

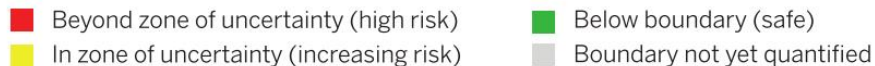
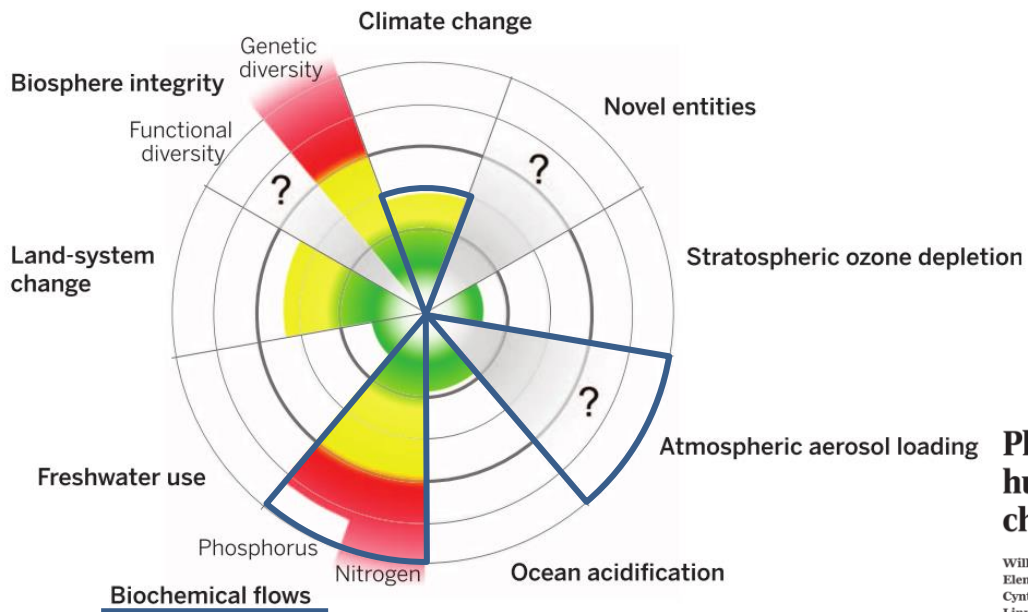
Integrating Resource Recovery with Energy Systems

**Thermochemical energy conversion laboratory
Department of Applied Physics and Electronics
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Why bother?



Planetary boundaries: Guiding human development on a changing planet

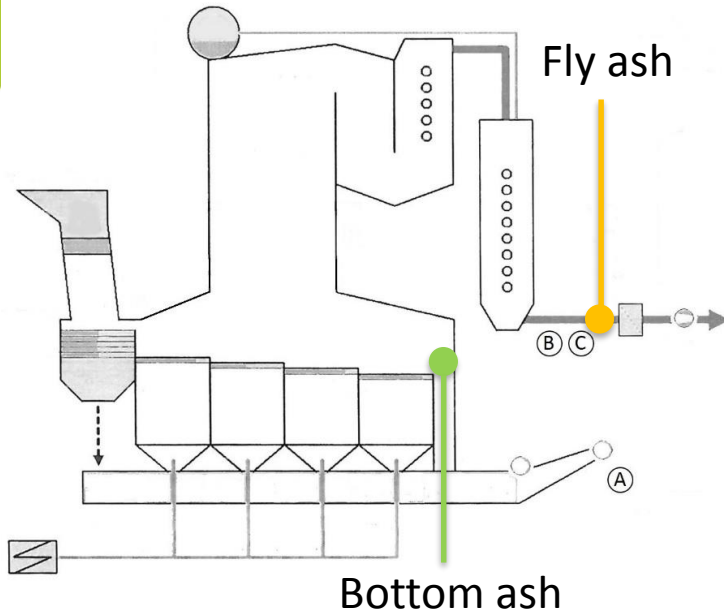
Will Steffen,* Katherine Richardson, Johan Rockström, Sarah E. Cornell, Ingo Fetzer, Elena M. Bennett, Reinette Biggs, Stephen R. Carpenter, Wim de Vries, Cynthia A. de Wit, Carl Folke, Dieter Gerten, Jens Heinke, Georgina M. Mace, Linn M. Persson, Veerabhadran Ramanathan, Belinda Reyers, Sverker Sörlin

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Thermochemical energy systems as reactors

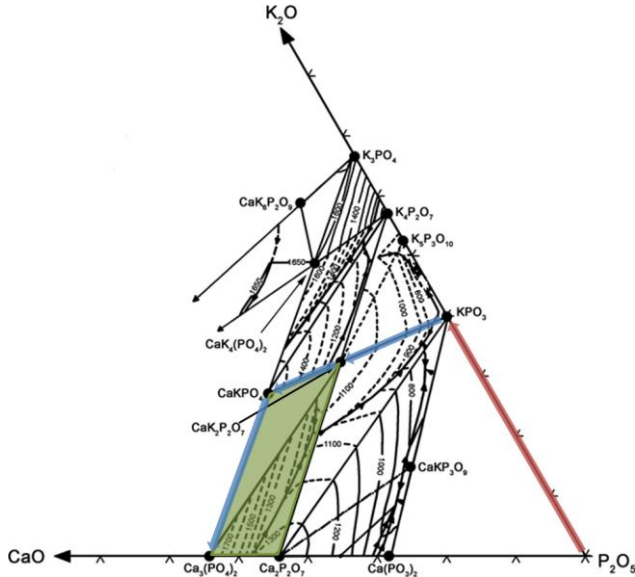


- Volume – throughput range in tons per hour
- Temperatures enabling fast reaction kinetics
- Possible control of oxidation states for certain elements
- Emission and particulate matter control measures
- Use the system to separate elements

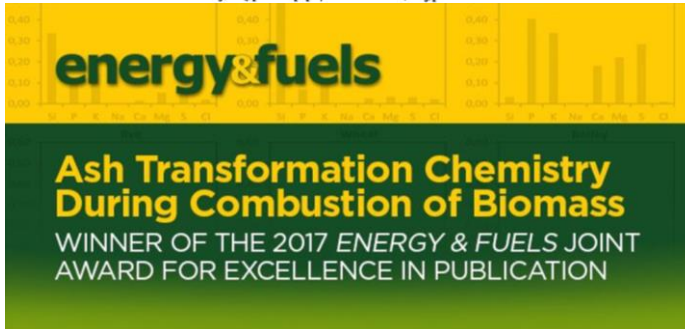
Rebbling, A.; Näzelius, I.-L.; Piotrowska, P.; Skoglund, N.; Boman, C.; Boström, D.; Öhman, M.

Waste Gypsum Board and Ash-Related Problems during Combustion of Biomass. 2. Fixed Bed, Energy & Fuels **2016**, 30 (12), 10705–10713.

Understanding elemental distribution



- C,H,N,O – usually converted
- Ash forming elements important
- Thermodynamic equilibrium modelling for predictions
- Lacking complete prediction tools
- Fundamental model for ash transformation reactions



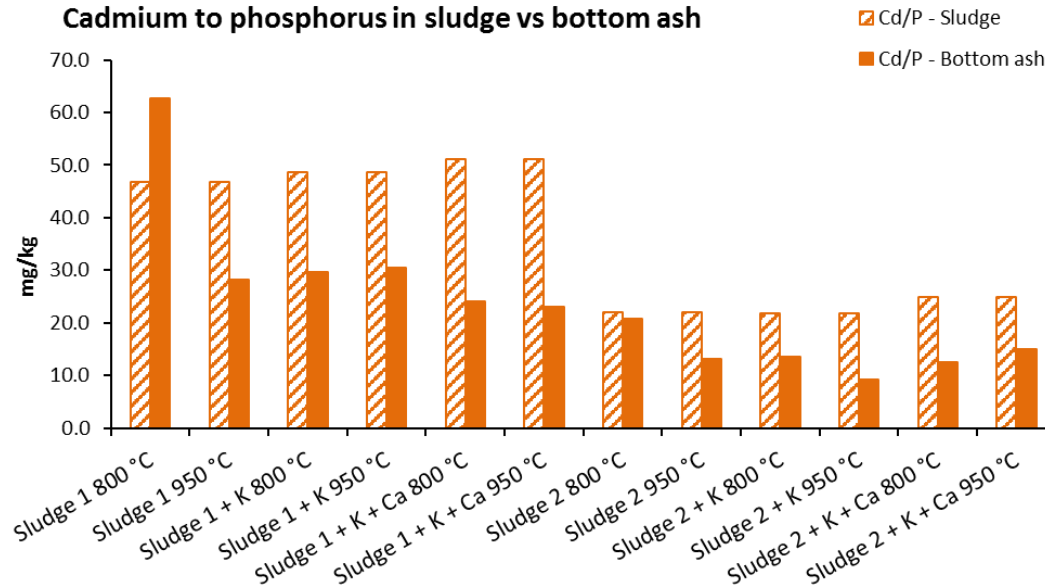
Skoglund, N.

Ash chemistry and fuel design focusing on combustion of phosphorus-rich biomass. Doctoral thesis, Umeå university, Umeå, 2014.

Examples from phosphorus-projects



- Depletion of Cd in P-rich ash
- Bottom ash fraction separated
- Fuel design based on chemistry



On-going and future work



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BIO4ENERGY



Vetenskapsrådet



Forskningsrådet Formas

Formas främjar framstående forskning för hållbar utveckling



Energimyndigheten

- Determining heavy metal speciation in P-rich ash fraction
- Affecting path of N from raw material through energy system
- Coupling ash transformation reactions to organic emissions, e.g. dioxins
- Directing speciation of valuable elements
- Plant growth experiments

Thank you for your attention!



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