مدينة الملك عبد الله للطاقة
الذرية والمتجددة K•A•CARE

Building the Renewable Energy Sector in Saudi Arabia

Established by Royal Order on 17 April 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…"

"King Abdullah City for Atomic and Renewable Energy"

Royal Decree No. A/35 3/5/1431 A.H.

Renewable Energy Development Targets

Target Capacity by 2032

Optimizing Energy Generation with Alternative Energy Economic Sector Development

Nuclear	17 GW
Renewable	54 GW

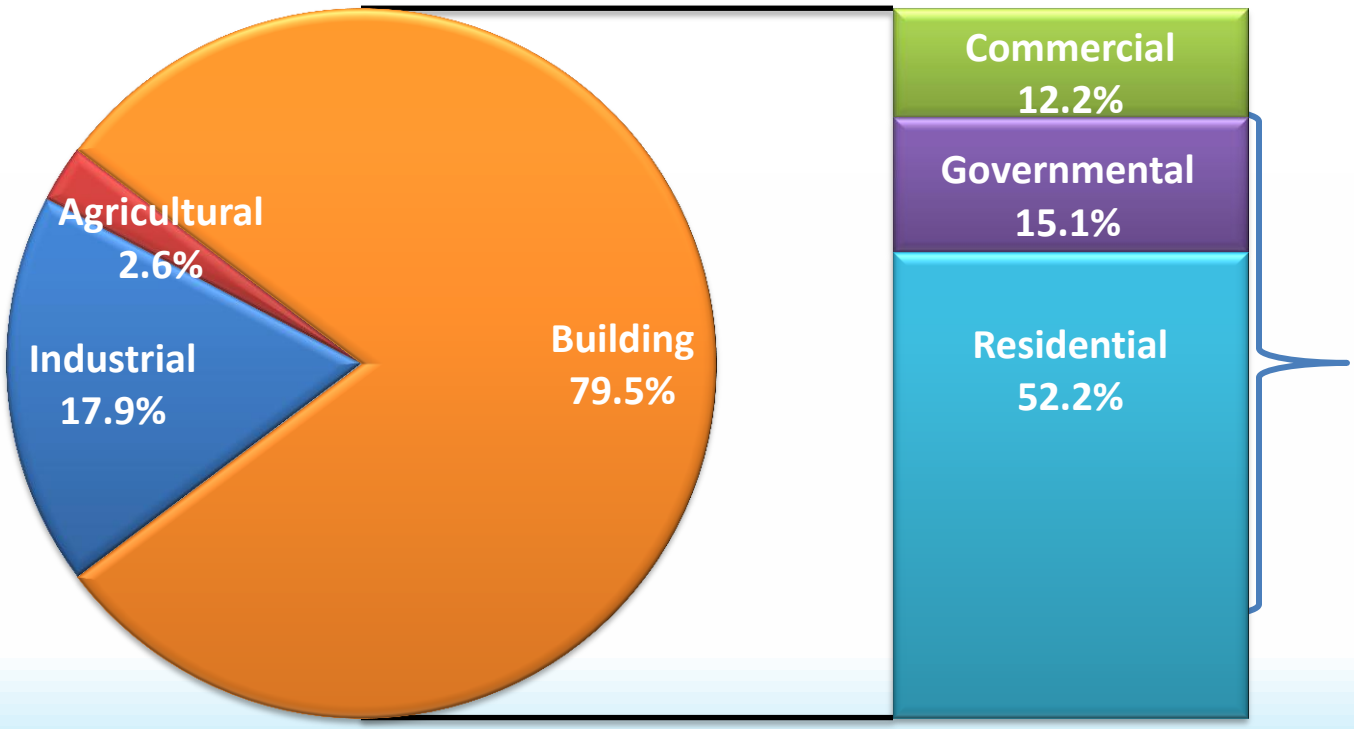
Target Renewable Capacity by 2032

Solar PV الكهروضوئية	16 GW
Solar CSP الشمسية الحرارية	25 GW
Wind الرياح	9 GW
Waste-to-energy تحويل النفايات إلى طاقة	3 GW
Geothermal حرارة جوف الأرض	1 GW

The Case for Alternative Energy

Energy Consumption Patterns

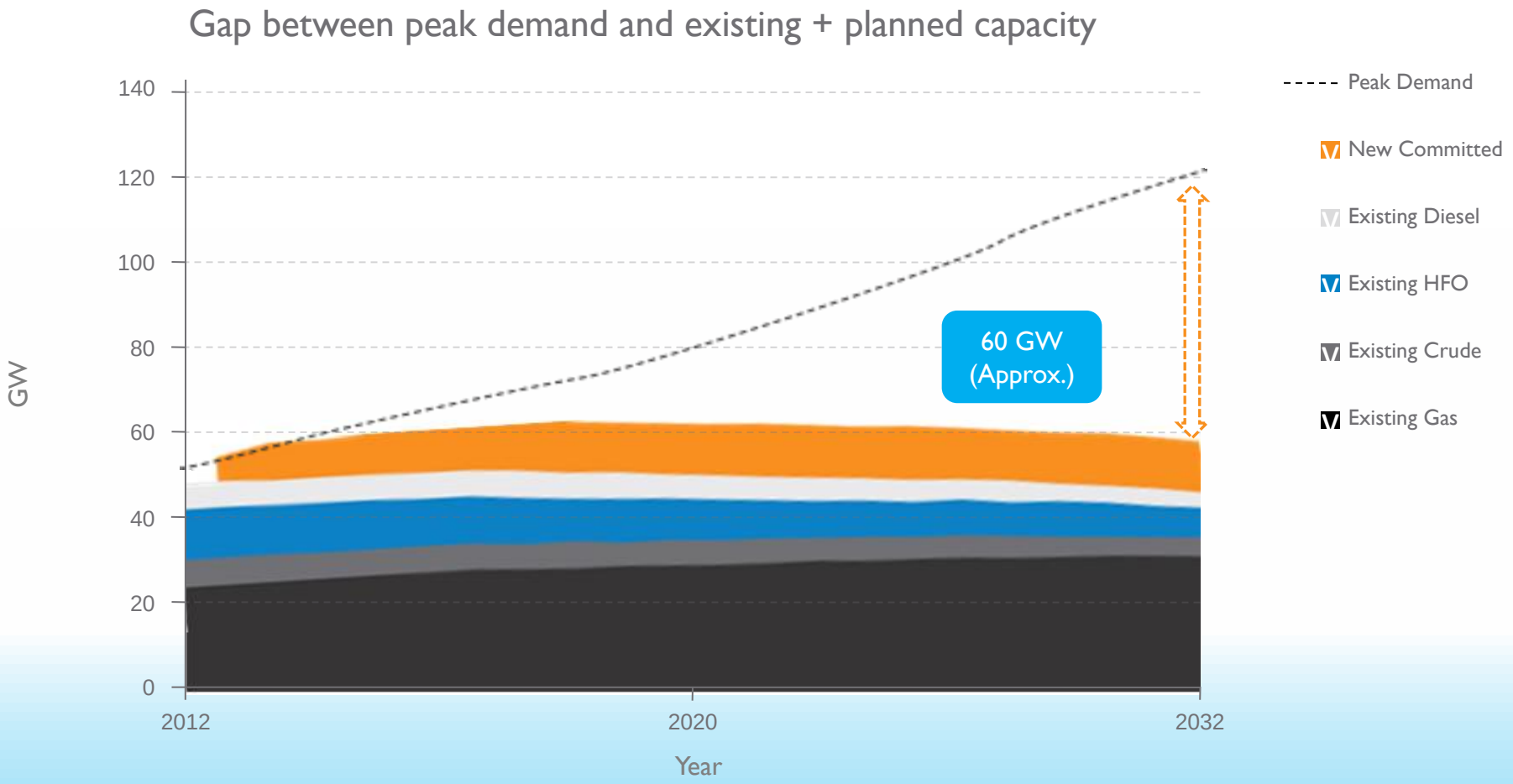
Total of 193,472 GWH



70% consumed by HVAC

Source: Saudi Electricity Company (SEC) 2009

…Creating Tremendous Capacity Gap



Maximizing Return

Oil Saved	Economic Sector	Sustainability

How Much Can We Do ?

- Demand Growth
- Demand Pattern
- Technology Characteristics

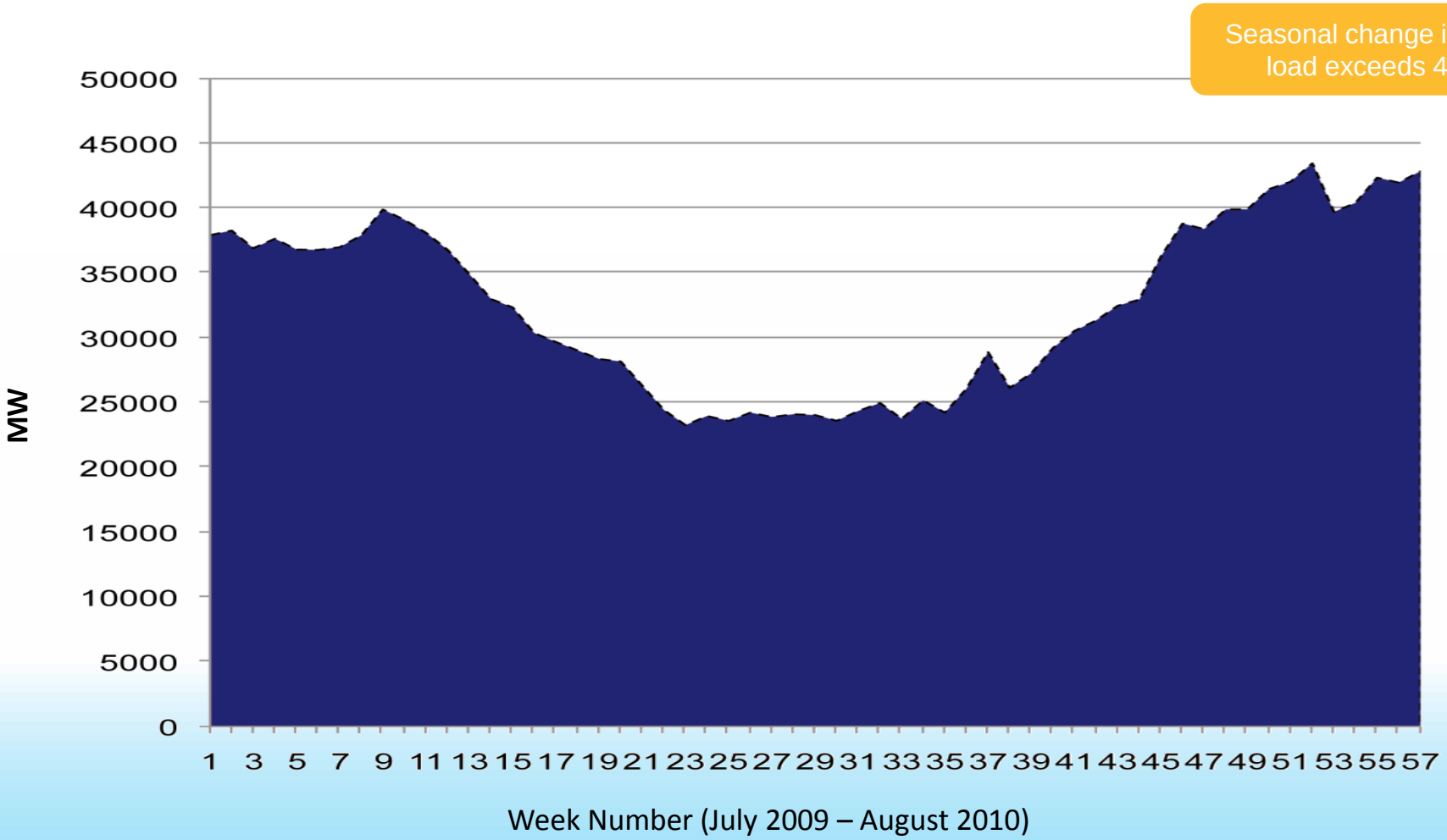
How Much Should We Do ?

- Economics
- Sustainability
- Technology maturity

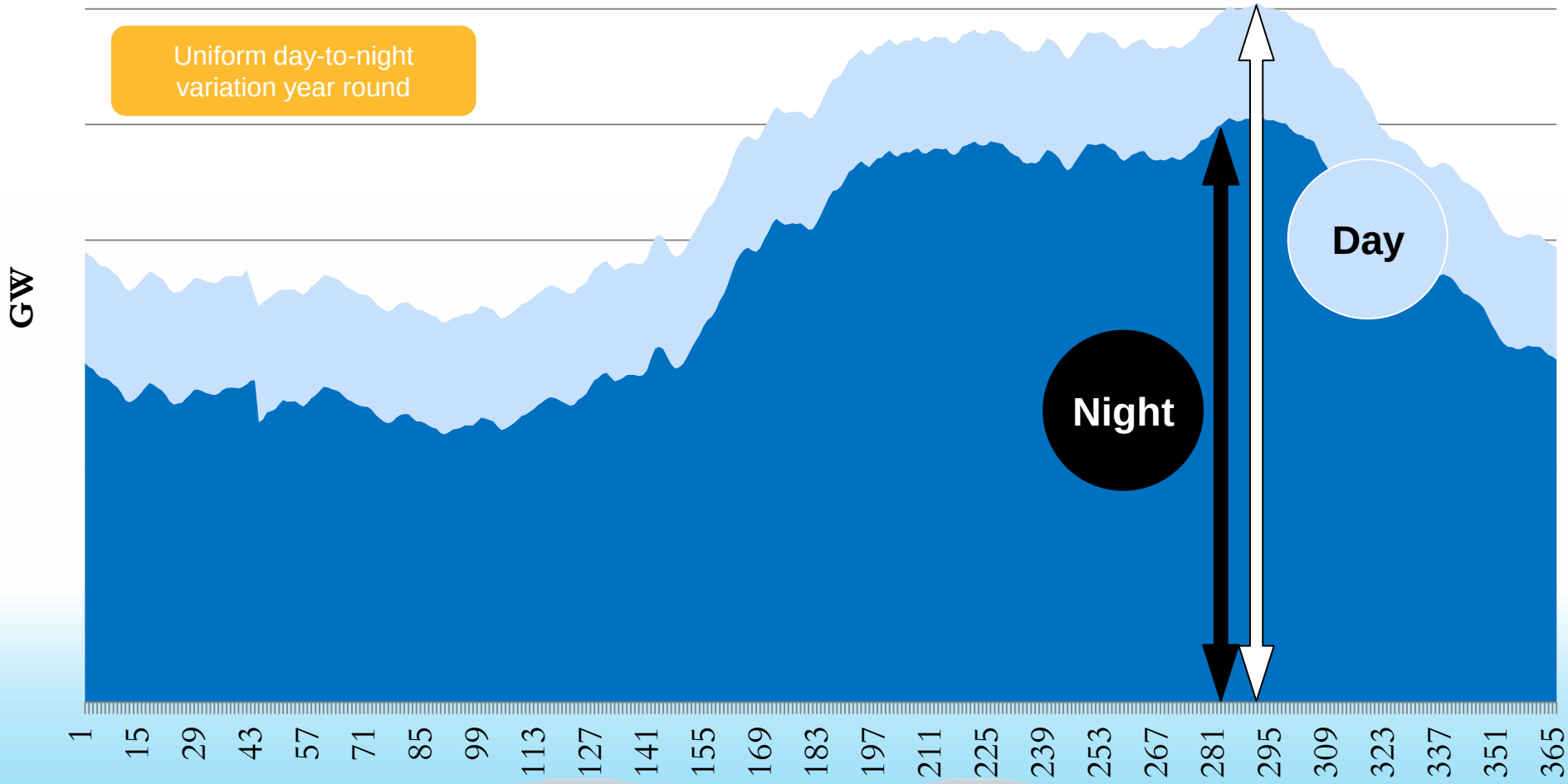
Selecting the Optimum Energy Mix

Annual Electricity Demand Pattern in KSA

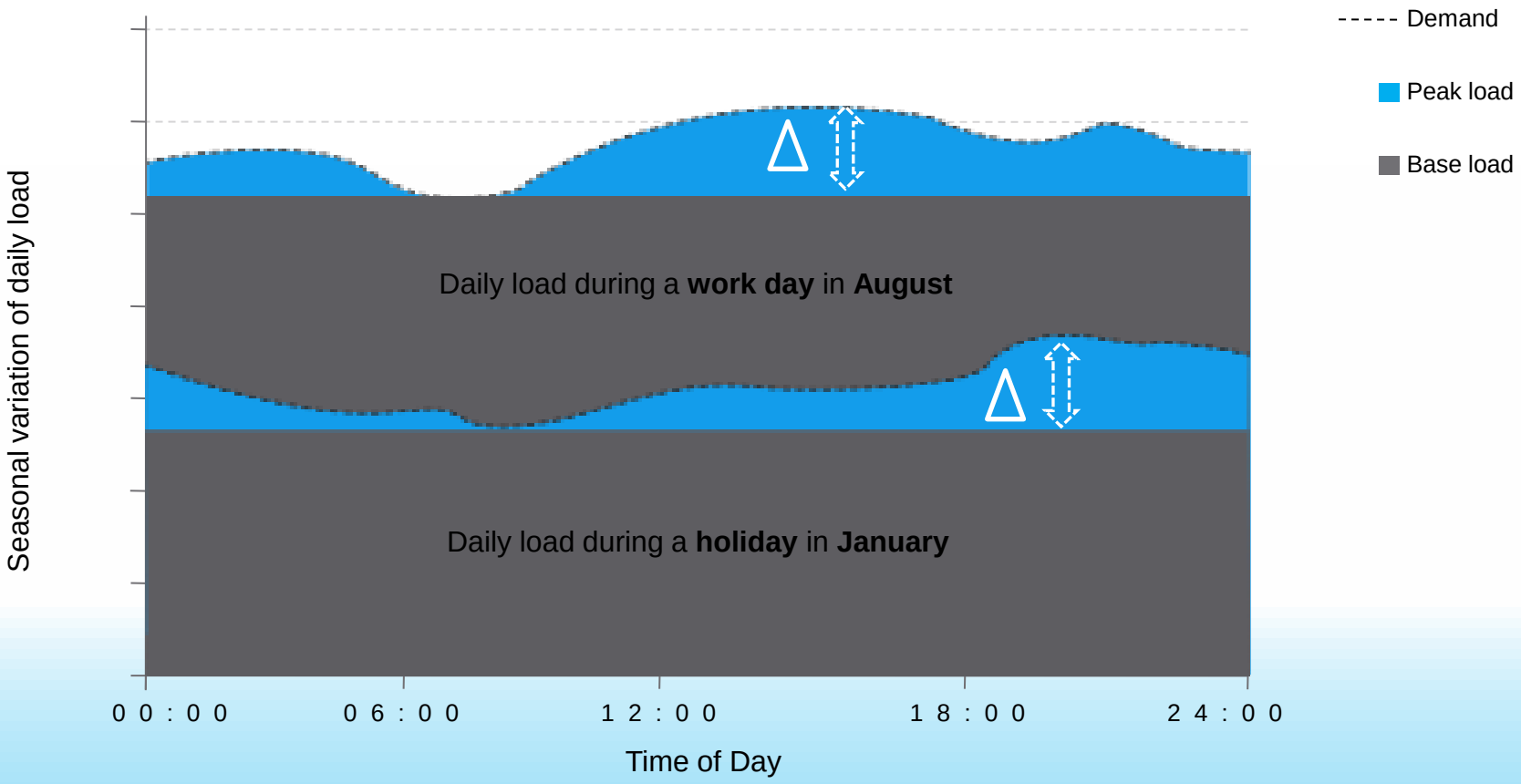
Seasonal change in peak load exceeds 40%



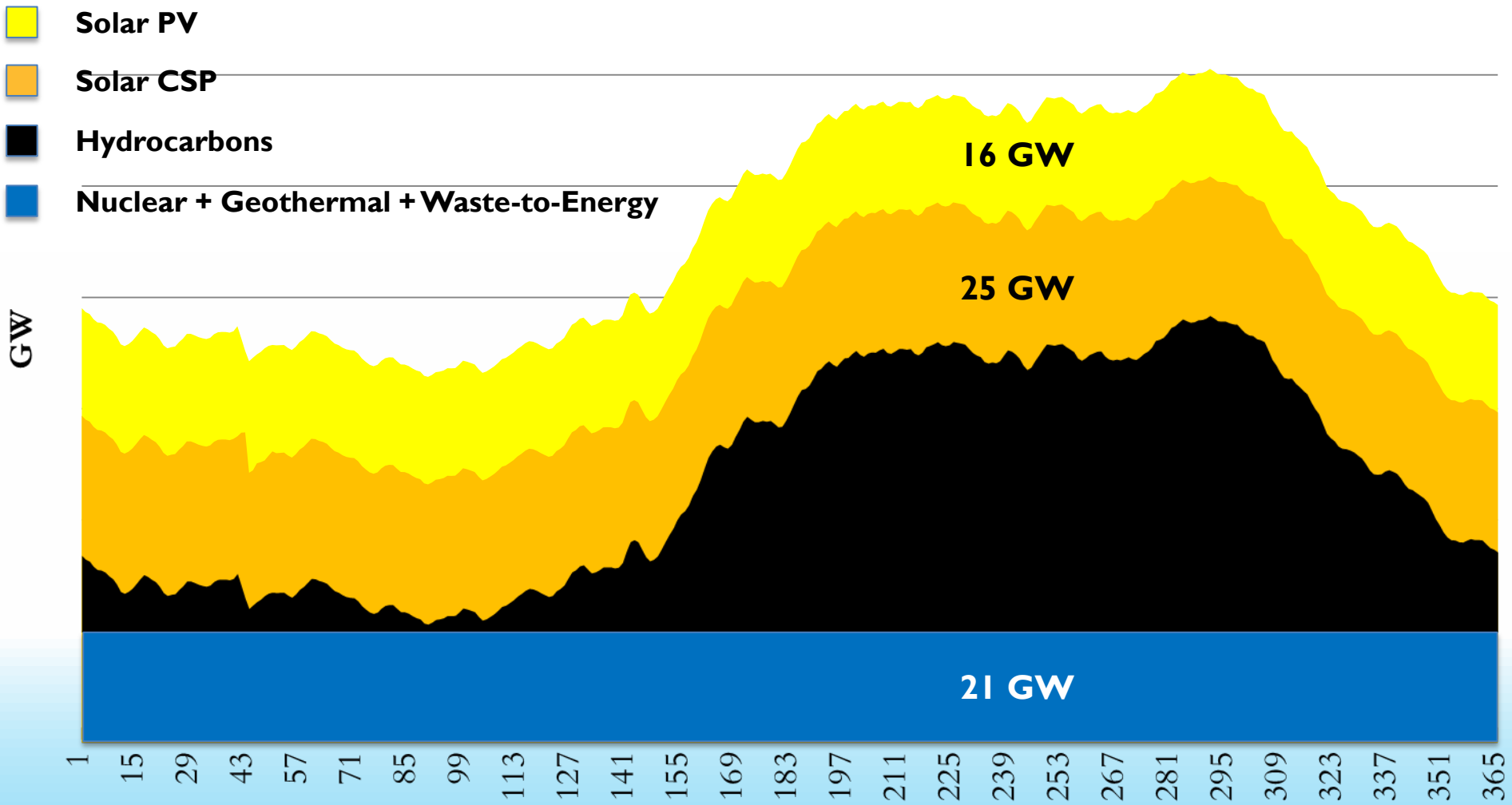
Day-Night Load Variation for Saudi Arabia



Daily Electricity Demand Pattern



Proposed Energy Mix



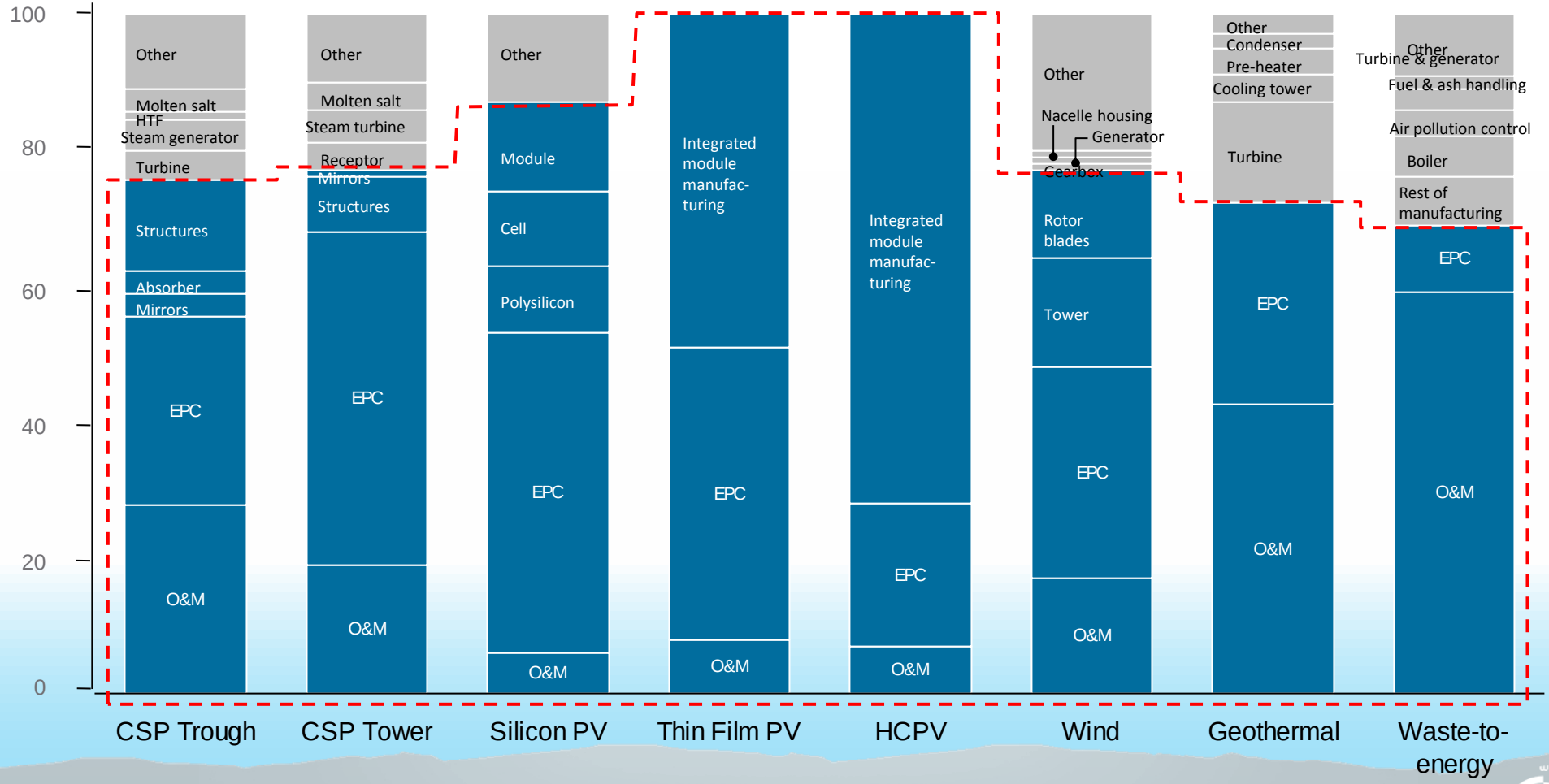
K·A·CARE Mandate


Policies & Strategies
Execution
Regulatory
Investment & Business
R&D & Innovation
Internation al Relations
Human Capacity
K.A.CARE City
Mandate

Renewable Energy Value Chain Development

Manufacturing, EPC and O&M split

% total capex and opex throughout the plant lifetime



Potential RE Value Chain Components

CSP Technology	Elements
1 Trough	• Collector • Mirror • Absorber • EPC & O&M • Molten Salts • HTF • Steam turbine and generator • Storage Tank • Other power block elements • Minor elements
2 Tower	• Heliostat • Mirror • EPC & O&M • Receiver • Molten Salts • Steam turbine and generator • Storage tank • Other power block elements • Minor elements

PV Technology	Elements
3 Thin Film	• Integrated Module Factory • EPC & O&M • Inverter • Rest of balance of system
4 HCPV	• Integrated Module Factory • Tracking System • EPC & O&M • Inverter • Rest of balance of system
5 Silicon	• EPC & O&M • Poly Silicon manufacturing • Inverter • Wafer • Cell • Module • Rest of balance of system

Technology	Elements
6 Wind	• Blades • Towers • EPC & O&M • Gearbox • Generator • Power converter • Nacelle housing and assembly • Bearings • Minor elements
7 Waste-to-Energy	• EPC & O&M • Steam Turbine • Boiler • Grate • Other power block elements • Minor elements
8 Geothermal	• EPC and O&M • Steam Turbine • Heat exchanger • Condenser • Minor elements

Value Chain Development

Building a World-Class Solar Energy Sector:

Industrial investment

Research, development and innovation

Technology development

Education and training

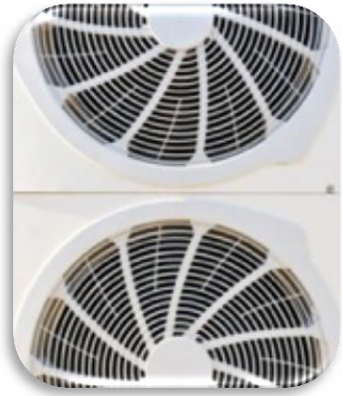
Human capacity development

Value Chain Development: Beyond the Solar Cell and the Mirror

Electricity Generation

Industrial Energy Applications

Seawater Desalination & Water Management Applications



District & Solar Cooling

Research & Development & Innovation (RDI)

The RDI mission supports the K.A.CARE mandate of sustainable energy mix and a viable value chain…

RDI Mission

Be the national technology leader in renewable and nuclear energy
and
the global leader in development of renewable and nuclear energy technologies optimized for Saudi Arabian environments
to
support K.A.CARE's target of 50% renewable and nuclear energy in the Kingdom by 2030.

The top-level missions and long-term measures of the success of the RDI program…

Renewable Energy

Mission

Renewable energy technology research and development program that enables significant and optimized deployment of renewable technologies in Middle East & North African environments.

Measure

Develop technologies that will generate renewable power in the Kingdom at a cost equal to or less than retail generation rates (achieve local grid parity) with a diverse energy mix for baseload power by 2030.

Energy Efficiency

Mission

Technology and outreach program that enables efficient use of energy, cost savings, and conservation of resources by KSA industry & residents.

Measure

Develop technologies with 50% lower energy consumption than current commercial products in the top electricity consuming sectors by 2020.

Nuclear Energy

Mission

Establish a technical base in applied nuclear science in the power, medical, and industrial fields to develop the safe use of atomic energy for peaceful purposes in the KSA.

Measure

Develop, design, and license new technologies optimized for the Kingdom for the next wave of nuclear power to generate value chain revenue greater than the development costs by 2030.

Achieving K.A.CARE'S goals for transformation of the Saudi energy mix requires excellence in **"Mission-Directed" RDI**

Mission Directed Research*:

Scientific investigation and technological development

…designed to achieve specific, well-identified technical and commercial outcomes

…essential to fulfillment of major policy or economics driven outcomes

..within a defined timeline and a budgeted investment

**From RDI Strategy report by SRI and Battelle, June 2011.*

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Renewable Resource Monitoring & Mapping Program (RRMM)

Renewable Resource Monitoring and Mapping (RRMM) Program Purpose

- **Program Purpose:** To establish a high-quality, solar and wind resource monitoring network for KSA, and integrate solar and wind (and eventually geothermal and waste-to-energy data) into an online, interactive Renewable Resource Atlas

- The RRMM Program will provide data that fulfills multiple **stakeholder needs**, such as:
  - Resource data for **energy facility (power project) investors**
  - Detailed, quality data to enable **researchers** to develop new and improved technologies
  - Data for other studies such as renewable grid integration

RRMM Projects

- The RRMM program covers four projects in the near term as shown below (up to the year 2020)
- We are approaching the end of the 1st project which covers the installation of the monitoring stations and Renewable Resource Atlas release

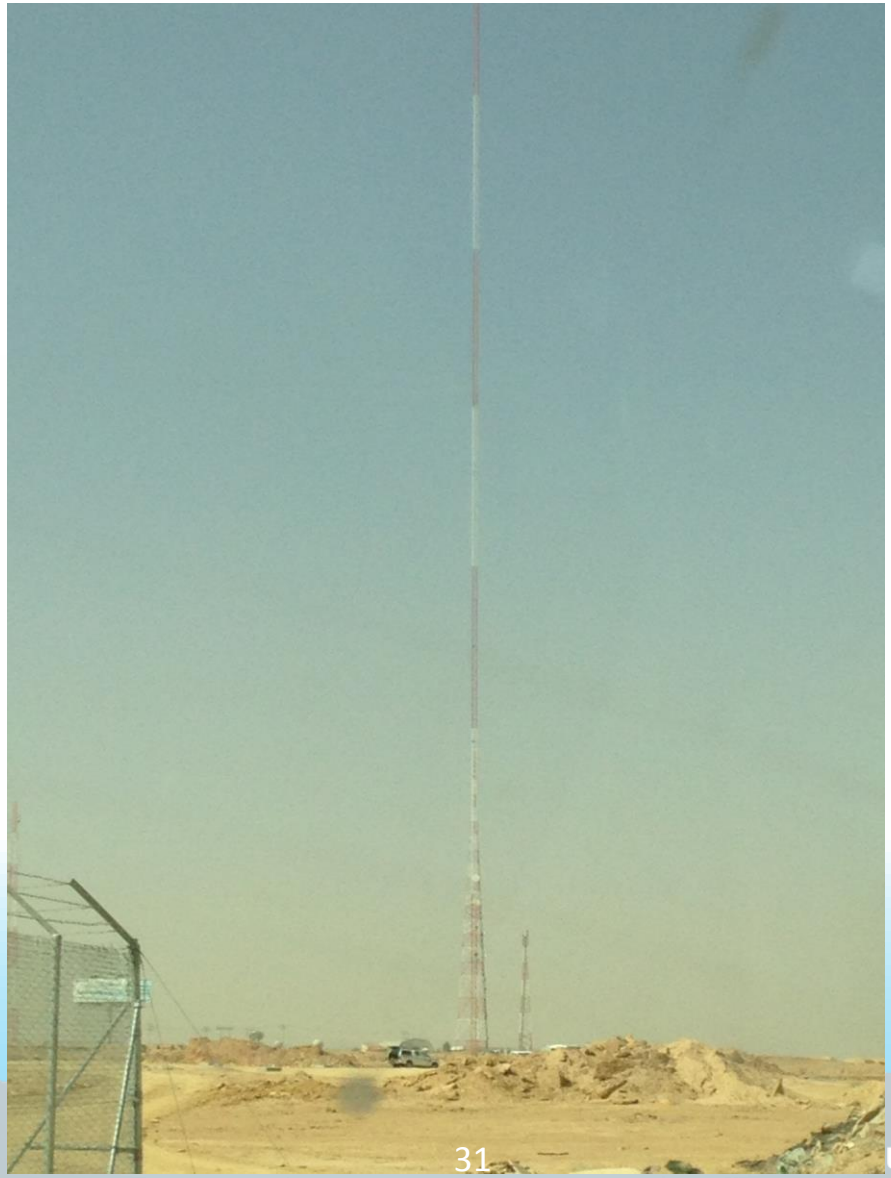
2012	2013	2014	2015	2016	2017	2018	2019	2020
	RE.1 Renewable Resource and Environmental Measurement and Monitoring							
Resource monitoring and mapping	Identify energy development areas		Advanced weather & aerosols forecasting		Sensors & methods development			

Current Progress

- Around thirty "Tier 2" stations installed (about halfway through)
  - Earliest installed in January 2013
- One "100 meter Met-Mast" installed in the future K.A.CARE site south of Riyadh
- Finalizing the Renewable Resource Atlas (Atlas will be officially launched in the end of November 2013, with data only from ground solar monitoring stations)

Stations Currently Installed

First Met-Mast Installed Early September 2013



Renewable Resource Atlas – Home Page

Next Steps

- Create a solar resource model covering all of KSA that utilizes the ground stations and satellite readings
- Create a solar resource forecasting model (big part of this will be creating a dust prediction model)
- Create a PV and CSP simulation tool for KSA
- Create similar models and tools for wind energy

شكرا جزيلا .....

Thank You .....