How will Future Megatrends affect Steel Demand and Products?

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Facing stagnant global economy and faltering steel intensity under excess capacity, will steel demand continue to increase with new and innovative products?

Global Steel Demand

Global Steel Intensity = Global Steel Demand/World GDP

Overcapacity = Crude Steel Capacity – Crude Steel Production

Crude Capacity Additions by Region

World: 15.3 [mil. ton] -6.7
Asia: 20.4
MENA: 14.2
NAFTA: 1.2
Europe: 3.3

Global Steel Intensity

2013: 21.5
2019: 17.7

Megatrends

How will megatrends affect steel demand and products in the future?

Source: worldsteel, OECD Steel Committee, World Bank, POSRI

⇒ How will megatrends affect steel demand and products in the future?
Steel demand growth and development of the global steel industry has been led by four main drivers (trends) of steel-consuming industries.

**On-going Trends**

1. **Urbanization**
   - Urbanization Rate
   - Steel Consumption

2. **Globalization**
   - Export/GDP
   - Steel Consumption

3. **Motorization**
   - Motorization Rate
   - Steel Consumption

4. **Industrialization**
   - Industrial Production
   - Steel Consumption

Source: worldsteel, World Bank, IHS Markit, POSRI
New Rising Trends: 4th Industrial Revolution

Hyper-connected and hyper-intelligent Society will require steel-consuming industries to be smart with new biz. models and capabilities, as well as the steel industry.

2. Megatrends

**Communication**
- Connection of people, things, & data
- Emergence of platform biz
- Stronger consumer power
- From ‘own’ to ‘use’
- Product life cycle↓, customer need↑

**Mobility**
- EV value chain
- Self-driving system
- Combustion engine-based VC collapsed
- Sharing economy (Car sharing)

**Energy**
- New & renewable energy
- Battery & ESS
- Energy prosumer
- Global climate action

**Industry**
- Smart manufacturing, Smart bldg. & city
- New convergence biz.
- High SW competitiveness
- Invaders from other biz. areas
Impact on Steel Demand and Products

On-going trends and new rising trends will bring changes to the landscape of steel-consuming industries and steel demand & products

**On-going Trends**
- Motorization
- Urbanization
- Globalization
- Industrialization

**New Rising Trends**
- 4th Industrial Revolution
- • Hyper-Connectivity
- • New Mobility
- • Energy Revolution
- • Smart & Convergence

(Changes in steel-consuming Industries)

1. **Steel Demand**
   - Product/Investment Demand
   - Steel Contents/Intensity

2. **Steel Products**
   - Needs for Steel Products
   - High strength & toughness
   - High corrosion resistance
   - High performance

- Automobile
- Construction
- Shipbuilding
- Energy
New mobility paradigm (EVs, autonomous cars, car sharing) brings changes to automobile demand, design and materials.

New Mobility Paradigm (In 2035)

- **C**: Connected
  - 45% Preference-based personalization Enabled (>L3)

- **A**: Autonomous
  - 18% of new cars will be Level4-5 autonomous

- **S**: Shared
  - 27% of mobility demand will be absorbed by mobility service

- **E**: Electrified
  - 45% of new cars sold in 2035 will be electrified

Source: McKinsey, IHS Markit, BNEF, Roland Berger
Demand for new cars will rise less than expected as the market gradually adopts autonomous driving technology and car sharing.

**Impact of New Mobility on Automobile Demand**

- **Motorization of emerging countries**
  - 2015: 90 million units
  - 2035 On-going trend-based Scenario: 137 million units
  - 2035 New Mobility Scenario: 123 million units
  - **CAGR 2.1%**

- **Car sharing impact**
  - Family-, ride-, car sharing combined with autonomous vehicle effect
  - Number of Level 4-5 Autonomous Vehicles: 21

- **Increasing mobility**
  - Low cost travel, teenagers, elderly (New mobility scenario)

Source: POSRI based on IHS Markit data  * 1.9 million commercial vehicle units included ('35)
New mobility platform design will emerge as electrification and mobility service develop – Newer passenger shell design, battery protection strategy

**New Mobility Platform**

**Weight comparison of ICE and EV**

- ICE
  - Engine
  - Fuel tank
  - Muffler

- EV
  - Battery
  - Power electronic
  - E-motor

**Battery protection using high-strength materials**
- Protection area
- High-voltage battery

**Changes in passenger/cargo shell design**
- New protection strategy
- Light modular cabin design

**Source:** RolandBerger, VW Golf example
Advanced joining and forming technology allows automakers to use the right material at the right place which will bring the rise of the multi-material era.

<table>
<thead>
<tr>
<th>Material</th>
<th>Cost ($/kg)</th>
<th>Relative Strength</th>
<th>Relative Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild Steel</td>
<td>0.8-1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>HSS</td>
<td>0.8-4</td>
<td>2.1</td>
<td>1</td>
</tr>
<tr>
<td>Aluminum</td>
<td>1.7-6</td>
<td>0.9</td>
<td>0.34</td>
</tr>
<tr>
<td>Magnesium</td>
<td>2-2.5</td>
<td>1</td>
<td>0.24</td>
</tr>
<tr>
<td>Carbon fiber</td>
<td>15-30</td>
<td>1.7</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Source: Renault EOLAB, BNEF

Audi A8 Body Structure

ASF → MSF
Aluminum Space Frame Multimaterial Space Frame

8% Steel 40.5%
92% Alu 58%
1.5% Mg

Source: Audi

Development of various joining technology

Mechanical Joining
Clinching, punch Riveting, hemming, ...

Metallurgical Joining
Laser welding, friction welding, resistance welding, ...

Chemical Bonding
Liquid, gel, tape, patch, ...

Source: Audi
Steel intensity declines as automobile materials become lighter and stronger owing to stricter standards for fuel efficiency, electrification and safety issue.

**CO₂ Emission Regulation [g/km]**
- 141('15) → 100('25) → 60('35)
  → 5~7% Weight reduction every 10 years

**Increasing Lightweight materials**
- AHSS, Aluminum, Composites
- Steel Content Reduction
  → 60%('15) → 52%('25) → 46%('35)

**Safety**
- High Strength Steel (HSS, AHSS, UHSS): 16%('15) → 22%('35) of vehicle total

**Steel Content* Per Vehicle**

<table>
<thead>
<tr>
<th>Year</th>
<th>Curb Weight (kg/vehicle)</th>
<th>Steel Content (%)</th>
<th>HSS and above (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>1,543</td>
<td>16% (+3%)</td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td>1,414</td>
<td>19% (+3%)</td>
<td></td>
</tr>
<tr>
<td>2035</td>
<td>1,341</td>
<td>22% (+3%)</td>
<td></td>
</tr>
</tbody>
</table>

**Steel Demand**

<table>
<thead>
<tr>
<th>Year</th>
<th>Cars* [million tonne]</th>
<th>Commercial Vehicles [million tonne]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>204</td>
<td>194</td>
</tr>
<tr>
<td>2025</td>
<td>203</td>
<td>195</td>
</tr>
<tr>
<td>2035</td>
<td>191</td>
<td>183</td>
</tr>
</tbody>
</table>

* Source: POSRI

* Steel Content: Finished Steel & Iron Products, Cars(Light Duty Vehicle): Curb weight under 6 ton
Under the trend of urbanization, cities will be transformed into Mega City, Smart and Green City in the future.

**Urbanization**

- **1995**: 2,576
- **2015**: 3,981
- **2035**: 5,556

**Urban Population (mil.)**

- **1995**: 45%
- **2015**: 54%
- **2035**: 63%

**Mega Cities**

- **1995**: 14
- **2015**: 29
- **2035**: 48

*No. of cities over 500,000 population*

**Smart & Green Cities**

- **IoT connected infra, Recycle, Reuse**

Image credit: andrewprokos.com

Source: UN World Urbanization Prospects
Global steel demand for construction will rise by 2.3% each year for the next 15 years, due to fast growing construction investment though steel intensity declines.

**Urbanization**
- Share of material cost ↓, labor cost ↑
- Fast-growing lower-intensity* sector
  - * infra, commercial, residential sector

**Smart & Green Cities**
- **Super Structure** (buildings/bridges)
  - → High strength steel ↑ Steel demand ↓

**Megacities**
- Rising share of smartization cost
  - • IoT, sensors in intelligent structure

### Construction Investment & Steel Demand

**Steel Intensity:** 100 ('15) → 95 ('25) → 89 ('35)

*steel intensity [2015=100] = steel demand/construction investment (tonne/thousand US$)

**Steel Demand**

Source: POSRI based on IHS Markit
As deglobalization progresses, overcapacity will linger until 2025, meanwhile, eco-friendly natural gas trade will grow and eco- & smart ships lead the market.

**Sustainable Future Ships**

- **Larger & lighter ship**
  - Ultra large vessel
  - LNG related vessels
  - LNG Carrier
  - LNG-FPSO*
  - FSRU**

- **Eco-ship & Smart ship**
  - Efficient fuel (LNG, fuel cell)
  - Connected / Unmanned Ship
  - Autonomous Ship

**Slowing Trade**

<table>
<thead>
<tr>
<th>Year</th>
<th>Global GDP (Trillion US$)</th>
<th>Export (% of GDP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>74.3</td>
<td>28%</td>
</tr>
<tr>
<td>2025</td>
<td>98.3</td>
<td>29%</td>
</tr>
<tr>
<td>2035</td>
<td>129.2</td>
<td>29%</td>
</tr>
</tbody>
</table>

**Shipbuilding Demand**

- **Bulker**: Declining coal demand
- **Tanker**: Slowing oil demand growth
- **Gas Carrier**: Fast growing gas demand
- **Containership**: Slowing world trade
- **Others**: Leisure ships, etc.

Source: Clarkson, POSRI
Image credit: Wikimedia commons
Global energy demand is expected to grow until 2035. There will be a gradual transition toward renewable energy in the share of fuels.

### Primary Energy Demand by Fuel Type

Shares of oil and coal decline, whereas those of gas and renewable energy grow fast.

<table>
<thead>
<tr>
<th>Year</th>
<th>Fossil Fuels (%)</th>
<th>Renewables (%)</th>
<th>Natural gas (%)</th>
<th>Oil (%)</th>
<th>Coal (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>27%</td>
<td>25%</td>
<td>31%</td>
<td>31%</td>
<td>22%</td>
</tr>
<tr>
<td>2025</td>
<td>23%</td>
<td>23%</td>
<td>16%</td>
<td>16%</td>
<td>5%</td>
</tr>
<tr>
<td>2035</td>
<td>14%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>4%</td>
</tr>
</tbody>
</table>

*Source: World Energy Outlook 2019, IEA (Stated Policy Scenario)*

### Electricity Generation by Fuel Type

Share of renewable energy in total electricity generation will grow to 40% led by wind and solar power.

<table>
<thead>
<tr>
<th>Year</th>
<th>Fossil Fuels (%)</th>
<th>Renewables (%)</th>
<th>Nuclear (%)</th>
<th>Solar PV (%)</th>
<th>Hydro (%)</th>
<th>Nuclear (%)</th>
<th>Other renewables (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>64%</td>
<td>8%</td>
<td>10%</td>
<td>16%</td>
<td>2%</td>
<td>11%</td>
<td>4%</td>
</tr>
<tr>
<td>2025</td>
<td>58%</td>
<td>15%</td>
<td>8%</td>
<td>16%</td>
<td>5%</td>
<td>9%</td>
<td>4%</td>
</tr>
<tr>
<td>2035</td>
<td>51%</td>
<td>15%</td>
<td>9%</td>
<td>15%</td>
<td>11%</td>
<td>9%</td>
<td>4%</td>
</tr>
</tbody>
</table>

*Source: World Energy Outlook 2019, IEA (Stated Policy Scenario)*

*Note: Mtoe: Million tons of oil equivalent, TWh: Terrawatt hour*
Steel demand will rise with energy investment growth, although steel intensity of energy sector declines gradually.

**Steel Demand**

- **2015**: 102 million tonne
- **2025**: 134 million tonne
- **2035**: 158 million tonne

**Energy Investment**

- **2014-2018 Annual Investment**
  - T&D: 1,068 (52%)
  - Energy efficiency: 291 (14%)
  - Nuclear: 238 (12%)
  - Renewables: 430 (21%)
  - Energy Infra.: 1,051 (40%)

- **2019-2040 Annual Investment**
  - T&D: 623 (23%)
  - Energy efficiency: 531 (20%)
  - Nuclear: 50 (2%)
  - Renewables: 623 (23%)
  - Energy Infra.: 400 (15%)

**Steel Intensity**

- **Steel Intensity: 100 ('15) → 99 ('25) → 97 ('35)**
  - steel intensity [2015=100] = steel demand/energy investment (tonne/thousand US$)

**Share of Energy Infra. Invest.**

- **85% ('15) → 83% ('35)**

**Steel Intensity in infra.**

- **0.039 ('15) → 0.036 ('35) [tonne/thousand US$]**

**Share of T&D Investment**

- **15% ('15) → 17% ('35)**

**Steel Intensity in T&D**

- **0.07 ('15) → 0.06 ('35) [tonne/thousand US$]**

Global Steel Demand Forecast

Under the new trends, global steel demand will still be on a growing path, even though growth rate moderates.

- Demand for new cars less than expected due to car sharing
- Slowing global trade and demand for containership
- Increasing construction investment ('15-'35) CAGR 2.7%
- Increasing energy investment ('19-'40) US$2,673 (Billion US$ per annum)

Steel Demand Forecast

[million tonne]

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>2025</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>714</td>
<td>927</td>
<td>1,135</td>
</tr>
<tr>
<td>Energy</td>
<td>202</td>
<td>203</td>
<td>191</td>
</tr>
<tr>
<td>Shipbuilding</td>
<td>72</td>
<td>67</td>
<td>102</td>
</tr>
<tr>
<td>Automobile</td>
<td>102</td>
<td>134</td>
<td>158</td>
</tr>
<tr>
<td>Others</td>
<td>415</td>
<td>549</td>
<td>561</td>
</tr>
</tbody>
</table>

CAGR 1.3% 2.2% 1.5% (‘16-’35) 1.8%

Source: POSRI

Note: Shipbuilding sector includes other transportation
Demand for other sectors is forecast using industrial production index

Future Steel Demand

- Demand for new cars less than expected due to car sharing
- Slowing global trade and demand for containership
- Increasing construction investment ('15-'35) CAGR 2.7%
- Increasing energy investment ('19-'40) US$2,673 (Billion US$ per annum)
Demand is rising for high strength and highly formable steel with low cost, and the steel industry is delivering multi-material issues for automotive body and products.

**Research on Automotive Steel Sheet**

- **High strength & elongation with performance and versatility**
  - Expanded application of giga-pascal AHSS for lighter cars
  - Highly efficient hyper NO for EV motors, bio-shield steel for sensors, vibration damping steel, etc.

- **Resistant to cracking and adaptable to types of welding**
  - LME (Liquid metal induced embrittlement)
  - Hydrogen induced embrittlement
  - High welding performance

- **Machining & parts technology for multi-materials delivering**
  - Assembling multi-material body and parts
  - Teardown & Recycling issue
  - Galvanic corrosion problem

* DP (Dual Phase), TRIP (Transformation Induced Plasticity), XF (eXtra Formable) steel, TWIP (TWinning Induced Plasticity), CP (Complex Phase), Mart (Martensitic) Steel, FB (Ferrite and Bainite)
Increasing demand for new steel products in line with urban regeneration and the rise of future architecture ⇒ Pioneering B2B2C* market with premium construction steel

*Business to Business + Business to Customer

**Urban Concentration & mega structures**
- High-performance & multi-purpose CR
- Earthquake- & fire- resistant steel

**New speed transport infrastructure**
- New technology for infrastructure construction including hyperloop

**Floating City and Underground City**
- High performance marine steel
- High strength, high-corrosion resistant steel

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**Brand-Marketing Premium Solutions**

- **Steel Product Supplier**: Providing raw material
- **Solution Manufacturer**: Manufacture & market solution
- **Construction Firm**: Choose brand "INNOVILT"
- **End-user**: Use brand "INNOVILT"

*POSCO’s Premium Construction Brand “INNOVILT” example*
Customers’ needs become more sophisticated and varying
Demand is rising for high-strength, sour-resistant, high-performing cryogenic steel

**Shipbuilding**
- Gas carrier → Cryogenic gas carrier
- Container ship → High-strength container ship
- Bunker → Low cost bunker

**Plant**
- LNG onshore plant (TANK) → Cryogenic, high strength
- Petrochemical plant (Pressure vessel) → Cryogenic, high strength
- Wind power (Tower, substructure) → Fatigue-resistant, marine steel

**OCTG & Linepipe**
- OCTG → Sour-resistant, high-strength
- Linepipe → Sour-resistant, high-strength

- High-strength cryogenic steel for deep sea and polar region operations
  : high strength BCA, TMCP

- Maximization of abrasion & fatigue-resistance
- Thick steel plate for offshore wind tower
  Radiation shield steel for nuclear power

- High strength and sour-resistant steel for extreme conditions
  : API Linepipe
The steel industry will need to adapt to new trends in steel demand, and produce better and innovative products satisfying varying needs of customers.

- Challenges for the steel industry during the next decade are two-fold,
  - First, global excess capacity may continue to increase since crude capacity additions are rising.
  - Second, the steel industry needs to create new demand and satisfy increasing demand.

- Global steel demand will grow to reduce the excess capacity that is expected under control.
  - Steel demand growth (1.8% annually) will fall short of GDP growth owing to falling steel intensity, however, steel demand will not peak in quantitative terms for the next 15 years.
  - Steel demand for construction and energy will grow above 2% annually, and for shipbuilding modestly while that of automobiles will be maintained.

- Customer needs for more advanced steel products are rising and the steel industry will continue to evolve through:
  - Continuous R&D and innovation to develop steel for eco-friendly car, smart city & infra, future ships, eco-friendly energy, etc and maintain its premiumization.
Thank you!

If you have any comment and suggestion on this presentation, please feel free to send an e-mail to ‘jgoh@posri.re.kr’.