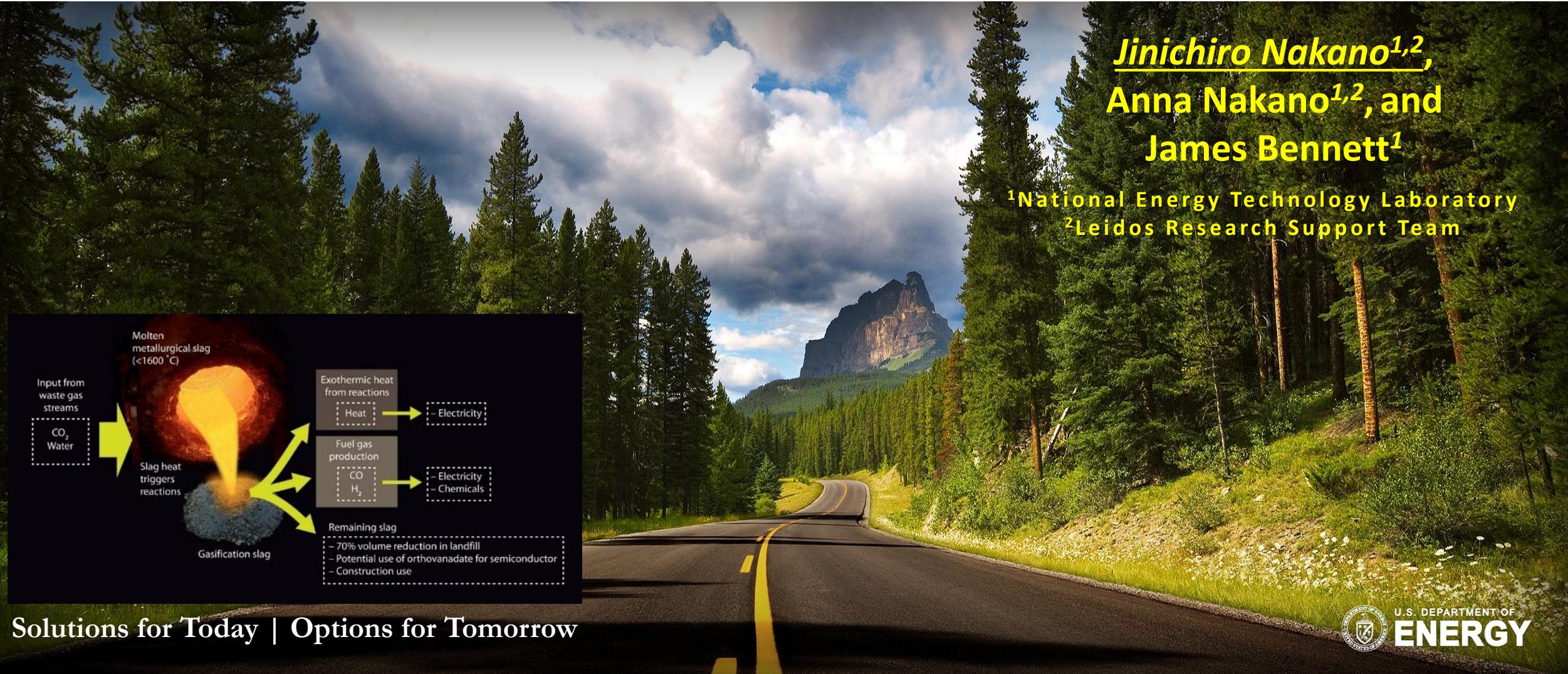


Conversion of waste from gasification facilities, refineries, and steelmaking plants to H₂ and/or CO

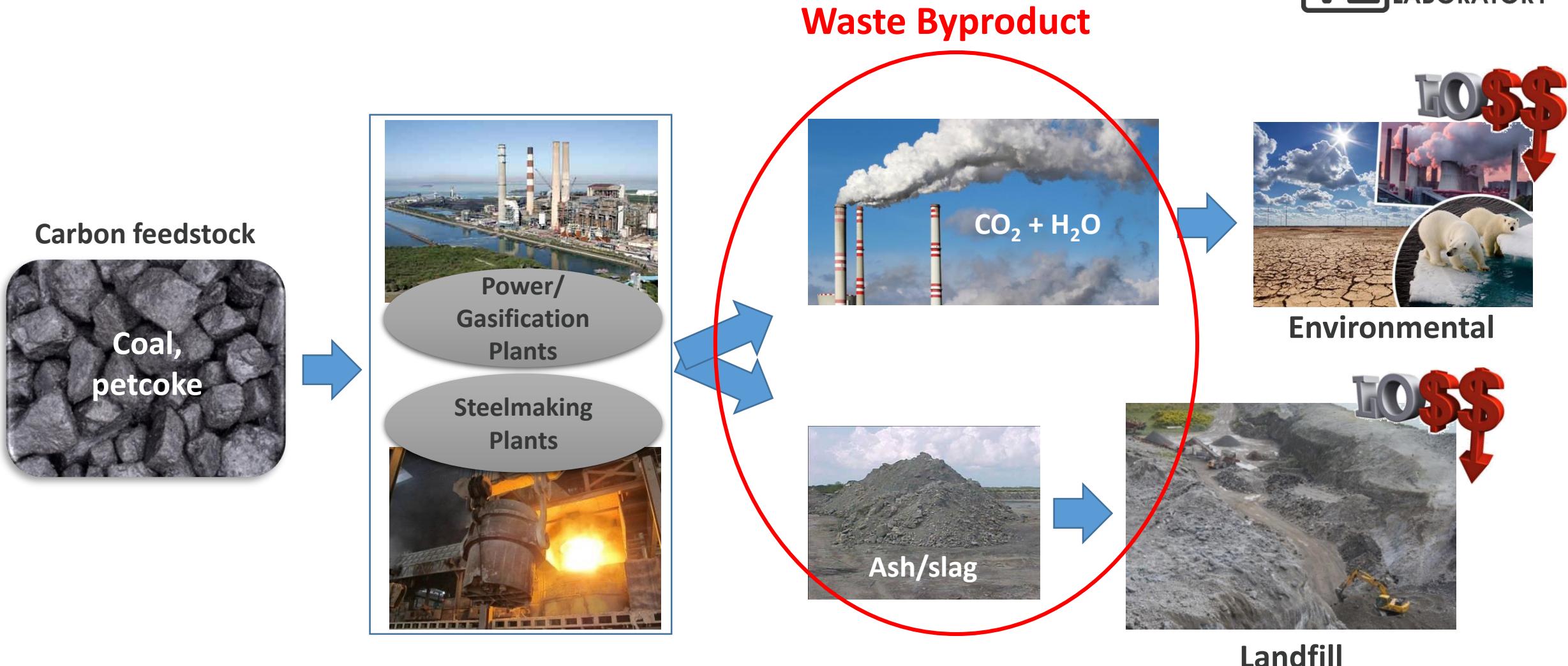


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Anna Nakano^{1,2}, and
James Bennett¹

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Problems

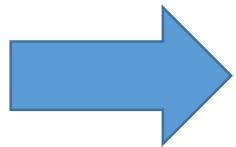


Ideal resolution

Waste Byproduct



Ash/slag



Valuable products?



FUELS!



Approach at NETL – The Slag Conversion

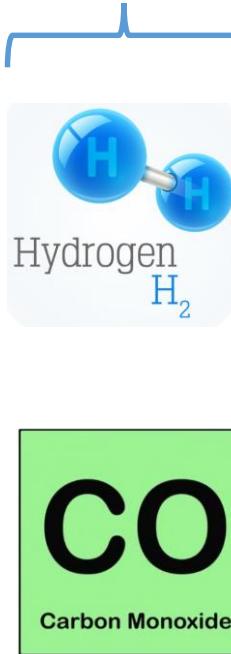


Industrial waste stream



Slag Conversion

Products

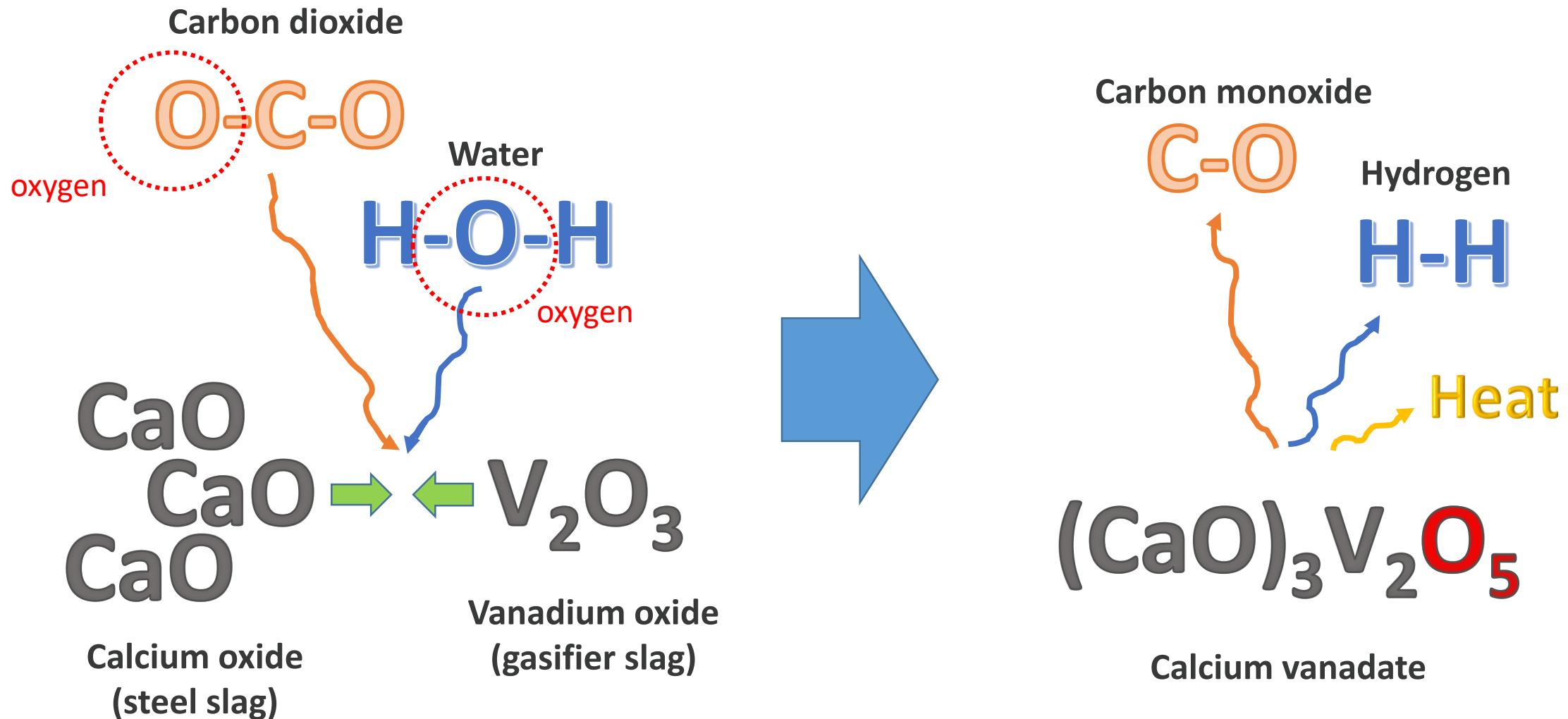


Features:

- Only industrial waste
- Simple mixing of slags with CO_2 (and/or H_2O)
- Easy retrofit
- Reduces carbon emission while generating fuels at minimal operation cost
- High conversion rate (99%)

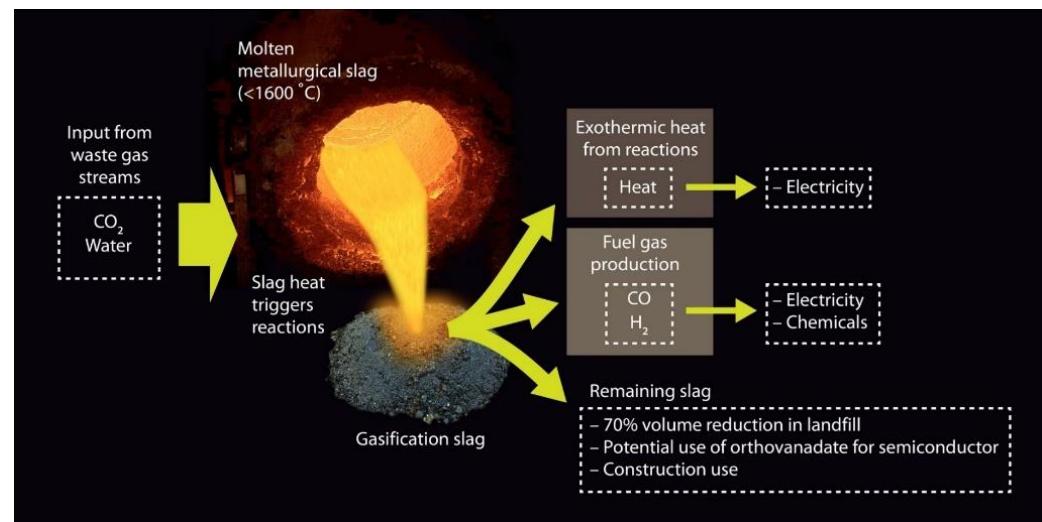
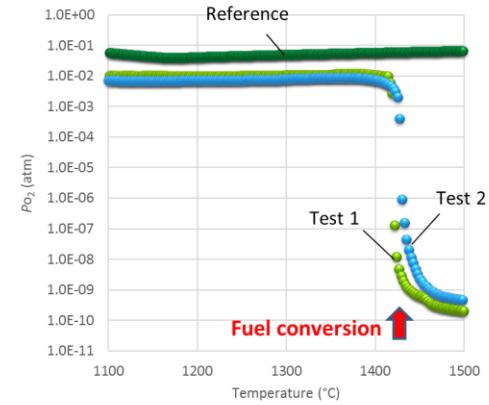
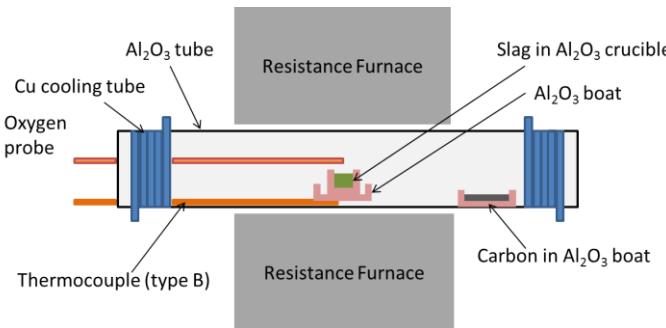


How it Works – The Slag Conversion



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



Applications

- **Reduction in carbon fuel needs and overall CO₂ emissions at:**
 - Gasification plants, power plants, iron & steelmaking plants, oil refinery facilities, gas producers
- **Chemical and synthetic fuel production using the CO and H₂ 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

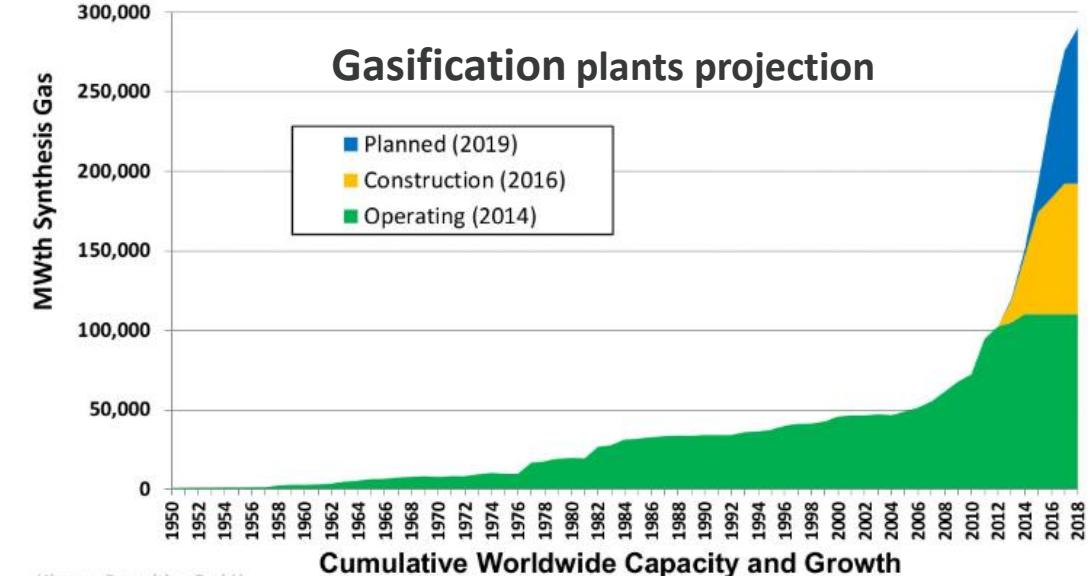
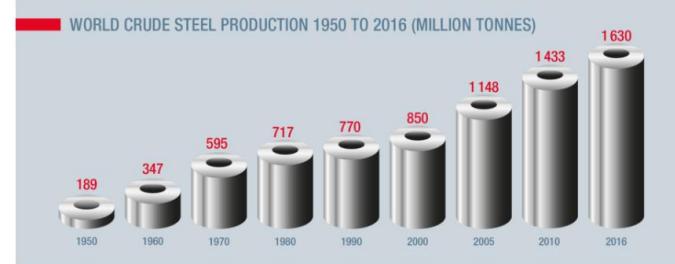
If practiced at	Annual additional power generation	Annual CO ₂ mitigation
Steel plant (20 kt steel/day)	195 MW	1 Mt
Perspective profit/savings	\$54M – 244M	\$50M – \$100M

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 CO₂ from power generation per year x Cost of carbon capture and storage (\$50-100/t CO₂)
 - = **\$700 Billion - \$1.4 Trillion per year**

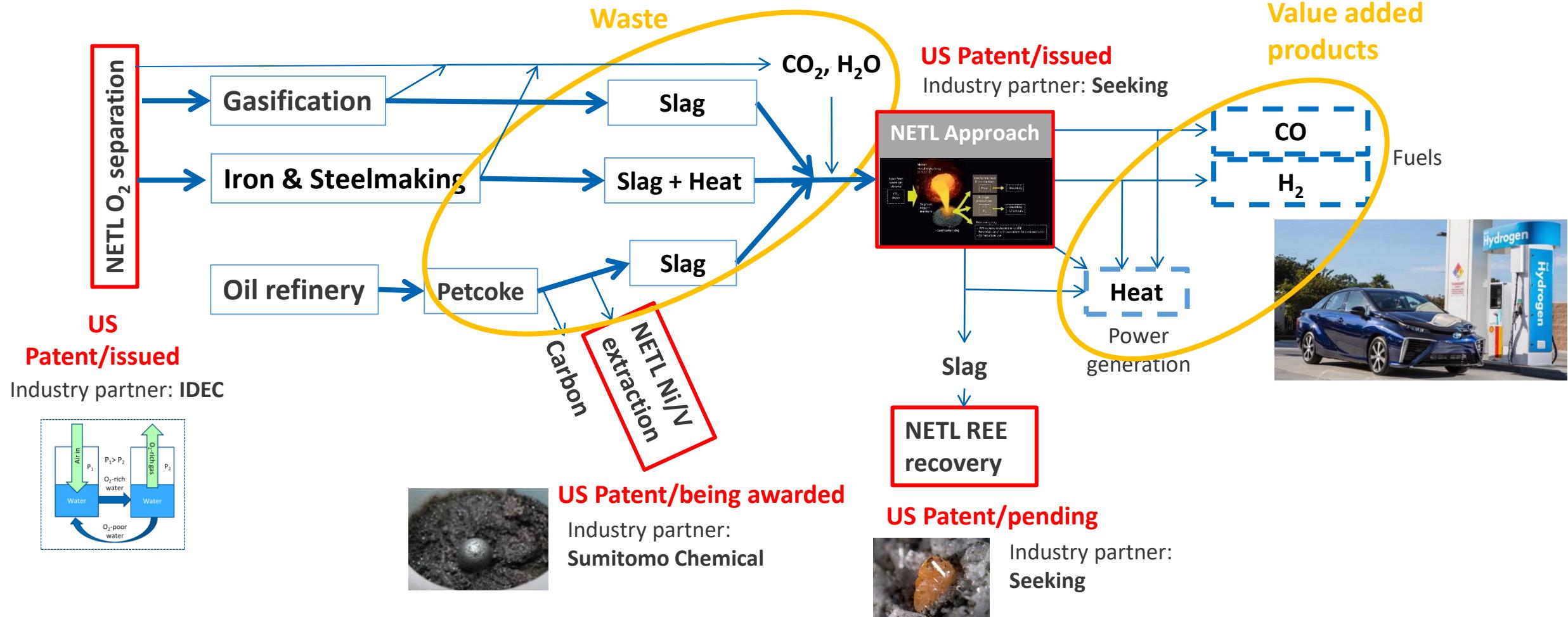
WORLD STEEL IN FIGURES 2017

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:
Jinichiro Nakano (jinichiro.nakano@netl.doe.gov)
- NETL Partnership Options
 - Licenses
 - Cooperative Research and Development Agreements
 - Contributed Funds Agreements
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