Saudi Arabia’s Renewable Energy Strategy and Solar Energy Deployment Roadmap
Kingdom of Saudi Arabia

- Oil wealth has made possible rapid economic development, which began in the 1960’s and accelerated in the 1970’s.
- Saudi oil & gas reserves are the largest in the world, and Saudi Arabia is the world’s leading oil producer and exporter.
- The population of Saudi Arabia is approximately 26,534,504
  - 0-14 years: 28.8%
  - 15-64 years: 68.2%
  - 65 years and over: 3%
King Abdullah City for Atomic and Renewable Energy
Established by Royal Order April 17, 2010, the Mission is to be:

"...The driving force for making atomic and renewable energy an integral part of a national sustainable energy mix, creating and leveraging the competitive advantages of relevant technologies for the social and economic development of the Kingdom of Saudi Arabia..."
Key K.A.CARE Objectives

• **CREATE** a sustainable economic sector for Saudi Arabia anchored by local alternative energy demand market

• **CONTRIBUTE** to job creation, GDP growth, environmental footprint reduction and sustainable development

• **MAINTAIN** highest levels of safety, security and transparency
Execution of K.A.CARE Mandate

- **SUGGEST** alternative energy mix
- **DEVELOP & LEAD** execution plans
- **PLAN** for and **BUILD** physical city

Sustainable and efficient energy future for KSA
Maximizing Return

Oil Saved

Economic Sector

Sustainability

How Much Can We Do?
- Demand Growth
- Demand Pattern
- Technology Characteristics

How Much Should We Do?
- Economics
- Sustainability
- Technology maturity
Building the Optimum New Energy Mix
Energy growth drivers

- **POPULATION** growth at an annual rate of 3.2% (2004 – 2010)

- Robust **ECONOMIC** growth (4.3% 2008, 0.1% 2009, 3.8% 2010, 6.8% 2011)

- **INDUSTRIAL** production growth* of 6.6% (2008, 2.9% 2009, 5.3% 2010)

* In constant prices (1999 base year)  
Source: Central Department of Statistics. 2011
Growth in Fossil Fuel Consumption Already High

KSA’s oil demand rose 27% during the last 4 years
Forecast of energy demand growth

At current pace, domestic consumption of fossil fuels is expected to nearly triple by 2030

* Total local consumption (transportation, industry, electricity, etc)

Source: Aramco CEO. 2010
Energy flow in the Kingdom of Saudi Arabia

- 54% Oil and 46% Gas
- 22.7% used as industrial feed stocks.
- 21.1% of primary energy used in Transport sector, (or 39% of total oil consumption).
- 604 TWh ~ 34.2% of total primary energy used in KSA, with 32% generation efficiency.
Peak Power Demand Will Nearly Triple in Next 20 Years...

Source: ECRA 2010
...Creating Tremendous Capacity Gap

Gap between peak demand and existing + planned capacity

- Peak Demand
- New Committed
- Existing Diesel
- Existing HFO
- Existing Crude
- Existing Gas

60 GW (Approx.)
Energy Consumption Patterns

Total of 193,472 GWH

- Industrial: 17.9%
- Agricultural: 2.6%
- Commercial: 12.2%
- Governmental: 15.1%
- Residential: 52.2%
- Building: 79.5%

70% consumed by HVAC

Source: Saudi Electricity Company (SEC) 2009
Parameters Affecting Energy Mix Development

- Economics of hydrocarbons saved
- Value chain development
- Electricity and desalination demand patterns
- Technology choices
- Regulatory and physical infrastructure requirements
- Human capacity development
Annual Electricity Demand Pattern in KSA

Seasonal change in peak load exceeds 40%

Week Number (July 2009 – August 2010)
Day-Night Load Variation for Saudi Arabia

Uniform day-to-night variation year round
Forecasted Daily Electricity Demand Pattern 2032

Daily load during a **work day** in **August** 2032

Daily load during a **holiday** in **January** 2032
Energy Development Targets
Target Renewable Capacity by 2032

Maximizing Renewable Deployment Return

54 GW
Solar Resources in KSA
Target Renewable Capacity by 2032

- Solar PV: 16 GW
- Solar CSP: 25 GW
- Wind: 9 GW
- Waste-to-energy: 3 GW
- Geothermal: 1 GW
### Target Solar Capacity by 2032

<table>
<thead>
<tr>
<th>Solar Technology</th>
<th>Energy Generation* Contribution (TWh/y)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Solar PV</strong></td>
<td>28 - 35</td>
<td>4.4 – 5.5</td>
</tr>
<tr>
<td><strong>Solar CSP</strong></td>
<td>75 - 110</td>
<td>11.7 - 17.2</td>
</tr>
</tbody>
</table>

*Load factor: PV = 0.2 – 0.25, CSP = 0.34 – 0.5*
Target Renewable Energy Contribution by 2032

Renewable Energy

Energy
Generation* Contribution (TWh/y)

150 - 190

% 23 – 30

* Load factor: PV = 0.2 – 0.25, CSP = 0.34 – 0.5, Wind = 0.2, Geothermal = 0.9, Waste-to-energy = 0.85
Gradual Deployment of Alternative Energy

*Load factor: PV = 0.2, CSP = 0.34, Wind = 0.2, Geothermal = 0.9, Waste-to-energy = 0.85
Proposed Energy Mix 2032

- Solar PV
- Solar CSP
- Hydrocarbons
- Geothermal + Waste-to-Energy

16 GW
25 GW
60.5 GW
4 GW+ Other sources
Load-Specific Technology Component of the Proposed Energy Mix by 2032

• **PV** will meet total day time demand year round

• **GEOTHERMAL + WASTE-TO-ENERGY + OTHER SOURCES** will meet base-load demand up to night time demand during winter

• **CSP** with storage will meet maximum demand difference between **PV** and base-load technologies

• **HYDROCARBONS** will meet the rest of the demand

• **WIND** will be dedicated for desalination
Overview of the execution plans

**Policy**
- Approval and publishing of a national policy on nuclear and renewable energy

**Laws and regulations**
- Development of laws and regulation
- Creation of regulator bodies
- Ratification of treaties
- Revising existing laws

**Investment vehicles and strategy**
- Creation of Alternative Energy Technology Company
- Setup of loan guarantees and soft loan programs

**Operating model**
- Creation of holding company for nuclear power
- Formation of standalone off-taker for sector

**R&D and human capital development**
- Development of R&D capabilities
- Development of engineers, technicians and other specialists
Deployment Roadmap
Renewable Energy Deployment Roadmap

2013

1st RE Project

2015

2.35 GW

1.05 GW

2020

17.35 GW

6.5 GW

2025

28.4 GW

10.8 GW

2030

41.1 GW

13 GW
Renewable Energy Value Chain Development
Value Chain Development

Building a World-Class Alternative Energy Sector:

- Industrial investment
- Research, development and innovation
- Technology development
- Education and training
- Human capacity development
Renewables Manufacturing, EPC and O&M split

% total capex and opex throughout the plant lifetime
Recommended Key Activities for Core Localization in Renewable Energy Total Spend

% total capex and opex throughout the plant lifetime
Value Chain Development: Beyond Solar Cell, Blade and Mirror

- Electricity Generation
- Industrial Energy Applications
- Seawater Desalination & Water Management Applications
- District & Solar Cooling
Localization of Renewable Energy Industry

Maximizing benefits of alternative energy requires localization policies …

…which depends highly on local skills…

…and cooperation and JV’s
Value Chain Activation Plan

Value chain enablers
1. Value chain organization capacity building
2. Independent quality assurance authority
3. Industrial readiness program (cost, quality, delivery)
4. SME development program
5. FDI attractiveness and promotion
6. Stakeholder engagement and communication
7. Global vendor engagement & qualification
8. Alignment with current and planned national initiatives

Value chain interfaces
9. Value Chain Opportunities
10. Regulatory environment
11. Development of R&D centers and programs
12. Development of local human capabilities
13. Leveraged procurement
14. Feed-in tariff / PPA
15. Bid preparation
16. Program and project structure

Steps:
1. Step 1: Capability gap assessment
2. Step 2: Identification & prioritization of preferred local suppliers
3. Step 3: Readiness action plan
4. Step 4: Action plan evaluation and validation
5. Step 5: Assist in JV/partner selection
6. Step 6: Monitor implementation
7. Step 7: Certification process assistance
8. Step 8: Action plan evaluation and validation
9. Step 9: Identification & prioritization of preferred local suppliers
Socioeconomic, Environmental and Indirect Economic Impact
# Potential Socioeconomic and Other Tangible Returns

<table>
<thead>
<tr>
<th>Additional Returns from Alternative Energy Economic Sector Development</th>
<th>KPIs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct employment opportunities in alternative energy generation</strong></td>
<td>137,000 jobs</td>
</tr>
<tr>
<td><strong>GDP contribution from Alternative Energy employment opportunities for Saudis</strong></td>
<td>USD 51 billion</td>
</tr>
<tr>
<td><strong>Contribution to economy from export of Alternative Energy products and services</strong></td>
<td>USD 40-60 billion</td>
</tr>
<tr>
<td>Reduction in CO₂ emissions from power plants</td>
<td>60%</td>
</tr>
<tr>
<td>Reduction in NOₓ emissions from power plants</td>
<td>75%</td>
</tr>
<tr>
<td>Reduction in SO₂ emissions from power plants</td>
<td>70%</td>
</tr>
<tr>
<td>Potential cross-border and intercontinental energy export (renewables)* during off-peak season</td>
<td>10-30 GW</td>
</tr>
</tbody>
</table>

* DESERTEC Industrial Initiative (DII)
Other Enablers
Sustainable Renewable Energy Sector:

• **Legal and Regulatory Framework:**
  - **Locally:** sends a clear signal to the population, the private sector and all governmental entities that the Kingdom is dedicated to significantly expanding its renewable energy program.
  - **Internationally:** sends a clear message to other nations that Saudi Arabia is serious in utilizing renewable sources of energy and in doing its part to protect the environment as a responsible global citizen.
  - **Investors:** a single legislation that regulates the renewable sector will give investors confidence in the manner by which the Kingdom intends to regulate its renewable sector thereby encouraging investment i.e. legislation will provide stability to the sector and thus investor confidence.

• **Licensing and permitting:**
  - Identifying the roles and responsibilities of other governmental agencies such as ECRA, PME, MOMRA etc..
Sustainable Renewable Energy Sector:

- **Research, Development and Innovation:**
  - The ultimate goal of K.A.CARE is defined by the mandate stated in the Royal decree on Apr. 17, 2010 to contribute to sustainable development in the Kingdom by using science, research and industries related to renewable.
  - This project is intended to help drive towards this goal by developing the structure and framework of research capability through a network of National Labs and User facilities.
  - Mission driven research.
  - Cooperative research & development programs.
Sustainable Renewable Energy Sector:

• **Renewable resource monitoring and mapping program in the Kingdom of Saudi Arabia:**
  - The RRMM Program will collect and deliver accurate and high quality (spatial & ground) data for solar, wind, geothermal, and waste-to-energy resources to support research, industrial applications, and deployment projects.
  - The RRMM Program will support both the planned rapid deployment of renewable energy projects and the research programs to develop renewable technologies.

• **Energy Entrepreneurship Initiative:**
  - To foster the inherent capabilities and competitiveness of the Kingdom of Saudi Arabia’s SME and entrepreneurial ecosystem, to capture the business opportunities, facilitate innovation and promote local content leveraged through the national renewable energy program.
Sustainable Renewable Energy Sector:

- **Grid impact:**
  - The success of K.A.CARE in delivery of reliable and stable sustainable energy at targeted levels is critically dependent on major new developments in grid capacity, capability and operations.

- **Exporting electricity:**
  - The objectives of the study were to analyse the economic viability of electricity exports from the Kingdom to the EU and to explore the practical arrangements needed to achieve the economic benefit. Furthermore, the study was to investigate alternate markets other than the EU to export to. In summary, the aim of the study was to answer three fundamental strategic questions:
    - Is electricity trading with the EU economically viable for the Kingdom?
    - If so, is electricity trading with the EU practically achievable?
    - Which other potential markets should be investigated?
Sustainable Renewable Energy Sector:

- **Micro Generation:**
  - Remote locations that are not grid-connected, such as border posts, highway family rest areas and remotely located mosques, small size villages represent an excellent potential for micro generation, with hybrid designs including solar energy and desalination, solar energy and cooling, etc. The daily needs of the electricity are fulfilled, normally, via diesel generators, where the fuel is transferred periodically to these bases.

- **K.A.CARE Renewable Energy Competitive Procurement:**
  - Maximize the economic benefit from its resources, including its hydrocarbon sector. Falling costs of renewable energy make clean power a viable option where it is used to displace the burning of oil; as long as that oil is valued at the international selling price.
  - As part of this diversification, the tender program is intended to establish benchmark prices across each of the sectors in a local context and to provide jobs and skills for Saudis.
K.A.CARE City
The K.A.CARE city will include the following:

- National Sustainable Energy Laboratory
- Industrial clusters
- Alternative energy farm
- Energy park
- Technical training institutions
- Technical incubators
- Commercial facilities
- Convention centers, exhibition halls and other public amenities
- KA-CARE headquarters and residential facilities
- Basic infrastructure
First Phase of K.A.CARE City

City infrastructure requirements for Phase 1

City energy requirement from renewables

3-5 year R&D focused development program for 8,000 to 10,000 residents (including 800 scientists)
K•A•CARE Renewable Energy
Competitive Procurement
Competitive Procurement Portal:

• Learn about K.A.CARE's renewable energy vision for the Kingdom, including the program stages and timeline and the related Overview of the Competitive Procurement Process (CPP).

• View the CPP White Paper which offers a more detailed process and specific goals for the program.

• Submit feedback on the CPP White Paper for K.A.CARE to consider in finalizing the subsequent documents.

• Allow potential developer/investor to register to gain access to the successive Requests for Proposal (RFPs) and Power Purchase Agreements (PPAs) and to receive the latest news and updates related to the Program Status & Timeline.
• Initially, the CPP will consist of an Introductory Round with pre-packaged sites identified by K.A.CARE, followed by additional procurement rounds scheduled sequentially thereafter.

• These initial rounds are the focus of this officially released White Paper titled, “Proposed Competitive Procurement Process for the Renewable Energy Program”.

<table>
<thead>
<tr>
<th></th>
<th>Total size (MW)</th>
<th>Sector breakdown (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introductory Round</td>
<td>500-800</td>
<td>5-7 projects across the wind and solar sectors</td>
</tr>
<tr>
<td>1st procurement round</td>
<td>2,000-3,000</td>
<td>Solar PV - 1,100; STEG - 900</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wind – 650; Others: 50-350</td>
</tr>
<tr>
<td>2nd procurement round</td>
<td>3,000-4,000</td>
<td>Solar PV - 1,300; STEG - 1,200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wind - 1,050; Other: 50-350</td>
</tr>
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</table>
CPP White Paper:

• K.A.CARE is establishing a standalone government-backed entity, the Sustainable Energy Procurement Company (SEPC), responsible for administering the procurement and executing and managing the PPAs.

• Qualified proponents will be able to submit proposals electronically through this portal.

• The evaluation of proposals will combine price and non-price factors, enabling alignment of the CPP with the broader objectives of KA.CARE.

• Prior to the launch of each round, qualified proponents will have the opportunity to review and comment on draft RFPs and the terms of the PPAs, and K.A.CARE/SEPC may consider using this feedback in finalizing the RFPs and PPAs.
### CPP White Paper:

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Role</th>
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<tbody>
<tr>
<td>King Abdullah City for Atomic and Renewable Energy (KA.CARE)</td>
<td>It is responsible for defining and implementing Saudi Arabia's clean energy programme</td>
</tr>
<tr>
<td>Sustainable Energy Procurement Company (SEPC)</td>
<td>SEPC is a standalone government-guaranteed entity responsible for administering the procurement and executing and managing the power purchase agreements</td>
</tr>
<tr>
<td>Sustainable Energy Research Fund (SERF)</td>
<td>A fund that will receive 1% of gross revenues from developers. This will be allocated to research applications that have potential for commercialisation. It will be administered by SESC.</td>
</tr>
<tr>
<td>Sustainable Energy Service Centre (SESC)</td>
<td>It is responsible for providing support to developers throughout the programme, including on local content issues</td>
</tr>
<tr>
<td>Sustainable Energy Training Fund (SETF)</td>
<td>A fund that will receive 1% of gross revenues from developers that will be allocated to sustainable energy training programmes. It will be administered by SESC.</td>
</tr>
<tr>
<td>Developer Research Advisory Council (DRAC)</td>
<td>To be part of the SESC and focused on R&amp;D in the Kingdom, making recommendations on how to contribute to its intellectual capital. It will also sponsor an annual Sustainable Energy Research Conference and run a prize competition</td>
</tr>
<tr>
<td>Developer Training Advisory Council (DTAC)</td>
<td>Focused on training programmes and ensuring that developers' programmes are adequate.</td>
</tr>
</tbody>
</table>
Sustainable Energy Procurement Company:

IPP

Electricity

PPA

Coordination

Tender the projects

Prepackaged sites

RE resource

Grid Connection

Local Content

Permeating & Licensing

Saudi Electricity Company
The Kingdom of Sustainable Energy
Summary

New Energies Will:

- CONTRIBUTE to a sustainable future for Saudi Arabia
- PRESERVE non-renewable fossil fuel resources
- SAFEGUARD Saudi Arabia’s international energy leadership
- TRANSFORM KSA into the Kingdom of Sustainable Energy
شكرا جزيلًا.....