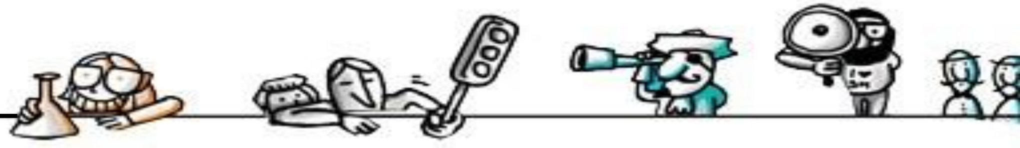
Switch Energy Case Competition

Team 111 – DreamTeam



# Egypt / Turkey Energy Evaluation & Plan

Pranjal Sheth, Nathan Hazlett, Sarah Grace Kimberly

# Team

## Pranjal Sheth

- Finance student at the University of Houston in the Bauer College of Business with a minor in energy sustainability
- Advisor for The Energy Coalition, Pecan Credit, and Stedu Association
- Co-Founder of LiQuidium, a hard-tech startup focused on sustainable critical mineral extraction
- Previous work in energy at Hastings Equity Partners, Mizuho Securities, Venturous and Moelis & Co
- Presented at / Attended COP28 in Dubai, Student Energy Summit in Abu Dhabi, and conferences in Singapore, New York, Silicon Valley, Boston, Austin and Houston

## Sarah Grace Kimberly

- Finance & Accounting student at the University of Houston in the Bauer College of Business
- Senior Fellow for TEX-E, a MIT/Harvard-run energy entrepreneurship program
- Co-Founder of BeadBlocker, a startup focused on decreasing microplastics waste through patent-pending technology
- Previous work in energy at Morgan Stanley, Main Street Capital, New Climate Ventures, and Jefferies
- Semi-Finalist on NBC's "The Voice", professionally touring musician and recording artist

## Nathan Hazlett

- BS Petroleum Engineering '24 (Summa Cum Laude in 3 years) and MS Finance '25 from Texas A&M University
- Vice President Emeritus of Texas A&M's Society of Petroleum Engineers
- Founder of Energy Rush: The Largest Freshmen-Exclusive Company Networking Event in Texas A&M History
- Previous work at Pioneer Natural Resources, Hilcorp Energy on Alaska's North Slope, and Jefferies Energy Investment Banking
- While studying abroad in Qatar, took 1st Place in the International Paper & Presentation Contest at the Petro Barza in Oman by presenting on LNG expansion as the key to the United States' energy transition

# **Turkey –** Europe & Asia

**Population**
87.5 million

**Urban**
67 million, 77%

**Rural**
20.5 million, 23%

**GDP per Capita**
$9,587 USD

**Minimum Wage**
$614 USD / month

**Inflation Rate**
49.5% (September 2024)

**Area**
783,562 sq km

**Government**
Presidential Republic

**Number of Languages**
Turkish, Kurdish, others

**HDI Ranking**
45th

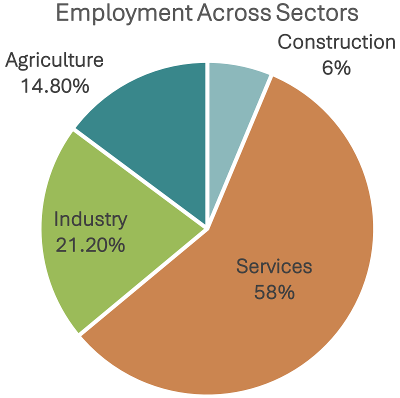
**Life Expectancy**
77.7 years

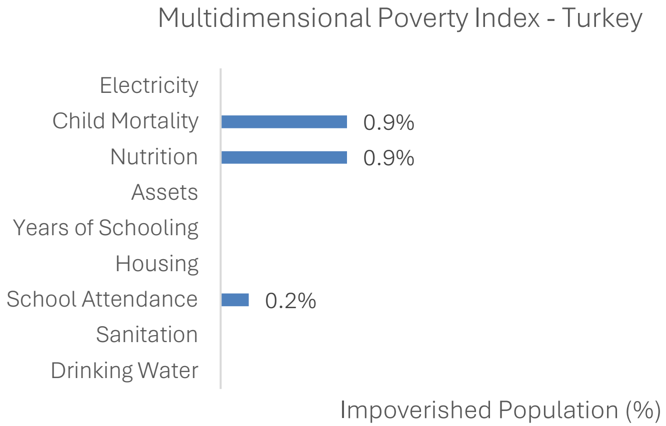
**Death Rate**
6.2 per 1,000

**CO2 Emissions**
4.03 metric tons / capita

**Electricity Access**
100% (universal access)

**Climate**
Diverse, due to landscape




# **Egypt** – Africa

**Population**
117 million

**Urban**
43 million, 42%

**Rural**
61 million, 58%

**GDP per Capita**
$3,832 USD

**Minimum Wage**
$97 USD / month

**Inflation Rate**
26.2% (August 2024)

**Area**
1,001,450 sq km

**Government:**
Semi-Presidential Republic

**Number of Languages**
Arabic, English, French

**HDI Ranking**
106th

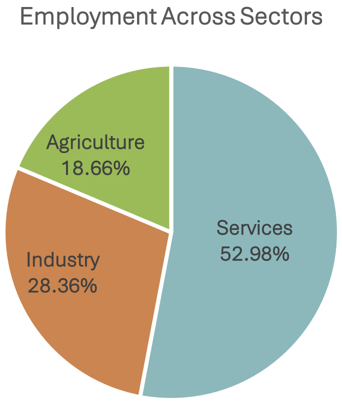
**Life Expectancy**
72.7

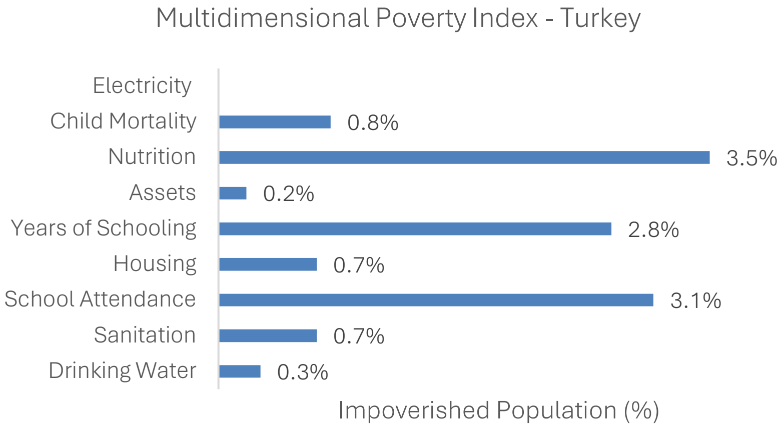
**Death Rate**
4.3 per 1,000

**CO2 Emissions**
2.1 metric tons / capita

**Electricity Access**
100%

**Climate**
Hot, dry, desert-like




MPI Report, 2024, HDI Ranking Turkey, Egypt; Employment Stats from World Bank – Turkey, Egypt; Death Rates, Turkey, Egypt; Inflation – Turkey, Egypt

# Turkey – Overview

Turkey has not yet committed to net zero targets but is making investments in renewable technologies.

1. **Accessibility:** Relatively strong accessibility but may vary between rural and urban areas. Turkey is heavily reliant upon imports.

2. **Environmental Impact:** **Coal accounts for 36%** of electricity generation, and Turkey has not yet committed to net zero targets.

3. **Quality of Energy Services:** Turkey is investing in energy efficiency programs, smart meters, and renewable integration with the grid.

4. **Reliability:** Urban areas experience less than **1 outage per 1,000 customers** annually. Increased LNG imports and solar/wind generation has improved reliability.

5. **Affordability:** Electricity prices have risen sharply due to greater than **50% inflation in 2022**. The Energy Market Regulatory Authority (EMRA) introduced price caps.

6. **Safety:** Around **15% of households lack access** to clean cooking fuels, impacting health, and heating/cooling is inadequate in some rural areas during extreme weather.

7. **Security:** Turkey's energy infrastructure is vulnerable to attacks, with over **50 incidents targeting energy facilities** between 2015 and 2020, highlighting ongoing security risks.

8. **Potential for Roadblocks:** Turkey faces political instability, financial constraints, and infrastructure gaps that hinder efforts to reduce energy poverty, particularly in rural regions.

Turkey Energy Mix & Overview

# Egypt – Overview

Egypt has not yet committed to net zero targets and lacks investment in renewable technologies.

1 **Accessibility:**
Although **>90% of households are connected to the national grid**, outages are common during peak summer months; less accessibility in rural areas

2 **Environmental Impact:**
**High reliance on fossil fuels**, but emissions have decreased because of increased natural gas use; **little scalable renewable energy**

3 **Quality of Energy Services:**
Services are generally affordable, reliable, and safe, but several key areas for improvement exist

4 **Reliability:**
**Government targets <10 outages per 1,000 customers per year**, but these targets have not been met following 2024's **12% increase in daily electricity consumption**

5 **Affordability:**
Government subsidies make energy relatively affordable, but many **Egyptians still pay 10% - 20% of their salary on energy alongside a large tax burden**

6 **Safety:**
Widespread switching to **LPG** for cooking has had **a positive effect on health**, but Egypt's **infrastructure lacks modern safety features**

7 **Security:**
Critical energy facilities near the Suez Canal are heavily guarded by military, but **rural infrastructure is more vulnerable; heavily reliant on imports too**

8 **Potential for Roadblocks:**
Significant political and bureaucratic hurdles, lack of skilled energy workers, and supply chain limitations present roadblocks.

Sources: IEA, Carnegie Endowment for International Peace, World Bank, U.S Department of State

# Political Landscape and Energy Poverty Legislation in Egypt and Turkey

Turkey and Egypt struggling to fight rising energy prices and dependence upon imports

## Turkey

*Battling Inflation & Heavily Dependent Upon Natural Gas Imports*

**Overview:** Turkey is a unitary parliamentary republic, with President Recep Tayyip Erdoğan playing a central role in policy direction.

Energy policy is a key part of Erdoğan's administration, aiming for energy independence and security.

### Current Policy

- **Free Gas Month:** In May 2023, Turkey offered a one-month free natural gas supply to households, a move widely seen as a relief measure amid high inflation. However, this is not a long-term solution to energy poverty.
- **Inflation and Energy Prices:** Turkey's central bank is curbing extremely high inflation (over 80% end 2022), which is down to about 50% currently
- **Renewable Energy Investments:** The government is quadrupling investment in wind and solar energy by 2035, with hopes of reducing energy import dependency and combating energy poverty in the long run.

## Egypt

*Subsidies "crutch" being removed & Energy Poverty Persists*

**Overview:** Egypt is led by President Abdel Fattah el-Sisi since 2014.

Energy policy is tightly controlled by the central government, with the Ministry of Petroleum and Mineral Resources overseeing energy production and distribution.

### Current Policy

- **Subsidy Reform**: Recently, Egypt has gradually removed subsidies on fuel and electricity, a key contributor to the rise in energy costs for vulnerable populations.
- **Renewable Energy Law**: In 2014, Egypt passed a law incentivizing renewable energy projects, focusing on solar and wind.
- **Energy Poverty:** A significant portion of Egypt's population, especially in rural areas, lacks consistent access to reliable energy. Energy poverty is exacerbated by high inflation and insufficient infrastructure.

Free Gas Month, Inflation in Turkey, Renewable Investments in Turkey, Subsidy Reform in Egypt, Renewable Energy Law in Egypt , Inflation Policy Turkey

# Turkey Energy Issue Analysis

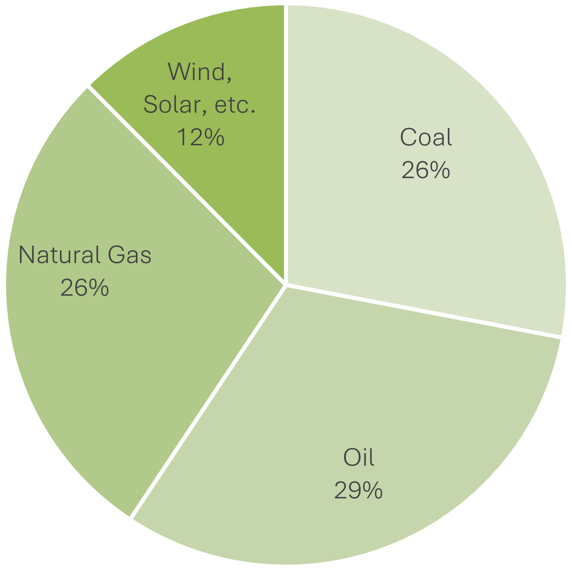
Turkey has not yet committed to net zero targets but is making investments in renewable technologies.

| 1902 | 1923 | 1970 | 1994 | 2001 | 2013 | 2019 |
|---|---|---|---|---|---|---|
| First electricity generation in Ottoman Empire - Tarsus | Republic of Turkey established - nationalization of power infrastructure | Turkish Electricity Authority (TEK) established | TEK split into TEAŞ and TEDAŞ | Electricity Market Law - market liberalization | Energy Market Regulatory Authority (EMRA) strengthened | National Energy Efficiency Action Plan launched |

## Vision 2030 Progress

| | | |
|---|---|---|
| 100 GW total installed capacity by 2030 | → | 107 GW total installed capacity (2024) |
| 95% electricity access nationwide | → | 99.9% electricity access achieved |
| 65% renewable energy production by 2035 | → | 58.7% renewable energy production (2024) |

## Turkey Energy Mix




Turkey Energy Mix, National Energy Efficiency Action Plan, Climate Scorecard,

# Egypt Energy Issue Analysis

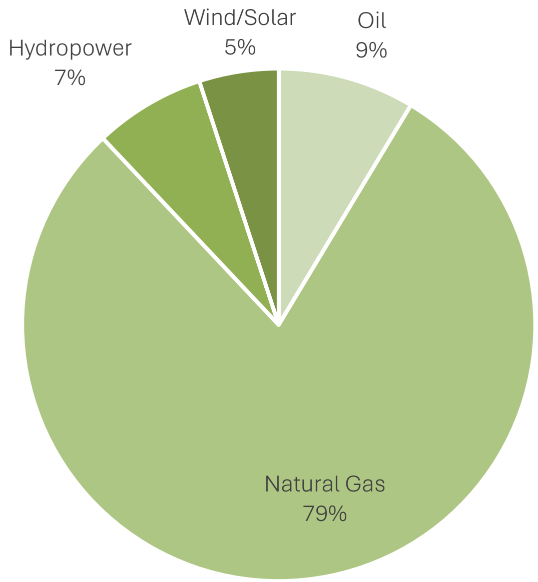
Egypt has not yet committed to net zero targets and lacks investment in renewable technologies.

| 1903 | 1957 | 1964 | 1976 | 1996 | 2015 | 2022 |
|---|---|---|---|---|---|---|
| First electricity generation in Cairo | Establishment of the Ministry of Electricity | Aswan High Dam begins operation, boosting hydroelectric power | Egyptian Electricity Authority formed | Electricity sector restructuring begins to allow private investment | Feed-in Tariff program launched to encourage renewable energy | Integrated Sustainable Energy Strategy targets 42% renewables by 2035 |

## Integrated Sustainable Energy Strategy Progress

Renewables account for 42% of electricity mix (2035) → Renewables account for 12% of electricity mix (2024)

## Egypt Energy Mix




Sources: ISPI, GGGI, SolarReviews, Sunwatts, IEA, IRENA, EIA, MPED, Arab Development Portal

# Comparison

Overall, Turkey is less impacted by energy poverty than Egypt, though both have significant room for improvement

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| | | |
|---|---|---|
| ACCESSIBILITY | Reasonable access with issues – 3 | 4 – Very accessible to majority |
| ENVIRONMENTAL IMPACT | Significant impact – 2 | 2 – Significant impact |
| QUALITY OF ENERGY SERVICES | Low quality with service issues – 2 | 3 – Average quality |
| RELIABILITY | Unreliable; frequent interruptions – 2 | 3 – Occasional disruptions |
| AFFORDABILITY | Expensive, affordability concerns – 2 | 3 – Affordable for most |
| SAFETY | Moderately safe, but with some issues – 3 | 3 – Some issues |
| SECURITY | Insecure with significant issues – 2 | 3 – Moderately secure |
| POTENTIAL FOR ROADBLOCKS | Significant potential for roadblocks – 2 | 3 – Moderate potential for roadblocks |

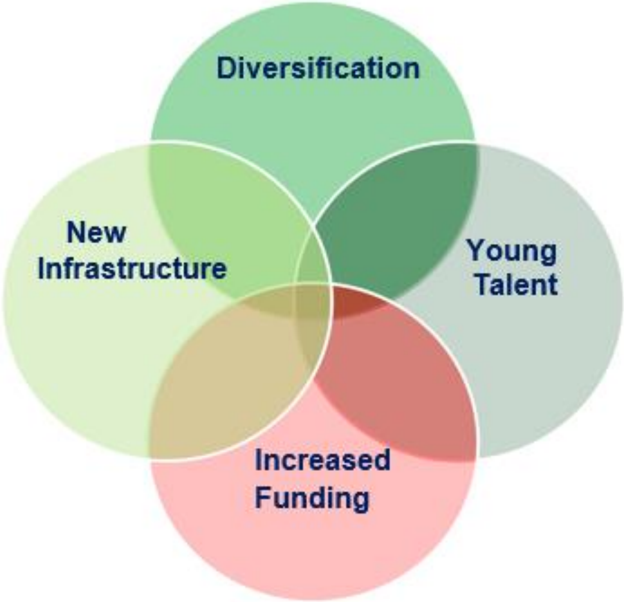
24

Sources: IEA, Carnegie Endowment for International Peace, World Bank, U.S Department of State

# Candid Conversations – Hossam Ebaid's Perspective

Cairo native Hossam Ebaid drew upon his experience as a full-time petroleum engineer in Egypt and as a PhD Candidate at Texas A&M to offer his perspective on Egypt's energy policy needs

*"Egypt is struggling more than people realize. Blackouts keep happening, prices are high, and pollution is so bad. I am working to fix this, but we need more people to help."*




**Undiversified energy pool**: Natural gas and oil provide almost all domestic energy needs—significant opportunity exists from other sources

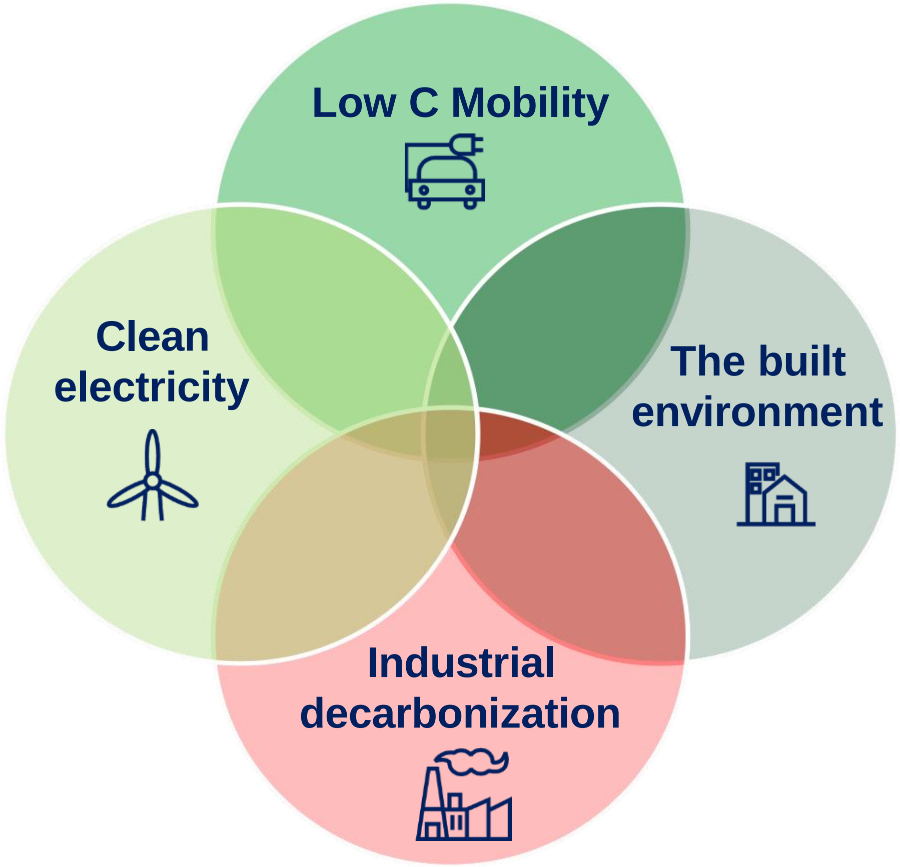
**Energy is somewhat affordable (for now):** Government subsidies have kept energy prices low, but the subsidies are dwindling

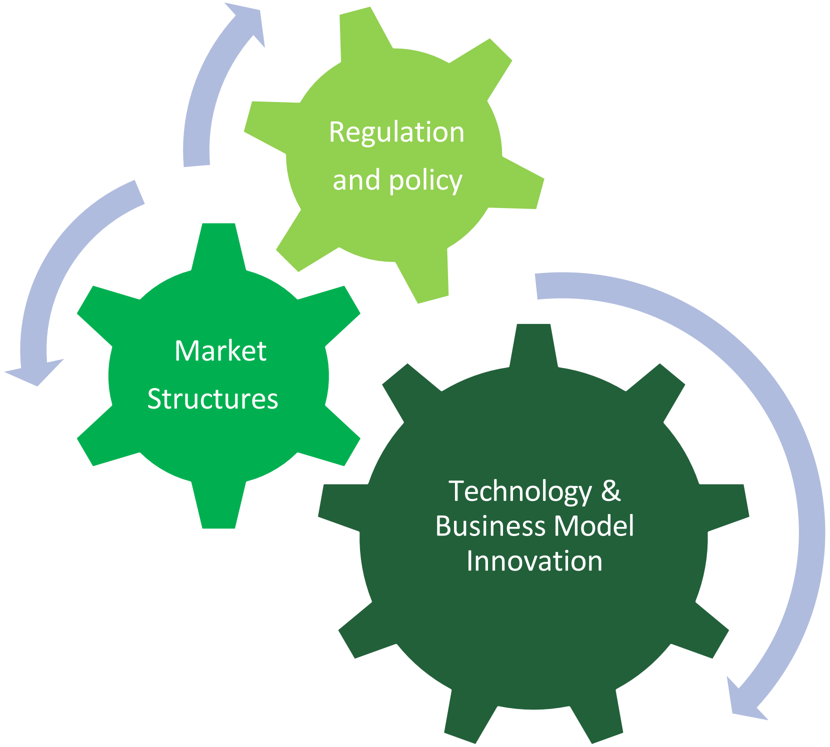
**Egypt lacks qualified energy workers**: Western institutions must educate more Egyptian energy engineers to fill the talent vacuum

Sources: [ScienceDirect], [CurresWeb], [International Rivers], [ResearchGate]

# The Big Picture – Prioritizing Allocation of the $32.4 Billion Budget

The most cost-effective renewable energy sources for Egypt are *solar photovoltaic (PV) systems*, *wind power*, *micro-hydro systems*, *small-scale energy storage solutions, and minor grid and agricultural improvements*




**High-Impact, Low-Cost Technologies**: Emphasizing the most cost-effective energy technologies with low operational costs.

**Maximizing Coverage for Energy-Poor Regions:** Direct investment towards areas with the greatest energy poverty.

**Sustainability and Scalability**: Implementing scalable technologies that can grow over time to meet increasing demand.

Source: Global Carbon Budget 2019, Global Energy Perspective – Reference Case 2019, McKinsey 1.5C Scenario Analysis; IPCC RCP8.5 IEA WEO 2019, expanded by Woods Hole Research Center

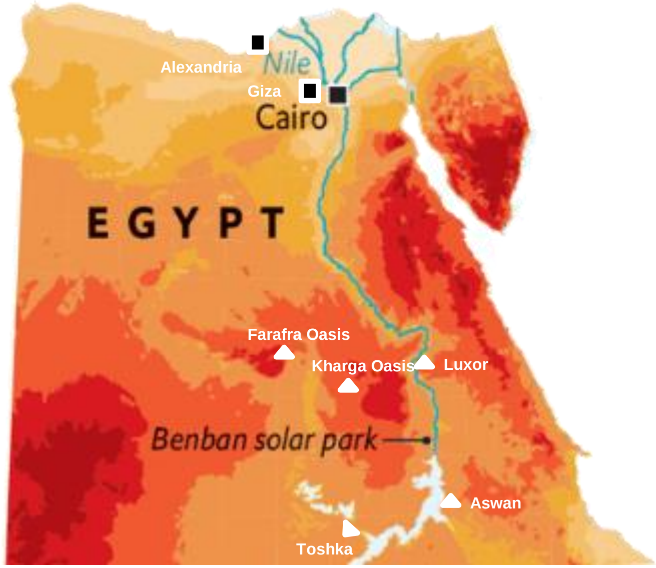
Sources: IEA, Scaling with Growth

# Solar Systems - $12B Allocation

**Solar Photovoltaic (PV) systems** are the most cost-effective and sustainable solution for Egypt's energy challenges due to several reasons:

**74B**
MWh Solar Potential

**2% >>> 12.6%**
Change in total % of Electricity Generation from 2024 to 2034




## Solar Farms ▲

•**Farafra Oasis** and **Kharga Oasis**: These areas have high solar irradiance and plenty of unused space.
•**Toshka** and **Lake Nasser**: Proximity to water bodies provides an opportunity for solar farms with solar-cooling technologies.
•**Dakhla Oasis**: A region known for its solar potential and suitability for large installations.
•**Aswan** already hosts the **Benban Solar Park**, and expanding the solar capacity here would be logical.

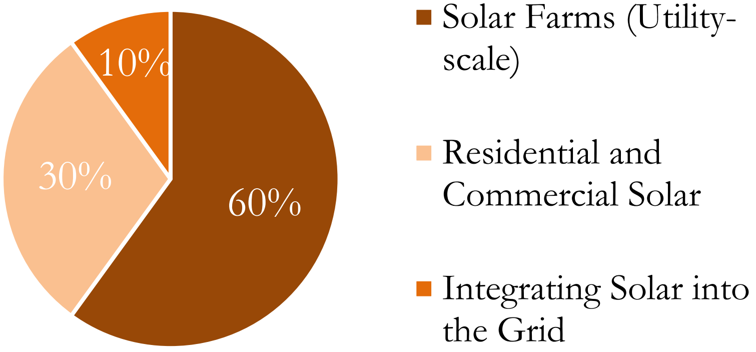
## Residential and Commercial Solar ■

•**Cairo** and **Giza**: These densely populated urban areas would benefit from rooftop solar PV systems.
•**Alexandria**: As a coastal city with significant activity, solar can reduce fossil fuel dependence.

## Cost-effective Implementation and Maintenance

- Solar PV technology has experienced significant cost reductions. The average cost of installing large-scale solar systems is around **$500,000 per MW in Egypt**.
- Solar PV has very low maintenance costs compared to fossil fuel-based systems. After installation, **operational costs can be as low as $20/MWh**, allowing affordable electricity for Egypt's population.
- Budget would allow the installation of approximately **3 GW of rooftop solar** and **14.4 GW of utility scale solar**

## Budget Allocation




Sources: ScienceDirect, NREL, 2030 Goals

# Wind Power - $8B Allocation

Egypt has considerable wind energy potential, particularly along the Red Sea coast and in parts of the Western Desert

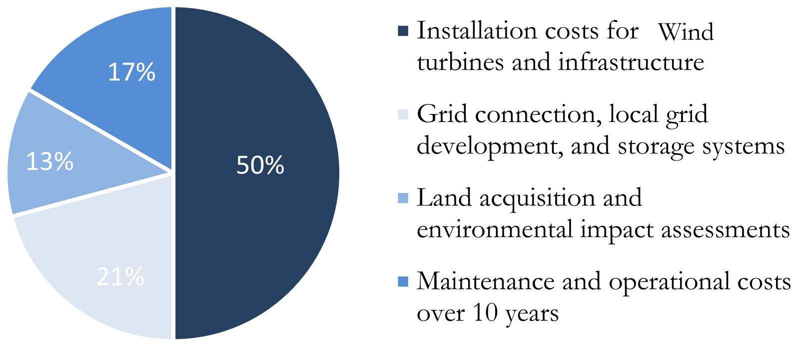
## Wind Farms

1. Gulf of Suez:
    1. Primary region for wind energy development due to its consistently high wind speeds (8-10 m/s).
    2. Existing wind farms like Zafarana and Gabal El Zayt show the region's capacity for large-scale wind energy. Expanding in this region makes sense due to available infrastructure and proven wind speeds
    3. Target Capacity: 2.5 GW
2. Western Desert (West Nile):
    1. Regions such as El Dabaa and areas west of the Nile offer strong wind potential (7-9 m/s). These areas are sparsely populated and have the land available for large wind farm development
    2. The government has already earmarked some regions in the Western Desert for wind farm development.
    3. Target Capacity: 1.5 GW
3. Red Sea Coast:
    1. The stretch between Hurghada and Safaga has significant wind potential and is an emerging site for wind farms. This region benefits from proximity to key tourist and industrial zones that need sustainable energy solutions
    2. Target Capacity: 0.7 GW

## Cost-effective Implementation and Maintenance

- Given the high capacity factors of wind farms in the Gulf of Suez (up to 50%), Egypt could aim to generate 10-15% of its energy from wind by the end of the 10-year plan. This translates to approximately 5-6 GW of installed capacity by 2034, up from the current 1.5 GW. This could meet the annual electricity demand of approximately 5-6 million households
- Onshore wind has an average cost of $1.3-1.5 million per MW of installed capacity
- Egypt has regions with wind speeds up to 8-10 m/s (high)

## Budget Allocation




Sources: Egypts Wind Capacity, WAPA, 10GW Wind Farm, Wind Energy Analysis

# Nile-based Energy Solutions- $6B Allocation

Systems can be used both **off-grid and for grid-connected applications**; they have minimal ecological impacts and do not require large reservoirs compared their larger dam counterparts

**95%**

Of Egypt's population lives along the Nile

**Micro-Hydro Systems:**

- **Upper Nile (Southern Egypt):** Low population density but high agricultural activity, micro-hydro to power irrigation and small towns
- **Delta Region**: small-scale systems to serve local communities and industries.
- **Capacity:** 300-500 MW

**Grid Integration and Infrastructure:**

- Improving transmission lines
- Funds also used for energy storage technologies

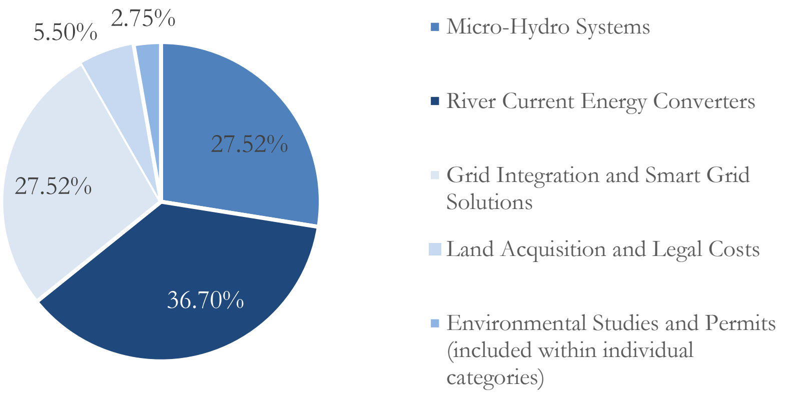
**River Current Energy Converters::**

- **Cairo region:** Fast flowing water and proximity to urban centers
- **Nile Delta region:** Power the high concentration of coastal area
- **Capacity:** 200-400 MW

## Impact

- Micro-hydro systems are a **cost-efficient and sustainable solution for utilizing the Nile's natural resources** to reduce energy poverty
- With the combination of micro-hydro systems and river current energy converters, we expect that these Nile-based renewable technologies will contribute around **2-3% of Egypt's energy mix** by 2034.
- While these percentages may seem modest, their impact on rural electrification and off-grid communities will be transformative.

## Budget Allocation

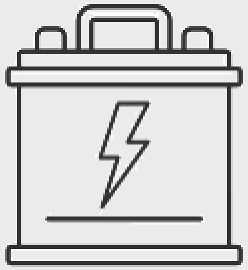



Sources: ScienceDirect, CurresWeb, International Rivers, ResearchGate

# Small-scale Energy Storage Systems – 4B / Solar Canopies over Canals - 2.4B

Systems can be used both **off-grid** to reduce energy waste across agriculture and communities with power requirements outside of conventional time periods

**Small-Scale Energy Storage Systems** as a critical element of its renewable energy plan



### Key Locations for Energy Storage Installation:

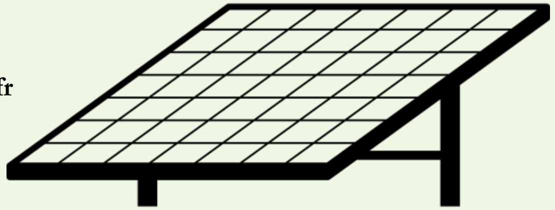
1. **Nile Delta Region**: One of the most fertile and agriculturally important regions in Egypt, it has a large network of irrigation canals that would benefit from both energy production and water conservation.

2. **Faiyum Governorate**: This region has extensive irrigation networks and consistently high levels of solar radiation.

3. **Upper Egypt (Aswan to Luxor)**: This area is suitable for solar canopies because of its proximity to agricultural lands and long irrigation canals, while also having the potential for significant solar energy production.

**Solar Panels above Irrigation Canals** offers dual benefits: It generates **clean energy** while simultaneously reducing **water evaporation** from the canals.

### Key Locations for Solar Canopy Installation:



**1. Nile Delta Region**
•**Location**: The Nile Delta, particularly in the governorates of **Beheira**, **Kafr El Sheikh**, and **Sharqia**.
•**Reasoning**: The Nile Delta is the heart of Egypt's agricultural production. It has an extensive canal network that feeds irrigation water to farmland. Installing solar panels here would optimize land use and reduce water evaporation due to shading from the solar panels.
•**Advantages**:

- High agricultural activity and high water demand.
- Solar potential is good, averaging over **5.5 kWh/m²/day**.
- Wide canals can support large-scale solar installations.

**2. Toshka Project (Southern Egypt)**
•**Location**: Near the Toshka Lakes and the Toshka agricultural project in southern Egypt.
•**Reasoning**: This area is part of Egypt's desert reclamation projects, where large tracts of land are being developed for agriculture using irrigation from the Nile. Solar canopies could provide renewable energy for local development while reducing water loss.
•**Advantages**:

- High solar irradiance (6-7 kWh/m²/day).
- Government focus on expanding agriculture and infrastructure in the region.
- Canals are key to irrigating desert land.

Sources: History, Irrigation Improvement Projects, Delta-Alliance, USGS, Water-Technology

# Public Private Partnerships – Increasing Available Budget

Raise ***additional funds through PPPs***, bringing in private investors to finance expansions in energy infrastructure, while keeping the government as a key partner

## Steps to Implement the PPP Model:

- **Policy Framework**: Establish laws that promote PPPs, ensuring clear roles, risks, and rewards for both public and private entities. The policy would include guaranteed purchase agreements, tax exemptions, and fast-track permits.
- **Attracting Investment**: Target international and domestic investors with a focus on infrastructure funds, energy companies, and sustainability-focused investors. This can be done through energy auctions, where investors bid on projects (*similar to how Uruguay auctions renewable energy projects*).
- **Initial Investment Target**: Aim to raise *an additional $10-12 billion over the next 10 years* through PPPs, specifically allocated for natural gas and CCUS.

### Natural Gas Maintenance / Expansion:

**Objective**: Increase the share of natural gas in the energy mix while using the technology to stabilize the grid as renewable energy grows
**Estimated Additional Budget**: $7 billion (from PPP)
**Use of Funds**:

- Build or expand combined cycle gas power plants with efficiency rates exceeding 60%
- Upgrade natural gas distribution infrastructure for energy security
- Dual-use plants: Allowing some plants to switch between natural gas and renewable hydrogen in the future

**40-50%**

Of Egypt's total energy generation

### CCUS Investment:

**Objective**: Capture carbon emissions from natural gas power plants and other heavy industries
**Estimated Additional Budget**: $3-5 billion (from PPP)
**Use of Funds**:

- Install carbon capture units at large-scale gas plants and industrial sites.
- Develop carbon transportation infrastructure (pipelines) to carry captured CO2 to storage sites.
- Invest in research and development to improve CCUS efficiency and reduce costs.

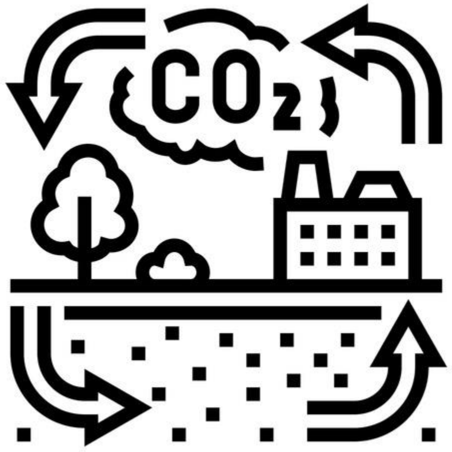
**90%**

Of Egypt's CO2 emissions reduced (10M tons of CO2 annually)

Sources: Public-Private Partnership Handbook, Global Gas Outlook, World Energy Investment, Energy.gov, Congressional Budget Office, IEA

# Carbon Capture, Utilization & Storage (CCUS) – $3-5B Allocation

Egypt can curb emissions from fossil fuels via CCUS; provides cleaner baseload energy that supplements renewables



## Case Study – Unlocking CCUS in Ultra Deep Saline Aquifers in Western Desert of Egypt

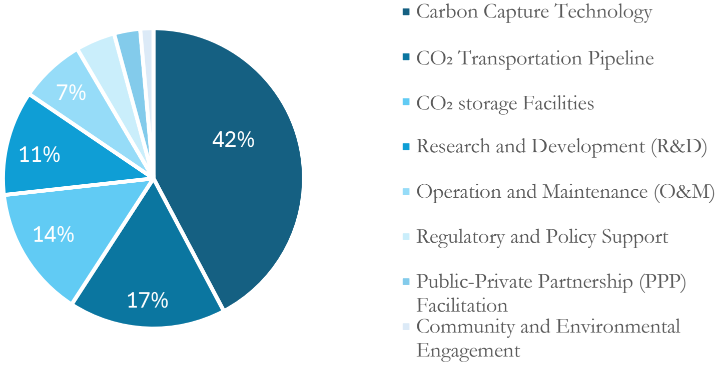
The following experiment designed by Egypt's Cherion Oil & Gas Company provides early leads for domestic CCUS

1. **Objective:** The study explores carbon capture and sequestration (CCS) in ultra-deep saline aquifers in Egypt's Western Desert to store CO2 emissions from gas processing facilities.
2. **Challenges:** The target reservoirs are deeper than 3 km, with high pressure and salinity, posing difficulties for typical CO2 trapping mechanisms.
3. **Approach:** The process involves site selection, dynamic simulation, and coupling with geomechanical models to evaluate CO2 storage feasibility and integrity.
4. **Phases:** Conducted in three phases—site screening, reservoir feasibility assessment, and site feasibility evaluation (including surface facilities and geomechanics).
5. **Site Selection:** Sites are ranked based on geological criteria, such as reservoir structure, depth, and proximity to faults, with some selected for detailed feasibility studies.
6. **Simulation Results:** Injection scenarios showed varied CO2 containment success, with high salinity and relative permeability significantly affecting plume spread.
7. **Recommendations:** Managed sequential injection, starting from the formation's bottom, can enhance CO2 trapping, paving the way for future CCS projects in similar environments.

## CCUS will make Egypt's existing energy sources cleaner

- **Decarbonizing Natural Gas:** Since natural gas is a major part of Egypt's energy mix, CCUS can help decarbonize gas-fired power plants by capturing emissions before they are released into the atmosphere.
- **Enabling Cleaner Energy Transition:** CCUS supports the transition to renewable energy by addressing emissions from existing fossil fuel infrastructure, providing a bridge to a low-carbon economy.
- **Reducing Air Pollution:** By lowering CO2 and other pollutant emissions from industrial sources, CCUS can improve air quality, benefiting public health and the environment.

## Budget Allocation




Sources: SLB, NationalGrid, IEA, ScienceDirect, Clean Air Task Force

# Economic Gain –$108.14B Gain for Government & Individuals

## 1 Revenue from Renewable Energy Exports and Carbon Credits

- With increasing renewable capacity, **Egypt can export excess electricity**, especially to neighboring countries in Europe, the Middle East, and Africa, via interconnected grids.
  - 5% exportable energy: ~3,615 GWh annually.
  - At a regional average electricity export price of $0.06 per kWh, this would **generate around $217 million annually in export revenue**.
- Egypt could also monetize carbon credits from reducing CO2 emissions as it transitions away from fossil fuels. The international carbon market values these reductions.

**$12.17B+**

(Earned on Exports + Carbon Credits)

## 2 Cost Savings from Reduced Fossil Fuel Imports and Subsidies

- Energy Displacement: By 2034, the **new renewable capacity** of 23.1 GW **will displace** the need for **natural gas** to generate approximately 72,300 GWh annually.
  - At a global average price of $0.20 per cubic meter of natural gas, this equates to **$2.89 billion in savings annually** on natural gas imports.
- Subsidy Reduction: Egypt could cut subsidies by 20% by reducing its dependence on fossil fuels.
  - Current fossil fuel subsidies are estimated at **$4-5 billion annually**. A 20% reduction would save about $1 billion annually in subsidies.

**$38.9B+**

(Saved on Fossil Fuels + Subsidies)

## 3 Economic Impact through Job Creation and Local Economic Growth

- Income Impact: Assuming each renewable energy job generates an average salary of **$6,000 annually for lower-skilled workers** and **$15,000 annually for skilled workers**, the total wage impact is significant
- The presence of renewable energy infrastructure will stimulate local economies through **increased spending, infrastructure development, and improved energy access**. This economic stimulation will:
  - **Increase GDP by an estimated $2-4 billion annually** by boosting local businesses, retail, and services in areas with new energy infrastructure.

**$20-40B+**

(Earned by Jobs and Economic Growth)

## 4 Consumer Savings from Lower Energy Costs and Net Metering

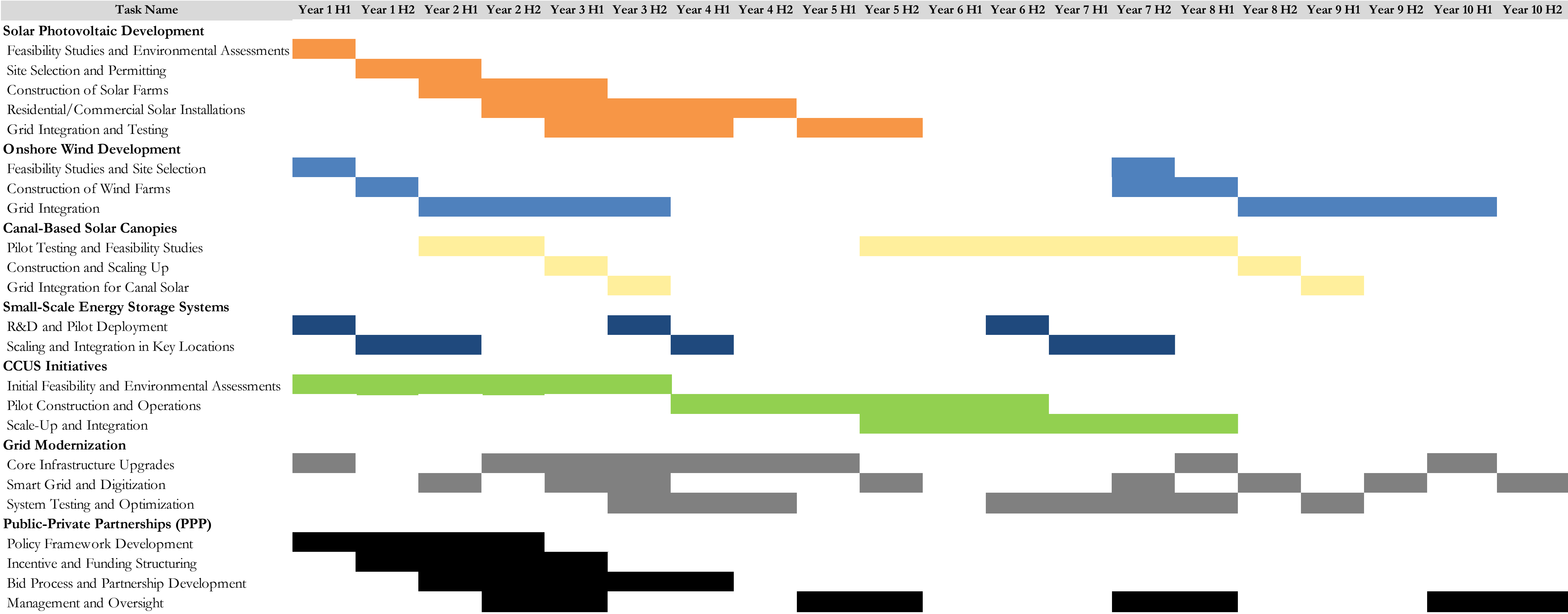
- Household Energy Savings: On average, solar energy can reduce household electricity bills by 50-70%. For a household consuming 400 kWh per month, **monthly savings would range from $20-$28** (at an average electricity cost of $0.10 per kWh).
  - Annually, this results in savings of **$240-$336 per household**.
- Income from Excess Generation: If 3 GW of rooftop solar is installed, and 10% of the energy generated is sold back to the grid (~450 GWh annually), **consumers could earn $27 million annually** (at $0.06 per kWh).

**$17.07B+**

(Saved/Earned on Lower Energy Costs and Net Metering)

Sources: ISPI, GGGI, SolarReviews, Sunwatts, IEA, IRENA, EIA, MPED, Arab Development Portal

# Implementation Timeline




- Immediate start to all initiatives – feasibility, pilot and environmental tests
- Funds kept for regular upgrades/maintenance/change to new technologies
- Grid Modernization and PPP monitoring spread throughout the 10-years
- Two rounds of deployment kept for technologies to allow for commercial testing and optimization

# Diversification

Building a sustainable development plan for Egypt – while improving quality of life

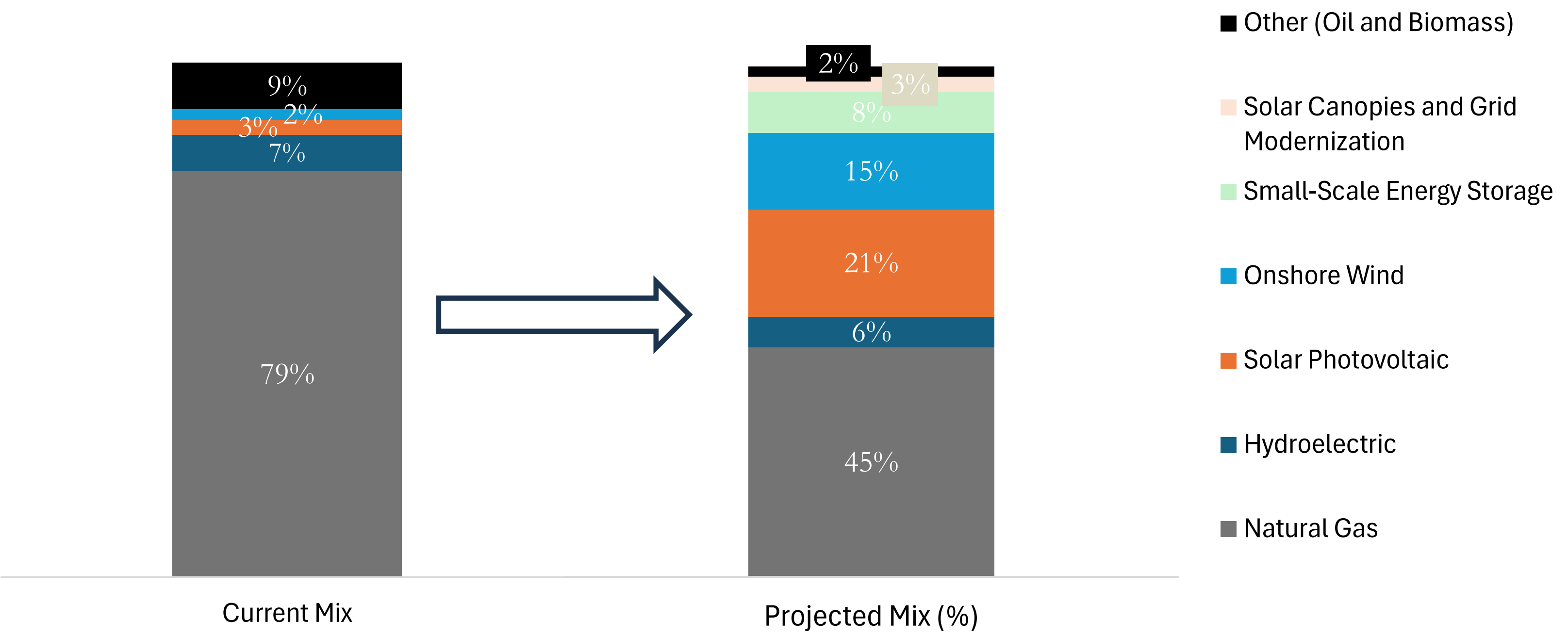
**Key Outcomes:**

•**Diversification**: Natural gas's share drops from 75% to 40-50%, with solar and wind significantly increasing their shares.

•**Increased Renewable Generation**: Solar and wind contribute up to 40% of the total energy mix, marking a shift towards cleaner energy sources.

•**Grid Stability**: Energy storage systems support grid reliability, essential for integrating variable renewable sources like solar and wind.

•**Reduced Carbon Emissions**: The combined impact of increased renewables and CCUS technology on natural gas plants lowers Egypt's carbon footprint.




10% 7%
Transmission Losses

2h <.5h
Average Outage Time (hours/day)

87% 98%
Energy Access (% of population)

11% 40%
Renewable Energy Share

~209,100
Jobs Created

Sources: IEA, Sustainable Development, Newarab, Egypt Today, Reuters, World Bank

# Environmental & Social Impact

Our plan takes careful measures to prioritize environmental and social outcomes

**Sustainability:**

- Emphasizing renewable resources like **solar and wind** positions Egypt toward long-term environmental sustainability
- By targeting areas with high solar irradiance and wind potential **maximizes natural resource** use, **reducing dependence on fossil fuels** and lowering carbon emissions
- Provisions for ongoing innovation in energy storage and **grid efficiency** ensure that renewable energy sources remain viable

**Public Health:**

- Transitioning away from fossil fuels and significantly reducing air pollution and greenhouse gas emissions **mitigates respiratory and cardiovascular health issues**
- Improvements in air quality reduces exposure to harmful pollutants, particularly **benefiting populations in urban areas where pollution levels are high**
- Focus on energy access in rural areas provides reliable electricity for health facilities, ensuring consistent **refrigeration for vaccines and power for medical equipment**

ESG

**Affordability:**

- Cost-effective renewable resources, decentralized systems, and strategic public-private partnerships
- Focus on micro-grids and community-owned solar projects **minimizes the need for extensive infrastructure**, bringing down costs in underserved regions
- Leveraging international green financing and grants allows for **lower upfront expenses**, making clean energy accessible to low-income communities
- **Reducing reliance on imported energy** and focusing on domestic renewable production provides a stable energy supply

**Cultural Sensitivity:**

- Community engagement and local input throughout the implementation process **respect Egypt's diverse cultural landscape**
- By focusing on rural and semi-urban areas and providing decentralized, community-managed energy systems, the plan **empowers local communities**
- **Integrating local leaders** into the planning and implementation phases ensures that projects align with regional needs and cultural practices

Sources: IEA, Scaling with Growth

# Impact Analysis – Surrounding Countries

Egypt's neighboring countries **benefiting from Egypt's progress**


1. Libya
   - **Cross-Border Electricity Exports**: Libya could import electricity to support its grid, which has been weakened by conflict. This can provide stable power and reduce oil reliance.
   - **Knowledge Transfer for Renewables**: Egypt's expertise in solar technology and public-private partnership models could benefit Libya as it seeks to expand its own renewable sector.
2. Sudan
   - **Increased Power Imports**: Power can be supplied to Sudan, which would enhance Sudan's energy security, benefiting its agriculture and industry.
   - **Water Resource Management**: The solar canopy technology over canals in Egypt could serve as a model for Sudan, helping it conserve water in agricultural areas.
3. Saudi Arabia
   - **Enhanced Renewable Energy Trade**: Saudi Arabia's "Vision 2030" plan includes ambitious renewable energy goals. Partnering with Egypt could support both countries' energy transitions, potentially leading to cross-border renewable energy trade.
   - **CCUS Technology Collaboration**: With Egypt investing CCUS, both countries could collaborate on carbon management, an area important for Saudi Arabia's oil and gas industry.
4. Israel
   - **Cross-Border Grid Stability and Energy Exchange**: Israel and Egypt are connected via gas pipelines, and enhancing this relationship through renewable electricity exports could support Israel's energy stability. Excess renewable energy from Egypt could reduce Israel's natural gas demand during peak solar production.
   - **Joint Innovation and Technology Development**: Israel has a highly developed technology sector, and partnering on renewable energy innovations (such as battery storage and grid management) could boost both countries' R&D and commercialize new solutions applicable across the Middle East.
5. Syria
   - **Potential for Electricity Imports**: Egypt's renewable energy projects could provide cost-effective electricity
   - **Reduced Regional Reliance on Oil**
6. Jordan
   - **Energy Import Reduction**: Jordan could access cleaner and cheaper power from Egypt's solar and wind sources.
   - **Joint Solar Projects**
   - **Desalination and Water-Energy Nexus**: Jordan faces severe water scarcity, and Egypt's innovations in solar and water management could support desalination projects in Jordan

Sources: EnergyNews, UNDP, U.S Department of State, IRENA, International Trade Administration

# Impact Analysis –Paired Countries

## Feasibility of proposed energy plan in **Turkey**

### Pros of Implementing the 10-Year Plan in Turkey

**1.Diversified Energy Mix**

1. **Pro**: Expanding renewable sources (solar, wind) would reduce Turkey's heavy reliance on natural gas and coal, enhancing energy security and reducing exposure to volatile fossil fuel prices.
2. **Pro**: Increased renewables would help Turkey meet EU standards, supporting Turkey's goal of joining the EU and aligning with **EU Green Deal** goals.

**2.Energy Independence**

1. **Pro**: By developing domestic renewable resources, Turkey could reduce its reliance on imported natural gas (currently 99% imported), lowering energy costs and trade deficits.

**3.Economic and Employment Growth**

1. **Pro**: Renewables and grid modernization projects would create local jobs in construction, technology, and maintenance sectors. The plan would stimulate Turkey's economy, especially in renewable technology production and installation.

**4.Enhanced Grid Stability and Reliability**

1. **Pro**: Upgrading Turkey's grid and adding storage would improve resilience against power outages and support efficient integration of intermittent energy sources (wind, solar), benefiting both urban and rural areas.

**5.Environmental and Health Benefits**

1. **Pro**: Reducing fossil fuel dependence with renewables and CCUS (Carbon Capture, Utilization, and Storage) would decrease emissions, improve air quality, and help Turkey reach its **2030 emission reduction targets** under the Paris Agreement.

### Cons of Implementing the 10-Year Plan in Turkey

**1.Economic Constraints and Inflationary Pressures**

1. **Turkey's Current Economic Situation**: Turkey faces high inflation and economic volatility, which can strain both government budgets and private sector willingness to invest in long-term infrastructure projects. High borrowing costs and limited fiscal flexibility could make it challenging for Turkey to fund large-scale renewables and grid upgrades without placing pressure on the economy.

**2.Land Use Conflicts**

1. **Competing Land Needs**: Unlike Egypt's vast desert areas, Turkey has limited undeveloped land suitable for large-scale solar and wind farms. Agricultural regions like **Konya** or **Adana** could be ideal for solar but are vital for food production, creating potential conflicts between energy and agriculture needs. Similarly, wind projects in **Aegean coastal regions** could face challenges from local resistance due to tourism and residential concerns..

**3.Upfront Costs for Grid Modernization and Energy Storage**

1. **Newer Infrastructure**: Turkey's grid is more developed than Egypt's, integrating high levels of intermittent renewables would require changes to a newer version

**4.Uncertain Investment Environment**

1. **Challenges in Attracting Private Sector Investment**: Turkey has a mixed track record with public-private partnerships (PPPs), and attracting consistent investment can be challenging due to concerns over regulatory stability. High inflation and currency fluctuations create risks for foreign investors, which could affect Turkey's ability to finance large-scale renewable projects on favorable terms.

Sources: IEA, Carnegie Endowment for International Peace, World Bank, U.S Department of State

# Appendix

# Jobs Justification

**1. Solar PV Jobs**
Solar projects typically create the most jobs per megawatt (MW) due to the labor-intensive nature of panel installation, maintenance, and related infrastructure work.
- **Utility-Scale Solar Farms**: Utility-scale solar projects create about **5-7 direct jobs per MW** during construction, and around **0.2-0.4 jobs per MW** for operations and maintenance.
  - For 14.4 GW (14,400 MW) of utility-scale solar farms, this would translate into:
    - **Construction Jobs**: 72,000 – 100,800 temporary jobs during construction.
    - **Ongoing O&M Jobs**: 2,880 – 5,760 permanent jobs for operations and maintenance.
- **Rooftop Solar (Residential/Commercial)**: Rooftop installations generate about **15 jobs per MW** for installation and around **0.3-0.5 jobs per MW** for maintenance.
  - For 3 GW (3,000 MW) of rooftop solar, this would generate:
    - **Installation Jobs**: 45,000 jobs during installation.
    - **Ongoing O&M Jobs**: 900 – 1,500 permanent jobs.

**2. Onshore Wind Power Jobs**
Onshore wind projects tend to have lower job intensity than solar but still offer substantial employment during construction and ongoing operations.
- Wind farms typically create about **3-5 jobs per MW** during construction and **0.2 jobs per MW** for maintenance and operations.
  - For 5.7 GW (5,700 MW) of onshore wind:
    - **Construction Jobs**: 17,100 – 28,500 jobs.
    - **Ongoing O&M Jobs**: 1,140 permanent jobs.

**3. Micro-Hydro Jobs**
Micro-hydro projects, although smaller in scale, require considerable labor for installation and ongoing technical support.
- Micro-hydro typically generates around **7-10 jobs per MW** during installation and **0.5 jobs per MW** for maintenance.
  - For 1 GW (1,000 MW) of micro-hydro systems:
    - **Installation Jobs**: 7,000 – 10,000 jobs.
    - **Ongoing O&M Jobs**: 500 permanent jobs.

**4. Grid Modernization and Energy Storage Jobs**
The modernization of Egypt's grid and the deployment of energy storage systems will also create jobs. Typically, this creates about **1 job per MW** of new renewable energy integrated for installation and maintenance.
- For approximately 17 GW of new renewable capacity (solar, wind, and hydro), this would generate:
  - **Grid Modernization and Storage Jobs**: 17,000 jobs for grid integration and energy storage installation.

**Total Job Creation Estimate**
Combining these categories, we get the following estimate:
- **Construction Jobs**:
  - Solar (Utility + Rooftop): 117,000 – 145,800 jobs.
  - Wind: 17,100 – 28,500 jobs.
  - Micro-Hydro: 7,000 – 10,000 jobs.
  - Grid Modernization: 17,000 jobs.

**Total Construction Jobs**: 158,100 – 201,300 jobs (over 10 years).
- **Permanent O&M Jobs**:
  - Solar (Utility + Rooftop): 3,780 – 7,260 jobs.
  - Wind: 1,140 jobs.
  - Micro-Hydro: 500 jobs.

**Total Ongoing O&M Jobs**: 5,420 – 8,900 permanent jobs.

**Conclusion**
Over the 10-year period, the plan could create **approximately 158,100 – 201,300 construction jobs** and **5,420 – 8,900 permanent jobs** in operations and maintenance, contributing significantly to job creation in Egypt's renewable energy sector. These jobs will span across rural and urban areas, benefiting various segments of the population and driving economic growth.

# Location Choices

## Micro-Hydro Systems:

| Location | Population | Population in Energy Poverty | Current Avg Power (kWh/capita) | Target Daily Power (kWh/capita) | Proximity to Nile (km) |
|---|---|---|---|---|---|
| Aswan | 1500000 | 500000 | 3 | 6 | 0 |
| Upper Egypt | 12000000 | 5000000 | 1.5 | 5 | 50 |

## Solar:

| Location | Population | Population in Energy Poverty | Current Avg Power (kWh/capita) | Target Daily Power (kWh/capita) | Sunlight Hours |
|---|---|---|---|---|---|
| Western Desert | 3500000 | 1200000 | 1.5 | 5 | 10 |
| Gulf of Suez | 600000 | 300000 | 2.5 | 6 | 11 |
| Nile Delta | 40000000 | 12000000 | 1.8 | 4.5 | 8.5 |

## Wind:

| Location | Population | Population in Energy Poverty | Current Avg Power (kWh/capita) | Target Daily Power (kWh/capita) | Average Wind Speed (m/s) |
|---|---|---|---|---|---|
| Gulf of Suez | 600000 | 300000 | 2.5 | 6 | 8.5 |
| Red Sea | 1200000 | 500000 | 2.2 | 5.5 | 7.5 |
| Sinai | 1500000 | 700000 | 1.8 | 5 | 6.8 |

## Storage:

| Location | Population | Population in Energy Poverty | Current Avg Power (kWh/capita) | Target Daily Power (kWh/capita) | Storage Capacity (MWh) |
|---|---|---|---|---|---|
| Western Desert | 1500000 | 500000 | 2 | 5 | 100 |
| Upper Nile | 10000000 | 4000000 | 1.8 | 4.5 | 200 |

## Canopies:

| Location | Population | Population in Energy Poverty | Current Avg Power (kWh/capita) | Target Daily Power (kWh/capita) | Water Savings (m3/year) |
|---|---|---|---|---|---|
| Nile Delta | 40000000 | 12000000 | 1.8 | 4.5 | 1000000 |
| Faiyum | 3000000 | 1000000 | 1.6 | 4 | 800000 |
| Upper Egypt | 12000000 | 5000000 | 1.5 | 5 | 600000 |

## Grid Modernization:

| Location | Population | Population in Energy Poverty | Current Avg Power (kWh/capita) | Target Daily Power (kWh/capita) | Loss Reduction (%) |
|---|---|---|---|---|---|
| Western Desert | 3500000 | 1200000 | 1.5 | 5 | 20 |
| Gulf of Suez | 600000 | 300000 | 2.5 | 6 | 15 |
| Cairo | 20000000 | 6000000 | 3 | 8 | 25 |
| Nile Delta | 40000000 | 12000000 | 1.8 | 4.5 | 18 |

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