



Conferência Internacional
**Energia Sustentável
na Guiné-Bissau**
Guinea Bissau Sustainable Energy
International Conference

6-7 Dezembro
December 2016 / BISSAU
Hotel Leijer Neves



Projetos ligados à rede: Estudos de caso na CEDEAO

Grid-connected projects: case studies in the ECOWAS region



Eder Semedo

ECREEE



Status of Utility Scale RE Capacity in the region

Total installed grid-connected RE capacity stands at **5,779.05 MW** (incl. medium and large hydro)

- 5,505.88 MW Hydro
 - (221.44 MW small hydro)
- 228.52 MW Solar PV
- 27.05 MW Wind
- 16.04 MW Biomass

- **493.05 MW** total RE capacity excl. medium and large hydro



ORGANIZAÇÃO:



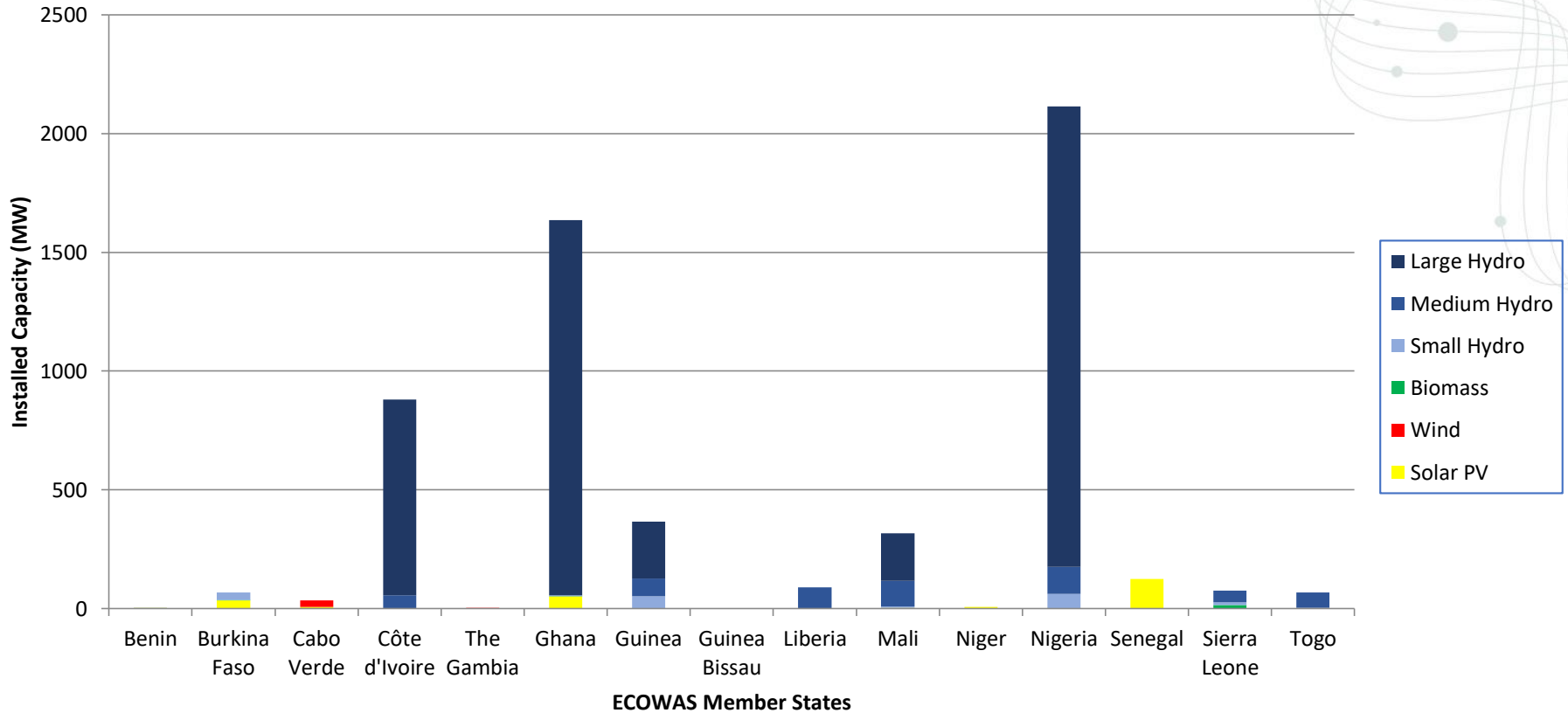
APOIO:





Status of Utility Scale RE Capacity in the region

Total Installed RE Capacity per Country



ORGANIZAÇÃO:



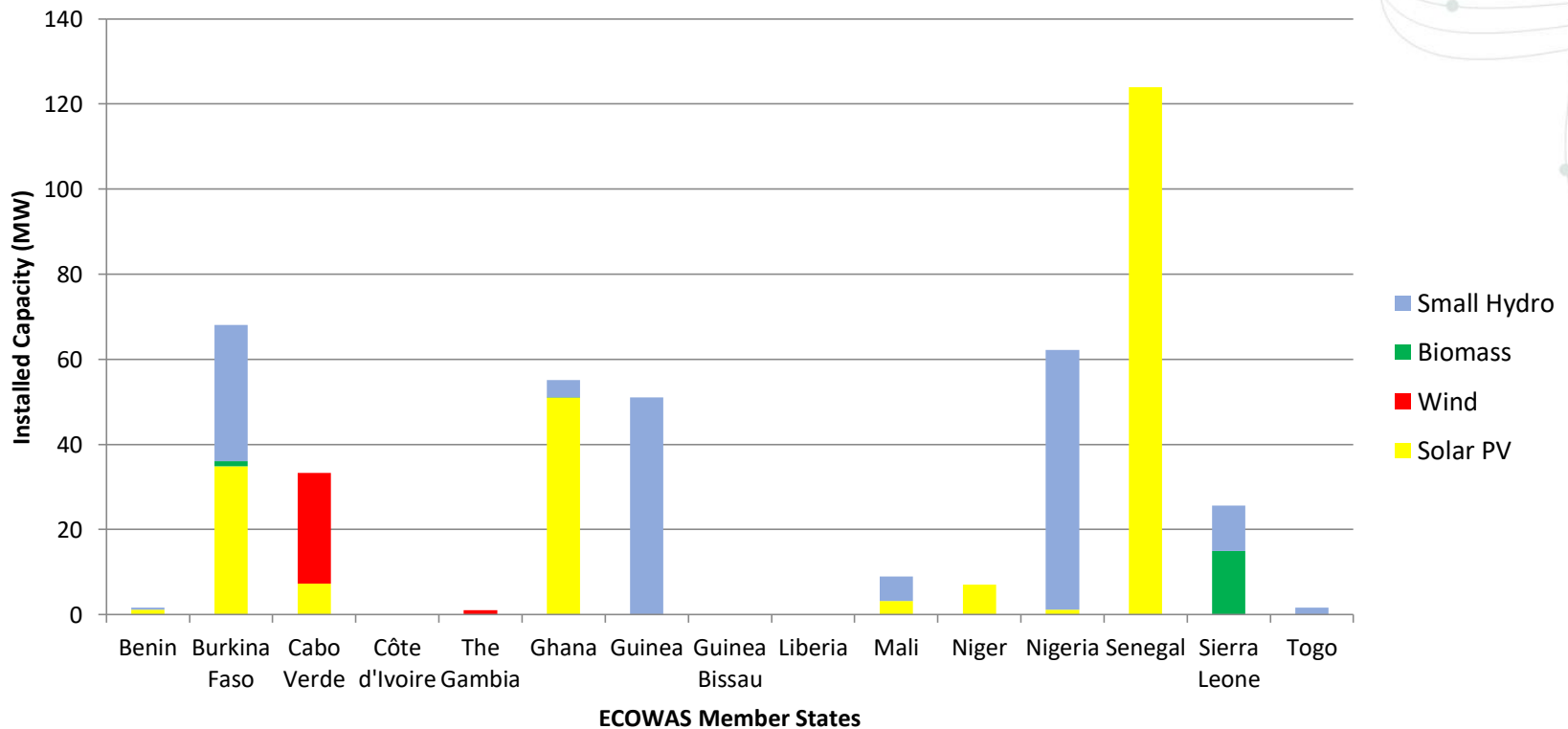
APOIO:





Status of Utility Scale RE Capacity in the region

Total Installed RE Capacity per Country (excl. medium and large hydro)



ORGANIZAÇÃO:



APOIO:





ECREEE activities on Grid-connected RE

- Support the development of grid-connected RE projects with the potential of becoming important projects through technical assistance (TA)
- ***Document and disseminate the experiences with grid-connected RE flagship projects in West Africa***
- Supporting the creation of an enabling environment for public and private investments in RE

<http://www.ecreee.org/TA-flagship-projects>

ORGANIZAÇÃO:



APOIO:





Case studies documented by ECREEE

- Cabeólica wind project in Cabo Verde
- *Electric Wind project in Cabo Verde*
- Santiago and Sal solar PV plants in Cabo Verde
- Navrongo Solar PV project in Ghana
- *Solar PV IPP projects in Senegal*

<http://www.ecreee.org/page/grid-connected-renewable-energy-flagship-projects>

ORGANIZAÇÃO:



APOIO:





Case studies documented by ECREEE

- Cabeólica wind project in Cabo Verde
- **Electric Wind project in Cabo Verde**
- Santiago and Sal solar PV plants in Cabo Verde
- *Navrongo Solar PV project in Ghana*
- *Solar PV IPP projects in Senegal*

<http://www.ecreee.org/page/grid-connected-renewable-energy-flagship-projects>

ORGANIZAÇÃO:



APOIO:





Grid integration of the **ELECTRIC WIND** project in Cabo Verde

- **Key facts**

Site	Aguada de Janela, Paúl, Santo Antão island
Technology	Wind generators (refurbished)
Capacity	0.5 MW (2x 250 kW)
Developer	Electric Wind, S.A.
Operator	Electric Wind, S.A.
Commissioning	April 2011
Investment cost	900,000 EUR
Financing	Equity, shareholder loans, grant

ORGANIZAÇÃO:



APOIO:





Grid integration of the **ELECTRIC WIND** project in Cabo Verde

- **Key facts**

Timeline	
2007 - December	Signature of grant agreement with the Dutch government
2008 - July	Formation and registration of joint venture
2008 - November	Certification of foreign investor status, power production license and signature of PPA
2010 - March	Bankruptcy of Main Wind BV
2010 - November	Replacement of Main Wind BV by Green Energy Services
2011 - April	Commissioning

ORGANIZAÇÃO:





Grid integration of the **ELECTRIC WIND** project in Cabo Verde

- Cabo Verdean developer Electric, SA targeting smaller islands with lower peak loads.
 - Santo Antão: approx. 40,000 inhabitants (12,000 clients); 9.8 MW installed capacity (thermal); 3 MW peak load; 1.5 MW base load
 - Co-financed in the framework of a program from the Dutch government (PSOM/PSI)
 - New company Electric Wind, SA created with a Dutch shareholder
 - IPP license; 20-year PPA with the utility
 - Corporate tax exemption (first 5 years of operation)
 - Wind turbines manufactured in 1993, operated for 14 years in the Netherlands, reinstalled in Cabo Verde.

ORGANIZAÇÃO:



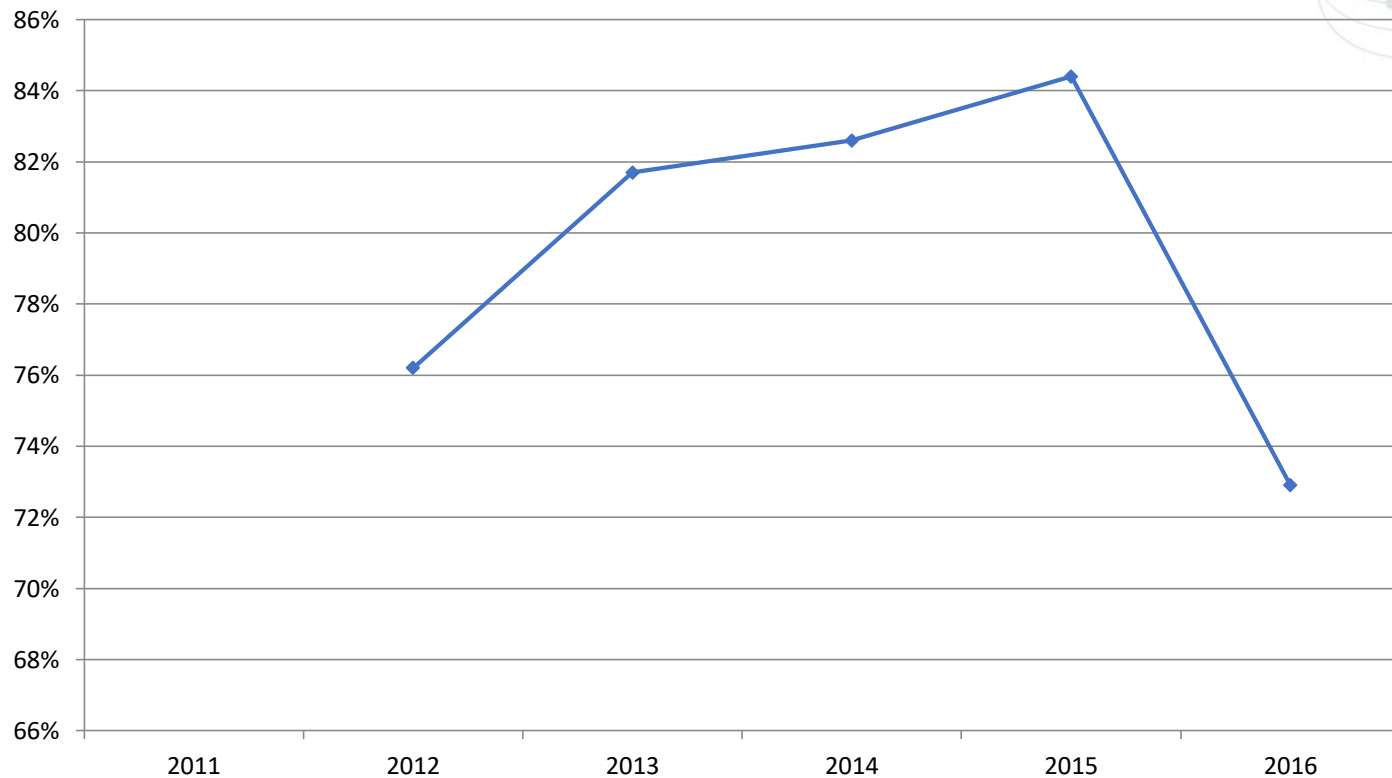
APOIO:





Grid integration of the **ELECTRIC WIND** project in Cabo Verde

Operational availability: 2012-2016



ORGANIZAÇÃO:



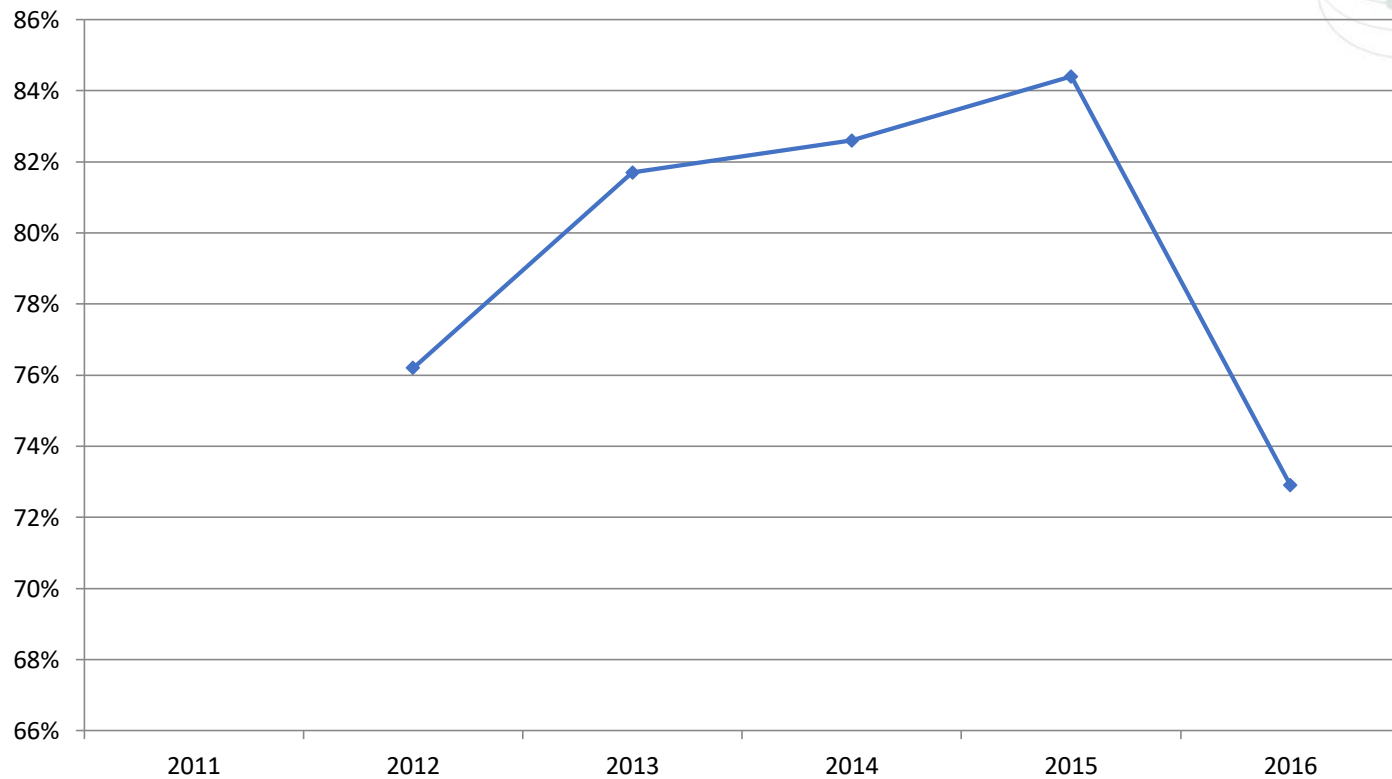
APOIO:





Grid integration of the **ELECTRIC WIND** project in Cabo Verde

Operational availability: 2012-2016



ORGANIZAÇÃO:



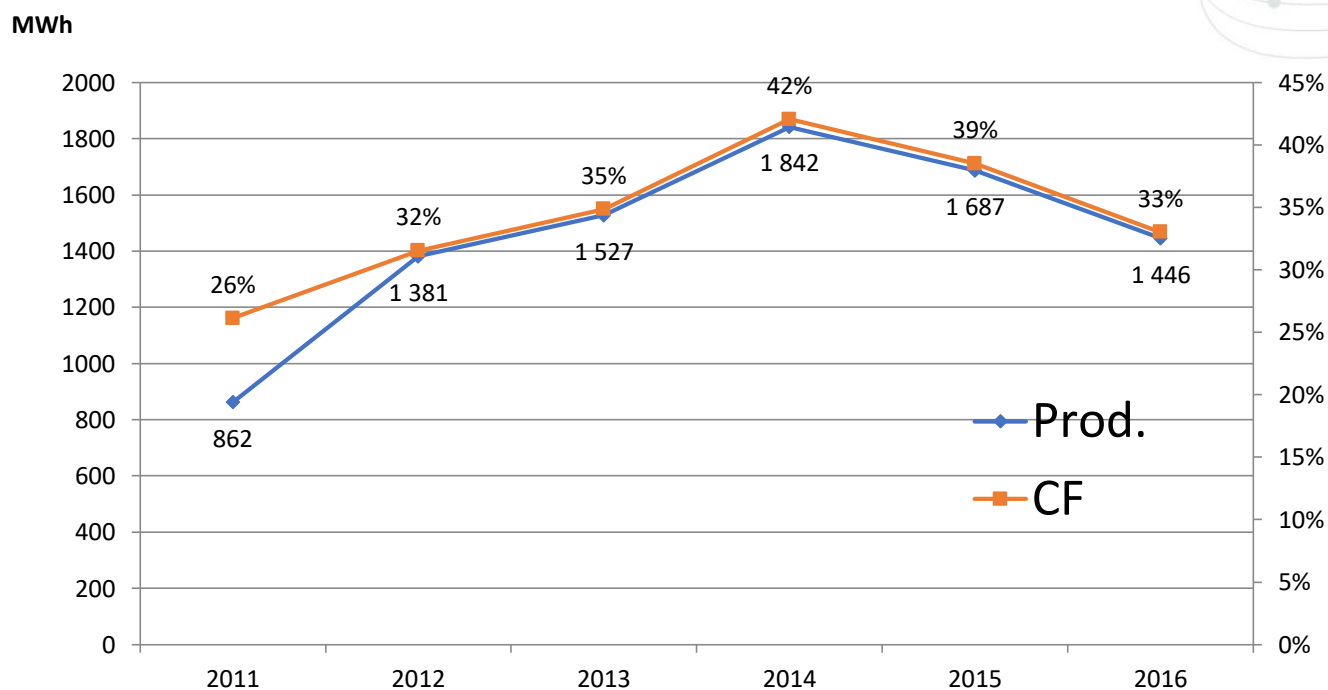
APOIO:





Grid integration of the **ELECTRIC WIND** project in Cabo Verde

Production & Capacity Factor



ORGANIZAÇÃO:



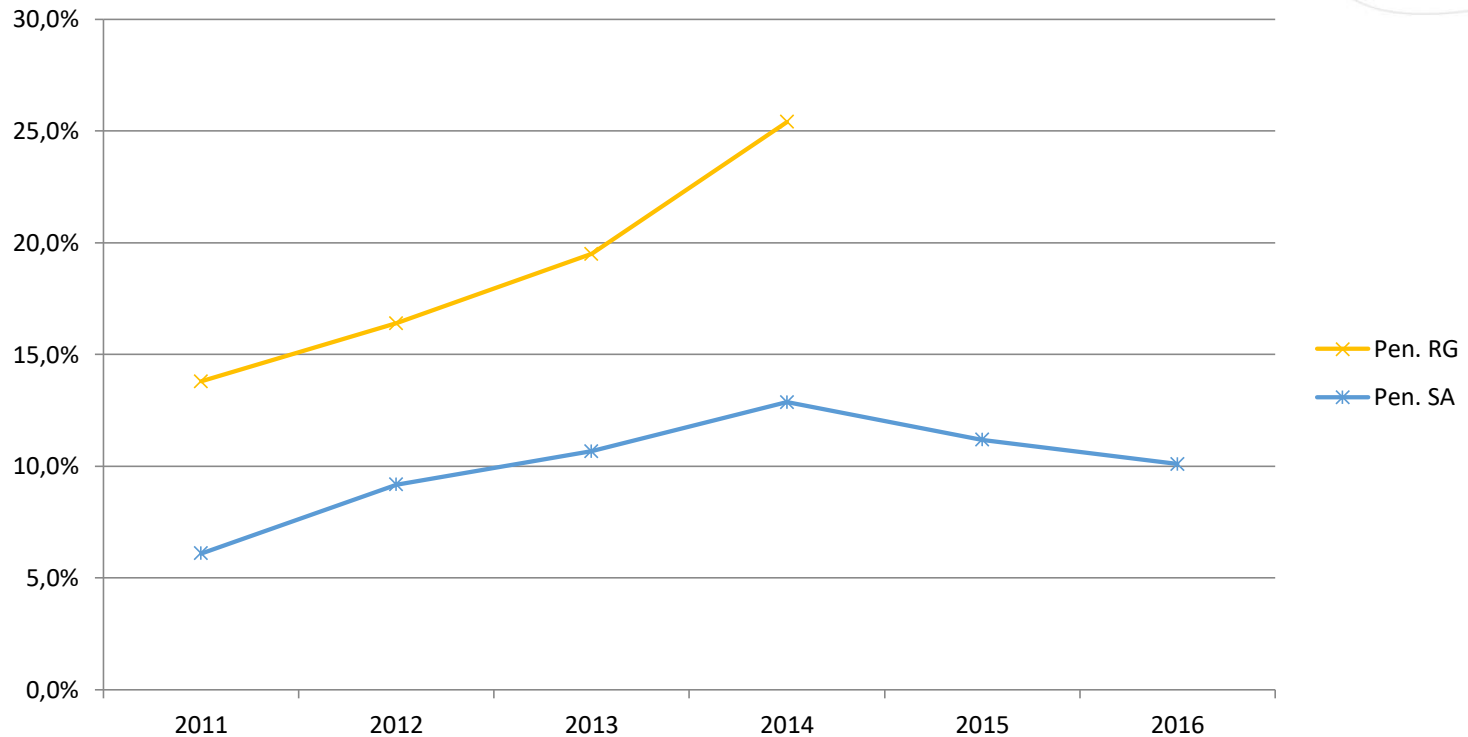
APOIO:





Grid integration of the **ELECTRIC WIND** project in Cabo Verde

Yearly average wind penetration in the electrical system



ORGANIZAÇÃO:



APOIO:





Grid integration of the **ELECTRIC WIND** project in Cabo Verde

Grid Integration Challenges

- Significant reduction of errors from 2012 to 2016: improved technical performance
- No capability to control the active power production; sudden wind variations dramatically shifts production values
- Connected with a small grid whose control and regulation systems of frequency was not efficient enough

ORGANIZAÇÃO:



APOIO:





Grid integration of the **ELECTRIC WIND** project in Cabo Verde

Financial Viability - Tariffs

Year	2012	2013	2014	2015	2016
Average fuel cost on the island of Santo Antão (c€/kWh)	0.29	0.24	0.25	0.18	0.14
Wind power tariff (c€/kWh)	0.15	0.13	0.13	0.13	0.13

ORGANIZAÇÃO:



APOIO:





Grid integration of the **ELECTRIC WIND** project in Cabo Verde

Financial Viability – Fuel Savings

Year	2011	2012	2013	2014	2015	2016	TOTAL
Production (kWh)	861,759	1,381,310	1,527,097	1,841,690	1,687,104	1,445,758	8,744,718
Fuel savings (liter)	237,049	389,223	434,277	560,857	477,867	384,006	2,483,279
Foreign currency savings (€)	203,827	326,714	286,426	345,663	213,117	127,873	1,503,621
Avoided greenhouse gas emissions (ton CO ₂ eq.)	612	981	1,084	1,308	1,198	1,026	6,209

ORGANIZAÇÃO:



APOIO:





Case studies documented by ECREEE

- Cabeólica wind project in Cabo Verde
- *Electric Wind project in Cabo Verde*
- Santiago and Sal solar PV plants in Cabo Verde
- Navrongo Solar PV project in Ghana
- ***Solar PV IPP projects in Senegal***

<http://www.ecreee.org/page/grid-connected-renewable-energy-flagship-projects>

ORGANIZAÇÃO:



APOIO:





Case studies documented by ECREEE

- Cabeólica wind project in Cabo Verde
- *Electric Wind project in Cabo Verde*
- Santiago and Sal solar PV plants in Cabo Verde
- Navrongo Solar PV project in Ghana
- ***Solar PV IPP projects in Senegal***

<http://www.ecreee.org/page/grid-connected-renewable-energy-flagship-projects>

ORGANIZAÇÃO:



APOIO:





First 3 Solar PV IPP in Senegal

- Situation in Senegal:
 - Reforms in the energy sector since 2010
 - Promotion of Renewable Energy
- Setting objectives
 - Increasing the installed renewable energy capacity to 20% of the total installed capacity by 2017
 - Reducing the cost of generation and the electricity tariff for households and companies
 - Increasing the share of renewables in the energy mix in order to improve the energy independence of the country
- *In a short period of time Senegal reached 124 MW of installed Solar PV at a competitive starting price of 0.10 EUR/kWh... How?*

ORGANIZAÇÃO:



APOIO:





First 3 Solar PV IPP in Senegal

- Situation in Senegal:
 - Reforms in the energy sector since 2010
 - Promotion of Renewable Energy
- Setting objectives
 - Increasing the installed renewable energy capacity to 20% of the total installed capacity by 2017
 - Reducing the cost of generation and the electricity tariff for households and companies
 - Increasing the share of renewables in the energy mix in order to improve the energy independence of the country
- *In a short period of time Senegal reached 124 MW of installed Solar PV at a competitive starting price of 0.10 EUR/kWh... How?*

ORGANIZAÇÃO:



APOIO:





First 3 Solar PV IPP in Senegal

Program Milestones

- 2011: over 100 spontaneous applications for renewable energy IPPs (mainly solar) had been received by the Ministry of Energy – *transition period*
- June 2012: Selection committee is established. 72 IPPs are shortlisted based on a first appraisal.
- 31st December 2013: Deadline to submit bids with a fixed PPA price of FCFA 65 / EUR 0.10 per kWh.
- January 2014: Senelec invited ten IPPs to negotiate PPAs (nine solar, one wind)
- August 2015: Creation of Renewable Energy Department at Senelec serving as one-stop-shop for developers (acceleration of process)
- February 2016: Bokhol is the first project to sign PPA
- October 2016: First phase of Malicounda plant commissioned shortly followed by Bokhol plant
- June 2017: Santhiou Mékhé plant commissioned

ORGANIZAÇÃO:



Associação
Lusitana
de Energias
Renováveis

APOIO:





First 3 Solar PV IPP in Senegal

- Selection committee:
 - Ministry of Energy
 - Senelec
 - ANER
 - ASER
 - National Energy Efficiency Agency
 - CRSE
- Bidding process:
 - » Price (1.75% annual indexation)
 - » Technical
 - » Financial
 - » Planning
 - » 25 years PPA (take or pay)
- ESIA
- National grid integration study done by Senelec after selection of 10 projects

ORGANIZAÇÃO:



APOIO:





First 3 Solar PV IPP in Senegal

Key facts			
Site	Bokhol	Malicounda	Santhiou Mékhé
Installed capacity	20 MWp	22 MWp	30 MWp
Developer	Senergy 2	Solaria Kima	Senergy PV
EPC Contractor	Omexom (Vinci)	Techno Solaire	Solairedirect (Engie)
Inauguration	Oct. 2016	Nov. 2016	June 2017
Investment cost	FCFA 15.7 billion / EUR 23.93 million	FCFA 22 billion / EUR 33.53 million	FCFA 27 billion / EUR 41.15 million
Financing	75% debt from single European lender	Full equity	75% debt from single European lender

ORGANIZAÇÃO:



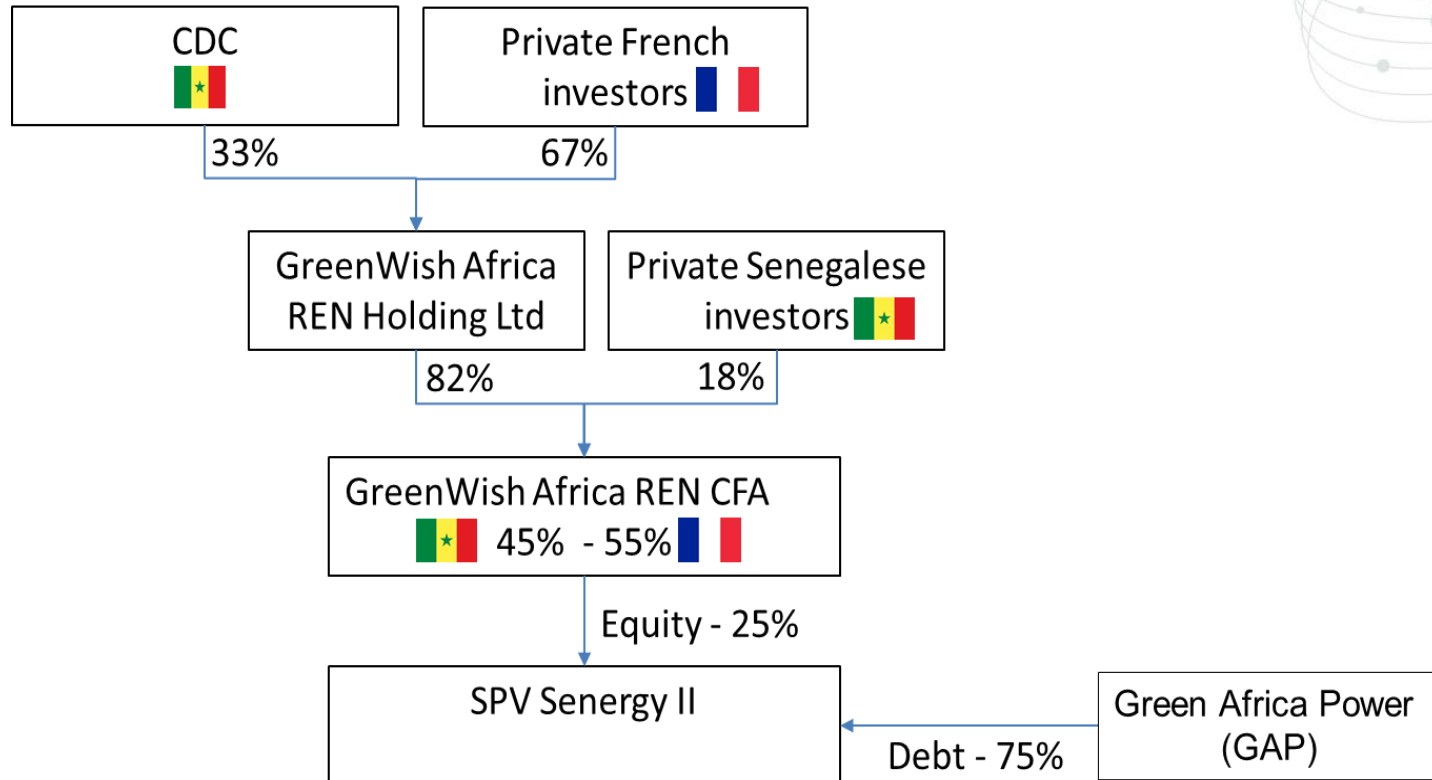
APOIO:





First 3 Solar PV IPP in Senegal

- Bokhol



ORGANIZAÇÃO:



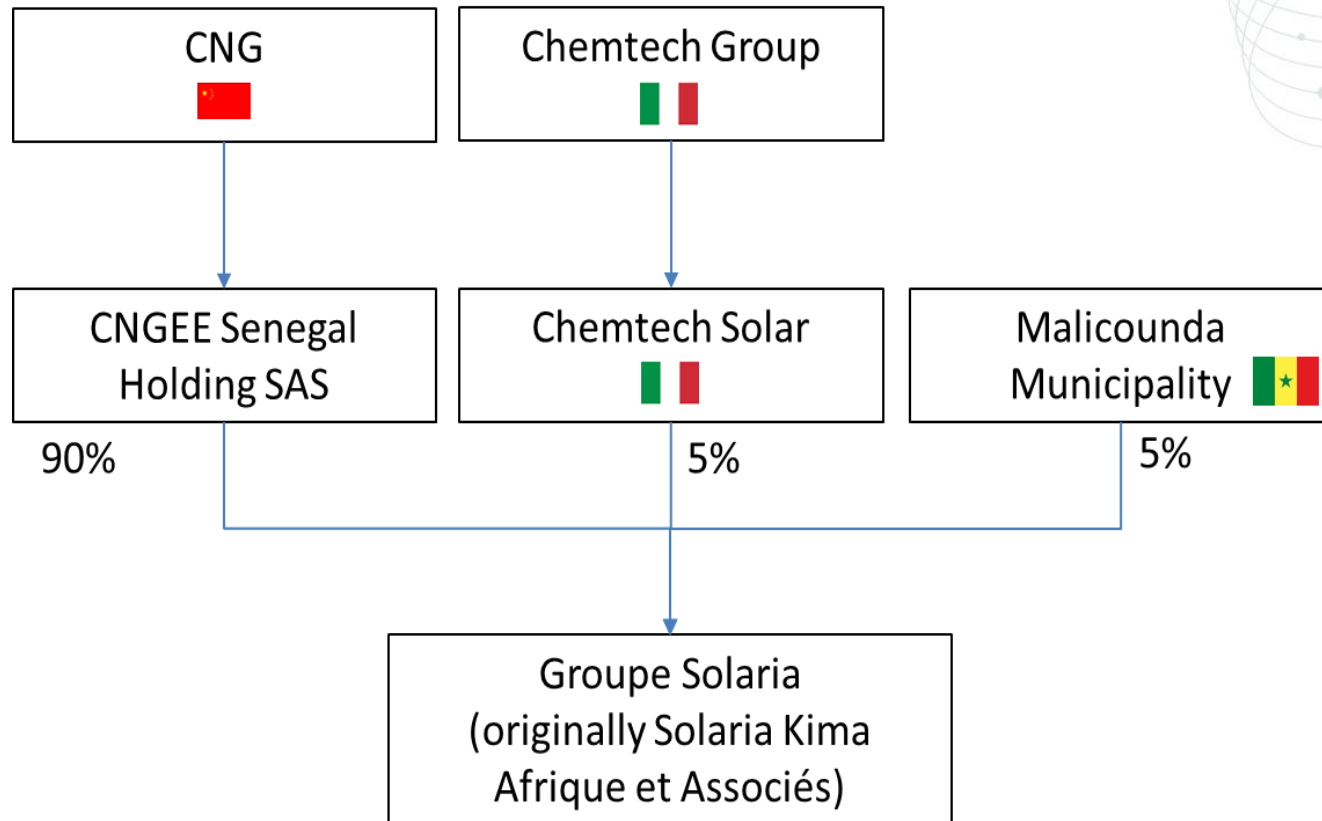
APOIO:





First 3 Solar PV IPP in Senegal

- **Malicounda**



ORGANIZAÇÃO:



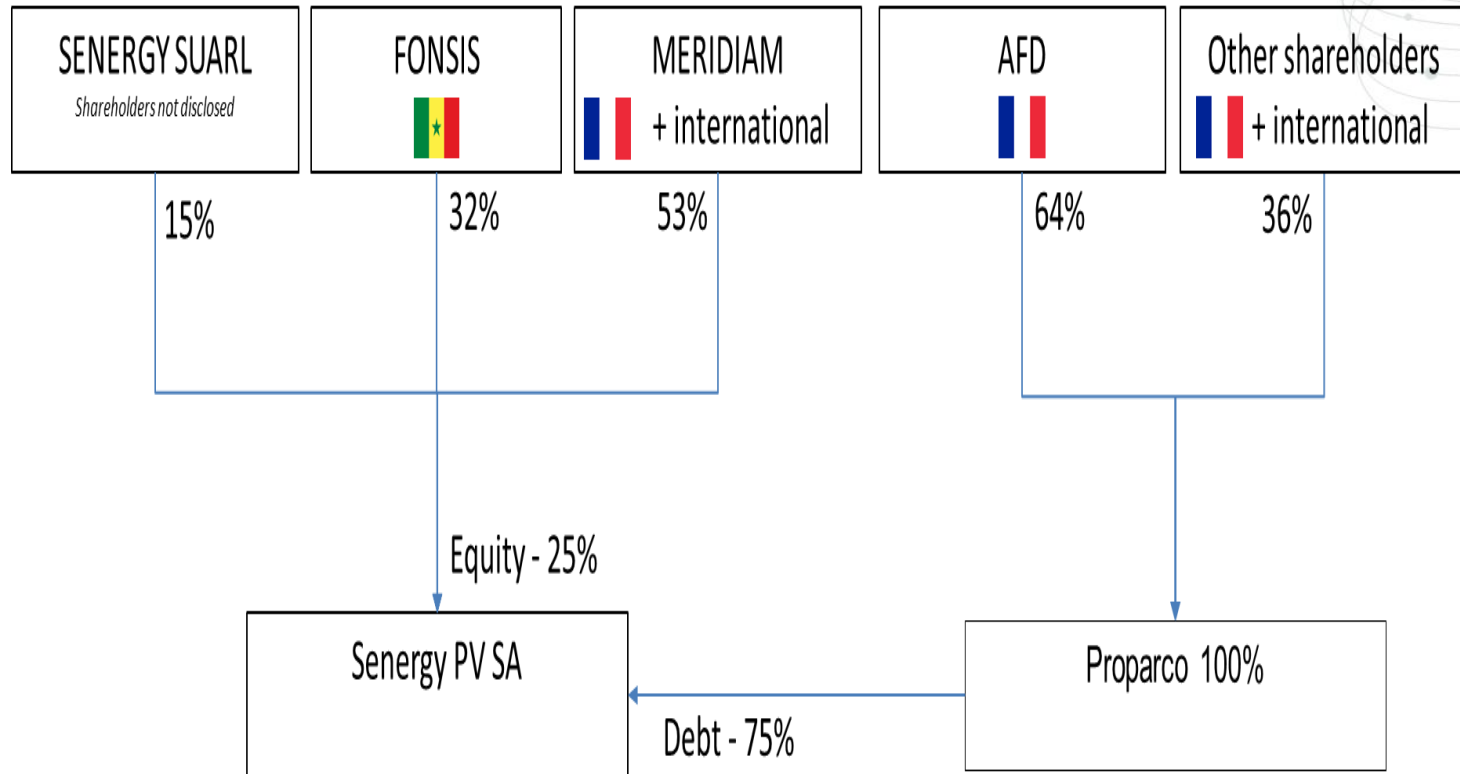
APOIO:





First 3 Solar PV IPP in Senegal

- **Santhiou Mékhé**



ORGANIZAÇÃO:



APOIO:





First 3 Solar PV IPP in Senegal

- **Community relations and Socio-economic benefits**

	Bokhol	Malicounda	Santhiou Mékhé
Announced job creation during construction	150	105 in total 59 skilled	350
Free equity given to the community	2%	5%	4%
Other community benefits	- Installation of small PV systems, micro grids and street lights - 1 flour mill	- 20 ha agricultural project - 1 maternity - Electrification of 22 villages - LV + MV electrical training	- 10 ha agricultural project - 1 maternity - Micro-credit lines for women and youngsters - 1 borehole

ORGANIZAÇÃO:



APOIO:





First 3 Solar PV IPP in Senegal

Conclusions

- **Senegal leading West Africa in non-hydro RE**
- **Importance of sovereign guarantees provided by the Senegalese government**
- **Agreed kWh price is similar to variable cost of generation and provides long-term tariff stability**
- **Two of the plants with significant Senegalese capital**

ORGANIZAÇÃO:



APOIO:





Obrigado
Thank you
Merci

esemedo@ecreee.org

ORGANIZAÇÃO:



APOIO:

