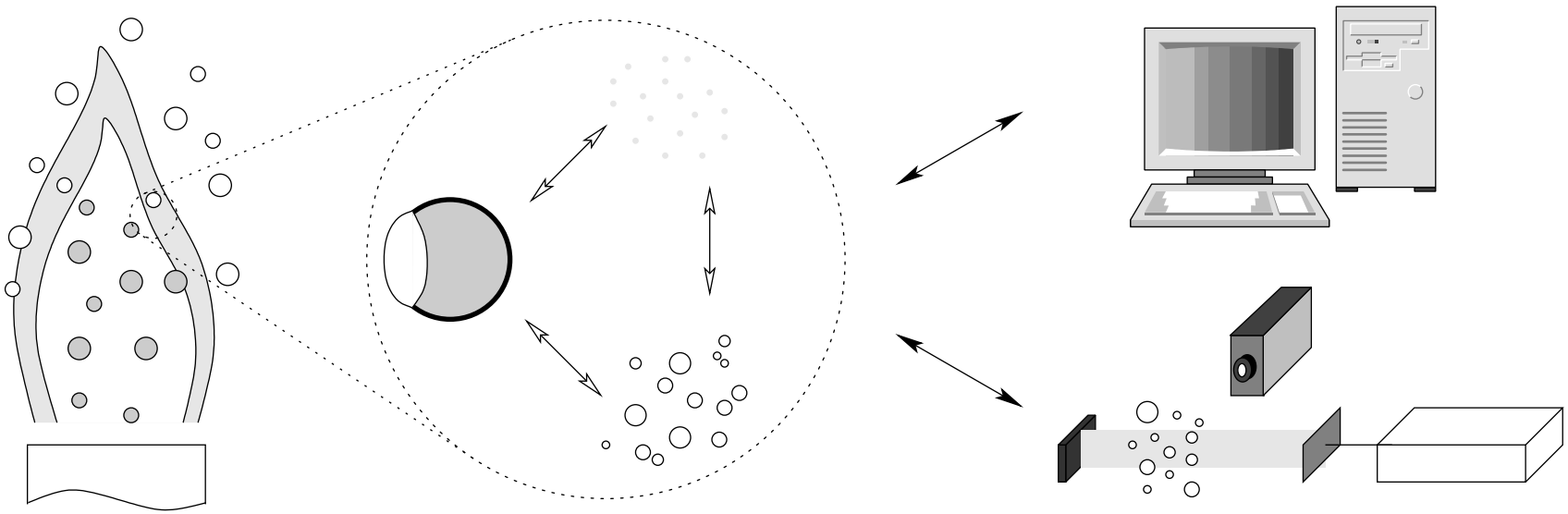
Emmy Noether Group Magdeburg Ruhr University Bochum

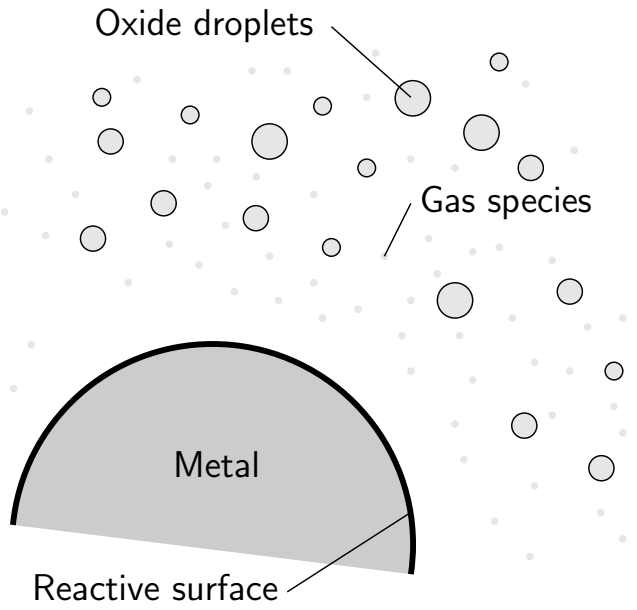
Workshop on Metal Fuels and Metal Dust Combustion

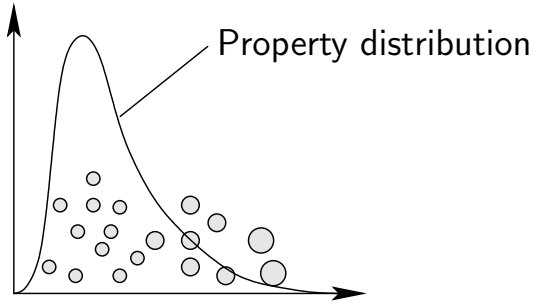
Welcome and Introduction

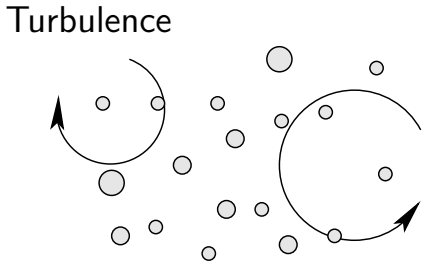


Outline

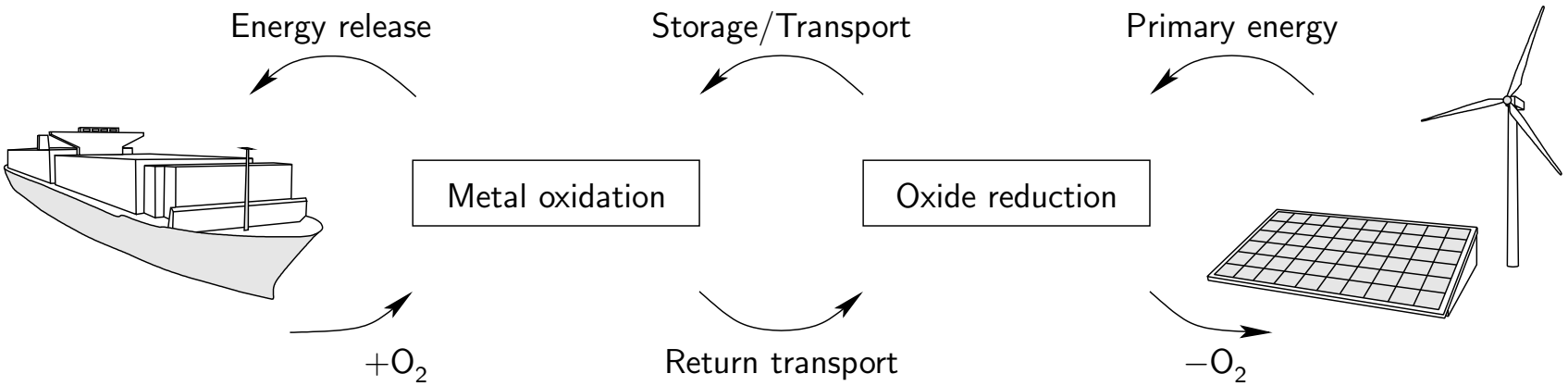
1. Towards a sustainable energy economy
2. How is this workshop structured?
3. About you
4. Target dust flames





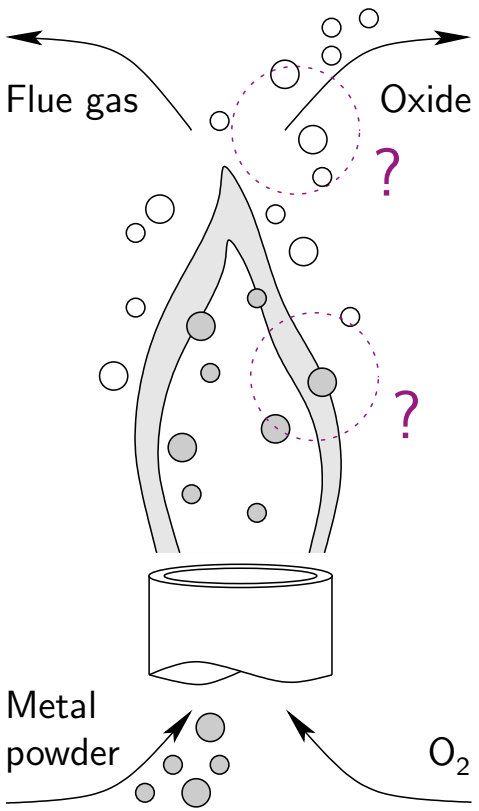


Towards a sustainable energy economy



Open questions about the combustion of metal powders

- Fuel conversion ratio? Power density?
- Metal oxide collection? Oxide aerosols?
- NO_x?

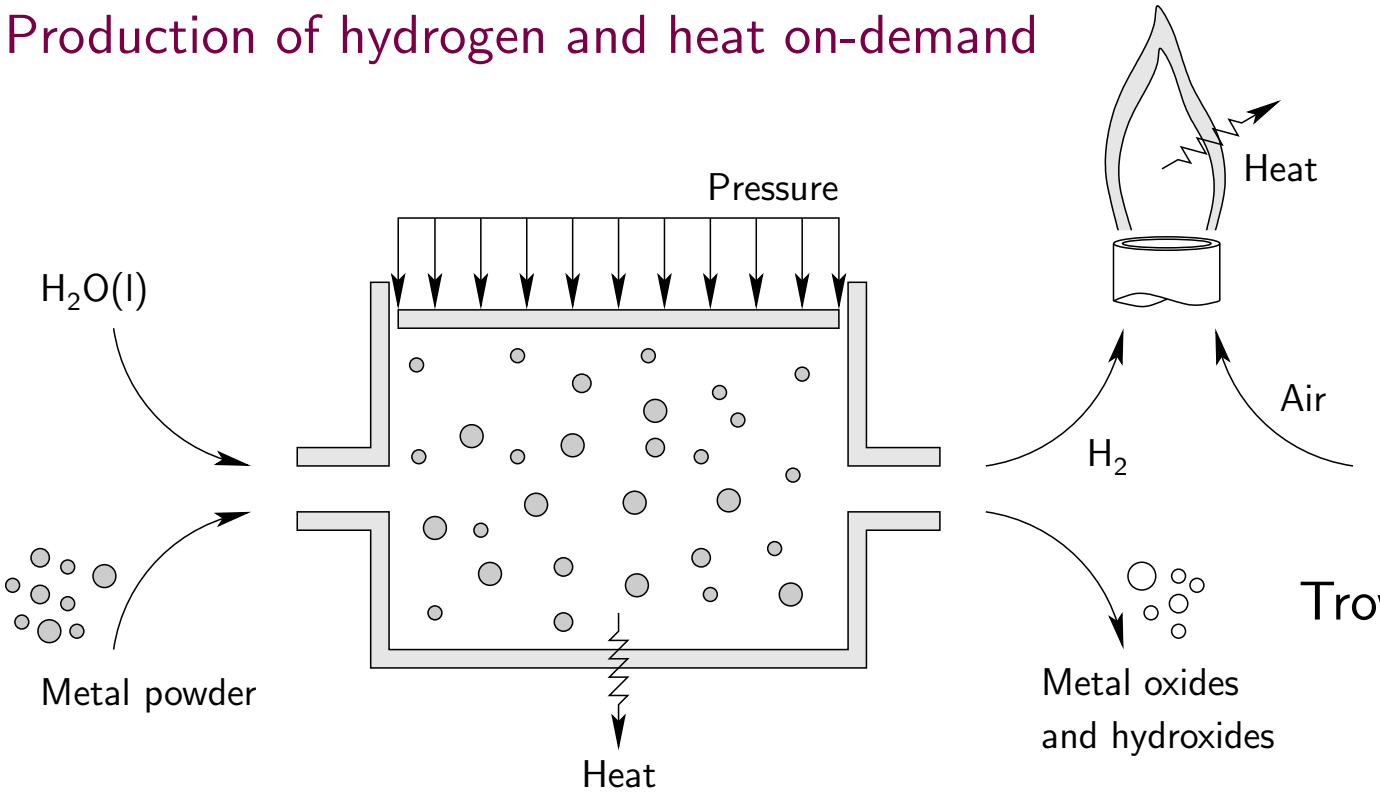


Bergthorson et al. (2015), Bergthorson (2018)

Besides constituting energetic materials, metal particles may also serve as O_2/H_2-carriers.

Metal-water slurry reactors

Production of hydrogen and heat on-demand



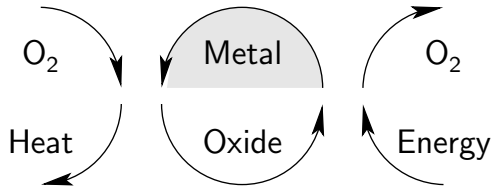
Trowell et al. (2022)

Open questions about metal-water reactions

- Fuel conversion? Deposition of oxides and hydroxides?
- Conditions for reaction onset?
- Sensitivity to particle size, shape and impurities?

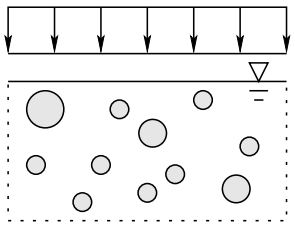
How is this workshop structured?

1 Cycle economy



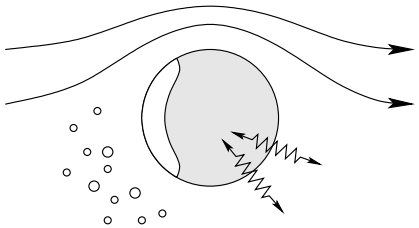
- Economic viability
- Cycle efficiency
- Retrofitting and infrastructure

2 Metal-water slurry reactors



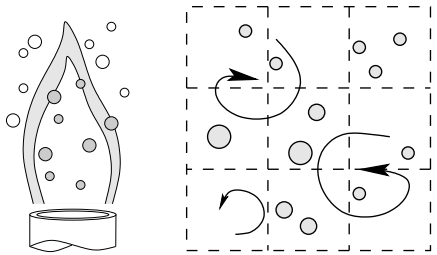
- Hydration/oxidation kinetics
- Ignition conditions
- Dissolution of oxide skin

3 Single particle combustion



- Surface chemistry
- Impurities
- Oxide smoke formation

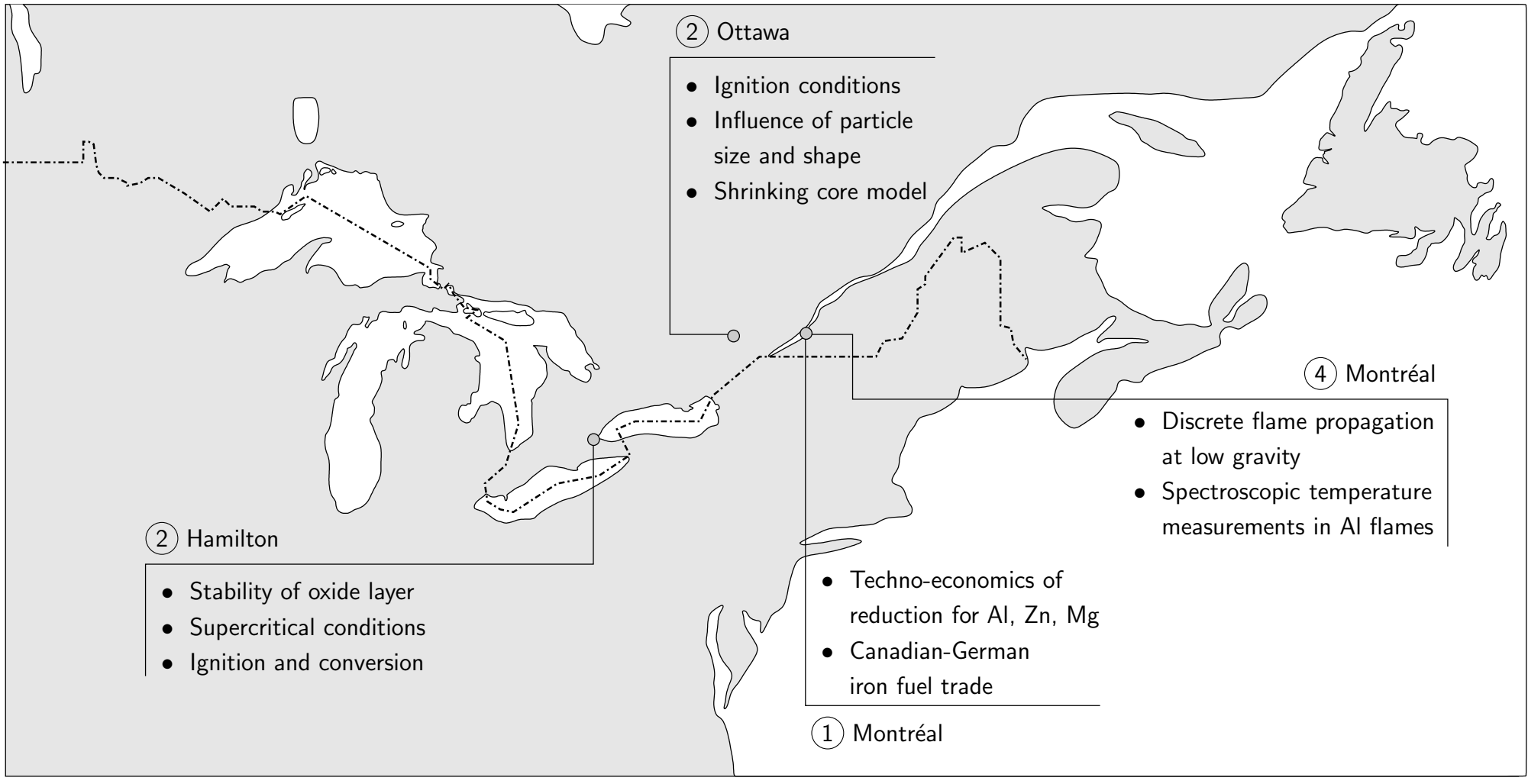
4 Dust flames



- Flame propagation
- Flame speed measurements
- Modelling particle-laden flows

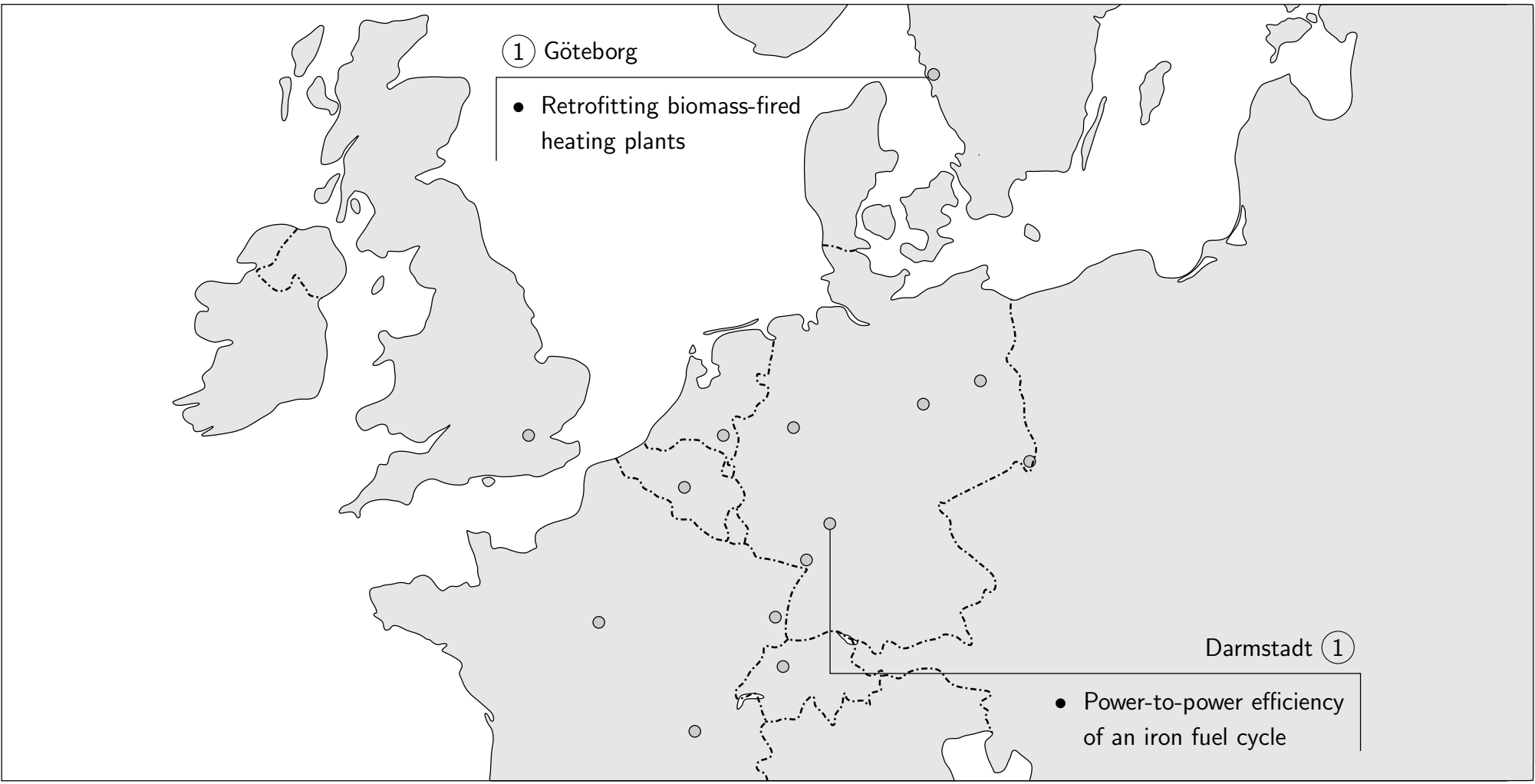
About you – Contributions from Canada

(1) Cycle economy (2) Metal-water reactors (4) Dust flames



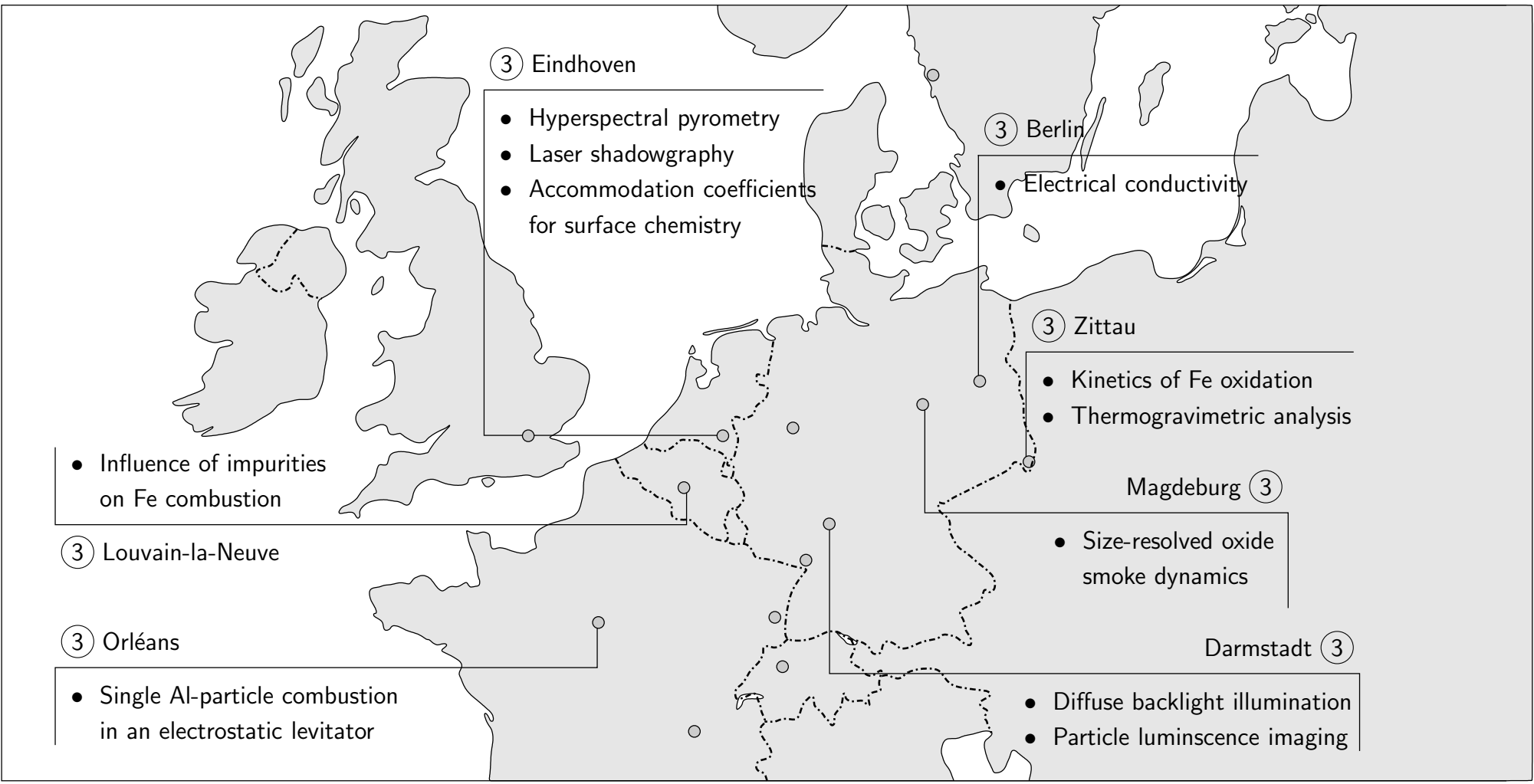
About you – Contributions from Europe

(1) Cycle economy



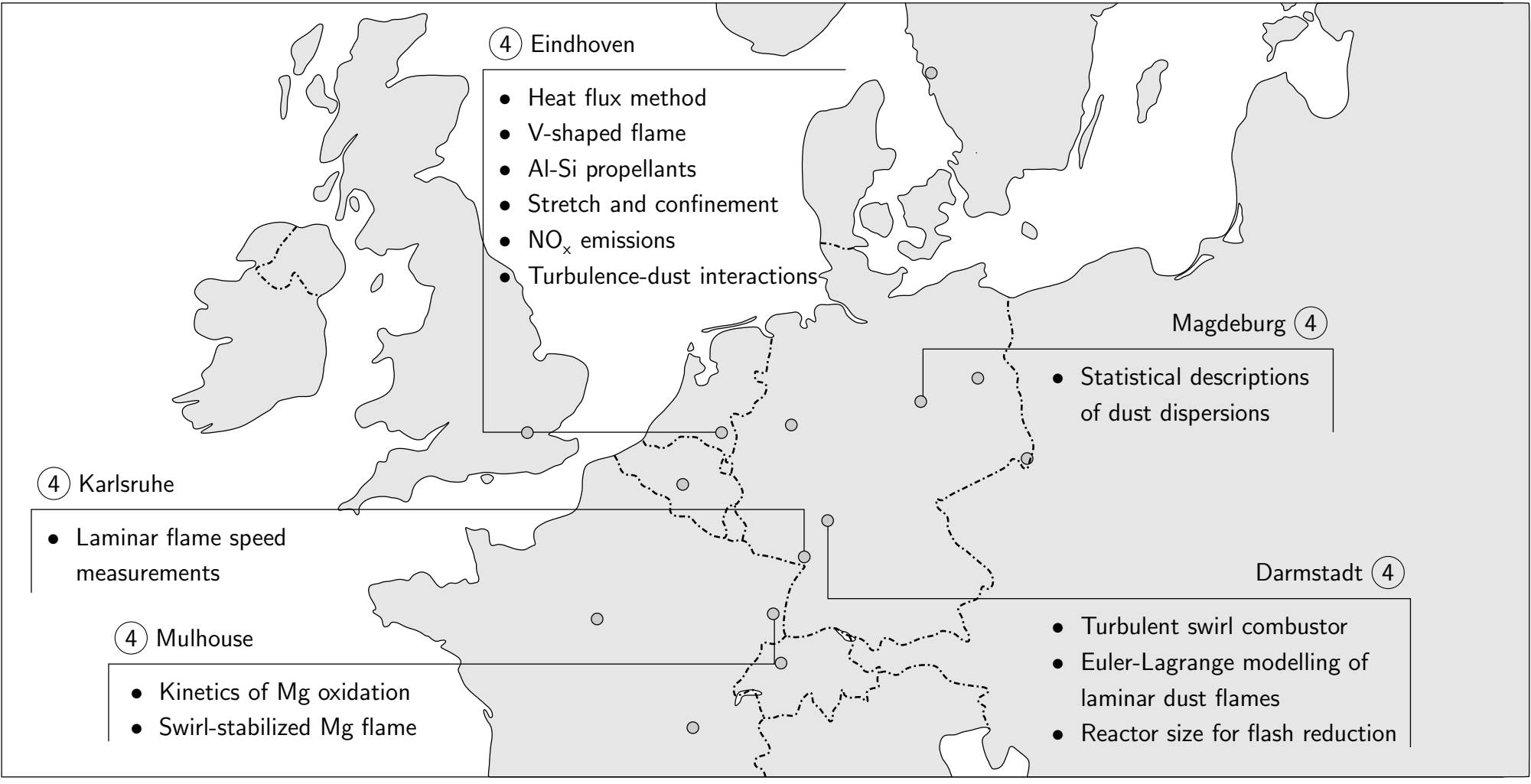
About you – Contributions from Europe

③ Single particle combustion



About you – Contributions from Europe

4 Dust flames



About you – Industrial participation

Target dust flames

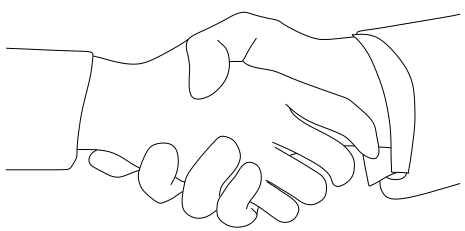
. . . similar in spirit to the flames defined by the TNF and PTF Workshops

What are target flames?

- Well-defined, reproducible and simple boundary conditions
- Morphologically and chemically well-characterized fuel powders
- Amenable to systematic variations of operating conditions (*e.g.*, equivalence ratio, size distribution, pre-heating)
- Experimentally analyzed on the level of *global* (*e.g.*, flame speed, conversion) and *local* observables (*e.g.*, pollutant profiles, temperature)

Target flames could

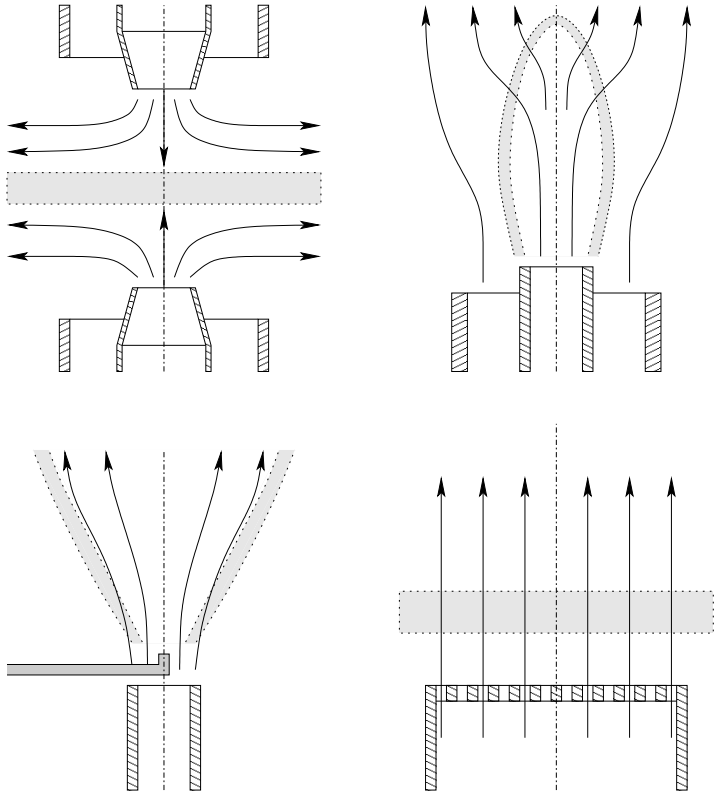
- allow for a comprehensive model validation
- assist the identification of modelling challenges
- provide a common basis for sharing submodels
- guide application or development of diagnostics



Over to the scientific sessions . . .

Questions we may discuss

- Which flame configuration?
- Could dust batches be shared?
- Could existing datasets be amended?
- Isolation or elimination of phenomena?
- Platform?



Scientific sessions

We look forward to today's contributions and thought exchanges and wish to thank you for attending and supporting this workshop

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Bibliography

Bergthorson, J. M., S. Goroshin, M. J. Soo, P. Julien, J. Palecka, D. L. Frost, and D. J. Jarvis (2015), "Direct combustion of recyclable metal fuels for zero-carbon heat and power", *Applied Energy* 160, pp. 368–382.

Bergthorson, J. M. (2018), "Recyclable metal fuels for clean and compact zero-carbon power", *Progress in Energy and Combustion Science* 68, pp. 169–196.

Trowell, K., J. Blanchet, S. Goroshin, D. Frost, and J. Bergthorson (2022), "Hydrogen production via reaction of metals with supercritical water", *Sustainable Energy Fuels* 6.14, pp. 3394–3401.