Energy Transition and Renewable Energy in Korea

12th December 2017

Sanghoon Lee
Director, Green Energy Strategy Institute
IEA - 2°C Scenario

- Limiting the global mean temperature rise to below 2 °C would require an energy transition of exceptional scope, depth and speed.
- Improvements to energy and material efficiency, and higher deployment of RE are essential components of any global low-carbon transition.

[Global emissions abatement by technology in the 2°C Scenario relative to the New Policies Scenario]

Source: IEA, 2017, Perspectives for the Energy Transition.
IRENA – REmap in 2050

- Accelerated deployment of RE and energy efficiency measures are the key elements of the energy transition
- The share of RE needs to increase from 16% of the TPES in 2015 to 65% in 2050
- RE would be the largest source of energy supply under Remap in 2050, representing two-thirds of the energy mix.

[Global total primary energy supply, 2015-2050]

Source: IEA, 2017, Perspectives for the Energy Transition
• Decarbonization of Power sector in the 2DS

• Currently Fossil fuels account for around 68% of global electricity generation
• To meet climate goals, global electricity generation is almost completely decarbonized by 2050
• The share of RE in the generation mix increases from 22% in 2013 to 67% by 2050

[Global electricity generation mix in the 2DS, 2013-50]
• Low-carbon policy measures in INDCs

• RE is reportedly the most widely adopted policy measure to implement INDCs
• Nuclear power is expected to play a limited role in combating climate change
• **RE in European electricity system**

• Wind power capacity increased the most and then followed by Gas fired power and Solar PV since 2000 in EU-28

• Nuclear power, coal fired power decreased in terms of power capacity in EU

[Net power generation capacity added in the EU-28 from 2000 to 2015]

Global Investment in Renewable Energy

- USD 249.8 billion was invested in constructing new renewable power plants
- RE accounts for 63.5% of new investment in power capacity
- PV capacity: USD 113.7 billion
- Wind capacity: USD 112.5 billion
- Fossil fuel capacity: USD 113.8 billion
- Nuclear capacity: USD 30 billion

Global Investment in Power Capacity, by Type (Renewable, Fossil Fuel and Nuclear Power), 2012-2016

Source: BNEF.
• **New Energy Outlook 2017 by BNEF**

  - BNEF expects $10.2 trillion to be invested in new power capacity to 2040, of this 72% goes to RE or $7.4 trillion. Solar takes $2.8 trillion and wind $3.3 trillion.
  - Wind and solar account for 48% of installed capacity and 34% of electricity generation world-wide by 2040.
  - Solar PV LCOE will drop by 66% by 2040, offshore wind LCOE decline 71% by 2040.
  - A further $5.3 trillion investment in 3.9TW of zero-carbon capacity will be needed to meet 2°C trajectory.

  [Outlook of annual capacity additions by technology, 2016 - 2040 (GW)]

• **China 2050 High RE Penetration Scenario and roadmap**

• China is accelerating to reduce the share of coal, deploy non-fossil energy and improve energy intensity to cope with climate change and domestic air pollution as well.

• Wind power capacity will increase to 300GW by 2020, 1,100GW by 2030 and Solar PV increase to 200GW by 2020, 1,000GW by 2030.

• RE will account for 53% of total power generation in 2030.

• RE will account for 86% of total power generation and non-fossil energy 91% in 2050.

• Debates on Energy Mix since last Presidential Election in Korea

• Public awareness of nuclear safety and fine dust has been increasing and the public pressure driving the change of energy policy
• Most candidates for last presidential election promised energy policy change to reduce the share of nuclear power and coal fired power and then utilize more RE and gas fired power.
• **Transformation of Energy Policy by New Government**

- On 19th June 2017, President Moon announced the transformation of Energy policy from nuclear and coal to RE and gas as a bridge energy reflecting the people’s voice for nuclear safety and better environment.

<table>
<thead>
<tr>
<th>Stop Nuclear power construction and strengthen nuclear safety</th>
<th>Sustainable Energy Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Cancel 6 reactors’ construction plan</td>
<td>• Stop new construction of coal fired power plants</td>
</tr>
<tr>
<td>• Prohibit license renewal of old nuclear power plants</td>
<td>• Review the constructing 9 coal fired power plants on the zero base</td>
</tr>
<tr>
<td>• Induce social consensus on constructing two reactors through deliberative poll</td>
<td>• Phase out old coal fired plants sooner</td>
</tr>
<tr>
<td>• Strengthen nuclear safety standard and the committee of nuclear safety</td>
<td>• increase the capacity factor of gas fired plants higher</td>
</tr>
<tr>
<td></td>
<td>• increase the share of renewable electricity in generation mix by 20% by 2030</td>
</tr>
</tbody>
</table>

⇒ These changes will be reflected to 8th electricity supply and demand plan.
• **Roadmap of Phase-out of nuclear power plants**

<table>
<thead>
<tr>
<th>classification</th>
<th>numbers</th>
<th>capacity</th>
<th>(GW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New ones</td>
<td>6 reactors</td>
<td>8.8GW</td>
<td></td>
</tr>
<tr>
<td>Old ones</td>
<td>14 reactors</td>
<td>12.5GW</td>
<td></td>
</tr>
<tr>
<td>Wolsung 1</td>
<td>1 reactor</td>
<td>0.7GW</td>
<td></td>
</tr>
</tbody>
</table>
• Review of current energy transition policy in Korea

• Moon administration is transforming energy policy towards safer, heathier and more sustainable future

• Energy transition policy is now talking about power mix, not energy mix

• Electricity policies also focus on installed power capacity mix, not electricity generation mix

• Phase-out of nuclear power plants will take a very long time (63 years more)

• Within Moon administration’s term of office, the share of nuclear power will reach peak

• Energy transition policy shows the lack of short- term detail and needs to align with energy price measures and electricity market reform

• Energy transition policy has no close linkage yet to new climate action plan
- Global trend of Renewable Energy

* Source: World Energy Balances 2016 (IEA), Korea Energy Agency
• Composition of RE generation in Korea

• Lowest share of RE among OECD countries
• Waste energy accounts for 59.6%
• Solar PV and Wind power account for 16.3%

source: Korea Energy Agency, 2016 RE Statistics
Renewable Energy Supply (TPES) in Korea

Source: Korea Energy Agency
• RE power capacity and generation in Korea
• Korea RE Industry growth (2007 → 2015)

source: Korea Energy Agency
• Status of PV industry in Korea

PV export (hundred Million Dollars)

2012: 19.7
2013: 20.5
2014: 24.2
2015: 30.0
2016: 35.8

Capcity of Korean PV enterprises

Cell
1. Hanwha Q Cells (5,200MW/year, World 1st rank)
   PERC (Passivated Emitter and Rear Cell)
   Efficiency 19.5%, 1st commercialized for Polycrystalline Cell
2. LG Electronics (1,100MW/year)
   22% efficiency for N-Type Monocrystalline Bifacial Cell
3. Hyundai Heavy Industries (600MW/year)
4. Shinsung E&G (600MW/year)
   21.7% efficiency of Monocrystalline PERC cell

Polysilicon
1. OCI (52,000ton/year, World 3rd rank)
2. Hanwha Chemical (15,000ton/year)
3. Hankook Silicon (15,000ton/year)

Module
- Global production capacity 10GW
- Domestic production capacity 6.4GW

Source: Korea Energy Agency
• Status of Wind industry in Korea

- 1,031MW installed by 2016
  - Onshore wind: 77 sites, 519 turbines, 996.22MW
  - Offshore wind: 3 sites, 12 turbines, 35MW

- Domestic turbine market share
  - 2010: 5.9%
  - 2016: 48.1%

- Capacity of Korean Wind enterprises

<table>
<thead>
<tr>
<th>Turbine</th>
<th>Doosan Heavy Industries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3MW on/offshore turbine, 5.5MW offshore turbine</td>
</tr>
<tr>
<td></td>
<td>- world 5th rank Offshore turbine supplier in 2016 (30MW, 1.5%)</td>
</tr>
<tr>
<td>Hyosung</td>
<td>5.5MW offshore wind turbine certified in Germany (July, 2015)</td>
</tr>
<tr>
<td>Unison</td>
<td>750KW, 2MW, 2.3MW wind turbine</td>
</tr>
<tr>
<td>Hanjin</td>
<td>1.5MW, 2MW wind turbine</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tower</th>
<th>CS Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wind tower global market share 6.5%</td>
</tr>
<tr>
<td></td>
<td>Manufacturing at Canada, China, Viet Nam and UK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Forging</th>
<th>Tae-woong</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>400 customers including world turbine top 10 enterprises</td>
</tr>
</tbody>
</table>

source: Korea Energy Agency
- **Renewable electricity target by 20% by 2030**

  - The share of renewable electricity (plus others) in generation mix will increase from 7% in 2017 to 20% in 2030
  - The target is not high compared to the status of OECD. Currently, the share of renewable electricity account for around 24% in OECD electricity generation
  - Currently, solar PV capacity is around 5.5GW and wind is 1.1GW, that’s why the target can be very ambitious for South Korea
  - To achieve 20% target by 2030
    - Newly 30~31GW of Solar PV and 16~17 GW of wind capacity will be added by 2030
    - Increasing RPS mandatory rate (28% by 2030)
    - Local community participation: Citizens, farmers and community power
    - Reforming site planning procedure for RE projects
    - Promoting offshore wind farms
    - Efficient demand side management
    - Investment for grid stability: T&D investment, securing backup power