Synthesis of grid impact project

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K.A.CARE has been collaborating actively with key stakeholders (SEC, ECRA, MoWE, NGSA) towards the future integration of renewables.

3 major pillars are essential to build an economic, reliable, stable and sustainable system: regulation, planning and operation.

System regulation - On Sep 10th, the GCSC approved the amendments to the grid enabling the integration of renewables.

System planning and operation - We believe the introduction of renewable will satisfy all planning and operation criteria:
- A study conducted by K.A.CARE demonstrated that the integration of renewables will not jeopardize the system reliability.
- Planned SEC upgrades will allow the integration of ~14 GW renewables in the grid by 2020.
- K.A.CARE adopted a renewable-mix to minimize the effect of intermittencies on the system.
- Conventional units will have sufficient dispatch flexibility in winter and summer to maximize the output of renewables while maintaining the system stability and reliability.

The introduction of renewables and the multiplication of players in generation will require the creation of an independent entity to coordinate renewable plants and support the system operators.

K.A.CARE has initiated further collaboration with key stakeholders to develop the SSECC

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1 Grid Code Supervisory Committee
2 K.A.CARE’s grid impact project
3 Saudi Sustainable Energy Control Centre
KA CARE has been collaborating actively with key stakeholders towards the future integration of renewables

**MoWE**
- MoWE has clarified the broader KSA electricity context and law
  - International connections plans
  - Other long term plans

**ECRA**
- ECRA has clarified the regulation framework
  - Grid code
  - Costs allocation mechanism
  - Connection process
  - Market rules

**SEC**
- SEC has explained the system planning information and requirements
  - Generation Planning
  - Transmission Planning
  - Planning methodologies and criteria
  - System modelling
  - Connection studies

**National Grid SA**
- NGSA has described the system operation and its requirements
  - Grid operation
  - Generation operation
  - Control center functions
  - Scheduling processes
  - Markets operation

1 ECRA study; Development of a Roadmap for a National Electricity Market in KSA
3 major pillars are essential to build an economic, reliable, stable and sustainable system

<table>
<thead>
<tr>
<th>System Regulation</th>
<th>Description</th>
<th>Status toward introduction of renewables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Set of rules governing the sector</td>
<td>Critical amendments to the grid codes were voted in Sep. 2014 enabling the future introduction of renewables</td>
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<tr>
<td></td>
<td>- Grid code</td>
<td>- An active working group with ECRA has been created to follow-up progress of system regulation</td>
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<td></td>
<td>- Cost allocation mechanism</td>
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<td></td>
<td>- Connection process</td>
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<tr>
<td>System Planning</td>
<td>Long term vision of sector development</td>
<td>Technical study regarding effect on renewable on system planning and operation finalized</td>
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<td></td>
<td>- Generation mix adequacy</td>
<td>- An active working group with SEC has been created to follow-up on system planning</td>
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<td></td>
<td>- Transmission security</td>
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<tr>
<td>System Operation</td>
<td>Day to day management of the system</td>
<td>- An active working group with NGSA has been created to follow-up on system operation</td>
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<td></td>
<td>- generation flexibility</td>
<td></td>
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<td></td>
<td>- Grid operations</td>
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On Sep 10th, the GCSC approved the amendments to the grid code enabling the integration of renewables

### Why modifying the grid code?

- The grid code defines **obligations, responsibilities, and accountabilities** of all the parties towards ensuring **open, transparent, non-discriminatory, and economic access and use** of the grid while maintaining its **safe, reliable, and efficient operation**

- It was initially drafted for conventional units only, i.e. some clauses:
  - are irrelevant for renewables
  - will generate additional costs to renewables

### Introduction of new amendments

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
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<tbody>
<tr>
<td>1st contact established</td>
<td>July 2013</td>
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<tr>
<td>Amendments presentation</td>
<td>Dec 2013</td>
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<tr>
<td>KACARE became an official member</td>
<td>Oct 2013</td>
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<td>First workshop</td>
<td>Feb 2014</td>
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<td>Second workshop</td>
<td>April 2014</td>
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<td>Third Workshop</td>
<td>Aug 2014</td>
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<td>GCSC’s 22nd meeting</td>
<td>May 2014</td>
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<td>1st set of amendments voted “yes”</td>
<td></td>
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<tr>
<td>1st set of amendments</td>
<td>May 2014</td>
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<tr>
<td>Voting in GCSC’s 23rd meeting</td>
<td>Sep 2014</td>
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On Sep 10th, the 2nd set of Amendments proposed by KA CARE were approved

- All sets (+20) amendments have been unanimously voted YES.
  
  “This is a milestone, it has been a very long time that we haven’t all agreed on so many new amendments”
  
  – Voter
Planned SEC upgrades will allow the integration of ~14 GW renewables in the grid by 2020

SEC planned upgrades by 2020¹

- Development of 1500km HVDC transmission corridors
- Reinforcements of 380kV interconnections between operating areas
- Connection of isolated areas
- Other reinforcements inside the operating areas

~14 GW renewables could be integrated in specific mode of the 2020 grid without major reinforcements

¹ Description of major upgrades

SOURCE: SEC, KACARE study on grid impact
K.A.CARE adopted a renewable-mix to minimize the effect of intermittencies on the system

**SYSTEM OPERATION**

**K.A.CARE adopted a renewable-mix to minimize the effect of intermittencies on the system**

- **Renewable generation is intermittent**
  - **Typical PV output**
    - 1 MW
  - **Possible CSP with storage output**
    - 1 MW

- **CSP with storage can help compensate intermittencies**
  - Storage allows for a controlled distribution of energy during the day
  - KSA could leverage this technology to compensate other renewable intermittencies

- **Solar energy can be distributed during the day**

- **PV do not generate energy at night**
- **Weather disturbance during the day could reduce energy output**
- **Wind power is also intermittent across the day**

**All renewables will be connected to the grid**

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1 During a 24-hours period
The introduction of renewable and the multiplication of players in generation will require the creation of a national entity to coordinate renewable plants and support the system operators.

### Development of generation

- KSA will see a multiplication of players in generation
  - KSA has seen the introduction of new generation players with the introduction of IPP in the past 10 years
  - While this is expected to continue, the introduction of renewables and nuclear will bring other players

- The introduction of renewable will require further coordination between generation units
  - Intermittencies will require compensation within renewable sources and from conventional plants
  - Dispatch and maintenance optimization schedule will be required

### Creation of a new national coordination entity

- As observed in many countries leveraging significant renewable capacity, the Saudi Sustainable Energy Control Center (SSECC) will:
  - facilitate the integration of sustainable generation in the power system and support the TSP\(^1\)
  - organize and centralize data from generation plants (e.g., forecast, maintenance requirements, etc.)
  - coordinate generation plants forecasted dispatch

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1 Transmission system provider

SOURCE: KACARE study on grid impact
Thank you...

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