

POWER OUT

A free eBook describing in factsheet form, the process of loadshedding, the what's and whys and how the Rapid rise of Solar PV as a solution to the energy crisis also brings opportunities for all

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Power Out - Loadshedding in South Africa and the Rise of Solar PV – a free eBook

Introduction

If you're living in South Africa, you've undoubtedly experienced the frustration of sitting in the dark, wondering when the power will return.

Loadshedding has become an unwelcome part of South African life, affecting everything from how we cook dinner to how we run our businesses.

This factsheet, in eBook form, is brought to you by gmcenergy-solutions and provides essential information about loadshedding in South Africa:

- what it is?
- why it happens?
- the technical aspects behind it
- how solar PV offers a path toward energy independence

Whether you're a student trying to study, a young professional working from home or someone just trying to keep your phone charged, this information is relevant to you.

Let's dive in



Chapter 1: Understanding Loadshedding - The Technical Reality

What Exactly Is Loadshedding?

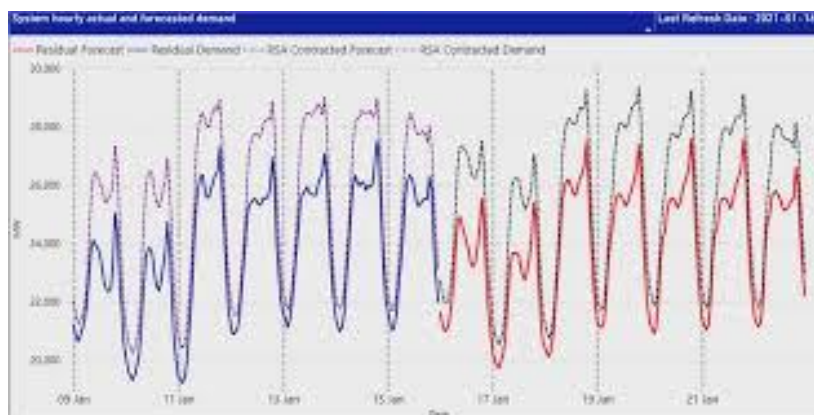
Each day Eskom set up contracts to buy electricity from the Power Stations.

The Power Stations, in addition to producing electricity, also need to perform maintenance on their generators which can be out of service for any number of reasons as well as for unknown durations.



Thus, at times Eskom is unable to buy enough power to match the country's needs.

Under these conditions when there is insufficient electricity to supply all the users at the same time, Eskom instructs the municipalities to share their assigned electricity allowance, in a rotational manner.

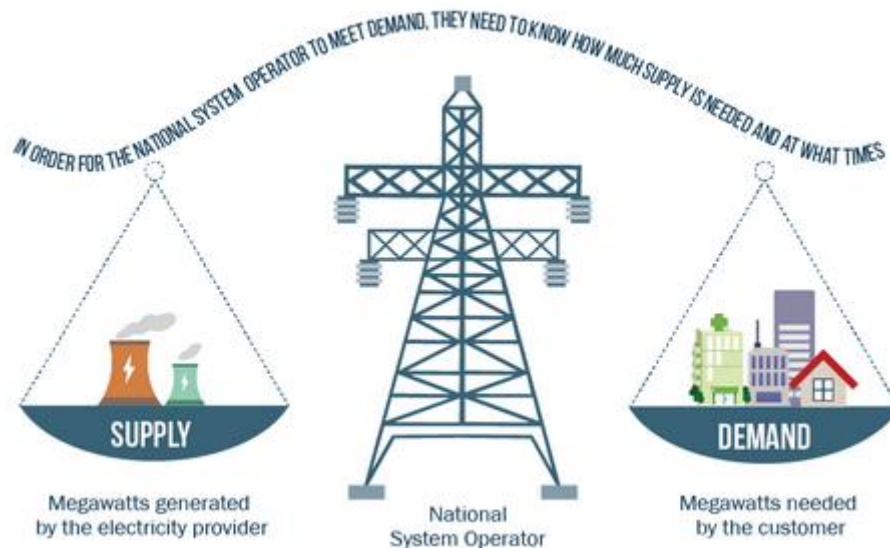


Loadshedding is a controlled process performed by municipalities, where suburbs are switched off in rotation for two hours and then on again intentionally, to prevent the entire power system from collapsing.

In technical terms, it's a last-resort measure implemented by system operators to maintain grid stability when electricity **demand** exceeds available **supply**.

Primary goal

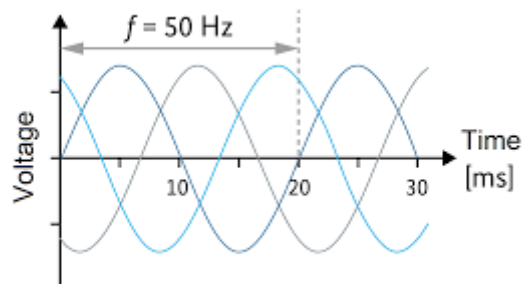
The primary goal of loadshedding is to maintain system frequency at 50Hz, which is critical for the stable operation of the power grid.



When demand exceeds supply, the system frequency drops below 50Hz, which can damage equipment, cause widespread blackouts, and potentially lead to a complete system collapse.

Why Is Maintaining 50Hz So Critical?

The 50Hz frequency (60Hz in some countries like the USA) is the standard at which alternating current (AC) power systems operate.



This frequency must be maintained within strict limits for several reasons:

1. **Equipment Protection:** Most electrical equipment is designed to operate at this specific frequency. Deviations can cause damage to both industrial and household appliances.
2. **System Synchronization:** All generators connected to the grid must operate in perfect synchronization. The 50Hz frequency serves as the "heartbeat" that keeps everything in sync.

3. **Grid Stability:** Significant deviations from 50Hz can trigger automatic protection systems that disconnect parts of the grid, potentially causing cascading failures.
4. **Preventing Blackouts:** Controlled loadshedding is far preferable to uncontrolled blackouts, which can affect critical infrastructure like hospitals and water treatment facilities.

A Global Utility Strategy

It's important to note that loadshedding is not unique to South Africa. System operators worldwide employ this strategy when facing supply shortages.

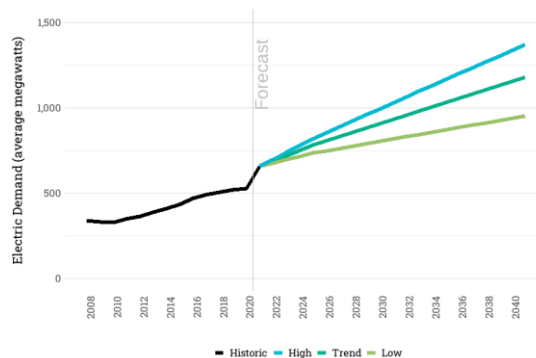
Countries like India, Pakistan, Bangladesh and even developed nations like the United States (California) and Australia have implemented forms of loadshedding during extreme circumstances.

The difference in South Africa is the frequency and predictability of loadshedding, which has become a scheduled part of daily life rather than an exceptional emergency measure.

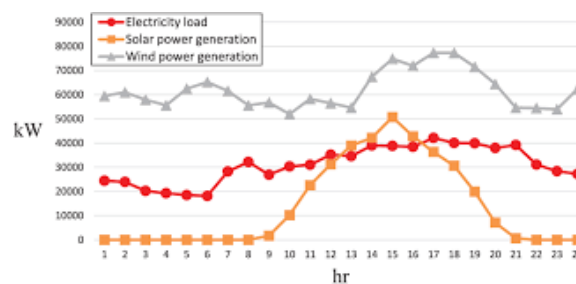
How System Operators Balance Supply and Demand

Under normal circumstances, the system operator follow a methodical process to maintain grid stability:

1. **Demand Forecasting:** System operators forecast electricity demand for the day ahead based on historical patterns, weather forecasts, and other factors.



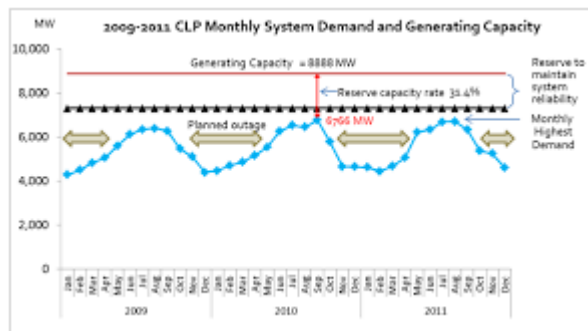
2. **Generation Scheduling:** Based on these forecasts, they schedule which power plants will operate and at what capacity to meet the expected demand.



3. **Real-time Balancing:** Throughout the day, operators make adjustments as actual demand differs from forecasts, bringing additional generation online or reducing output as needed.



4. **Reserve Margins:** Prudent system operators maintain reserve capacity that can quickly respond to unexpected changes in demand or supply.



5. **Emergency Measures:** When demand threatens to exceed supply despite these measures, loadshedding is implemented as a last resort.

When Emergencies Occur

When there's a sudden loss of generation capacity (such as when a power plant trips offline unexpectedly), system operators must act quickly:

1. **Primary Response:** Within seconds, the frequency begins to drop as demand exceeds supply.
2. **Automatic Responses:** Some industrial customers with agreements to reduce load automatically disconnect.
3. **Emergency Declaration:** If the imbalance is severe, an emergency is declared.
4. **Loadshedding Implementation:** If other measures are insufficient, loadshedding is implemented according to predetermined schedules to reduce demand to match available supply.

Chapter 2: South Africa's Unique Power Crisis

Aging Infrastructure and Historical Context

South Africa's power crisis is largely attributable to its aging generation fleet.

Most of Eskom's coal-fired power stations were built in the 1970s and 1980s and are now well past their design lifespans.

These plants require increasingly frequent maintenance and experience more breakdowns as they age.

For decades, these power stations were maintained according to strict schedules that ensured their reliability.

However, during the early 2000s, as electricity demand grew and reserve margins shrank, there was increasing pressure to keep plants running rather than taking them offline for necessary maintenance.

The Neglected Maintenance Program

From approximately 2001 onwards, Eskom began deferring critical maintenance to keep up with growing demand.

The term used by Eskom management was “Sweat the Assets”!!!

This decision, while providing short-term relief, created a maintenance backlog that has had severe long-term consequences:

1. **Deferred Maintenance:** Regular maintenance was postponed, allowing minor issues to develop into major problems.
2. **Running to Failure:** Plants were increasingly operated until components failed rather than being proactively maintained.
3. **Loss of Skills:** Over time, experienced maintenance personnel retired or left, taking valuable institutional knowledge with them.
4. **Declining Performance:** Plant performance steadily declined, with increasing breakdowns and decreasing efficiency.

Attempts to Rectify the Situation

In recent years, Eskom has attempted to address this maintenance backlog through various initiatives:

1. **Philosophy of Excellence:** A maintenance philosophy aimed at returning to world-class standards.

2. **Reliability Maintenance Program:** A structured approach to addressing the most critical maintenance needs.
3. **Generation Recovery Plan:** A comprehensive strategy to improve the performance of the generation fleet.
4. **Mid-life Refurbishment:** Major overhauls of some power stations to extend their operational lives.

Despite these efforts, the scale of the maintenance backlog, combined with design flaws in new power stations like Medupi and Kusile, has made progress slow and difficult.

The result has been persistent loadshedding as Eskom struggles to balance the need for maintenance with the demand for electricity.

A Brief History of Loadshedding in South Africa

Loadshedding isn't new to South Africans. Here's a quick timeline:

- **2007-2008:** The first major loadshedding crisis hit South Africa, catching many by surprise. This was the first clear indication that Eskom's generation capacity was insufficient to meet demand.
- **2014-2015:** Loadshedding returned after a period of relative stability, highlighting that the underlying issues had not been resolved.
- **2018-2019:** Another wave of power cuts swept across the country as Eskom's generation capacity continued to deteriorate.
- **2020-Present:** Loadshedding has become increasingly frequent and severe, with Stage 6 loadshedding (the highest level at the time) first implemented in December 2019 and becoming more common since.

The Different Stages of Loadshedding

Eskom uses a stage system to indicate the severity of loadshedding and the amount of capacity that needs to be removed from the grid to maintain stability:

Stage	MW to be shed	Expected outages
Stage 1	Up to 1,000 MW	2 hours at a time, up to once per day
Stage 2	Up to 2,000 MW	2-2.5 hours at a time, up to twice per day
Stage 3	Up to 3,000 MW	2.5 hours at a time, up to three times per day
Stage 4	Up to 4,000 MW	2.5 hours at a time, up to four times per day

Stage	MW to be shed	Expected outages
Stage 5-6	Up to 6,000 MW	More frequent outages
Stage 7-8	Up to 8,000 MW	Potentially 12+ hours per day

Each stage represents an additional 1,000 MW that needs to be removed from the national grid to maintain the critical 50Hz frequency and prevent a total system collapse.

Why Does Loadshedding Happen?

Several factors contribute to South Africa's ongoing power crisis:

1. **Aging Infrastructure:** Many of Eskom's power plants are old and require frequent maintenance.
2. **Insufficient Maintenance:** Years of inadequate maintenance have led to frequent breakdowns.
3. **Construction Delays:** New power stations like Medupi and Kusile have faced significant delays and technical issues.
4. **Coal Quality Issues:** Poor quality coal affects the efficiency of power generation.
5. **Corruption and Mismanagement:** Years of alleged corruption and mismanagement have hampered Eskom's operations.
6. **Growing Demand:** South Africa's electricity demand has grown faster than new generation capacity.
7. **Weather Events:** Heavy rain can affect coal quality, while extreme heat increases demand.
8. **Limited Reserve Margin:** The system has insufficient reserve capacity to handle unexpected outages.
9. **Transmission Constraints:** In some cases, generation capacity exists but cannot be delivered to where it's needed due to transmission limitations.

Chapter 3: The Rapid Rise of Solar PV in South Africa

Solar PV Installation Growth

The growth of solar PV installations in South Africa has been remarkable in recent years, driven primarily by the ongoing energy crisis and the decreasing costs of solar technology.



Let's look at the numbers:

- **2023:** South Africa added approximately 2,430 MW of solar capacity, representing one of the strongest years for solar growth in the country's history.
- **2024:** In the first 10 months of 2024, South Africa added 961 MW of solar capacity. While this represents a slowdown from 2023, it still demonstrates significant ongoing investment in solar technology.
- **2025 (Projected):** According to Mordor Intelligence, South Africa's solar PV market size is estimated to reach 6.73 gigawatts in 2025.
- **2026-2030 (Forecast):** The solar PV market is expected to grow at a Compound Annual Growth Rate (CAGR) of 11.17%, reaching approximately 11.42 gigawatts by 2030.

This growth is particularly impressive considering that just a decade ago, solar PV was a relatively minor contributor to South Africa's energy mix.

Several factors have contributed to this rapid expansion:

1. **Declining Costs:** The cost of solar PV modules has decreased by more than 80% over the past decade, making solar increasingly competitive with traditional energy sources.
2. **Loadshedding Crisis:** The persistent and worsening loadshedding situation has driven businesses and households to seek alternative energy sources.

3. **Regulatory Changes:** Amendments to regulations, including the lifting of the 100 MW licensing threshold for embedded generation projects, have made it easier to develop solar projects.
4. **Corporate Investment:** Major corporations have increasingly invested in solar to ensure energy security and meet sustainability goals.
5. **Residential Adoption:** Homeowners have embraced solar solutions, from small backup systems to complete off-grid setups.

The Shift from Utility-Scale to Distributed Generation

While early solar growth in South Africa was dominated by utility-scale projects under the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), recent years have seen a significant shift toward distributed generation:



- **Commercial and Industrial (C&I) Sector:** Businesses have rapidly adopted solar to reduce electricity costs and ensure operational continuity during loadshedding.
- **Residential Sector:** Household solar installations have surged, with many South Africans investing in systems ranging from basic backup solutions to comprehensive grid-tied systems with battery storage.
- **Microgrids and Community Projects:** Innovative models for shared solar resources have emerged, allowing communities to pool resources for greater energy security.

This shift represents a democratization of energy production, moving away from centralized generation toward a more resilient, distributed model.

Chapter 4: Youth Unemployment and the Solar Opportunity

The Youth Unemployment Crisis

South Africa faces one of the highest youth unemployment rates globally, creating significant social and economic challenges:

- **Overall Youth Unemployment:** According to Trading Economics, the youth unemployment rate (ages 15-24) stood at 59.6% in the fourth quarter of 2024, a slight improvement from 60.2% in the third quarter.
- **Expanded Age Range:** When considering young people aged 18-34, the unemployment rate was approximately 55% in early 2025, according to Harambee Youth Employment Accelerator.
- **Education Impact:** Stats SA reports that the share of unemployed young people without a matric qualification dropped from 61.6% in 2014 to 51.3% in 2024, showing some improvement but still highlighting significant challenges.
- **Regional Variations:** Urban areas generally show slightly lower youth unemployment rates than rural areas, where opportunities are more limited.

These statistics represent not just numbers but millions of young South Africans unable to find work, develop skills, and contribute to the economy. The consequences extend beyond economics to social cohesion, mental health, and national development.

Solar PV: A Job Creation Engine

The rapid growth of the solar PV sector presents a significant opportunity to address youth unemployment. The renewable energy sector, particularly solar, is labor-intensive and requires a diverse range of skills:

- **Job Creation Potential:** According to ESI Africa, between 85,000 to 275,000 new green jobs are forecast in South Africa by 2030, primarily in energy and power production.
- **Jobs per Gigawatt:** Research by Earthlife Africa indicates that when solar thermal energy is used to generate 1 GWh of electricity, approximately 10.4 jobs are created.
- **Value Chain Opportunities:** The solar PV value chain creates jobs across multiple sectors, from manufacturing and construction to installation, maintenance, and support services.
- **Current Employment:** The renewable energy sector in Southern Africa already employs approximately 73,000 people, with significant growth potential as installations continue to increase.

Types of Jobs in the Solar PV Sector

The solar industry offers diverse career paths suitable for various education levels and skill sets:

Technical Roles:

- **Solar PV Installers:** Hands-on professionals who mount, install, and connect solar panels.



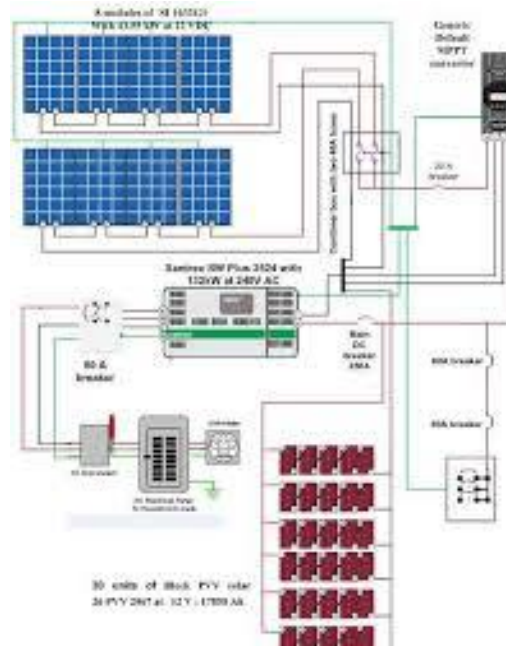
- **Electrical Technicians:** Specialists who handle the electrical connections and system integration.



- **Maintenance Technicians:** Skilled workers who perform regular maintenance and troubleshooting.



- **System Designers:** Professionals who design optimal solar systems based on client needs and site conditions.



Professional Roles:

- **Electrical Engineers:** Qualified engineers who design and oversee complex solar installations.
- **Project Managers:** Professionals who coordinate solar projects from conception to completion.
- **Energy Consultants:** Specialists who advise clients on optimal energy solutions.
- **Financial Analysts:** Experts who assess the economic viability of solar projects.

Support and Sales Roles:

- **Sales Representatives:** Professionals who market solar solutions to potential clients.
- **Customer Service Specialists:** Staff who support clients before, during, and after installation.
- **Administrative Staff:** Team members who handle paperwork, permits, and logistics.
- **Marketing Professionals:** Specialists who develop strategies to promote solar adoption.

Manufacturing and Supply Chain:

- **Production Workers:** Staff involved in manufacturing solar components.
- **Quality Control Specialists:** Professionals who ensure product quality and reliability.
- **Logistics Coordinators:** Experts who manage the movement of equipment and materials.
- **Warehouse Staff:** Workers who handle inventory and equipment storage.

Skills Development and Training Needs

For young South Africans to benefit from these opportunities, appropriate training and skills development are essential:

- **Technical Training:** Practical skills in electrical work, installation techniques, and system design.
- **Safety Protocols:** Comprehensive training in working at heights, electrical safety, and general construction safety.
- **Digital Literacy:** Skills in using design software, monitoring systems, and digital tools.
- **Business Acumen:** Understanding of project economics, customer relations, and basic business operations.
- **Soft Skills:** Communication, teamwork, problem-solving, and adaptability.

The good news is that many of these skills can be developed through short courses, apprenticeships, and on-the-job training, making them accessible to young people without extensive formal education.

Chapter 5: Pathways to Solar Careers for Young South Africans

Education and Training Options

For young South Africans interested in solar careers, several educational pathways exist:

Formal Education:

- **TVET Colleges:** Technical and Vocational Education and Training colleges offer relevant certificates and diplomas in electrical engineering and related fields.
- **Universities:** Degree programs in electrical engineering, renewable energy, or environmental science provide comprehensive theoretical knowledge.

- **Industry Certifications:** Specialized solar PV installation and design certifications offered by industry bodies.

Alternative Pathways:

- **Short Courses:** Focused training programs that teach specific skills needed for entry-level positions.
- **Apprenticeships:** Learning through working alongside experienced professionals.
- **Online Learning:** Digital courses that provide theoretical knowledge accessible from anywhere.
- **Practical Workshops:** Hands-on training sessions focused on installation and maintenance skills.

Getting Started in Solar:

First Steps

For young South Africans or anyone looking to enter the solar industry, these practical steps can help:

1. **Gain Basic Knowledge:** Understand the fundamentals of solar PV technology, electrical systems, and energy concepts.
2. **Develop Technical Skills:** Build practical skills in electrical work, tool usage, and basic construction.
3. **Obtain Safety Training:** Complete courses in electrical safety, working at heights, and general construction safety.
4. **Network in the Industry:** Connect with solar companies, attend industry events, and join relevant associations.
5. **Start with Entry-Level Positions:** Consider roles as installation assistants, sales support, or administrative staff to get a foot in the door.
6. **Continuous Learning:** Stay updated on evolving technologies, regulations, and best practices in the industry.

GMC Energy Solutions Solar PV Fundamentals Course:

Your Gateway to the Solar Industry

Understanding the basics of solar PV technology is the essential first step toward a career in this growing field. GMC Energy Solutions' comprehensive "Solar PV Fundamentals" course is specifically designed for young South Africans with no technical background who want to enter this exciting industry.

This course covers:

- The science behind solar energy and photovoltaic conversion
- The Solar panel or module – how does it work?
- Energy yield calculations and system efficiency
- How to put together a solar generator
- Theory and basic formulae essential

Unlike highly technical courses that require extensive prior knowledge, our course presents these concepts in straightforward, accessible language with real-world examples relevant to South Africa.

By completing this course, you'll gain:

- A solid foundation in solar PV concepts that employers value
- Practical knowledge applicable to various roles in the industry
- Understanding of the South African solar market and its opportunities
- Confidence to pursue further specialized training or entry-level positions
- A competitive edge in a rapidly growing job market

Whether you're looking to start a career as a solar installer, sales representative, project coordinator, or entrepreneur in the solar space, this GMC Energy Solutions course provides the essential knowledge you need to take that first step.

Conclusion: Solar PV - Powering South Africa's Future

The convergence of South Africa's energy crisis, high youth unemployment, and the rapid growth of solar PV creates both challenges and opportunities. As the country continues its transition toward renewable energy, the solar industry stands ready to not only provide clean, reliable electricity but also create meaningful employment for thousands of young South Africans.

The statistics are clear: South Africa's solar capacity is projected to nearly double by 2030, creating tens of thousands of new jobs across the value chain. For a country with youth unemployment rates approaching 60%, these opportunities represent pathways to economic empowerment and professional growth.

The democratization of energy through solar PV also creates opportunities for entrepreneurship, with young South Africans starting businesses in installation, maintenance, consulting, and other solar-related services. This entrepreneurial potential further multiplies the employment impact of the solar transition.

As loadshedding continues to challenge South African households and businesses, solar PV offers both an immediate solution to energy insecurity and a long-term career opportunity for the country's youth. By investing in the knowledge and skills needed for this industry, young South Africans can position themselves at the forefront of the country's energy transition.

The journey begins with understanding the fundamentals of solar PV technology - how it works, how it's implemented, and how it creates value in the South African context. With this knowledge as a foundation, the possibilities for career growth and development are substantial and growing.

Take the First Step with [gmcenergy-solutions](#)

Ready to explore opportunities in South Africa's booming solar industry? gmcenergy-solutions is of the strong belief that knowledge is the real path to independence, Independence from the issues facing the country especially the high levels of unemployment, energy security and lack of direction facing young adults.

These are real challenges, and knowledge is the foundation for taking the right step in developing yourself first in a professional manner with the right knowledge so that you can forge your own career and employment path in the field of solar PV

The booming solar PV is looking for professional skills, take the future in your own hands and develop yourself.

Our courses are structured specifically for young adults with no technical background or anyone who want to understand the basics of solar technology and its applications in South Africa.

With the Solar PV fundamentals course, you'll gain comprehensive theoretical knowledge that can serve as the foundation for various career paths in the solar industry. Within this course we explain the various roles such as design, development, maintenance, and for future business owners in the solar PV industry, that is needed and lies ahead. There is a lot to learn and we provide the guidance!

Take your first course and begin your professional journey toward a bright future in the Solar PV industry by visiting us at <https://www.solutions.gmcenergy-solutions.co.za/solar-pv-fundamentals/> and start your **gmc PV Pathfinder** journey. The first course, Solar PV Fundamentals and is a foundational course for you to get started, no matter what your current technical level is right now. The course is light and explores all the fundamentals needed as well as initial guidance on the various roles the industry is requiring, is only R1699 and the first 200 to sign up will receive a R400 discount or look out for further email information.

About gmcenergy-solutions

gmcenergy-solutions is a South African entity dedicated to empowering individuals and communities with sustainable energy knowledge and solutions.

We specialize in alternative energy solutions that are expertly engineered to meet the unique needs of South African homes and businesses.

Our mission is to help South Africans overcome energy challenges through education, innovation, and practical solutions.

From our comprehensive training courses to our expert consulting services, we're committed to driving the adoption of renewable energy across South Africa.

Visit our website <https://www.solutions.gmcenergy-solutions.co.za/solar-pv-fundamentals/> to learn more about our courses, products, and services.