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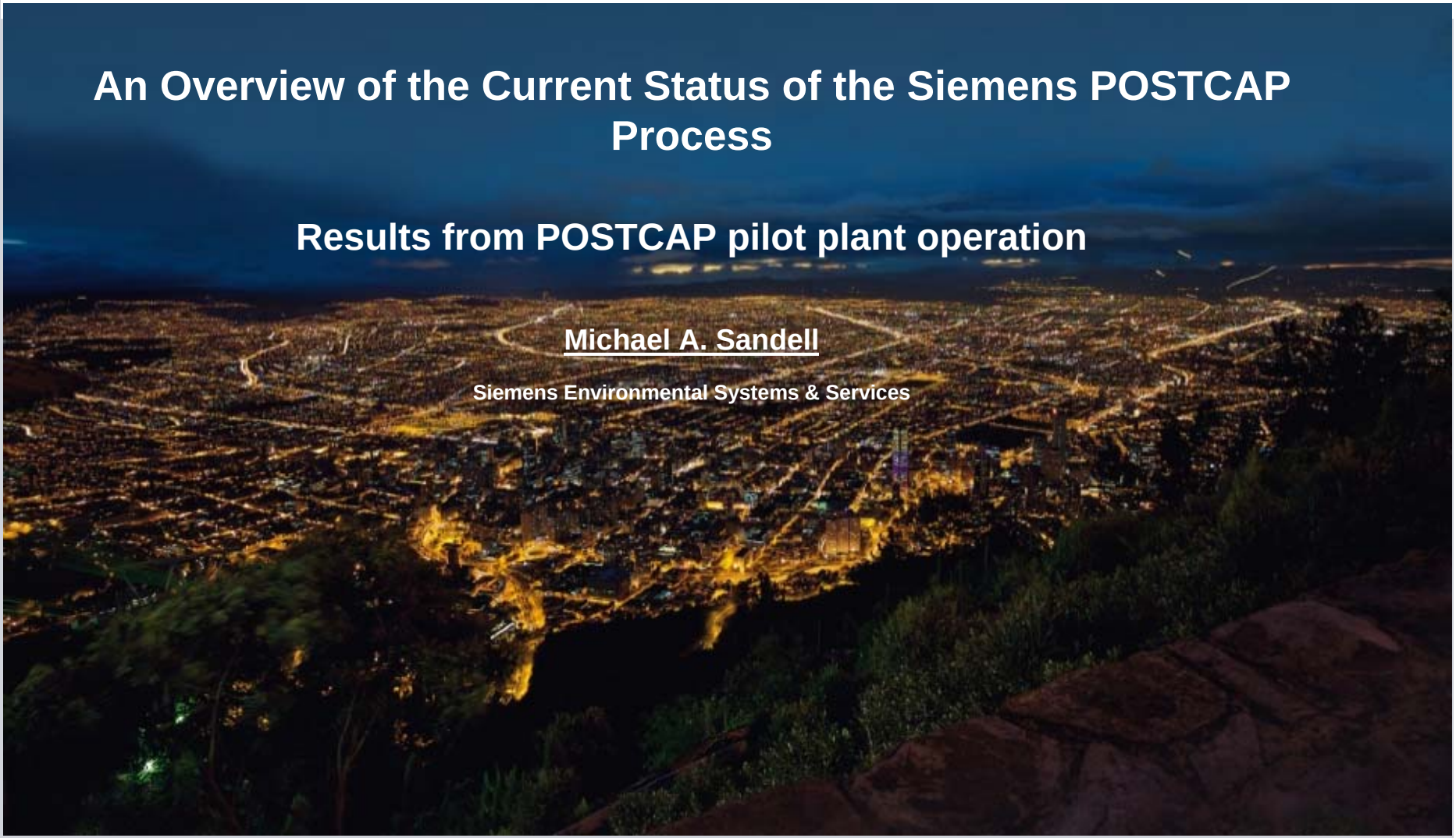
An Overview of the Current Status of the Siemens POSTCAP Process

Results from POSTCAP pilot plant operation



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Siemens solutions for CO_2 capture

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IGCC / Pre-combustion carbon capture

“Technology units proven or ready”, integration in new build IGCC plants

- Gasification technology with multi-fuel capability
- Scrubbing Technologies from oil & gas
- F-class LC Gas Turbine
- Alternative route for chemical / fuel production / SNG and hydrogen economy

Mastering technological / contractual complexity.

Post-combustion carbon capture

“Scalable” market introduction, for new build and retrofit Steam PP

- Enhancement potential for solvents, scrubbing process and for integration into the power plants
- Siemens develops process based on amino acid salt formulations
- Preferred solution for CCS demonstration projects

Mastering Scale up from pilot to demo plant

Siemens Fuel Gasifier

Siemens IGCC technology applied in Puertollano (E)

Siemens scrubbing process test lab

Post-Combustion carbon capture plant design

Siemens solutions are ready for the implementation in the upcoming CCS demonstration projects

Capture development – “second generation process”

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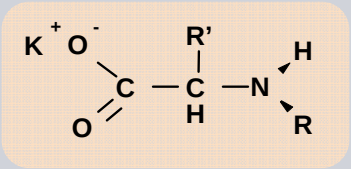
1st generation:
amines, ammonia

2nd generation:
Amino acid salt



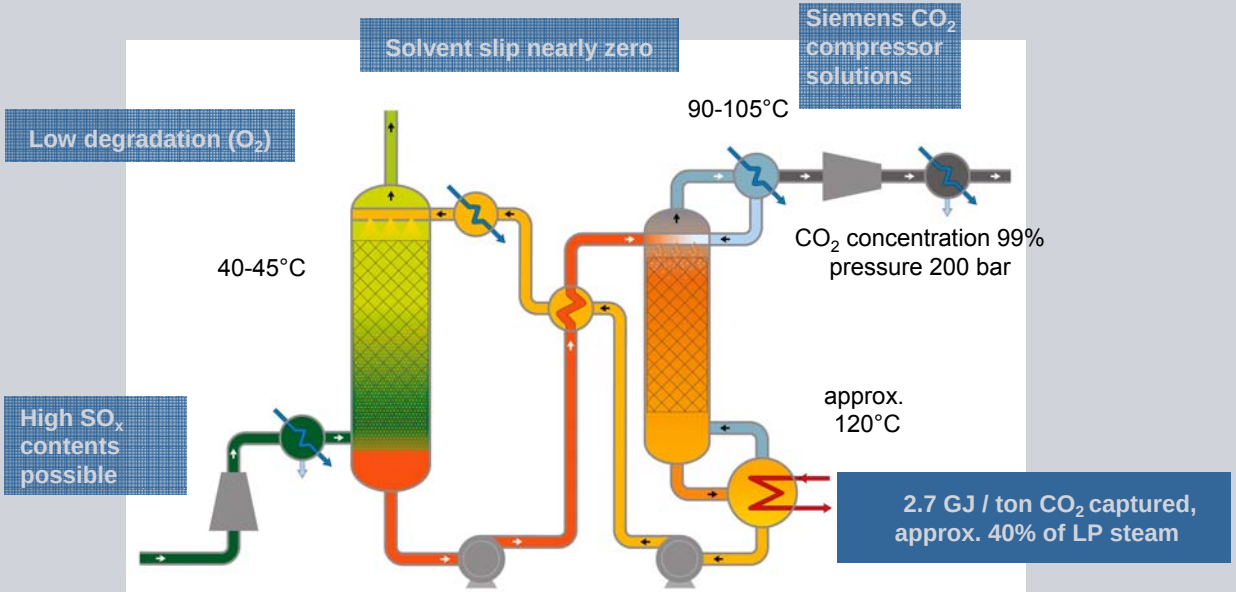
Salts have no vapor pressure

- No thermodynamic solvent emissions
- Not flammable
- Not explosive
- Odorless
- No inhalation risk
- Chemically Stable
- Naturally Occurring

1st generation:
basic process setup

Improved setup (2nd generation):

Status: **8.5 % pts.**



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

Prevention of crystallization

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Absorption capacity

- A high CO_2 loading of the solvent was achieved
- Various SO_x concentrations can be safely adjusted to investigate the behavior of active AAS substance

Crystallization behavior for different solvent concentrations

- Crystallization behavior as a function of temperature and CO_2 loading was extensively studied and is well understood
- Several process arrangements were made in order to prevent crystallization

Crystallization effects were safely avoided

Solvent stability

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Results

Components	Amino Acid Salt w/o H_2O wash
VOC	not detectable
Formaldehyde	not detectable
Methylamine	not detectable
∑Nitrosamines	not detectable
Ammonia	<1 ppm

- the solvent is highly stable and do not lead to measurable loss of active substance due to degradation
- by-products in the liquid phase are salts with no vapor pressure
- No production of any mentionable amounts of emissions
- small amounts of heat stable salts (HSS) and nitrosamines will be removed with a reclaimer

The amino-acid salt is stable against thermal stress and oxygen environments!

Fortum and Teollisuuden Voima (TVO) plan to retro-fit Meri-Pori 565 MW coal-fired power plant

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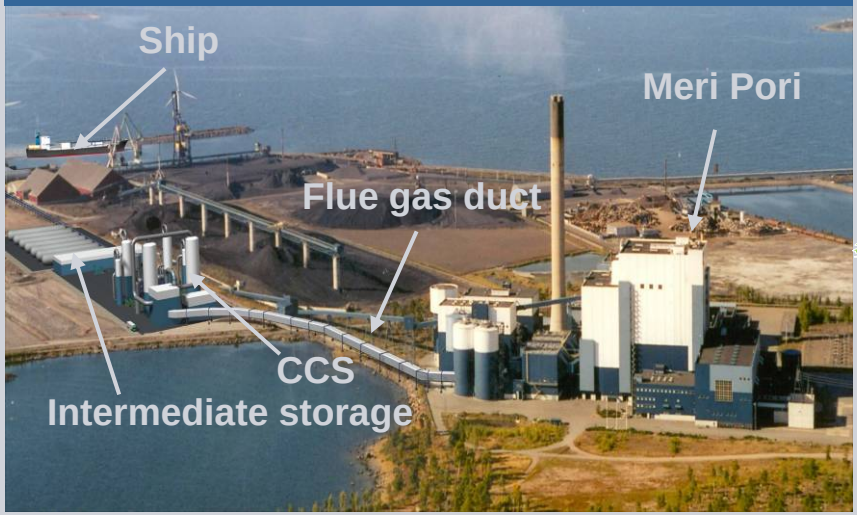
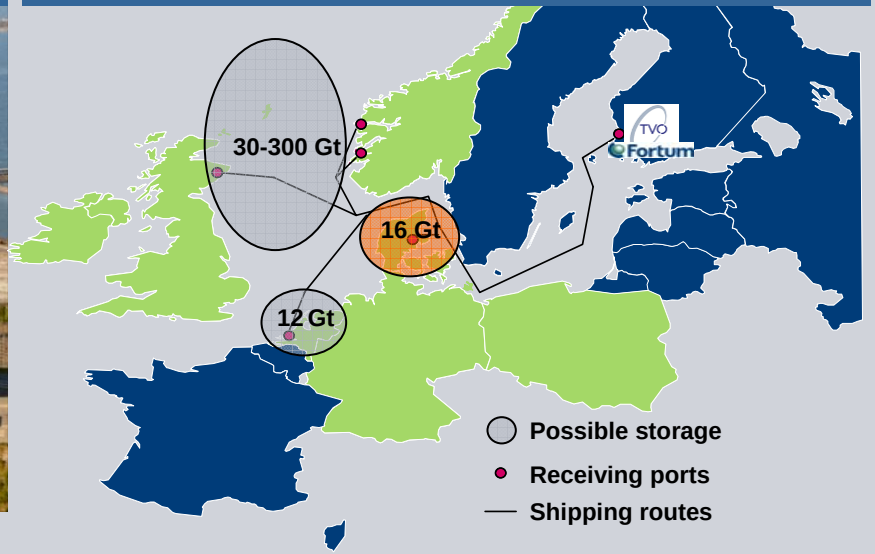
Retrofit project



- 50% Slip stream
- Aim to reduce CO_2 emissions with ~1,25 million ton/year, as well as NOx and SOx emissions
- Siemens Post-Combustion Technology selected
  - Post-combustions technologies
  - Oxy-Fuel technologies

Use of CO_2 for EOR



- CO_2 will be captured in Meri-Pori, transported abroad for storage and sequestered in geological formations
- FINCAP commissioning 2015

Conclusion and Outlook

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- Promising properties of the Siemens POSTCAP CO_2 capture process using AAS were confirmed from actual pilot plant operation
- A CO_2 capture rate of 90% and above was achieved.
- The existing AAS process simulation model was validated.
- No crystallization effects appeared.
- Applicability of stainless steel 1.4571 (316L) as preferred construction material was confirmed.
- An efficiency drop of only 8.5 %-pts (including CO_2 compression to 200 bar and auxiliary power demand) can be achieved.
- The amino-acid salt is stable against thermal stress and oxygen environments which appear under real operation conditions.
- Solvent stability and low emissions have been experimentally confirmed.
- No mentionable amounts of emissions could be found.