



SIEMENS

Siemens AG - Energy Sector

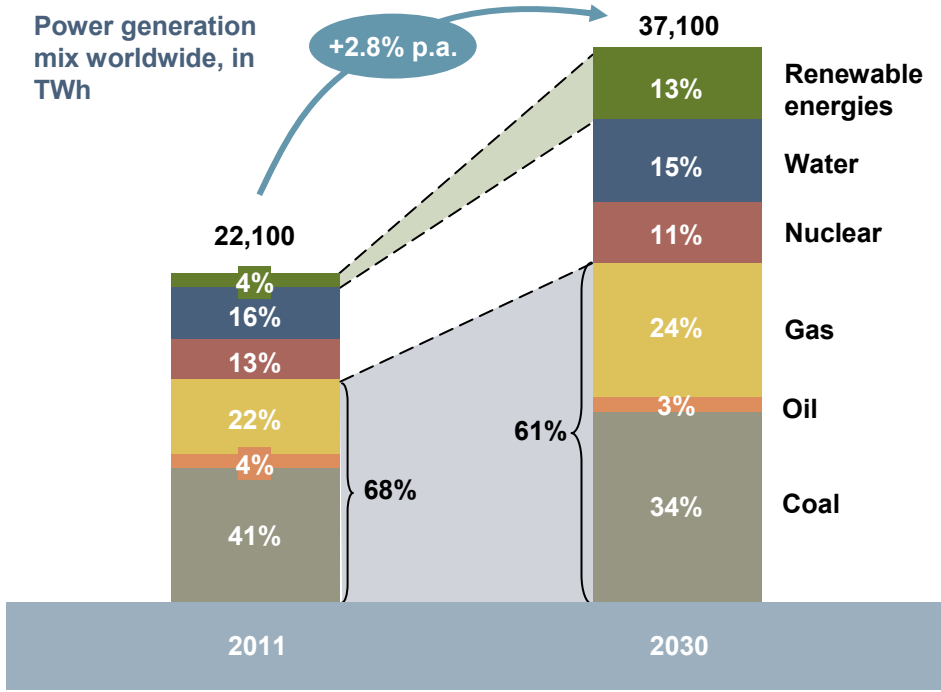
CO₂ Capture Utilization and Sequestration (CCUS)

Technical challenges and cost reduction potential for post-combustion carbon capture

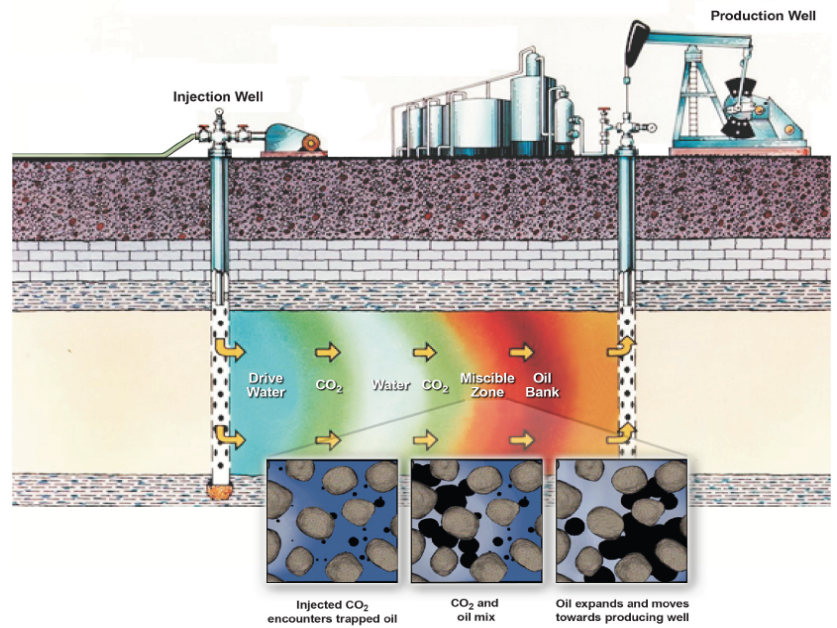
Drivers of CCS – Development

Global electricity market : demand for electricity still growing. CO₂ emissions will increase without CCS

EOR with CO₂ is well-proven technology employed in USA. Demand of CO₂ is increasing



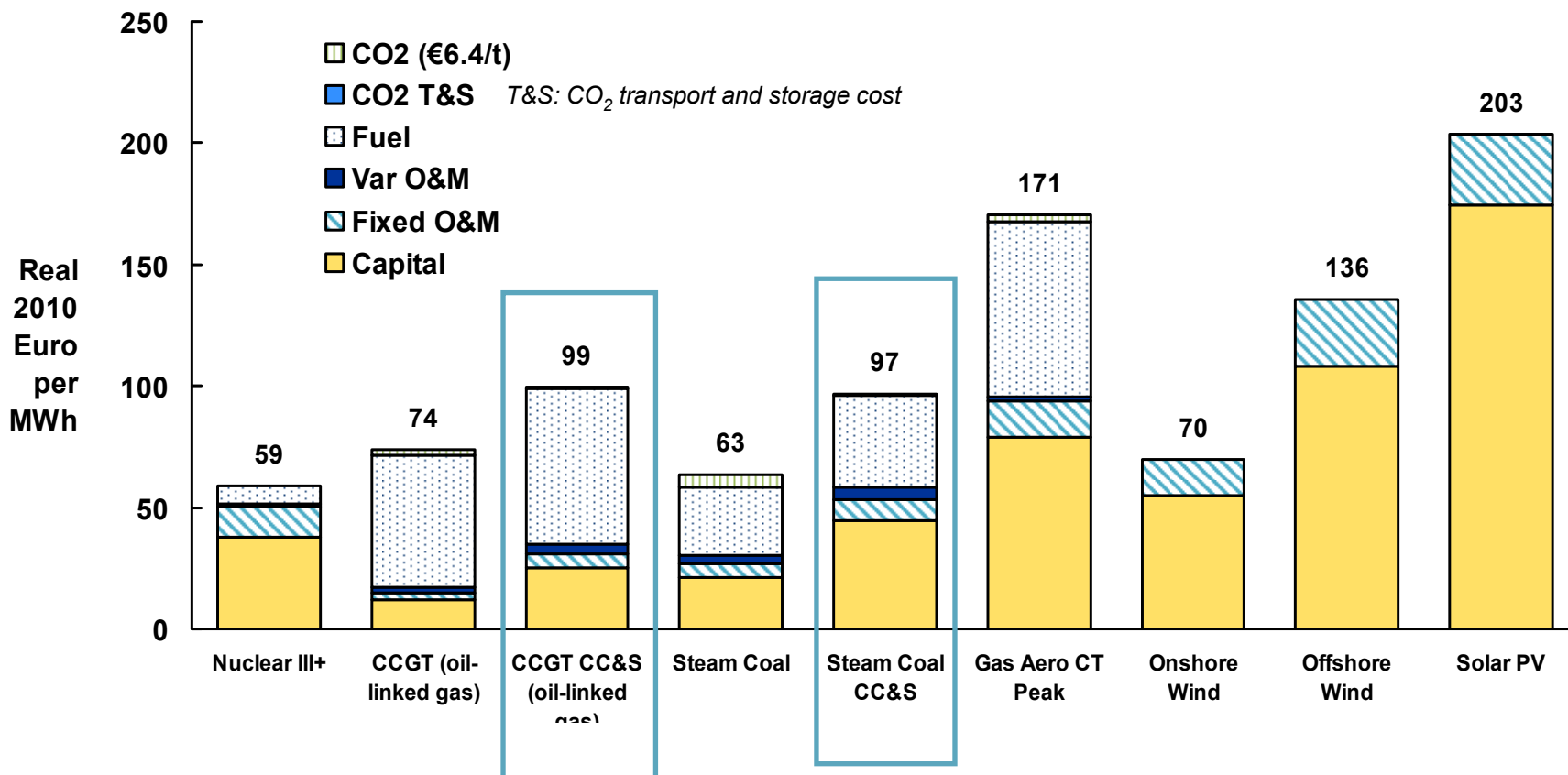
Source: Siemens



Generation Costs of Electricity

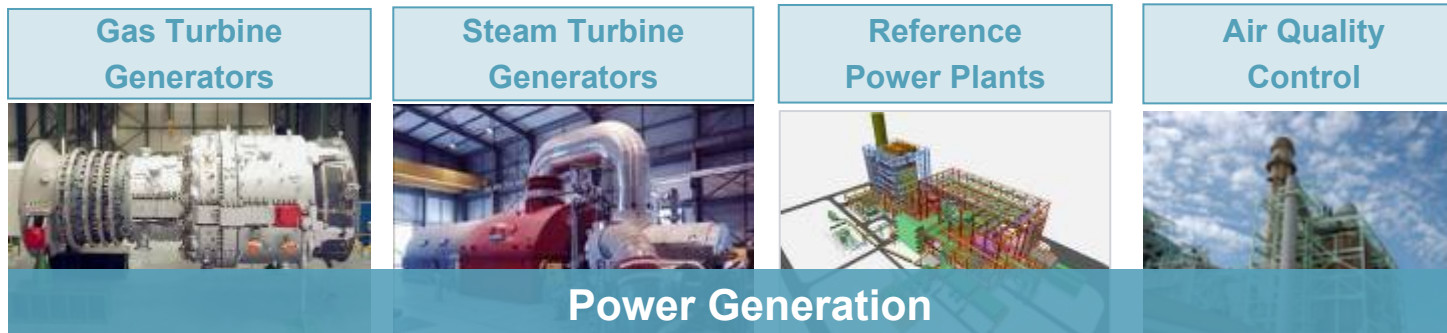
IHS CERA European LCOE 2013

Levelized Cost of Electricity (LCOE)

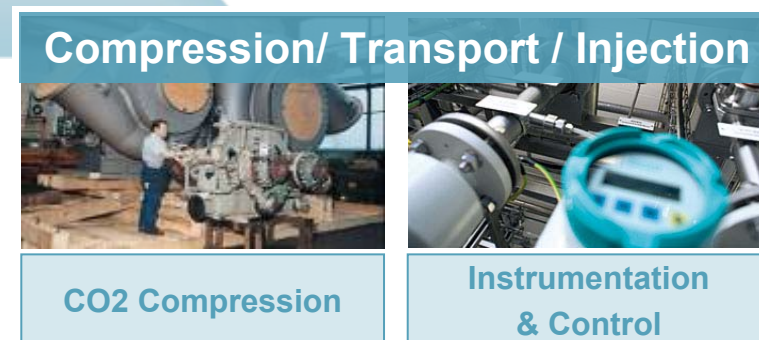


Ranking of electricity generation costs in line with Siemens expectations: CCUS is cost-competitive with other low-carbon generation options.

Siemens competencies for fossil power generation with CCS



Combination of products and integration know-how



CO₂ Reduction Potential through CCUS Siemens' Portfolio

PostCap™ Technology



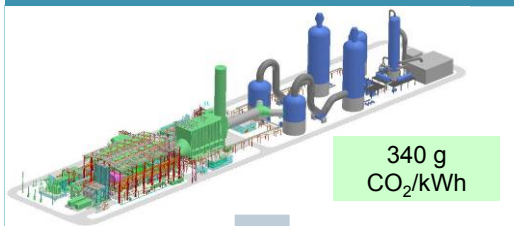
Validated in unit 5 of E.ON Staudinger steam power plant in Germany

Gasifier Technology



Demonstration in Chinese Large Scale Projects

700 MW CCPP in O&G Business



340 g CO₂/kWh

800 MW Steam Power Plant



730-1000 g CO₂/kWh

400 MW IGCC (Summit)



730-800 g CO₂/kWh

approx. **1,8 Mio** tons of CO₂ reduction per year

✓ 40* g CO₂/kWh

approx. **4,0 Mio** tons of CO₂ reduction per year

✓ 80* g CO₂/kWh

approx. **2,0 Mio** tons of CO₂ reduction per year

✓ 80* g CO₂/kWh

*90% CO₂ capture rate

Siemens PostCap™ Technology

Limited solvent degradation
(O₂, SO_x, NO_x, thermal)

Nearly zero solvent emissions;
no additional washing steps required

HSE: "Easy to handle", within
safety standards of power plant

FGD polishing
not required
(coal)

Flue
Gas

Proprietary Reclaiming system limiting
solvent losses, Sellable sulfur product

Flue
Gas

CO₂

CO₂
> 99%

40-45°C

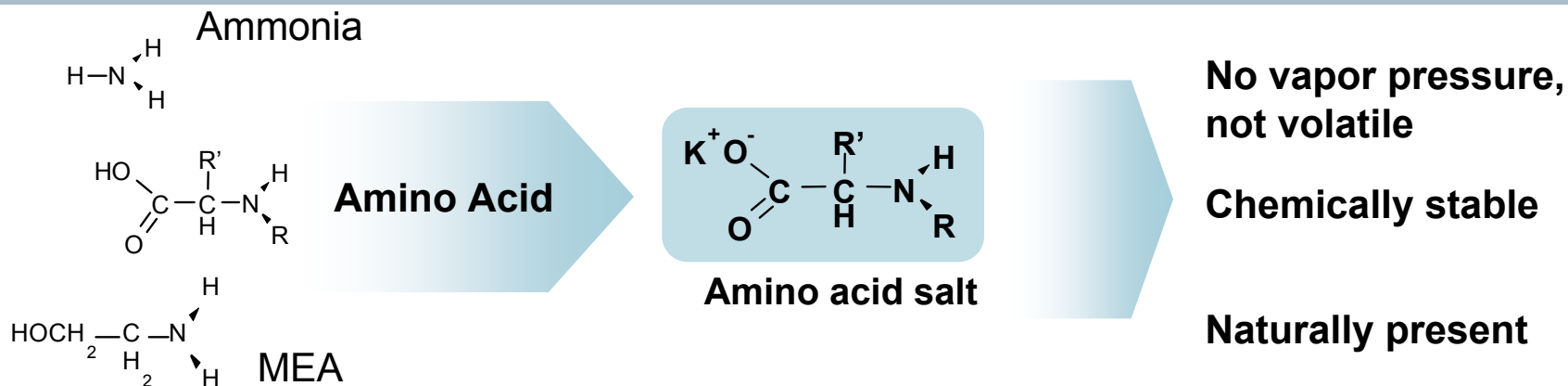
90-105°C

Thermal energy need: 2.7 GJ/t CO₂ captured. Full size,
overall efficiency drop: 6%-pts (@90% capture, w/o
compression)

Design target for fossil Power Generation w/ CCS:
Design target for Enhanced Oil Recovery (EOR):

lowest LCOE
lowest €/tCO₂

Amino acid salt is the basis of our solvent



Salts have no vapor pressure

- No thermodynamic solvent emissions
- Not inflammable
- Not explosive
- Odorless
- No inhalation risk



Negative ion is less sensitive to O₂

- Low degradation

Amino acids are naturally present

- Biodegradable
- Nontoxic
- Environmentally friendly



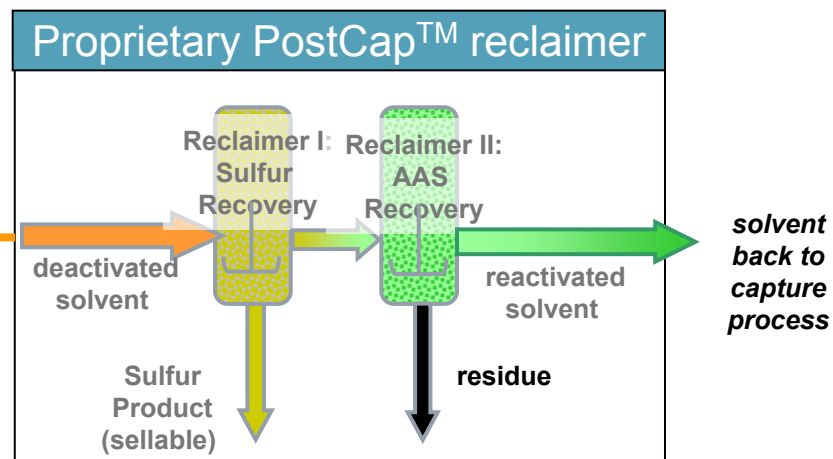
Solvents based on amino acid salts are economic, have low environmental impact and are easy to handle.

Siemens' Reclaimer Technology Proprietary Know-How



Two-Step Reclaiming:

- ✓ High amount of solvent can be recycled
- ✓ Sellable Sulfur product
- ✓ FGD retrofit can be avoided
- ✓ Small amount of residue

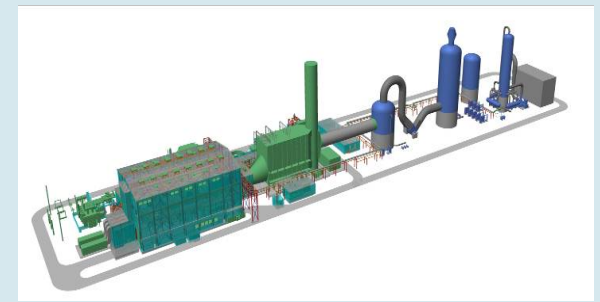


PostCap™ Pilot Plant at E.ON Staudinger

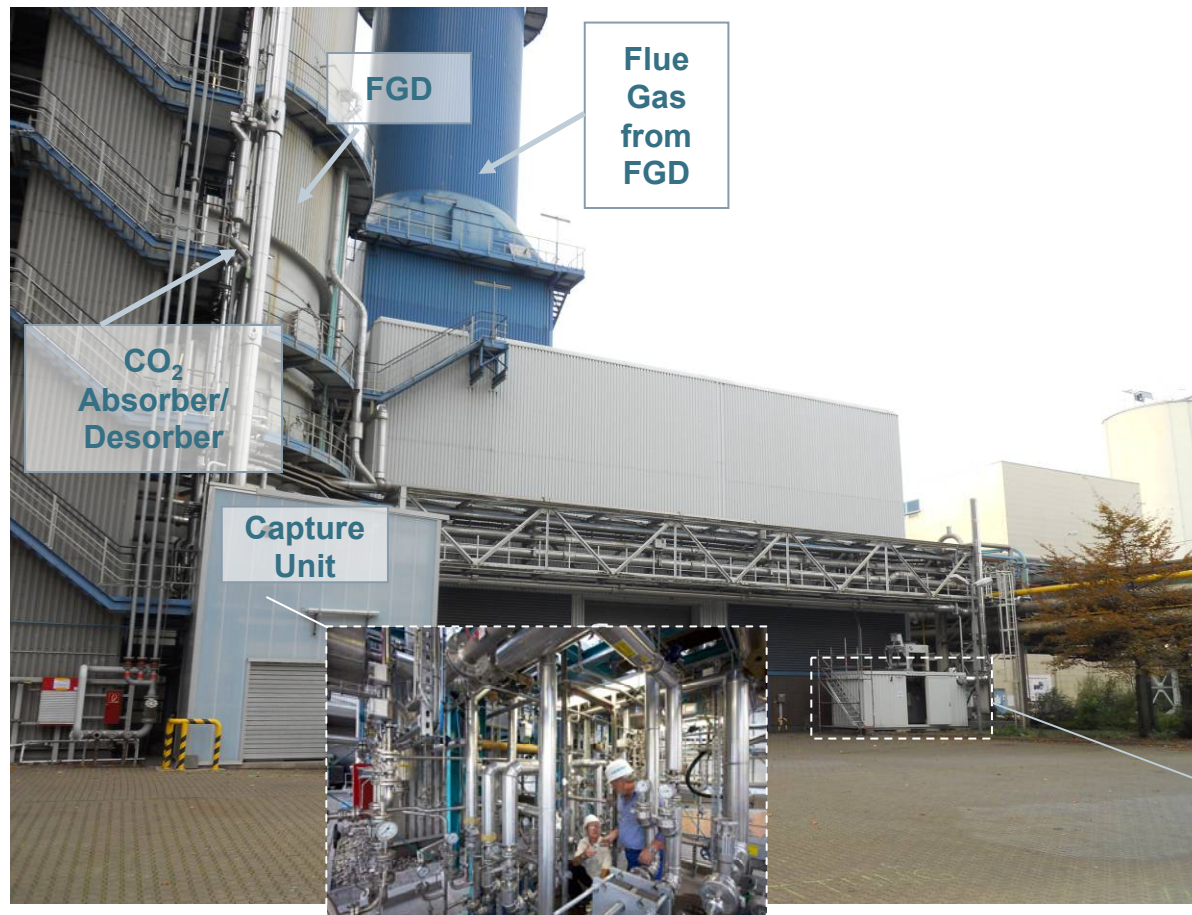


Project	Siemens PostCap™ Pilot Plant
Location	Frankfurt, Germany
Customer	E.ON (coal-fired power station Staudinger)
Commissioning	September 2009
Plant size	Approx. 1 t/d CO ₂
Operating Hours	> 8,000 hours

- Siemens PostCap™-Technology verified
- Simulation tools and scale up-methods validated
- Optimizations and adaptations ongoing



TQP Mongstad - Call Off 2a Pilot Plant Operation with Gas Burner



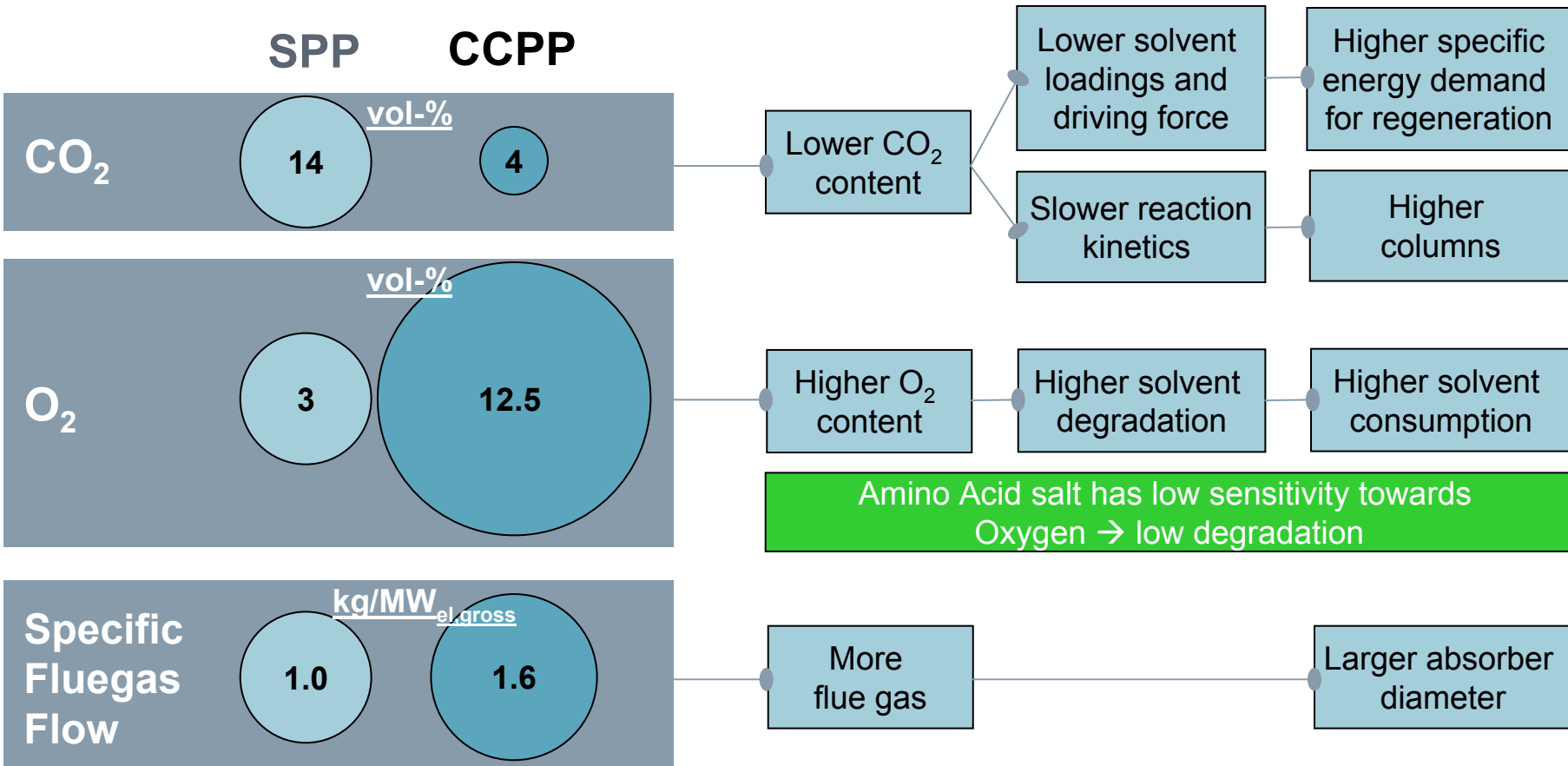
Targets of TQP:

- 3,000 operation hours
- Monitoring emissions
- Monitoring performance



Test program end March 2013 with 3,000 operating hours to be completed


Solvent and process optimization for CCPP with Post Combustion capture required



Currently Post-Combustion projects for gasfired power plants in NOR, UK and GCC region under evaluation.

Masdar full-scale CO₂ Capture Project



Project	Masdar full-scale CO ₂ capture project
Location	United Arab Emirates
Customer	Masdar Carbon 
Process	Combined Cycle Power Plant
Plant size	1.8 Mio tons of CO ₂ per year
Commissioning	tbd

SIEMENS

MASDAR  مصدر
شركة أبوظبي لطاقة المستقبل
ABU DHABI FUTURE ENERGY COMPANY

Long-term strategic partnership

Agreement signed March 3rd 2011

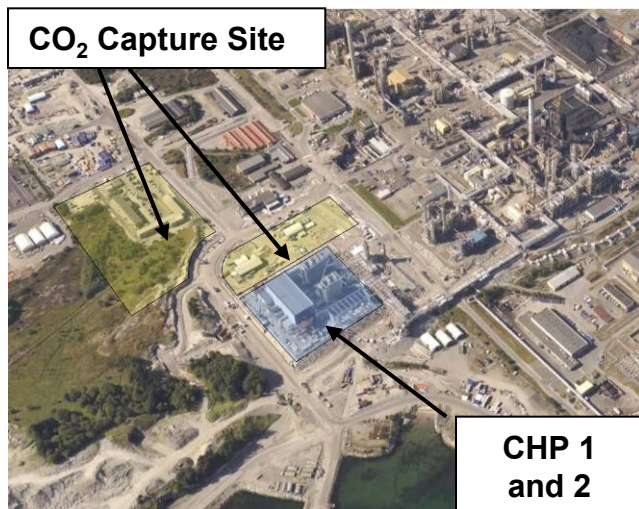


- Overall target 2030: Capture 30 Mio tons/a for EOR in Abu Dhabi
- Highly advanced CO₂ pipeline network (target 500 km) with excess capacity for growth until 2030
- 1st step being negotiated (early 2013): CO₂ from steel manufacturing, approx. 0.8 Mio tons/a CO₂ => pipeline project
- Possible 2nd step:
 - CO₂ from gas fired power plant (target 1.8 Mio tons/a CO₂): MASDAR-Siemens CCS Collaboration
 - Siemens PostCap™ selected: FEED for PostCap™ CO₂ Capture plant finalized by Siemens

Full-scale CO₂ Capture Mongstad Project



Project	Full-Scale Carbon Capture Mongstad (CCM)
Location	Mongstad Refinery, Norway
Customer	Statoil Petroleum AS
Process	Combined Heat and Power Plant
Plant size	1.2 Mio tons of CO ₂ per year
Status	License procurement process commenced

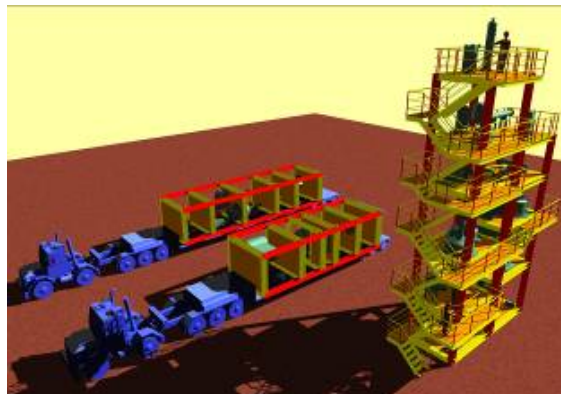
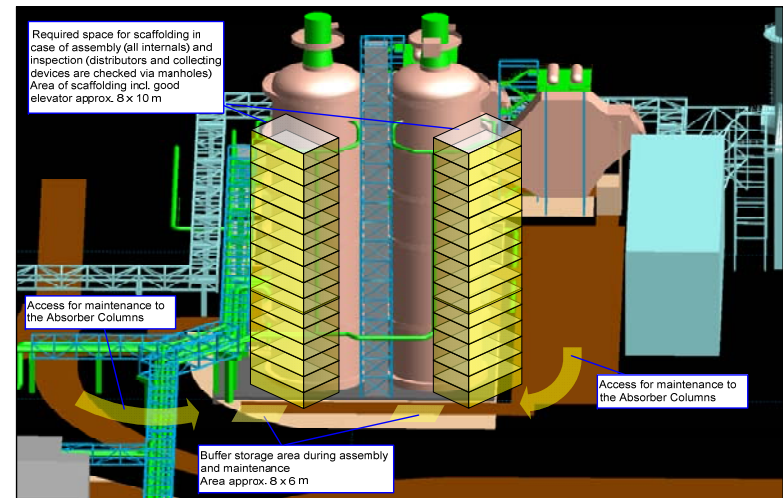


Ongoing: Technology Qualification Program (TQP) of CO₂ post-combustion capture technologies, divided into three phases:

1. Feasibility study to show that the technology can be used at Mongstad (completed in 2012)
2. Demonstrate process operation and specified emission level: lab stress tests completed end of 2012; pilot plant 3,000 hours test period completed before end of March 2013
3. Concept Phase incl. costing for design of full-scale CO₂ capture (to be completed May 2013)

Constructability, Maintainability, Transport Critical for Realization

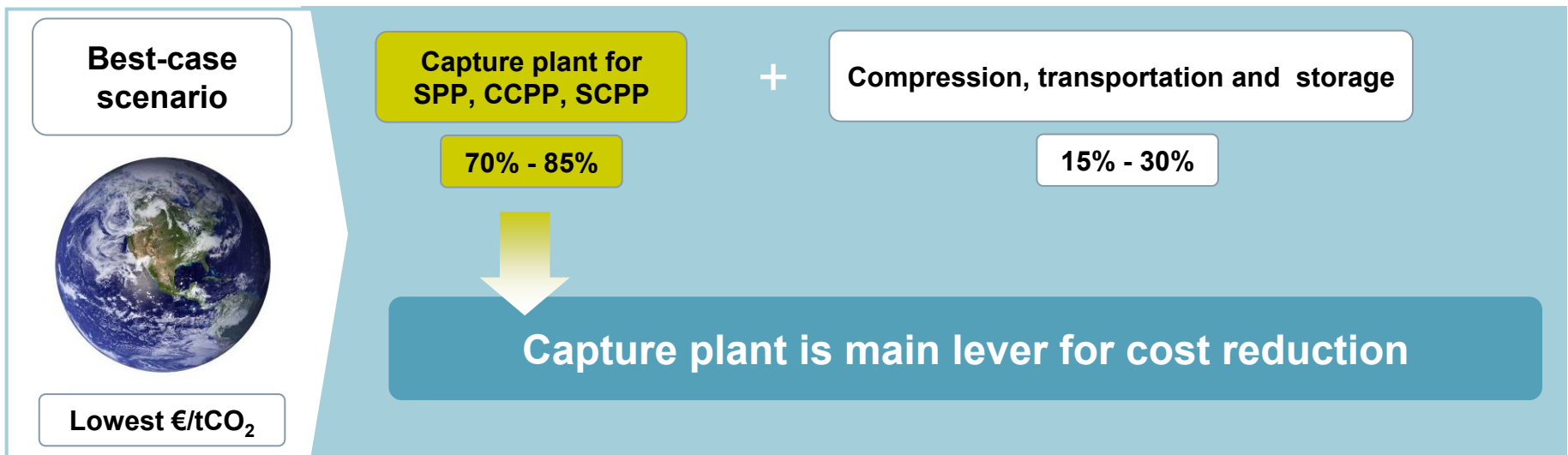
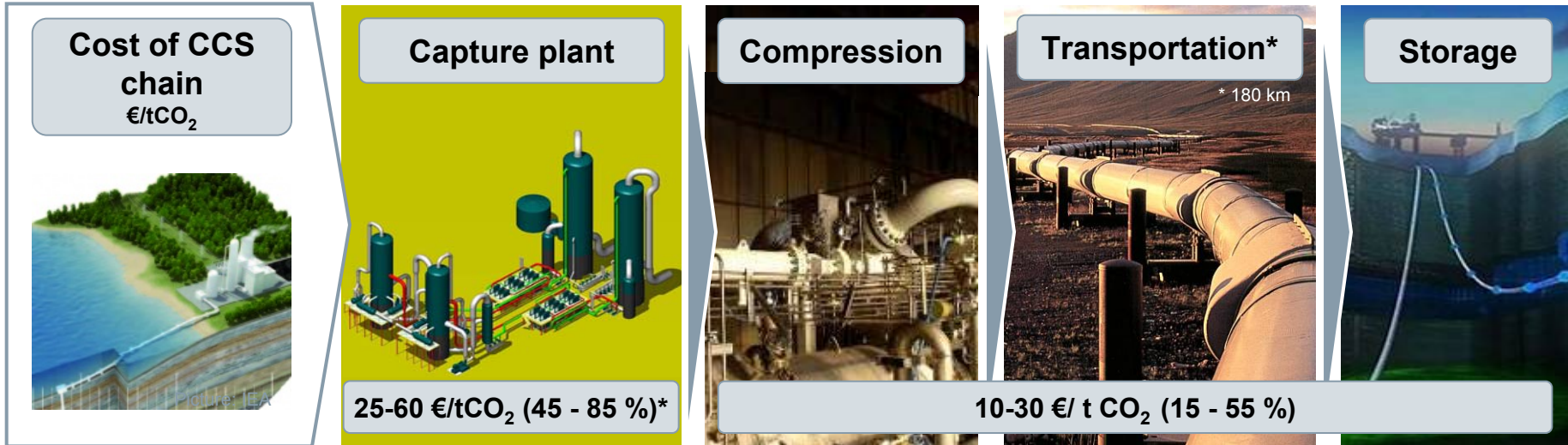
Constructability
of large-scale CO₂ Capture equipment successfully validated.



Reclaimer as proprietary equipment delivered by Siemens

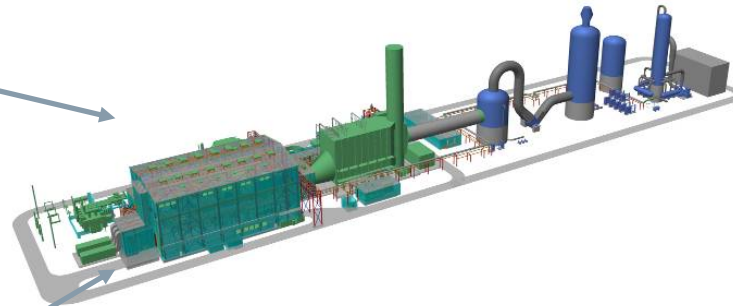
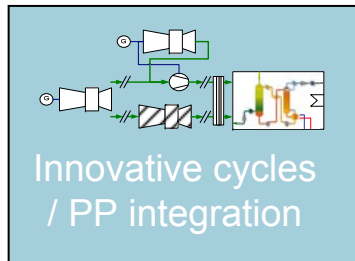
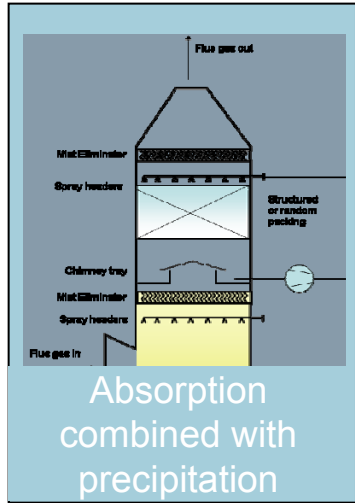
Transportable, skid mounted unit, consisting of standard equipment for chemical plants

Total Cost of Carbon Capture and Storage, the Main Drivers are Fuel and Investment Costs



Careful Selection of Post-Combustion Technology is Key for CAPEX and OPEX Reduction

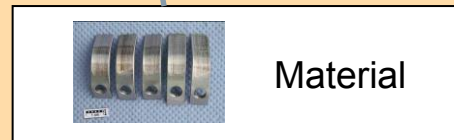
outstanding cost reduction potential achievable with Siemens PostCap™



Short term cost reduction potential



Alternative concepts for direct contact cooling



Target engineering / economy of scale

Short term potential for cost reduction: > 20 %, long term > 30 % achievable.

Summary

Fossil fuels will maintain a big share in global electricity production. CCS is one essential measure to cope with climate change. Further, CO₂ supports enhanced oil recovery (CCUS)

Siemens developed a post-combustion CO₂-capture technology based on chemical absorption process which is retrofitable to coal and gas fired power stations

The so called PostCap™ process exhibits an outstanding environmentally friendly character and it is very energy efficient. Applications in other industrial areas feasible.

The advantages of the PostCap™ process have successfully been verified in the Staudinger pilot plant and engineering projects globally. It is ready to be applied in demonstration scale projects

Mid term cost reduction potential of about 20% could be leveraged, long-term > 30% achievable

A nighttime aerial view of a city, likely New York City, with numerous skyscrapers illuminated by lights. The Chrysler Building is prominent on the right side. The background is dark blue, and the lights create a vibrant, glowing effect.

SIEMENS

**“Many thanks for your kind
attention”**

Contact:

Gernot Schneider

Director Marketing, Sales, Communication

Carbon Capture and Sequestration

Siemens Energy Sector, Fossil Division, Conventional Islands

Mobile: +49 (173) 7049-186

gernot.schneider@siemens.com

Disclaimer

This document contains forward-looking statements and information – that is, statements related to future, not past, events. These statements may be identified either orally or in writing by words as “expects”, “anticipates”, “intends”, “plans”, “believes”, “seeks”, “estimates”, “will” or words of similar meaning. Such statements are based on our current expectations and certain assumptions, and are, therefore, subject to certain risks and uncertainties. A variety of factors, many of which are beyond Siemens’ control, affect its operations, performance, business strategy and results and could cause the actual results, performance or achievements of Siemens worldwide to be materially different from any future results, performance or achievements that may be expressed or implied by such forward-looking statements. For us, particular uncertainties arise, among others, from changes in general economic and business conditions, changes in currency exchange rates and interest rates, introduction of competing products or technologies by other companies, lack of acceptance of new products or services by customers targeted by Siemens worldwide, changes in business strategy and various other factors. More detailed information about certain of these factors is contained in Siemens’ filings with the SEC, which are available on the Siemens website, www.siemens.com and on the SEC’s website, www.sec.gov. Should one or more of these risks or uncertainties materialize, or should underlying assumptions prove incorrect, actual results may vary materially from those described in the relevant forward-looking statement as anticipated, believed, estimated, expected, intended, planned or projected. Siemens does not intend or assume any obligation to update or revise these forward-looking statements in light of developments which differ from those anticipated.

Trademarks mentioned in this document are the property of Siemens AG, its affiliates or their respective owners.