

ACLA COURSE STUDY GUIDE

Renewable Energy for Africa

From solar to wind to hydro to geothermal — master the technologies powering Africa's clean energy future.

Eng. Kwame Boateng · Beginner

6 modules · 18 lessons · 6 weeks

About This Course	2
Module 1: Foundations of Renewable Energy and Africa's Energy Landscape	3
1.1 What Counts as Renewable Energy	3
1.2 Africa's Current Energy Mix and Access Gap	3
1.3 Why Africa's Renewable Potential Is Considered Exceptional	4
Module 2: Solar Energy for Africa	4
2.1 How Solar Photovoltaic (PV) Technology Works	4
2.2 Why Africa Is Well Suited to Solar	4
2.3 Scales of Solar Deployment	5
Module 3: Wind Energy for Africa	5
3.1 How Wind Turbines Generate Electricity	5
3.2 Africa's Wind Corridors	5
3.3 Challenges Specific to Wind Development in Africa	6
Module 4: Hydropower for Africa	6
4.1 How Hydropower Works	6
4.2 Large-Scale Hydropower in Africa	6
4.3 Small and Micro-Hydro	7
Module 5: Geothermal and Bioenergy for Africa	7
5.1 How Geothermal Energy Works	7
5.2 Africa's Geothermal Potential Along the Rift Valley	7
5.3 Bioenergy: Traditional Use and Modern Potential	8
Module 6: Energy Storage, Mini-Grids, Policy and Financing for Scaling Renewable Energy in Africa	8
6.1 Why Energy Storage Matters	8
6.2 Mini-Grids and Decentralised Energy Access	8
6.3 Policy, Regulation and Financing for Scale-Up	9
Final Assessment & Certificate	9

About This Course

Renewable Energy for Africa is a comprehensive, self-paced course designed for students, professionals, entrepreneurs, policymakers, and anyone seeking a solid, practical understanding of how renewable energy technologies work and how they are being deployed across the African continent. The course combines technical fundamentals with real African case studies from Kenya's geothermal fields to Ethiopia's Grand Renaissance Dam, so that learners understand not just how each technology works, but how it performs in practice, what has made projects succeed or struggle, and what policy and financing tools are shaping the sector's future. The course is organised into six modules, each covering a major renewable energy theme, complete with explanatory content, a real-world case study, curated YouTube videos for further learning, and a 15-question multiple-choice quiz to check understanding. The course concludes with a cumulative 15-question Final Assessment; learners who score at least 80% receive a Certificate of Completion.

Course information

Course	Renewable Energy for Africa
Instructor	Eng. Kwame Boateng
Level	Beginner
Structure	6 modules · 18 lessons · 6 weeks
Assessment	Module quizzes (pass mark 60%) and a final test (pass mark 80%). Certificate issued on final success, verifiable at acla.io/verify .

What you will be able to do

1. The scientific and engineering fundamentals behind solar, wind, hydropower, geothermal, and bioenergy technologies.
2. Why Africa is considered to have some of the richest renewable energy potential in the world, and the specific factors (irradiation, wind corridors, rift geology, river systems) that make this true.
3. Real African case studies, including Kenya's renewable-dominant grid, Egypt's Benban Solar Park, the Lake Turkana wind farm, Ethiopia's Grand Ethiopian Renaissance Dam, Kenya's Olkaria geothermal complex, and Nigeria's mini-grid programme.
4. How energy storage and mini-grids extend the reach and reliability of renewable power, particularly for communities not served by national grids.
5. The policy tools (feed-in tariffs, competitive auctions, net metering) and financing mechanisms (blended finance, development finance institutions) that determine whether renewable projects get built.
6. How to critically evaluate the trade-offs, economic, environmental, social and geopolitical — involved in scaling renewable energy across diverse African contexts.

How to use this study guide

This guide is the complete companion to the Tapi Learn mobile course. Each chapter corresponds to one course module and reproduces every lesson in full, including the key takeaways. Read a lesson in the app, then revisit the same text here to revise; the structure and headings match the in-app lesson reader. After finishing a module, take the module quiz in the app (60% to pass), and after all modules, the final test (80% to pass) to earn your verified ACLA certificate of completion.

Module 1: Foundations of Renewable Energy and Africa's Energy Landscape

Renewable energy is energy collected from resources that are naturally replenished on a human timescale: sunlight, wind, flowing and falling water, geothermal heat, and organic...

3 lessons · 6m

1.1 What Counts as Renewable Energy

Renewable energy is energy collected from resources that are naturally replenished on a human timescale: sunlight, wind, flowing and falling water, geothermal heat, and organic (biomass) material. Unlike coal, oil, gas, or uranium, these resources are not depleted by continuous use, and most of them produce little or no greenhouse gas emissions once the generating equipment is built. The main renewable technologies used at scale today are solar photovoltaics (PV) and solar thermal, onshore and offshore wind turbines, hydropower (large dams and small/micro-hydro), geothermal power plants, and bioenergy (biomass, biogas, and biofuels). Each has a different resource footprint, cost profile, and suitability depending on geography, which is why most serious energy plans combine several of them rather than relying on just one.

1.2 Africa's Current Energy Mix and Access Gap

Africa is home to about 1.4 billion people, yet the continent still accounts for a small share of global electricity generation. More than 600 million people, concentrated mainly in Sub-Saharan Africa, still lack access to electricity, and an even larger number rely on charcoal or firewood for cooking. At the same time, several African countries already generate the majority of their electricity from renewables: Kenya's grid is over 80% renewable (mainly geothermal and hydro), and Ethiopia relies overwhelmingly on hydropower. Africa contributes only a small fraction of historical global greenhouse gas emissions but is disproportionately exposed to the effects of climate change, including droughts that reduce hydropower output and disrupt rain-fed agriculture. This makes diversified renewable energy planning, not reliance on a single source, central to both energy security and climate resilience.

1.3 Why Africa's Renewable Potential Is Considered Exceptional

The International Renewable Energy Agency (IRENA) and the African Development Bank have repeatedly identified Africa as having some of the best solar irradiation levels on Earth, some of the strongest and most consistent wind corridors (such as the Turkana Corridor in Kenya), major untapped hydropower potential (particularly in the Congo Basin), and one of the world's most active geothermal regions along the East African Rift Valley. Despite this, Africa has historically attracted a small share of global renewable energy investment, due to barriers including weak grid infrastructure, higher perceived investment risk, currency volatility, and limited local technical capacity. Overcoming these barriers, rather than a shortage of resource, is the central challenge this course will keep returning to. .

Module 2: Solar Energy for Africa

Solar PV panels are made of semiconductor cells, most commonly silicon, that convert sunlight directly into direct current (DC) electricity through the photovoltaic effect. An...

3 lessons · 6m

2.1 How Solar Photovoltaic (PV) Technology Works

Solar PV panels are made of semiconductor cells, most commonly silicon, that convert sunlight directly into direct current (DC) electricity through the photovoltaic effect. An inverter then converts this DC electricity into alternating current (AC) for use in homes, businesses, or the grid. Panel efficiency, mounting angle, temperature, and dust accumulation all affect real-world output, which matters a great deal in dusty, high-irradiation environments typical of much of Africa. Solar thermal systems, by contrast, use mirrors or lenses to concentrate sunlight to generate heat, which can drive a turbine (concentrated solar power, or CSP) or be used directly for water heating or industrial processes. CSP is less common than PV in Africa today but has been deployed at scale in Morocco's Noor Ouarzazate complex, one of the largest CSP facilities in the world. .

2.2 Why Africa Is Well Suited to Solar

Much of Africa receives some of the highest levels of solar irradiation on the planet, often exceeding 2,000 kWh per square metre per year in large parts of the Sahel, East Africa, and Southern Africa. Unlike hydropower, solar generation is far less dependent on rainfall patterns, and unlike large infrastructure such as dams or transmission-heavy wind farms, small-scale solar can be deployed rapidly and incrementally, which matters where grid extension is slow or uneconomical. This has made solar central to Africa's off-grid electrification strategy: pay-as-you-go solar home systems, solar lanterns, and solar mini-grids have connected millions of households that are unlikely to be reached by the national grid within the next decade.

2.3 Scales of Solar Deployment

Solar is deployed across a spectrum: household solar lanterns and solar home systems (a few watts to a few hundred watts) serve individual families; solar mini-grids (tens of kilowatts to a few megawatts) serve whole villages or trading centres; and utility-scale solar farms (tens to hundreds of megawatts), such as Egypt's Benban Solar Park, one of the largest solar installations in the world, feed directly into national grids. Each scale serves a different purpose and faces different challenges: household systems face affordability and after-sales-service challenges; mini-grids face regulatory and tariff-design challenges; utility-scale plants face financing, land, and transmission-connection challenges. .

Module 3: Wind Energy for Africa

A wind turbine converts the kinetic energy of moving air into rotational motion via blades attached to a rotor, which spins a generator to produce electricity. Turbine output...

3 lessons · 6m

3.1 How Wind Turbines Generate Electricity

A wind turbine converts the kinetic energy of moving air into rotational motion via blades attached to a rotor, which spins a generator to produce electricity. Turbine output rises sharply with wind speed (roughly with the cube of speed), which is why site selection finding locations with strong, consistent wind matters enormously to a project's economics. Modern utility-scale turbines are typically 2-4 MW each and are grouped into wind farms connected to the grid via a substation and transmission line. Onshore wind (built on land) dominates in Africa today; offshore wind, common in Europe, remains largely undeveloped on the continent. .

3.2 Africa's Wind Corridors

Certain African locations experience unusually strong, steady wind due to their geography. The Turkana Corridor in northern Kenya, where a gap between highland areas creates a natural wind tunnel (the 'Turkana jet'), produces wind speeds and consistency that rival or exceed the best sites in Europe. Similar high-potential corridors exist in Ethiopia's highlands, coastal Morocco, coastal South Africa, and parts of Egypt along the Gulf of Suez. This natural advantage means wind turbines in these locations can operate at very high capacity factors (the share of time they generate at or near full output), which improves project economics even where upfront transmission costs are high.

3.3 Challenges Specific to Wind Development in Africa

Even excellent wind resources do not guarantee easy development. Wind farms are often located far from population and demand centres, meaning substantial transmission infrastructure must be built before power can reach consumers, a major driver of project cost and delay. Wind farms also require large upfront capital investment, long development timelines (often eight years or more from planning to commissioning), and careful environmental and social impact assessment, including effects on bird and bat populations and on communities whose land is used. Because output varies with wind conditions, wind is typically paired with other generation sources (hydro, geothermal, or storage) to maintain grid stability, reinforcing the broader lesson from Module 1 that diversified generation mixes are usually more resilient than single-source systems.

Module 4: Hydropower for Africa

Hydropower generates electricity by using the force of flowing or falling water to spin a turbine connected to a generator. Large hydropower plants typically involve a dam that...

3 lessons · 6m

4.1 How Hydropower Works

Hydropower generates electricity by using the force of flowing or falling water to spin a turbine connected to a generator. Large hydropower plants typically involve a dam that creates a reservoir, storing water and allowing generation to be controlled and adjusted to match demand, an advantage over intermittent sources like solar and wind. Small and micro-hydro systems, by contrast, often use 'run-of-river' designs that redirect a portion of a river's flow through a turbine without a large dam or reservoir, making them cheaper and less disruptive but also less controllable. Hydropower's key strength is dispatchability: unlike solar and wind, a hydro plant with a reservoir can increase or decrease output on demand, making it valuable for grid stability. Its key vulnerability is dependence on rainfall and river flow, which is increasingly disrupted by climate variability and drought. .

4.2 Large-Scale Hydropower in Africa

Africa's major rivers, the Nile, Congo, Zambezi, and Niger, have long been sites for large hydropower development. Ethiopia's Grand Ethiopian Renaissance Dam (GERD) on the Blue Nile, inaugurated in September 2025, is now Africa's largest hydropower plant, with a design capacity of 5,150 MW. The Congo River is estimated to hold the single largest undeveloped hydropower potential of any river system in the world, centred on the long-proposed (and still largely unrealised) Grand Inga project. Large hydro projects can transform a country's energy security and enable regional power exports, but they are capital-intensive, take years or decades to build, and can create transboundary political tensions when rivers cross national borders as seen in the prolonged dispute between Ethiopia, Sudan, and Egypt over the GERD's effect on downstream Nile flows.

4.3 Small and Micro-Hydro

Small-scale and micro-hydro systems (from a few kilowatts up to around 10 MW) are well suited to mountainous, high-rainfall regions such as parts of East and Central Africa, and can power villages or mini-grids without the cost, displacement, or long timelines of large dams. They generally have a much smaller environmental footprint since they do not require large reservoirs, though they still depend on consistent river flow and can be affected by seasonal variation and upstream land-use changes such as deforestation.

Module 5: Geothermal and Bioenergy for Africa

Geothermal power taps heat stored underground, usually where magma lies relatively close to the surface, heating groundwater into steam or hot water that can be brought to the...

3 lessons · 6m

5.1 How Geothermal Energy Works

Geothermal power taps heat stored underground, usually where magma lies relatively close to the surface, heating groundwater into steam or hot water that can be brought to the surface through wells. That steam drives a turbine directly (dry steam or flash-steam plants) or transfers its heat to a secondary working fluid with a lower boiling point (binary-cycle plants), which then drives the turbine. Because it depends on underground heat rather than weather, geothermal can generate continuously at very high capacity factors, often above 90%, making it one of the most reliable renewable sources available. .

5.2 Africa's Geothermal Potential Along the Rift Valley

The East African Rift Valley, where the African tectonic plate is slowly splitting apart, creates ideal conditions for geothermal energy across Kenya, Ethiopia, Tanzania, Djibouti, and Uganda. Kenya is the clear regional leader and the seventh-largest geothermal electricity producer in the world, with its Olkaria field near Naivasha hosting several power plants operated mainly by KenGen. Kenya's total geothermal potential is estimated at around 7,000-10,000 MW, of which only a fraction has so far been developed, indicating significant room for expansion across the region.

5.3 Bioenergy: Traditional Use and Modern Potential

Bioenergy, energy derived from organic material such as wood, crop residues, animal waste, and purpose-grown energy crops already accounts for the largest single share of energy consumption in much of Sub-Saharan Africa, mainly in the form of firewood and charcoal used for cooking. This traditional use is often inefficient and linked to deforestation, indoor air pollution, and significant health impacts, particularly for women and children who typically do the cooking. Modern bioenergy applications aim to convert the same resource base into cleaner, more efficient energy: biogas digesters convert animal manure and organic waste into methane-rich gas for cooking and small-scale electricity generation; biomass gasification and combustion plants can use agricultural residues (such as sugarcane bagasse or rice husks) to generate grid electricity; and improved cookstoves reduce fuel use and smoke exposure even where a full transition to biogas or electricity is not yet feasible. .

Module 6: Energy Storage, Mini-Grids, Policy and Financing for Scaling Renewable Energy in Africa

Solar and wind are variable: they generate electricity only when the sun shines or the wind blows, which creates a mismatch with continuous demand. Battery energy storage systems...

3 lessons · 6m

6.1 Why Energy Storage Matters

Solar and wind are variable: they generate electricity only when the sun shines or the wind blows, which creates a mismatch with continuous demand. Battery energy storage systems (BESS) address this by storing surplus generation (for example, midday solar output) and releasing it when generation is low or demand is high (such as evenings). As battery costs have fallen sharply over the past decade, storage has moved from a niche add-on to a core part of bankable renewable projects across African markets including South Africa, Egypt, Zambia, Namibia, and Kenya. Storage also improves grid stability, allowing a higher share of variable renewables to be integrated without compromising reliability, and can substitute for costly diesel backup in mini-grids and commercial and industrial facilities. .

6.2 Mini-Grids and Decentralised Energy Access

A mini-grid is a small-scale electricity generation and distribution system, typically combining solar PV (often with batteries and sometimes biomass or diesel backup), that serves a defined community or cluster of customers independently of the national grid. Mini-grids are especially valuable in remote or dispersed rural areas where extending the national grid is technically difficult or not economically justified for years or decades. Programmes such as Nigeria's Rural Electrification Agency mini-grid rollout and the multi-country Africa Mini-Grids Programme (supported by UNDP and the Global Environment Facility) have connected hundreds of thousands of households and businesses to reliable power, often prioritising 'productive use' customers such as agro-processors and small enterprises to make the mini-grid's revenue base more sustainable.

6.3 Policy, Regulation and Financing for Scale-Up

Technology alone does not scale renewable energy policy and finance do. Common policy tools include feed-in tariffs (a guaranteed price for renewable electricity fed into the grid), competitive auctions (which have driven down solar and wind prices across Africa by awarding contracts to the lowest bidder), net metering (allowing consumers who generate their own power to sell surplus back to the grid), and dedicated mini-grid regulations that set clear tariff and licensing rules for developers. On the financing side, blended finance, combining concessional funding from development finance institutions with private capital has been critical to making early-stage African renewable projects bankable, given the historically higher perceived risk (currency, political, and off-take risk) attached to the continent. Institutions such as the African Development Bank, IRENA, the Sustainable Energy Fund for Africa (SEFA), and various national rural electrification agencies play recurring roles across almost every project discussed in this course. .

Final Assessment & Certificate

The final test draws on questions from every module. The pass mark is 80%. When you pass, Tapi Learn issues a certificate of completion bearing your name, the course title, your final score, a unique certificate number and the signature of the CEO of the Pan African Network for Climate Action (PANFCA). Each certificate carries a verification URL (acla.io/verify/<number>) so employers and partners can confirm its authenticity. You can download the certificate as a PDF directly from the app at any time, and your progress and certificates are backed up to the cloud under your email address.

The Africa Climate Leadership Academy (ACLA) is a pan-African education initiative of the Pan African Network for Climate Action. All Tapi Learn courses are free. Learn more at <https://acla.io> and get the app at <https://acla.io/tapi-learn>.