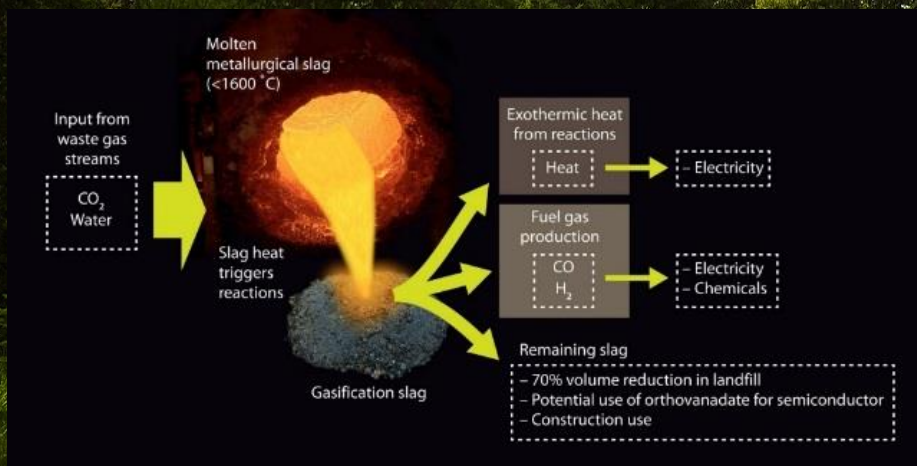


# Conversion of waste from gasification facilities, refineries, and steelmaking plants to H<sub>2</sub> and/or CO

***Jinichiro Nakano<sup>1,2</sup>,  
Anna Nakano<sup>1,2</sup>, and  
James Bennett<sup>1</sup>***

<sup>1</sup>National Energy Technology Laboratory

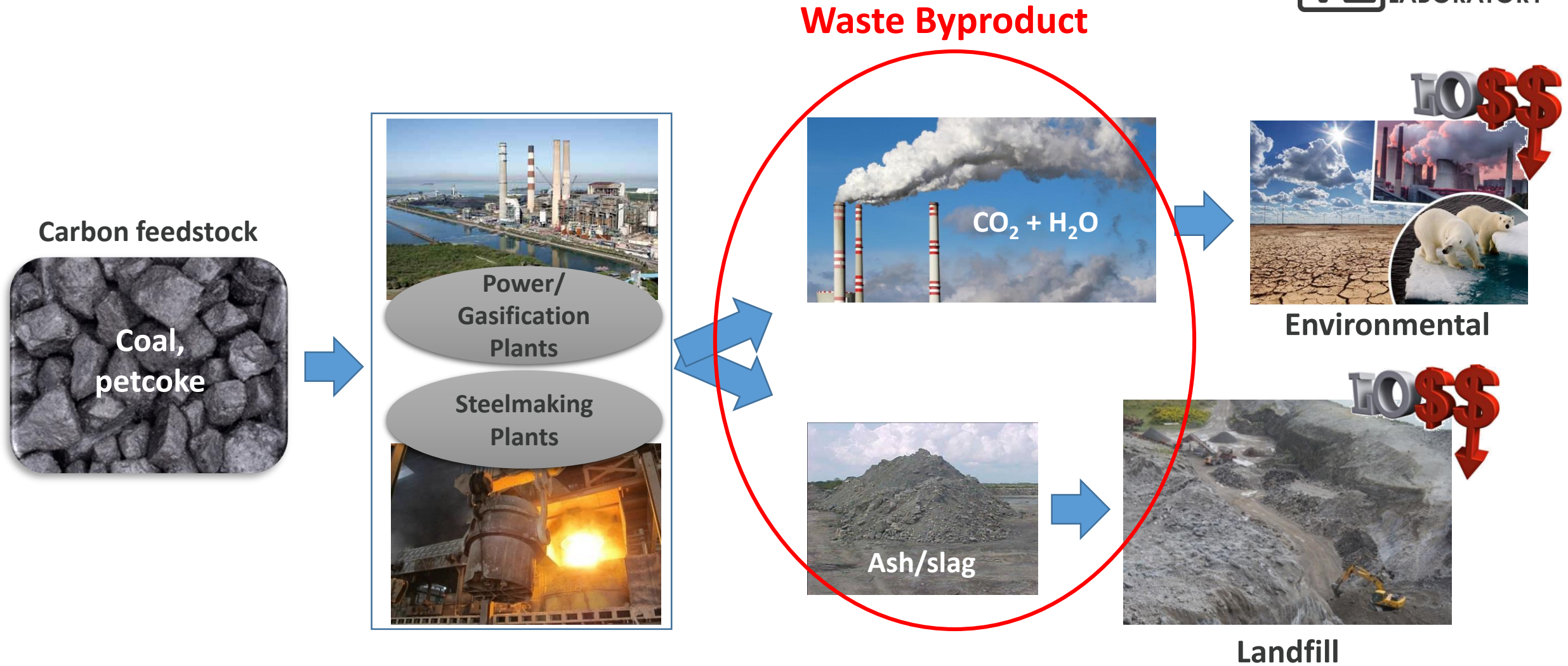
<sup>2</sup>Leidos Research Support Team



Solutions for Today | Options for Tomorrow



# Problems

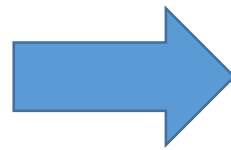


# Ideal resolution

## Waste Byproduct



+



Valuable  
products?

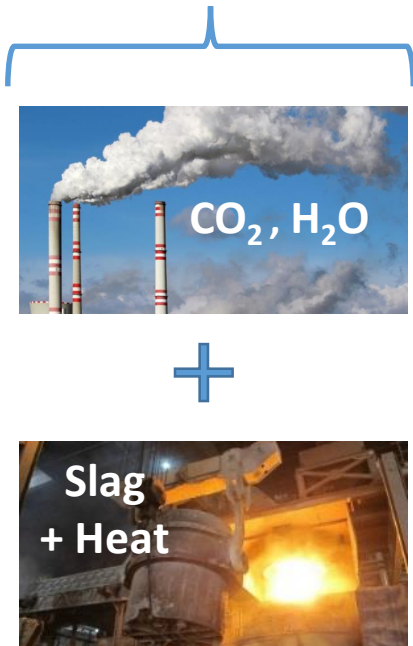


FUELS!



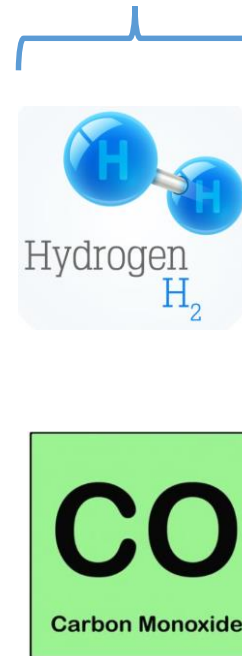
# Approach at NETL – The Slag Conversion

## Industrial waste stream



**Slag  
Conversion**

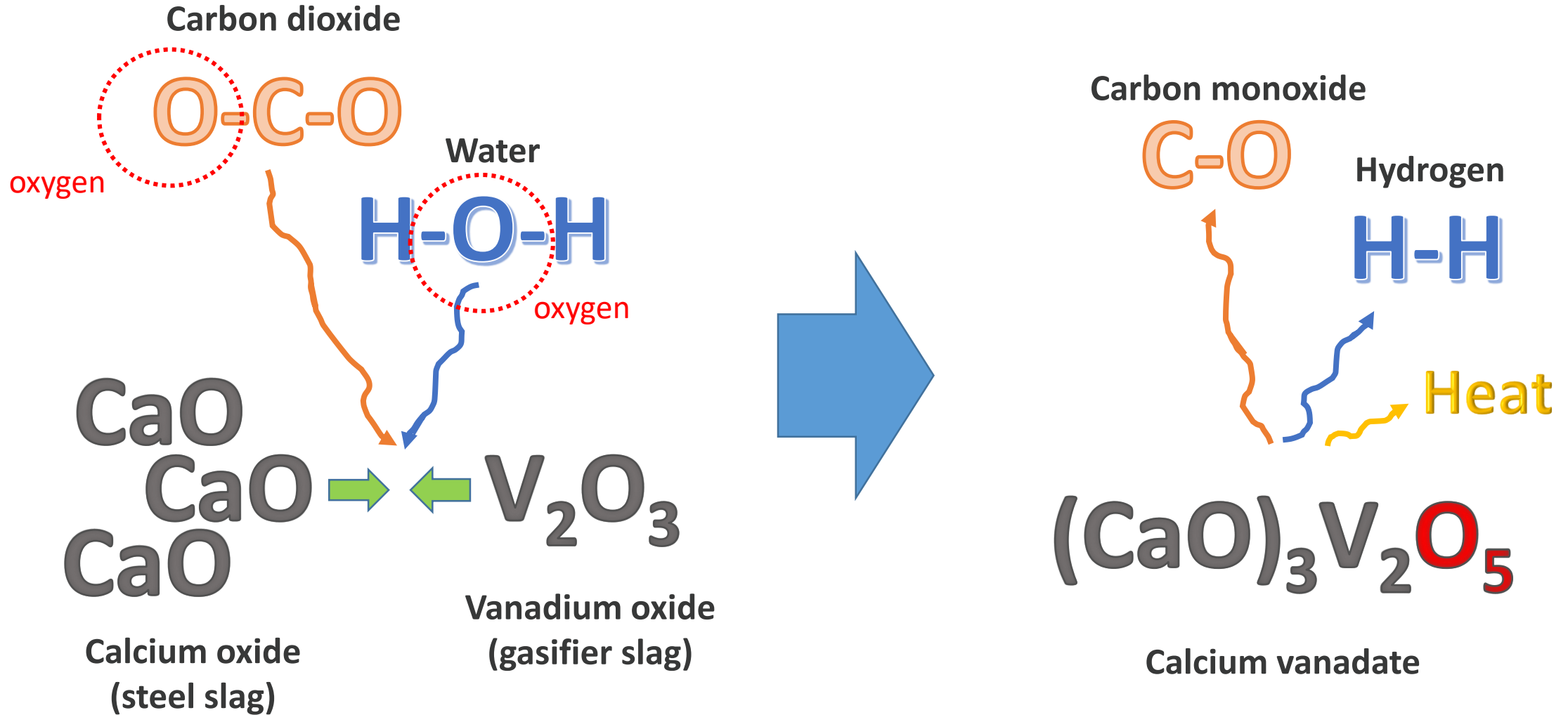
## Products



### Features:

- Only industrial waste
- Simple mixing of slags with  $\text{CO}_2$  (and/or  $\text{H}_2\text{O}$ )
- Easy retrofit
- Reduces carbon emission while generating fuels at minimal operation cost
- High conversion rate (99%)

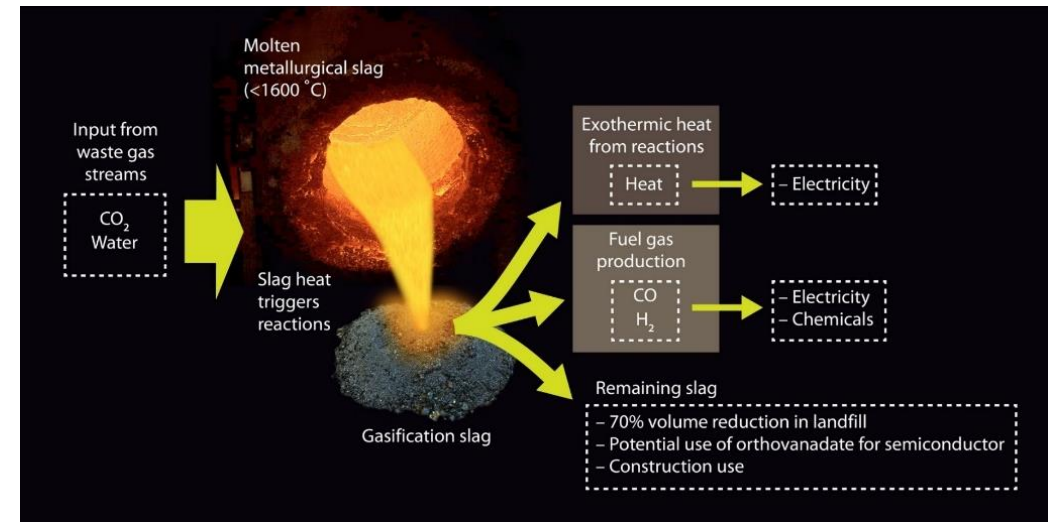
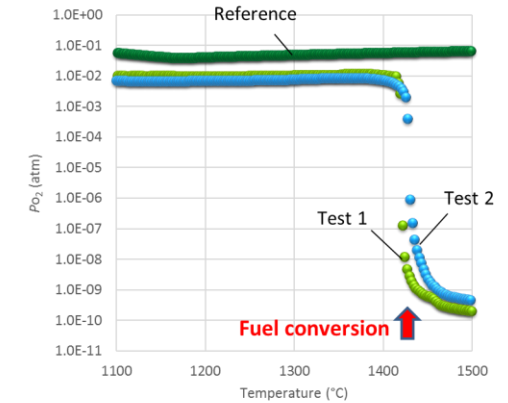
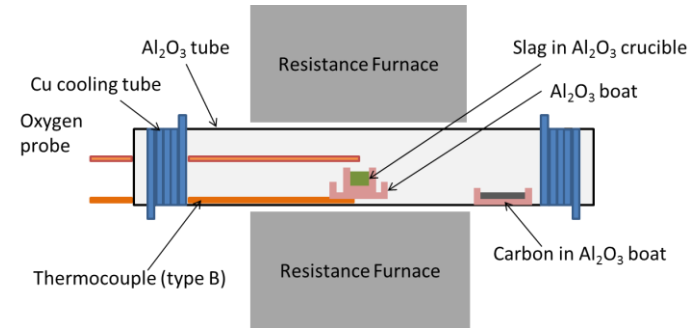
# How it Works – The Slag Conversion





# Current Status on Technology

- 2012: Concept proven on lab scale
- 2014: Concept first published in journal (J Int. Hydrogen Eng.)
- 2016 – 2017: Invited conference lectures
- 2017: US patent issued (US9,840,756)
- 2017: TMS Best Professional Energy Paper Award
- 2018: IChemE Global Award for Energy Finalist



- Reduction in carbon fuel needs and overall CO<sub>2</sub> emissions at:
  - Gasification plants, power plants, iron & steelmaking plants, oil refinery facilities, gas producers
- Chemical and synthetic fuel production using the CO and H<sub>2</sub> generated at:
  - Chemical companies, gas companies, fuel producers (clean energy vehicles)



# EXPECTED if the technology is implemented

- **Less carbon feedstock** required  
– reducing operation cost
- **Additional fuel** generation –  
lowering overall production cost  
– passed onto the public
- **Additional heat** generation (for  
**extra power production**) – extra  
dollar
- **Reduction in carbon** emission
- **Smaller waste** footprint – less  
landfill volume

If practiced at	Annual additional power generation	Annual CO <sub>2</sub> mitigation
Steel plant (20 kt steel/day)	195 MW	1 Mt
Perspective profit/savings	\$54M – 244M	\$50M – \$100M

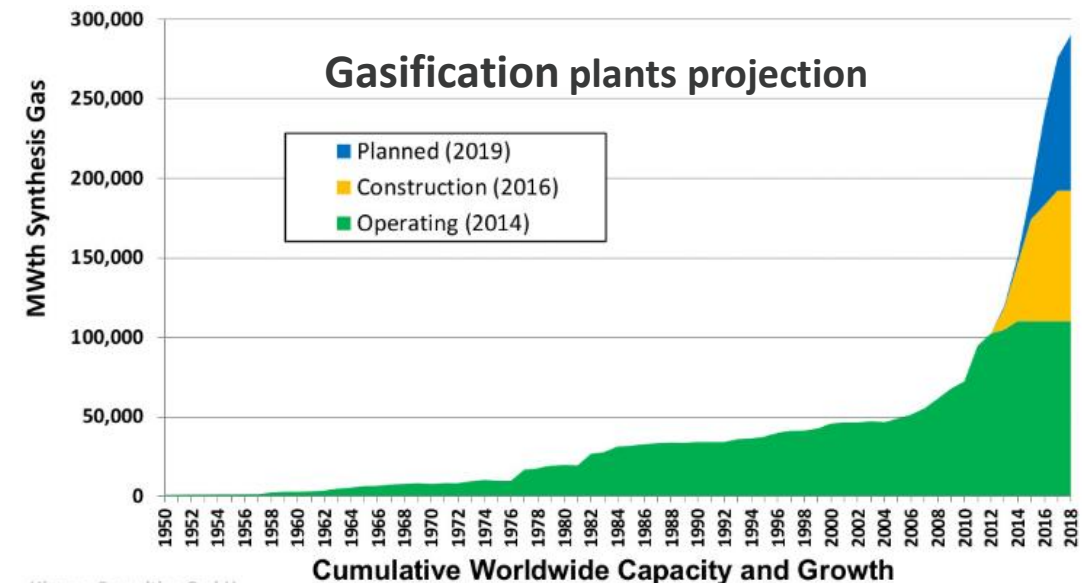
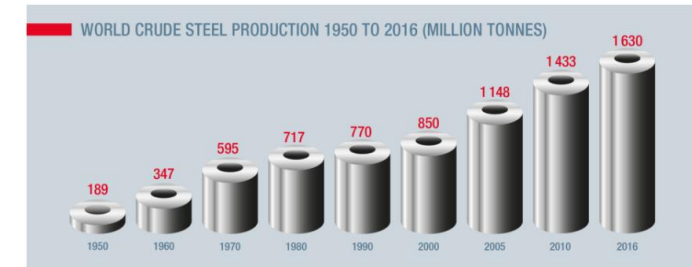


# Market Opportunity (Worldwide)

- 960 million tons slag annually generated at steel plants
  - = 61 GW (from this technology)
  - = **\$17 - \$76 Billion per year**
- 14 billion tons CO<sub>2</sub> from power generation per year x Cost of carbon capture and storage (\$50-100/t CO<sub>2</sub>)
  - = **\$700 Billion - \$1.4 Trillion per year**

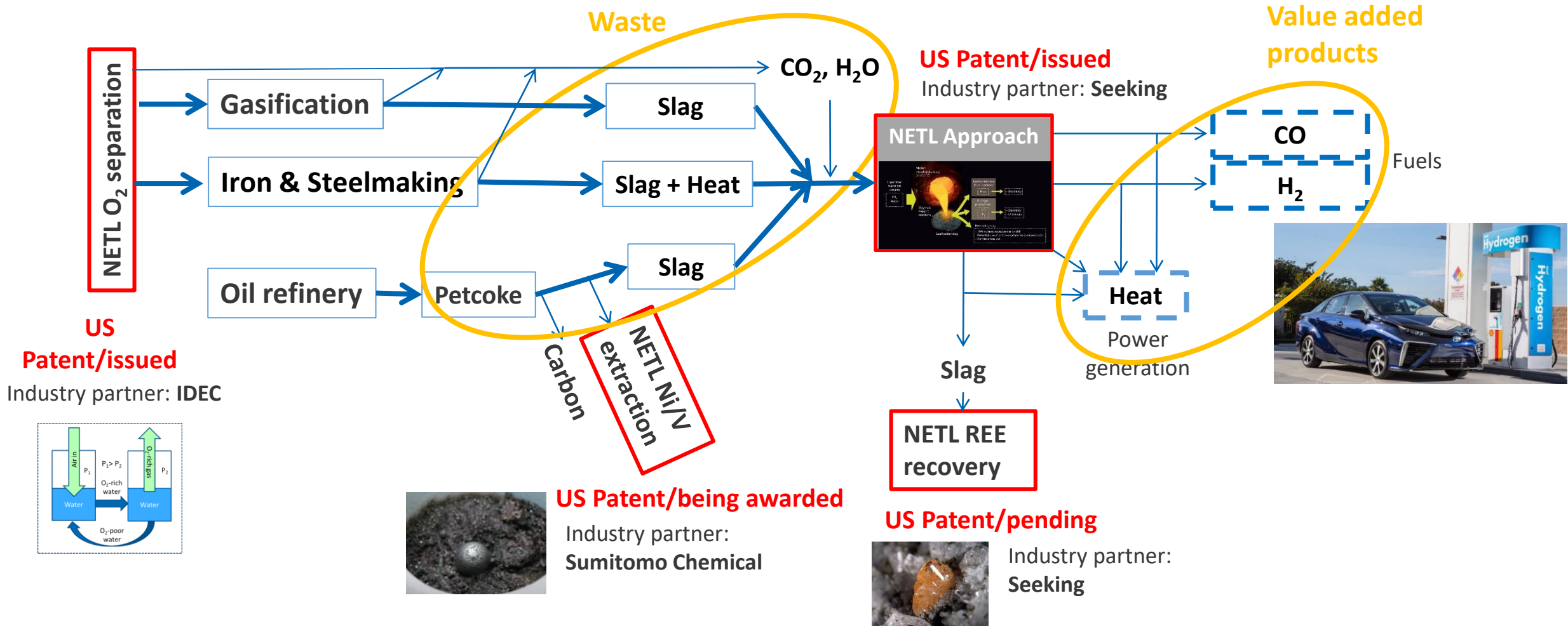
## WORLD STEEL IN FIGURES 2017

STEEL AS A PRODUCT IS SO VERSATILE AND FUNDAMENTAL TO OUR LIVES THAT IT IS CONSIDERED ESSENTIAL TO ECONOMIC GROWTH.



# Future Vision

Combined Efforts → Will Result in Significant Synergy





# Thank You



- **Contact:**

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- **NETL Partnership Options**

- Licenses
- Cooperative Research and Development Agreements
- Contributed Funds Agreements

- **For more Information contact:**

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## Disclaimer

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