Project Collaboration in Africa

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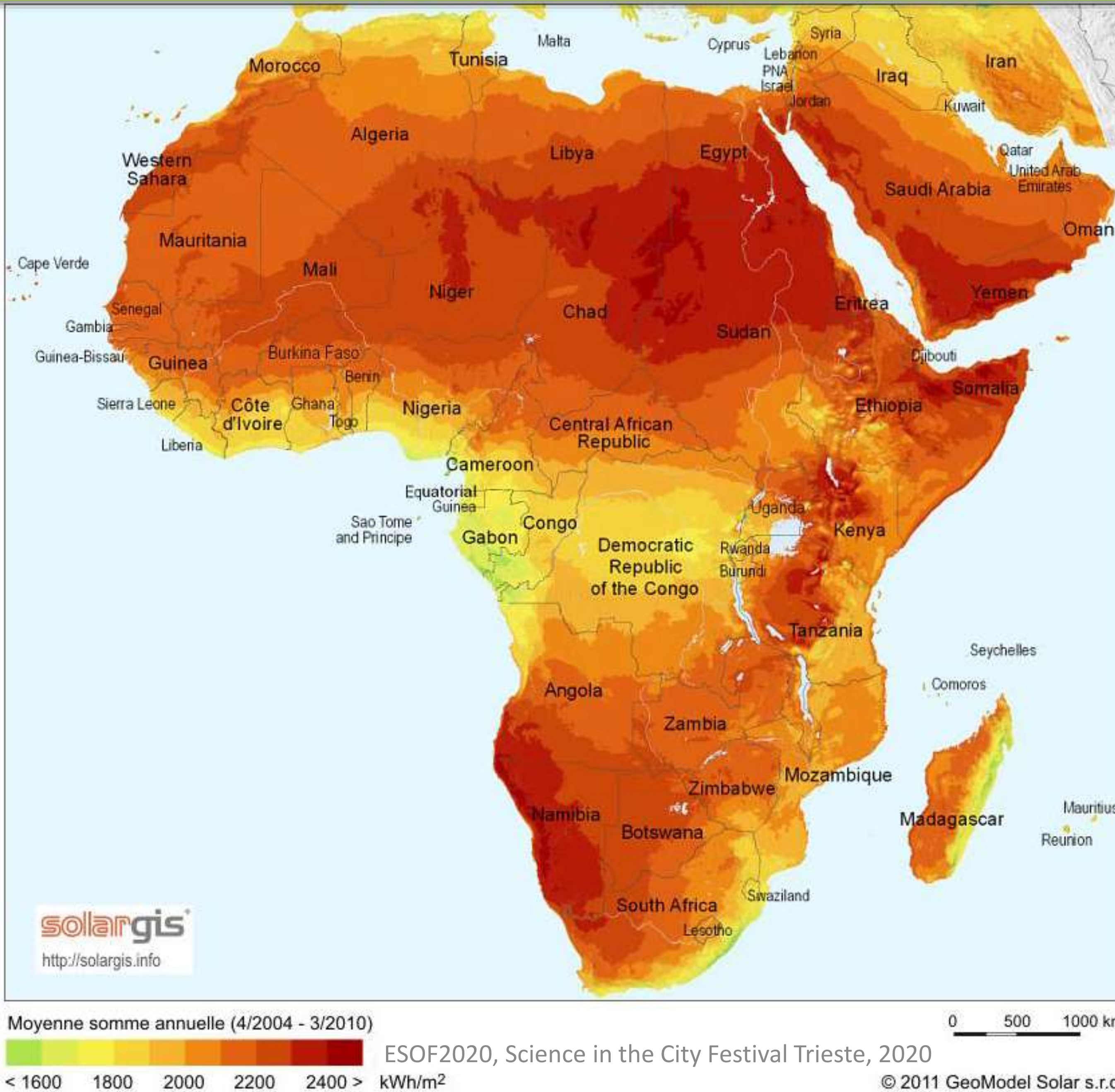
Summary

Context and Situation in Africa and ECOWAS Countries

Collaboration between African Research and Innovation Actors and Udine Researchers

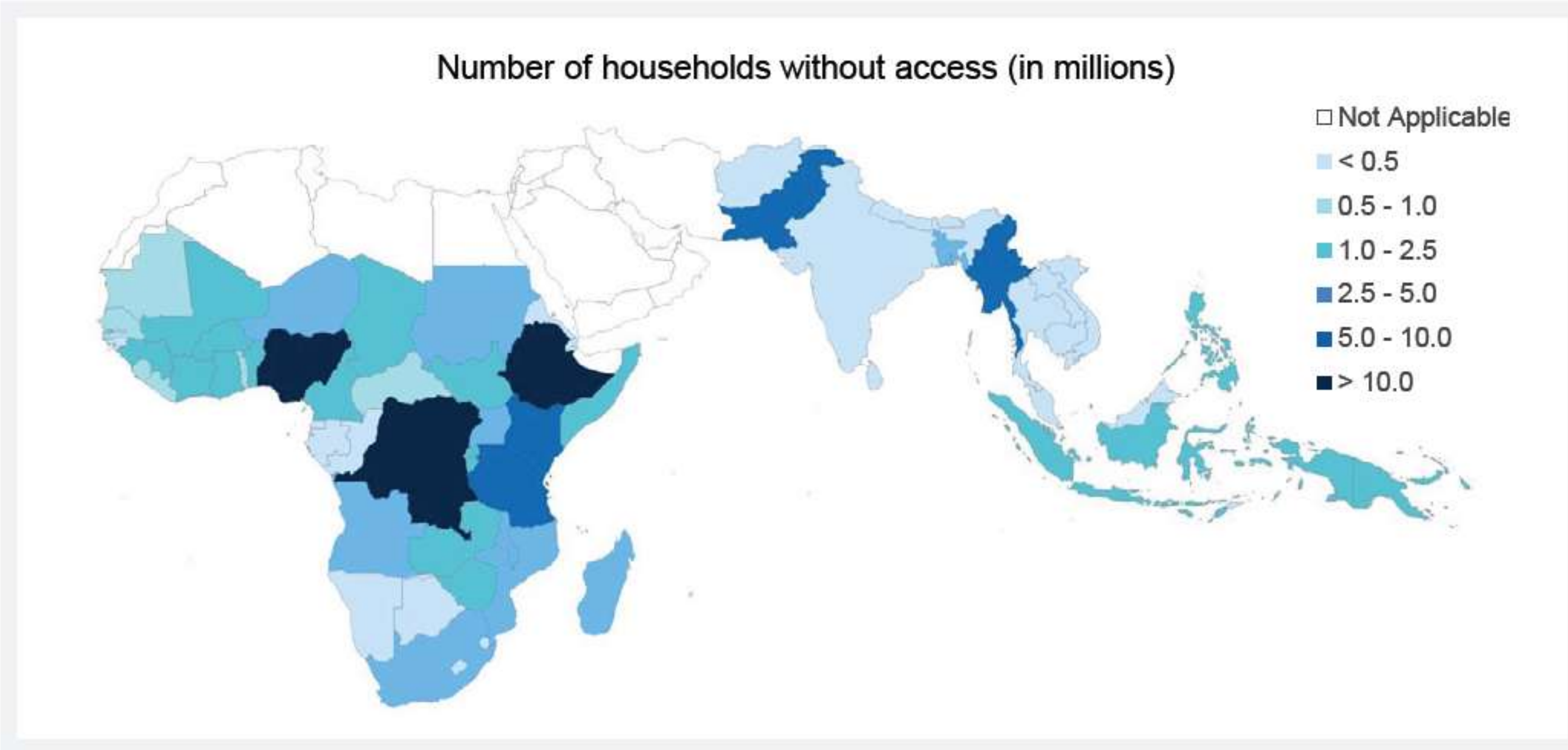
Conclusion and Perspectives

Context and Situation in African and ECOWAS Countries



Context and Situation in Africa and ECOWAS Countries

Across Key Energy-Deficit Countries in Africa and Asia–Pacific, 716 Million People Do Not Have Access to Electricity (Absolute Numbers)

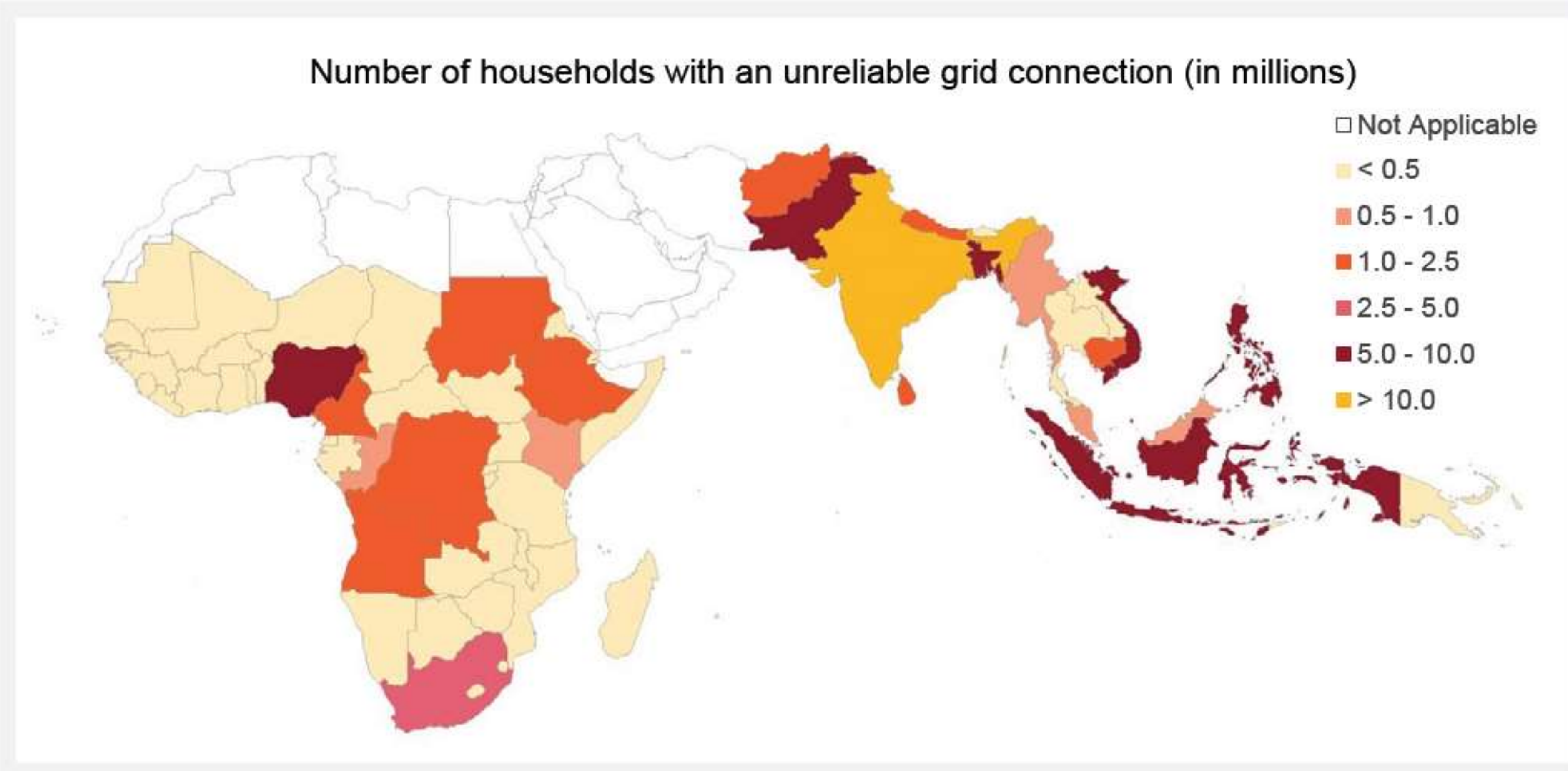


Source: Vivid Economics and Open Capital Advisors analysis of International Energy Agency et al., Tracking SDG 7.

Over 80 percent) of people without electricity access live in Sub-Saharan Africa.
Within this region, the countries with the largest populations without access in terms of absolute numbers are Nigeria (89 million), the Democratic Republic of Congo (68 million), and Ethiopia (61 million).

Context and Situation in Africa and ECOWAS Countries

More than One Billion People Suffer From an Unreliable Grid Connection, Many of Whom Are in South Asia and West Africa

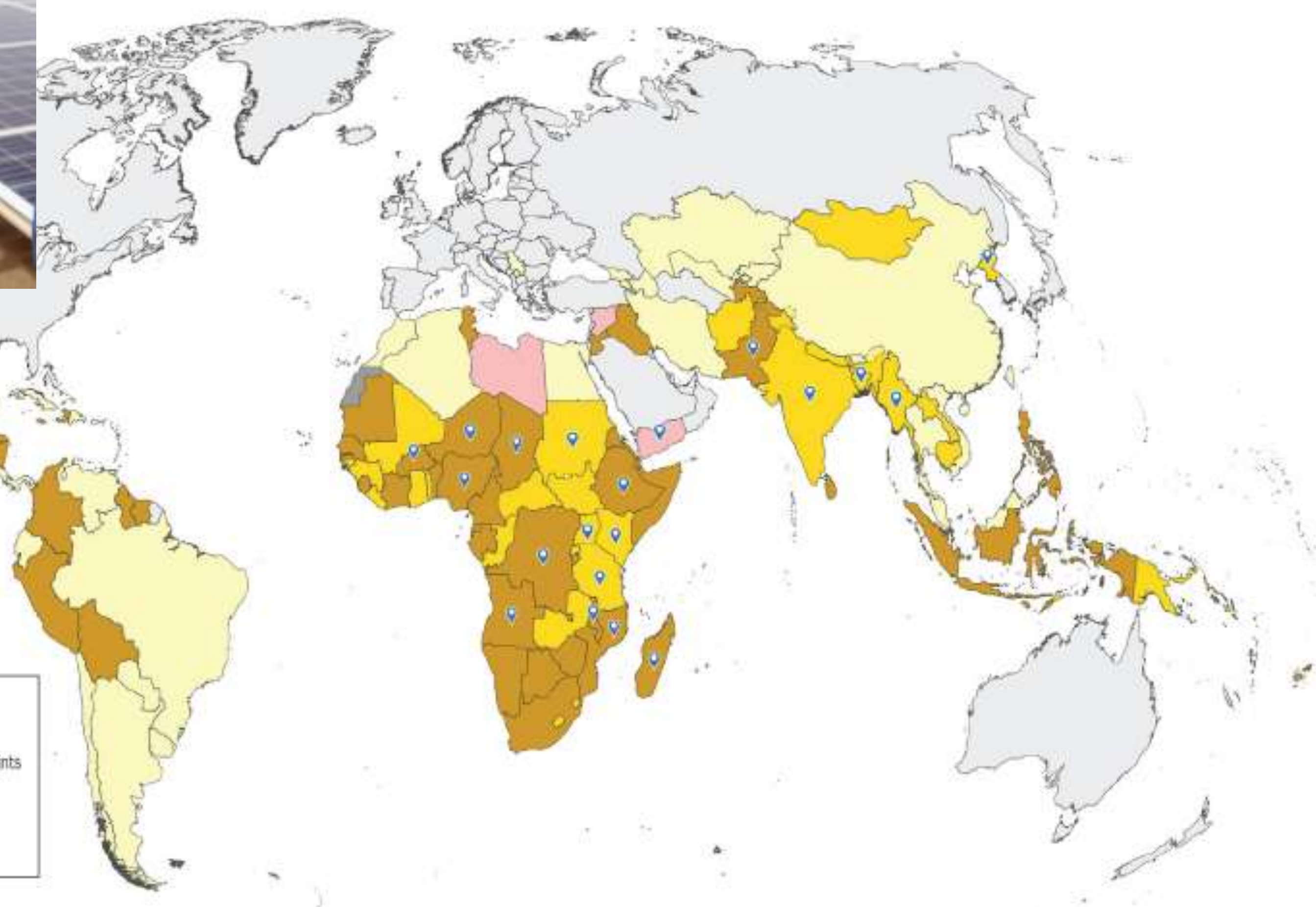


Source: Vivid Economics and Open Capital Advisors analysis of ESMAP, Diagnostic Reports Based on the MTF; Afrobarometer, Round 7 Data; and The World Bank, Enterprise Surveys.

The largest concentrations of people with unreliable grid connections are in South Asia and West Africa

Context and Situation in Africa and ECOWAS Countries

50 MW installed PV solar, at Toujounine, Mauritania, source: financialafrik.com



Source: World Bank.

Context and Situation in Africa and ECOWAS Countries

Estimated Potential in RE

❖ **hydraulic** 25 000 MW

❖Solar radiation 5 to 7 kWh/ m² /day

❖Very important quantity in biomass: example for Senegal: 40 Mtep as primary energy

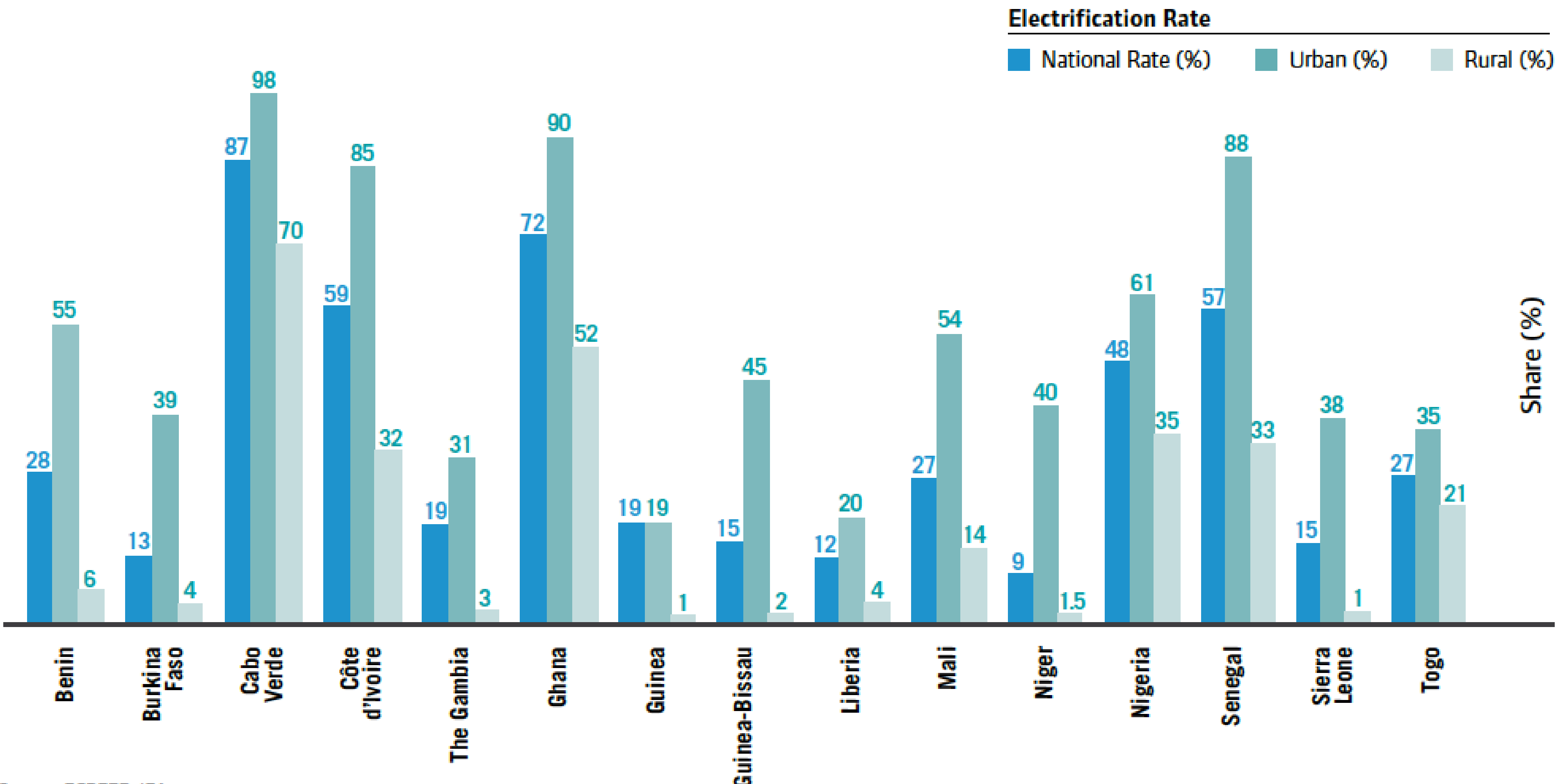
❖Wind in the coast around 6 m/s

❖The data presented: Warsila Group

The ECOWAS countries:

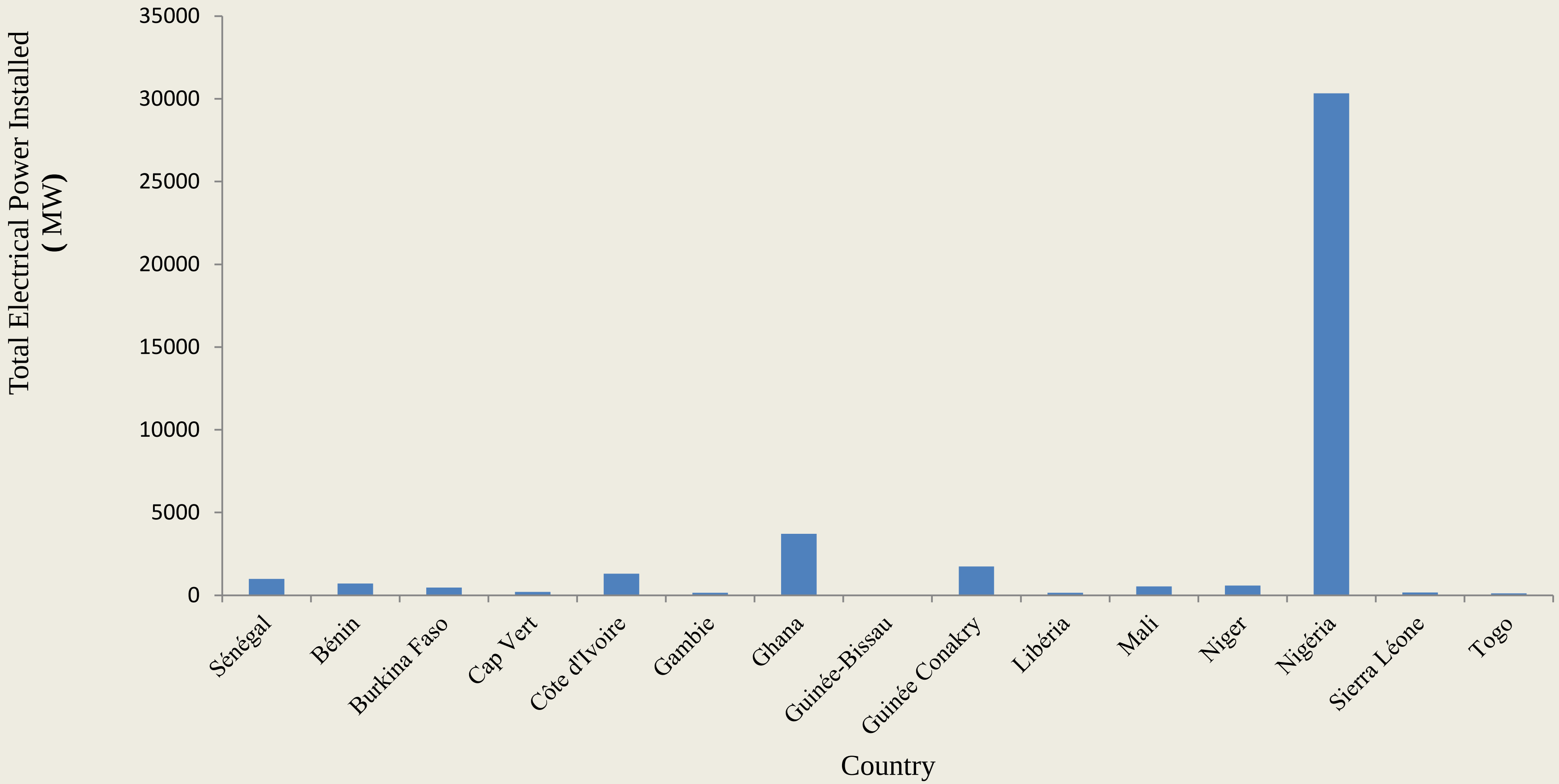
- Low electrification rate, especially the rural regions (around 30 %).
- Population growth very strong and accordingly energy needs grow at a rapid rate.
- Important resources, including fuel and a good potential in renewable energies.
- Lack of real data on its potential in renewable energy and the rate of RE in energy consumption
- Problem of employment real cause of migration

Context and Situation in Africa and ECOWAS Countries



Source: ECREEE, IEA

Context and Situation in Arfica and ECOWAS Countries



ESOF2020, Science in the City Festival Trieste, 2020

ESOF2020, Science in the City Festival Trieste, 2020

Context and Situation in Arfica and ECOWAS Countries

Renewable energy rate on total energy installed

$$R_{RE} = \frac{Installed\ RE\ Power}{Total\ Power\ Installed} x100 \qquad (1)$$

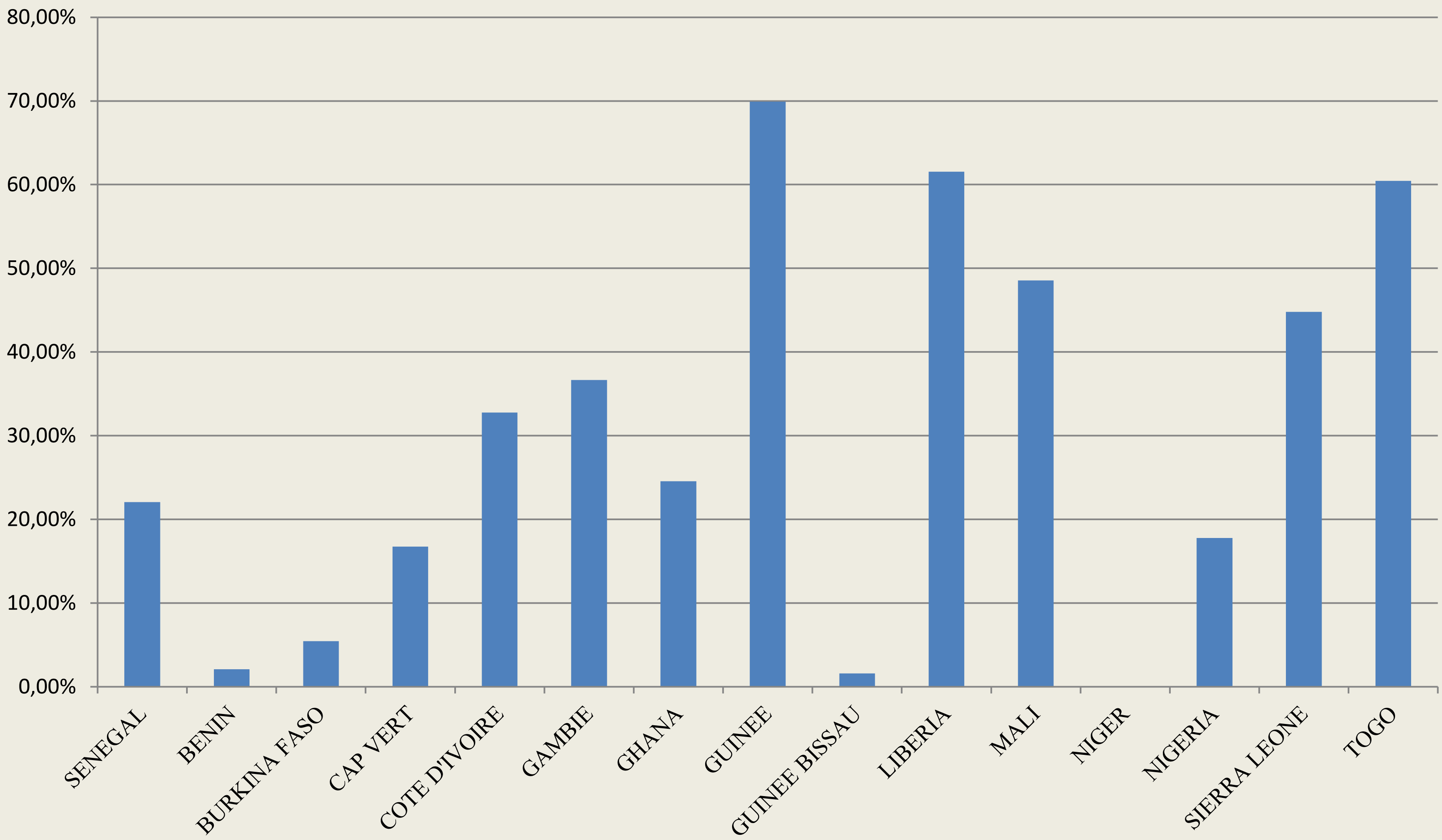
Solar energy rate on Renewable energy

$$R_{SE} = \frac{Solar\ energy\ power\ installed}{Total\ RE\ Power\ installed} x100 \qquad (2)$$

Solar energy rate on Total energy

$$R_{SE/TE} = \frac{Solar\ energy\ power\ installed}{Total\ power\ energy\ installed} x100 \qquad (3)$$

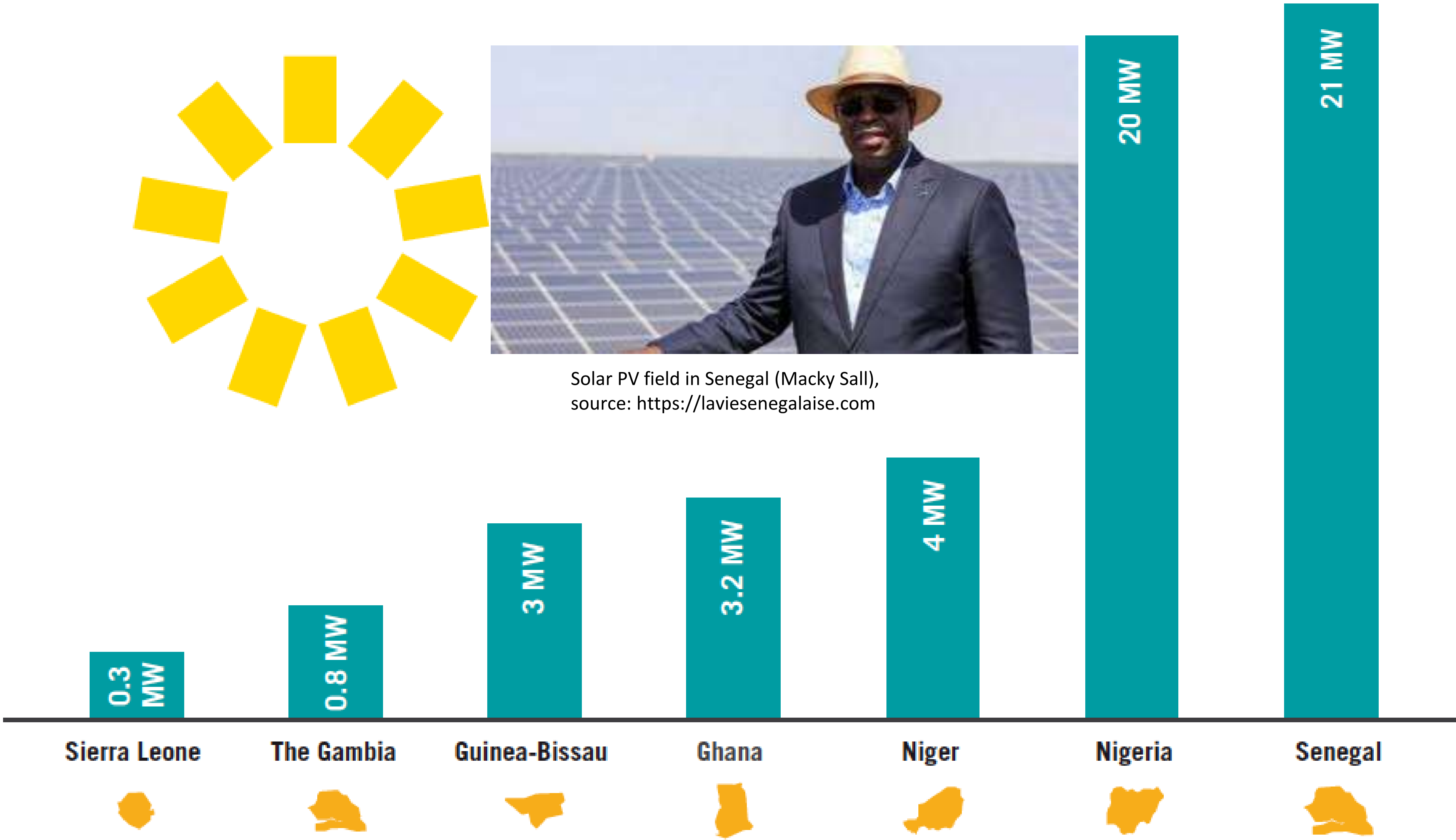
Context and Situation in Arfica and ECOWAS Countries



Renewable Energy Rate in % per Country

Context and Situation in Arfica and ECOWAS Countries

Estimated Installed Capacity of Distributed Solar PV in Selected ECOWAS Member States, 2012

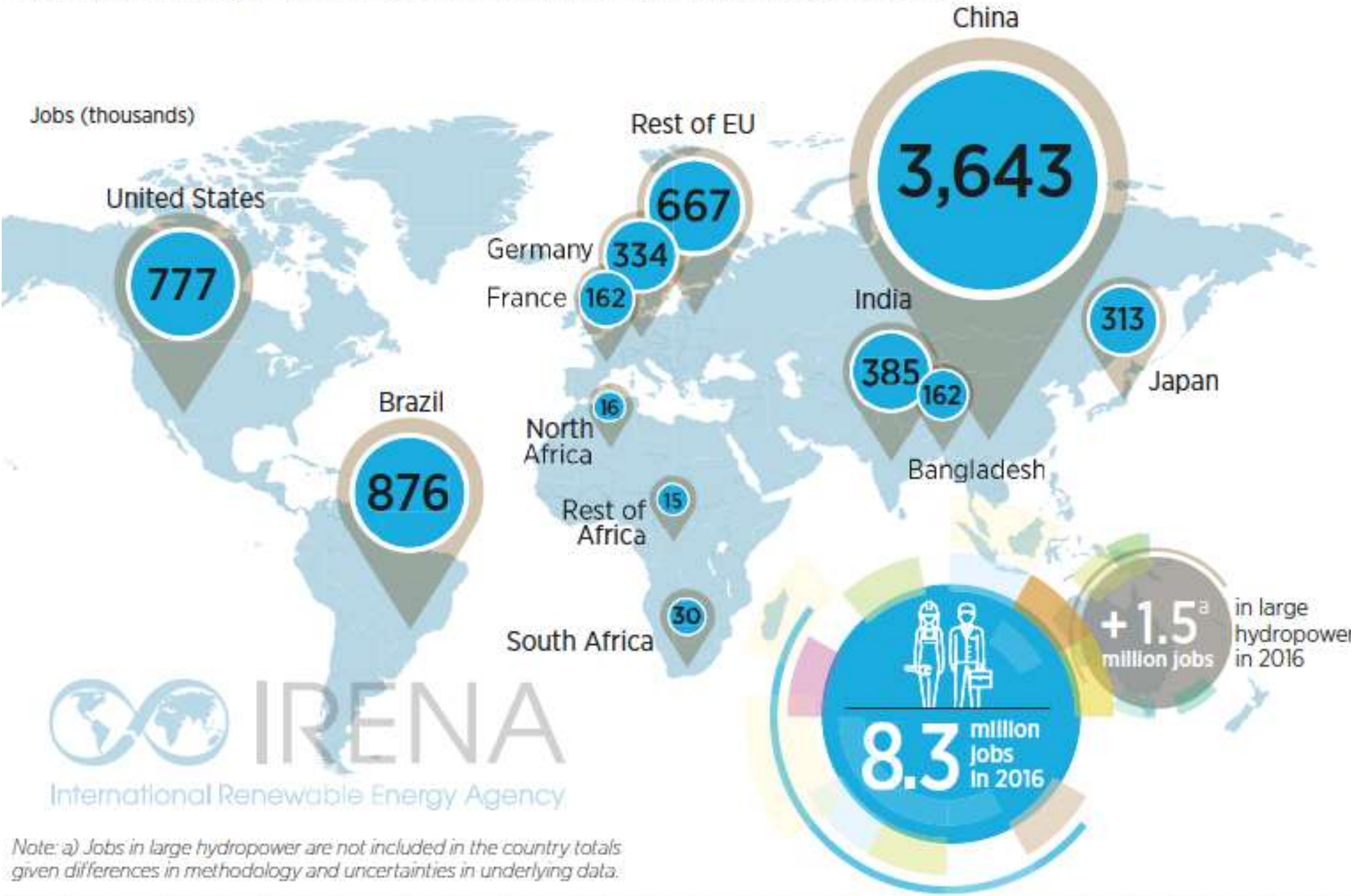


Solar PV field in Senegal (Macky Sall),
source: https://laviesenegalaise.com

Source: ECREEE, IEA

Context and Situation in Africa and ECOWAS Countries

FIGURE 5: **RENEWABLE ENERGY EMPLOYMENT IN SELECTED COUNTRIES**

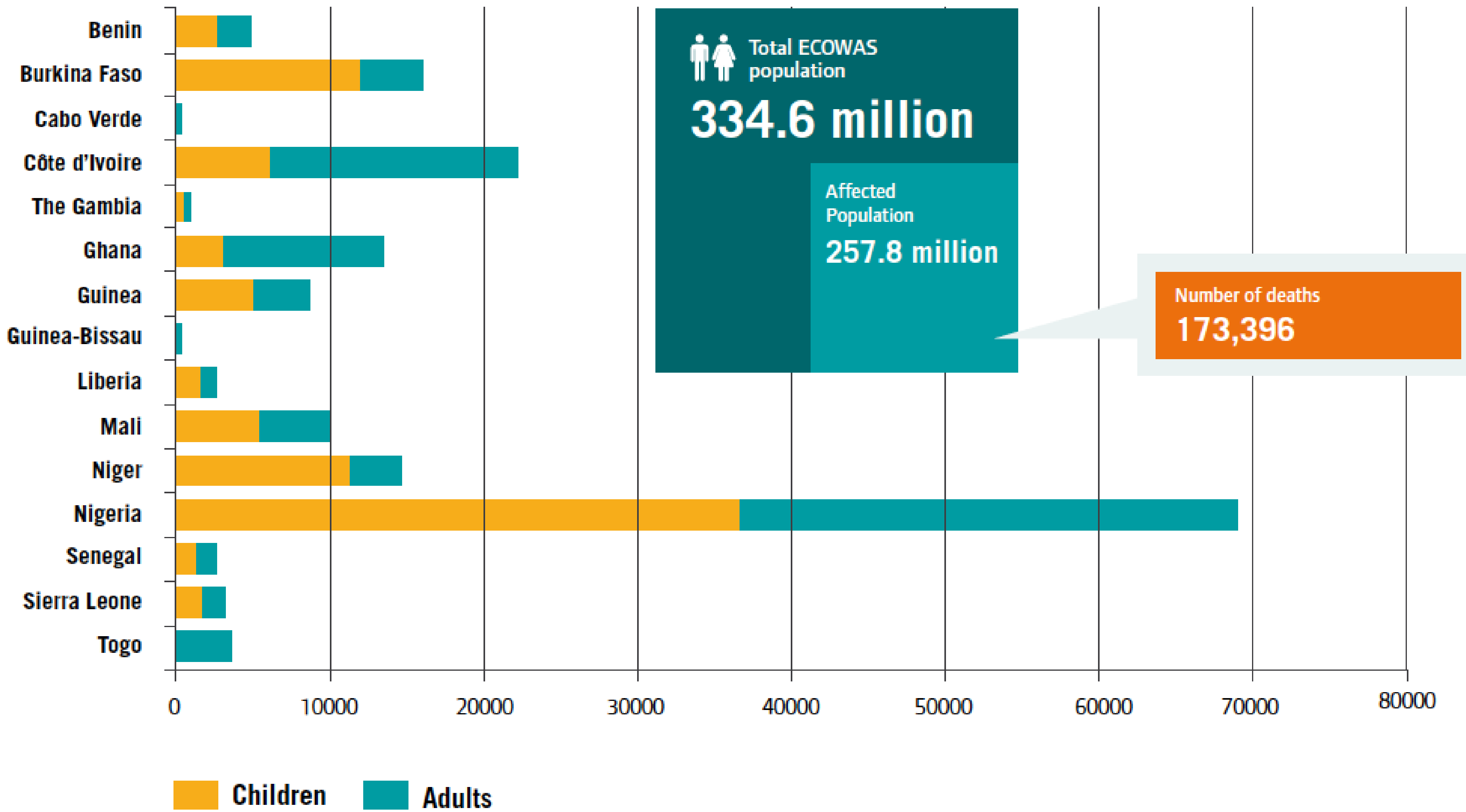


Note: a) Jobs in large hydropower are not included in the country totals given differences in methodology and uncertainties in underlying data.

10 Primary data are collected through correspondence with government entities and industry representatives. Secondary data are referenced from a review of a wide range of national, regional and global studies.

Context and Situation in Arfica and ECOWAS Countries

Deaths per Year from Household Air Pollution



Source: WHO, Global Alliance for Clean Cookstoves

Context and Situation in Africa and ECOWAS Countries

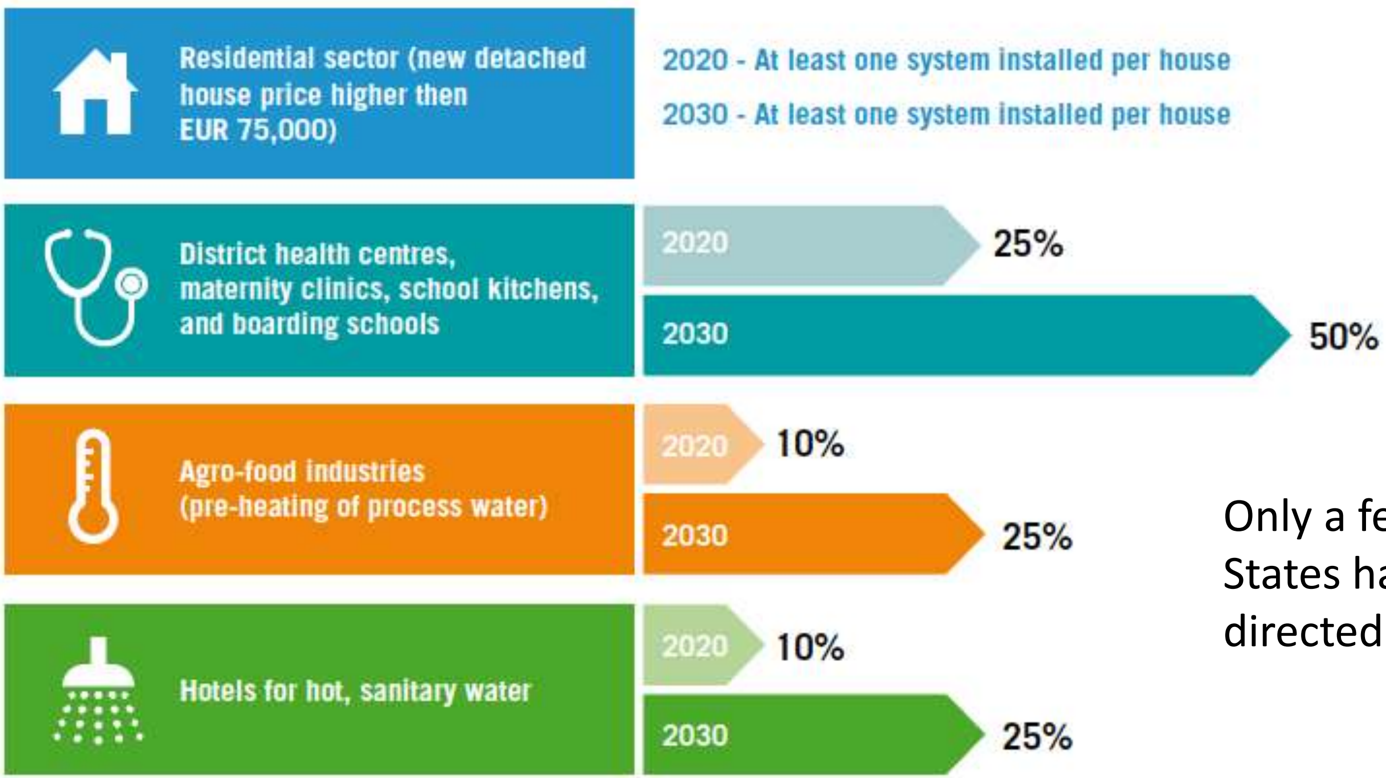
Benin	No target
Burkina Faso	No target
Cabo Verde	50% in the national grid by 2020
Côte d'Ivoire	5% by 2015; 15% by 2020; 20% by 2030
The Gambia	35% electricity by 2020
Ghana	10% of electricity by 2020
Guinea	Solar: 6% by 2025 Wind: 2% by 2025
Guinea-Bissau	2% by 2015
Liberia	30% of electricity by 2021
Mali	10% by 2015; 25% by 2033
Niger	10% share in national energy balance by 2020
Nigeria[a]	Non-technology specific: 18% by 2020; 20% by 2030 Small-scale hydropower:[b] 600 MW by 2015; 2,000 MW by 2025 Solar PV: 75 MW by 2015; 500 MW by 2025 Solar thermal electricity: 1 MW by 2015; 5 MW by 2025 Biomass electricity: 600 MW by 2015; 2,000 MW by 2025 Wind: 20 MW by 2015; 40 MW by 2025
Senegal	20% by 2017
Sierra Leone	18% by 2015; 33% by 2020; 36% by 2030 Solar home systems: 1% penetration in the residential sector by 2015; 3% by 2020; 5% by 2030
Togo	15% by 2020

National Targets for Renewable Energy in ECOWAS Member States

[a] Nigeria's installed capacity targets are included in the Renewable Energy Master Plan which is currently in draft form. They are yet to be formally adopted.
[b] Nigeria defines small hydro as installations below 10 MW.
Source: see endnote 15 for this section.

Context and Situation in Africa and ECOWAS Countries

EREP Solar Water Heating Targets

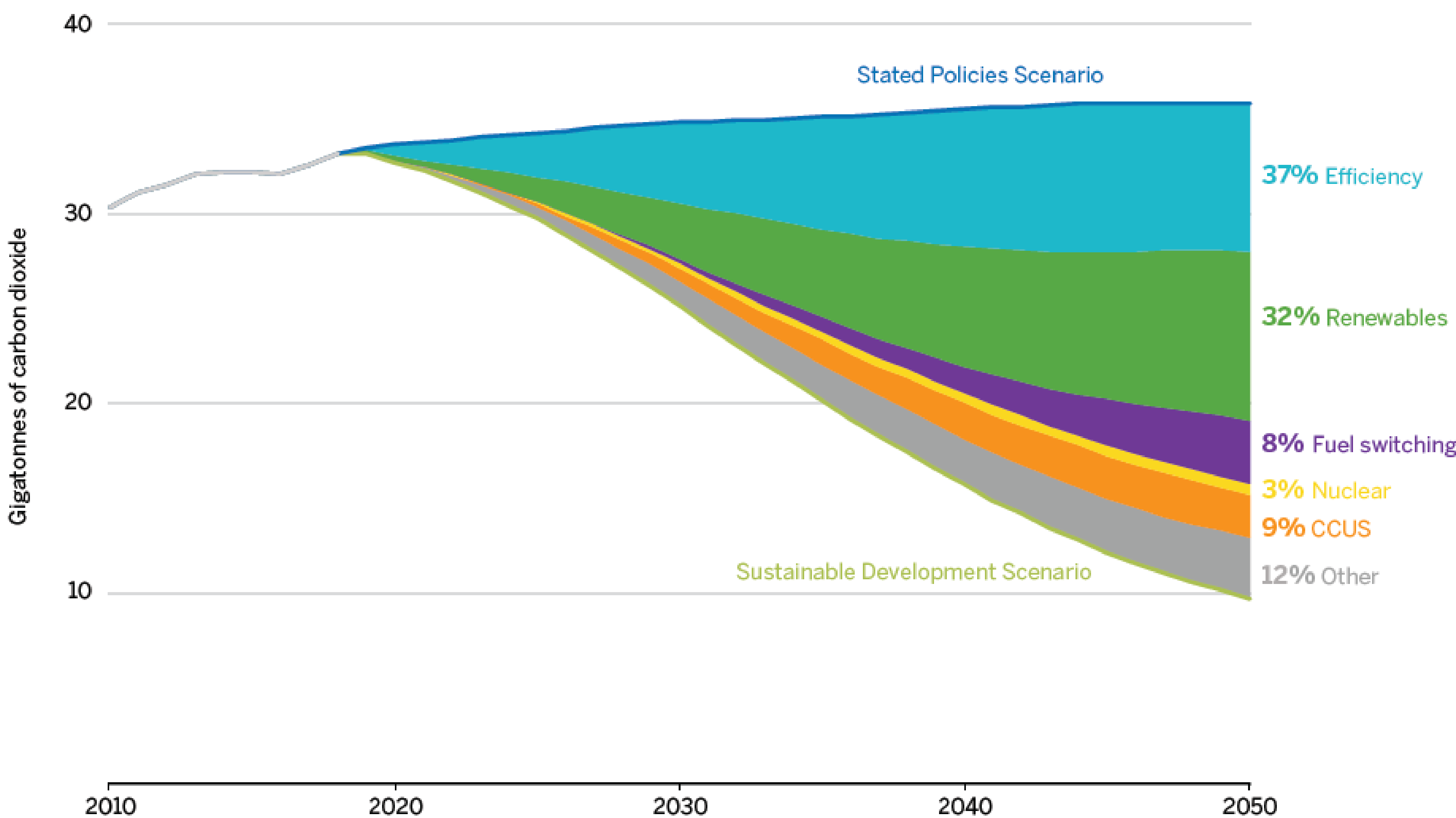


Source: see endnote 56 for this section.

Only a few ECOWAS Member States have targets or policies directed at renewable heat.

As with targets for renewable heating, few policies have been developed to promote the uptake of renewable energy in the heating and cooling sector. Both Ghana and Senegal have enacted mandates for the use of renewable heat

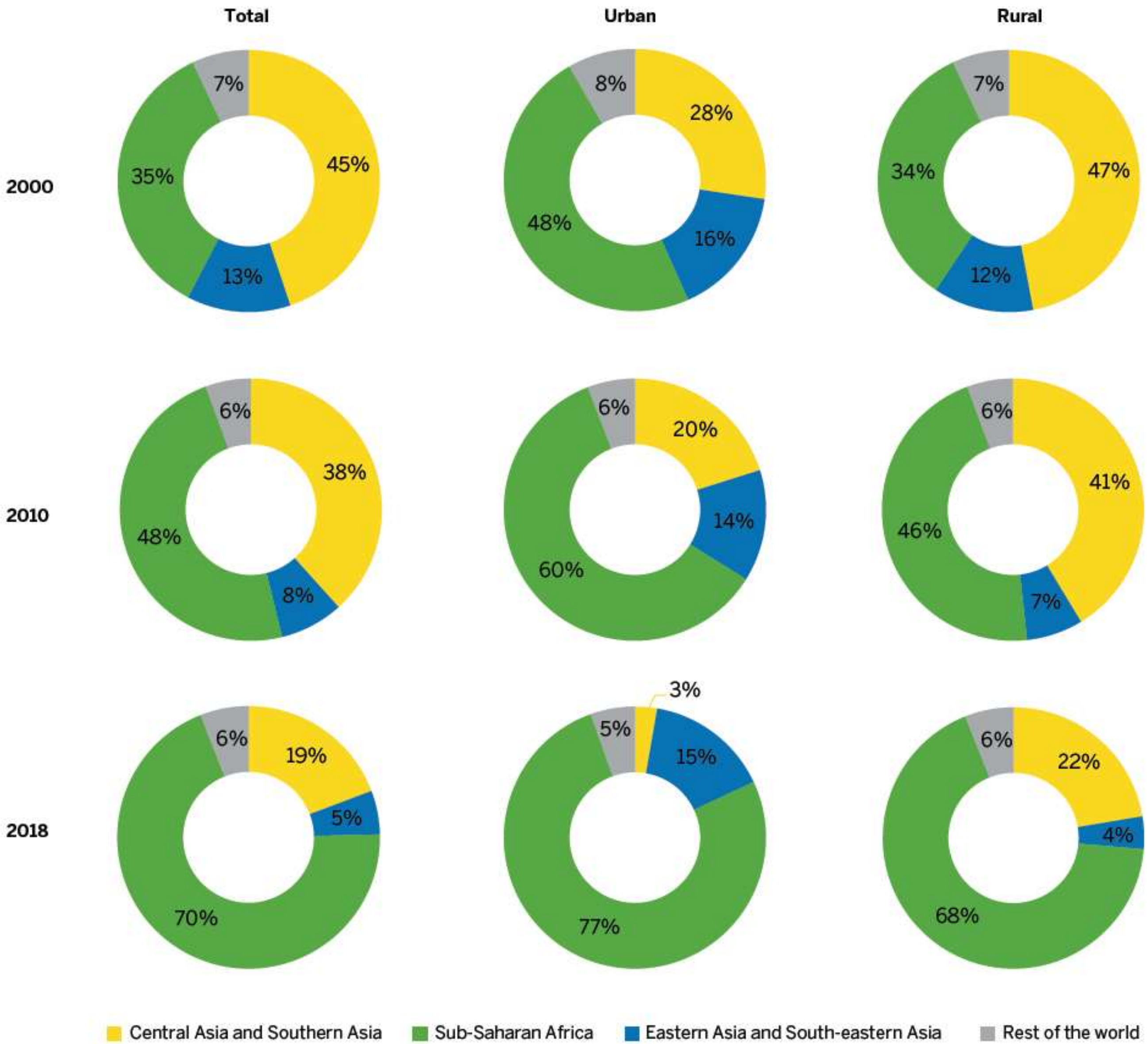
Context and Situation in Africa and ECOWAS Countries



Source: IEA 2019a.

Context and Situation in Africa and ECOWAS Countries

Comparison the evolution of energy deficit between Africa and Asia regions from 2000 to 2018



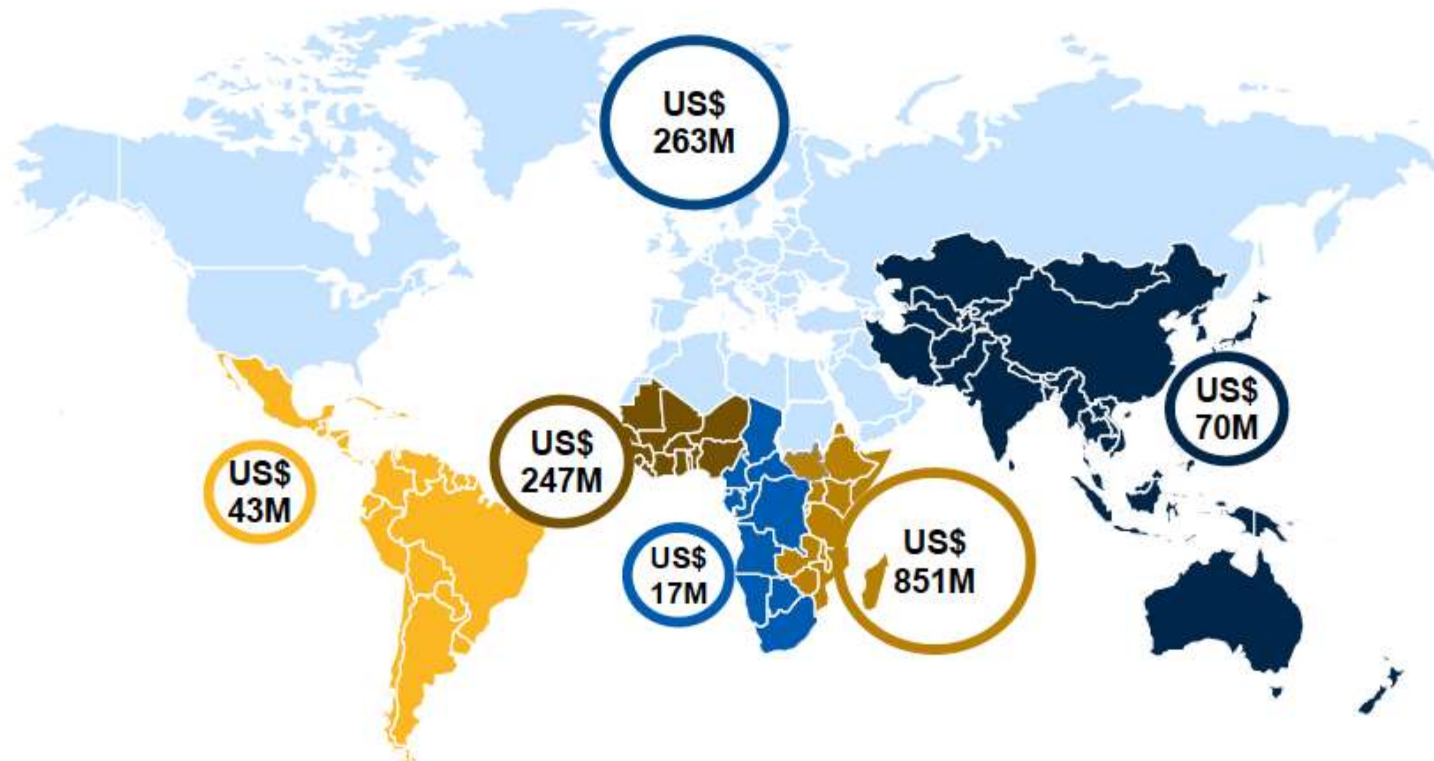
Source: World Bank.

Regional shares of the global access deficit, in total and along the urban-rural divide, 2000, 2010, and 2018

- In 2000 Africa occupied second postion behind S&E Asia except in urban area
- In 2010, the situation is reversed
- In 2018 Africa conutries occupied around 70 %
- Why such difference in reducing deficit rate?
- Did the solutions are not adequate or did less investment in Africa compared to Asia
- Did the funds not gone to targets?

Context and Situation in Africa and ECOWAS Countries

Total Cumulative Investments by Region (2012–2019)

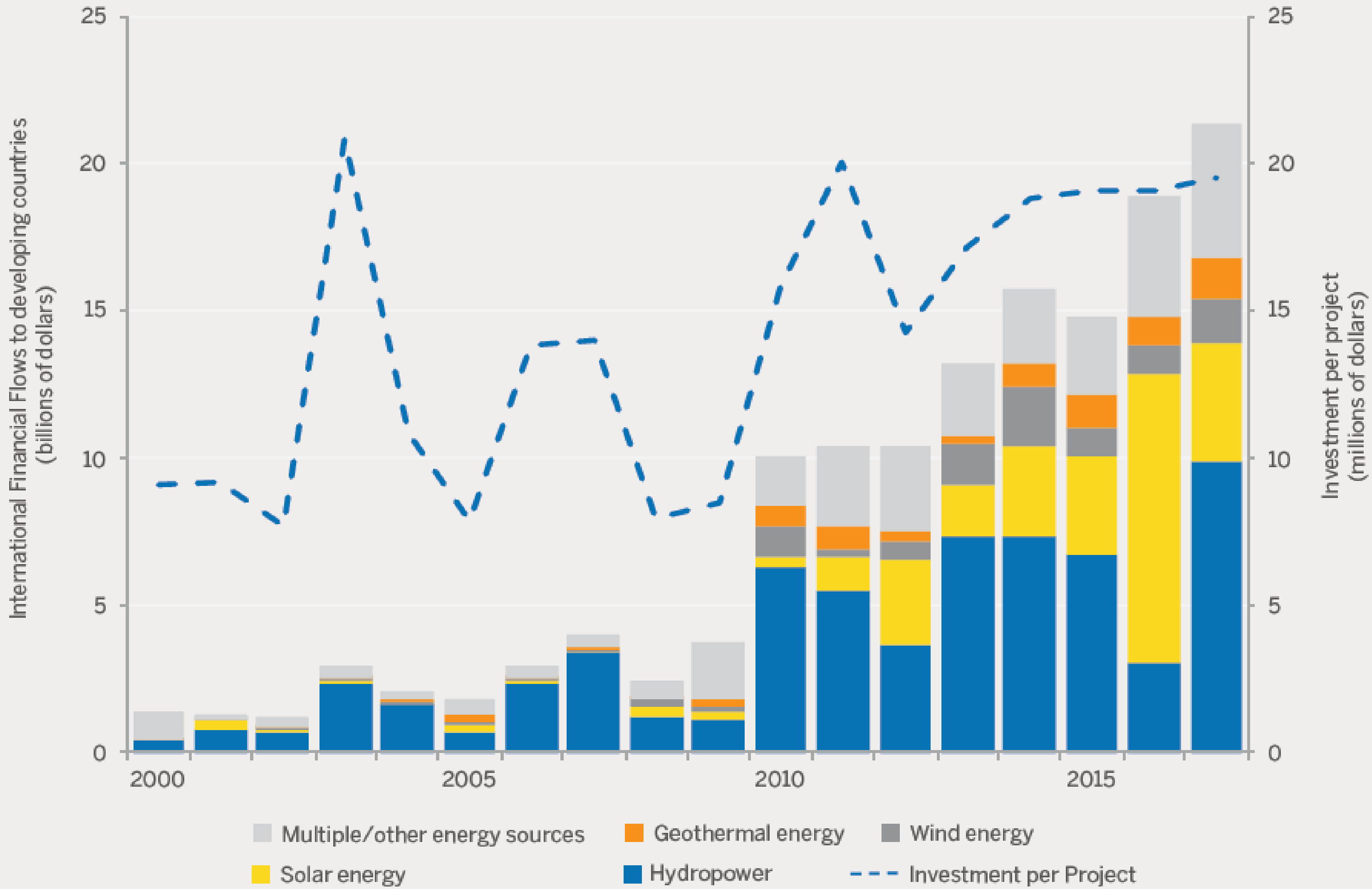


Legend: Eastern Africa, Western Africa, Middle & Southern Africa, Asia, Latin America & the Caribbean, Global (see note)

Source: Vivid Economics and Open Capital Advisors analysis of GOGLA, Deal Database.

Context and Situation in Africa and ECOWAS Countries

FIGURE B5.1.1 International financial flows to developing countries in support of clean and renewable energy (at 2017 prices and exchange rates)

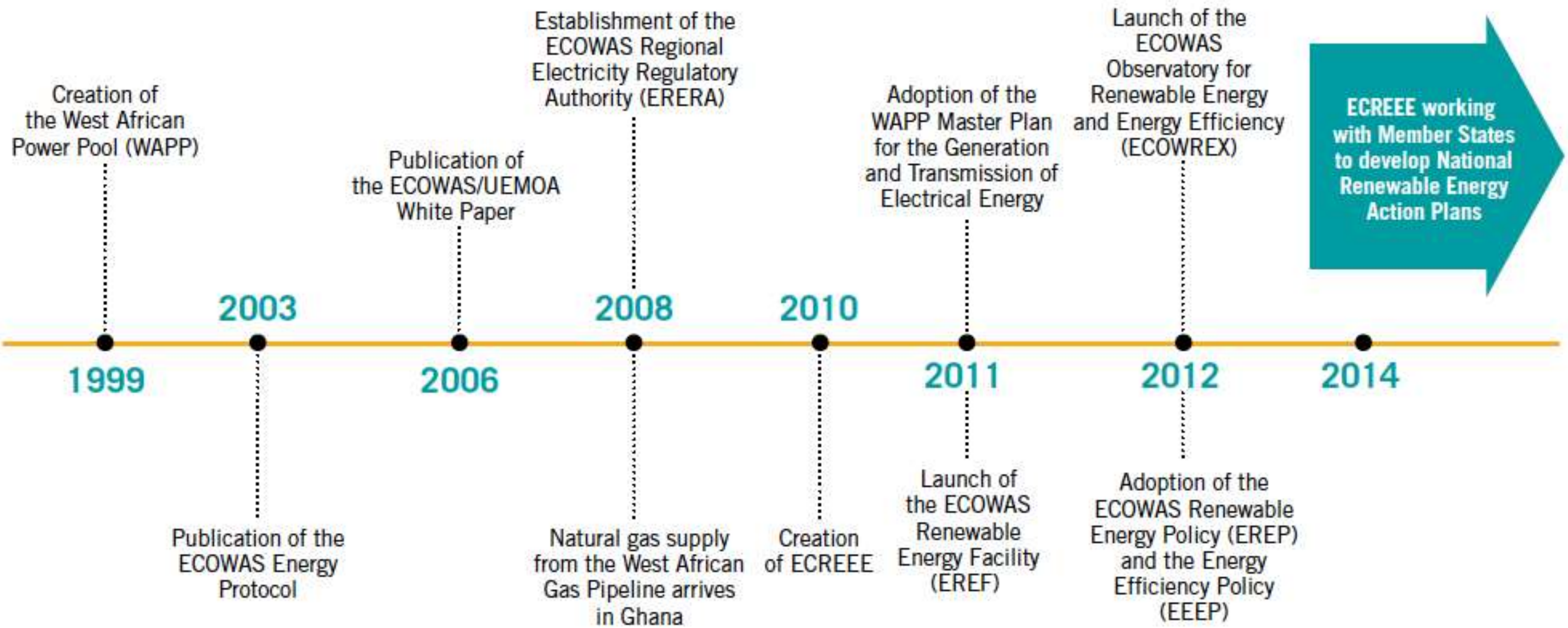


Source: Renewable Energy Public Investments Database.

ESOF2020, Science in the City Festival Trieste, 2020

Context and Situation in Africa and ECOWAS Countries

Milestones for Energy Cooperation and Integration in ECOWAS



Source: see endnotes 63-70 for this section.

Collaboration between African Research and Innovation Actors and Udine Researchers

Traditional technologies can make an important contribution to reducing co2 production, but they can hardly stop it. they cannot substitute fossil fuels entirely:

photovoltaic: only electricity, storage problem, no heat, efficiency problem, stability problem. Expensive.

wind: only electricity, storage problem

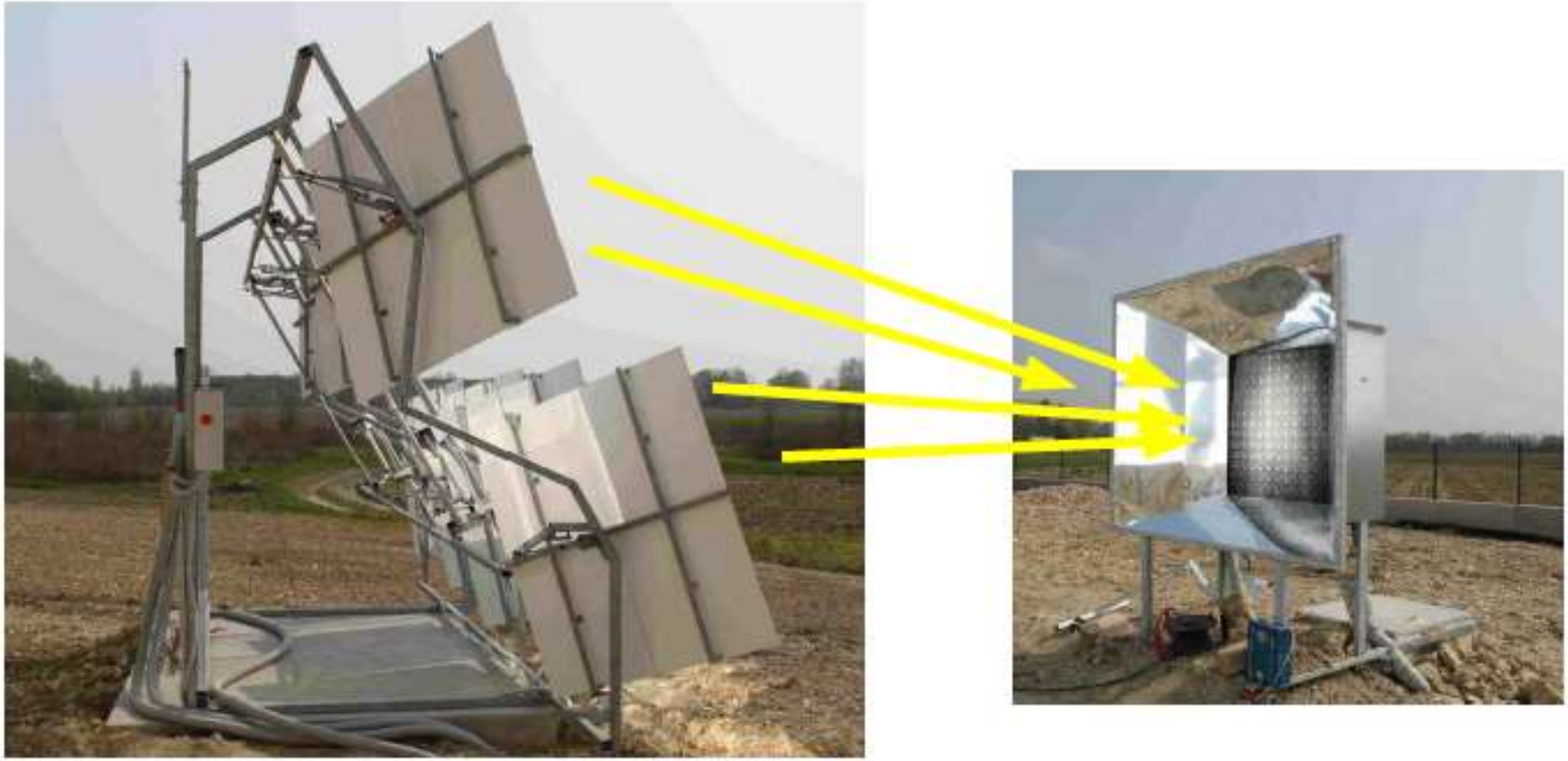
water: limited, big dams can destroy entire ecosystems and create political tensions between nations

non concentrating solar thermal: mostly low temperatures, sometimes very high temperatures (stagnation), technology at end of its development, cannot be improved any more.

concentrating solar (csp): very expensive, example Ouarzazate. 5 times

Trying to find and to develop new technologies.

linear mirror: simple, cheap, very long living, many different applications always with the same instrument water or air.



Grassmann, H., et al. (2013) *First Measurements with a Linear Mirror Device of Second Generation. Smart Grid and Renewable Energy, 4, 253-258*

The Linear Mirror

Consists of mirror elements, which are mechanically connected so they move concurrently and reflect concentrated sun light on a heat exchanger, which remains in a fixed position.

Our goal: create a linear mirror laboratory - group at the university of ziguinchor

Another recent example, which we are actively developing, is **the eolipile**: would be very helpful for renewable energies

- lack of literature

Studying eolipile in our group last months: no particular inefficiency for the eolipile. it deserves to be studied better, an industrial product seems possible.

- Details in the Group presentation

Collaboration between African Research and Innovation Actors and Udine Researchers

LCPM – Ziguinchor Senegal

- Prof. Diouma Kobor
- Dr Joseph Sambassène Diatta
- Dr Sérigne Thiao

African Dpa Actors

- Fairouz Malek, INP3, France
- Daniel EGBE, ANSOLE, Germany
- Ketevi Assamagan, ASP-ACP, BNL, USA

Udine and Trieste

- Hans Grassmann, Udine, ISOMORPH
- Marina Cobalt (Trieste)

Groupe

Génie des Matériaux pour l'Energie, l'Electronique et la Construction

(**GMEEC**)

Responsable: Pr Diouma Kobor

Permanent Members:

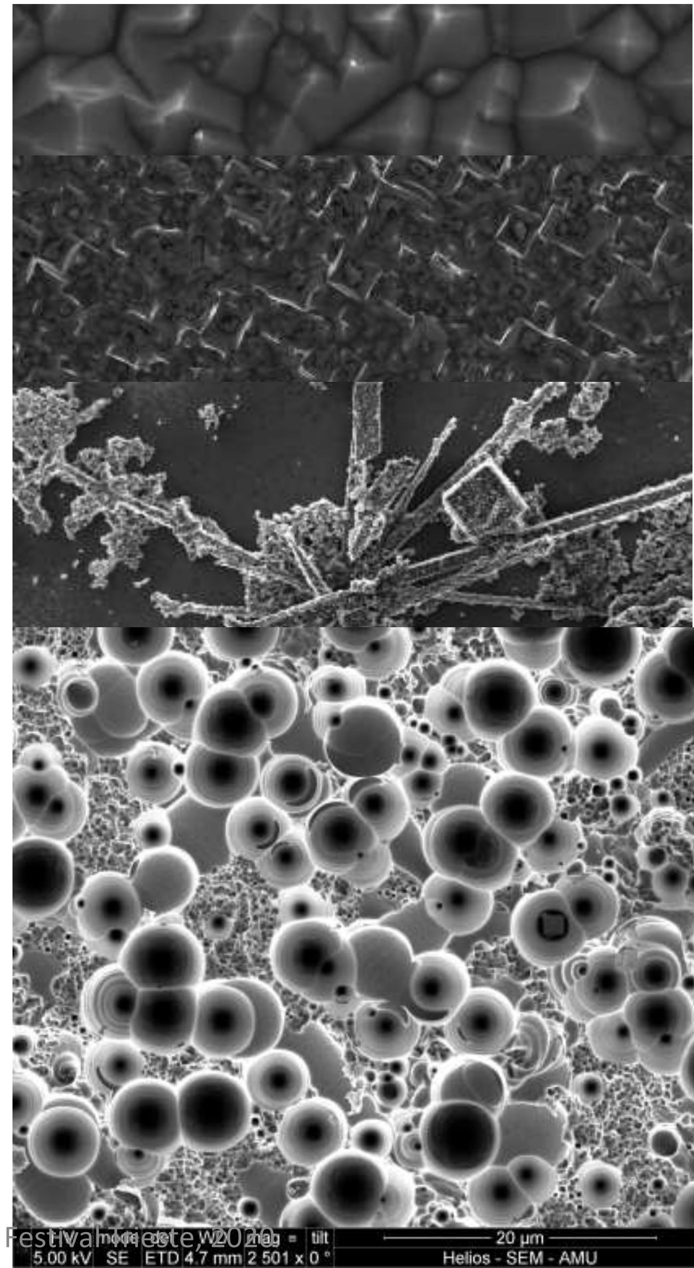
- 8 professors
- 4 postdocs
- 1 Technician

Non Permanent Members:

- 15 phD students
- 12 Master degree students
- 1 phD visiting students from partners

Main Topics

1. Fabrication and Characterization of Nanostructured Materials, Perovskites and thin films for Electronic, Photovoltaic and Biomedical Applications;
2. Characterization and Valorisation of Biomass for energy;
3. Elaboration and characterization of clays materials for energy efficiency;
4. **Simulation and Modelisation - Solar Photovoltaic - Solar Thermal in which we are working presently on Linear Mirror and Eolipile**



Characterization and Valorisation of Biomass for energy

Fig. 2: Conversion of biomass into char

Biomass technologies

Solid biofuel

Some pictures showing the first phase of production of fuel briquettes at the Assane Seck University of Ziguinchor.

1. Weighing the raw material

2. The filling

3. Advanced charring

4. Material's withdrawal

5. Mixing and grinding

6. Briquetting

7. Recovery of briquettes

Collaboration between African Research and Innovation Actors and Udine Researchers

Characterization and Valorisation of Biomass for energy

Construction du second biodigesteur en briques d'argile cuites

Briquettes de combustibles de résidus agricoles (coque de cajou, arachide, ..)

Characterization and Valorisation of Biomass for energy

Biogaz

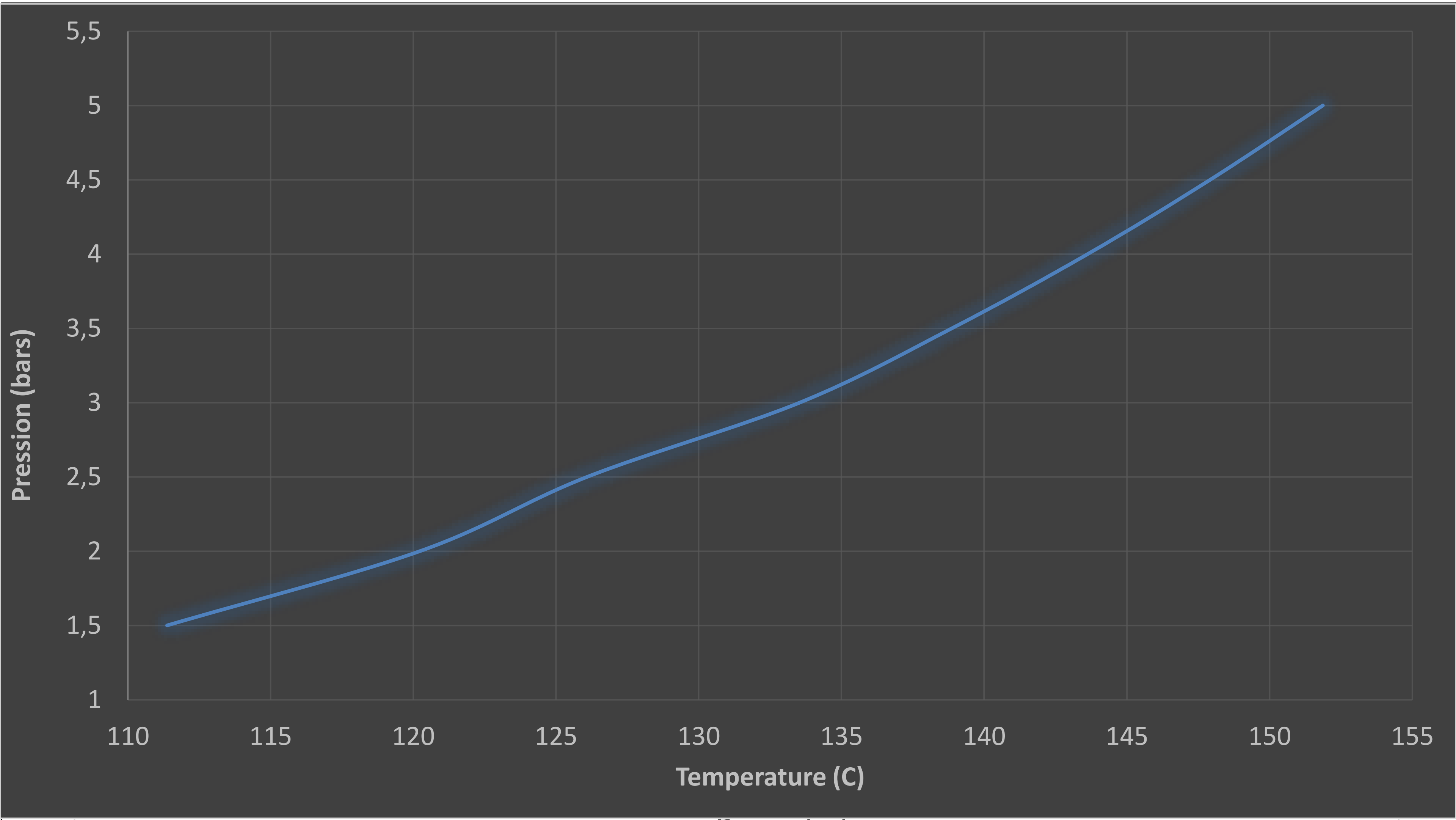
Digestat

(Fraction résiduelle non dégradée)

Éclairage

Fertilisant

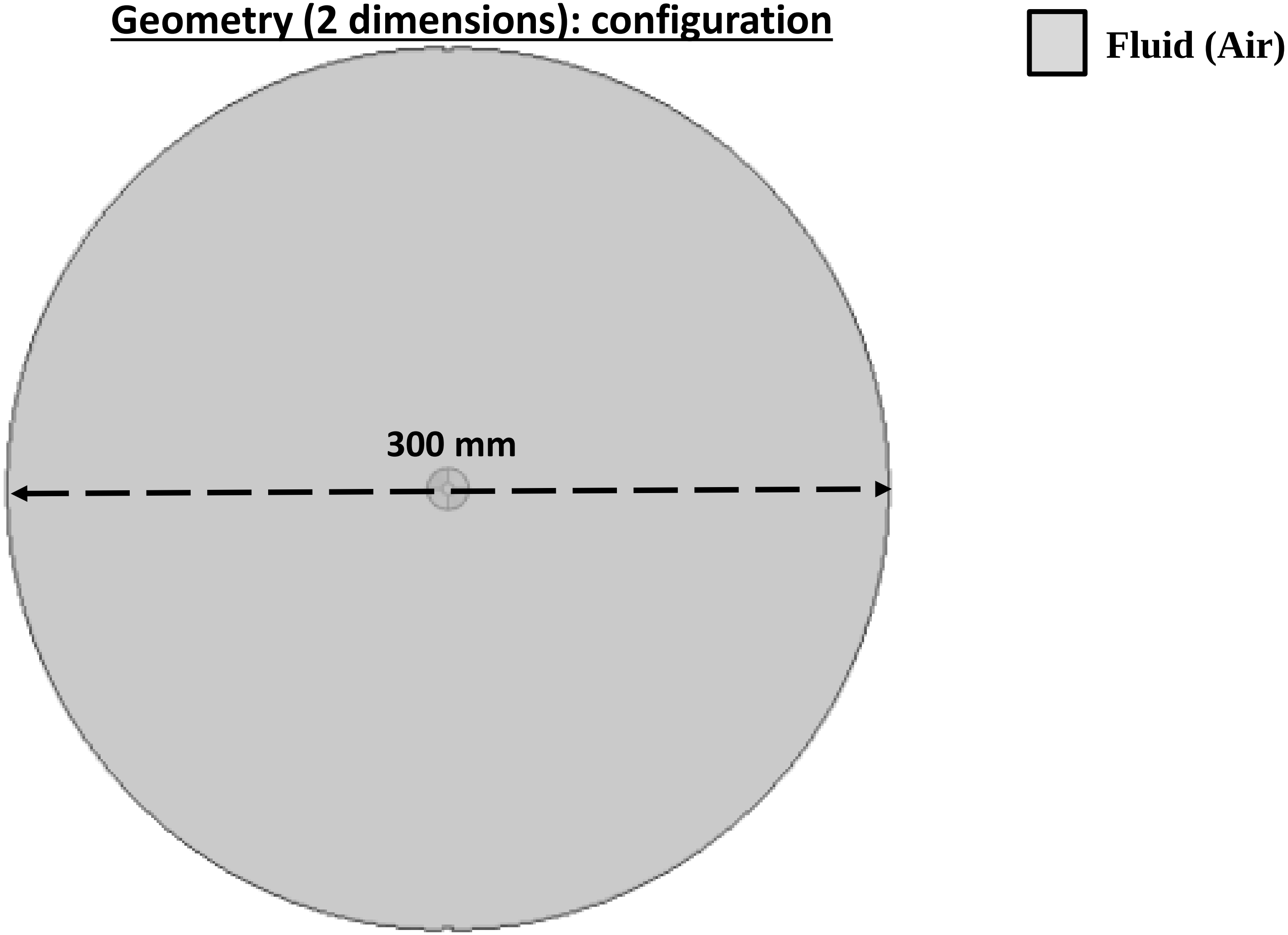
Simulation and Modelisation - Solar Photovoltaic - Solar Thermal: Example for Eolipile using Matlab



Rayon (m)

Simulation and Modelisation - Solar Photovoltaic - Solar Thermal: Example Numerical Modeling for Eolipile using COMSOL

<u>Geometry (2 dimensions): configuration</u>



Simulation and Modelisation - Solar Photovoltaic - Solar Thermal: Example Numerical Modeling for Eolipile using COMSOL

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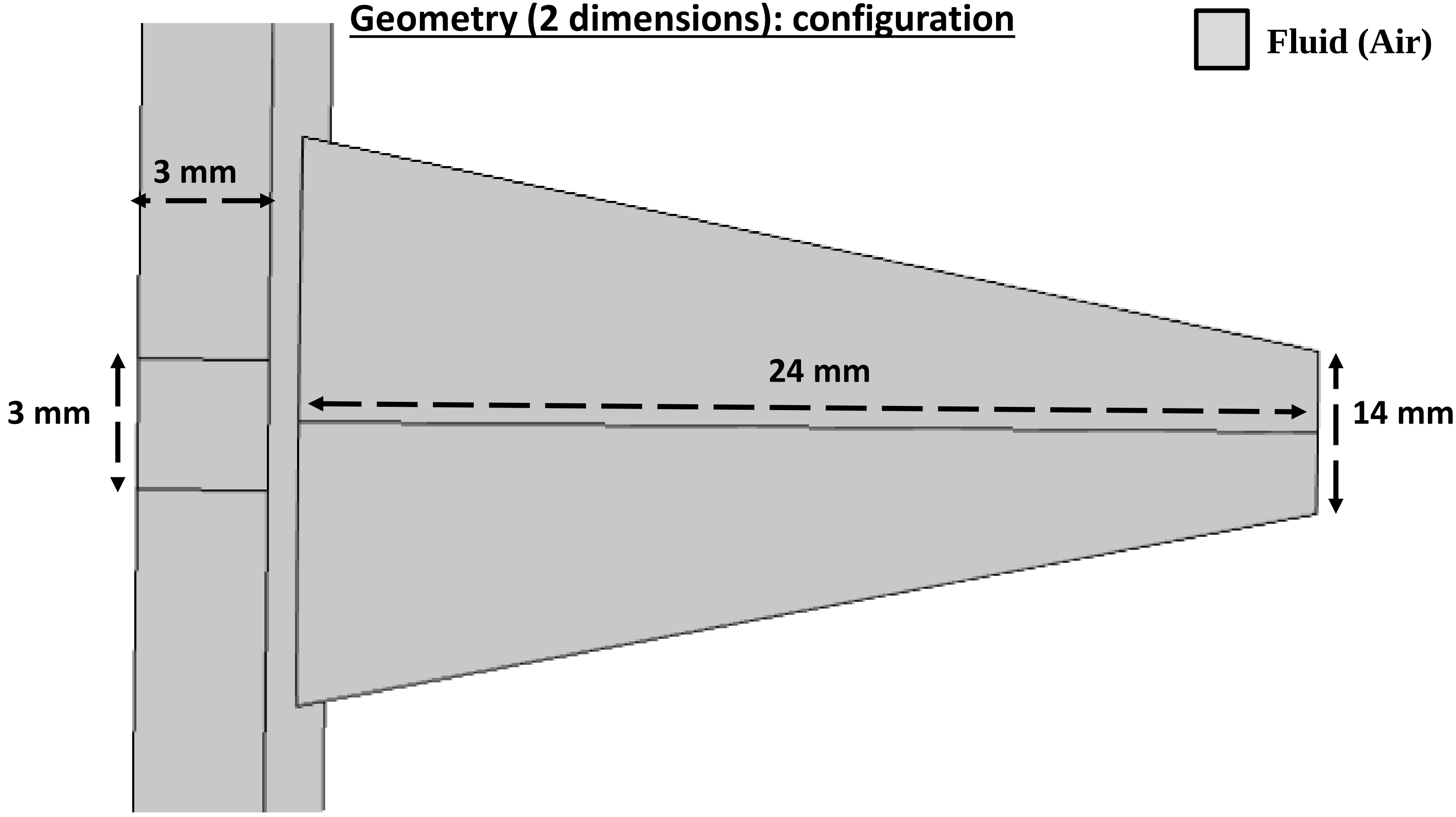
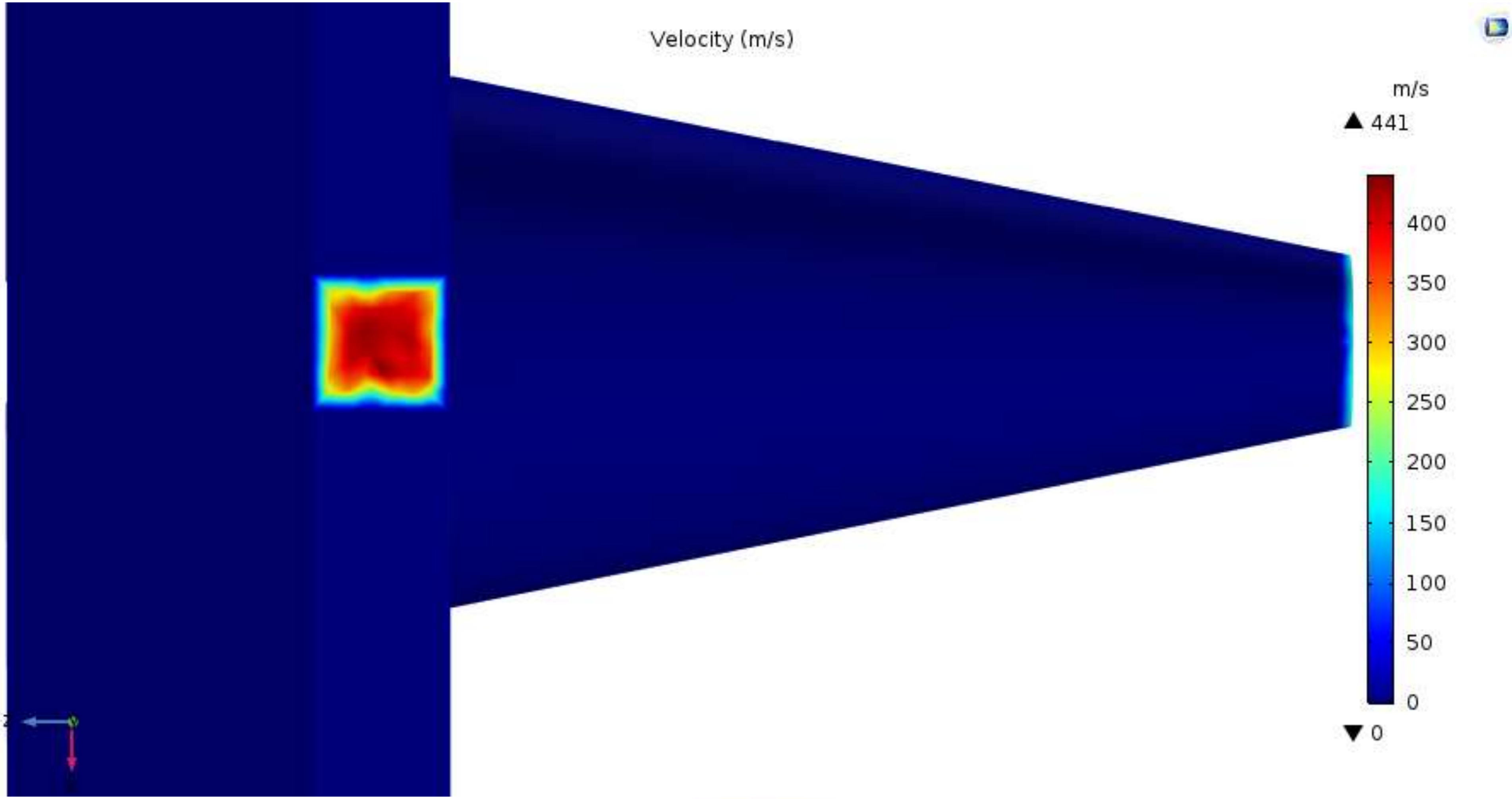


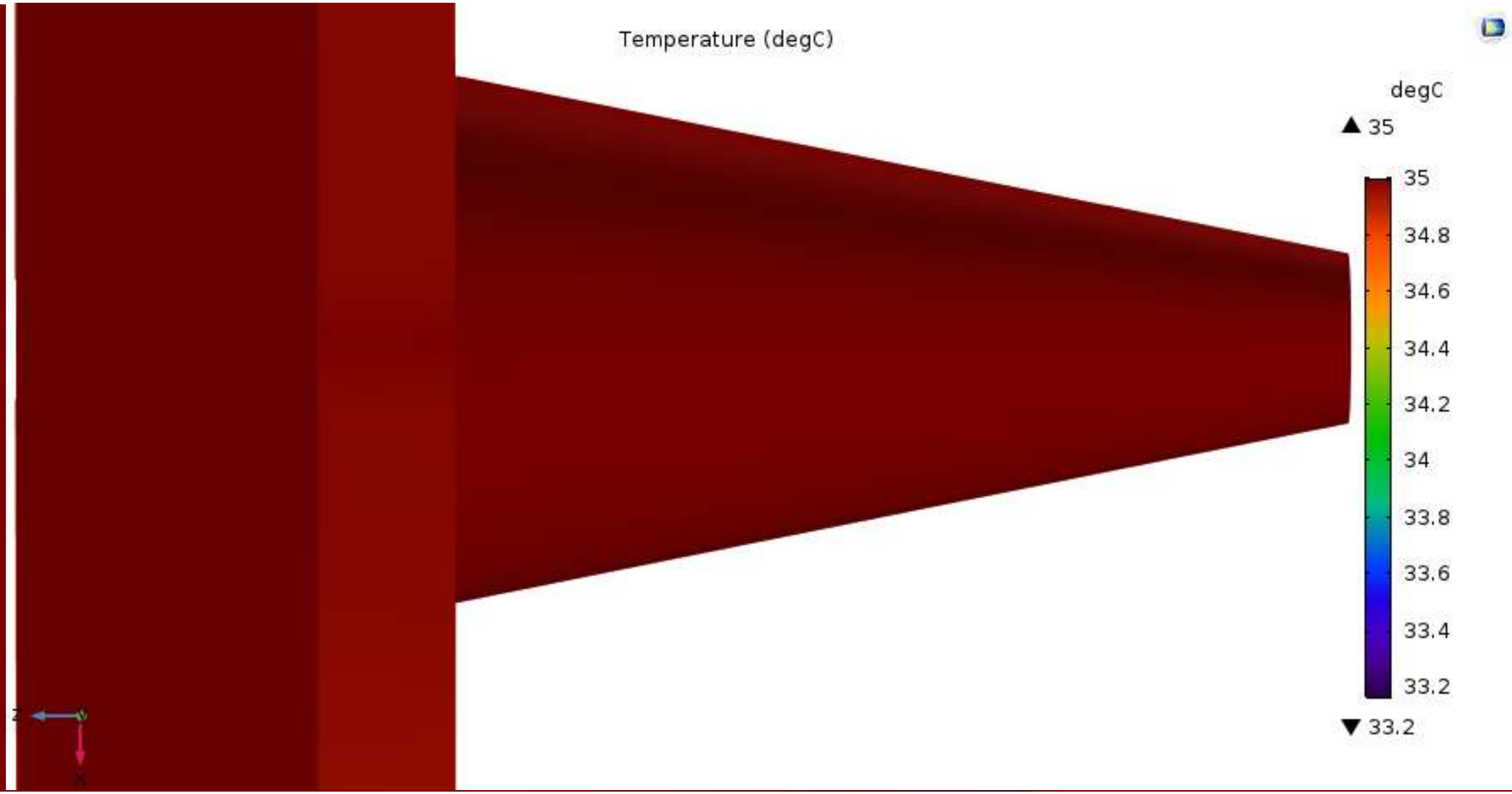
Results

Velocity



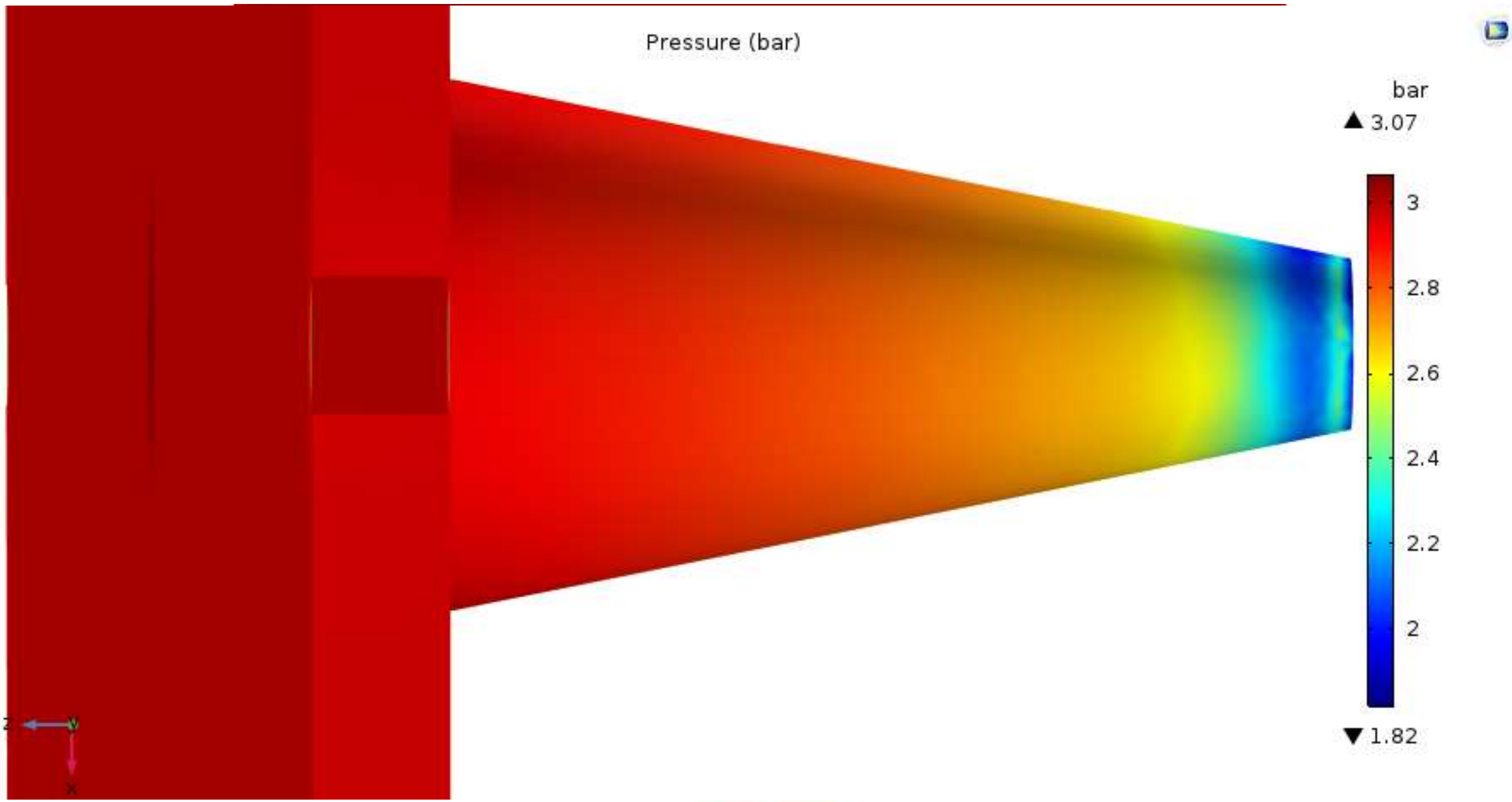
Results

Temperature



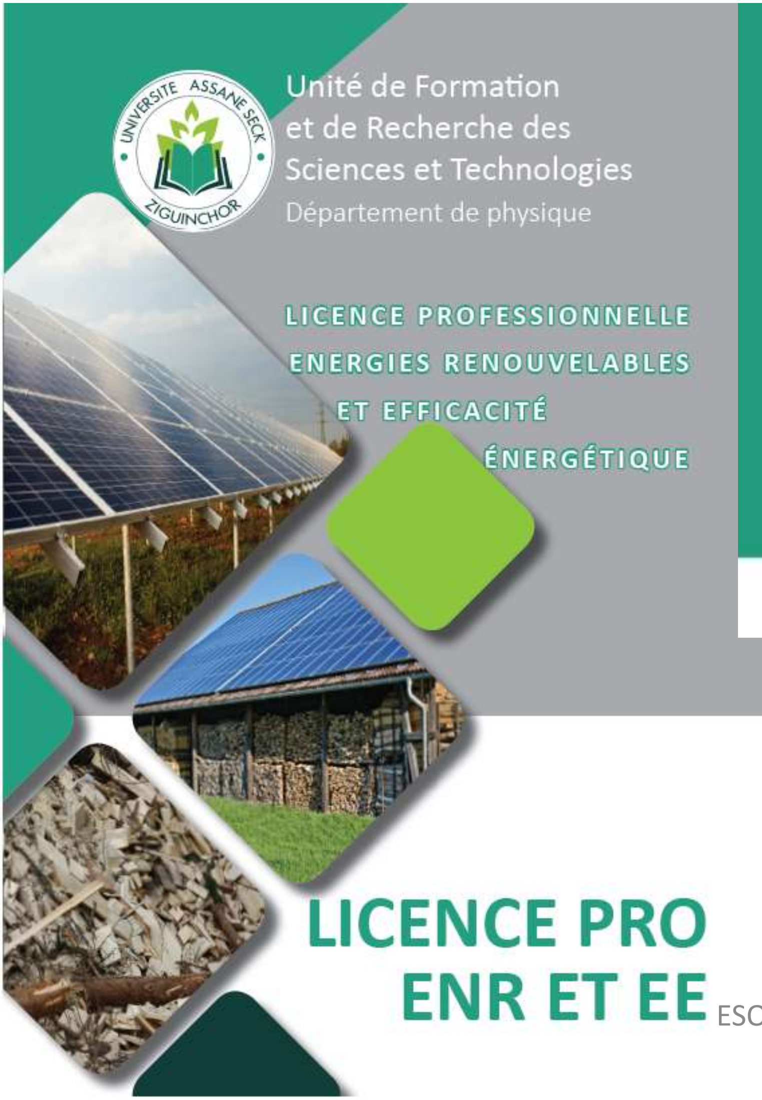
Results

Pressure

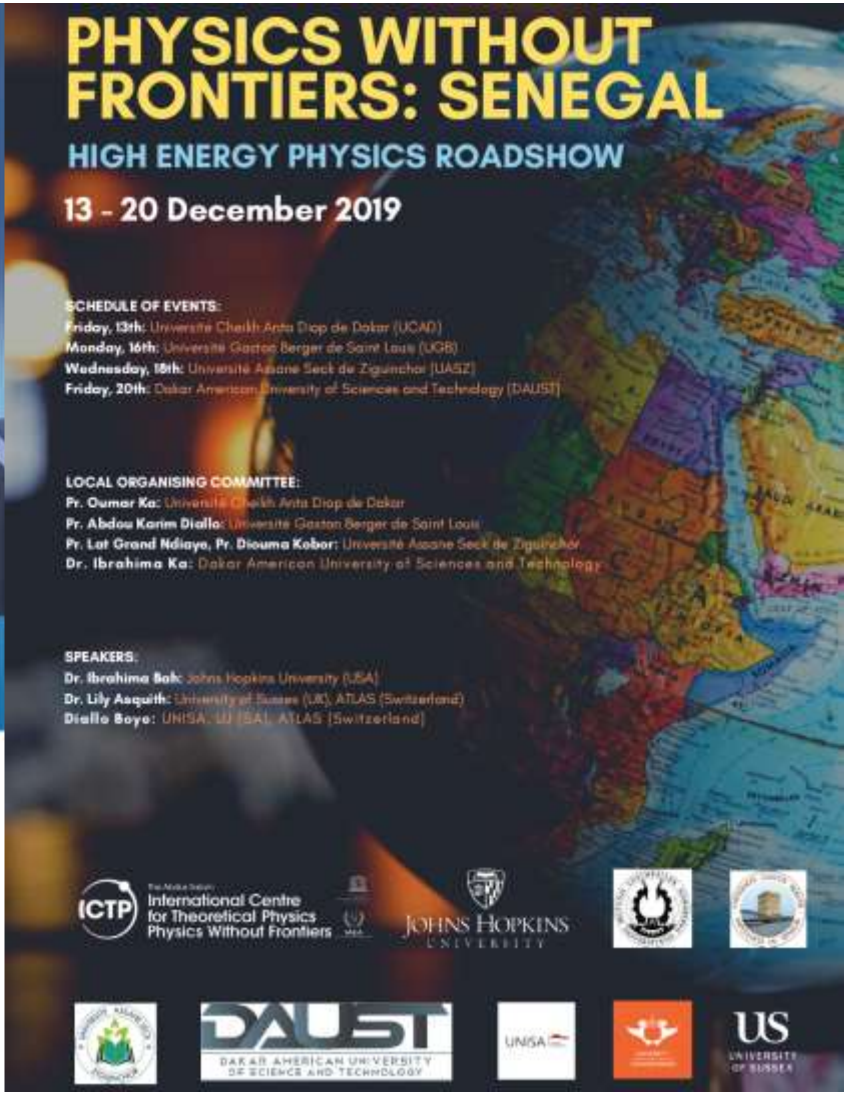


Other activities

Education



Recent Scientific Events



Simulation and Modelisation - Solar Photovoltaic - Solar Thermal in which we are working presently on Linear Mirror and Eolipile

African Scientific Diaspora Actors

- **Dr Daniel Ayuk Mbi EGBE ,** Coordinator of AFRICAN NETWORK FOR SOLAR ENERGY **(ANSOLE)**

ANSOLE e-Magazine Volume 6, 2020

B- Activities

1.(Co)organisation of scientific events

In 2019 ANSOLE (co)organized the following scientific meetings:

- 1st ANSOLE Scientific Meeting in Egypt (ASMEG 2019), 30 January 2019, Zewail City of Science and Technology, Giza, Cairo, Egypt
- 2nd ANSOLE Scientific Meeting in Côte d´Ivoire (ASMCI 2019), 28 March 2019, Université Nangui Abrogoua, Abidjan Côte d'Ivoire
- 1st ANSOLE Scientific Meeting in Democratic Republic of Congo (ASMCO 2019), 22 April 2019, Faculté Polytechnique-Université de Kinshasa (UNIKIN), Kinshasa, DRC.

Left) ANSOLE Scientific Meeting in Egypt (ASMEG 2019). Right) ANSOLE Scientific Meeting in DRC (ASMCO 2019)

Collaboration between African Research and Innovation Actors and Udine Researchers

Simulation and Modelisation - Solar Photovoltaic - Solar Thermal in which we are working presently on Linear Mirror and Eolipile

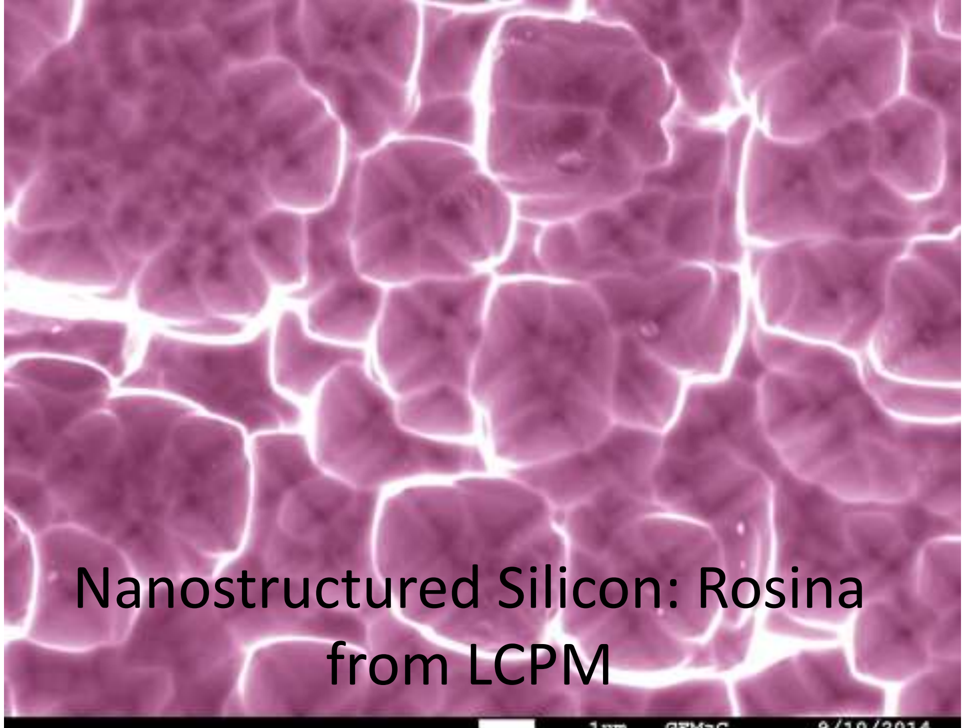
Conclusion and perspectives

- ❖ **Find financial supports for funding the new project;**

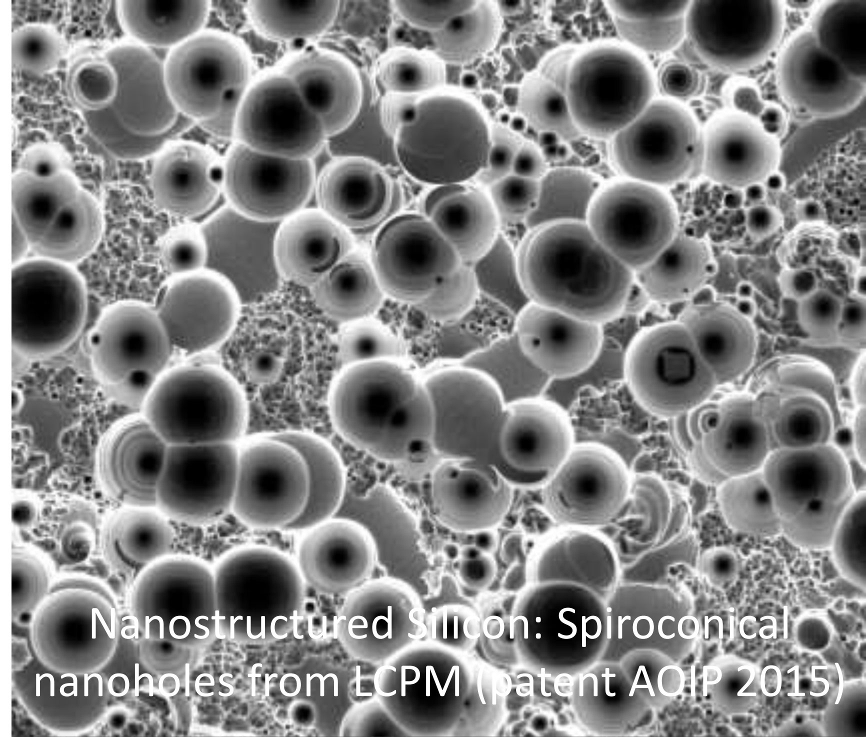
- ❖**Install Linear Mirror and Applications Group in LCPM/UASZ in Senegal;**

- ❖**Researchers and students exchange between UASZ, Udine, ICTP, INP3, BNL and ANSOLE partners.**

- ❖**Conduct theoritical and fundamental physics studies on the solar thermal particularly Linear Mirrors: simulation, modeling and rays incident angle effects on the solar thermal efficiency**



Nanostructured Silicon: Rosina from LCPM



Nanostructured Silicon: Spiroconical nanoholes from LCPM (patent AOIP 2015)

Thank You for your Attention

Enjoy Nano for Energy Conversion

Nanostructured Silicon: Rhombedral Stared Nanosheets from LCPM (PCT 2019)