MINISTRY OF ELECTRICITY AND ENERGY
THE REPUBLIC OF YEMEN

GENERAL DEPARTMENT FOR RENEWABLE ENERGY

NATIONAL STRATEGY FOR
RENEWABLE ENERGY
AND ENERGY EFFICIENCY

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1 Executive Summary of the National Strategy for Renewable Energy (REN) and Energy Efficiency (EE)

1.1 Key Power Sector Issues

The Power Sector in Yemen is mainly focussing the following generation challenges:

- High demand growth rate
    - High peak demand case: projected peak demand of 3,181 MW in 2025 from current peak demand of app. 1,485 MW
- Limited natural gas supply for domestic utilization (not committed for export)
    - Power Generation Master Plan projects 2858 MW gas turbine capacity in 2025 (96% of the national generation capacity)
    - Uncommitted proven reserves can only sustain 1154 MW for 25 years
    - Uncommitted proven and probable reserves can support 1745 MW for 25 years
- Capacity shortage in 2025 ranges between 1,177 – 2,158 MW and translates into an electricity generation gap between 7,888 – 14,462 GWh[1].

1.2 Supply Options

Options to meet these challenges and generation shortage include:

- Interconnection with the national grids of neighbouring Arab and East-African countries
    - Least likely short-term option as such proposed regional projects require time consuming bilateral or multi-national negotiations and introduce a mid-term dependency from electricity imports, but
    - Important long-term strategic option in order to export carbon-free “Green Electricity” generated by REN technologies, not only to neighbouring countries but in the future even to Europe (Solar Plan of the EU)
- Diesel power generation
    - Least likely option since the cost of diesel generation is higher than alternative options and depends on import of diesel.
- Natural gas generation
    - Least likely option because of its dependence on the discovery and confirmation of additional natural gas reserves.
    - Reallocations from existing and future export commitments is unlikely as due to dwindling oil reserves, natural gas could play an important source of government revenues in the future.

[1] Depending on different demand forecast scenarios under a business as usual approach without introducing proposed REN and EE measures.

- Renewable energy power generation

  This is the most viable option since national resources are abundant and the economic cost of generation is lower than diesel fuel

  - Wind energy technical practicable potential – 34,286 MW
  - Geothermal energy technical practicable potential – 2,900 MW
  - Landfill gas technical practicable potential – 6 MW

  In the medium- to long-term also solar-thermal technology options (Concentrated Solar Power – CSP) will become economically viable once economy-of-scale mechanisms get triggered by worldwide installed generation capacity

  - CSP technical practicable potential - 18,600 MW

- Energy Efficiency (EE) and Demand Side Management (DSM)
  - This option does not generate electricity as such but contributes to the reduction of electricity demand especially in urban centres.
  - The identified saving potential of app. 220 MW generation capacity or 650 GWh electricity generation should be un-locked within 3 - 5 years[2]

1.3 Proposed policy objectives to promote renewable power generation and energy efficiency

Apart from the relevant policies elaborated in the electricity law of 2009 the proposed strategy for REN and EE was guided by the following **general policy objectives:**

- optimize the utilization of domestic energy resources to prevent increasing dependence from future fuel and energy / electricity imports and to improve security of fuel supply (energy security),

- diversify the country's energy mix by increasing the share of renewable energies in electricity generation (from the interconnected national grid over isolated grids down to the household level) to decrease the dependence from fossil fuels, to improve the country's economic situation and to protect the environment and climate by avoiding Green House Gas (GHG) emissions,

- ensure poverty alleviation, sustainable rural development and economic growth by promoting access to decentralized renewable energy conversion technologies to be incorporated in governmental development plans in all relevant sectors,

[2] Identified EE measures include the following programs (saving potential in MW given in brackets): promotion of CFL (90), linear fluorescent lamps (7.3), solar water heaters (23.6), water heating improvement (12.6), power factor correction in gov installations (32.4), industrial energy audits (1.5), standardization and labelling (44) and introduction of time of use tariffs (37.8)

- eliminate peak and energy shortages faced by the electricity sector through the promotion of renewable energies as well as through improved energy efficiency and conservation among main consumer classes,
- alleviate the impact on the poor of future rising fuel and electricity prices by promoting energy efficiency and conservation initiatives,
- promote sustainable electricity sector development by creating and opening up the Yemeni electricity market in the field of renewable power generation and power distribution in rural areas, to foreign and private investors (Independent Power Producers) as well as to various non-governmental institutions to provide renewable energy services in rural areas (Rural Energy Service Providers).

1.4 Proposed renewable energy and energy efficiency targets

- Grid electricity (large scale electricity generation)
    - o High market penetration scenario – 20% of generation mix in 2025 (3467 GWh)
    - o **Baseline scenario – 15 % of generation mix in 2025 (2600 GWh).**

      This translates into an overall installed capacity in the year 2025 of
        - **400 MW from wind farms**[3]
        - **160 MW from geothermal power stations and**
        - **6 MW from power stations using landfill gas**
    - o Low market penetration scenario – 10% of generation mix in 2025 (1733 GWh)

- Off-grid electrification (electrification of individual rural Households-HH)[4]
    - o High market penetration scenario – 160.000 rural HH (65% of identified market potential) to be electrified Solar Home Systems until 2025 (installed capacity app. 8 MWp)
    - o **Baseline scenario – 110.000 rural HH (45% of identified market potential) to be electrified** Solar Home Systems **until 2025 (installed capacity app. 5.5 MWp)**

[3] Assuming that the generation capacity based on fossil fuels can be accelerated beyond PECs master plan for generation also the installed capacity of wind farms will be increased correspondingly but should not contribute to more than 15% of the overall installed generation capacity in the interconnected national grid. Only interconnection with the grid of neighboring countries will allow to significantly un-lock the country's enormous renewable energy potential.

[4] This off-grid electrification target stems from the National Rural Electrification Strategy which will be implemented by the Public Authority for Rural Electrification (PARE). Due to the fact that it aims at the dissemination and promotion of renewable energy systems it was decided to integrate it into the Executive Summary of the overall National Strategy for REN and EE.

- Low market penetration scenario – 60.000 rural HH (25% of identified market potential) to be electrified with Solar Home Systems until 2025 (installed capacity app. 2.5 MWp)

- Energy Efficiency
  - High Market penetration scenario – 20% increase in energy efficiency in the power sector until 2025
  - **Baseline scenario – 15 % increase in energy efficiency in the power sector until 2025**
  - Low Market penetration scenario – 10% increase in energy efficiency in the power sector until 2025

- Solar Water Heaters
  - High market penetration scenario – 60% of market potential in 2025 (300,000 units) representing a saving potential of 686 GWh
  - **Baseline scenario – 40 % of market potential in 2025 (200,000 units) representing a saving potential of 457 GWh**
  - Low market penetration scenario – 20% of market potential in 2025 (100,000 units) representing a saving potential of 229 GWh

Once **Concentrated Solar Power (CSP)** generation gets economically viable due to increased accumulated generation capacity installed worldwide it is recommended to implement a 100 MW CSP station in Yemen.

As the CSP technology can contribute to partially cover the base load demand in the future, regardless of the current prices the MEE will immediately start to identify the most promising areas and develop at least three CSP projects beyond pre-feasibility stage and will try to source donor funding to buy down the economic cost of generation and accelerate implementation.

After carrying out a reassessment of the potential of **biogas** units on the rural household level a national program for the widespread dissemination of biogas digesters will be developed if deemed to be viable. The implementation of such a program would be managed either by PARE or another concerned governmental institution to be determined during the course of such a feasibility study.

Given the challenging boundary conditions during and after the recently kick-started reform process in the power sector prescribed by the electricity law it is recommended to set the renewable energy and energy efficiency targets according to the **baseline scenario** as presented above.

1.5 Strategies to Remove Barriers and Promote Renewable Energies and Energy Efficiency

To achieve the above targets, the MEE has formulated strategies that enhance market deployment of renewable energy technologies and energy efficiency measures as well as remove barriers to renewable energy development and energy conservation in the country.

Seven strategic areas of intervention were identified and the above barriers were classified according to these strategic areas:

- Policy
- Resource utilization and market access
- Financial and fiscal incentives
- Financing
- Institutional arrangement
- Information and capacity building
- Legal framework

Strategic measures to remove these barriers were elaborated which represent the main components of the strategy for renewable energy and energy efficiency. These are summarized in *Table 1-1*.

Table 1-1: Components of the Renewable Energy and EE Strategy

Strategic Area	Barriers	Strategic Measures
1. REN and EE Policy	• Lack of REN and EE Policy Framework	**Adoption of REN and EE policy objectives and targets** **<u>General REN policy objectives:</u>** • optimize the utilization of domestic renewable energy resources to prevent dependence from future energy / electricity imports • diversify the country's energy mix by increasing the share of renewable energies (REN) in electricity generation (both grid and off-grid), • ensure poverty alleviation, sustainable rural development and economic growth by promoting access to decentralized renewable energy conversion technologies • eliminate peak and energy shortages faced by the electricity sector through the promotion of renewable energies as well as through improved energy efficiency and conservation • alleviate the impact on the poor of future rising fuel and electricity prices by promoting energy efficiency and conservation initiatives • promote sustainable electricity sector development

		by creating and opening up the Yemeni electricity market in the field of renewable power generation and power distribution in rural areas, to foreign and private investors (Independent Power Producers) as well as to various non-governmental institutions to provide renewable energy services in rural areas (Rural Energy Service Providers) **<u>Renewable Energy and Energy Efficiency targets</u>:** <u>Grid electricity</u> • Baseline scenario – 15 % of electricity generation mix in 2025 (2600 GWh) <u>Off-grid electricity</u> • Baseline scenario – electrification of 110 000 rural households with individual solar home systems (SHS) in 2025 amounting app. 5.5 MWp of installed capacity and 45% of market potential (corresponding strategy to be implemented by the Public Authority for Rural Electrification – PARE) <u>Solar water heaters</u> • Baseline scenario – 40 % of market potential in 2025 (200,000 units installed) <u>Energy Efficiency</u> • Baseline scenario – 15% increase of energy efficiency in the power sector until 2020
2. REN Resource Utilization and Market Access	• No specific agency responsible for promotion and coordination in the field of REN and EE	• MEE to act as the leading governmental agency for the promotion of grid-based REN generation technologies and EE • PARE to act among other tasks as the sole national agency for the promotion of REN technologies for decentralized off-grid electrification • Creation of an inter-ministerial committee for energizing rural development (Ministry of Education, Ministry of Public Health and Population, Ministry of Local Affairs, Ministry of Agriculture, Ministry of Water and Environment as well as Social Fund for Development , Public Works Project and Environment Protection Authority)

	• Lack of REN access frameworks	• Elaboration of a REN Resource Area Development Plan
		  • identifying and prioritizing geographic locations in Yemen with high practicable potential for electricity generation from REN and
		  • registering the most important REN resource areas at the Land Authority earmarked for REN generation projects and turning it into governmental property wherever possible

		• Establishment of an IPP Framework for REN projects specifying[5],
		  • Procedures for REN resource area contracting
		  • land lease agreement,
		  • power purchase tariff options (technology based, either negotiated or feed-in tariff scheme).

	• Lack of technical standards for grid connection of REN projects	• Technical standards for grid-connection (grid-code) to be elaborated together with PEC and to be integrated in the standardized power purchase agreements (chapter 3 of the REN and EE Strategy report)
	• Lack of a national solar water heater program	• Development of a solar water heater Market Transformation Framework encouraging local production and employment including delivery mechanisms and financing schemes (chapter 5 of the REN and EE Strategy report)
	• Lack of a national biogas program for rural households	• Assessment of the potential of biogas digesters on the household level in rural areas and elaboration and implementation of a national biogas program promoting the local production and subsidized dissemination of biogas digesters
	• Lack of technical standards for EE	• Specification of energy efficiency standards, labels protocols, codes of practice and other criteria for energy efficiency and conservation
3. Financial and Fiscal Incentives	• High upfront costs	• Application of existing Investment Law incentives (income tax holidays, import duty exemption, etc) for all renewable energy projects implemented by private investors and the government

	• Lack of financial and fiscal incentives for the promotion of REN and EE	• Proposed additional measures include:
		  • soft loans,
		  • grid connection costs to be absorbed by PEC (future Corporation for Transmission),
		  • free land-use (to be specified in the land-lease agreement),
		  • subsidies on project studies, resource exploration and measurement (to be financed through the REN Fund).

		• Technology specific and scale dependent feed-in tariff scheme for renewable energies to be developed and approved after successful implementation of the first pilot demonstration schemes
		• Formulate and approve regulations for custom and tax

[5] MEE will sign a Memorandum with project developers to further investigate the identified renewable energy resource area. Each developer will be given two years to conduct resource measurement activities and project studies. At the end of the second year each developer must submit a proposal for power development. If the developer fails to submit a proposal, MEE will offer the site to another renewable energy power developer.

	• Insufficient remuneration of civil servants • Lack of financial and fiscal incentives for the promotion of EE and DSM	exemption for small scale renewable energy systems applicable in the field of rural development • All renewable energy projects to be developed with a carbon financing component (Clean Development Mechanism - CDM) to be registered at the EPA. • Establishing an attractive remuneration scheme in the REN/EE sector to facilitate recruitment of skilled and highly motivated employees • Provision of fiscal incentives and disincentives through tariffs and taxation to promote energy efficiency and conservation (Chapter 4 of the REN and EE strategy report)
4. Financing	• Lack of financing to support and promote REN and EE	• Establishment of a Renewable Energy and Energy Efficiency Fund to be managed under the MEE to provide financing for smart subsidies, demonstration projects and barrier removal activities • Implementation of credit schemes through a revolving fund to be managed under the PARE in order to enable poor rural households purchase REN systems especially for lighting (initially being implemented under the recently approved Rural Energy Access Project at PARE) (Chapter 6 of the REN and EE Strategy report)

5. Institutional Arrangement	• Lack of institutions and lack of coordination on the national, regional and international level	• Improve the institutional set-up within the power sector enabling it to play the required role in effectively promoting REN and EE
		• Phased institutional approach at the MEE:
		  • Immediate creation of a General Department for REN and EE in the MEE with units for
		  o Wind energy
		  o Solar energy
		  o Geothermal energy
		  o Policy, Planning, Regulation (including Clean Development Mechanism - CDM)
		  o Investment Promotion, Public Relations and Donor Fund Raising
		  o Energy Efficiency and Demand Side Management
		  • Creation of a separate sector for REN and EE in the MEE headed by a Deputy Minister within 3 years
		  • Creation of a separate Authority for REN and EE under the MEE within 5 years
		• Creation of a off-grid directorate under PARE being responsible for managing the national Solar Home System Program as well as the

		• Through the MEE the GoY joins at least one regional (Regional Centre for Renewable Energy and Energy Efficiency - RECREEE) and one international organization (International Renewable Energy Agency) for the promotion of Renewable Energies and Energy Efficiency (Chapter 7 of the REN and EE strategy report)

6. Information and capacity building	• Lack of awareness on REN and EE among investors and households	• Establishment of one-stop information and investment promotion centre at MEE in close coordination with the General Investment Authority (GIA).
		
		• Increase public awareness about the national Strategy for REN/EE through the implementation of public awareness campaigns
		  • on the national Solar Home System (SHS) program during the implementation of REN projects in rural areas (to be carried out by PARE)
		  • regarding the economic feasibility and poitive impacts on household budgets through replacing electrical heaters by solar water heaters
		
		• preparation of suitable awareness material for different target groups to explain the working principles of REN Systems and to promote the economic benefits of proposed energy efficiency measures

	• Lack of technical skills and capacities	• Creation of a national training centre for REN/EE within PEC"s Dahban Training centre to carry out capacity building programs in the field of REN/EE to test and licence REN equipment and to certify energy efficient products
		
		• Formulation of capacity building programmes to meet the needs of staff within the power sector as well as other national stakeholders
		  • Preparation of special REN/EE training programs for the staff being involved in the implementation of the REN/EE Strategy
		  • Preparation of training programs for engineers and technicians in the field of design implementation and maintenance of REN systems
		
		• Collaboration with national knowledge centres and regional and international agencies in implementing capacity building activities

	• Lack of support to research and development	• Support to knowledge centres in undertaking applied research to be financed through the REN Fund (Chapter 8 of the REN and EE strategy report)

7. Legal Framework	• Lack of REN legal and regulatory frameworks	• Adoption of a renewable energy by-law • Integration of REN legal and regulatory frameworks in the executive regulations of the Electricity Law or the renewable energy by-law (Chapter 9 of the REN and EE strategy report)

Whenever possible, especially large-scale renewable power generation projects will be developed and implemented through IPP schemes.

In order to increase investor's confidence and to demonstrate that the required legal and institutional framework has been put in place by the GoY the first renewable energy projects will be financed by the GoY together with international donors but also allowing and enabling Public Private Partnerships (i.e. creation of completely or partially government owned special purpose companies for the operation of REN power stations) and as such simulating future IPP conditions.

The guiding principle in the implementation of the rural development component of the Strategy for REN and EE is to create an enabling legal framework to attract foreign and private investors and to enable public private partnerships in the field of electricity generation, provision of local electricity services (Service Providers) as well as energy efficiency and conservation through:

- Creation of an enabling investment climate for private investors and cooperatives in the field of decentralized power generation
- Provision of an effective institutional framework to manage and operate rural electrification systems by Rural Electric Service Providers (especially consumer owned cooperatives) through the Public Authority for Rural Electrification (PARE)
- Provision of market based conditions for the private sector to participate in managing and operating rural electrification systems and ensure consumer protection (quality of service and regulated electricity tariffs)