3-2. Outlook of Industry Sector

Takashi Otsuki
Researcher, APERC
Contents

- Industry sector overview
- Methodology for the 7th Outlook
- Preliminary results
Industry has been accounting for about one-third of the global final energy consumption.

13 industries are included in the sector.

The share of industry in APEC has also been about one-third (28-34%) since 1980.

Note1: As of 2015. Data from IEA.
Iron & steel, non-metallic minerals and chemical/petrochemical are the three largest energy consuming industries

Global energy consumption in industry by sub-sector, 2015

- 20% Non-specified
- 18% Iron and steel
- 16% Chemical and petrochemical
- 31% Other nine sectors aggregated
- 15% Non-metallic minerals

APEC energy consumption in industry by economy, 2015

- USA
- Russia
- China

- These three sectors currently account for almost half of total energy consumption in industry
- Among APEC economies, China has driven the industrial demand growth in the 2000s

Note: Data from IEA.
Example of industrial activity:
Steel making in the iron and steel sector

**Major steel making processes**

- **Blast furnace**
  - Accounts for 70% of global steel production
  - Coal is the main fuel for heating as well as reducing iron ore

- **Electric arc furnace (EAF)**
  - Production using Scrap and pig iron or direct reduced iron
  - Electrical charge provides heat
  - Less energy required compared to blast furnace

- Energy consumption profiles largely vary by process in several sub-sectors
- Explicit modeling of industrial process is important for projections

Source: http://www.steelconstruction.info/images/thumb/6/61/B3_Fig4.png/500px-B3_Fig4.png
New industry model for the 7th Outlook
APERC’s energy demand and supply model structure
Energy demand is estimated through projecting industrial activities and energy intensity (energy intensity = energy consumption per unit of activity).
**Industrial activity module** was created to project industrial production in physical basis in energy-intensive sub-sectors. This enables to:

- Model the impacts of sector-specific factors, including steel recycle rate, clinker-to-cement ratio and recovered paper rate;
- Analyze process emissions in cement production (calcination process), which accounts for as much as 50% of its emissions; and,
- Estimate non-energy use, such as for feedstock in the chemicals, taking into account the products in each economy.

**Energy intensity module** was refined to assess the intensity improvements, taking into account the future choice of production processes and capacity changes (such as retirement of exiting facility and new additions)
Per capita consumption is one of the main outputs of the model.

Steel consumption per capita

![Steel consumption per capita graph]

Per capita consumption is a useful indicator to implicitly reflect the socio-economic factors, including the level of social infrastructure and people’s lifestyle.

Source: APERC.
Preliminary results
### General assumptions for the “BAU” and “TGT” scenario

<table>
<thead>
<tr>
<th></th>
<th>Business-as-Usual (BAU)</th>
<th>APEC Target (TGT)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Industrial output</strong></td>
<td>• Domestic consumption is projected based on an econometric model analyses as well as recent policies and industry views</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Model input data include GDP, population and historical production</td>
<td></td>
</tr>
<tr>
<td><strong>Energy intensity</strong></td>
<td>• Current operation practice remains over the period in terms of efficiency and renewables</td>
<td>• Accelerated retirements of existing facilities</td>
</tr>
<tr>
<td>and renewables</td>
<td></td>
<td>• BAT and efficient operation at newly added facilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Higher renewable use as a heat supply option</td>
</tr>
<tr>
<td><strong>Sector-specific</strong></td>
<td>• Current recycle rate (steel scrap, used paper, etc.) and clinker-to-cement ratio remain</td>
<td>• Accelerated recycle activities and higher additives for cement production</td>
</tr>
<tr>
<td>factors</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: BAT=Best Available Technology.
China remains the largest industry energy consumer, with a share around 50-55% from 2015 to 2050.

Energy demand in iron & steel and non-metallic minerals peak, while chemicals drives the growth among the most energy-intensive industries.

Source: APERC.
Decreasing production in China as well as gradual shifts to EAF contribute to curbing energy consumption.

Note 1: The figure shows only selected economies. Economies shown in the figure are the three largest producers in APEC as of 2015.
Note 2: Electric Arc Furnace. Source: World Steel, APERC.
Non-metallic minerals (BAU): Cement production also peaks in the BAU

### Cement production

** Millions tons of cement

<table>
<thead>
<tr>
<th>Year</th>
<th>1990</th>
<th>2000</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>3500</td>
<td>3000</td>
<td>2500</td>
<td>2000</td>
<td>1500</td>
<td>1000</td>
<td>500</td>
</tr>
<tr>
<td>APEC total</td>
<td>3500</td>
<td>3000</td>
<td>2500</td>
<td>2000</td>
<td>1500</td>
<td>1000</td>
<td>500</td>
</tr>
<tr>
<td>USA</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Energy demand in non-metallic minerals by fuel, APEC

- **Electricity**
- **Coal**
- **Gas**
- **Oil**
- **Heat**
- **Renewables**

**Note 1:** The figure shows only selected economies. Economies shown in the figure are the three largest producers in APEC as of 2015.

**Source:** USGS, APERC.

---

**Construction boom in China is assumed to slow down.**

Coal remains the main energy source, although gas consumption grows (driven by gas-producing economies)

Note 1: The figure shows only selected economies. Economies shown in the figure are the three largest producers in APEC as of 2015.
Source: USGS, APERC.
Chemical and petrochemical (BAU): Projected rise in chemical production leads to rising energy demand in the BAU

Growth is driven by population (for ammonia) and continuous demand growth in emerging economies (for petrochemical products)

Note1: The figure shows only selected economies. Economies shown in the figure are the three largest producers in APEC as of 2015.
Source: USGS, METI, APERC.
Assumptions for the APEC Target (TGT) scenario:
The TGT assumes best available technologies for new capacity

Energy intensity of clinker production

- Vertical shaft kilns
- Wet kilns
- Long dry process
- Dry kiln (four stage)
- Dry kiln (six stage pre-

Image of capacity mix change

Estimated current energy intensity of APEC economies: 3.1-6.1 GJ/t-clinker

- Existing technologies and sectoral energy intensity vary by economy
- Sectoral energy intensity is assumed to improve through replacing existing capacity with BAT¹ facilities

Note1: BAT=Best Available Technology
Source: IEA statistics, USGS.
Appendix: 
Cement production process

Production process

- Kiln consumes more than 99% of heat required for cement production

Clinker production
(calcination reactions, temperature: 1450°C)

\[ \text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2 \]
Industry final energy demand, BAU and TGT

- Energy savings of 9% in 2050 in the industry overall. Industry demand flattens around 2030

Savings in selected sub-sectors (APEC total, 2050)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron &amp; steel</td>
<td>15%</td>
</tr>
<tr>
<td>Cement</td>
<td>18%</td>
</tr>
</tbody>
</table>

Source: APERC.
Emissions from the industry, BAU

Under the TGT, annual emissions can be reduced by about 497MtCO₂ in 2050, almost equivalent to the current energy-related emissions in Korea¹

Note1: Annual energy related CO₂ emissions in Korea was 568MtCO₂ in 2014
Source: APERC and IEA.
APERC developed a tool to project industry activities on a physical-basis.

Energy consumption in the iron & steel and cement sub-sectors in APEC is projected to decline due to saturated production (driven mainly by China).

The TGT scenario shows the opportunities for energy savings: 9% in the industry overall and 10%+ in both iron & steel and cement.

Increasing efficiency leads to emissions reductions of about 500MtCO\textsubscript{2} in 2050 in the TGT compared to the BAU.

Future work includes:

- Outlook of renewable use in the TGT scenario (renewable potential estimation ongoing)
- Two degree scenario projection—modeling of CCS in iron & steel and cement
Thank you for your attention!
Appendix:
Modeling of renewable potential in the industry

Demand
Useful heat demand in each temperature range

Supply
Supply potential of GSHP, solar, and biomass

Renewable potential
- LT: determine the RE tech deployment priorities by cost
- MT and HT: Only biomass is applicable

Estimated the renewable utilization potential in each sub-sector with a consideration of useful heat demand (by temperature)

Note: GSHP=Geothermal heat pump; LT=Low Temperature; MT=Medium Temperature; and HT=High Temperature.
Appendix:
Renewable heat potential in selected industries in China

Note: Total final energy demand in these charts are obtained from the Outlook 6th edition.
Appendix:
Projection of crude steel production

Note: Data for Russia are available after 1992.
Appendix: Projection of cement production

Note: Data for Russia are available after 1992.
Appendix:
Projection of paper and paperboard production

Note: Data for Russia are available after 1992.