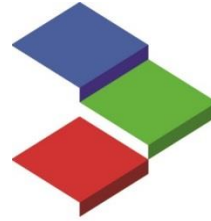




GRUPE DE LA BANQUE AFRICAINE
DE DEVELOPPEMENT



IDEV

Independent Development Evaluation
Évaluation indépendante du développement



AfDB Energy Sector Evaluation Emerging Findings

Hajime Onishi
Independent Development Evaluation (IDEV)
10 December 2015

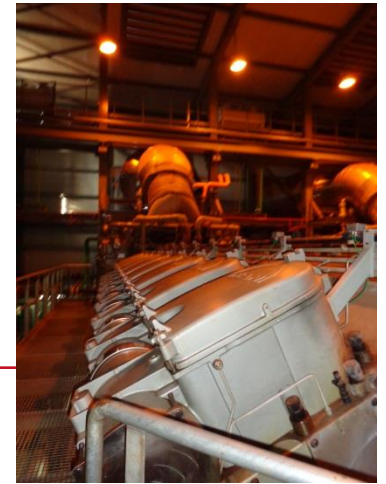
Learning from AfDB and World Bank Evaluations



Content

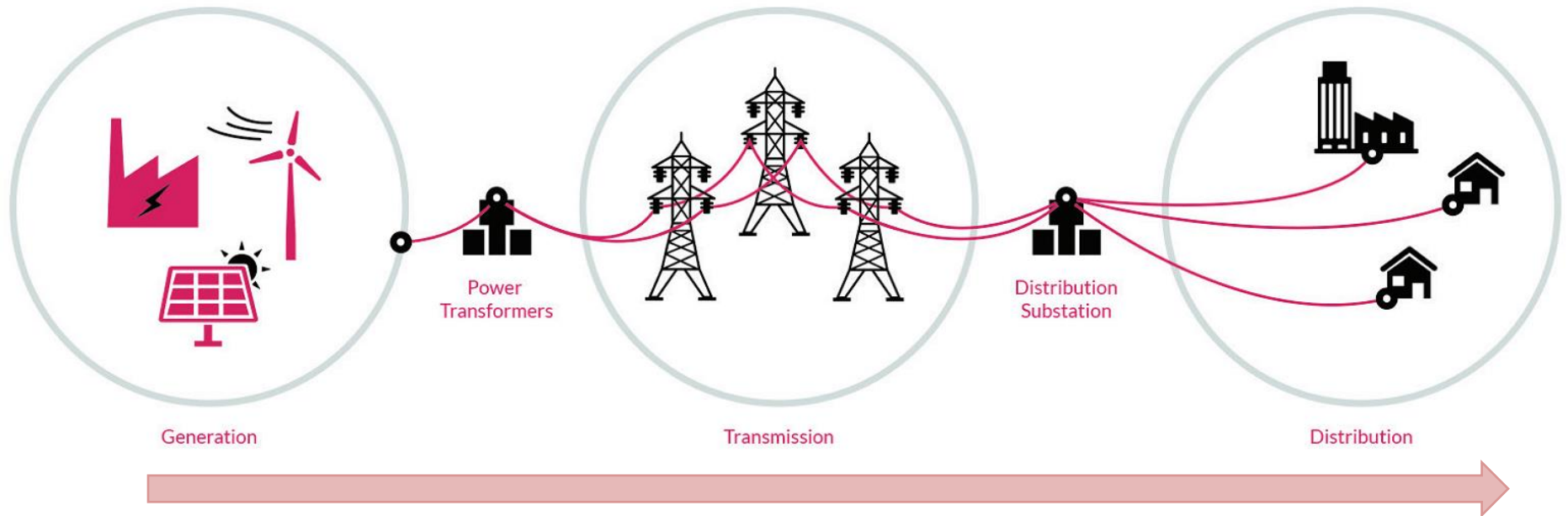
- Electricity is a “unique” product.
- AfDB has responded to the energy challenges in Africa.
- Innovation can overcome those challenges.





Electricity is a “unique” product.

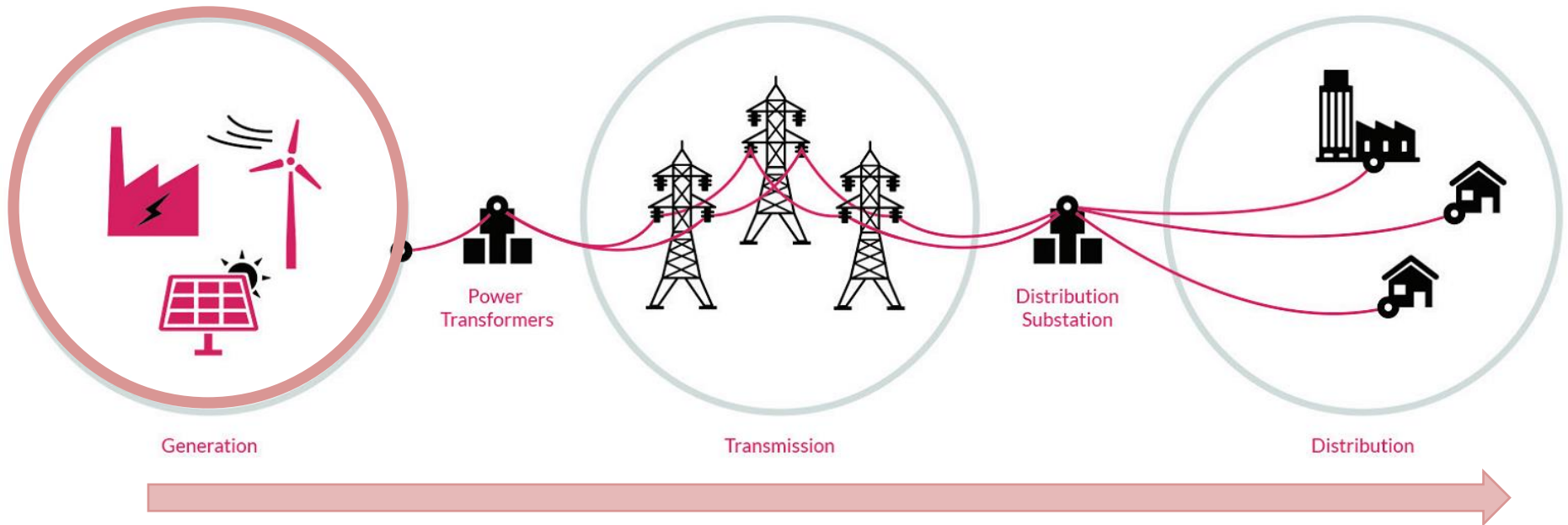
Electricity is a “unique” product.



Electricity cannot easily be stored.

Electricity cannot be contained in national grids.

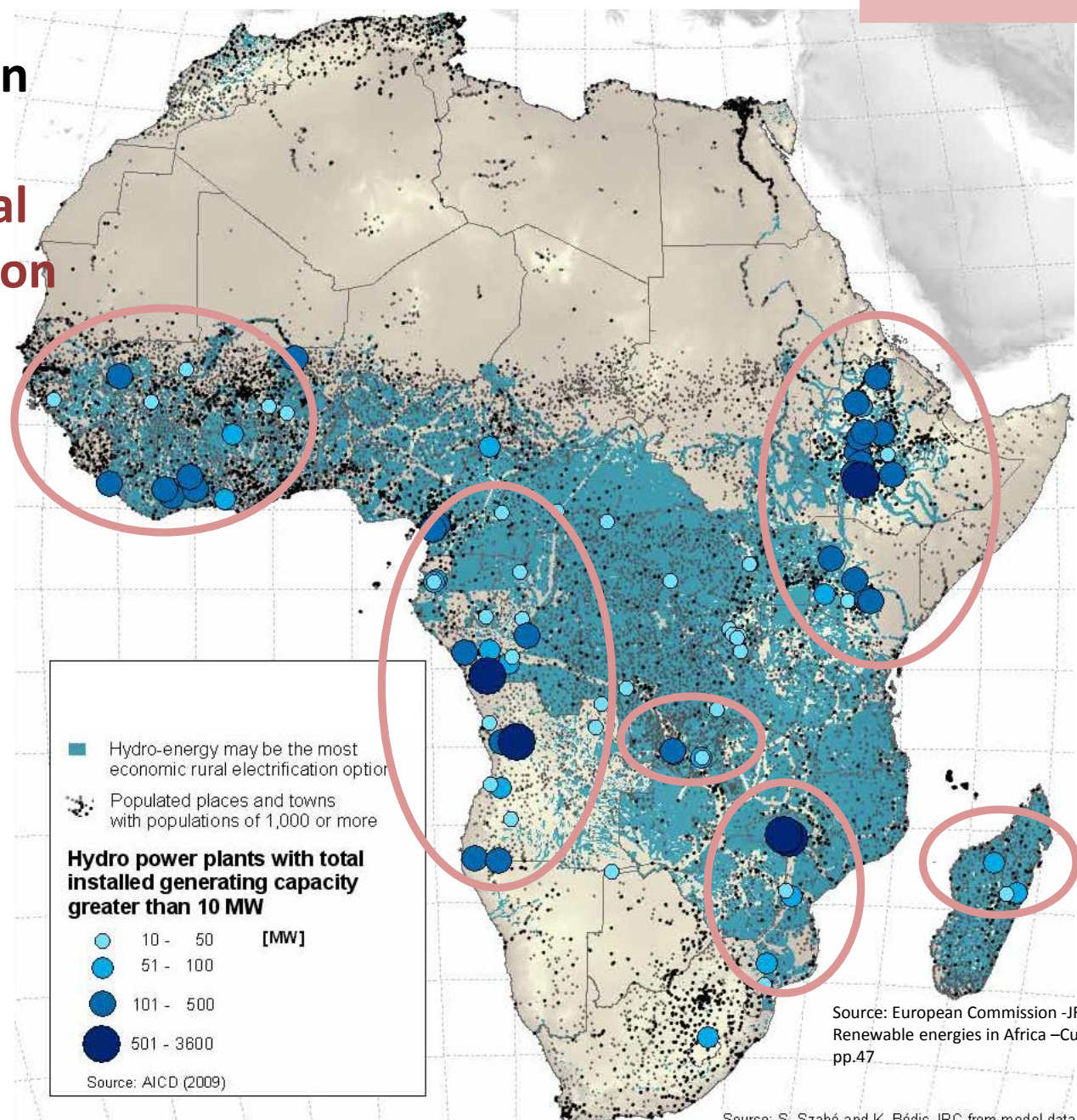
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Energy Challenges in Africa – Geographical Constraints on Generation



■ Hydro-energy may be the most economic rural electrification option

● Populated places and towns with populations of 1,000 or more

Hydro power plants with total installed generating capacity greater than 10 MW

○ 10 - 50 [MW]

○ 51 - 100

○ 101 - 500

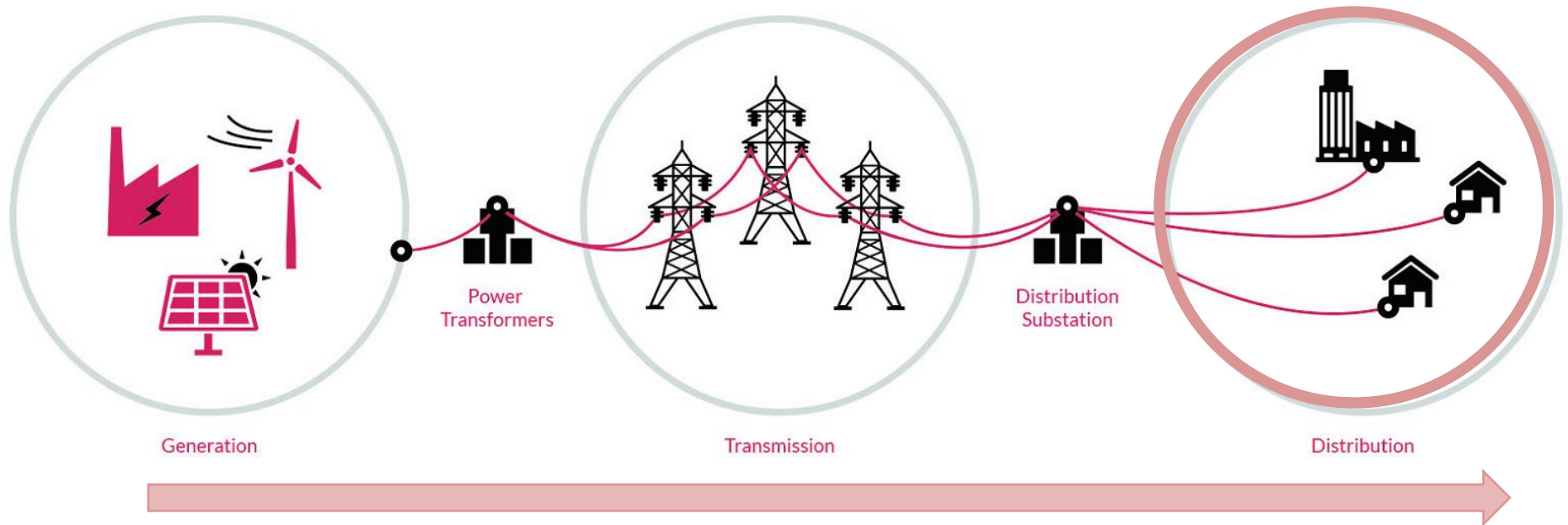
○ 501 - 3600

Source: AICD (2009)

Source: European Commission -JRC (2011) Renewable energies in Africa –Current Knowledge, pp.47

Source: S. Szahó and K. Róris .JRC from model data

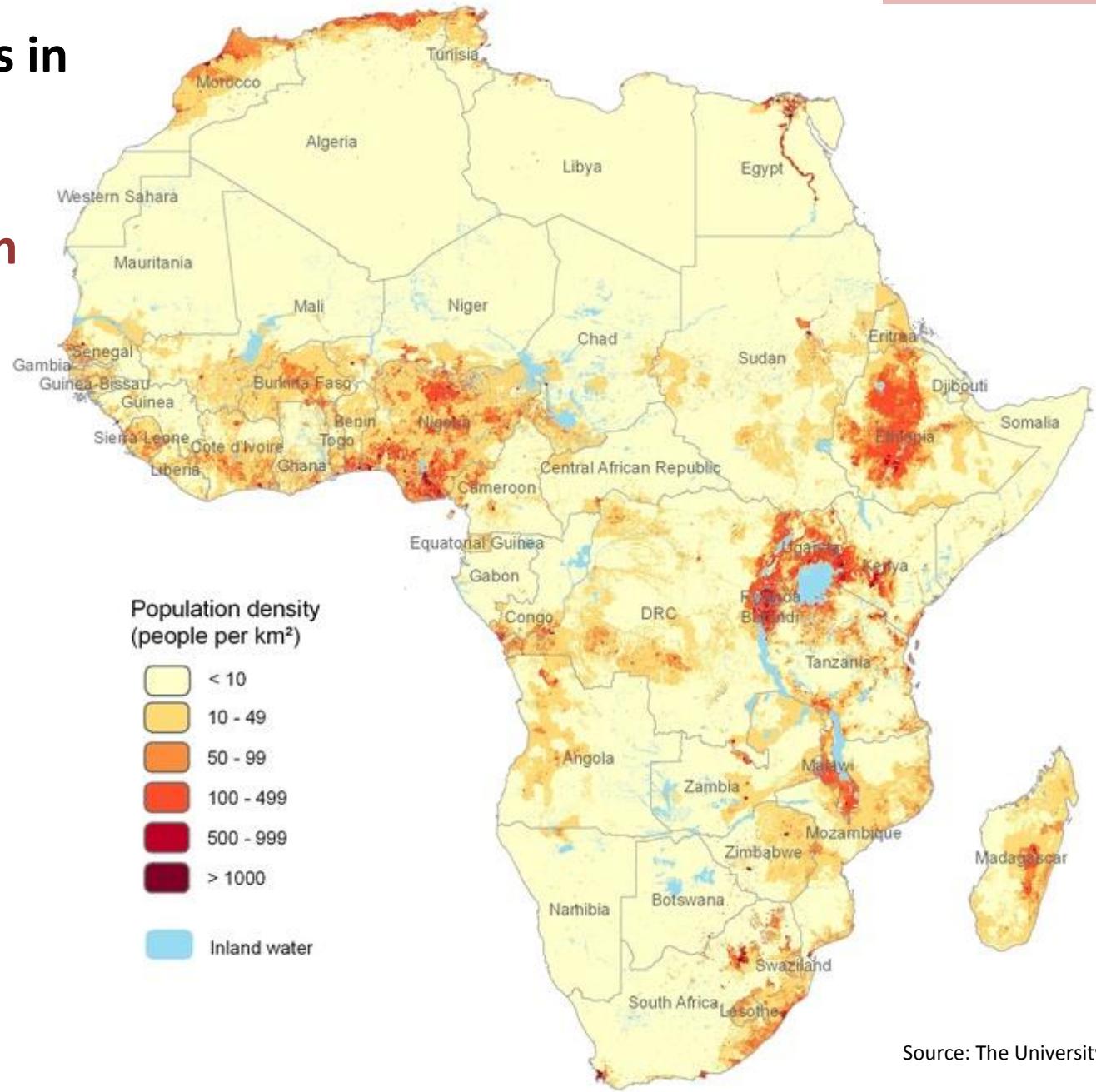
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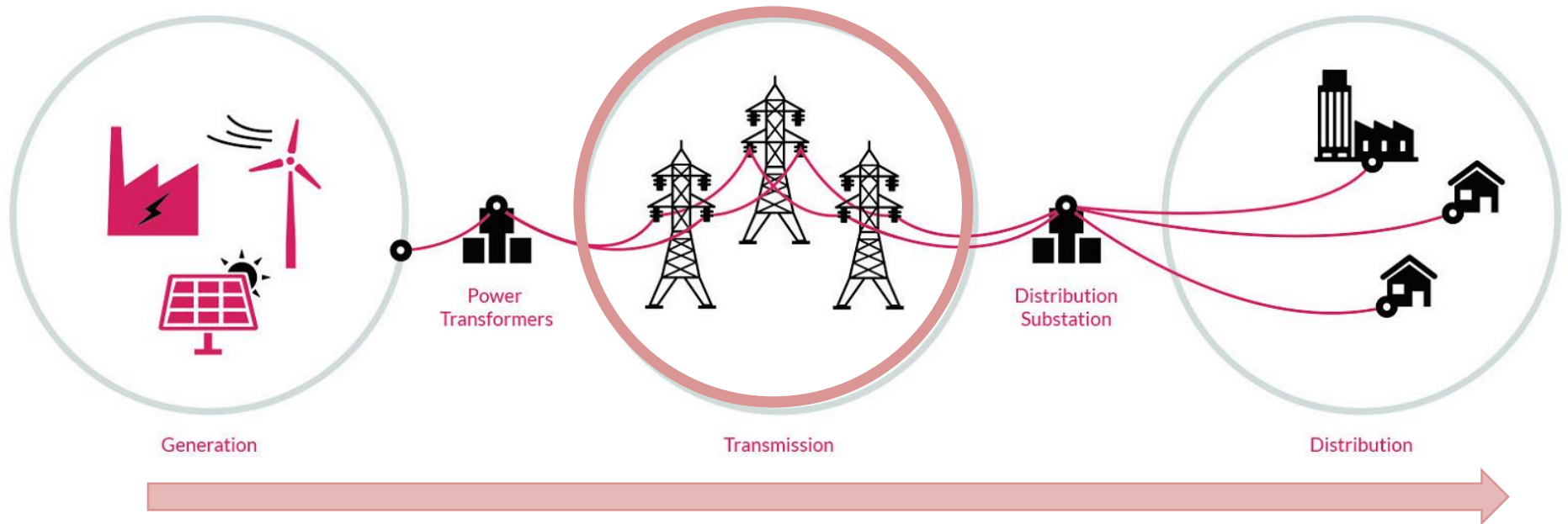
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Energy Challenges in Africa – Dispersed Population



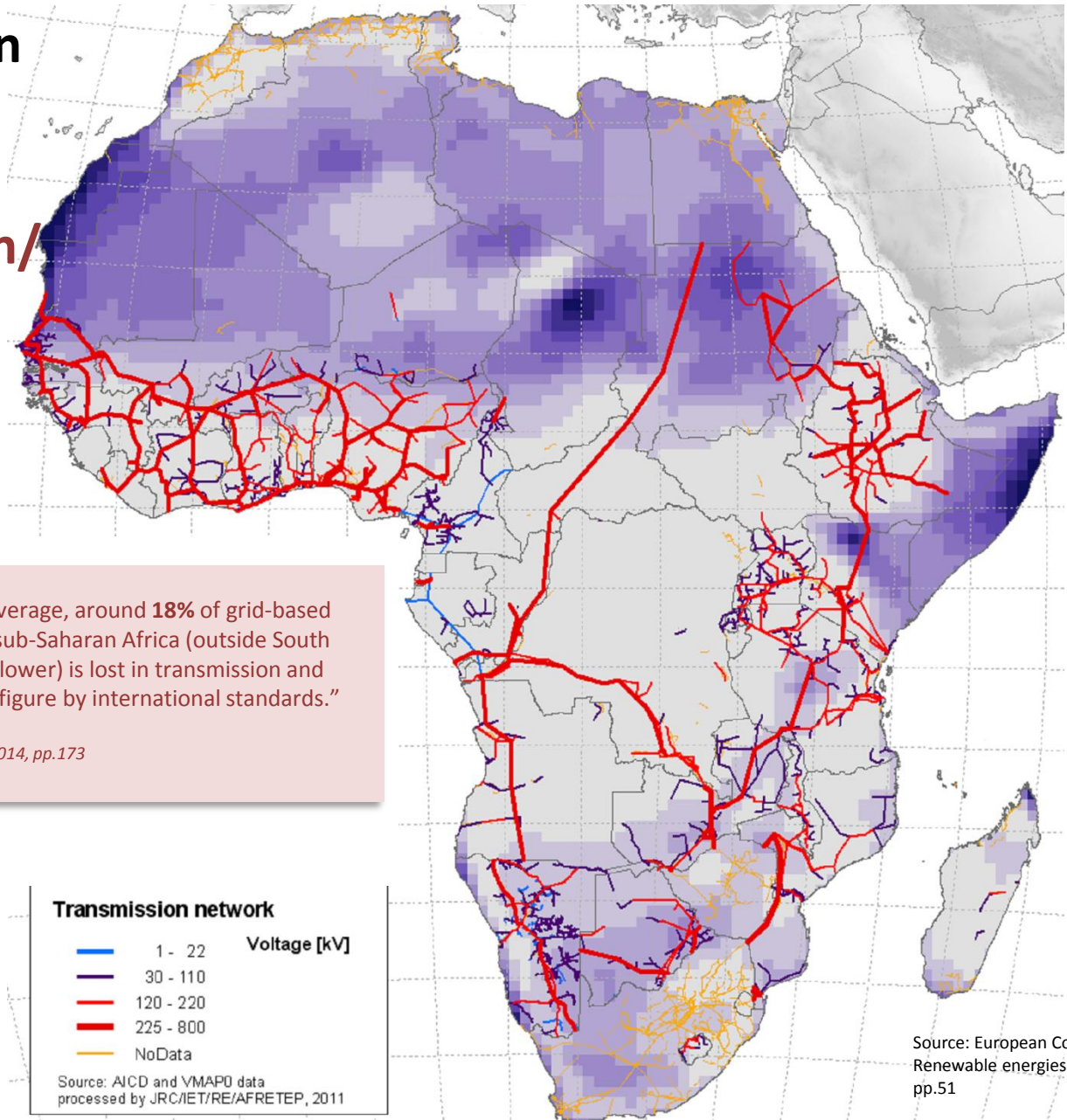
Electricity is a “unique” product.



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Energy Challenges in Africa – Unreliable Transmission/Distribution Network



“We estimate that, on average, around **18%** of grid-based electricity generated in sub-Saharan Africa (outside South Africa, where losses are lower) is lost in transmission and distribution, a very high figure by international standards.”

Source: Africa Energy Outlook 2014, pp.173

Transmission network

Color	Voltage [kV]
Blue	1 - 22
Purple	30 - 110
Red	120 - 220
Dark Red	225 - 800
Yellow	NoData

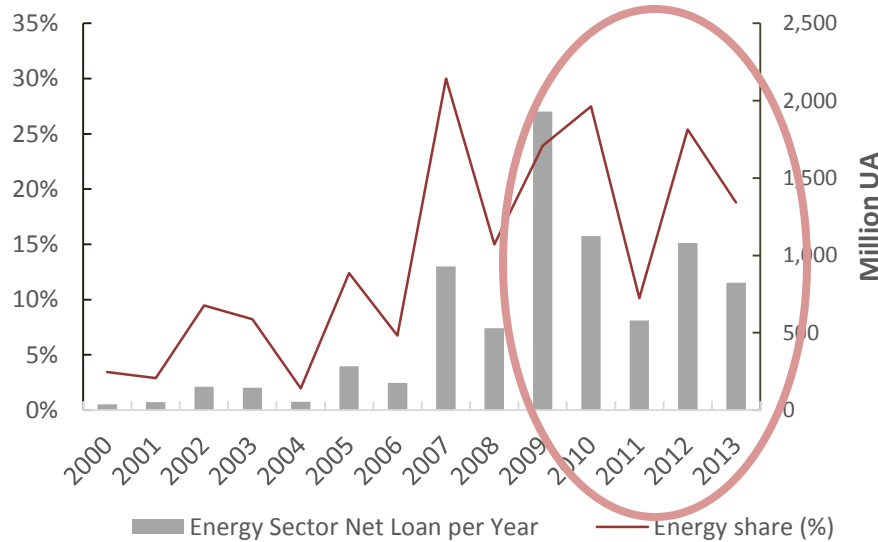
Source: AICD and VMAP0 data processed by JRC/ET/RE/AFRETEP, 2011

Source: European Commission -JRC (2011) Renewable energies in Africa –Current Knowledge, pp.51



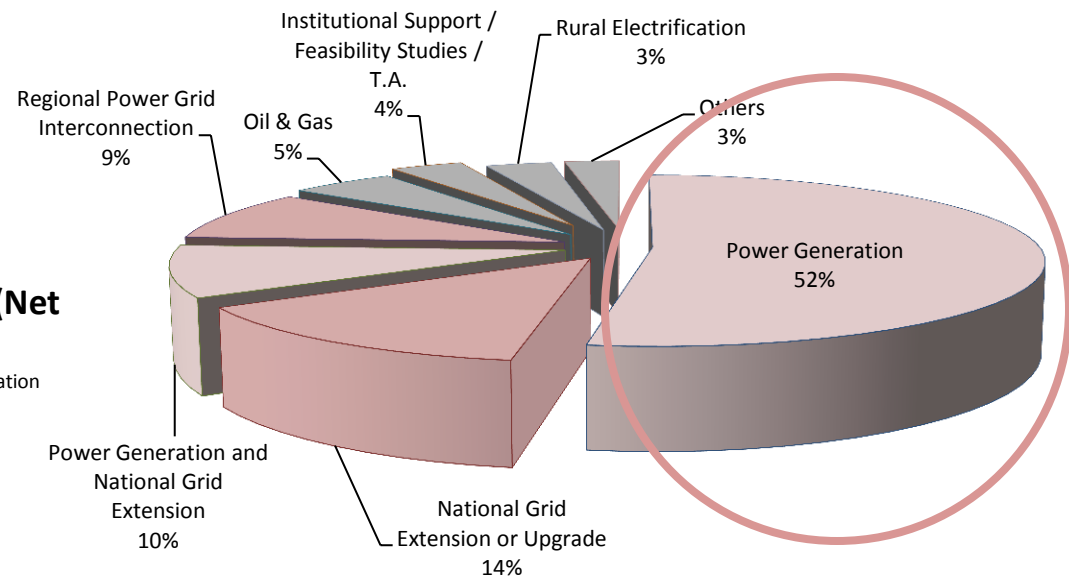
AfDB has responded to the energy challenges in Africa.

AfDB's Response to the Energy Challenges (2000-2013, N=152)



Energy Sector Share in Total Bank Group Commitments

Source: Portfolio Review of AfDB Energy Sector Evaluation

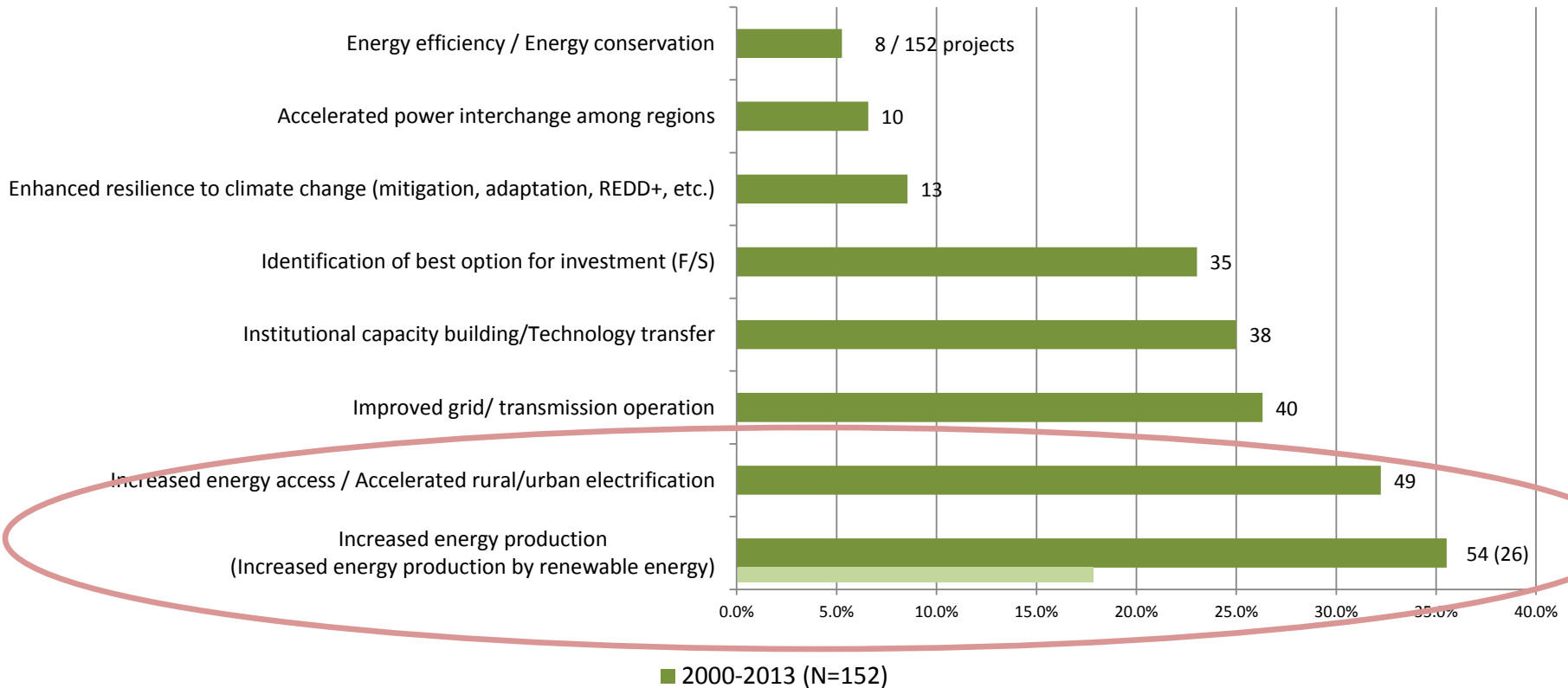


Share of Energy by Subsector (Net Commitments, 2000-2013)

Source: Portfolio Review of AfDB Energy Sector Evaluation

Classification of “Outcome Indicators” of AfDB Energy Projects (2000-2013, N=152)

Source: IDEV



AfDB Renewable Energy Projects

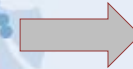
Source: AfDB (2015) Africa's Climate Opportunity: Adapting and Thriving, pp.16.

Morocco: Ouarzazate Solar Power Station (510 MW)

will avoid the emission of 762 000 tonnes of CO₂ a year.

Toward Africa Renewable Energy Initiative (AREI)

- 10 GW renewable energy generation capacity by 2020
- At least 300 GW by 2030



Sierra Leone: Addax Bioenergy Project (32 MW)

will produce ethanol from sugarcane and support electricity generation.

Democratic Republic of Congo (DRC): Hydro Power Project Inga III, Preparatory Phase

will support DRC in the optimal phasing of the project.

Kenya: Menengai Geothermal Development Project (400 MW)

will help meet Kenya's rapidly growing energy demand.

South Africa: Xina Solar One Project (100 MW)

will stimulate the renewable energy industry and create more than 1000 jobs.

Technology:



Biomass



Geothermal



Hydro

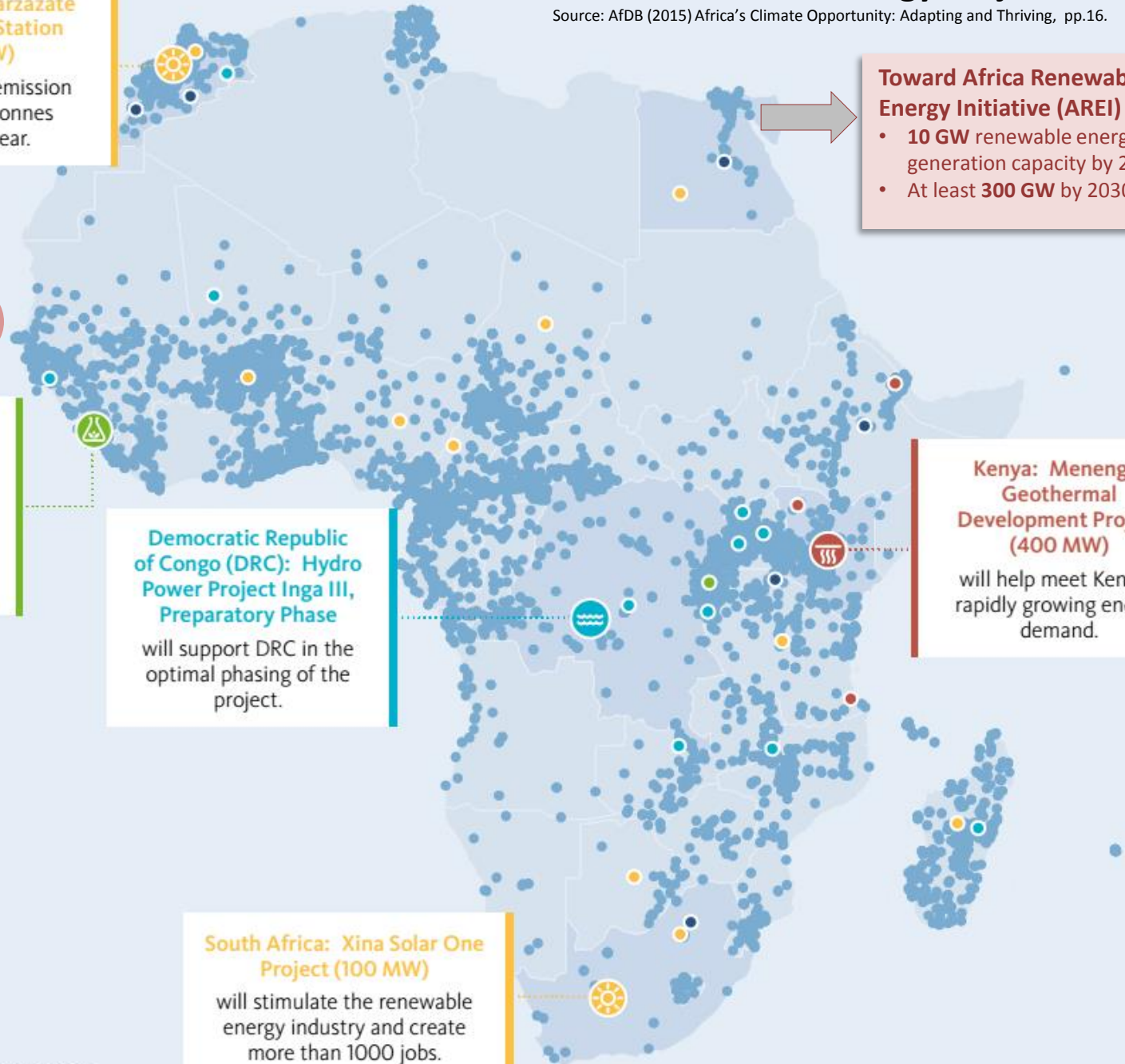


Solar

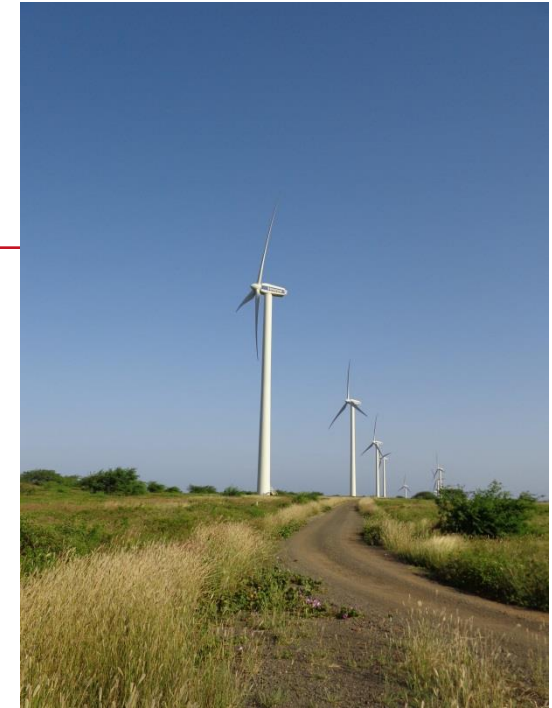


Wind

• Bank's project locations

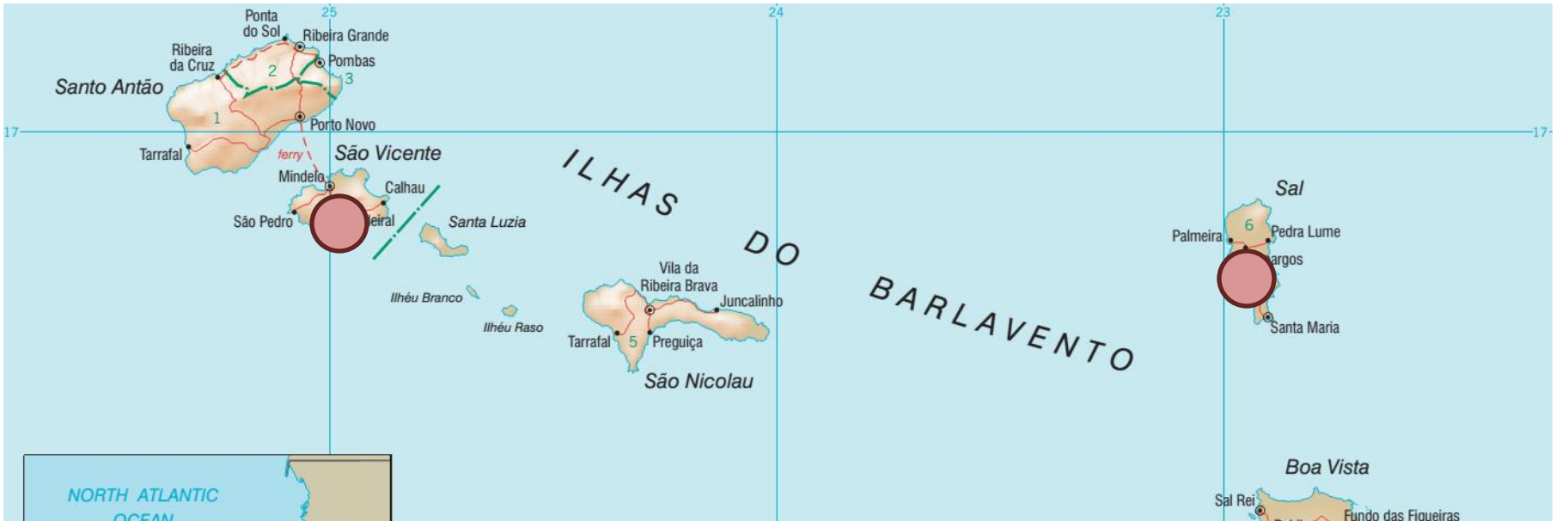


Case Study Project – Cape Verde Wind Farm



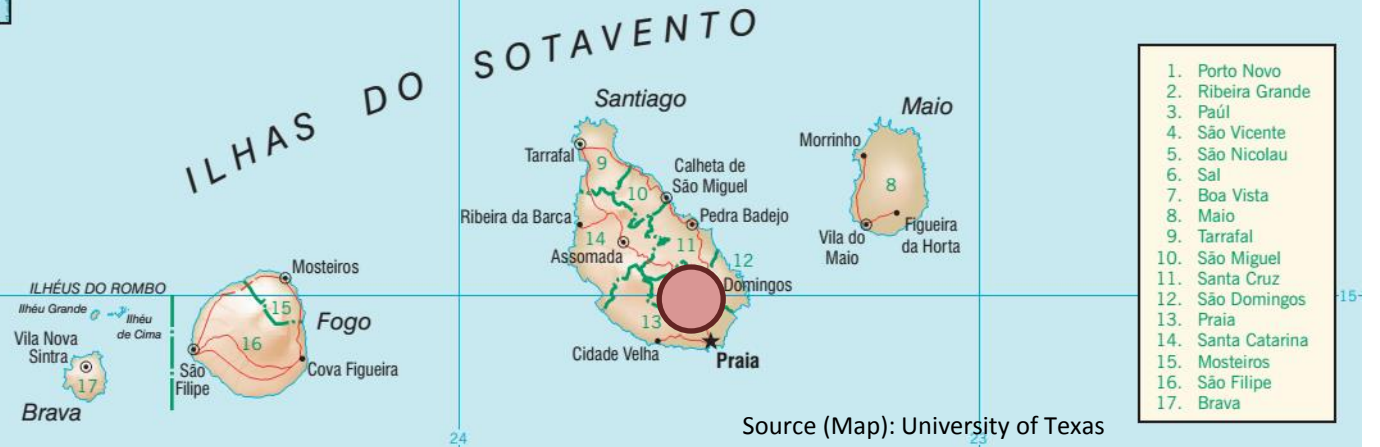
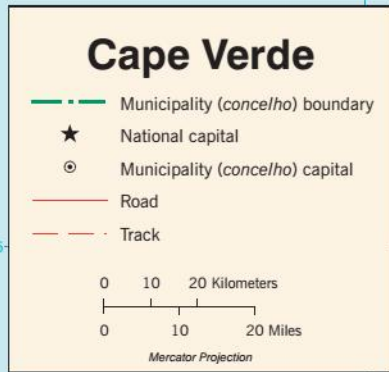
- ❑ Total project cost: **US\$90 million**
- ❑ Generation capacity: **25.5MW** in total
- ❑ First commercial-scale, privately financed, public private partnership (PPP) *wind farm* in Sub-Saharan Africa

The project won the 2011 Africa Energy Award.



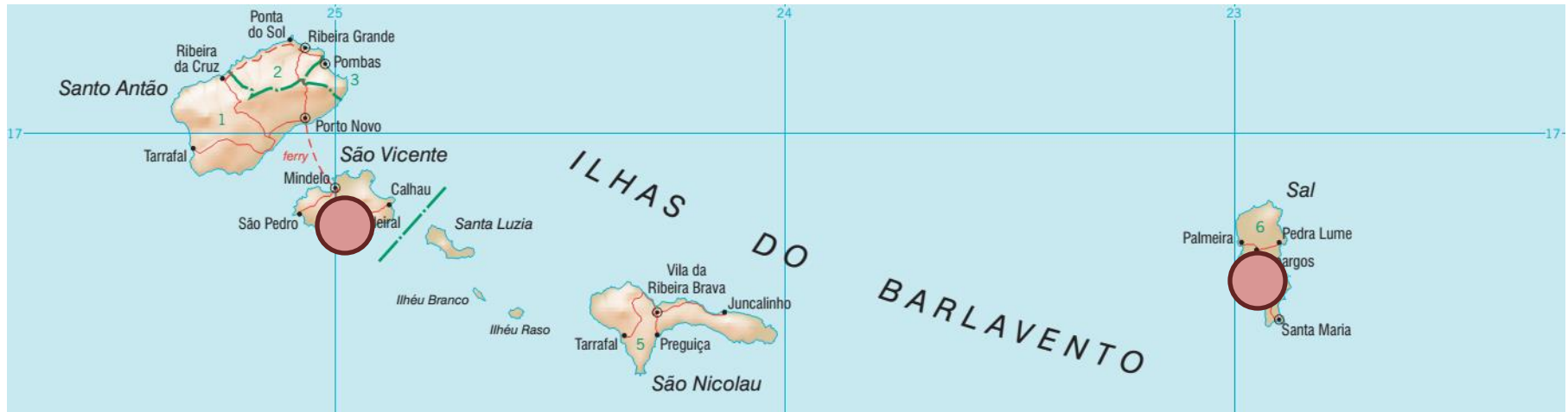
Island Name	Population	Installed Capacity	Take Over Date
São Vicente	78,000	5.95MW	December 2011
Sal	19,000	7.65MW	February 2012
Boa Vista	4,500	2.55MW	July 2012
Santiago	240,000	9.35MW	December 2011

Source (Data): IDEV draft case study reports



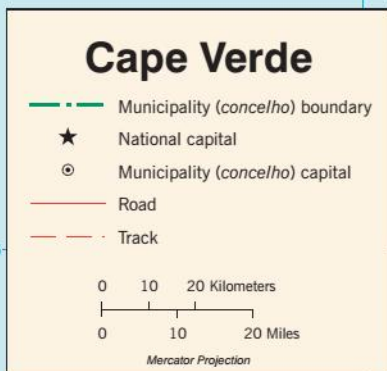
1. Porto Novo
2. Ribeira Grande
3. Paúl
4. São Vicente
5. São Nicolau
6. Sal
7. Boa Vista
8. Maio
9. Tarrafal
10. São Miguel
11. Santa Cruz
12. São Domingos
13. Praia
14. Santa Catarina
15. Mosteiros
16. São Filipe
17. Brava

Source (Map): University of Texas



Outcome Indicators	Baseline Value (Before the Project)	Target Value	Actual Value (After the Project)
Electricity generated by the Project	n/a	92,000 MWh (2013)	74,433 MWh (2014)
Increase the penetration of renewable energy sources	3% (2003)	30% (2013)	30% (2013)
National electrification rate	60% (2003)	Not reported	99% (2014)
Energy losses	17.3 % (2005)	24% (2010)	30% (2015)
Electricity tariff level	17.0 (CVE/KWh, 2002)	Not reported	35.0 (CVE/KWh, 2015)

Source (Data): IDEV draft case study report
 Data is being confirmed.



1. Porto Novo
2. Ribeira Grande
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Source (Map): University of Texas

Case Study Project – Cape Verde Wind Farm



- The level of operational *curtailment* enforced by the power utility Electra remains quite high.
- The total wind power wasted on the four islands - **25% of total available wind energy**





Santo Antão

São Vicente

ILHAS DO BARLAVENTO

Sal

Boa Vista

ILHAS DO SOTAVENTO

Santiago

Maio

ILHÉUS DO ROMBO

Fogo

Praia

Brava

1. Porto Novo
2. Ribeira Grande
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Source (Map): University of Texas



Cape Verde

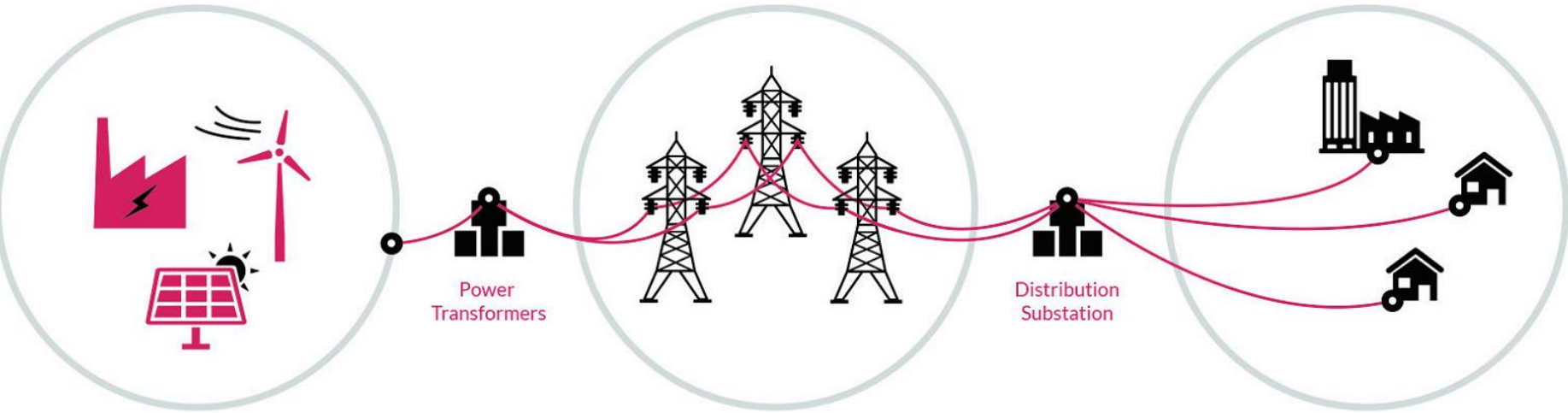
- Municipality (*concelho*) boundary
- ★ National capital
- ⊙ Municipality (*concelho*) capital
- Road
- Track

0 10 20 Kilometers
0 10 20 Miles
Mercator Projection



Electricity is a “unique” product,
but innovation can overcome the challenges.

Electricity is a “unique” product.



Generation

Transmission

Distribution

Electricity cannot easily be stored.

Electricity cannot be contained in national grids.

Innovations in the 21st Century

Grameen Shakti – Off-grid renewable energy supply (Solar Home Systems) with microcredit



Source: Grameen Shakti

Sodium-Sulfur (NaS) Battery – Grid Scale Electricity Storage Option



Source: NGK Ltd.

M-KOPA – Off-grid renewable energy supply (Solar Home Systems) with mobile money



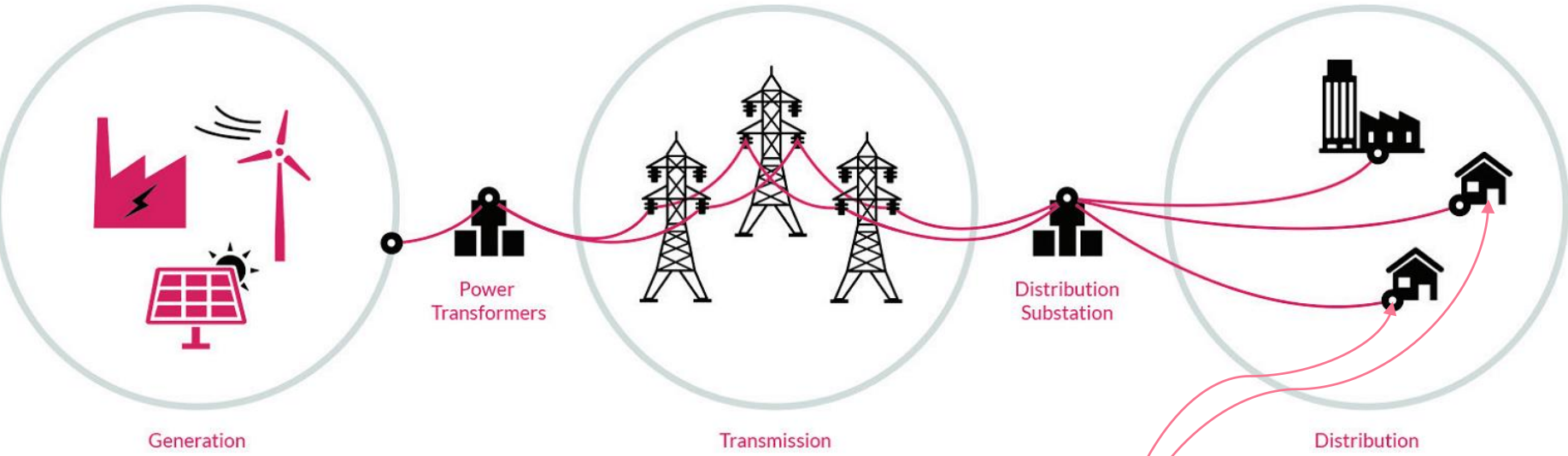
Image: By BiztechAfrica

Light-Emitting Diode (LED) – General lighting with low power consumption



Source: ABC Radio website

Electricity may no longer be a “unique” product.



Electricity ~~cannot easily~~ can be stored.

Electricity ~~cannot~~ be contained in national grids.

Off-grid rural/urban electrification is another option.



Case Study Project – Cape Verde Wind Farm



- The level of operational *curtailment* enforced by the power utility Electra remains quite high.
- The total wind power wasted on the four islands - **25% of total available wind energy**




Power Utility Electra is currently considering a “bulk storage” option



Emerging Lessons and Possible Recommendations

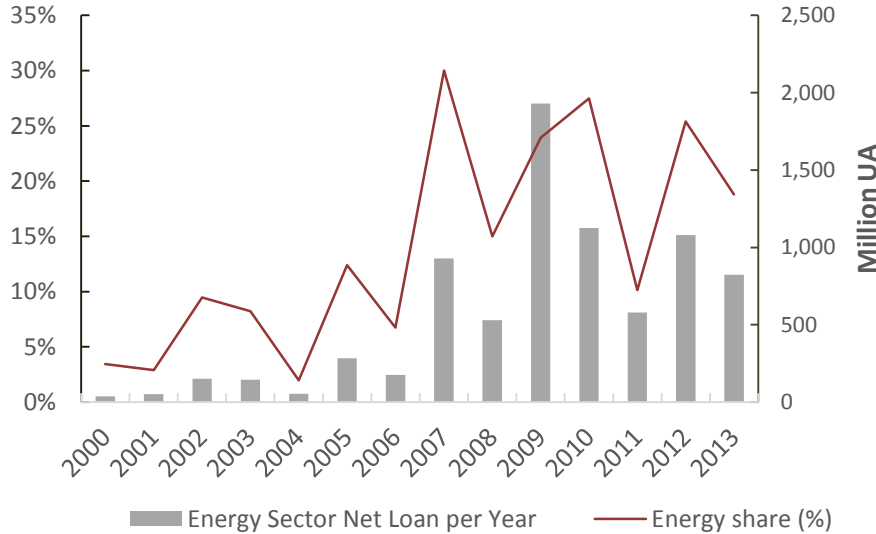
- Main land Africa may face similar challenges in the future
 - Much focus on “production”
 - Unreliable grid system
 - More “unstable” renewable energy (solar & wind, not geothermal & hydropower)
 - Generated electricity will be wasted??
- Innovation may change the way we intervene

- 
- *Off-grid solution with innovative financing tool**
 - *Carbon capture and storage (CCS)**
 - *Deep ocean water application**
 - Smart grid / Smart meter
 - Grid-scale electricity storage option (NaS Battery, Seawater pumped-storage, etc.)
 - Artificial Intelligence (AI) to the energy sector?
 - Large scale RBF (Results-Based Financing) to the energy sector?
 - Etc.

Thank you very much.

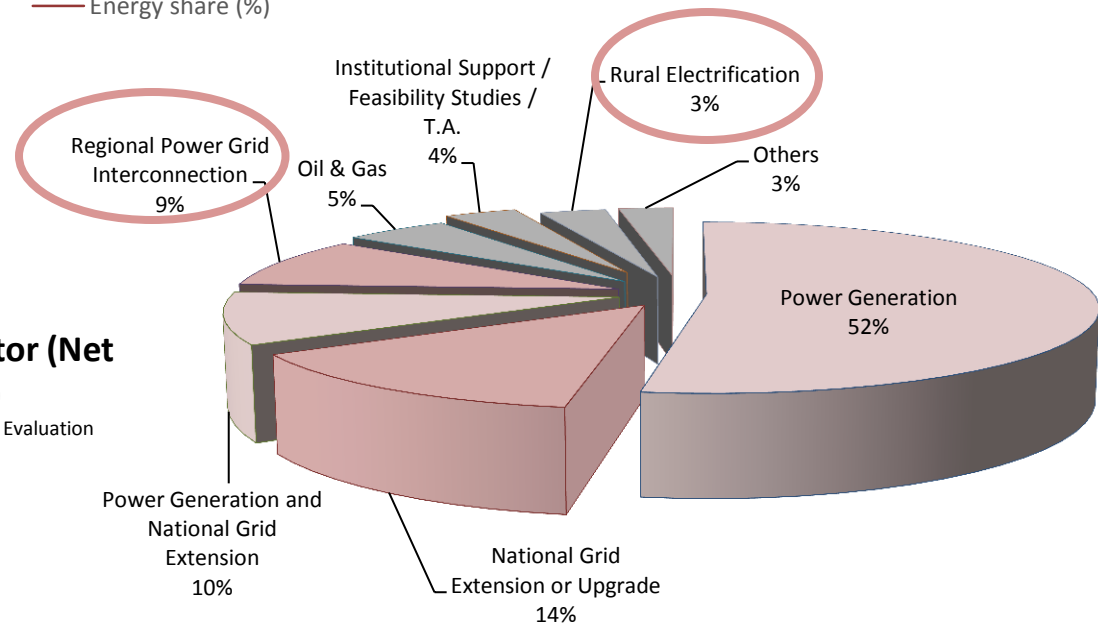


AfDB's Response to the Energy Challenges (2000-2013, N=152)



Energy Sector Share in Total Bank Group Commitments

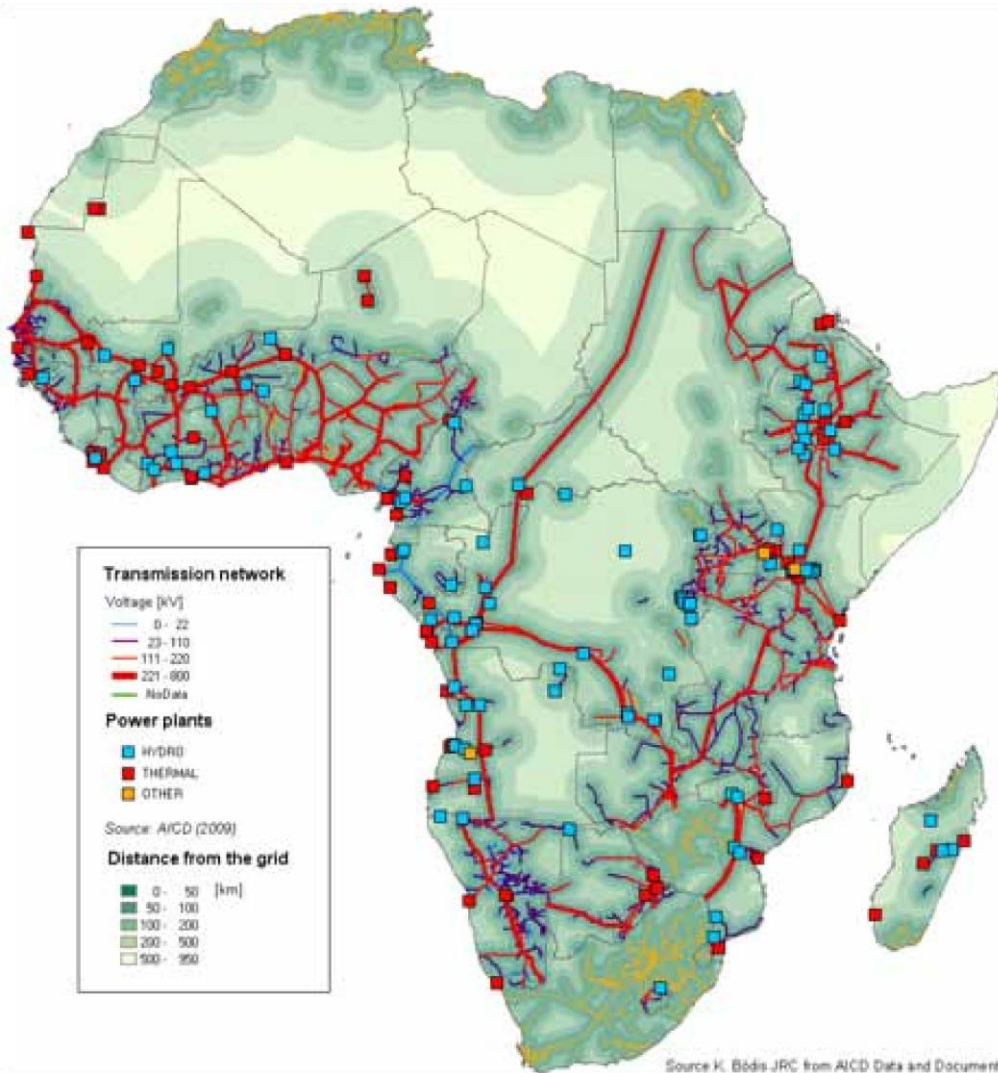
Source: Portfolio Review of AfDB Energy Sector Evaluation



Share of Energy by Subsector (Net Commitments, 2000-2013)

Source: Portfolio Review of AfDB Energy Sector Evaluation

Energy Challenges in Africa – Landlocked Countries and High Fuel Costs for Thermal Power

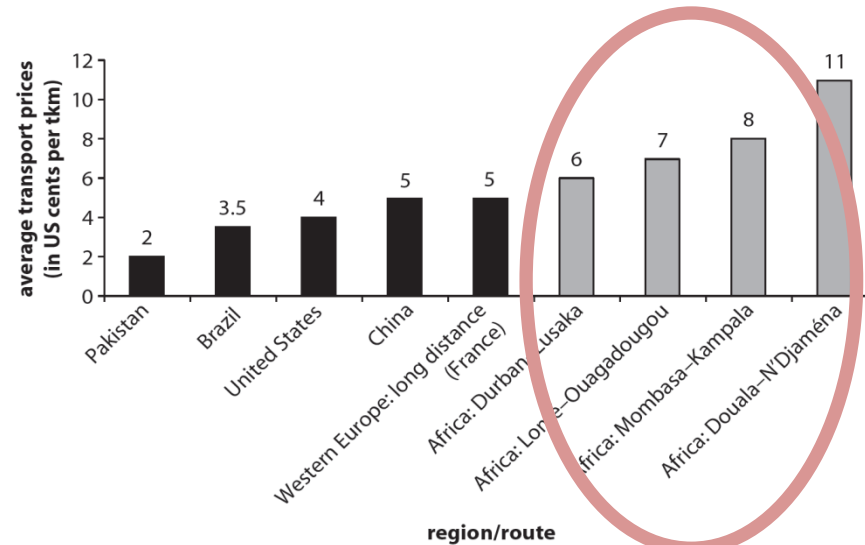


Source: K. Bódis-JRC from AICD Data and Documents

Source: European Commission -JRC (2011)
Renewable energies in Africa –Current Knowledge

Average Transport Prices

Source: Teravaninthorn, S. and G. Raballand (2008) "Transport Price and Costs in Africa: A Review of the Main International Corridors", *Africa Infrastructure Country Diagnostic, Working Paper 14*.



region/route