

# Challenges for zero-emission coal

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- ✓ Increasing global energy demand
- ✓ Necessity of Energy Access to All
- ✓ Big regional differences on relative costs of coal/natural gas/renewable/nuclear, especially when considering grid costs
- ✓ Risk of relying on single energy source



**Coal will remain one of the major energy sources.**

**Continuous efforts for improving coal fired power plants' efficiency is a responsible measure against climate change.**

✓ **Coal/Coal fired power plants + CCUS/Carbon Recycling  
= zero(near-zero) emission power source**

- Hydrogen incl. Ammonia is key.
- EOR and Carbon Recycling can be sources of revenue, while CCS is pure cost

✓ **IGCC/IGFC as key technology**

- functions as adjusting power against variable renewables
- efficiently captures CO<sub>2</sub> through pre-combustion process
- uses cheap unused low-grade coals

# Keys for realizing Carbon Recycling - CO<sub>2</sub> as a resource -

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## **1. Reduce capture cost or Establish system without capture**

- Currently appx. \$40/tCO<sub>2</sub>=3 ct./kWh up for coal fired power plant
- Bio-processes generally don't need condensed CO<sub>2</sub>

## **2. Establish efficient conversion process from CO<sub>2</sub> to target chemical**

- Already exist process through multiple intermediates
- Establish direct or semi-direct conversion from CO<sub>2</sub> to target material through catalyzers or bioprocess

## **3. Need cheap CO<sub>2</sub>-free hydrogen**

- If converting CO<sub>2</sub> to fuels/basic chemicals, hydrogen is necessary as energy & material source in most, if not all, cases.

## **4. Establish utilization methods hydrogen is no need**

- Mineralization can reduce cement use - big potential for CO<sub>2</sub> emission reduction