KAHRAMAA كهرماء
المؤسسة العامة القطرية للكهرباء والماء
Qatar General Electricity & Water Corporation

استراتيجية قطر الوطنية للطاقة المتجددة

Qatar National Renewable Energy Strategy

Contents

LIST OF ABBREVIATIONS

BESS	Battery Energy Storage System
CCUS	Carbon Capture Utilization and Storage
CO2	Carbon Dioxide
CCGT	Combined Cycle Gas Turbine
CS	Customer Service Department of KAHRAMAA
CSP	Concentrated Solar Power
DG	Distributed Generation
DLR	Dynamic Line Rating
ENA	Electricity Networks Affairs, a directorate within KAHRAMAA
EP	Electricity Planning, a department within KAHRAMAA
EPC	Engineering, Procurement and Construction
ES	Electricity Systems, a department within KAHRAMAA
GW	Gigawatts
GHI	Global Horizontal Irradiance
GHG	Greenhouse gas
GDP	Gross Domestic Product
GCC	Gulf Cooperation Council
GCCIA	Gulf Cooperation Council Interconnection Authority
HR	Human Resources Department of KAHRAMAA
IPP	Independent Power Producer
I-REC	International Renewable Energy Certificates
IRR	Internal Rates of Return
IT	Information Technology
KPI	Key Performance Indicators
kW	Kilowatt
kWh	Kilowatt-hour
LCOE	Levelized cost of energy
LNG	Liquefied natural gas

LIST OF ABBREVIATIONS

LOLE	Loss of Load Expectation
LOLP	Loss of Load Probability
MW	Megawatt
MWh	Megawatt-hour
NDC	National Determined Contribution
NDS	National Development Strategy
OCGT	Open Cycle Gas Turbine (also known as simple cycle)
O&M	Operations & Maintenance
PR	Public Relations Department within KAHRAMAA
PV	Photovoltaic
PSS	Power System Stabilizers
PSSE	Power System Simulation for Engineering
PLI	Production-Linked Incentives
PPP	GDP per Capita based on Purchasing Power Parity
PQ	Planning and Quality, a department within KAHRAMAA
PW	Planning and Development of Production and Water Resources, a department within KAHRAMAA
PWP	Production Planning and Purchase Section within KAHRAMAA's PW Department
RE	Renewable Energy
QDB	Qatar Development Bank
QEWC	Qatar Electricity & Water Company
QEERI	Qatar Environment and Energy Research Institute
QNRES	Qatar National Renewable Energy Strategy
REC	Renewable Energy Certificate
RDI	Research, Development, and Innovation
SINCAL	Siemens Network Calculation
tCO2	Tons of Carbon Dioxide
TRL	Technology Readiness Level
TW	Terawatt

LIST OF ABBREVIATIONS

TWh	Terawatt-hour
T&D	Transmission & Distribution
VRE	Variable Renewable Energy
WOQOD	Qatar Fuel Company

INTRODUCTION

1 Introduction

Qatar is a country of 11,581 km2 that is located on the north-eastern coast of the Arabian Peninsula in the Middle East. In early 2023, the total population of Qatar was 2.96 million, with 0.33 million Qatari citizens and 2.63 million expatriates. In terms of income, the country has ~80,000 USD of GDP per capita, the ninth highest in the world and the fifth highest in PPP terms.

Qatar is one of the world's largest exporters of liquefied natural gas (LNG). The country is endowed with large natural gas resources that can be produced at relatively low cost. The hydrocarbon sector has been the key contributor to the socio-economic growth of the country, representing 44% of the national gross domestic product of USD 237 Billion in 2022.

To drive the diversification of its economy while ensuring environmental sustainability, Qatar developed its 2nd National Development Strategy (NDS) that focuses on the following:

- Promote human development through a comprehensive and integrated healthcare system, quality education and training, and an efficient and committed workforce
- Establish a sound society through social protection, public security and safety, cultural enrichment, and sports excellence
- Sustain economic prosperity through economic infrastructure development, economic diversification and private sector development, and management of natural resources
- Achieve sustainable development that preserves the environment

As Qatar seeks to increase its use of renewable energy, it is important to consider the many benefits that the combination of renewable energy with highly efficient gas-fired dispatchable generation can provide. Currently, Qatar's power mix is mostly dominated by thermal capacity, but achieving an optimal share renewable energy is central in supporting the country as it works to deliver on its 2nd NDS goals.

These goals involve developing a sustainable and high-quality renewable energy infrastructure, optimizing, and sustaining Qatar's natural resources, and sustaining the environment for future generations. Renewable energy is also crucial for Qatar to meet its National Determined Contribution (NDC) commitment and Qatar National Strategy for Environment and Climate Change ambitions, which aim to reduce the country's greenhouse gas emissions by 25% by the year 2030, relative to the baseline scenario (business as usual).

The benefits of renewable energy are manifold. It can meet growing electricity demand at very competitive generation costs, while also displacing hydrocarbons used in desalination, power, and industrial sectors, and increasing export opportunities. In addition, renewable energy can reduce CO_2 emissions and limit pollution while promoting sustainable development.

Qatar's Vision for Renewable Energy aims to enable the development of a sustainable and affordable energy system. The QNRES is a comprehensive report outlining the country's renewable energy strategy and action plan.

The strategy's targets and initiatives have been integrated within the broader framework of Qatar's upcoming 3rd NDS. By increasing its use of renewable energy, Qatar can improve its environmental sustainability, reduce its greenhouse gas emissions, and build a robust renewable energy sector that will benefit its citizens and future generations.

EXECUTIVE SUMMARY

2 Executive Summary

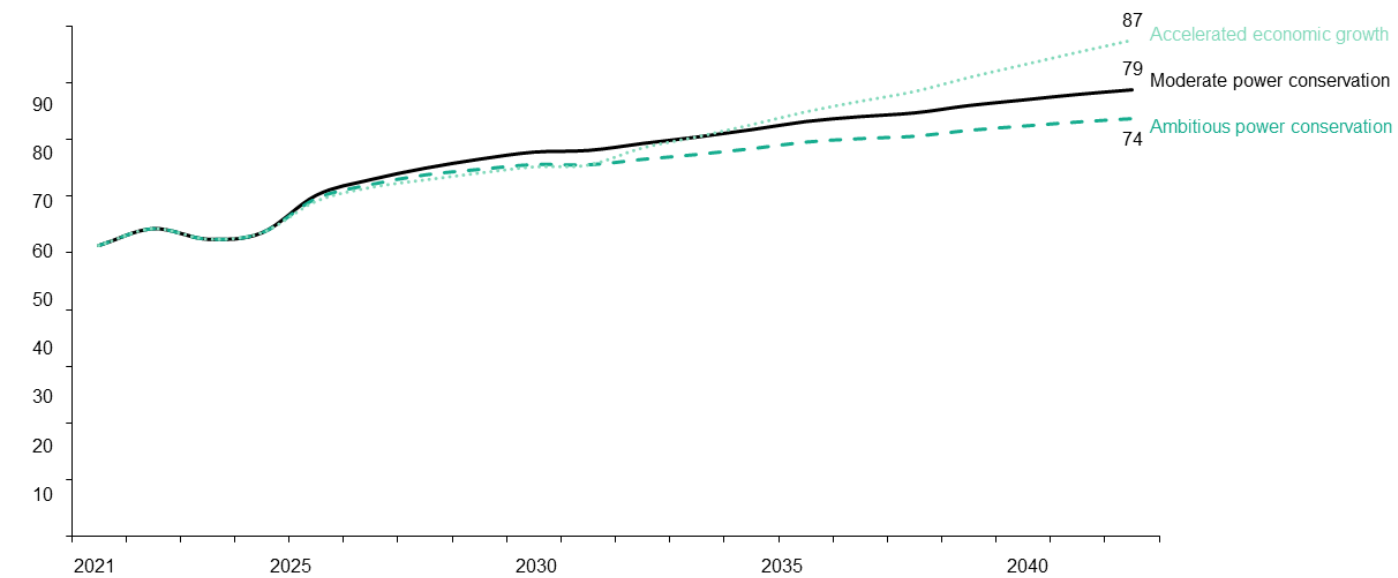
The Qatar National Renewable Energy Strategy (QNRES) seeks to ensure a sustainable transition in the nation's energy sector.

« The strategy aims to increase the use of renewable electricity, alongside low-cost natural gas-fired electricity generation to improve the quality of life for present and future generations.»

Emphasizing both economic development and environmental protection, the QNRES aligns with Qatar's commitment to a greener and more prosperous future.

Demand for electricity in Qatar is expected to rise significantly in the coming years driven by economic growth and demographic shifts. According to QNRES projections, the demand will increase from about 51 terawatt-hours (TWh) in 2021 to approximately 80 TWh in 2040. This substantial increase in electricity demand highlights the need for a sustainable and reliable energy infrastructure that can meet the growing needs of the nation.

Figure 1: Electrical energy demand growth forecast (TWh)



Currently, thermal electricity generating stations account for more than 90% of Qatar's total capacity. To meet future demand and reduce carbon dioxide (CO_2) emissions, Qatar plans to expand its use of renewable energy, particularly solar photovoltaic (PV) power. As the aging thermal stations are retired over the next decade, a combination of new renewable energy projects and high-efficiency thermal generation fuelled by natural gas will replace them.

Renewable energy has emerged as a competitive complement to traditional hydrocarbon-fuelled power plants. It plays a critical role in Qatar's pursuit of its goals outlined in the 2nd National Development Strategy (NDS). A comprehensive analysis conducted through a least-cost simulation engine developed specifically for the QNRES has revealed that Qatar should target to deploy a utility-scale renewable energy capacity of about 4 GW by 2030, with a primary focus on solar PV technology:

- This ambitious goal aims to increase renewable energy's share in the power mix from its current 5% to 18% by 2030
- The share of combined-cycle gas turbine (CCGT) thermal generation is expected to decrease from the current 80% share to 72% by 2030
- Open cycle gas turbines (OCGT) would decrease from 4% to 3% in the same timeframe
- The remaining 10% share of the power mix in 2030 will include the interconnection capacity, small-scale conventional, and small-scale renewables

In addition to increasing the penetration of large-scale renewables, Qatar is also encouraged to boost the deployment of distributed generation capacity. By 2030, the strategy recommends the installation of up to around 200 MW of distributed solar generation. This distributed generation capacity will enable more localized power generation, reducing strain on the centralized grid infrastructure and enhancing energy resilience.

Figure 2: Electricity supply demand balance (GW)

		2021	2030
	Demand	9.6	11.5
Conventional supply	**CCGT**	10.6	11.7
Conventional supply	**OCGT**	1.56	0
Conventional supply	**Small scale**	-	0.3
Conventional supply	**Imports interconnection**	1.2	1.2
Renewable supply	**Solar PV**	0.8	4
Renewable supply	**Small scale RE**	-	0.2

Note 1: These targets represent the most economical solutions, but further technical grid studies are needed.

Note 2: Reserve margin of 15% considered after 2030;

Note 3: Small scale RE covers residential, commercial, industrial, agriculture, & government sectors.

Note 4: Batteries are not considered as generators in RE share calculation

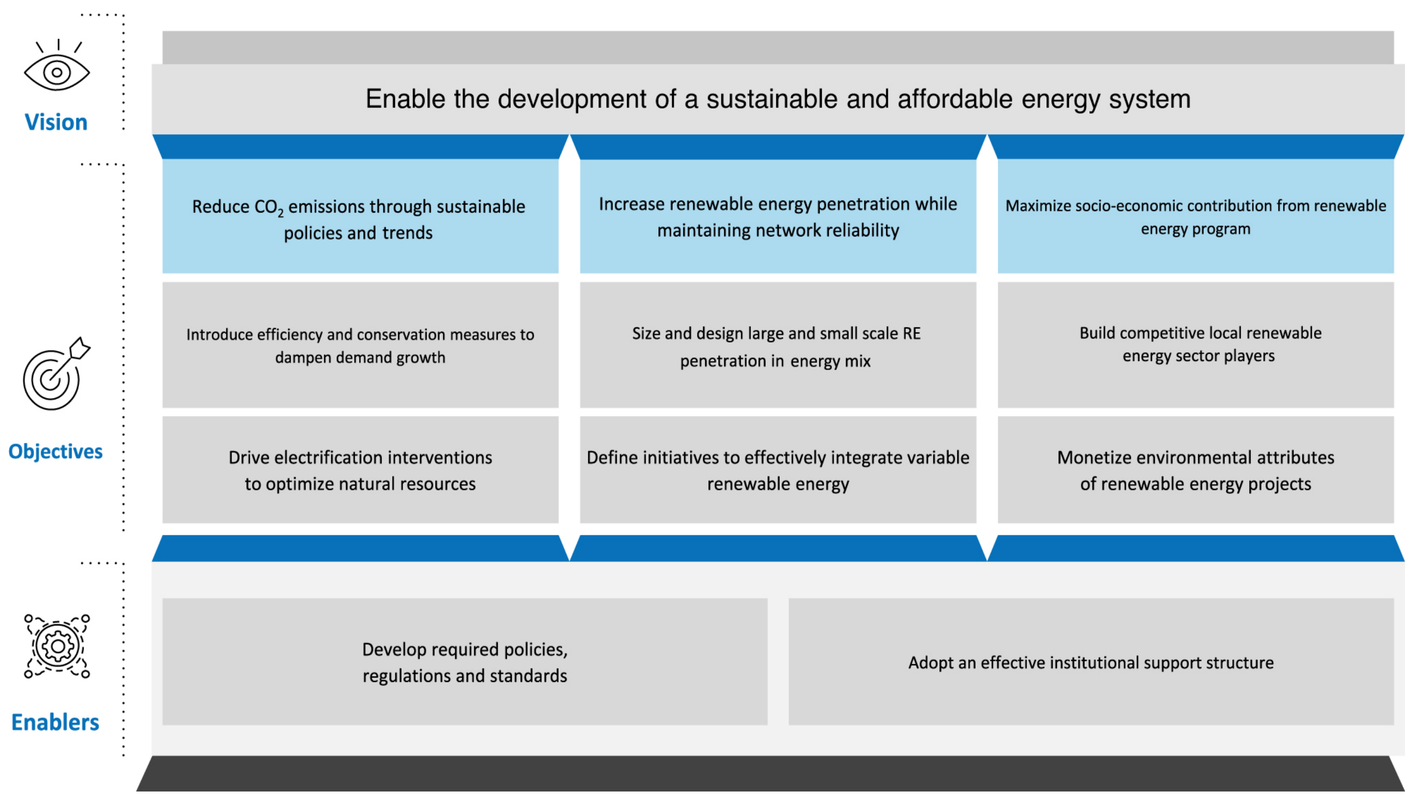
To achieve the renewable energy targets, the strategy identifies the need for substantial investment. The capital expenditure (CAPEX) required to be spent by 2030 is estimated to amount to 7.6 billion USD. These investments signify the long-term commitment required to support the development and integration of renewable energy infrastructure. Qatar has already taken key steps towards decarbonization by developing two solar PV power plants: Siraj-1 solar project at Al Kharsaa, operational since late 2022, and the QatarEnergy facility, currently under development.
Qatar benefits from high levels of Global Horizontal Irradiance (GHI), making it conducive for solar PV power generation.

Recognizing the dynamic nature of the energy sector, the QNRES highlights the importance of regularly revising power mix targets. It recommends that power mix targets be revised every three years to account for changes in estimated electricity demand and technology costs. This iterative approach ensures that the strategy remains aligned with evolving circumstances and maximizes the effectiveness of the transition to a sustainable energy future.

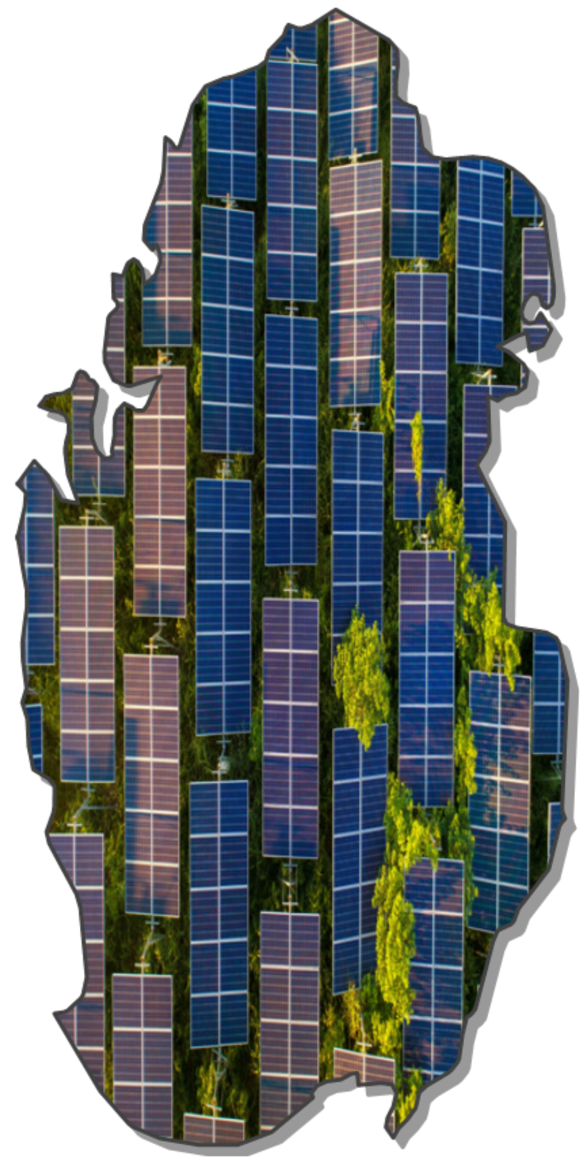
The QNRES focuses on three primary objectives:

- Reducing CO2 emissions through sustainable policies and trends, which will enhance environmental sustainability and contribute to improving air quality
- Increasing the penetration of renewable energy while maintaining network reliability, and
- Maximizing the socio-economic contribution from renewable energy.

Figure 3: Qatar National Renewable Energy Strategy (QNRES)



The QNRES aims to develop an affordable and sustainable energy system by harnessing Qatar's abundant natural gas resources and renewable energy potential. Increasing reliance on renewable electricity generation offers three major benefits:



Economic advantages

Renewable technologies offer cost-competitive solutions, leading to economic benefits. The recommended power mix, as outlined in the QNRES, is expected to reduce the average cost of electricity generation by 15% by 2030.

Environmental impact

By reducing greenhouse gas emissions, renewable energy contributes to improving the environment. The recommended power mix, as outlined in the QNRES, is projected to lead to a 27% reduction in CO2 emissions intensity by 2030 compared to the levels in 2021.

Energy security

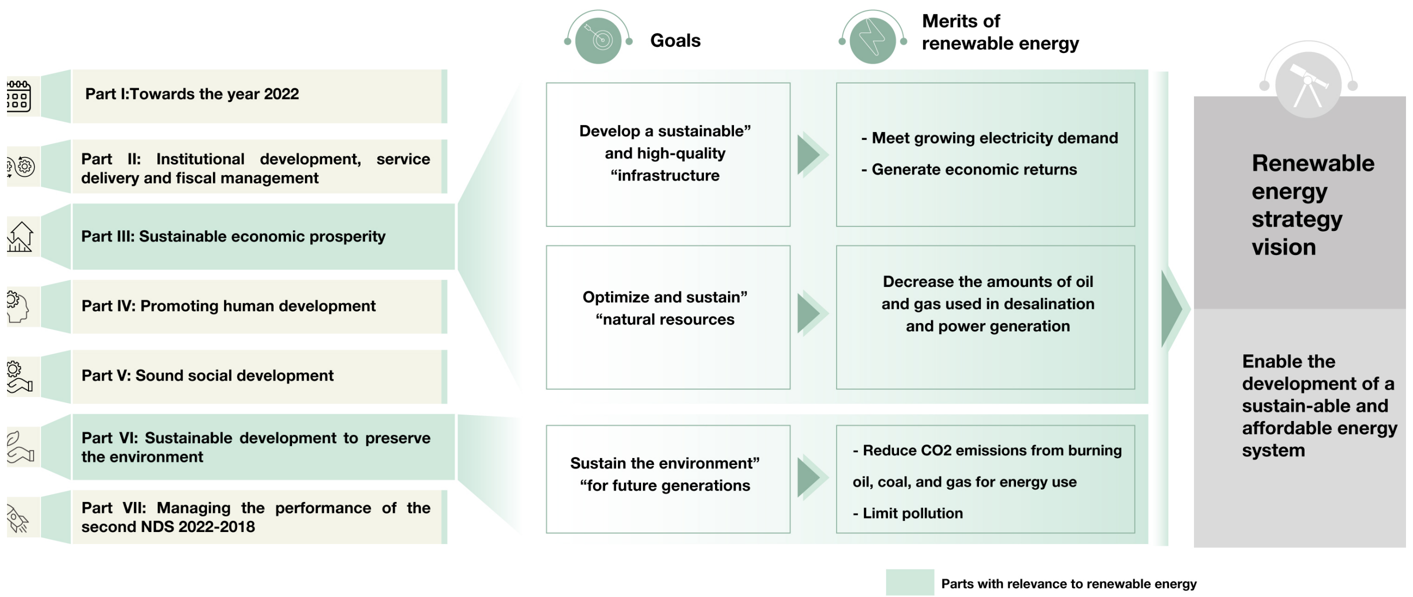
Diversifying the generation sources promotes energy security, enhancing stability in the energy sector. The QNRES recognizes the importance of ensuring that the transition to renewable energy does not compromise the reliability and resilience of the electricity system. To achieve this, the strategy uses a balanced approach that combines large-scale renewable energy installations with the use of high-efficiency thermal generation powered by natural gas.

An implementation budget of QAR 66 Mn has been estimated to put in place the required policy, regulatory, and institutional enablement in the years 2023-2025, and an implementation governance structure has been defined, assigning responsibilities to specific areas within KAHRAMAA and to relevant stakeholders beyond KAHRAMAA. Additionally, action plan initiative charters were drafted to track progress and ensure accountability for the fulfilment of the QNRES objectives.

BACKGROUND

3.1 Qatar 2nd National Development Strategy goals

Figure 4: Qatar second national development strategy goals



Renewable energy is of utmost importance for Qatar to achieve the goals outlined in the 2nd NDS. The 2nd NDS "Sustainable Economic Prosperity" goal identified two crucial goals: 1) the development of a high-quality and sustainable infrastructure and 2) the optimization and sustainable use of natural resources. Renewable energy is instrumental in helping Qatar achieve both goals, as it effectively meets the increasing demand for electricity, brings economic returns, and minimizes the usage of valuable gas resources in domestic power generation and desalination.

The 2nd NDS emphasized "Sustainable Development", which aims to preserve the environment for future generations. The adoption of renewable energy would help Qatar meet this goal by reducing carbon emissions and limiting pollution, promoting sustainable practices, and leaving a healthy environment for generations to come. The integration of renewable sources of energy will help Qatar promote a sustainable, efficient, and environmentally friendly economy that can support its citizens' well-being and aspirations while improving the quality of life and leaving a cleaner planet for future generations.

Renewable energy is also key to support Qatar in delivering on its National Determined Contribution (NDC) commitment and its National Environmental Strategy, which aims at reducing Qatar's GHG emissions by 25% by the year 2030, relative to the baseline scenario (business as usual). This will be complemented with the adoption of carbon capture technology to arrive at the optimal power mix considering Qatar's specific national circumstances and resource endowment.

The Qatar National Renewable Energy Strategy (QNRES) aims to enable the development of a sustainable and affordable energy system. The strategy's targets and initiatives will be integrated within the broader framework of Qatar's upcoming 3rd NDS.

This detailed assessment of Qatar's renewable energy ecosystem will cover four key dimensions:

Strategies and targets

- Sector strategy, targets and commitments
- Existing and ongoing initiatives to advance the RE sector

Institutional landscape and ecosystem

- Institutional setup and key sector stakeholders
- Delineation of roles and responsibilities
- Key enablers
  - Private sector
  - RE RDI
- Human capabilities

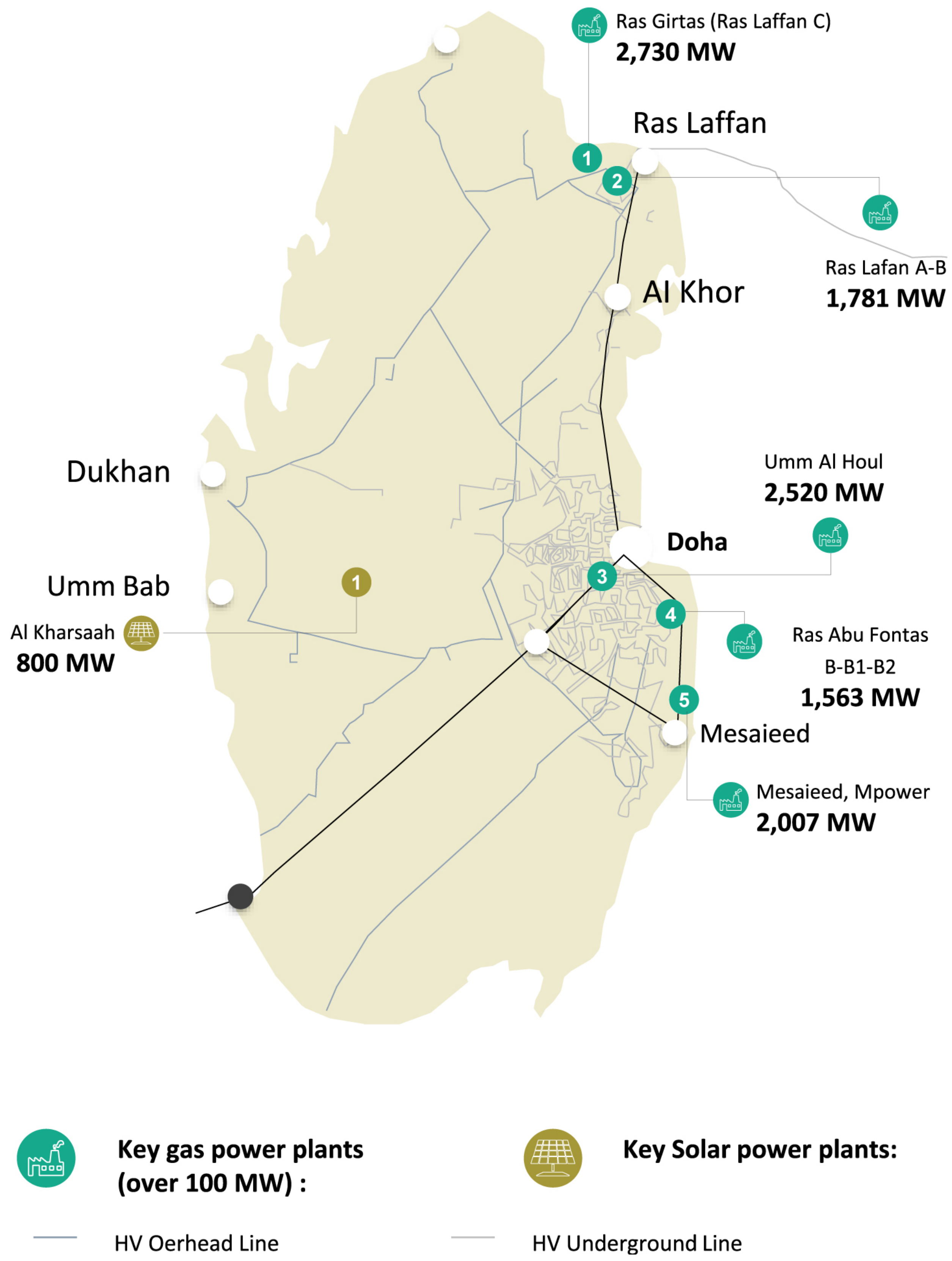
Policies and regulatory framework

- Utility scale REs regulatory and fiscal policies
  - Obtain approvals for land allocation
  - Pricing mechanisms
  - Fiscal incentives
- Small scale policy schemes

Technical and network readiness

- VRE integration challenges
- T&D planning practices
- Control center readiness
- Codes, standards, specifications, and quality control readiness for RE integration

Figure 5: Qatar's contracted electricity generation capacity (MW)



3.2 Strategy and targets

One of the critical factors to consider in the assessment of this dimension is the optimal balance of investment in renewable energy generation, dispatchable efficient gas-fired generation, energy storage systems, and Carbon Capture Utilization and Storage (CCUS) solutions.

Qatar's power mix currently is dominated by thermal electricity generation capacity that uses the nation's abundant natural gas, which can be produced at a relatively low cost.

> **«To achieve higher penetration of renewable energy at lowest cost while ensuring the highest level of electric system reliability, it is essential to leverage the flexibility of high-efficiency dispatchable gas-fired generation..»**

The adoption of CCUS technology can play a crucial role in mitigating CO2 emissions and minimizing the environmental impact of gas-fired generation.

Thermal energy plants currently have a total electricity generation capacity of about 11.3 GW, representing over 90% of Qatar's total electricity generation capacity. However, the expected commissioning of 2.2 GW of new thermal electricity generation by 2027 is an indication of the country's gradual approach for integrating renewable energy in its power mix. The recent commissioning of Siraj-1 solar project at Al Kharsaa (800 MWp DC) and the upcoming QatarEnergy (875 MWp DC) solar projects signal the country's readiness and commitment to effectively deploy utility-scale renewable energy projects.

Qatar has tremendous potential to increase its use of renewable energy sources due to the high quality of the nation's solar resource. The country's global horizontal irradiance (GHI) level is one of the highest in the world, with ten locations having a four-year average GHI rating of more than 2,000 kWh generated per square meter per year.

The adoption of renewable energy technologies in Qatar is becoming more attractive due to their decreasing levelized cost of energy (LCOE). The LCOEs generated by solar photovoltaic (PV) and wind energy have considerably decreased over the years. Solar PV LCOEs declined from approximately 4 US cents/kWh in 2017 to approximately 1.5 US cents/kWh in 2023, with an estimated further drop to approximately 1.0 US cents/kWh by 2030. Similarly, the LCOEs for wind energy decreased from around 5 US cents/kWh in 2017 to about 4.5 US cents/kWh in 2023 and anticipated to reach approximately 4.0 US cents/kWh by 2030.

Solar PV and wind energy sources have become competitive with conventional power generation at the present international gas prices. Qatar's conventional thermal capacity generation can be complemented by a share of renewable energy capacity to produce low-cost, low-emissions, reliable electrical power.

Qatar has a diverse range of renewable electricity generation resources, which includes large-scale as well as distributed PV. Presently, Qatar has over 9 MW of installed distributed solar PV across various segments, which includes around 4 MW at government customer sites, nearly 2 MW at residential sites, over 2 MW at commercial customer sites, and over 1 MW at industrial sites.

To further enhance their renewable energy plan, KAHRAMAA and the Qatar Environment and Energy Research Institute (QEERI) have taken the lead in several initiatives related to resource assessment, project piloting, and network evaluation. Both organizations support promoting and facilitating the implementation of renewable energy projects to help transition to an optimal and sustainable power mix.

Figure 6: Renewable energy-related initiatives

Topic	RE initiatives	Owner
Natural resource assessment	Solar atlas	QEERI
	Wind resource measurement	KAHRAMAA
Pilot RE projects	1 MW storage pilot	KAHRAMAA
Technical integration assessment	Transmission development plan	KAHRAMAA
	Maximum-PV integration assessment	KAHRAMAA

Key takeaways from the dimension of Strategy and Targets are

Strategy

The QNRES is Qatar's first renewable energy strategy. To achieve best practices, Qatar launched the comprehensive overarching renewable energy strategy framework that encompasses: specific renewable energy targets and technologies; the institutional landscape (governance and enablers); and supporting policies (e.g., land allocation, tendering models, and fiscal arrangements).

Targets

Qatar's approach to renewable energy, thus far, is set on short-term, conservative, and project-based goals. Renewable energy can, however, play a significant role in delivering Qatar's NDC commitment, which aims at reducing Qatar's GHG emissions by 25% by the year 2030, relative to the baseline scenario (business as usual). Qatar needs, therefore, long-term renewable energy targets (2030 and beyond) to provide sufficient visibility on the national direction to network planners and investors. Also, it should consider increasing its current renewable energy ambitions to affirm its commitment to climate change mitigation, generate scale to create a competitive market, and lower system costs considering international natural gas prices.

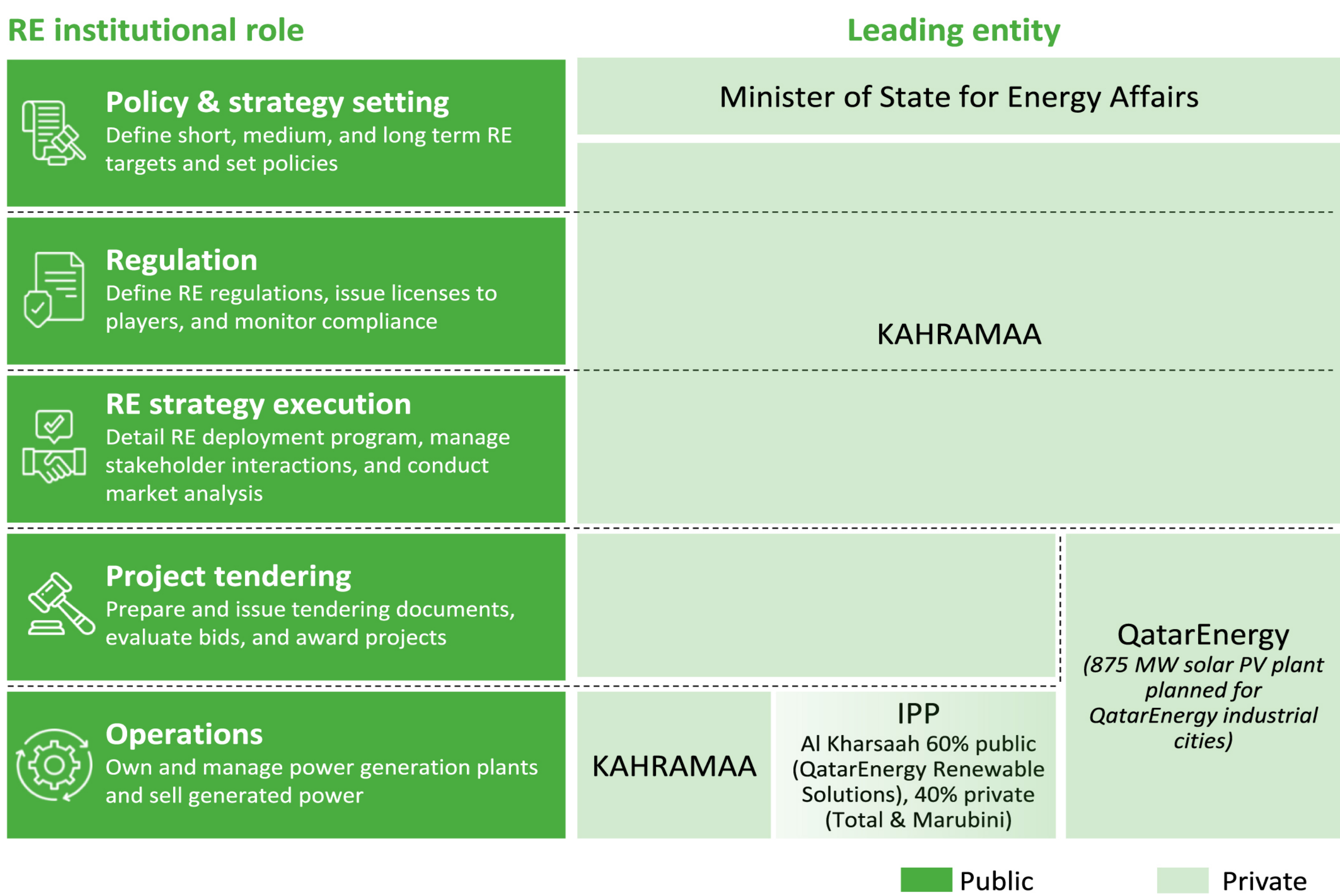
3.3 Institutional landscape and ecosystem

The assessment of this dimension will focus on institutional setup and key sector stakeholders, delineation of roles and responsibilities, and key enablers, such as private sector participation, renewable energy research, development, and innovation, and building human capabilities.

KAHRAMAA plays an integrated institutional role across the renewable energy sector, with responsibilities that include setting policy and strategy, regulation, renewable energy strategy execution, and a significant role in project tendering. The renewable energy plant that exists (Solar power plant at Al Kharsaa) is an independent power producer that is 60% owned by public investors (QatarEnergy Renewable Solutions).

QatarEnergy also plays a role in the renewable energy sector by planning and managing tenders and operations of its own renewable energy projects.

Figure 7: KAHRAMAA's role in the Qatari renewable energy sector

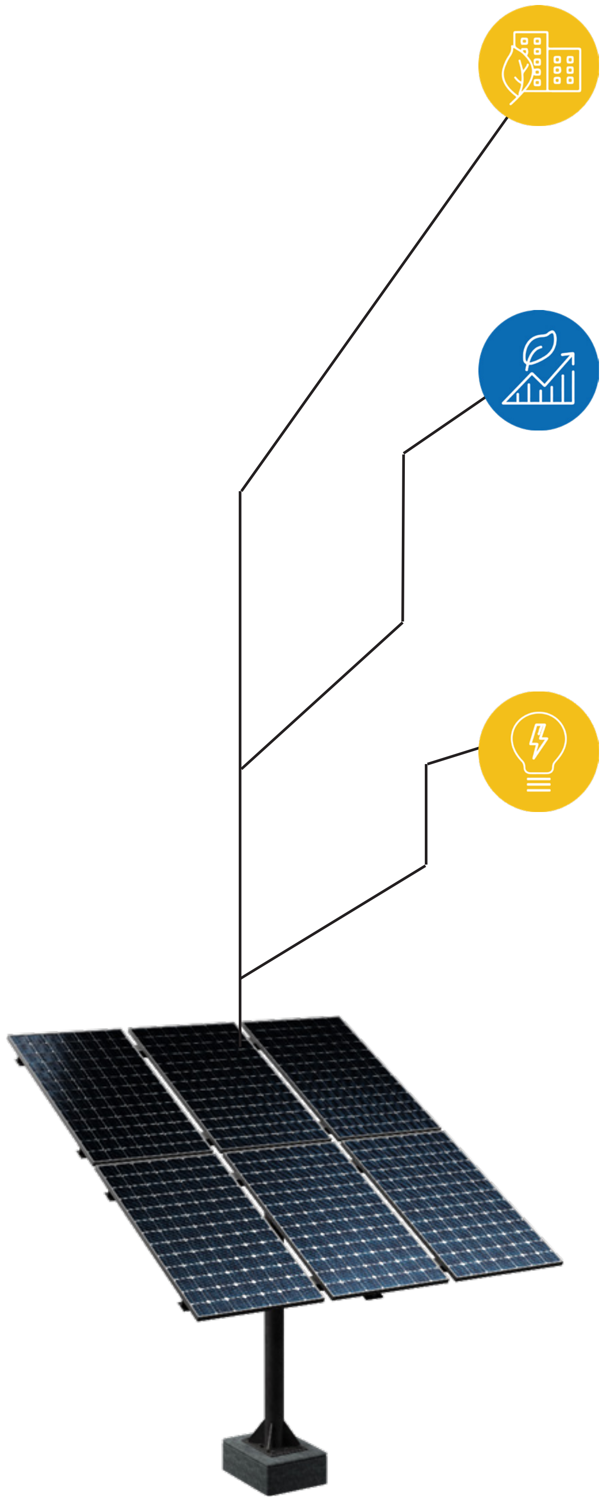


KAHRAMAA has established a new department to drive the growth of renewable energy, however, multiple work groups within KAHRAMAA are involved.

Beyond KAHRAMAA, several gaps still need to be addressed by key external stakeholders to enable the renewable energy sector to achieve its aspirations. For example

- As an input to renewable energy planning, the Ministry of Transport could define long-term electrification targets for the transport sector and the Ministry of Municipality could develop zoning regulations for Al Khor, Al Wakrah, and offshore areas to identify restricted and available areas for renewable energy projects.
- Regarding processes, policies, and regulations, the Ministry of Municipality could amend its building permit process to accommodate renewable energy while the Ministry of Environment and Climate Change could formalize/standardize the Environmental Impact Assessment process for renewable energy projects.

Within the institutional landscape and ecosystem, three key enablers are required to drive the development of renewable energy:



The private sector, which participates in activities across the renewable energy execution value chain, including development through local players.

Human capital, where local workforce capabilities are built-up to fulfil the renewable energy sector's growth plans across the required project phases from planning, to design, engineering, procurement & construction (EPC), and operations.

Research, development, and innovation, which seeks to adapt renewable energy technologies to Qatar's natural conditions for optimal results, launch pilot projects to explore new technologies and approaches, and manage any risks prior to project scale-up.

In the private sector, Qatar has two local utility-scale renewable energy developers — Nebras Power and QatarEnergy Renewable Solutions — and several small-scale developers. One large-scale renewable energy developer, QatarEnergy Renewable Solutions, focuses on the Qatari market. It operates the 800 MW DC Siraj-1 solar project at Al Kharsaa as well as some medium and small-scale projects for Qatar Fuel (WOQOD). The other large-scale renewable energy project developer, Nebras Power, has approximately 1,200 MW of projects. It focuses on foreign markets, including Jordan, Brazil, Oman, and Indonesia. Its projects include Amin (a 125-MW project in Oman), the Francisco Sa project (114 MW solar PV project in Brazil), and the AM solar facility (a 25-MW facility in Jordan). Smaller-scale renewable energy project developers include: Powergreen Innovations Unlimited, where the average project size is less than 1.7 MW; Sadeen Enterprises, which develops projects of about one megawatt or less; and Sama Sustainability & Renewable Energy, whose projects are less than 0.6 MW.

Figure 8: Local utility-scale and small-scale renewable energy developers in Qatar

Large-scale developers

Nebras power

Target locations	Jordan, Brazil, Oman, Indonesia
Capacity	1,200 MW
Projects	• Francisco Sá: 114 MW solar PV – Brazil • Amin : 125 MW – Oman • AM solar: 25 MW – Jordan

QatarEnergy Renewable Solutions

Target geography	Qatar
Capacity	800 MW
Projects	• Solar PV project in Al Kharsaah • Medium/small-scale PV projects for WOQOD[1]

Small-scale developers

powergreen INNOVATIONS UNLIMITED

Projects size	< 1.7 MW

Sadeen Enterprises

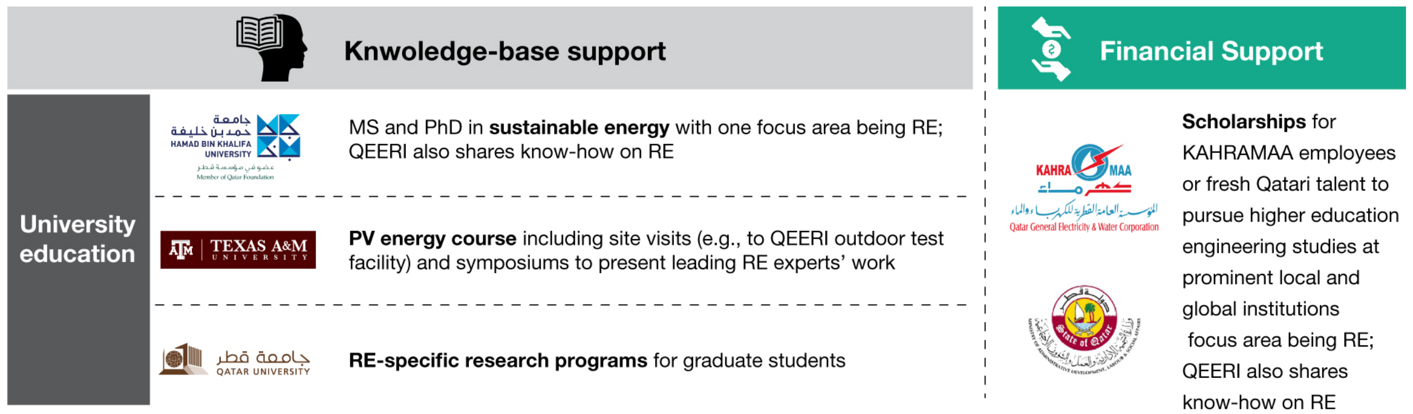
Projects size	< 1.1 MW

SAMA SUSTAINABILITY & RENEWABLE ENERGY

Projects size	< 0.6 MW

Regarding human capital, Qatar has a few programs in place to create a deeper pool of renewable energy talent. In terms of university coursework, Hamad Bin Khalifa University offers Master of Science and Ph.D. programs of study in sustainable energy, with one focus area being renewable energy. QEERI is engaged in numerous activities relevant to renewable energy such as knowledge sharing, research and development, piloting of new technologies, and testing facilities. Texas A&M University at Qatar offers a PV energy course that includes site visits (e.g., to QEERI outdoor test facility) and symposiums to present leading RE experts' work. Qatar University offers graduate-level research programmes on renewable energy. KAHRAMAA offers scholarships through the Ministry of Education and Higher Education that enable employees or new Qatari workers to pursue higher education engineering studies at prominent local and global institutions.

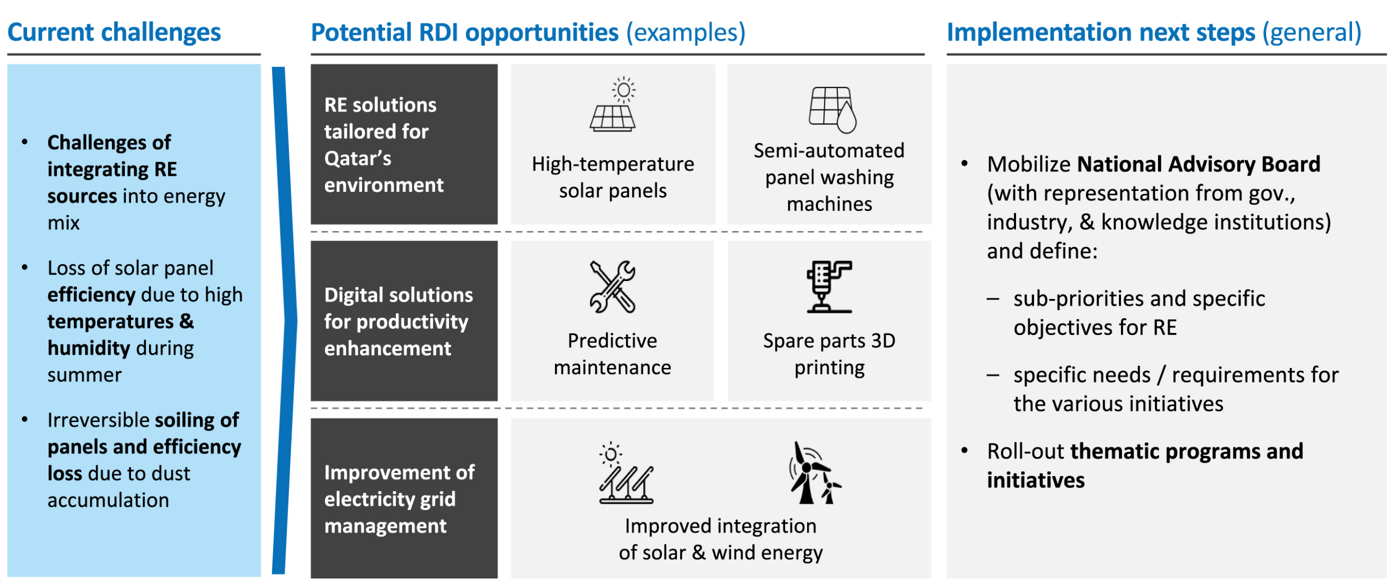
Figure 9: Key human capability-building institutions in Qatar



When it comes to Research, Development, and Innovation (RDI), Qatar is working to resolve several challenges, including integrating large amounts of renewable energy into the power mix, the loss of solar panel efficiency due to high temperatures and humidity during summer months, and the irreversible soiling of panels and efficiency loss due to dust accumulation. The Qatar RDI strategy defined research priorities that could help overcome these challenges, including:

- Crafting renewable energy solutions tailored to Qatar's environment, potentially including deploying high-temperature solar panels and semi-automated panel washing equipment
- Deploying digital solutions to enhance productivity, such as predictive maintenance and printing spare parts using 3D printers, and
- Improving electrical grid management to integrate more solar and wind generation capacity

Figure 10: QRDI strategy 2030 key takeaways



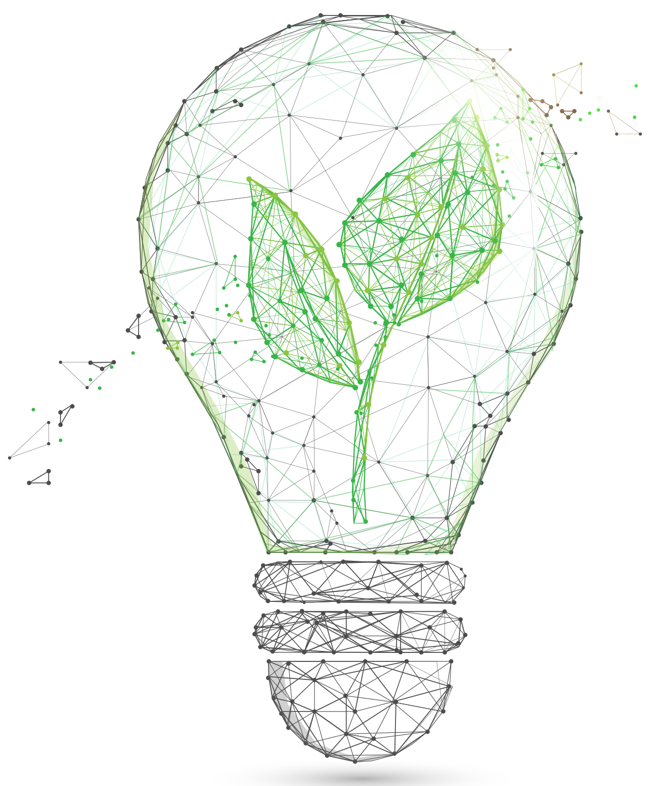
[1]currently handled by the Ministry of Administrative Development, Labour and Social Affairs as a unified source for the Government.
[2]Internship program provided for three consecutive years starting 2014.
[3]currently handled by the Ministry of Administrative Development, Labour and Social Affairs as a unified source for the Government 2) Internship program provided for three consecutive years starting 2014.

Many types of organizations, including University Research Centers, Technology Parks, and University Innovation Centres, conduct renewable energy RDI activities along the full range of the technology readiness level (TRL) spectrum. Their expertise could be mobilized to address the challenges to greater reliance on renewable energy.

The key takeaways for Qatar's institutional landscape and ecosystem

Renewable energy department

To advance and achieve best practices, the country should reassess the role of KAHRAMAA's renewable energy department to eliminate peripheral roles that do not focus on RE (e.g., general regulatory role) and concentrate on strategy execution (e.g., resource assessment, deployment program, obtain approvals for land allocation , RE promotion, and re-development) and enhance the department's capabilities by ramping up manpower and know-how and enhancing its coordination role to fully enable the sector



Private sector

Qatar has reached an intermediate stage, beyond nascency but not yet at a best-practice level. To keep moving forward, it should: continue empowering renewable energy developers to build up skills and capabilities; assess the attractiveness of Qatar's renewable energy manufacturing sector, with particular attention to building scale in its market; and consider the need for financial enablers if local renewable energy manufacturing is deemed attractive

Human capital

Qatar is also in an intermediate stage. To continue progressing, it should evaluate workforce capability gaps in collaboration with the private sector and define required expansions of undergraduate and graduate studies, training programmes, and financial support

RDI

In this area, Qatar is in an intermediate stage. To achieve best practices, Qatar should continue developing local RDI capabilities and influence efforts towards prioritized RDI focus areas.

3.4 Policies and regulatory framework

The assessment of this dimension will cover utility-scale renewable energy regulatory and fiscal policies (e.g., obtain approvals for land allocation, pricing mechanisms, and fiscal incentives) as well as small-scale policy structures.

Qatar has a large portion of its land potentially available for utility-scale renewable energy development, but the land acquisition process faces some challenges. The large number of stakeholders involved in the land allocation process creates the potential for delays in securing required approvals for large projects.

For utility-scale renewable energy systems, Qatar adopted a competitive bidding model in line with global trends. KAHRAMAA traditionally followed the independent power producer (IPP) contracting model for conventional power generation and extended the model for renewable energy. For utility-scale projects, Qatar currently offers pre-development support, guaranteed offtake, and equity participation to support the developers of renewable energy projects.

Moving forward, the activation of large-scale and small-scale renewable energy programs would require a policy and regulatory assessment across 22 areas.

Figure 11: Policy and regulatory assessment for greater RE deployment

Demand management	Energy mix targets	Network integration	Standards and guidelines	Institutional setup	Socioeconomic development
Energy conservation	Large scale RE targets	Planning procedures	Connection process/Building codes	KAHRAMAA reorganization	Tendering strategy (incl. project grouping, local content targets)
Energy efficiency measures	Distributed RE generation	Network code and producer/ grid interface	Standards and guidelines for RE	Other incentives for small scale	REC scheme
EVs penetration	RE land allocation	Measures to secure stable network	Solar water heater standard	Awareness campaigns	Incentive scheme to support local players
Transition to RO water production		Network integration studies	Consultant/ contractor qualification process	Capability building	

Policy requirements | Regulations requirements | No new policy or regulatory requirements

Policies are needed to: achieve large-scale and distributed generation renewable energy targets; allocate land; introduce incentives to implement the small-scale renewable energy certificates scheme; and adopt a plan to support local players.

Regulations are required to create a distributed generation renewable energy program; facilitate a network code/grid interface; enforce all standards and guidelines; and reorganize KAHRAMAA.

Below are considerations for some of the policy and regulation areas discussed above.

Large scale renewable energy targets:

There are various incentives and inducements that Qatar could consider to support the development of utility-scale renewable energy, such as ways to guarantee electricity offtake, debt and equity financing, rebates and remuneration, tax cuts

Distributed renewable energy generation:

Qatar currently does not have the legal and regulatory framework in place to facilitate development of those projects. Specifically, more work needs to be done on defining the remuneration scheme, self-consumption policy, regulation for grid connection, billing regulation, training and licensing of installers and certification of suppliers

Land allocation:

Qatar is in an early stage of maturity on this issue. It has a complex and lengthy land allocation process that impedes orderly development of renewable energy generation. To remedy this, the country should consider allocating large zones of land for renewable energy projects to fast track the land-allocation process and maximize efficiency of network investments.

Renewable energy certificate scheme/incentive plan to support local players:

Best-practice countries have a wide range of tailored fiscal policies to facilitate local private-sector construction of renewable energy. Qatar is in a middle stage of maturity on this issue. To advance, it should evaluate the adoption of additional financial incentives (e.g., green certificates, tax incentives, grants, and loans) that would support utility-scale renewable energy project development.

3.5 Technical and network readiness

Consideration of this dimension will include variable renewable energy (VRE) integration challenges; transmission & distribution (T&D) planning practices; and codes, standards, specifications, and quality-control readiness for renewable energy integration.

There are a variety of challenges involved with integrating a large share of VRE into the electricity grid.

Figure 12: Variable renewable energy grid integration challenges

	Supply fluctuation	Supply uncertainty	Low capacity factor	Nonsynchronous generation	Location-specificity
Definition	Output varies with meteorological conditions	Generation cannot be predicted with perfect accuracy	Low availability of energy resource	Does not provide mechanical inertial response[1]	Constrained by the presence of natural resources
Implications	Other plants or storage have to adjust output to maintain balance	Grid operators have to keep excess reserve or storage running in case of shortage in supply	Other plants need to cover for down time, but may not run enough to recover capital cost	Invest in additional technology to maintain balance e.g., synthetic inertia	May require additional grid investment to leverage the VRE supply

Based on a variety of influencing factors, KAHRAMAA's electrical grid may be able to safely meet its minimum load with VRE. This is a preliminary estimate based on interviews with KAHRAMAA and its stakeholders as well as an analysis by the consultant. It must be confirmed with a more thorough assessment. One negative influencing factor is Qatar's relatively small geographical area, which means an atmospheric event could impact VRE across the country. However, the impact of that factor is offset by various positive factors, including:

- Interconnection with Gulf Cooperation Council Interconnection Authority (GCCIA), which provides electrical inertia from bigger systems and provides for exploring further interconnection options.
- Reasonably meshed network, which provides network redundancy.
- Renewable energy natural resources are spread across country, reducing the potential impact of an electrical incident.
- In the short-term, it is unlikely to have a significant ramp-up of distributed generation capacity that might lead to local grid congestion instances.
- Qatar's generation fleet is dominated by thermal gas turbine and combined-cycle gas turbine power plants, which gives it flexibility to accommodate high ramping.

Figure 13: Influencing factors on ability to integrate renewable energy

Small geographical area	– Atmospheric event can impact all the country
Interconnection with GCCIA	+ Provision of inertia from bigger systems; potential for exploring further interconnection options
Reasonably meshed network	+ Provision of network redundancy
RE natural resources spread across country nation	+ Potential to reduce incident reference and grid impact
15% RE share largely achieved through utility scale projects	+ Minimal local grid congestion instances and reduced impact on demand profile from DG
High number of sunny days and expected PV dominance in RE	+ Largely predictable renewable energy production profile
Fleet of generation dominated by OCGT and CCGT plants	+ Flexible fleet capable of accommodating high ramps
Good planning practices for T&D network	+ Possible anticipation of any problem before encountering it

KAHRAMAA has desirable network planning practices that would facilitate the integration of VRE and limit its adverse impacts. For example:

- The development plan and grid master plan allow optimal techno-economic development
- The network impact studies use simulation tools (e.g., PSSE for Transmission and PSS/SINCAL for Distribution)
- Defining grid security planning criteria uses N-1 and N-2 planning criteria

One challenge however, is the development of regulation and policies for renewable energy, but efforts are ongoing to close gaps.

In general, Qatar needs to supplement its existing codes with new ones for distribution, metering, and grid-connected renewables. For its operations codes, Qatar still needs elements related to operating ranges, active power limitation, and withstand capability. Qatar also needs improved codes and standards to promote a safe and reliable management of power systems with renewable energy.

On the dimension of technical and network readiness, there are two key takeaways for Qatar

Regarding **variable renewable energy**, where Qatar currently is at a mid-point in its maturity, it should conduct a detailed assessment of the network's readiness for renewable energy integration and develop a plan to increase flexibility in line with the agreed-upon targets

Qatar's **T&D planning practices** also are at a midpoint.

To advance, it should conduct a comprehensive review of its

codes to address gaps, such as operating ranges, active power limitation, safety, and reliability management.

RENEWABLE ENERGY STRATEGY

4.1 Strategy vision, objectives, and enablers

Qatar developed a comprehensive renewable energy strategy to streamline the sector's growth. The strategy's vision is to enable the development of a sustainable and affordable energy system. Its three objectives are to:

- Reduce CO2 emissions through sustainable policies and trends.
- Increase renewable energy penetration while maintaining network reliability.
- Maximize the socio-economic contribution from its renewable energy program.

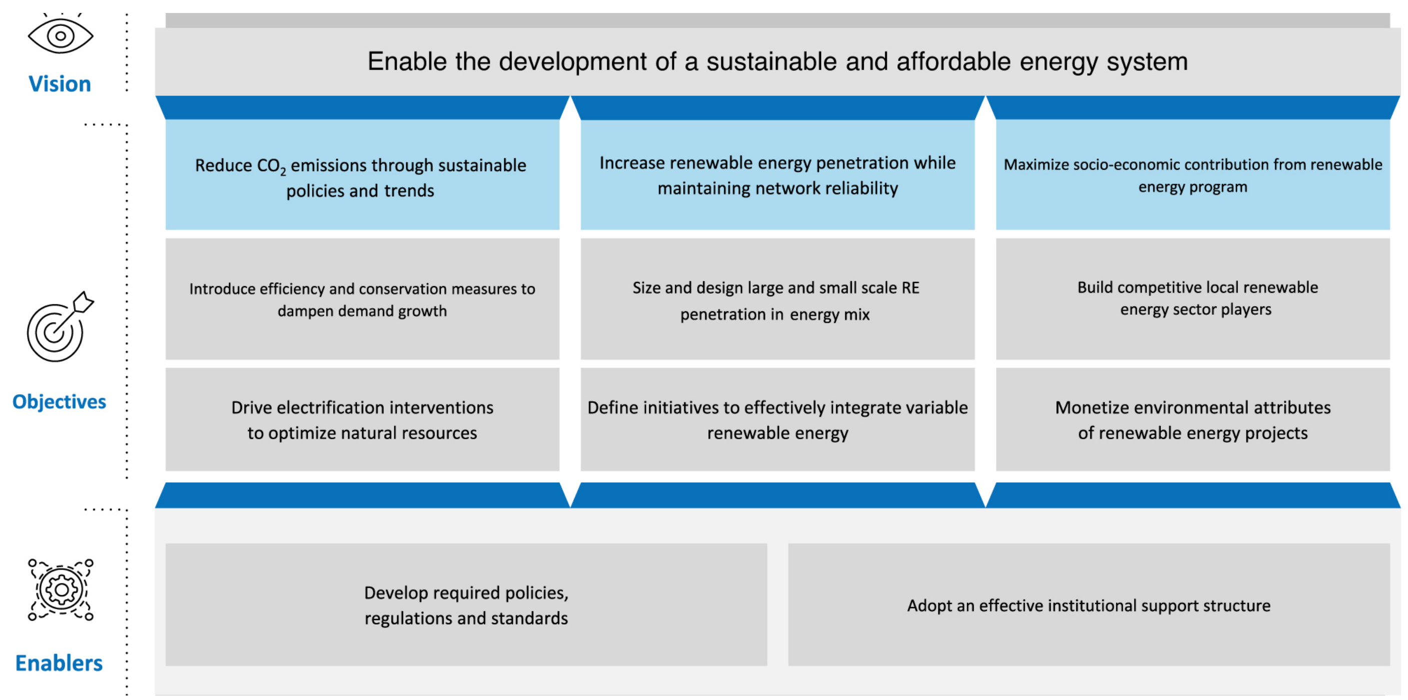
CO2 emissions reduction depends on the introduction of efficiency and conservation measures to decrease electricity demand growth. Electrification interventions also play a central role in optimizing the use of natural resources through the transition to more efficient and cleaner electrical alternatives, increased use of renewables, and fostering a circular economy.

Realizing the renewable energy penetration objective requires sizing, designing, and introducing large- and small-scale renewable energy generation into the power mix as well as defining initiatives to effectively integrate variable renewable energy.

Fulfilling the socio-economic contribution objective depends on building competitive local renewable energy sector organizations and monetizing the environmental attributes of renewable energy projects.

The key enablers to achieving Qatar's National Renewable Energy Strategy are developing required policies, regulations, and standards, and adopting an effective institutional support structure.

Figure 15: Qatar National Renewable Energy Strategy (QNRES)



4.1.1 Reducing CO_2 emissions through sustainable policies and trends

- The responsibility of the QNRES objective of reducing CO_2 emissions falls under Tarsheed, the already well-established National Campaign for the Conservation and Efficient Use of Water and Electricity in Qatar. It is important to note that achieving a reduction in CO_2 emissions is directly linked to introducing efficiency and conservation measures that decrease the demand growth for electricity. Additionally, electrification interventions are necessary to optimize the utilization of natural resources effectively. Existing conservation initiatives include:
- Air conditioner Energy Efficiency labelling
- Phase out of inefficient lamps
- KAHRAMAA Regulations for Electricity & Water Conservation
- Retrofit for Energy & Water Conservation Program
- Demand Side Management
- National Conservation (TARSHEED) Campaign

Nevertheless, the QNRES have a major positive impact on the environment, especially with respect to CO_2 emissions reduction as the introduction of renewable energy will result in a reduction of CO_2 emissions compared to the business-as-usual scenario and a reduction in CO_2 intensity per unit of electricity produced. This is detailed in the next section of this report (section 4.2).

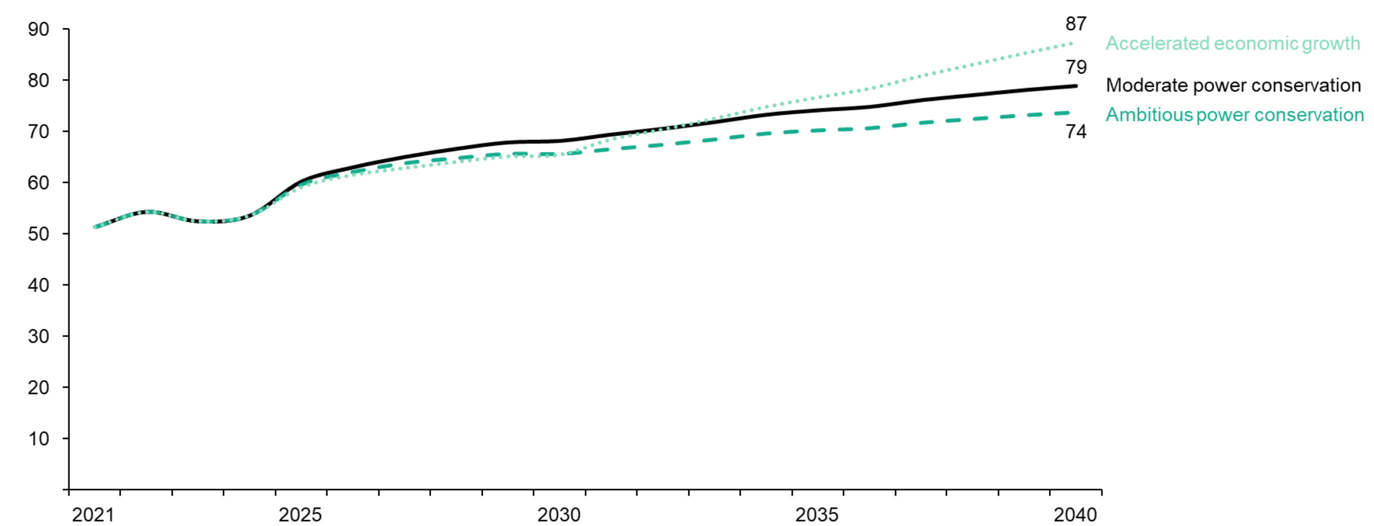
4.2 Increasing renewable energy penetration while maintaining network reliability

In selecting an optimal long-term power mix, several parameters were considered, including:

Electricity demand: What is Qatar's projected electricity demand? What are its possible annual load curves? The projection for increasing on-grid demand for electricity over the next decades is a key input to the power mix scenarios. Three clusters of factors will affect electricity demand growth:

- Macroeconomic drivers such as demographic changes, and gross and sectoral gross domestic product (GDP) growth
- National policy themes based on 2nd NDS, including energy conservation measures, energy efficiency programs, and electrification of the transport sector, and
- Other major trends, for example, the growth of distributed renewable generation and the transition to district cooling and penetration of reverse osmosis in desalination plants.

Demand for electricity in Qatar is expected to rise significantly in the coming years driven by economic growth and demographic shifts. According to QNRES projections, the demand will increase from about 51 terawatt-hours (TWh) in 2021 to approximately 80 TWh in 2040. This substantial increase in electricity demand highlights the need for a sustainable and reliable energy infrastructure that can meet the growing needs of the nation.Figure 16: Electrical energy demand growth forecast (TWh)



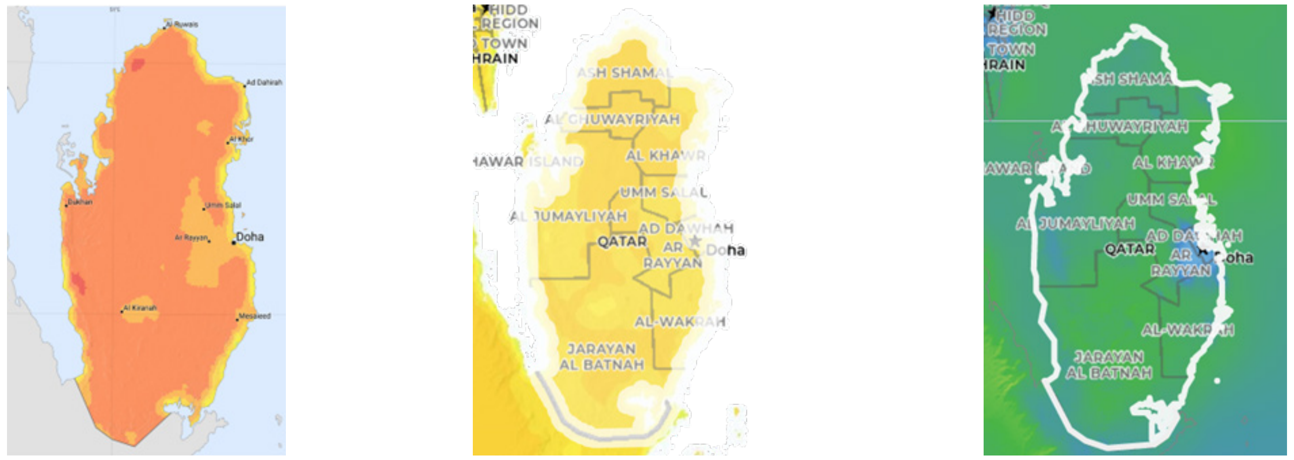
Generation assets: What are the parameters of Qatar's **existing** generation plants, e.g., capacity, technology, availability, efficiency, and O&M costs? What are the parameters of its **planned** generation plants? What are the parameters of **potential** new generation technologies that could be added to the power mix?

On the electricity generation side, the retirement and de-rating plan of existing generators is considered. Existing capacity of around 12 GW is projected to decline to 10.4 GW in 2040, assuming legacy assets are retired at the end of their contract periods. The efficiency of legacy power plants is kept constant based on 2020 actual values.

In addition, the planned capacities to be added for the Siraj-1 solar project at Al Kharsaa, QatarEnergy, and Facility E plants also are included.

To determine the most attractive renewable energy technologies for Qatar, a detailed techno-economic analysis was conducted on seven different renewable energy technologies: Hydropower; Photovoltaic (PV) Solar; Concentrated Solar Power (CSP); Wind; Geothermal, Bioenergy, and Ocean/Marine.
Two technologies were shortlisted as the most attractive renewable energy technologies that can be commercially deployed in Qatar: Solar PV and CSP.

Figure 17: Qatar natural resources



0 kWh/0 kWp – 5 kWh/1826 kWp

0 kWh/m² – 3700 kWh/m²

0 W/m² – 1000 W/m²

The entire Qatar area has an attractive PV output exceeding 4.67 kWh/kWp/day

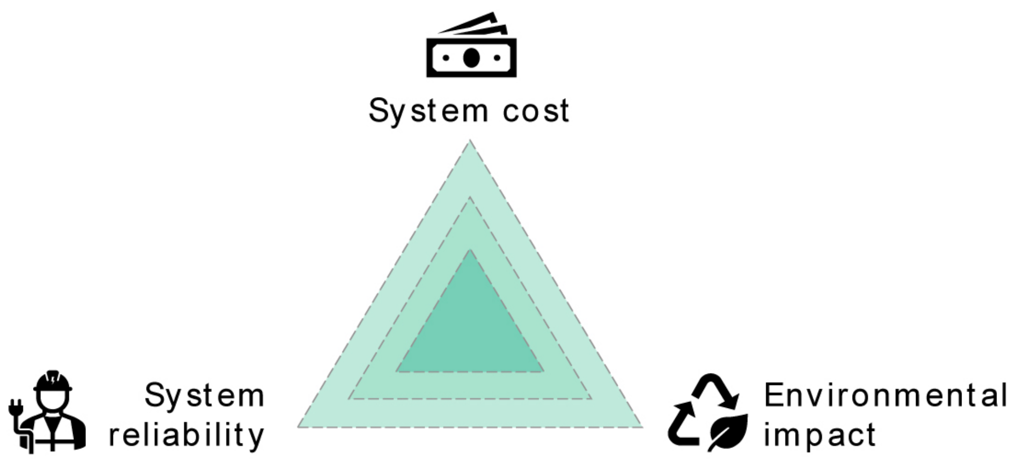
Solar PV has the highest attractiveness to Qatar because of the high horizontal irradiation levels and its low costs due to the mature technology.

DNI resource in Qatar is well distributed (except for coastal areas), with a moderate DNI of ~1,900 kWh/m2/year.
CSP has a medium attractiveness for the country because direct normal irradiation in Qatar is moderate and CSP technology is still relatively costly.

Almost the entire Qatar land would allow for an acceptable wind power density (>300 W/m2)
Wind has a medium level of attractiveness for Qatar because wind speeds are modest (average of 6-7 meters per second) in a small number of areas across the country.

To increase renewable energy penetration while maintaining network reliability, it is necessary to maximize benefits along three key objectives: cost; reliability; and environmental impact. Minimizing system costs includes all the power generation costs, such as capital expenditures, operating expenditures, and fuel costs. Maximizing system reliability refers to having the highest level of power available to always meet electricity demand across the country. Maximizing the environmental impact means reducing greenhouse gas (GHG) emissions measured in metric tonnes of carbon dioxide equivalent.

Figure 18: Objectives function



SYSTEM COST	Minimization of the overall power generation cost (CAPEX, OPEX, fuel, etc.)
SYSTEM RELIABILITY	Highest level of power availability to always meet demand across the country
ENVIRONMENTAL IMPACT	Reduction of greenhouse gas emissions quantified in Mt of CO2 eq

A comprehensive analysis conducted through a least-cost simulation engine reveals that Qatar should target a large-scale renewable energy installed capacity of 3.5 to 4 GW DC by 2030, driven by solar PV technology. Renewable energy would rise from its current 5% of the power mix to 18% by 2030. Over that same timespan, combined-cycle gas turbine (CCGT) thermal generation would drop from the current share of 80% to 72% in 2030. Simple cycle gas turbine thermal generation, also known as open cycle gas turbines (OCGT), would drop from 4% currently to 3% in 2030. The remaining 7% share of the power mix in 2030 will include the interconnection capacity, small-scale conventional, and small-scale renewables. Additional studies (mainly dynamic and stability analysis, including inertia) will be conducted to ensure that the power system is flexible enough to support these targets.

Figure 19: Electricity supply demand balance (GW)

		2021	2030
	Demand	9.6	11.5
Conventional supply	CCGT	10.6	11.7
	OCGT	1.56	0
	Small scale	-	0.3
	Imports interconnection	1.2	1.2
Renewable supply	Solar PV	0.8	4
	Small scale RE	-	0.2

Note 1: these targets represent the most economical solutions, but further technical grid studies are needed.
Note 2: reserve margin of 15% considered after 2030;
Note 3: small scale RE covers residential, commercial, industrial, agriculture, & government sectors.
Note 4: batteries are not considered as generators in RE share calculation

Beyond 2030, Qatar will conduct the required studies to refine and validate these targets.
The recommended power mix would reduce the average yearly production cost from 7.4 US cents/kWh in 2021 to 6.3 US cents/kWh in 2030.
In terms of CO2 emissions reduction, the recommended power mix will have significant impact.

In Qatar's total annual CO_2 emissions from the power sector despite a significant increase in demand. In fact, Qatar's annual emissions from the power sector would have reached 29.3 Mt in 2030, however, with the planned integration of renewables, the emissions will reach only 26.4 Mt that year

Reduction
10%

In Qatar's annual CO_2 intensity for each unit of electricity produced. In fact, Qatar's annual CO_2 intensity was around 0.5 $kgCO_2$/ MWh in 2021, however, with the planned integration of renewables, the intensity will be reduce to around 0.36 $kgCO_2$/ MW by 2030

Reduction
27%

In addition to increasing the penetration of large-scale renewables, Qatar should aim at boosting the deployment of distributed generation capacity. By 2030, Qatar should encourage the installation of up to 200 MW of distributed solar generation.
Power mix targets should be revised about every three years to account for changes in estimated electricity demand and technology costs.

Figure 20: The 2030 impact of the recommended power mix

		2021	2030
Cost	Average yearly cost (2030, 2021 real Bn USD)	7.4	6.3
	Total CAPEX (2022 to 2030, 2021 real Bn USD)		7.6
	OPEX (2030, 2021 real Bn USD)	3.6	4.6
Emissions	CO2 intensity (kg/MWh in 2030)	495	360
	CO2 intensity reduction vs 2021 (% in 2030)		27%
Energy mix	Gas power plants share of capacity (% of installed capacity in 2030)	100%	72%
	RE share of generation (% of total generation in 2030)	-	18%

The remaining 10% share of the energy mix in 2030 will include interconnection capacity, small-scale conventional energy sources and small-scale renewable energy sources.

4.2.1 Sizing and designing large- and small-scale renewable energy penetration in power mix

To accommodate the 2030 large-scale renewable energy targets of ~3.5 to 4 GW, Qatar will require about 55 square kilometers of additional land (excluding already allocated land for Siraj-1 solar project at Al Kharsaa), which represents approximately 0.5% of Qatar's total land area.

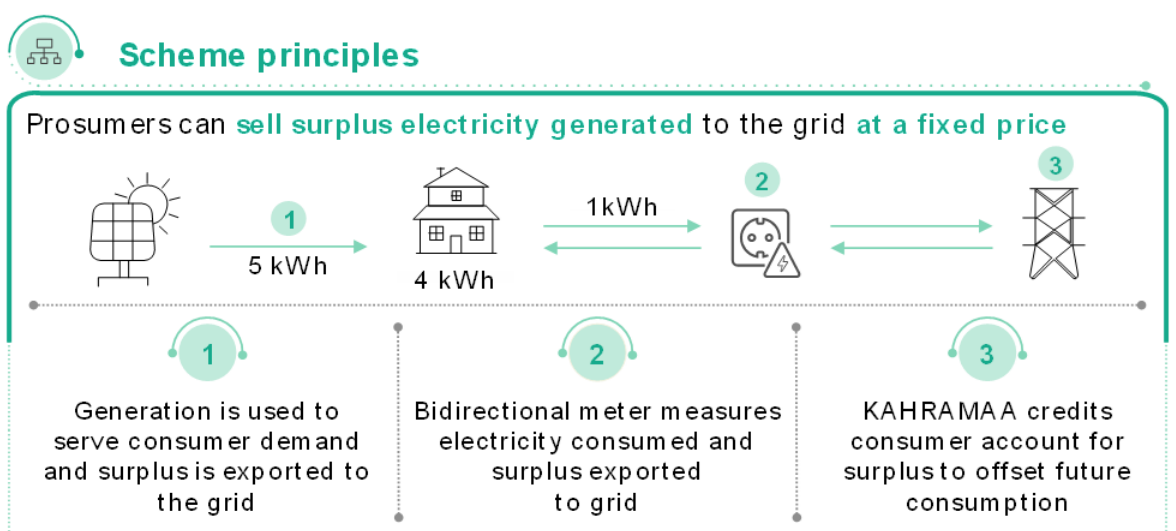
For smaller scale renewable energy distributed generation, an initiative was designed for the characteristics of the electricity system and consumers' profile of Qatar. It includes a specific incentive mechanism to make the solar PV initiative attractive for consumers. In addition, policy recommendations and a customer engagement strategy were developed. This Initiative will contribute to boosting awareness about renewable energy across the population.

The incentive mechanism comprises of a net-billing scheme that enables "prosumers" (e.g., customers with DG) to sell surplus power generated to the grid at a fixed price.

The principles of a small-scale renewable energy DG scheme are:

1. DG sited on a customer's premise is used to serve consumer demand and surplus is exported to the grid
2. A bidirectional meter on the customer's premise measures electricity consumed and surplus exported to grid, and
3. KAHRAMAA credits consumer account for surplus to offset future consumption

Figure 21: Net billing scheme



Net-billing programs have become popular around the world. There are significant benefits to such a program, including: it incentivizes consumers to install PV systems; it reduces pressure on the electricity network; and it provides flexibility to adjust surplus tariff over time.

4.2.1.1 Defining initiatives to effectively integrate variable renewable energy

Six categories of interventions can increase the system flexibility to accommodate renewable energy.

Each category of intervention could include several different tasks:

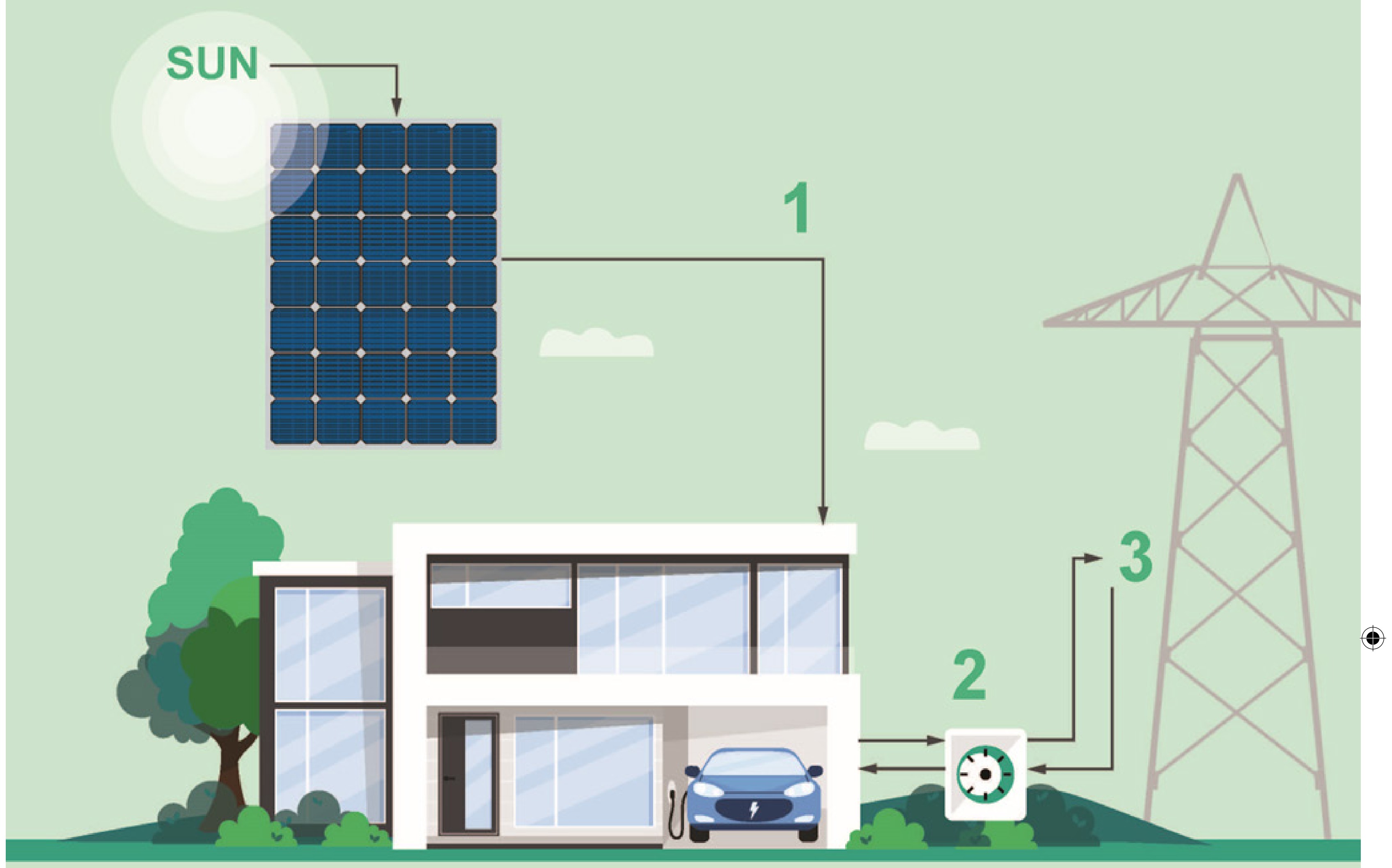
Figure 22: Integration interventions categories and description

System Operations	Transmission Networks	Flexible Generation	Flexible Demand	Storage	Market
Update the codes governing system operations to unlock significant flexibility in the existing infrastructure	Reinforce and expand the transmission network in alignment with VRE deployment and interconnect broader regions	Favor conventional and VRE technologies with better balancing responses	Aggregate customers willing to shift their demand based on grid requirements	Integrate storage technologies to help even out VRE's variable supply	Adopt new market structures such as (a) time and locational granularity and (b) new power supply value products
• Review of codes • Control center processes. • Advanced weather forecasting • Strategic curtailment of RE • RE technical requirements	• Transmission network expansion • Transmission asset reinforcement • Expanded balancing footprint. • Dynamic line rating (DLR)	• Flexible VRE equipment • Conventional turbine flexible ramping • Small-capacity peaking units • Behind the meter • Network / system operations	• Demand response based on grid needs. • Ancillary services to increase system flexibility and incentivize fast response	• Utility-scale storage to improve generation flexibility	• New market structures such as (a) time and locational granularity and (b) new power supply value products

Fourteen separate initiatives are needed to increase renewable energy penetration while maintaining network reliability:

1. Conduct technical studies for short-term power system design: Technical studies are needed to confirm or refine the short-term power mix.
2. Conduct ground measurements to validate wind energy: Measure wind resources in Qatar to ensure that the actual wind speeds are aligned with data in the technology review.
3. Obtain approvals for land allocation dedicated for renewable energy projects: Define the total land area that can be made available for renewable energy projects to identify the maximum solar and wind capacities that can be installed in Qatar.
4. Formulate a five-year renewable energy project deployment program: Develop a detailed renewable energy project deployment program with targets for individual projects.
5. Secure land plots for renewable energy projects: Perform the necessary activities to allocate specific land plots on which renewable energy projects can be hosted.
6. Conduct pre-development activities for renewable energy projects: Carry out all required studies and assessments on the land to ensure its suitability for hosting renewable energy projects.
7. Execute deployment program: Carry out all the activities needed to realize the renewable energy projects from tender preparations until finalization of agreements.
8. Prepare for launching the small-scale PV Program: Conduct preparatory activities required ahead of launching the solar PV Program.
9. Establish national renewable energy database: Perform the necessary activities to establish the renewable energy database for KAHRAMAA.
10. Carry out hosting capacity studies: Conduct the required studies to determine the hosting capacity in KAHRAMAA's transmission and distribution network for all voltage levels.
11. Conduct transmission expansion studies: Implement the transmission expansion plans to ensure the power system is upgraded based on the renewable energy targets.
12. Conduct smart grid studies: Perform the Smart Grid Roadmap and ADMS1 design at the transmission and distribution levels.
13. Conduct control system implementation study: Conduct a study to implement a control system for renewable generation to ensure outputs are in alignment with the technical standards.
14. Conduct renewable energy forecast implementation study: Carry out a study on the implementation of renewable energy forecasting.

HOW SOLAR NET BILLING WORKS



1

Electricity is produced through solar PV panels installed at your home or business. The electricity produced is first used to serve your demand, while surplus is sent to the grid.

2

A bidirectional meter measures how much electricity you use from the grid and how much surplus is sent back.

3

Kahramaa credits you for the surplus to offset future consumption resulting in lower electricity bills.

4.2.2 Maximizing socio-economic contribution from renewable energy program

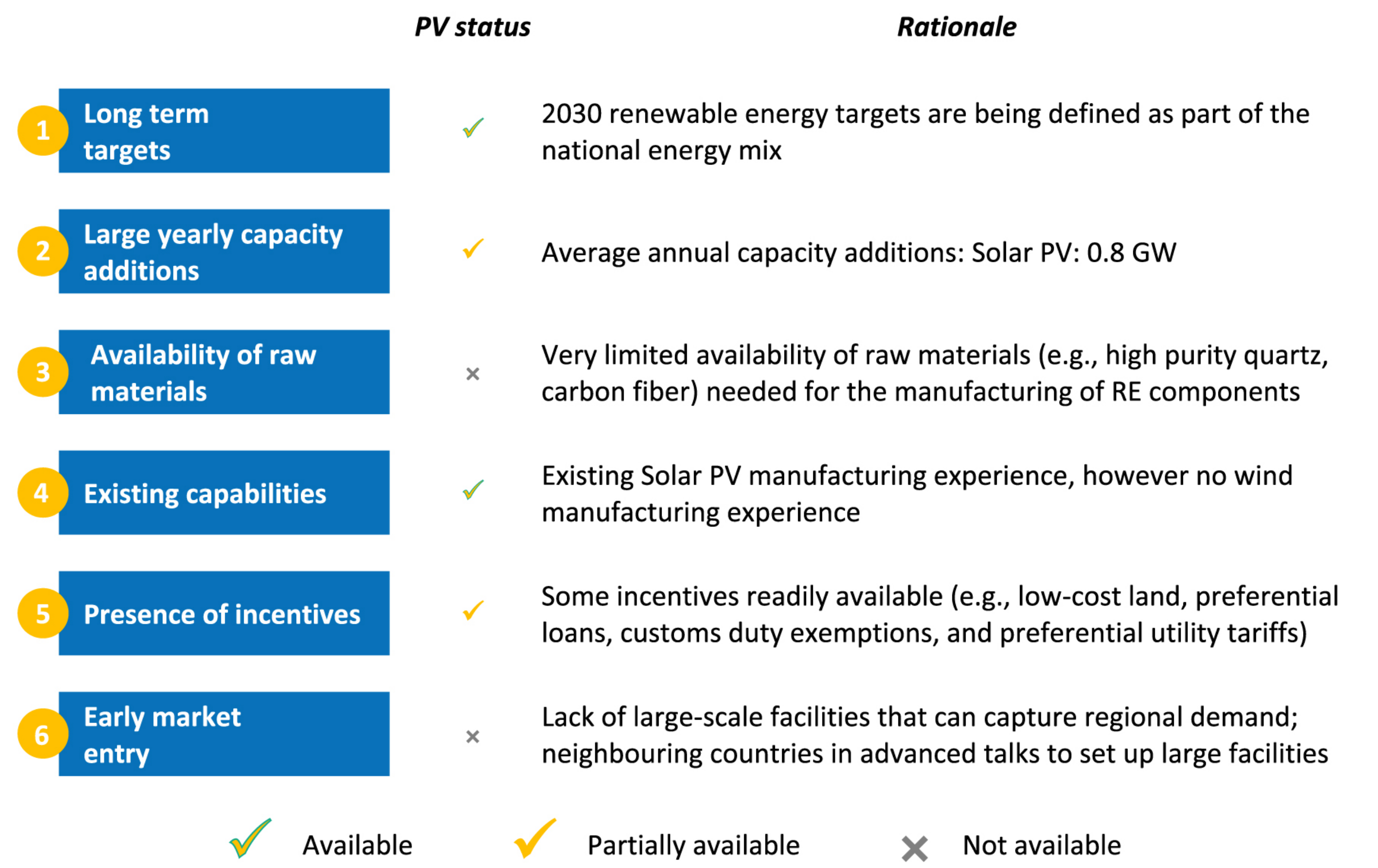
To realize the vision of an energy system that is affordable (as well as sustainable), Qatar's renewable energy strategy has two objectives: build competitive local renewable energy sector players; and create ways to monetize the environmental attributes of renewable energy projects.

Six key lessons can be derived from the renewable energy localization experiences of global and regional nations:

1. Establish long-term targets to provide visibility on the national direction to those who wish to invest in renewable energy manufacturing.
2. Increase yearly capacity additions by a large amount, which will guarantee sufficient scale to prepare attractive business cases for components manufacturing.
3. Secure adequate supplies of raw materials, capture the competitive advantage of sourcing raw materials locally to reduce overall costs.
4. Capitalize on existing capabilities to optimize manufacturing processes and reduce costs.
5. Introduce relevant manufacturing incentives (e.g., production-linked incentives [PLI], low-cost financing, etc.) to improve the business cases for renewable energy component manufacturing.
6. Act as a first mover by establishing manufacturing facilities to create early-market advantages in region.

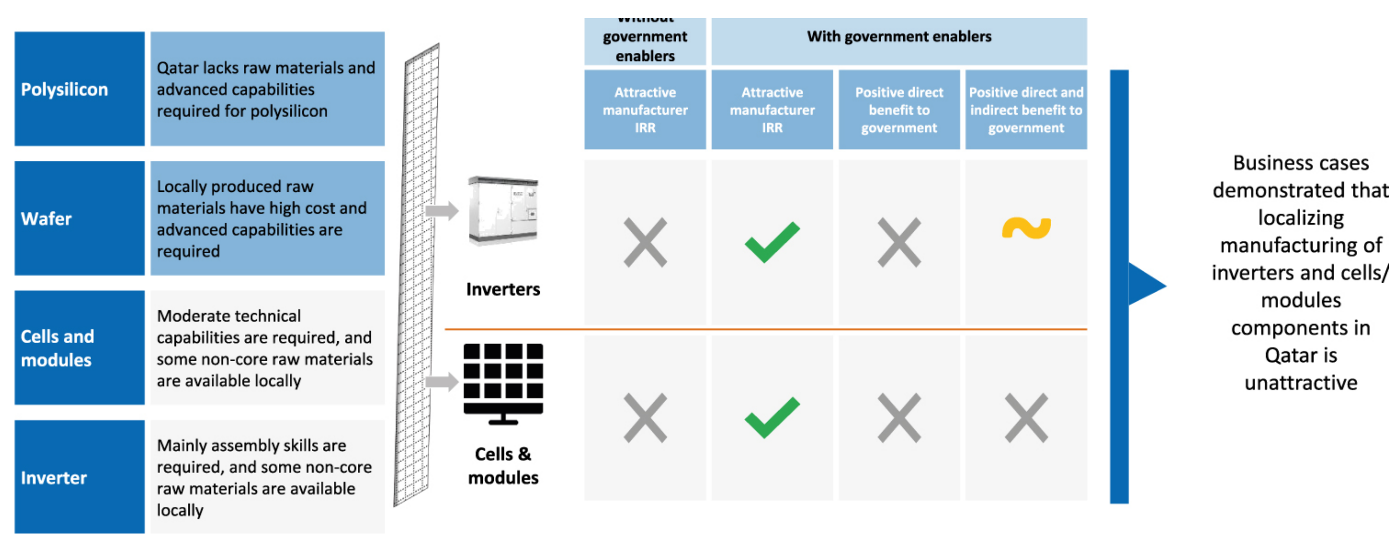
Based on these lessons, the viability of localizing solar PV component manufacturing was assessed. The assessment concluded that localized solar PV manufacturing could be considered for certain components, but wind power localized manufacturing would be unattractive due to lack of scale and competitive advantage.

Figure 23: Renewable energy local manufacturing capability assessment



There are four stages of local PV solar manufacturing: Polysilicon, Wafers, Cells and Modules, and Inverters. Although Inverters and Cells and Modules have a stronger business case than Polysilicon and Wafers, none of the four stages have strong business cases for local manufacturing.

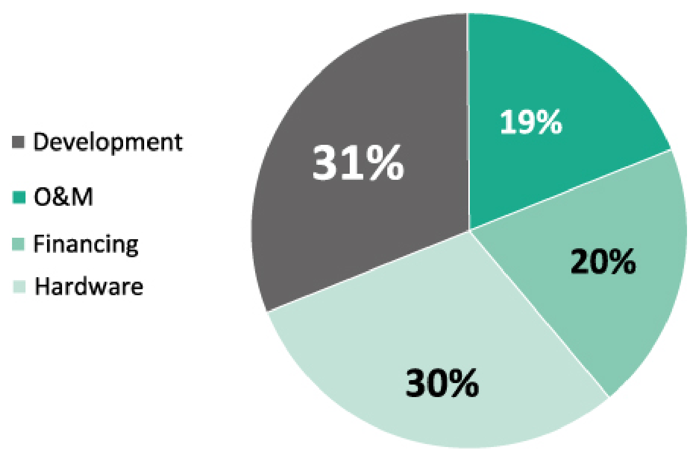
Figure 24: Business cases for local manufacturing of solar PV components



4.2.2.1 Building competitive local renewable energy sector players

Despite the unattractive market environment for locally manufacturing solar PV components, project development and operations and maintenance (O&M) — which account for approximately 40% of the cost of a utility-scale PV system — could be attractive for localization.

Figure 25: Cost breakdown for utility-scale solar PV

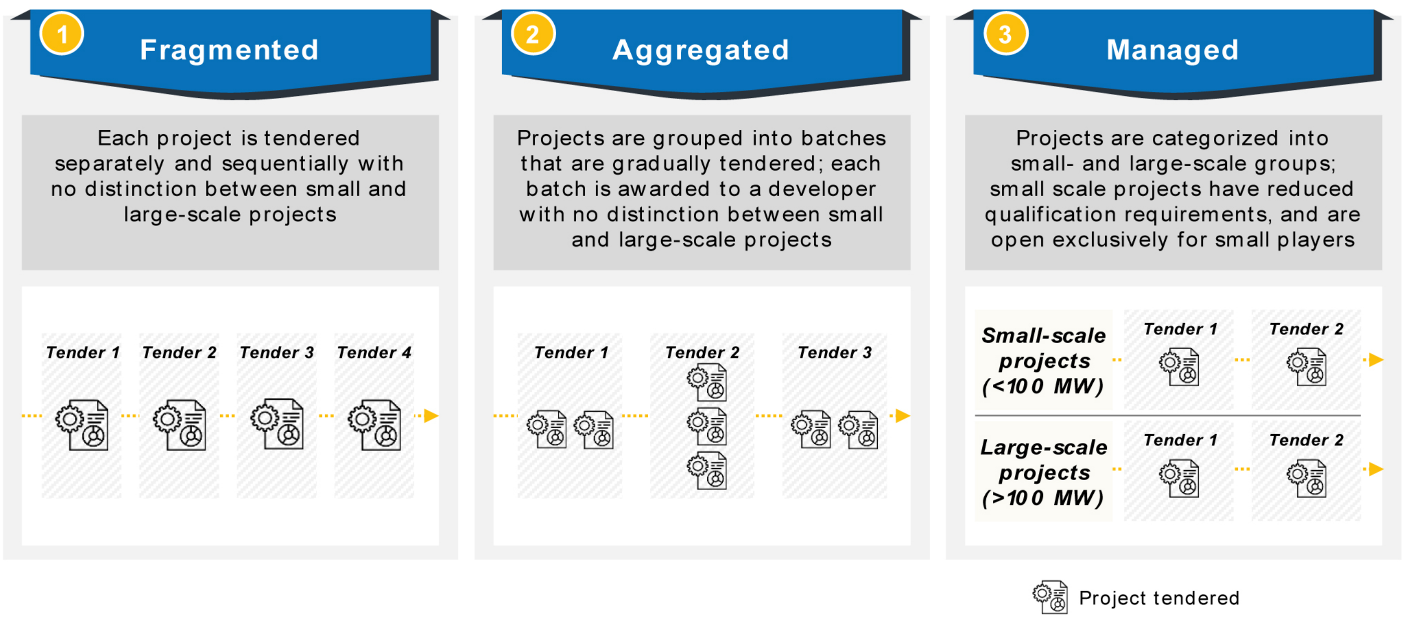


The benefits of localizing project development and O&M for large-scale solar PV include:

- Attractive IRR: Development internal rates of return (IRR) ranging between 8% and 10% and O&M IRR ranging between 10% and 12%
- Growing regional market: Significant growth in renewable energy project development in the Middle East and North Africa, and
- Strong local network: Local players have strong access to public entities and better understanding of the local market.
- But developers of small-scale solar PV projects may face multiple challenges when bidding for utility-scale renewable energy projects, such as:
- Limited credentials to qualify for large-scale projects: Off-takers typically require minimum criteria for pre-qualification, such as experience with large-scale projects, financial requirements, and local content requirements which only large players can satisfy.
- High competition from large/international players: Larger companies can submit more competitive bids due to lower execution risks, access to a broader supplier pool, high purchasing power with local/international suppliers, and access to low-rate loans.
- Lack of capabilities: Execution of utility-scale renewable energy projects necessitates specialized design, procurement, installation, and O&M capabilities, which smaller developers generally do not have.

To overcome these challenges, Qatar should introduce a tendering strategy that gives an opportunity for small/local developers to participate in larger renewable energy projects.

Figure 26: Tendering strategy options



A "managed" tendering strategy boosts the development of small-scale renewable energy developers, but there are pros and cons to this approach. The solar PV market could be separated into small-scale projects (less than 100 MW) and large-scale projects (over 100 MW). Small-scale projects could have reduced qualifications and be reserved exclusively for small PV players. The benefits of this approach are that small/local companies would have increased opportunities while larger projects could be tendered more rapidly. But this bifurcated market will result in higher LCOE than large-scale projects alone.

There are other targeted market interventions Qatar could continue or initiate to promote the development of local EPC (engineering, procurement & construction) and O&M companies.

For example:

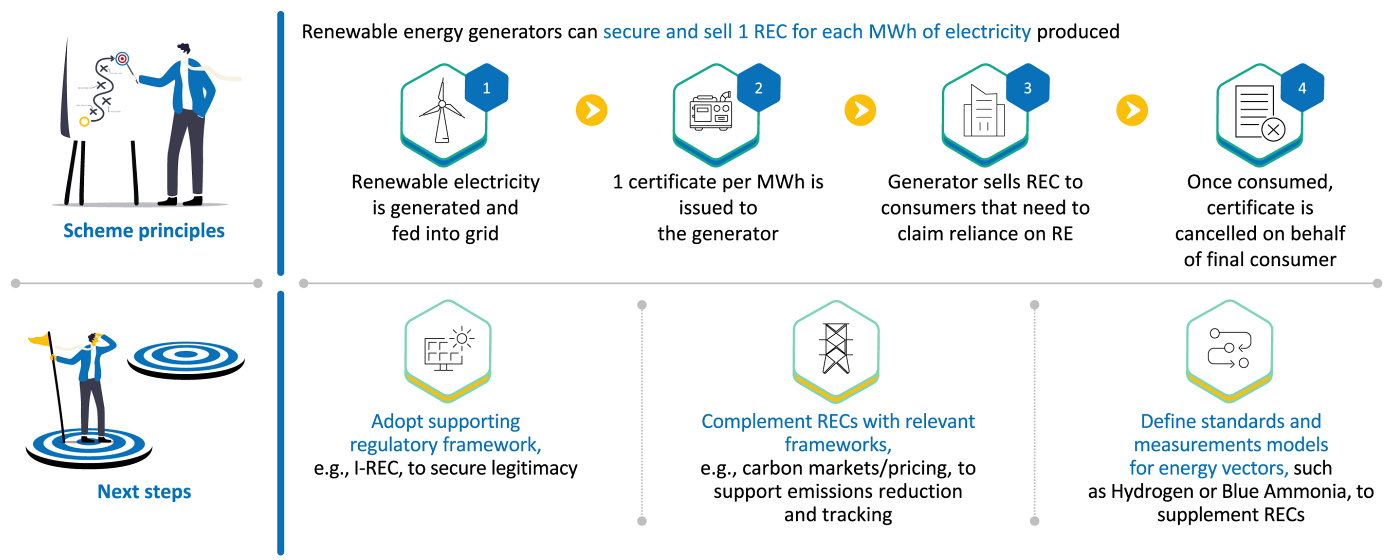
- Continue government-led pre-development activities: Detail resource availability and facilitate project licensing and grid connection processes to even the playing field.
- Local content targets: Introduce local content targets (defined by the Ministry of Finance) that are sufficient to require developers to engage with local EPC and O&M companies for the development and operations of the solar PV plant.
- Financing: Provide low-cost financing to support local players in setting up renewable energy-focused EPC and O&M companies.
- Vocational training: Offer affordable vocational training programs to encourage local developers, EPC firms, and O&M companies to enrol their employees and build their renewable energy capabilities.
- Certification: Provide renewable energy certification for EPC and O&M companies that meet a minimum threshold of capabilities.

4.2.2.2 Monetizing environmental attributes of renewable energy projects

There are two paths Qatar can pursue to capture the environmental attributes associated with renewable energy: carbon offsets or renewable energy certificates (RECs). Carbon offsets incentivize the avoidance or reduction of greenhouse gas emissions. RECs, on the other hand, incentivizes renewable energy production.

RECs are the more desirable path. With RECs, a tradeable credit is created with the production of each megawatt-hour of renewable energy. The certificates can be sold or traded, creating a new revenue stream in addition to the emission-free electricity that is produced. QatarEnergy is currently working on developing the Renewable Energy Certificate (REC) program.

Figure 27: Renewable Energy Certificate (REC) scheme



To introduce RECs, Qatar is best positioned to adopt the International Renewable Energy Certificate (I-REC) system, the common standard used in countries outside North America and Europe. The I-REC standard offers existing off-the-shelf standards, codes of practice, governance structures, and systems. I-REC is the general approach/standard used in the Gulf Cooperation Council (GCC). Qatar already is participating in the purchase/retirement of I-RECs.
Six initiatives are needed to maximize socio-economic contribution from the renewable energy program:

- Activate a renewable energy tendering strategy that incentivizes development of local players. This requires devising and activating a tendering strategy that enables and encourages participation of local market participants.
- Introduce local-content targets to incentivize developers to engage local EPC and O&M companies. The requires the introduction of feasible local-content targets in renewable energy projects to increase participation of local EPC and O&M organizations.
- Develop low-cost financing resources to support local players in setting up renewable energy-focused EPC and O&M companies. Achieving this will require the analysis and introduction of low-cost financing programmes for local developers to enable them to develop EPC and O&M capabilities and consequently increase local content.
- Offer affordable vocational training programs for employees of developers, EPC firms, and O&M companies. Creating suitable vocational training programs will upskill local renewable energy organizations.
- Implement an REC program. To achieve this, it will be necessary to conduct a specific set of activities to launch the REC program, including coordinating with relevant agencies, designing the program, and implementing the program.
- Provide REC training to incentivize EPC and O&M companies.

4.3 Developing required policies, regulations, and standards

Three clusters of necessary policies, standards, and processes were developed to enable the greater adoption of utility-scale and small-scale renewable energy. These are:

Policies and regulations, which includes:

- Analysing the remuneration schemes and incentive mechanismsa1
- Defining parameters for Net Billing scheme
- Assessing individual and collective self-consumption for consumers
- Establishing eligibility of consumer categories for DG programme
- Drafting a resolution for distributed renewable energy generation, and
- Developing a connection agreement between KAHRAMAA and prosumers.

Standards and guidelines, comprising the following:

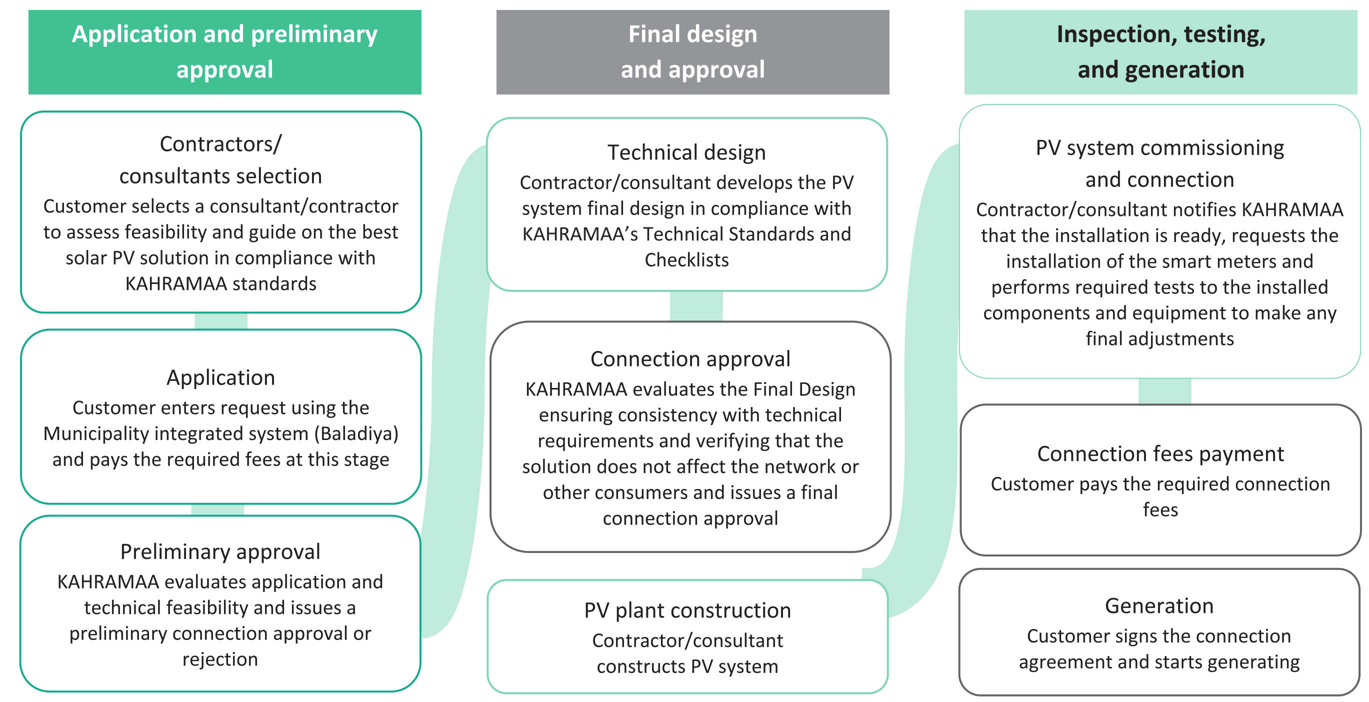
- Establishing technical standards for connection and integration of the solar PV systems
- Setting up technical standards for connection and integration of wind energy
- Developing guidelines to assess the grid impact of renewable energy resources connected into the electricity grid
- Creating connection guidelines for consumers
- Qualifying consultants and contractors for renewable energy generation
- Establishing eligibility standards for manufacturers' equipment, and
- Establishing guidelines for safety of the solar PV systems.

Processes and procedures, specifically:

- Developing a connection process for renewable energy generation
- Setting up guidelines for information to deliver in preliminary and final project design, and
- Establishing procedures for inspection and testing.

It also is recommended that a nine-step connection process be developed to efficiently connect small-scale (DG) solar PV systems to the grid. This connection process covers application and preliminary approval, final design and approval, and inspection, testing, and generation.

Figure 28: Connection process for small-scale PV



Further, two activities are needed to implement required policies, guidelines, and specifications to enhance renewable energy development:

- Qualify consultants and contractors, which involves defining and executing the processes required to qualify consultants and contractors, and
- Implement legislation and regulation necessary to guide and support the development of renewable energy.

4.4 Adopting an effective institutional support structure

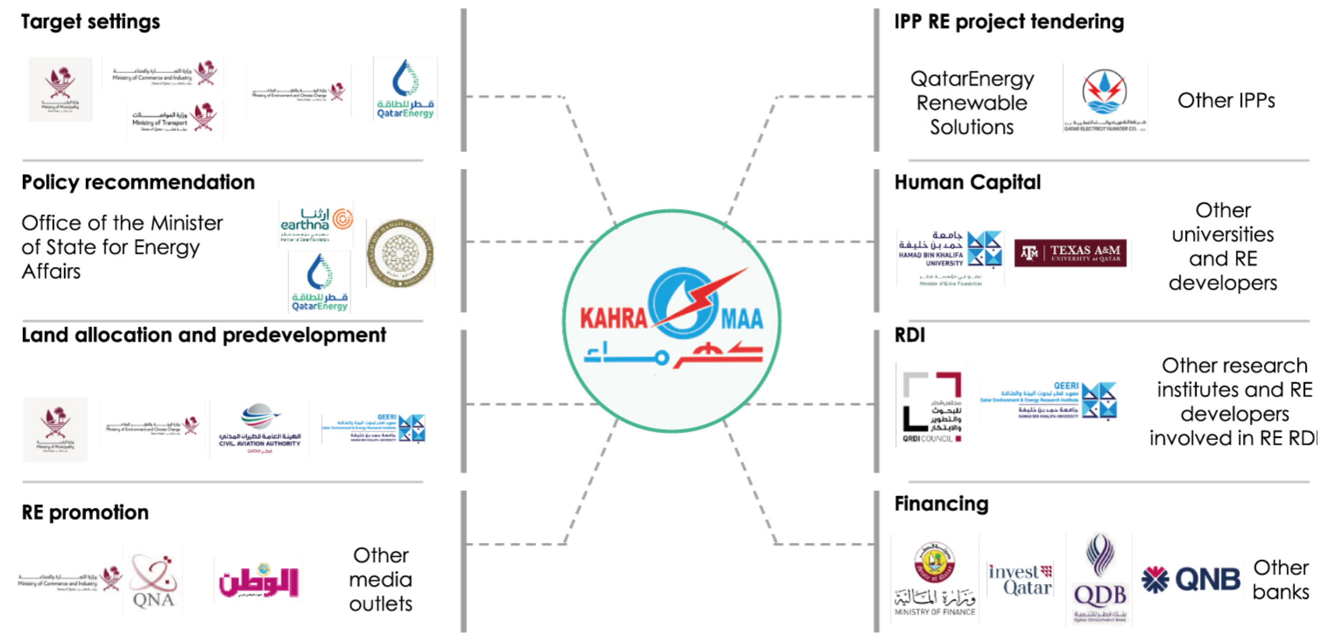
An effective institutional support structure must be developed to achieve the vision of developing a sustainable and affordable energy system. Eight renewable energy activities are typically conducted as part of a renewable energy program, and KAHRAMAA would be leading six of them, clustered around policy and strategy setting, tendering and off-taking, and regulation.

KAHRAMAA would take the lead in these three policy and strategy activities:

- Target setting: Define short-, medium-, and long-term renewable energy targets and technologies
- Policy recommendation: Recommend renewable energy policies for large-scale and small-scale projects, to be enacted by the relevant authority, and
- Market intelligence: Gather and analyse data related to the renewable energy market and other renewable energy-related topics nationally and globally.
- In the tendering and off-take arena, KAHRAMAA would lead in these activities:
- Renewable energy program development, meaning developing a renewable energy capacity deployment plan, securing and pre-developing land, and enabling renewable energy localization and adoption, and
- IPP renewable energy project tendering, including preparing and issuing tender documents, evaluating bids, awarding projects, and managing contracts.
- In regulating renewable energy, KAHRAMAA would define renewable energy regulations, issue licenses, and monitor compliance.
- Other activities relating to development and operations would be led by other entities. Those activities include:
- Development & Operation, including owning and managing generation plants and selling the electricity they produce. This would be led by independent power producers (IPPs).
- Enabling actions that support the development of the renewable energy sector by building up human capabilities, conducting R&D, providing attractive financing, etc. These activities would be led by a mix of public and private entities.

Going forward, KAHRAMAA will need to interact with multiple external stakeholders to drive renewable energy development in Qatar.

Figure 29: Renewable energy development stakeholder map



Six initiatives are needed to activate this new institutional setup and launch financing schemes, increase awareness, boost human capital development, and focus research, development, and innovation (RDI) to fulfil Qatar's renewable energy potential.

1. Set up a new regulatory unit in KAHRAMAA, which involves: developing the new regulatory unit's mandate, processes, procedures, and job descriptions; hiring resources; establishing professional capabilities; and detailing unit's plans in order to ensure the unit is fully active and functional.
2. Activate KAHRAMAA's renewable energy function to fulfil all the aspirations in number 1, above.
3. Introduce low-cost financing programs for small-scale renewable energy projects, which involves analyzing, proposing, and announcing funding mechanisms to encourage adoption of small-scale renewable energy.
4. Raise awareness and implement an advocacy campaign for renewable energy adoption in collaboration with relevant ecosystem stakeholders.
5. Recommend renewable energy RDI areas of focus for Qatar, which requires communicating renewable energy research priorities to affected stakeholders to reduce or remove pain points in the sector.
6. Create a renewable energy human capability development plan in which reskilling or upskilling initiatives address identified skills gaps to ensure the availability of skilled resources that would support achievement of the objectives of the Qatar National Renewable Energy Strategy.

Qatar National Renewable Energy Strategy (QNRES)

The QNRES will present a comprehensive with concrete initiatives to support the long-term developement of the renewable energy sector in alignement with the Qatar National Vison 2030.

ENERGY MIX GOALS

Increase the share of renewable energy in Qatar s capacity mix from:

5% 2022

18% 2030

This transformation of the national energy system will strengthen economic growth, energy security, and climate foe Qatar. By 2030, the QRESwould acheive:

15%
Reduction in generation cost

3
million Metric Tonnes/ year reduction in CO2

QAR 25 to 30 Bn
of investments

INTRODUCTION OF DISTRIBUTED GENERATION POLICIES

Consumers are allowed to generate electricty and connect PV system to the grid

Net billing and other financial incentives will be introduced for consumers

Users can lower electricity bill and generate profit from sale of surplus electricty

استراتيجية قطر الوطنـــية
للطاقـــــة المتجــــددة
Qatar National Renewable Energy Strategy

KAHRAMAA
كهرماء
المؤسسة العامة القطرية للكهرباء والماء
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