



UNIVERSITY OF  
BIRMINGHAM

BCES

# Converting Emissions into Wealth using Waste Energy

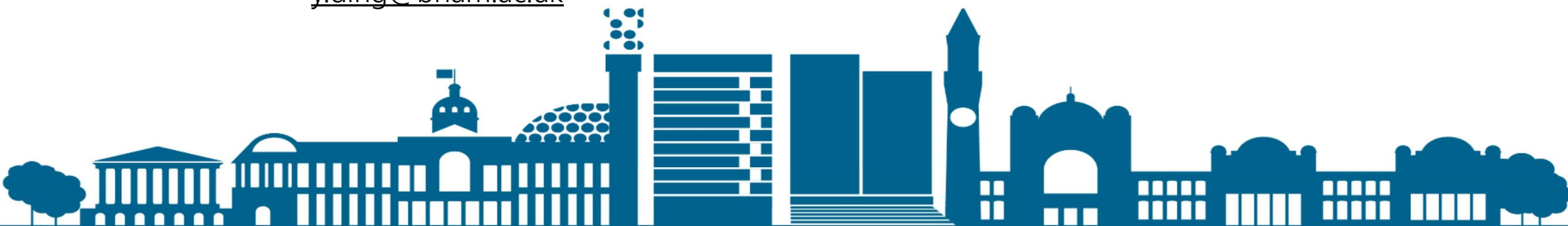
Present by Dr. Weiwei Zhao *PhD AMIMechE FHEA*

Corresponding to Prof. Yulong Ding *FREng FIChemE CEng*

Birmingham Centre for Energy Storage (BCES), School of Chemical Engineering,  
University of Birmingham, UK

email: [w.zhao@bham.ac.uk](mailto:w.zhao@bham.ac.uk)

[y.ding@bham.ac.uk](mailto:y.ding@bham.ac.uk)



International Frontier Summit on Sustainable and Green Chemical Engineering (IFS-SGCE), Xiangtan University, 27-30 Sept 2024



# Table of Content

1. Decarbonisation for Steelmaking Industry
  - Principle and MD Simulation
  - Reactor Operation and Process
  - Investment Economic Analysis
2. Thermal-Mechanical Energy Harvesting for EVs
  - Background and Algorithm
  - Progress Updates
3. About Birmingham Centre for Energy Storage





# Table of Content

1. Decarbonisation for Steelmaking Industry
  - Principle and MD Simulation
  - **Reactor Operation and Process**
  - Investment Economic Analysis
2. Thermal-Mechanical Energy Harvesting for EVs
  - Background and Algorithm
  - Progress Updates
3. About Birmingham Centre for Energy Storage





# Table of Content

1. Decarbonisation for Steelmaking Industry
  - Principle and MD Simulation
  - Reactor Operation and Process
  - Investment Economic Analysis
2. Thermal-Mechanical Energy Harvesting for EVs
  - Background and Algorithm
  - Progress Updates
3. About Birmingham Centre for Energy Storage





# Table of Content

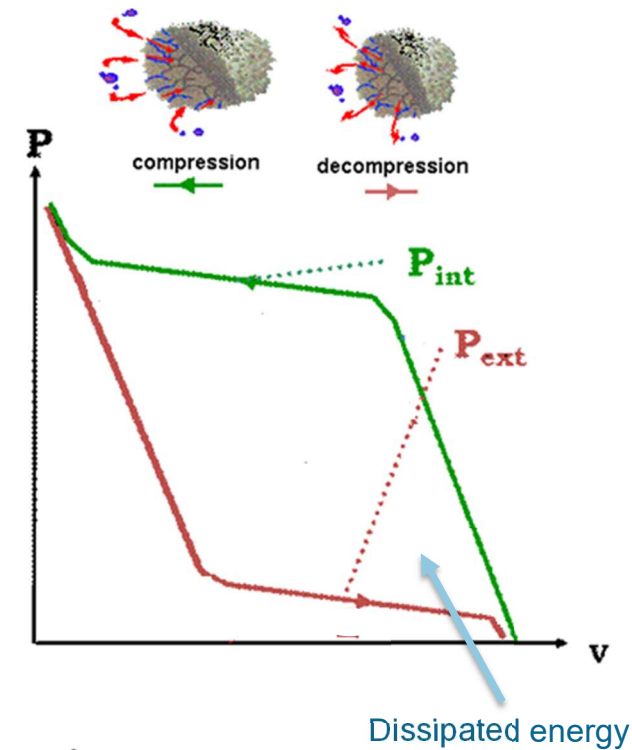
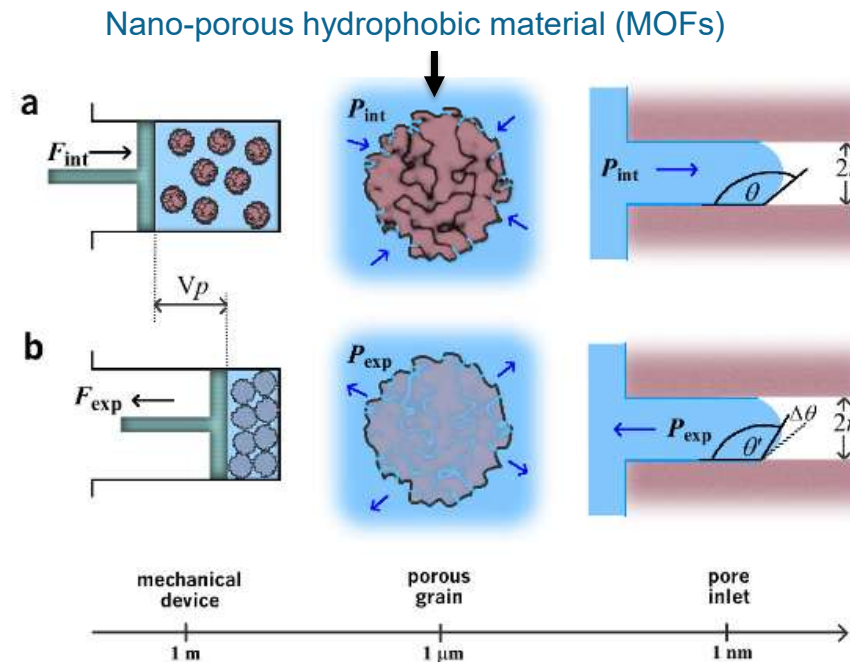
1. Decarbonisation for Steelmaking Industry
  - Principle and MD Simulation
  - Reactor Operation and Process
  - Investment Economic Analysis
2. Thermal-Mechanical Energy Harvesting for EVs
  - Background and Algorithm
  - Progress Updates
3. About Birmingham Centre for Energy Storage



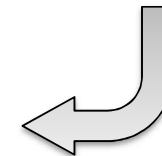
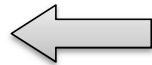
# Shock-absorber for Harvesting Dissipated Energy - Principle



UNIVERSITY OF  
BIRMINGHAM



Electricity





## Shock-absorber for Harvesting Dissipated Energy – Principle

Turn waste to wealth

Vibrational work



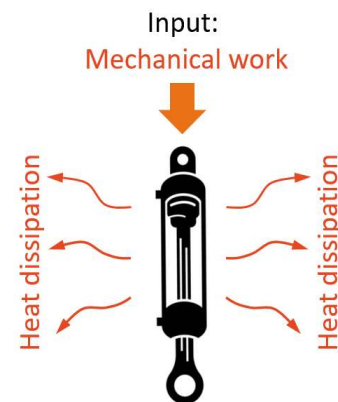
Damping friction



Heat dissipation

Wasted  
about 10% of total energy

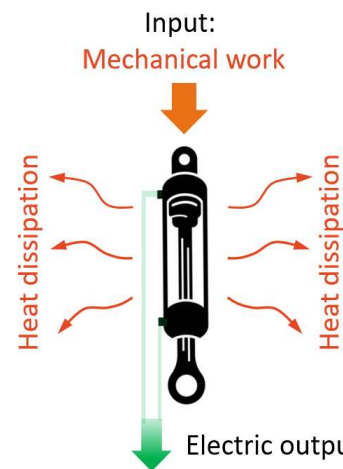
(a) Oil shock absorber



No electric output:

$$\text{Electricity} = 0$$

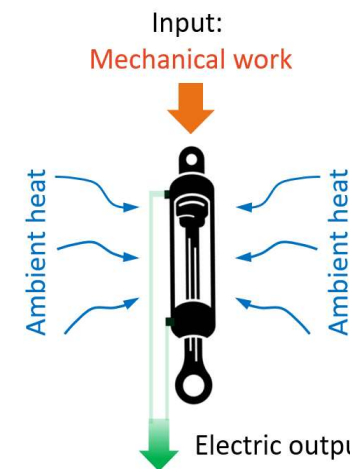
(b) Electromagnetic  
shock absorber



$$\text{Electricity} = \eta_{\text{mech}} \cdot \text{Work}$$

Ref. IEEE Transactions on Vehicular  
Technology, 2013, 62(3), 1065-1074.  
DOI: 10.1109/TVT.2012.2229308.

(c) Nanotriboelectrification  
shock absorber



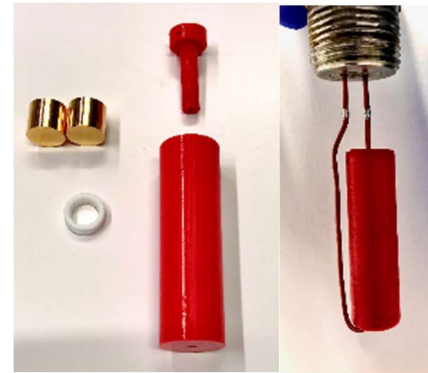
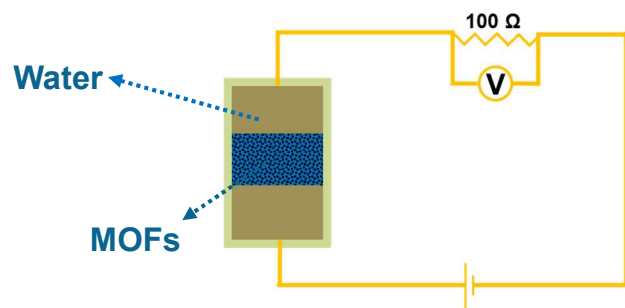
$$\text{Electricity} = \eta_{\text{mech}} \cdot \text{Work} + \eta_{\text{therm}} \cdot \text{Heat}$$

Ref. Electro-Intrusion Project | H2020  
| European Commission n.d.  
<https://cordis.europa.eu/project/id/101017858>





## Energy Recovery Shock-absorber experiments

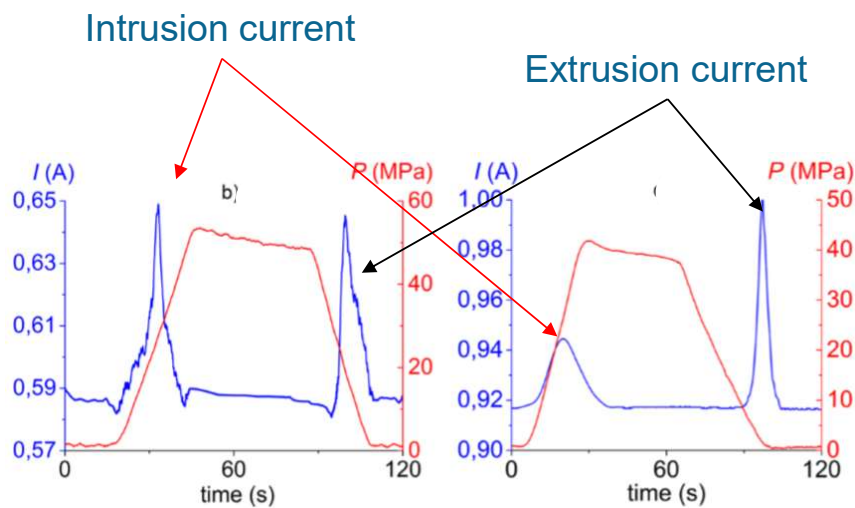


$$\frac{E_{elc}}{\Delta W_{mec}} = \frac{E_{elc}}{W_{int} - W_{ext}} =$$

$$= \frac{1.8}{8.5 - 1.3} = 0.25$$



Electrical energy is  
~25% of the  
mechanical work  
done



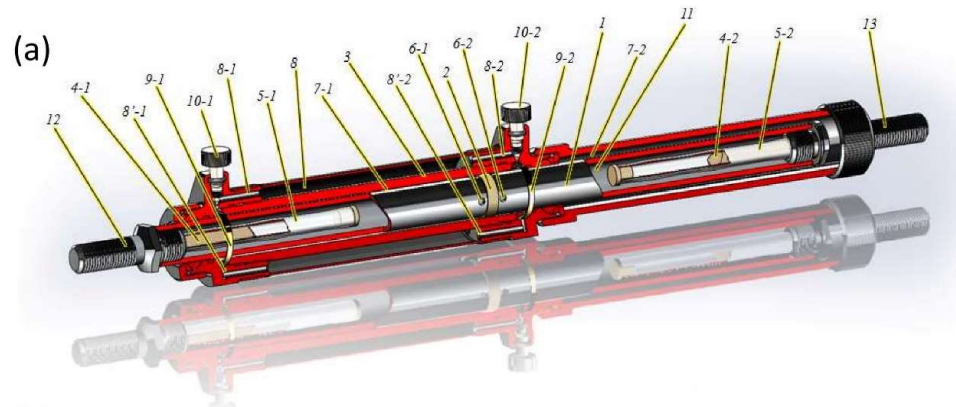


## Shock-absorber experiments – Device design and Road test



UNIVERSITY OF  
BIRMINGHAM

Prototype design  
Aug 2023



Prototype manufacturing July 2024



Road test and assessment Dec 2024





# Table of Content

1. Decarbonisation for Steelmaking Industry
  - Principle and MD Simulation
  - Reactor Operation and Process
  - Investment Economic Analysis
2. Thermal-Mechanical Energy Harvesting for EVs
  - Background and Algorithm
  - Progress Updates
3. **About Birmingham Centre for Energy Storage**



## About Birmingham Centre for Energy Storage (BCES)



UNIVERSITY OF  
BIRMINGHAM







# Thank you for your attention

Collaboration are warmly welcome

Dr. Weiwei Zhao (w.zhao@bham.ac.uk)

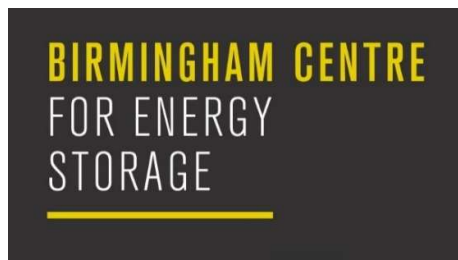
Prof. Yulong Ding (y.ding@bham.ac.uk)

European  
Innovation  
Council



UNIVERSITY OF  
BIRMINGHAM

Engineering and  
Physical Sciences  
Research Council



@BCES\_UoB



www.bham.ac.uk/BCES



BCES-Innovation

