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Kuwait Renewable Electricity Generation: Resources and Challenges

Scaling Up the Use of Renewable Energy in Rural Areas in ESCWA Member Countries

ESCWA Workshop

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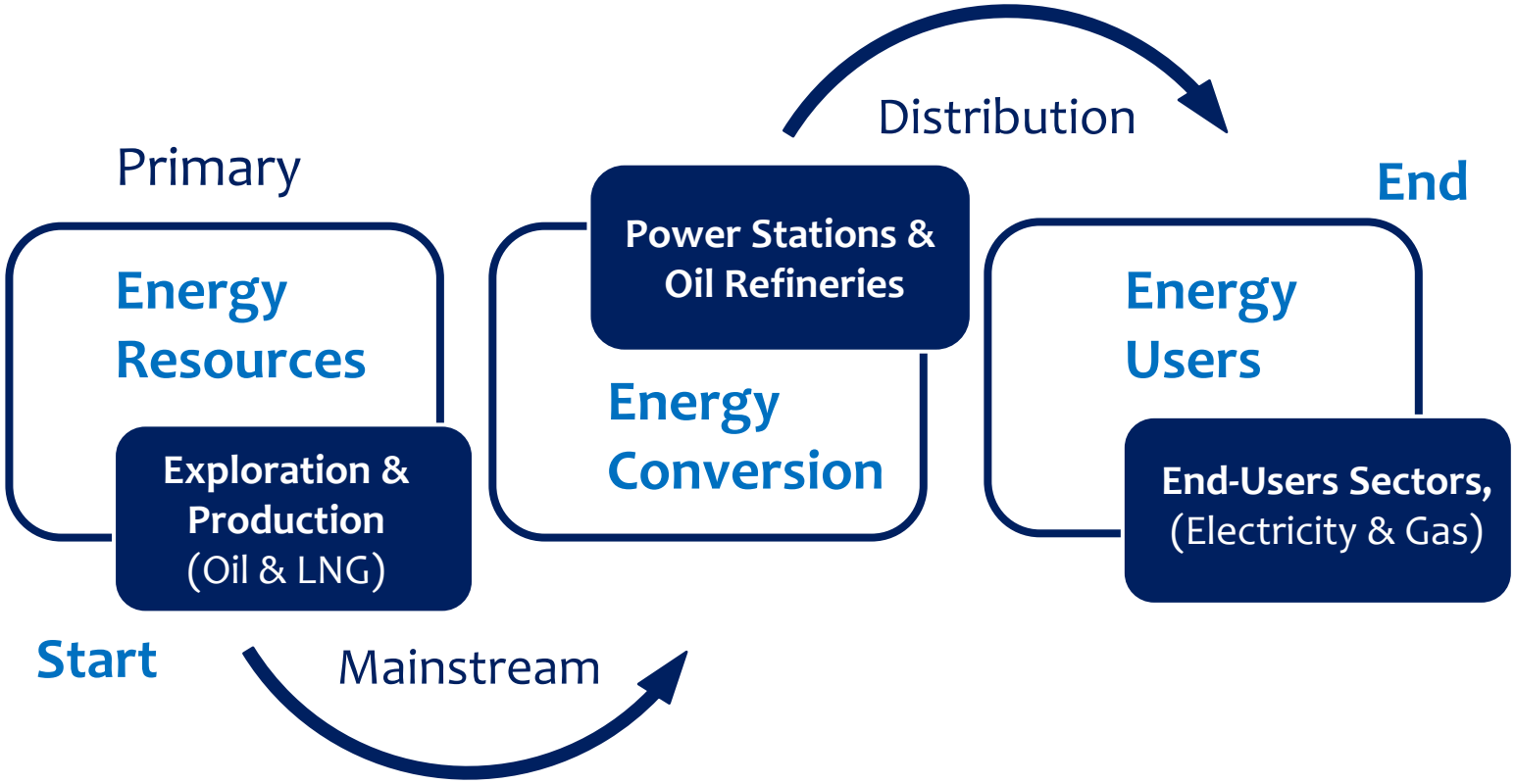
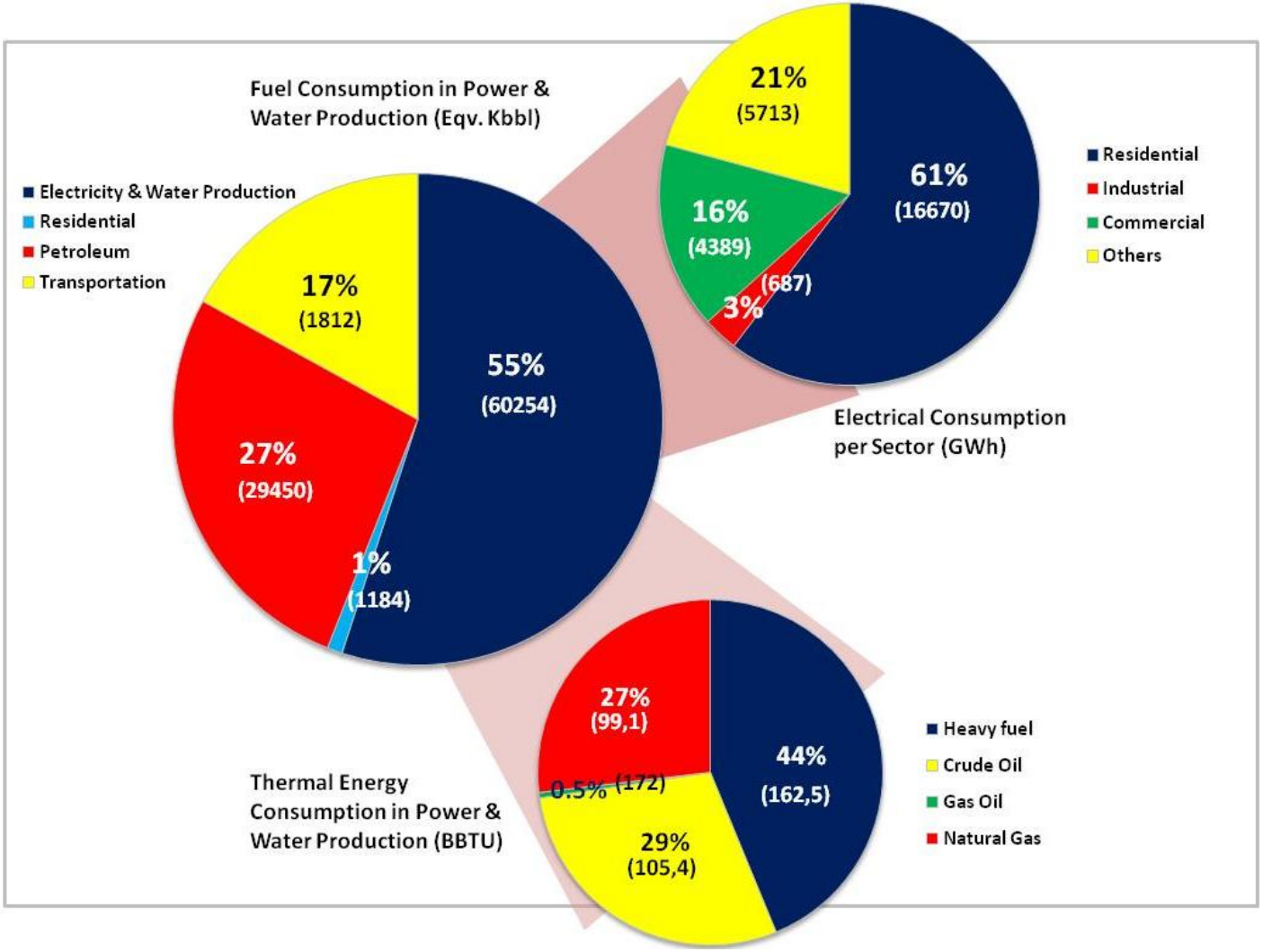
Kuwait Renewable Electricity Generation: Resources and Challenges

Presentation Outline

- Kuwait Energy Situation
- Main Challenge and Expectation Prospective
- Renewable resource prospects (potentials, cautions and actions)
- Target Renewable Energy Options and Scenario Analysis
- Challenges for Renewable Energy

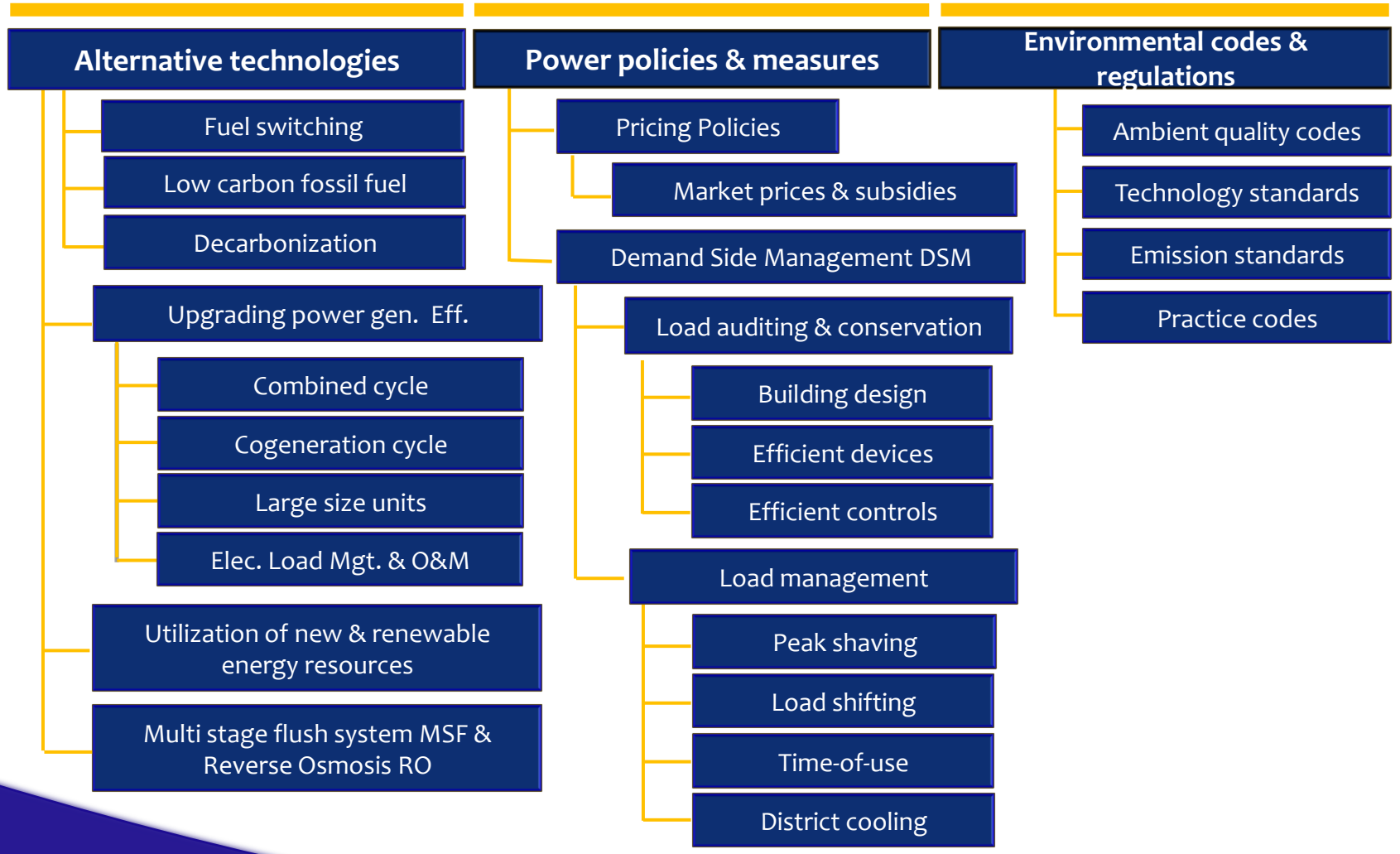


Reference Energy System



Current Kuwait Energy Mix & Distributions

Kuwait energy strategy & technology options – Utility (E &W) sectors



The Challenge

Today's pattern and trends in overall demand and supply equations are not sustainable.

This can only change if the inherent benefits of efficiency and alternative technologies are harvested through integrated clean strategies.

- Meeting high demand for electricity (Adaption).
- Reducing or preventing high emission rates (Mitigation).
- Meeting high demand from new resource (Diversification).

The Expectation

To devote substantial amount of resources and possible special programs to establish portfolio of both end-use efficiency and share of renewable / alternative technologies, and their combination with each other to achieve sustainable targets.

The Prospects

Potentials

Can be a significant, competitive option to simultaneously slow the growth of energy demand and reduce emissions while promoting clean economic development and energy security for decades to come.

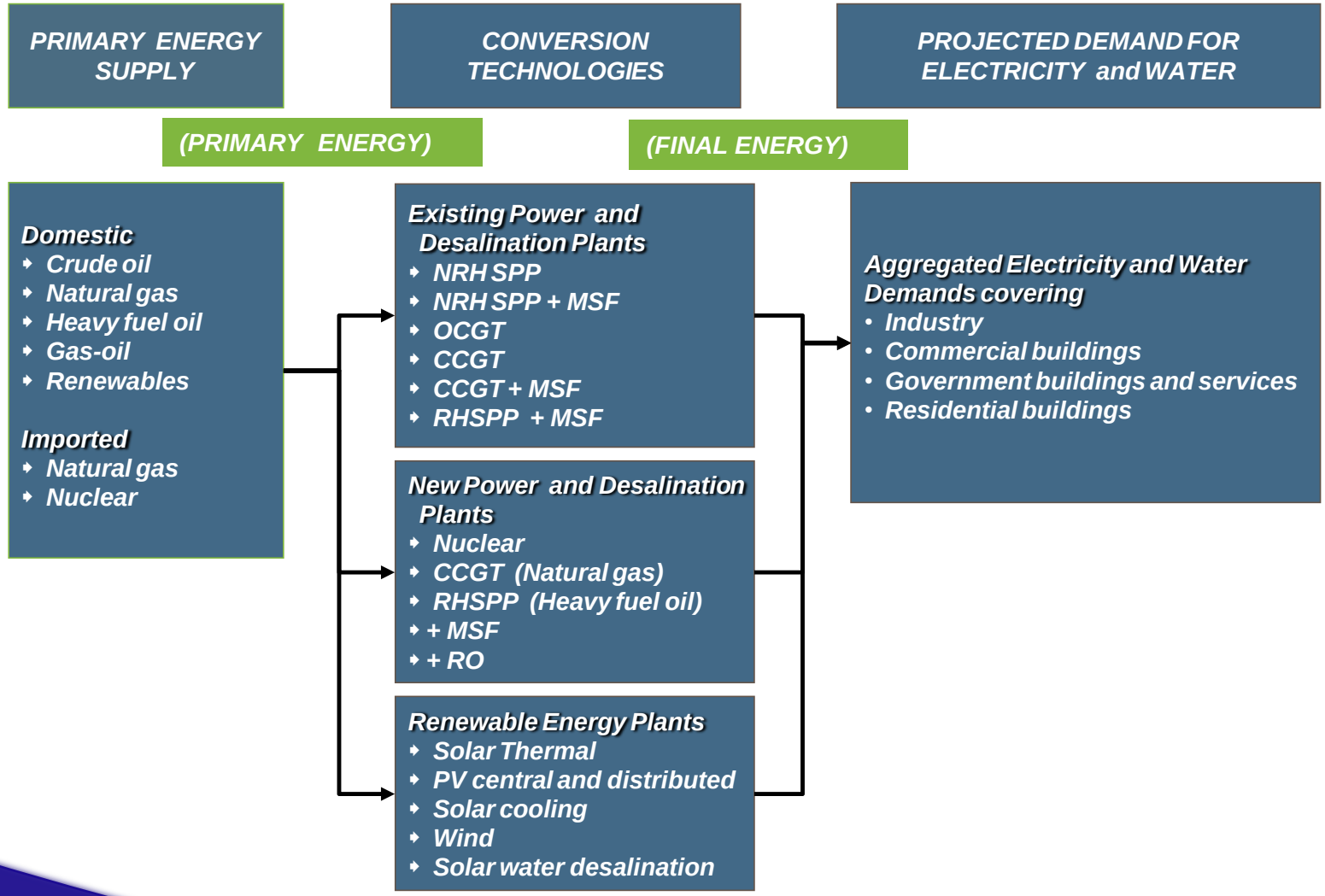
Assuming that;

- RE would reach its full potential in the next 20 to 50 years;
- RE could replace fossil-fuel peak power generation up to 20% by 2030.
- RE could curb energy-related global CO_2 emissions concentrations by up to one third by 2050 (compared with a BAU case).

The Objectives

1. A general assessment of the status on present & projected supply (oil & gas) resources, energy demand forecasts, (P&W capacities, fuel consumption) & identify the potential supporting measures driving this evolution.
2. A feasibility study of future RE technology options to forecast the trends of technology development, its characterizations & the economics of contribution in implementing these technologies.
3. An assessment, through a methodology, the impact of introducing RE on the potential financial gains & land-use, as part of the country's energy supply mix.

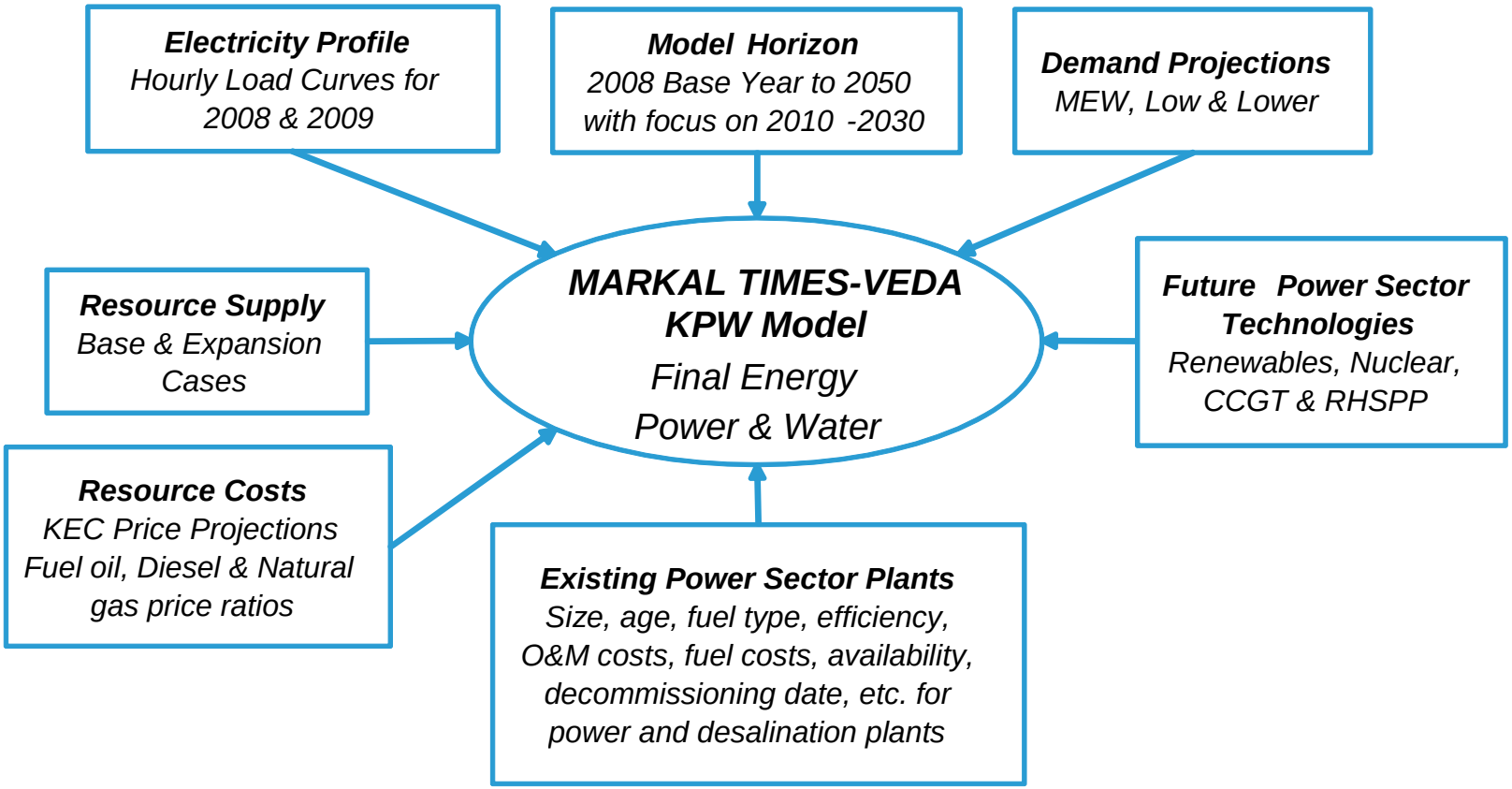
Simplified RES of the KISR Power and Water Model (KPW)



Kuwait RE Scenario Development and Analysis (2010-2030)

Acronym	Description
REF	A policy scenario based on historical fossil fuel development until 2008; fossil fuel demand kept constant after 2008; used as reference simulation to which alternative fossil fuel scenarios following KPC "reference" assumptions are compared for their impact.
REF-RE10	A target scenario that assumes REF technologies within the portfolio of future power plants to identify the cost-effective penetration of RE options that ramps-up from zero share in 2013 to the cost-effective share in 2030. (Suffix: RE10 is for 10% contribution from RE technologies).
REF-RE20	A target scenario that assumes REF technologies within the portfolio of future power plants to identify the cost-effective penetration of RE options that ramps-up from zero share in 2013 to the cost-effective share in 2030. (Suffix: RE20 is for 20% contribution from RE technologies).
REF-ff	A policy scenario based on REF; used as reference simulation to which a minimum fuel utilization constraint is placed on power plants as 60% for existing, 50% for new and 10% peaking. on are compared for their impact on the system. For existing and new plants the minimum constraint is relaxed to 20% with RE. (Suffix: ff is for flexible fossil operation).

Key Input Parameters



Technology Characterizations

Target Renewable Energy Categories & Options

6 Renewable Energy Supply Categories and 12 Technology Options

- Solar thermal technologies.
- Photovoltaic power plant technology.
- Photovoltaic grid-connected distributed technology.
- Solar cooling technology.
- Wind energy technology.
- Solar water desalination technologies.

Target Renewable Energy

Solar Thermal Technologies

- Parabolic Trough.
- Gas Combined Cycle Parabolic Trough Hybrid.
- Power Tower with Thermal Storage.
- Fresnel Panels.
- Parabolic Dish Stirling Engine.

Photovoltaic Power Plant Centralized Technology

- Land Based Utility scale PV.

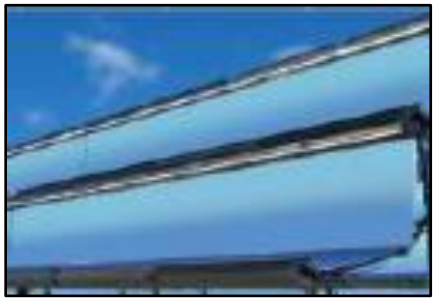
Photovoltaic Grid Connected Distributed Technology

- Commercial Roof-top systems.
- Residential roof-top systems.

Target Renewable Energy Options

Solar Cooling Technology

- Compound Parabolic Collector and Absorption Chiller System.

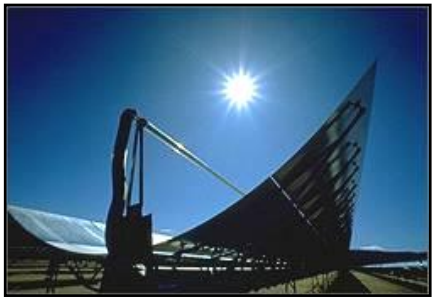


Wind Energy Technology

- Based on Class 4 wind speeds.

Solar assisted Water Desalination Technology

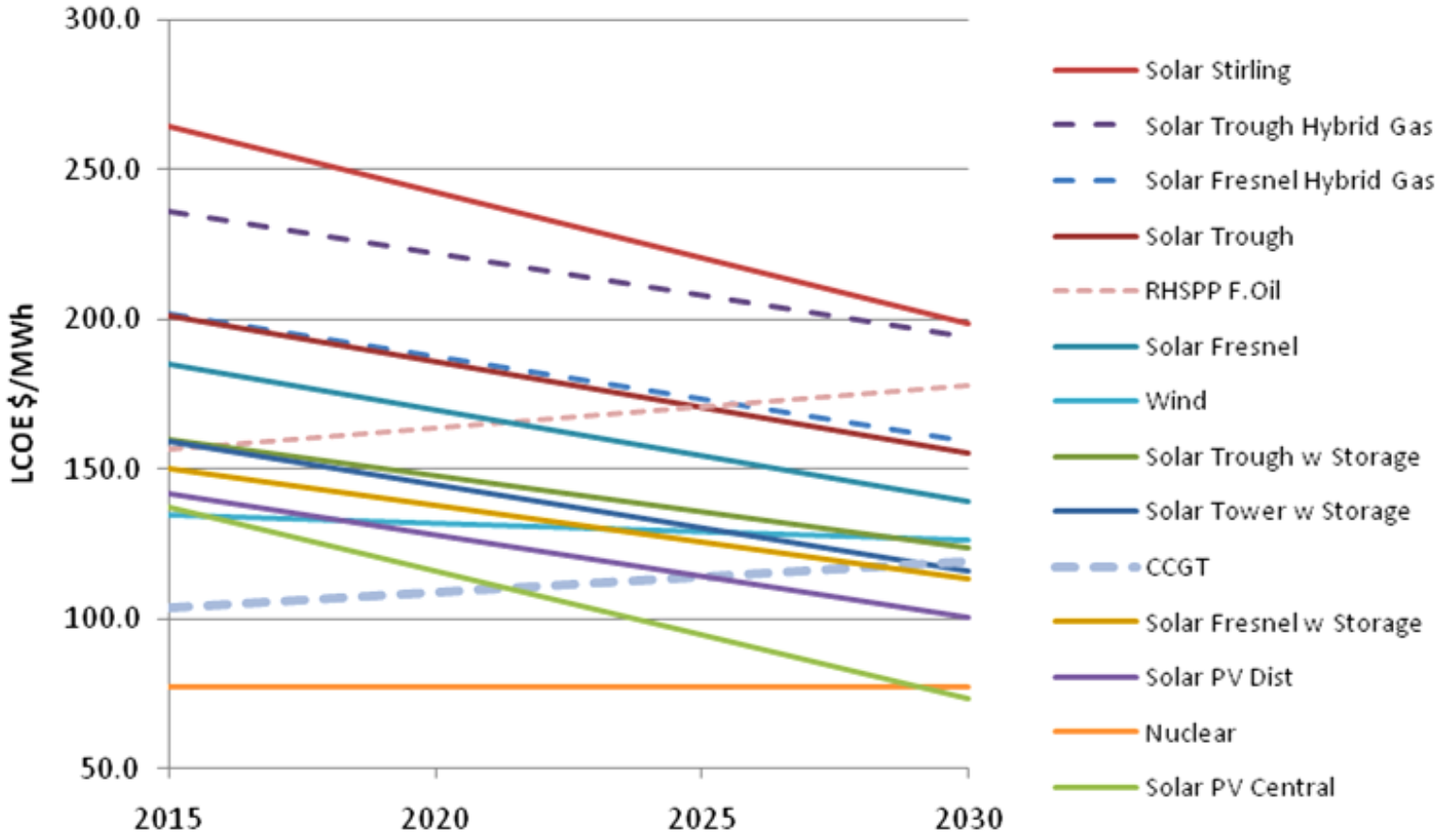
- Compound Parabolic Collectors with MSF Desalination System.
- Solar Thermal Power & RO System.

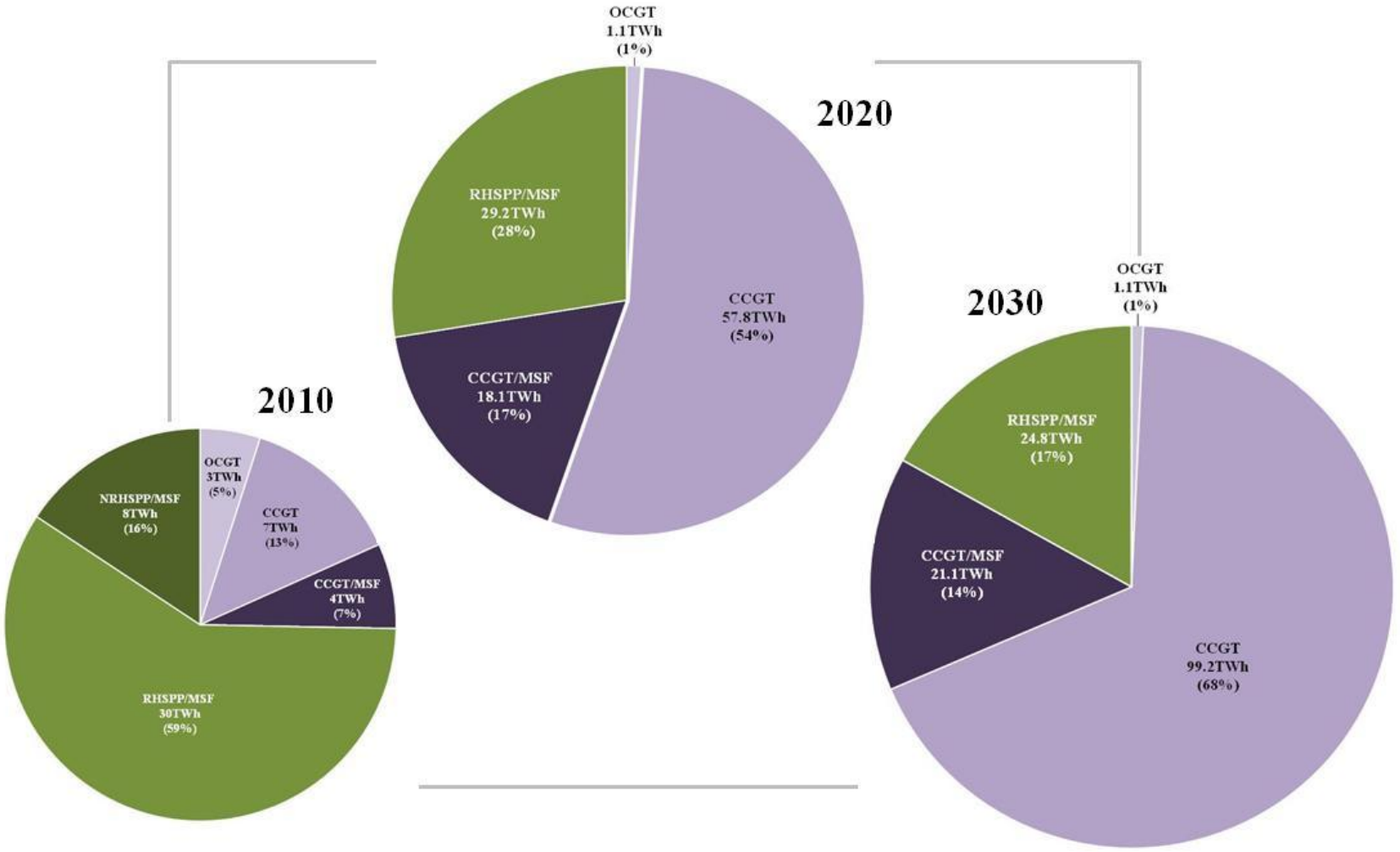


Key Renewable Energy Assumptions: Power Generation Technologies

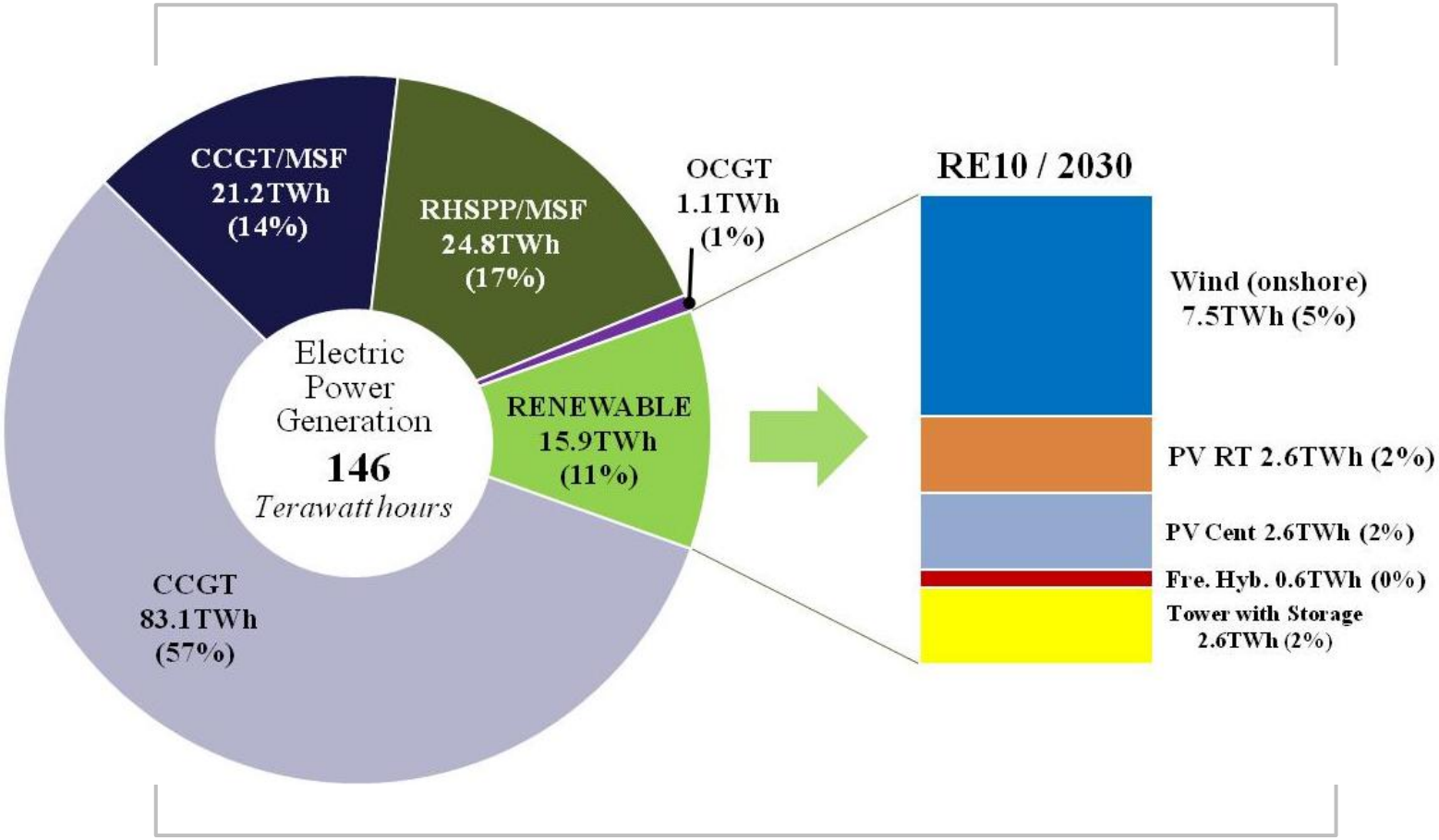
Technology	Inv Cost 2015 $/kW	Inv Cost 2030 $/kW	O&M 2015-2030 $/kW	Annual avail. %	Capacity Credit %	Start year	Inv Cap 2015-2030 MW/yr	Total Cap limit MW
Tower w storage	5,200	3,900	75 – 45	37%	50%	2015	200-500	NA
Trough	4,050	3,150	60 – 45	23%	0%	2015	200-500	NA
Trough w storage	5,400	4,200	60 – 45	37%	50%	2015	200-500	NA
Trough hybrid	4,405	3,595	100 – 85	23%	100%	2015	200-500	NA
Fresnel	3,680	2,760	60 – 45	23%	0%	2015	200-500	NA
Fresnel w storage	5,030	3,810	60- 45	37%	50%	2015	200-500	NA
Fresnel hybrid	4,072	3,244	60 – 45	23%	100%	2015	200-500	NA
Stirling engine	4,800	3,600	60 – 45	23%	0%	2015	200-500	NA
PV centralized	2,200	1,200	15 -7	17%	0%	2012	100-200	1558
PV rooftop (com+rsd)	2,500	1,800	17 – 10	17%	0%	2012	100-200	3115
Wind	1,950	1,800	31 – 31	17%	0%	2015	200-400	NA

Comparing Fossil and Renewable Energy Costs

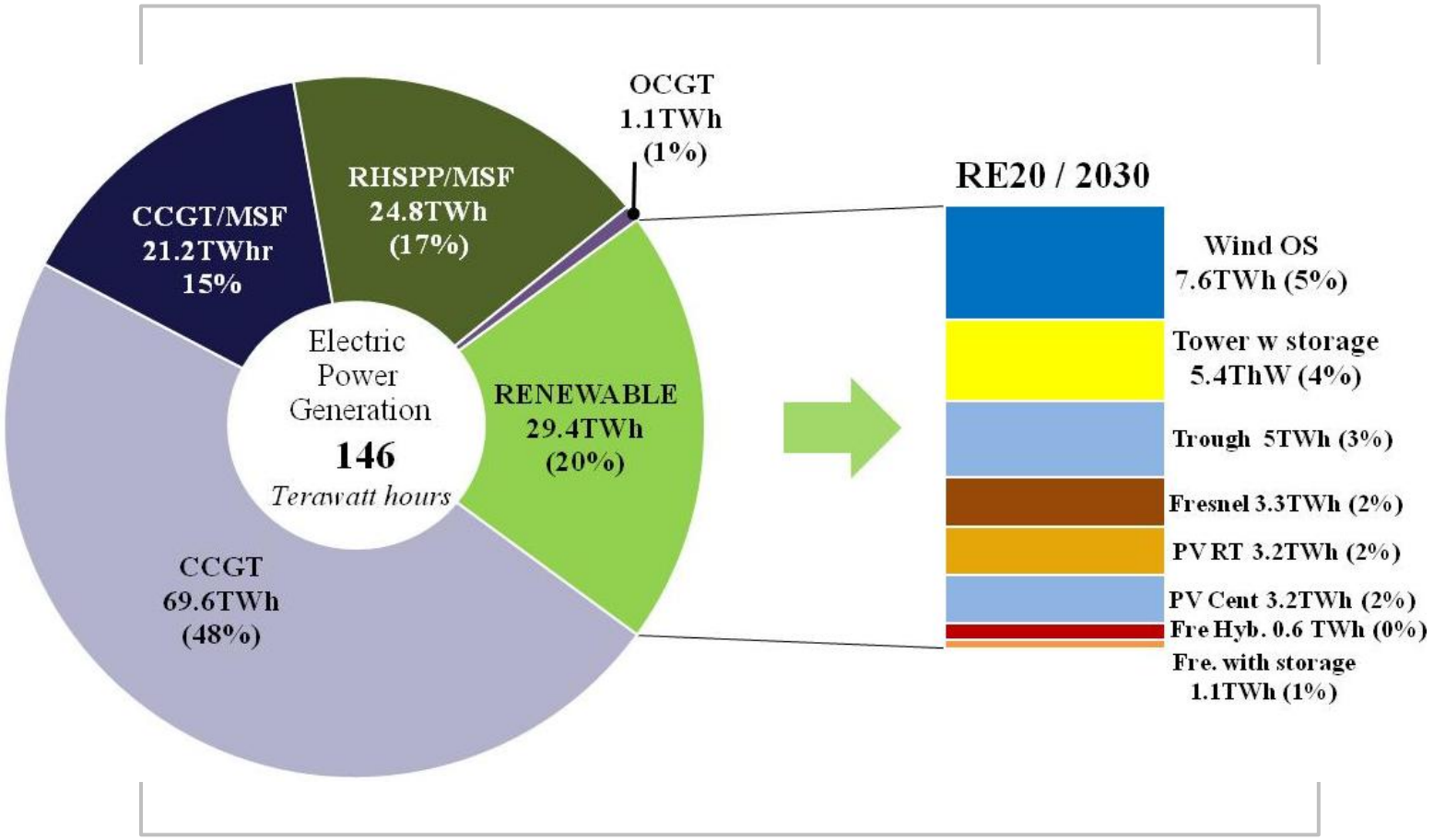




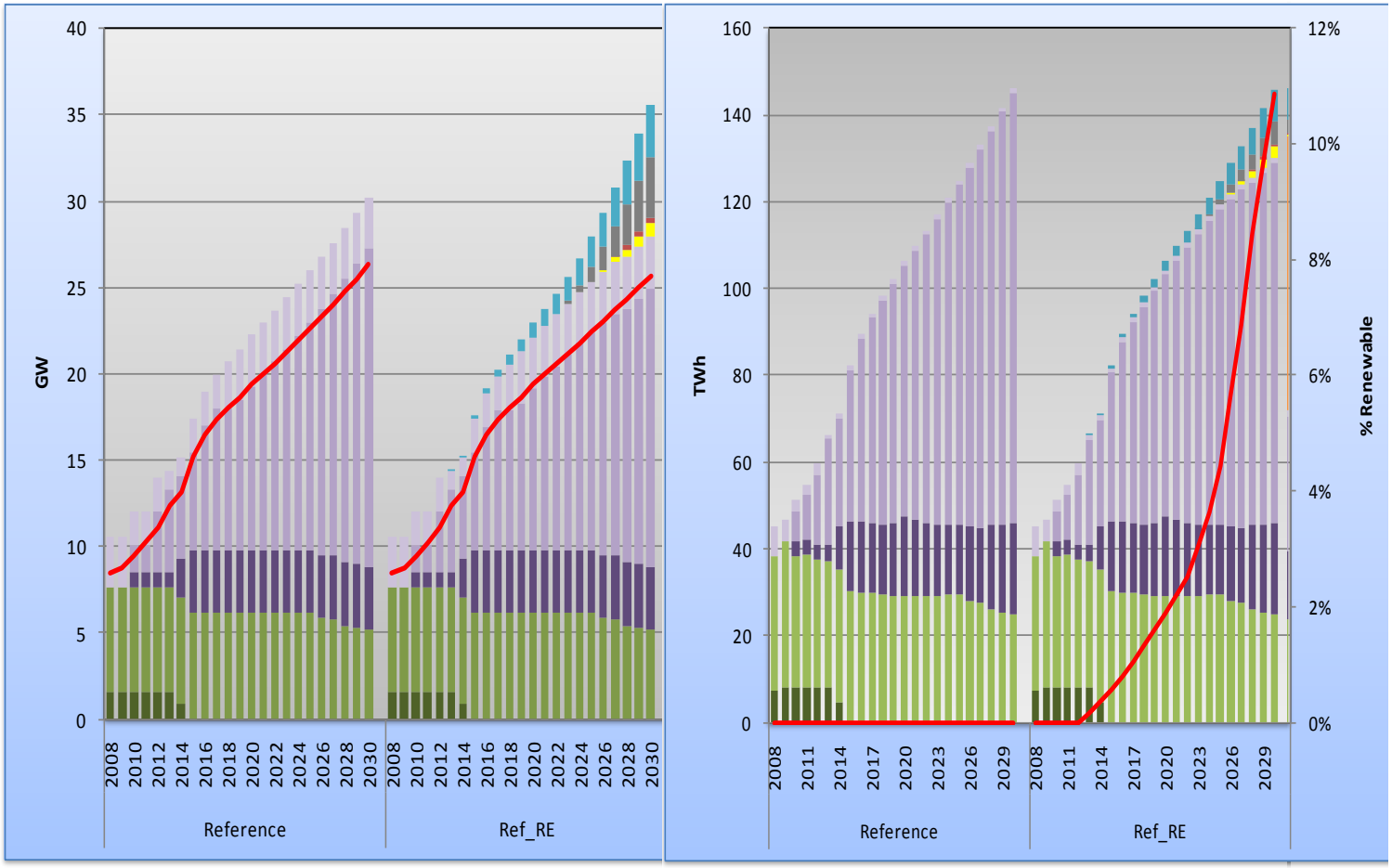
REF Energy Supply Mix



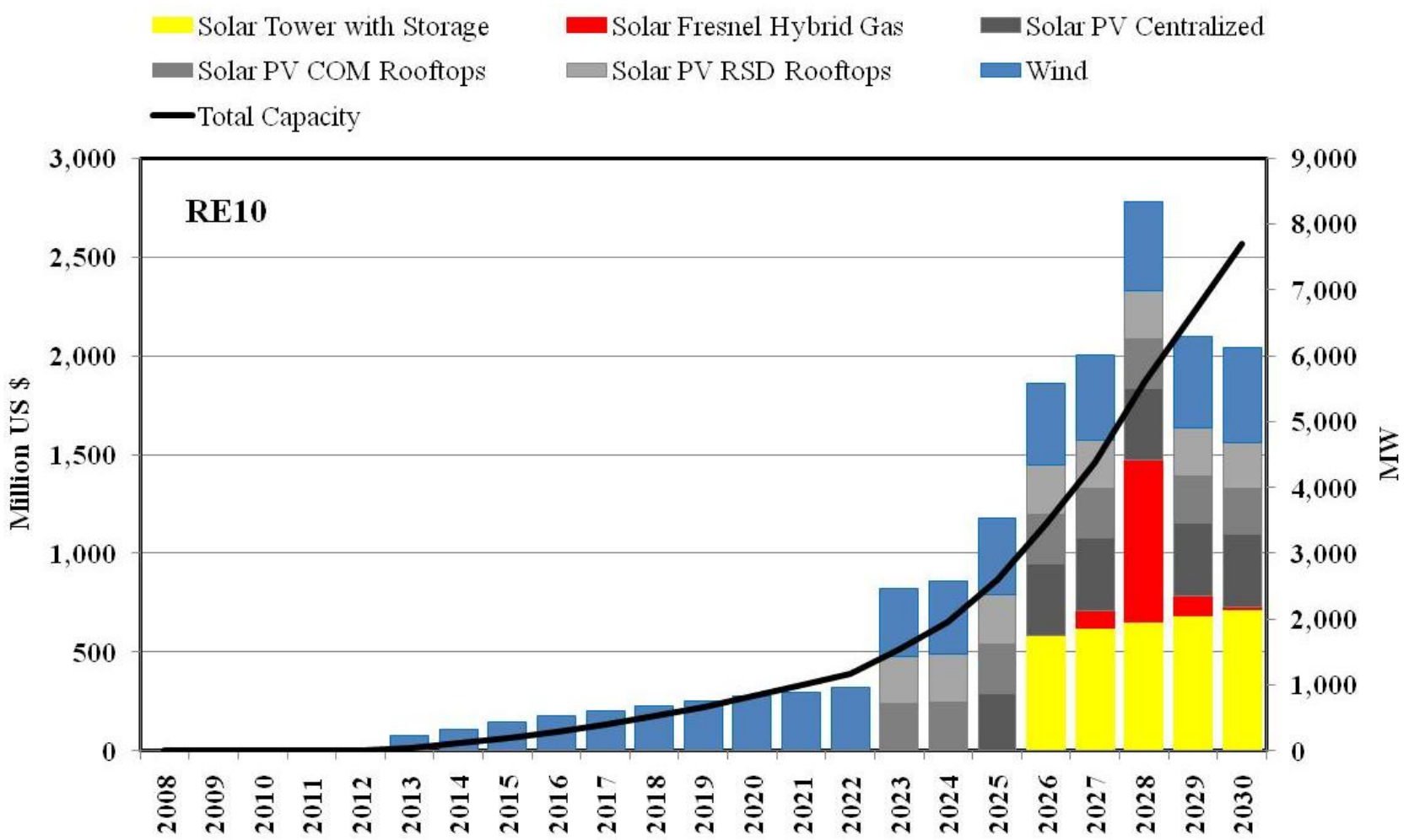
RE10 Energy Supply Mix



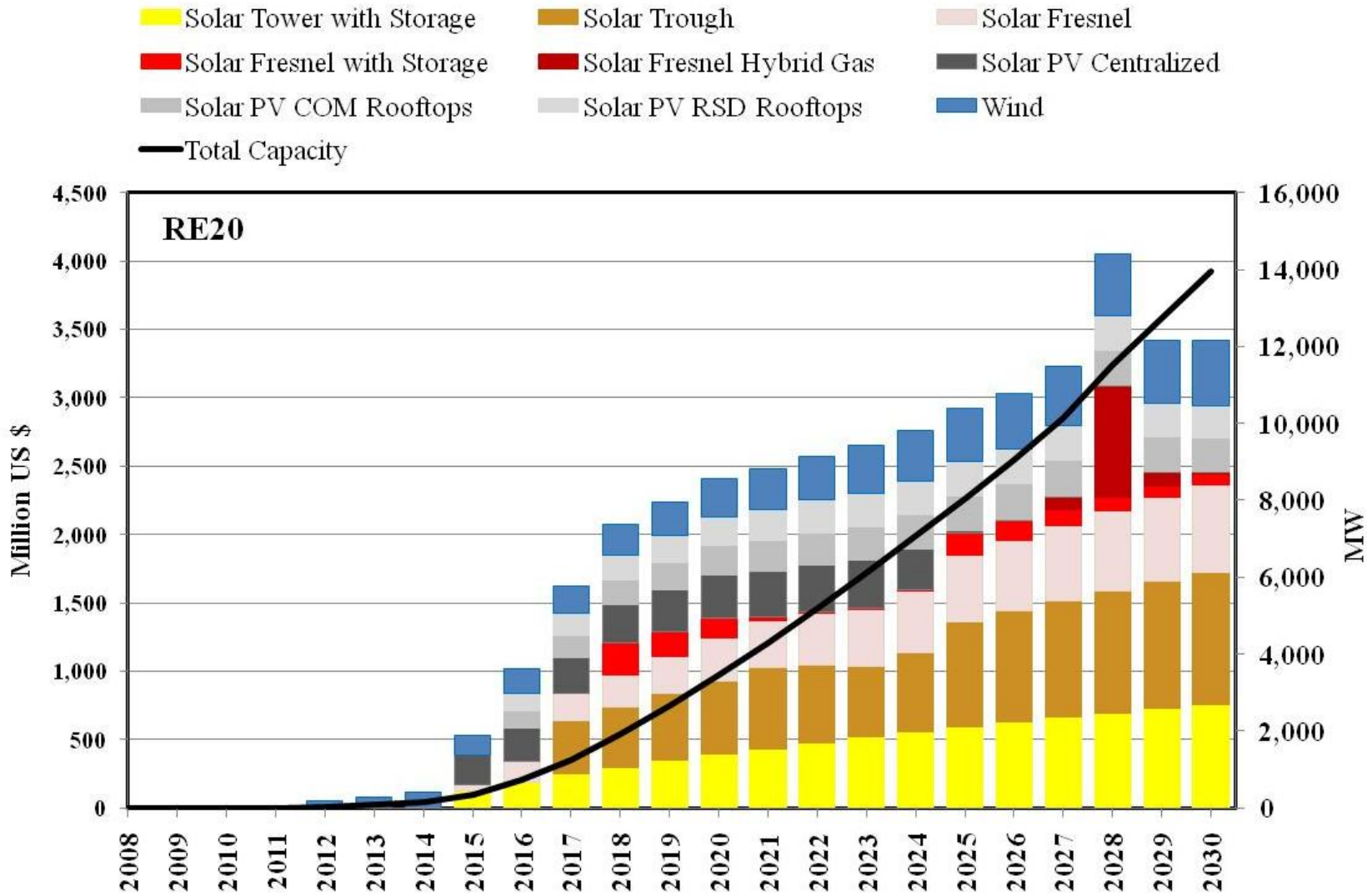
RE20 Energy Supply Mix



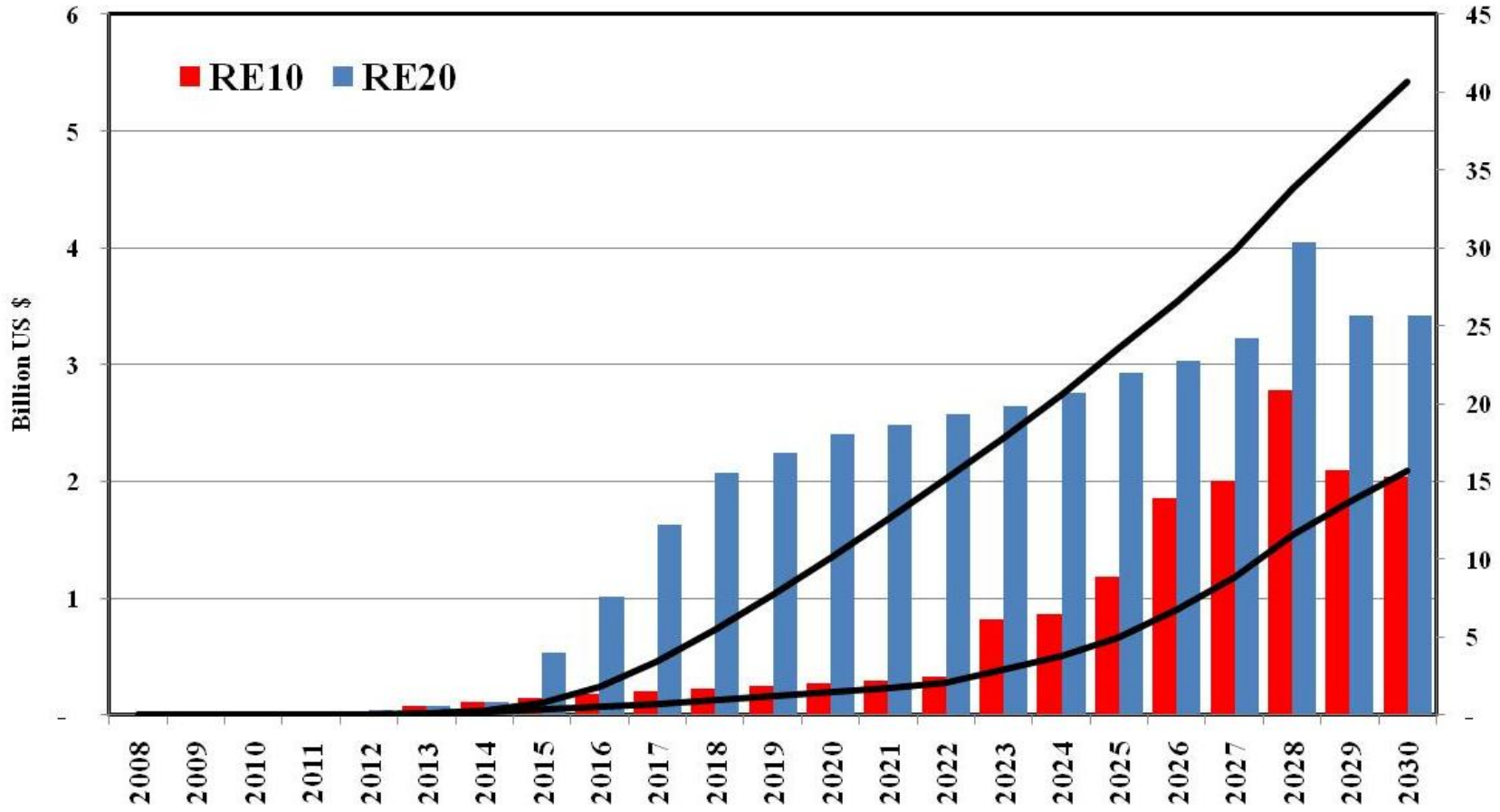
REF & RE10 Installed Capacity & Electricity Production



RE10 Yearly Deployment and Investment Costs



RE20 Yearly Deployment and Investment Costs



Total Deployment and Investment Costs

Kuwait RE Current and Future Projects

Research and Development & Demonstration Programs at KISR

- RE R&D Demons. Park (Wind, CSP, PV Cent. and Striling Dish) , 70 MW
- BIPV in new Administration / Centers Buildings, 1 MW
- PV Car Parking Shades with grid connection, 0.5 MW
- Thermal & PV Solar Simulators and Materials testing facilities, 15 labs

Government Sector

- BIPV & Rooftop in 100 school Buildings (MoEd.), 1 MW
- BIPV & PV Car Shades with Grid connected twin Buildings (MEW & MPW), I MW each
- Integrated Solar Combined Cycle (ISCC) & Gas Power Station (MEW), 280 MW

Commercial Sector

- BIPV & Rooftop in new Buildings (KPI), 1 MW
- BIPV & PV Car Shades with Grid connected Petrol Stations (KNPC), I MW
- PV for Remote oil & Gas fields various installations (KOC), 30 MW
- PV & Solar Thermal installations (Pan Arab & PAAET), up to 10 MW

Challenges for Renewable Energy

Resource and Power System Integration

- Intermittency, Variability & Capacity credit
- Transmission Availability & Access
- Infrastructure & Building Requirements
- Materials & Resources

Commercialization

- Technology Development, World's Tech. / Manufacturing Forecasts
- Policy and Regulatory Requirements, codes & regulations
- Long-term Integration Targets, Government and investors
- Government Funding loan , Subsidies, Tax-Credits & Feed-in Tariffs … etc.
- Human Resources & Training

Environmental Impact

- Renewable Energy Footprint Assessments, LCA
- Land –Use, Size & Availability