# Microgrid for CAREC

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# CAREC Snapshot (2015)

| Installed Capacity (9 CAREC Countries) | 78,109MW | |
|---|---|---|
| Countries with predominantly Thermal Based Power generation | Kazakhstan | Seasonal/Regional Imbalance |
| | Azerbaijan | Power Surplus |
| | Uzbekistan | Seasonal/Regional Imbalance |
| | Pakistan | Power Deficit |
| | Turkmenistan | Power Surplus |
| | Mongolia | Power Deficit |
| Countries with predominantly Hydro Based Power generation | Kyrgyz Republic | Seasonal/Regional Imbalance |
| | Afghanistan | Power Deficit |
| | Tajikistan | Seasonal/Regional Imbalance |

Source: http://www.carecprogram.org/index.php?page=energy-investment-forum-carec-regional-snapshot

# Key Power Sector Issues

- Skewed generation mix and high carbon intensity of the electricity sector necessitates inclusion of renewable sources in the generation mix
- Aged power generation, transmission & distribution systems requiring rehabilitation & modernization of electricity infrastructure
- Poor electrification rate and unreliable power supply
- The countries depend on hydro sources face severe winter shortages as reliability of supply decreases during winter months
- Inadequate electricity network infrastructure to connect load centers with the generation points

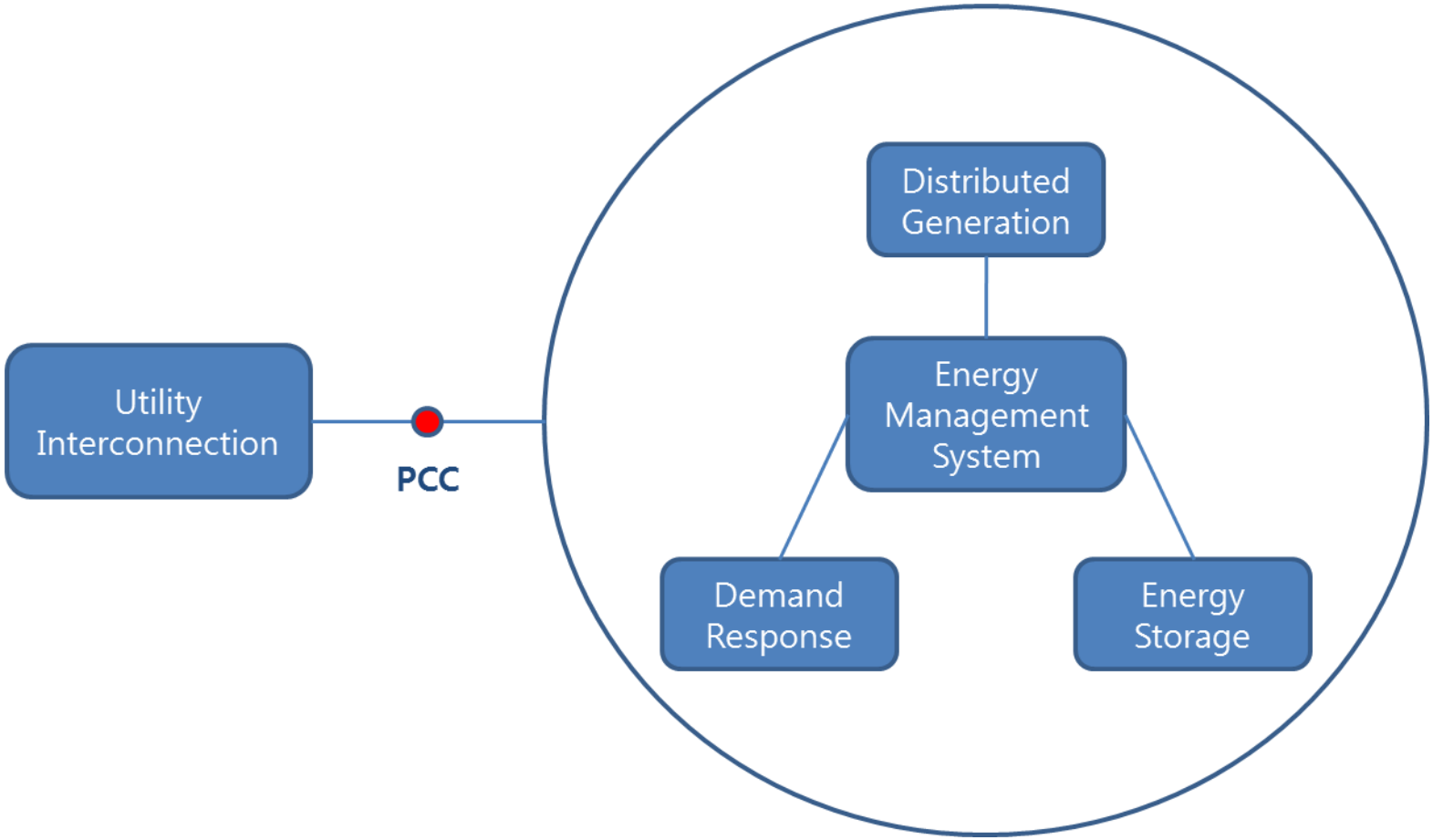
Source: ADB TA 8727: Study for a Power Sector Financing Road Map within CAREC

# Definition of Microgrid

- Grid whose size is micro ($10^{-6}$) scale
  - Normally ranges from tens of kW to tens of MW
  - Local grid not national grid
- Definition of DOE, USA

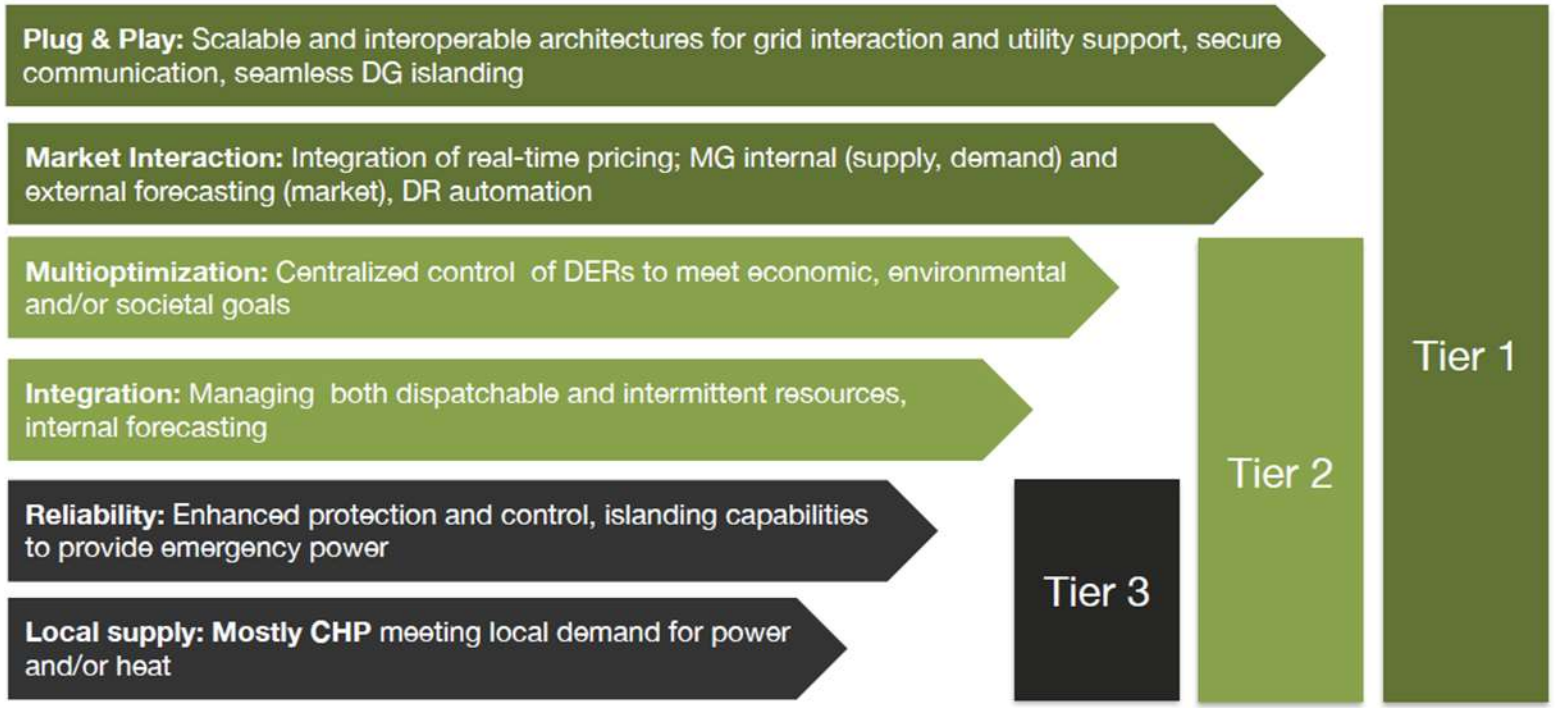
| Microgrid Definition | Key Attributes |
| --- | --- |
| • A microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode. | • Grouping interconnected loads and distributed energy resources<br>• Can operate in both island mode or grid-connected<br>• Can connect and disconnect from the grid<br>• Acts as a single controllable entity to the grid |

# Components of Microgrid



# Developments of Microgrid

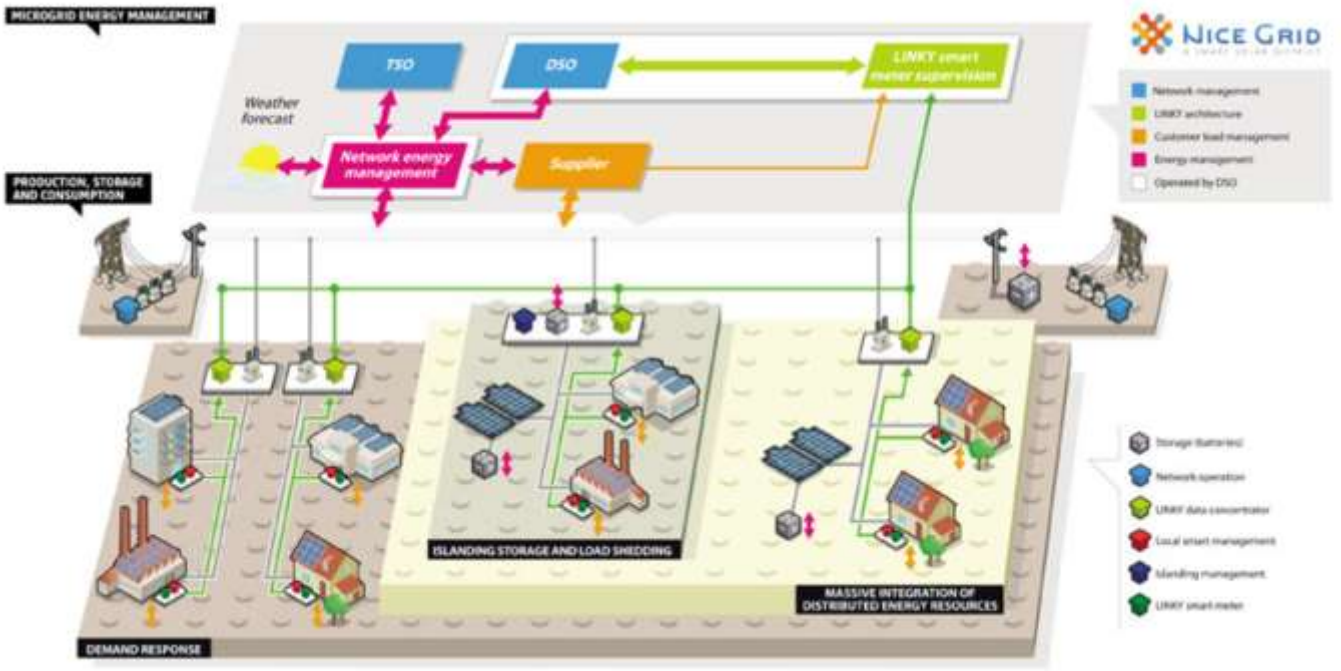
A microgrid is a set of distributed energy sources, loads and distribution network assets that are coordinated and controlled within clearly delimited geographical boundaries and can operate in grid-connected or islanded mode.




Source: GTM Research, North American Microgrids 2014: The Evolution of Localized Energy Optimization

# Smart Grid/Microgrid

- Microgrid is a building block of smart grid
  - Building a home (Smart Grid) with blocks (Microgrid) is the major trend of developed countries



# From Picogrid to Smart Grid

| Item | Picogrid (Remote) | Nanogrid | Microgrid | Smart Grid |
|---|---|---|---|---|
| Scale | Appliance Residential | Residential | Local | National |
| Capacity | 1kW and below[1)] | 5kW and below[2)] | kW ~ MW | MW ~ GW |
| Solution | DC | DC | AC/DC | AC |

1) From: “Off-Grid Renewable Energy Systems: Status and Methodological Issues”. IRENA, 2015
2) From: “Remote Microgrids and Nanogrids”, Navigant Research, 2015

# Short Term & Long Term Applications

| Item | Short Term | | Long Term | |
|---|---|---|---|---|
| Location | Urban | Rural/Remote | Urban | Rural/Remote |
| Smart Grid | Microgrid System Based | | Microgrid System Based | |
| Microgrid | Tier 2 | Tier 3<br>Picogrid<br>Nanogrid | Tier 1 | Tier 2 |

# Financing

- **Multilateral Development Bank (MDB)**
  - MDB is critical funding source to cover high installation costs of MG, if projects are considered in developing countries
- **International Finance Corporation (IFC)**
  - IFC invests MG projects in countries such as India and the Philippines through equity or debt financing, and the projects need to demonstrate good scale-up and replication potential to attract investment
- **Climate Investment Funds (CIF)**
  - CIF supports MG projects through two sub-programs (SREP, DPSP) in the form of grant, concessional loans, and guarantees
  - CIF currently manages $7.5bn funds with main contributions from the UK, US and Japan, and disbursed through 5 MDBs including World Bank, ADB, IDB, EBRD, and AfDB
- **Green Climate Fund (GCF)**
  - The Fund is a unique global initiative to respond to climate change by investing into low-emission and climate-resilient development
- **Global Environment Facility (GEF)**
  - GEF has achieved a strong track record with developing countries and countries with economies in transition, providing $12.5 billion in grants and leveraging $58 billion in co-financing for over 3,690 projects in over 165 countries

# Summary


**From: NREL, USA**


"We don't inherit the Earth from our parents. We borrow it from our children".