

# Planning Interconnections

Business model for cross border electricity transmission lines in GCC region

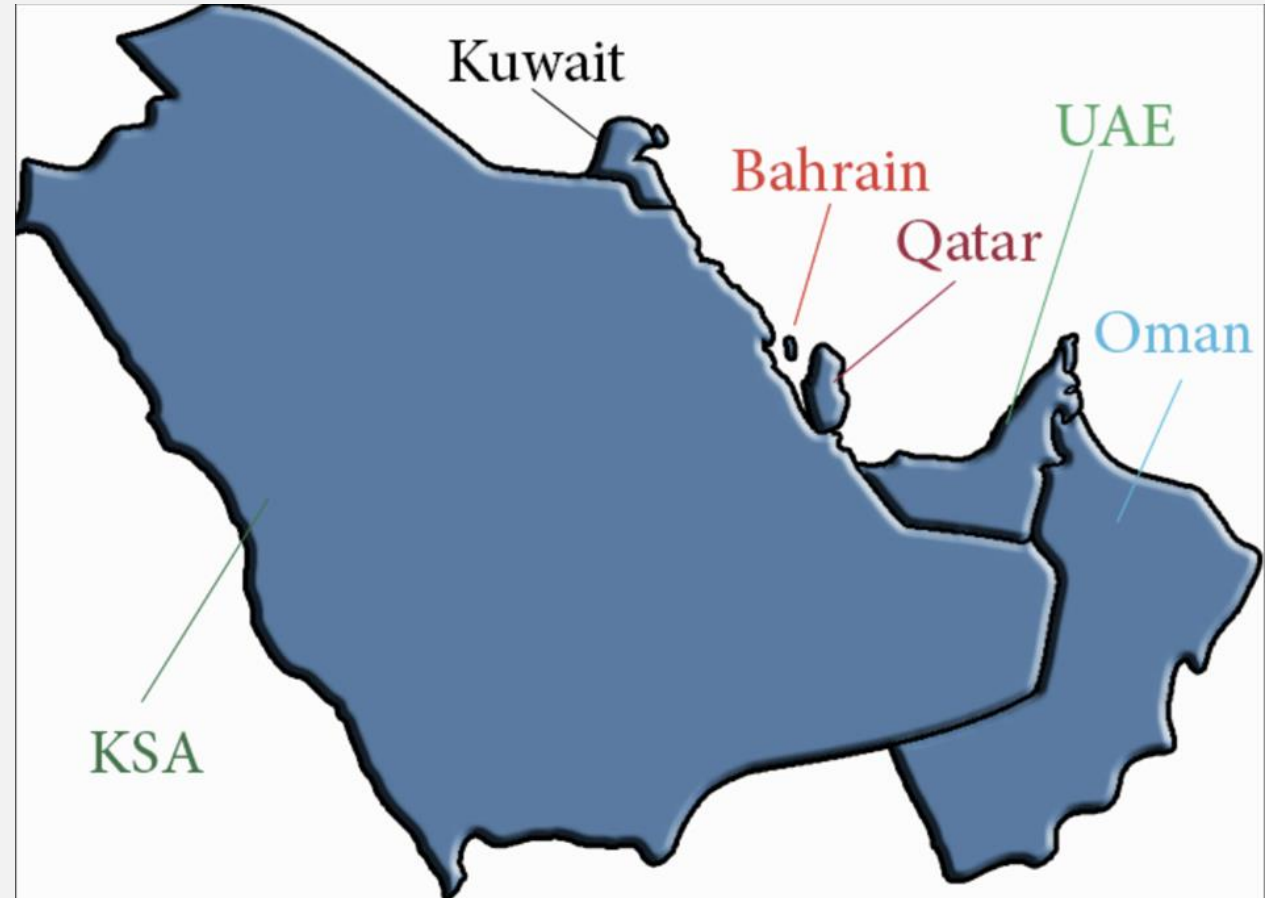


**Our Mission**

*A resilient interconnection grid ensuring power security and economic benefits*

# The GCC Region

- Bahrain is an Island, closer to KSA
- Kuwait & Qatar only borders KSA
- UAE & Oman have common border and borders with KSA
- The Challenge;
  - KSA operates at 60Hz
  - Kuwait, Bahrain, Qatar, UAE & Oman operate at 50Hz
- Cross border interconnections



# The GCC Interconnection Authority

## Established

July 2001  
Royal Decree No. M/21

## Owned by

- The six GCC Countries
- Authorized share capital is (\$US 1,407,000,000) divided into (1,407,000) shares of (\$US 1,000) each share

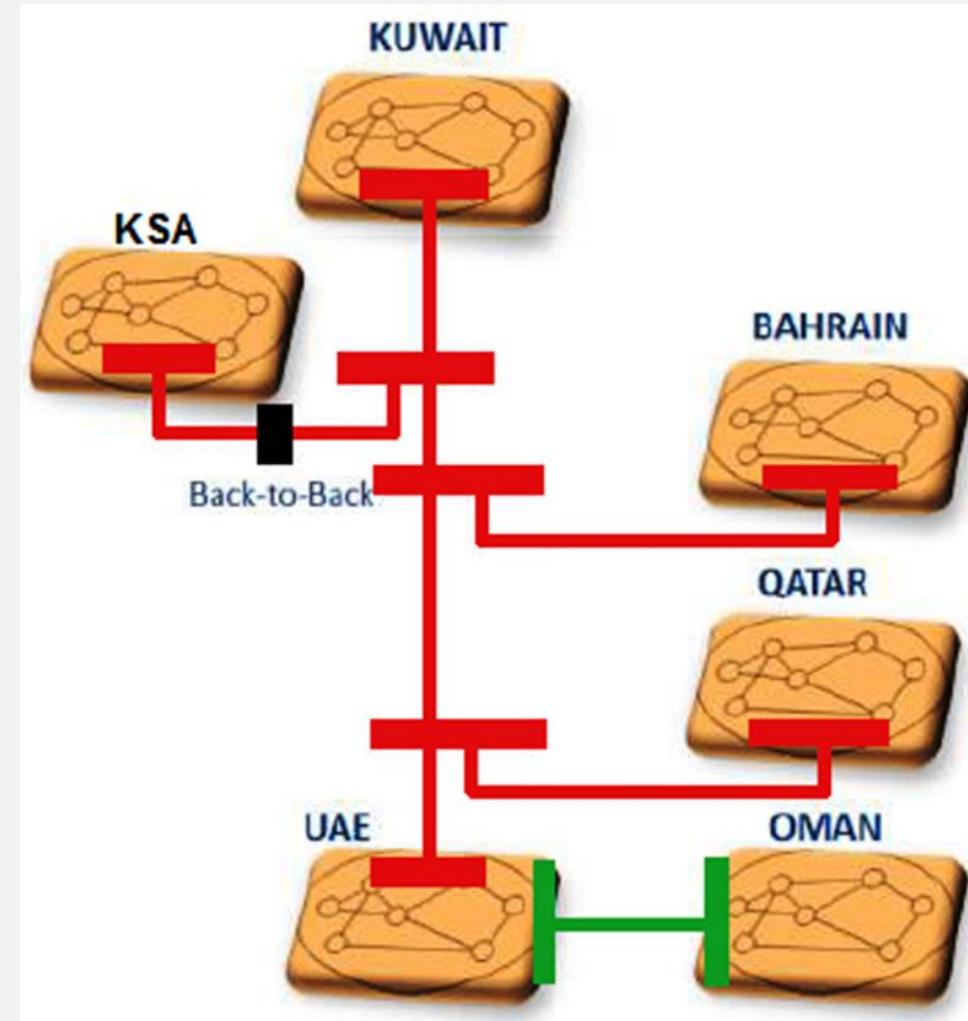
## Managed by

- Board of Directors
- Each member country is represented by two members.
- The Chairmanship is rotated among the member states every three years.



# The GCC Interconnector

- 400kV backbone
  - Synchronous connection
    - 2x400kV overhead lines connecting Kuwait, Qatar & UAE
    - 2x400kV Submarine cable connecting Bahrain
    - Oman not directly connected
  - Asynchronous connection
    - 3x660MW BtB HVDC connecting KSA
- UAE – Oman link
  - 2X220kV overhead lines



# Planning Criteria

- Primary criteria
  - N-1 criterion
    - loss of a circuit forming part of the transmission network
    - Loss of any single generating unit
    - Generating units if controlled by a single circuit breaker
    - Generating units if connected to the system by a single transformer
- Secondary criteria
  - Loss of a second element as per primary criteria with a probability greater than 10%
- Generation adequacy
  - Loss of Load Expectation (LOLE) of 5 hours/year
  - Remaining Capacity (RC)
    - Being the difference between available generating capacity and demand
    - Higher than 5% of Net Generating Capacity + Margin against the daily peak demand



# Preliminary considerations

- Interconnecting power systems yield multiple benefits
  - Shall be quantitatively assessed
  - Monetized to evaluate their profitability
- Continuous evolution in the identification of benefit indicators



**Benefits shall overweight costs.**



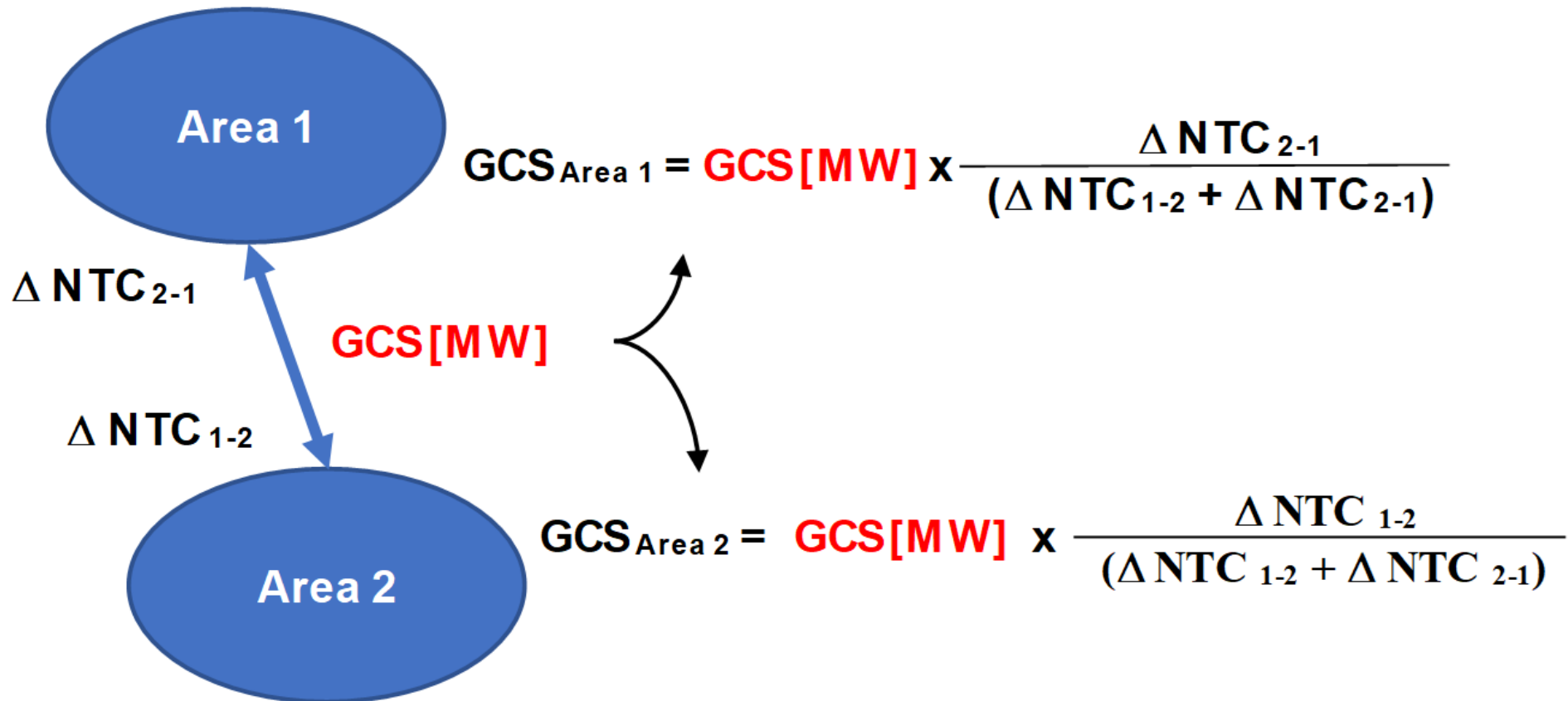
# Benefit Analysis

- Reference case (without Interconnector) against Interconnected case
  - Generation Adequacy
    - Installed capacity obligation
    - Reserve margins
  - Flexibility
    - Reserve sharing
  - Stability
    - Emergency support
- The avoided generation/capacity saving is monetized and considered as the benefit.
- Not considered in the Benefits
  - Economic exchanges between Member States
  - Increased Inertia (more RES integration)
  - Generator size (Increased N-1 size)
  - Reduction in CO2 emissions



# Allocation of benefits among Member States

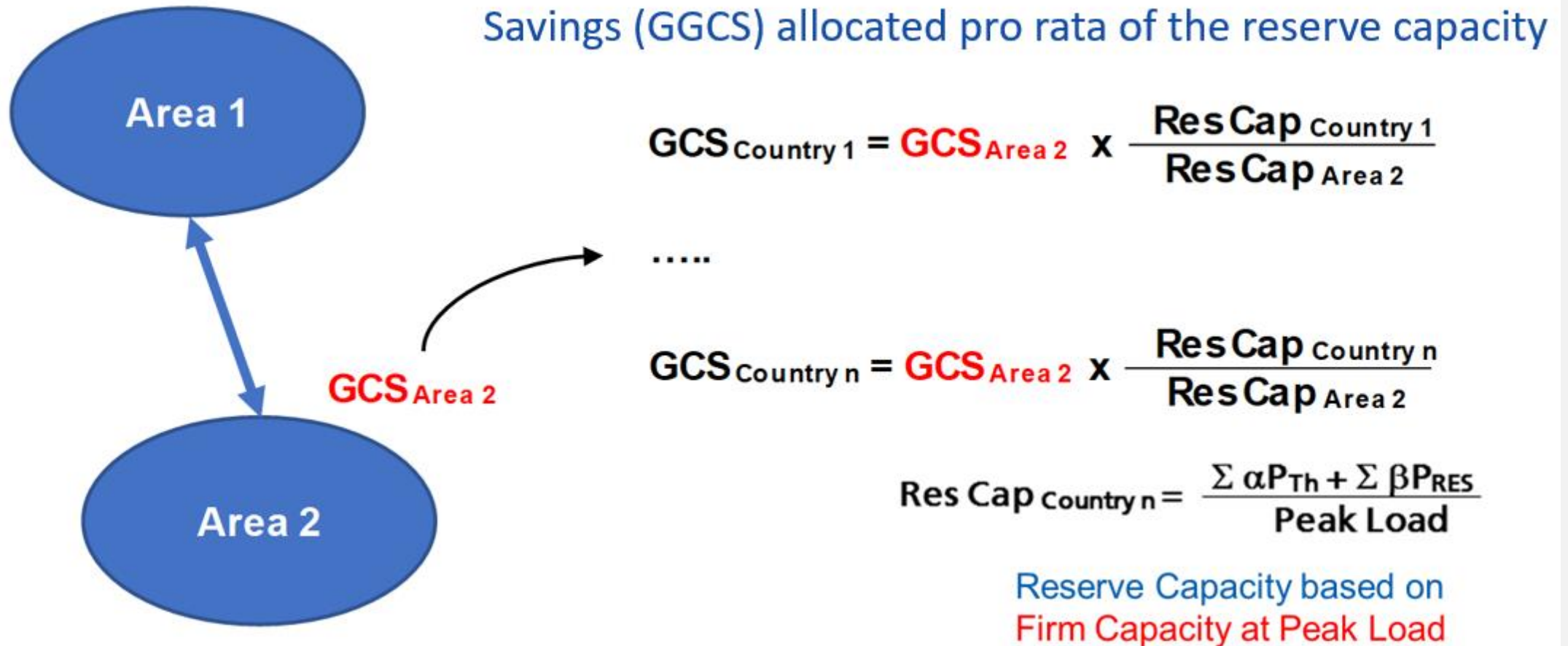
- Step 1: Saving (GCS) shared between Areas based on the NTC in the two directions





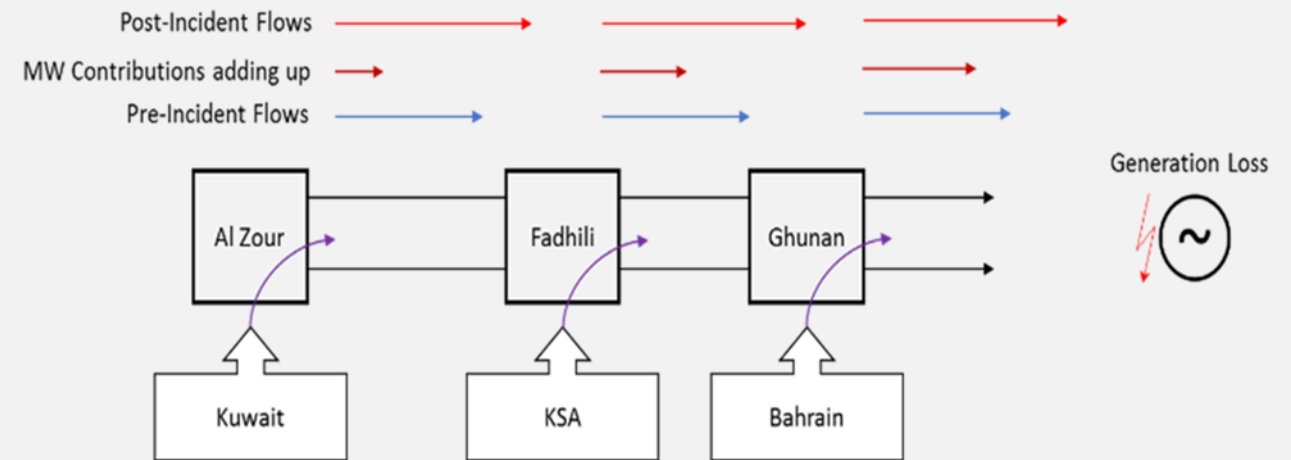
# Allocation of benefits among Member States

- Step 2: Saving (GCS) allocated to the Member States within the Areas

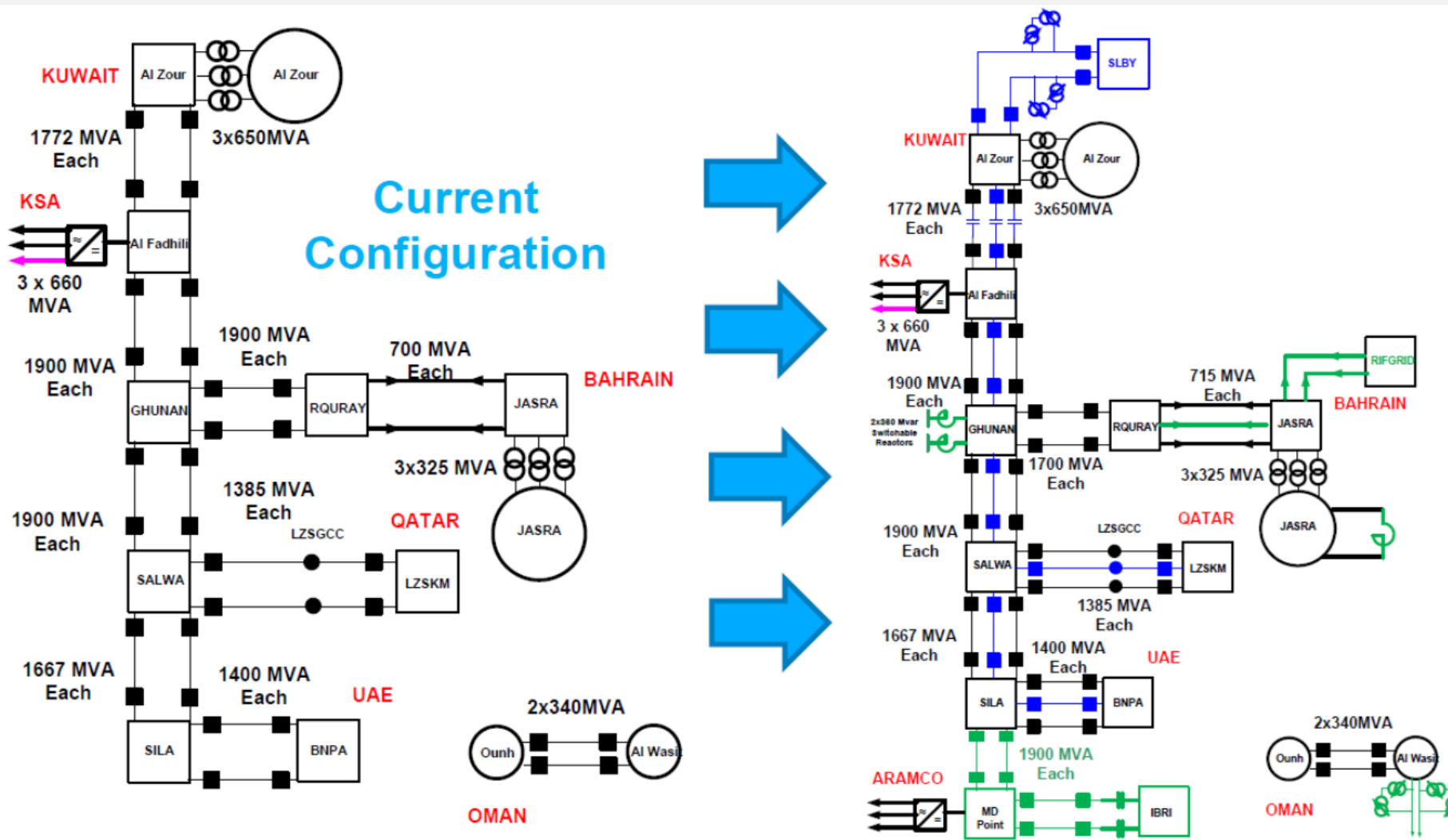


# Adequacy & Security beyond N-1

- Low probability high severity events
  - Concentration of mutual support
  - Larger power swings
  - Adequate stability margin-Not Economical
- Can trigger loss of Power System Integrity
- Solutions are Required
  - Augment the Maximum Transfer Capacity
  - Minimize the Risk of Disconnection



# Recommended expansion



# Step forward

- Standardization
  - To develop procedure for “benefit monetization and allocation”
    - Make it easier to replicate the same procedure to other reinforcement projects
  - To “keep it simple!”
- Possible evolution of the CBA to consider residual impact
  - Socio-economic welfare
    - Fuel savings due to economic exchanges
    - Emissions cost savings
  - Environmental
    - RES Integration
  - Grid losses



# Interconnections between Arab Countries

- Existing (E) and Potential (P) candidates

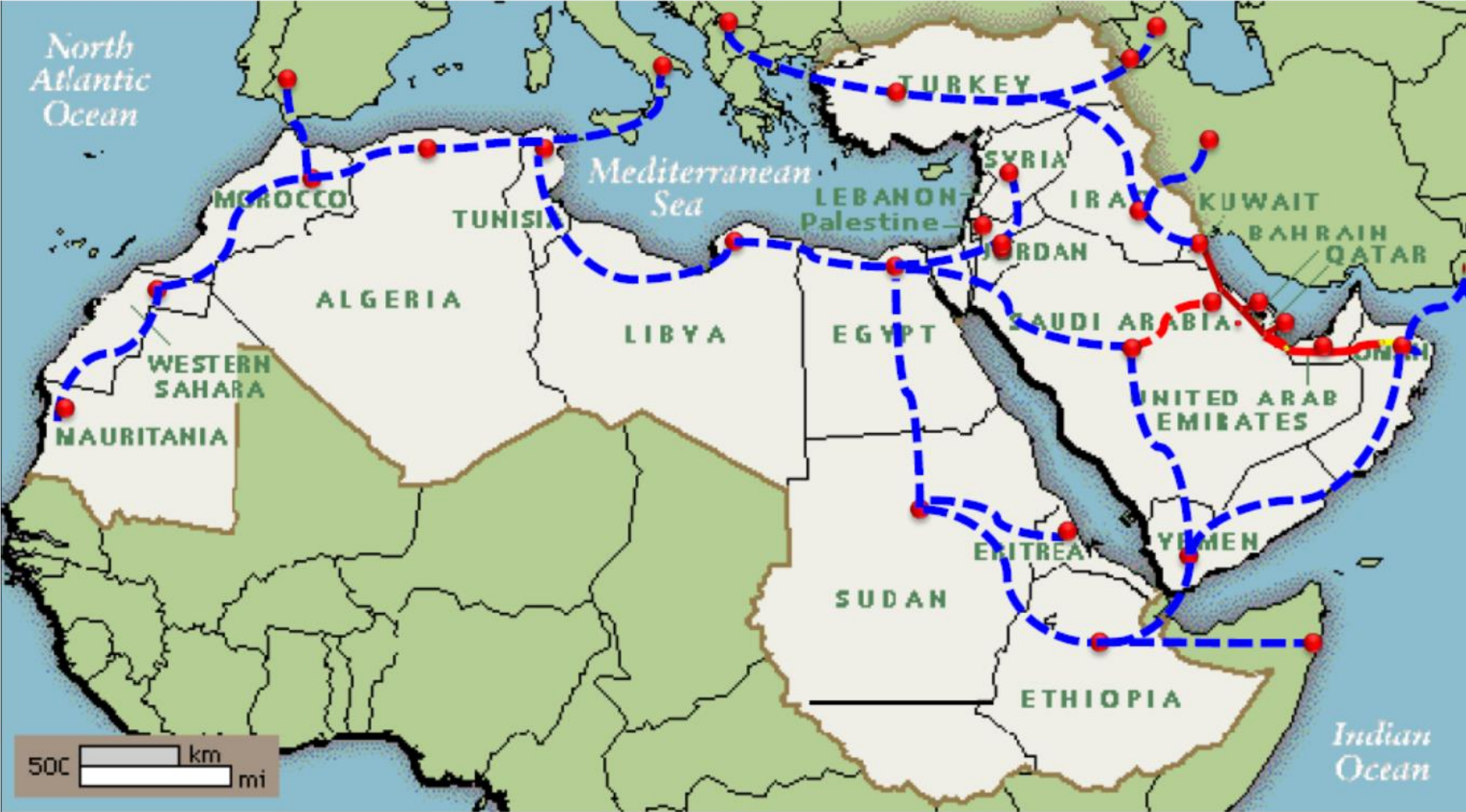
From	To																			
	Algeria	Bahrain	Egypt	Iraq	Jordan	Kuwait	Lebanon	Libya	Mauritania	Morocco	Oman	Palestine	Qatar	Saudi Arabia	Sudan	Syria	Tunisia	UAE	Yemen	
Algeria								P		E							E			
Bahrain														E						
Egypt				E										P	E(*) & P					
Iraq					P	P										E(*)				
Jordan			E	P							E			P		E				
Kuwait				P										E						
Lebanon																E				
Libya	P		E														E			
Mauritania																				
Morocco	E																			
Oman																		E	P	
Palestine					E															
Qatar																				
Saudi Arabia		E	P		P	E							E					E	P	
Sudan			E(*) & P																	
Syria				E(*)	E		E													
Tunisia	E																			
UAE											E			E						
Yemen											P			P						

(\*) Existing interconnections used in “islanded” operation mode for local power exchanges





# Going Beyond the GCC Region



# Proposed Corridors for Expansion



- The Northern direction to Jordan, Iraq and Syria with a possible indirect link with Turkey and Europe.
- The Eastern direction to reach Pakistan and India and then to Central Asian countries.
- The southern direction with a possible interconnection with Yemen, and a possible extension to Ethiopia and Djibouti.



# Thank You



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