



Infra Innovations, Inc.

Session 5: Oil, Gas & Coal Industry Exploration, Development and Sustainability

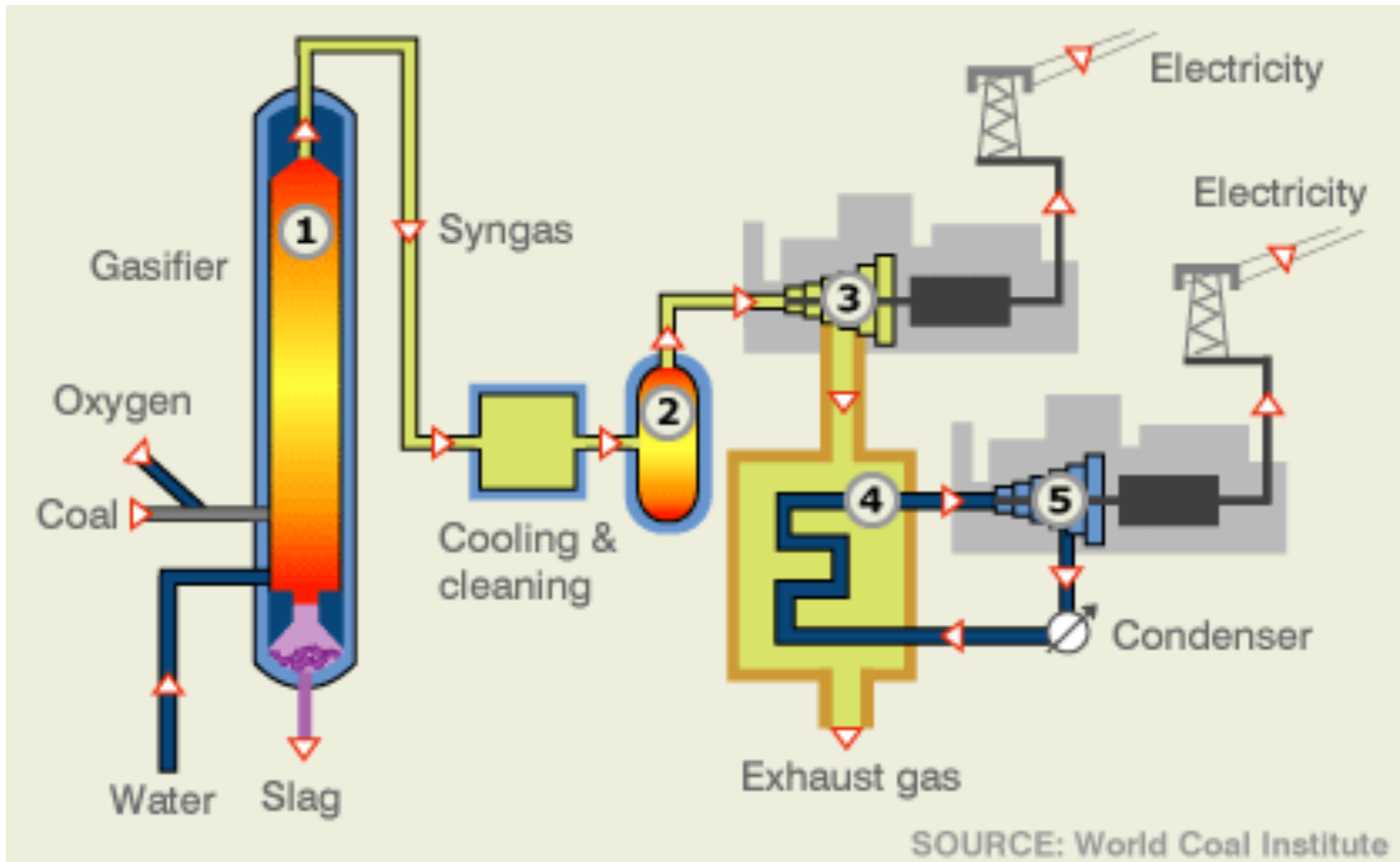
Integrated Gas Combined Cycle Power Plants in Japan: Sustainability Goals and Local Economic Development

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History of Boiler Efficiency Improvements

- In a conventional boiler, the heat is used to evaporate water → latent heat of vaporization
 - At its “critical point,” liquid water becomes steam without vaporization, and the latent heat becomes zero
 - All of heating energy goes into steam
 - The critical point is around 22 MPa and 374°C
 - ~1910 to 1950 Conventional Boiler @ 15 to 23% η
 - ~1950 to 1980 Supercritical Boiler @ 30 to 40% η
 - ~1980 to 2010 Ultra-Supercritical Boiler @ 40 to 43% η
- But most of the efficiency gains came from reducing the latent heat of vaporization. The next big efficiency jump must come from a new technology
- ~2015 to Present IGCC @ 48 to 50% η

Schematic Diagram of IGCC



Benefits of IGCC

- No fly-ash. Instead, glassy slag is formed
- 30% less cooling water
- 30% less boiler volume
- Modular construction (easy scale up)
- Mixed use of biomass is possible!

For SC and USC boilers, high ash melting temperatures are preferred

No. 1 New South Wales coal @ 1650°C

No. 2 Queensland coal @ 1600°C

No. 3 South African coal @ 1550°C

Powder River Basin coal @ 1200°C cannot be used as a primary fuel in these boilers

Why Montana?

Then, why am I talking about high efficiency coal technology in Montana?

Because coal with low ash melting points is a fuel of choice for IGCC

No. 1 Choice = Powder River Basin coal

We need PRB coal to advance IGCC technology worldwide!

Status of IGCC in Japan

250 MW IGCC demonstration plant has been operating in Nakoso since 2008

Two commercial size 540 MW units are under construction in the Tsunami-hit area of Fukushima

These projects are called Fukushima Economic Recovery Promotion through Advanced Thermal Power Plants

- **This region is adjacent to the nuclear power park, which was hard hit by the 2011 Tsunami**
- **The entire region is connected to Japan's electric transmission grid by a 500 kV network**
- **There is already a pool of skilled workers**
- **Fuel delivery infrastructure is already in place**
- **Construction of the two plants will create more than 2,000 jobs**

But where is the sustainable opportunity?

- **These plants will be used partly as a research and development facility for many years to come**
- **It will serve as national energy laboratories like in the US**
- **The region will have a population of highly educated scientists, engineers, and highly skilled technicians**
- **The Nakoso demonstration plant has been hosting international study groups on an average of once a week. Economic benefits from tourism are significant**

Nakoso IGCC Plant



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