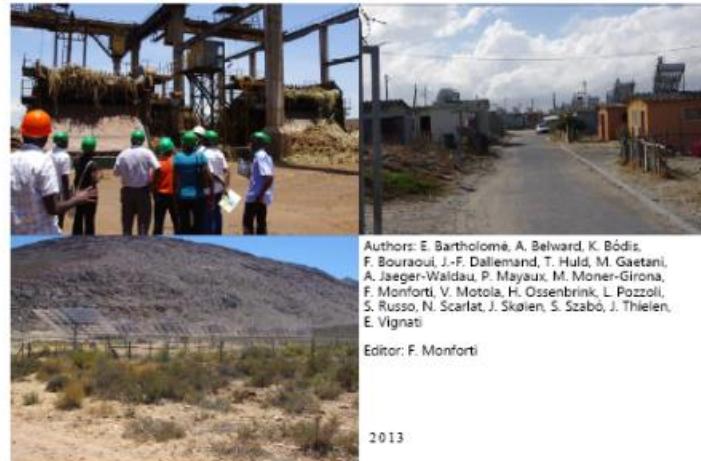
Edited by F. Monforti



## JRC SCIENTIFIC AND POLICY REPORTS

### The availability of renewable energies in a changing Africa

Assessing climate and non-climate effects



Authors: E. Bartholomé, A. Belward, K. Bodis,  
F. Bouraoui, J.-F. Dallemand, T. Huld, M. Gaetani,  
A. Jaeger-Waldau, P. Mayaux, M. Moner-Girona,  
F. Monforti, V. Motola, H. Ossenbrink, L. Pozzoli,  
S. Russo, N. Scarlat, J. Skøien, S. Szabó, J. Thielem,  
E. Vignati

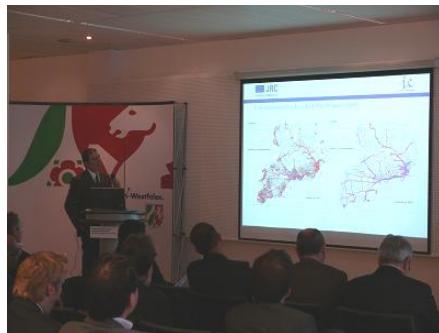
Editor: F. Monforti

2013



# 3 Presentations & papers (WP2 & WP3)

Presentations: some examples



## 4 Dissemination & collaborations

### Collaboration with International organisations



Collaboration within the network  
Expert interview in the dialogue stage

ECREEE-ECOWAS: Involvement in the Developments of a Regional RE Policy of the different African regions: Channelling experience and best practices between EU-Africa and also between the different African regions

IRENA: Working out more adequate methodology for GRID extension

European Regulators Regional Association: Energy Regulation in Emerging Countries  
-Providing access to electricity services  
-Investment incentives to meet growing electricity demand  
-Pricing and tariff setting  
-Reforms in the electricity sector

# REFERENCES



Details of the methodology of the mapping application can be found in the articles:

<http://iopscience.iop.org/article/10.1088/1748-9326/6/3/034002/pdf>

Energy solutions in rural Africa: mapping electrification costs of distributed solar and diesel generation versus grid extension

<http://www.sciencedirect.com/science/article/pii/S1364032113005844>

Sustainable energy planning: Leapfrogging the energy poverty gap in Africa

The tool for PV-diesel genset comparision (<http://sunbird.jrc.it/re2naf.html>)

The sustainable energy for small islands:

<http://iet.jrc.ec.europa.eu/remea/sustainable-energy-portfolios-small-island-states>

On the combination on small hydro and PV:

<http://iet.jrc.ec.europa.eu/remea/methodology-optimization-complementarity-between-small-hydropower-plants-and-solar-pv-systems>

Case study for Tanzania:

<http://iet.jrc.ec.europa.eu/remea/adaptation-feed-tariff-remote-mini-grids-tanzania-illustrative-case>

The Nature Energy article <http://www.nature.com/articles/nenergy2016140>.