GLOBAL SECURE

Sustainable Energy through China-UK Research Engagement (SECURE)

Principal Investigator: Professor AP Roskilly

Project Duration: 12 Months

Funding Body: EPSRC

http://research.ncl.ac.uk/globalsecure/

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China-UK Seminar on Sustainable Energy & New Power-Train System Technologies

Beijing Institute of Technology (BIT) in China

23-24 March 2013

Organised by BIT, University of Newcastle Upon Tyne (UNEW) & Chinese Society for Internal Combustion Engine (CSICE)

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Theme 3

‘Low Grade Heat Driven Cogeneration of Power & Cooling’

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Contents

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1. Introduction

- Background

The project is highly relevant to the priority areas of Energy and Environmental Change issues.

Fossil fuels are the main sources of energy we use today

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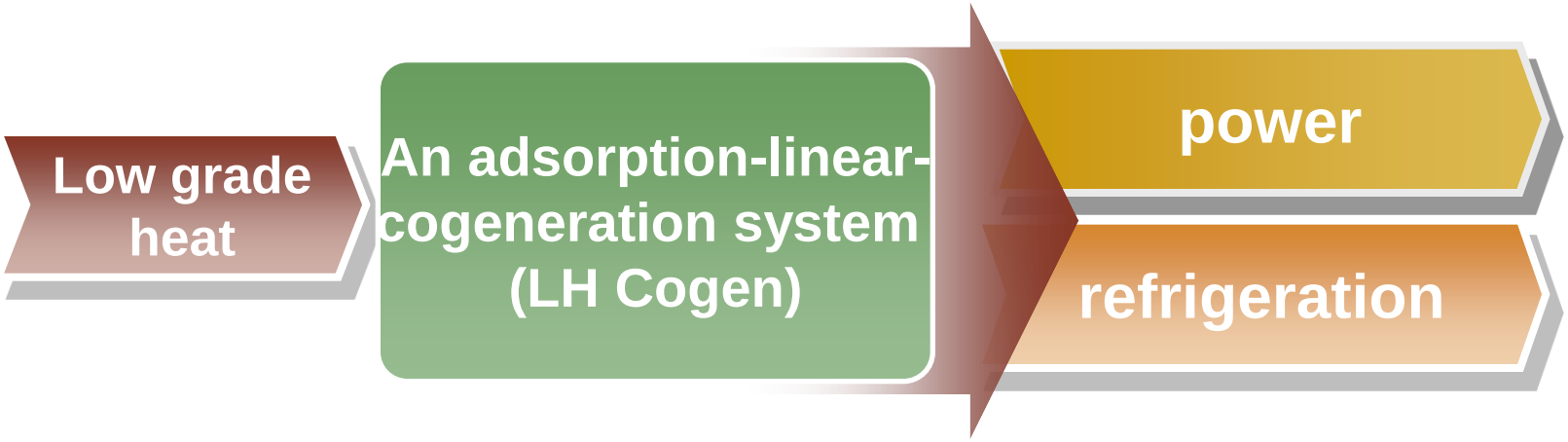
- Objective

Demonstration of the combination of adsorption chiller and electrical power generator using **low grade heat** from the sun or industries



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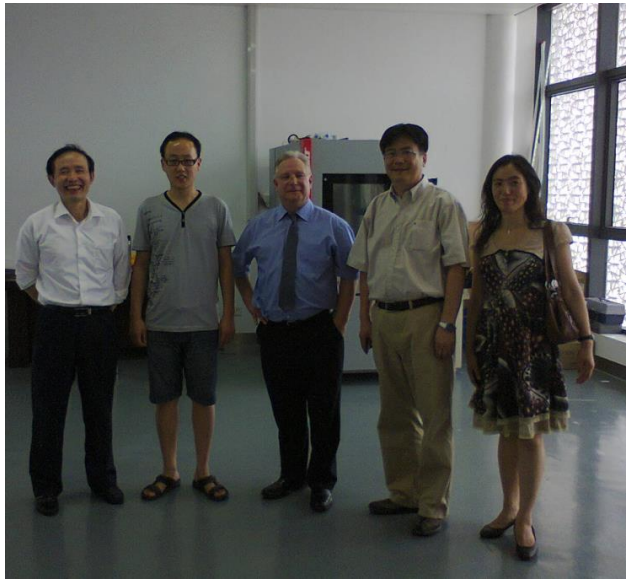
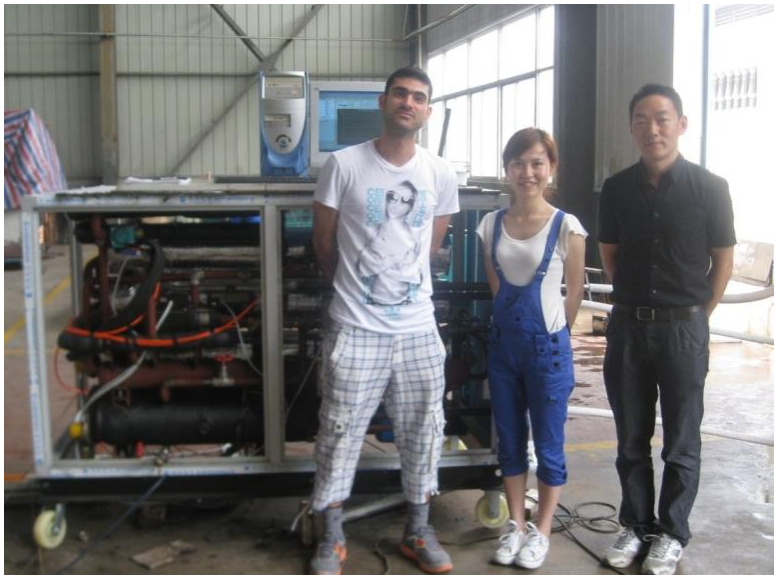
- Project partners:
  - **Shanghai Jiaotong University** (working on **cooling unit**)

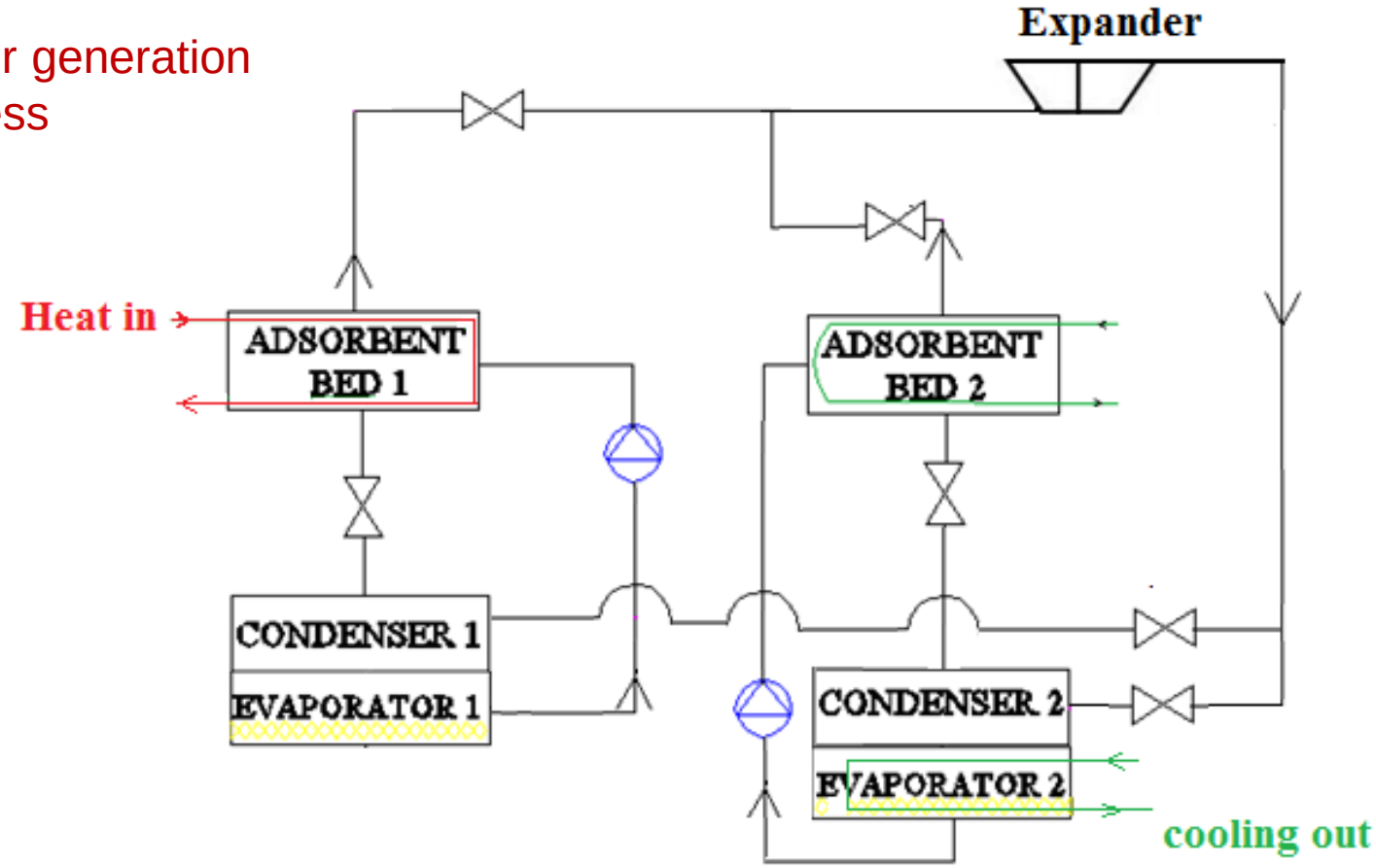




  - **Beijing Institute of Technology** (working on **linear expander unit**)

2. Principle of LH Cogen system

Power generation process



Cooling process

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3. Experimental test rig and initial results

Test setup in lab

Adsorption chiller in Lab

Cooling tower outside the Lab

Data collection devices

Control panel of chiller

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Operating conditions of Cooling test

Heating T(°C)	Evaporation T(°C)	Heat sink T(°C)	Cycle time(min)	Mass recovery time
135	0	20	10	1 min
			13	30 sec
				1 min
				2 min
			16	1 min
			18	1 min
		30	13	1 min
	-5	20	10	1 min
			13	30 sec
				1 min
				2 min
			16	1 min
			18	1 min
	-10	20	13	1 min
145	-5	20	13	1 min
	-10			
	0			
125	-5	20	13	1 min
	-10			
	0			
110	0	20	13	1 min
	-5			
100	0	20	13	1 min
			16	

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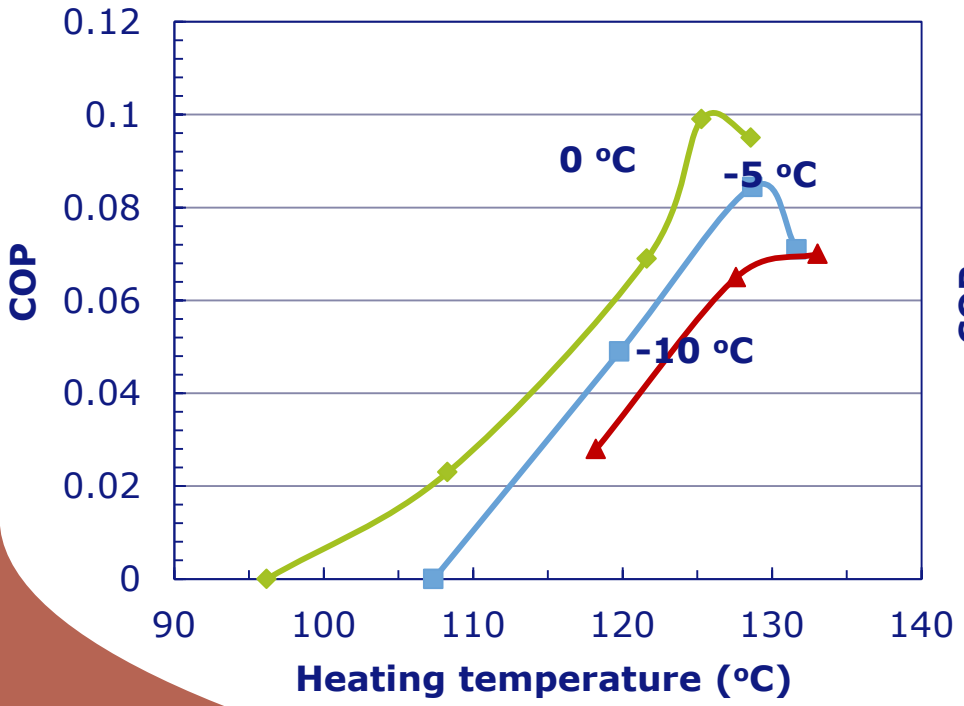
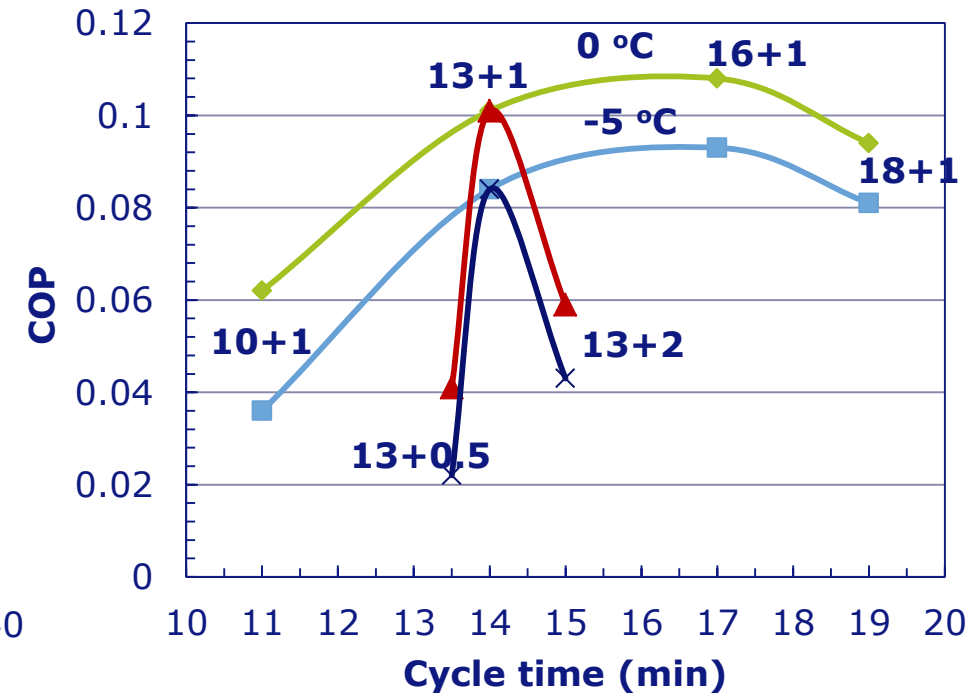
Cooling test results

First test results: the *average* cooling power was 2.88 kW at evaporation temperature -4.5 ºC, with *average* COP and *maximum* COP values around 0.18 and 0.27 , respectively.





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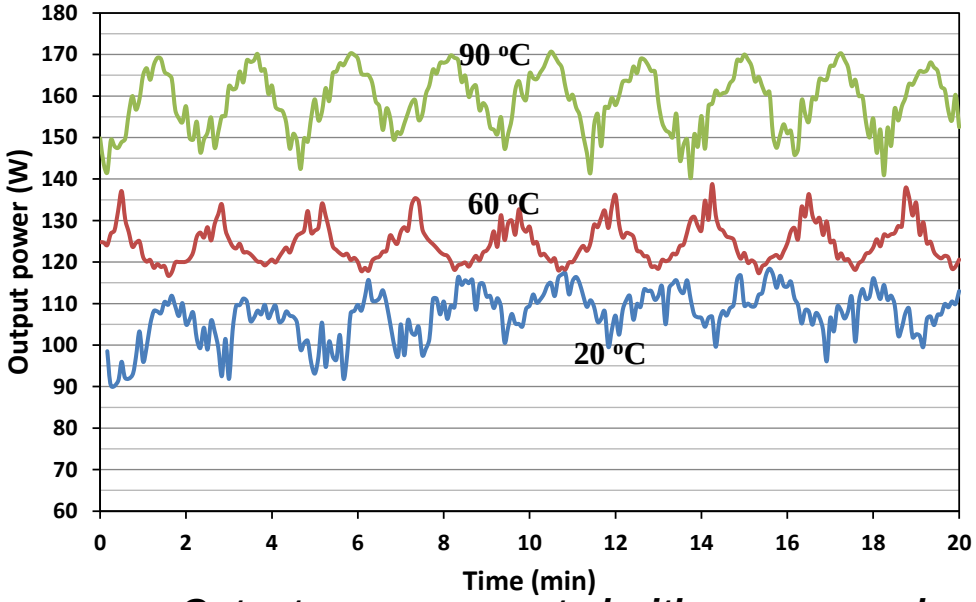
Scroll expander tested with compressed air

- The compressed air pressure remained around 3.0~4.0 bar;
- Three different compressed air temperature were 20 °C, 60 °C, and 90 °C, respectively.
- The flow rate was around 136.31 L/min when the air was heated at 90 °C

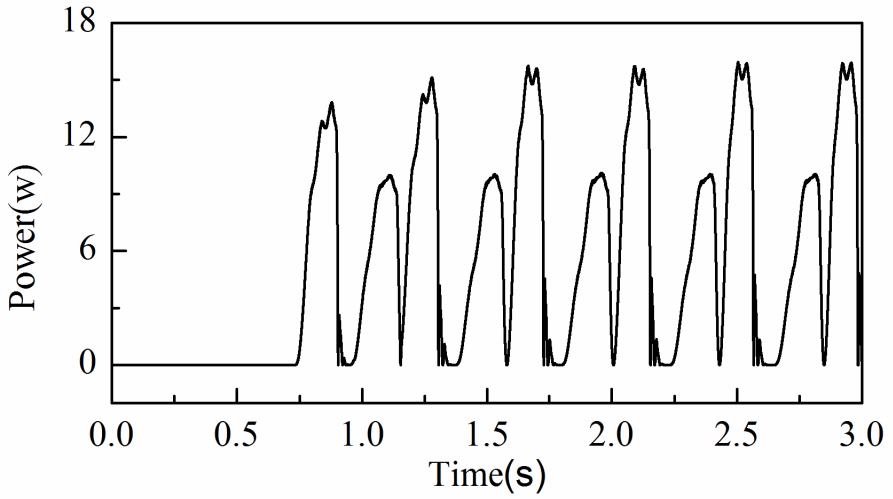


Output power generated with compressed air at different inlet temperature.

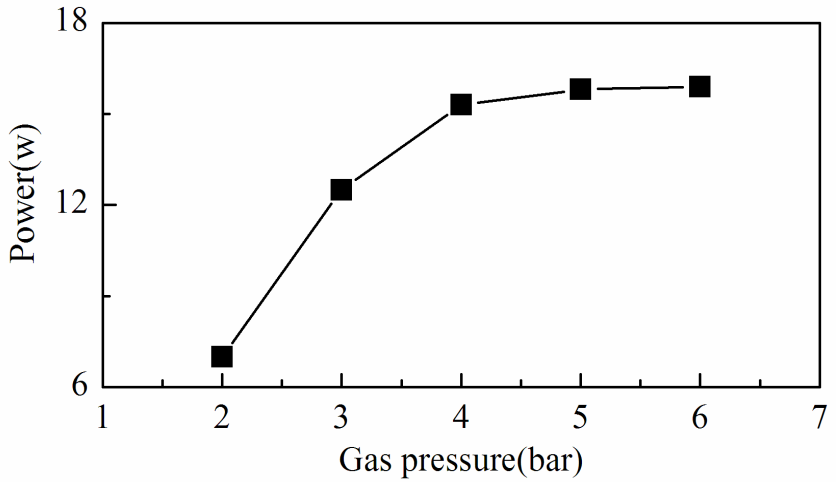
Table 1. Average value of the output

Temperature of compressed air (°C)	Average Power (W)	Average Current (A)	Average Voltage (V)	Increase rate of power with temperature	Increase rate of voltage with temperature	Increase rate of current with temperature
20	107.0	1.11	98.0			
60	124.52	1.20	112.65	16.37%	8.1%	14.95%
90	158.83	1.28	126.55	27.55%	6.7%	12.34%

Linear expander results



Power output at 6 bar intake pressure



Peak power at different intake pressure

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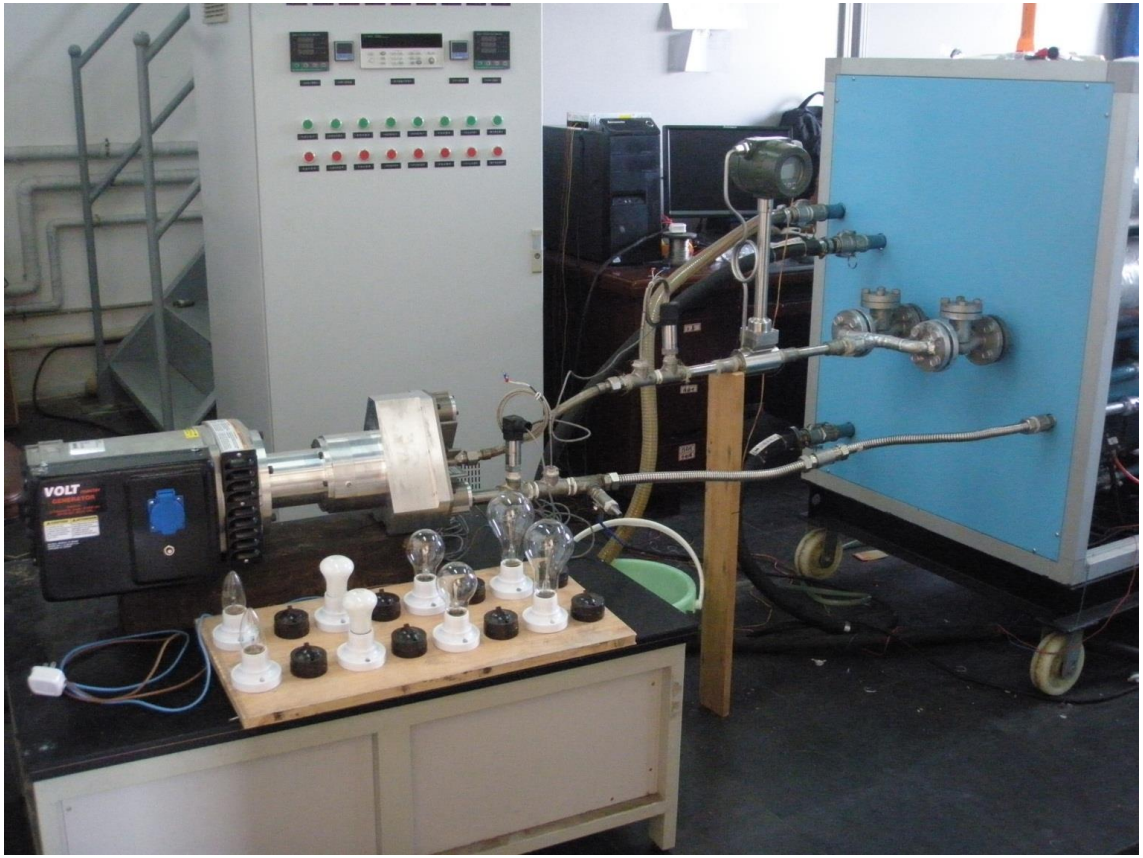
Integration with expander



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4. Outcomes

- A joint-paper draft has been produced:

  Experimental study of the performance of a free piston engine (linear expander) driven by high pressure air

- A report of experimental results from the tests of the adsorption unit

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5. Conclusions

- Cooling effect is achieved
- Expansion with air driven for power generation using expander show that it is working
- Further tests on the LH Cogen unit required

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6. Future work - project roadmap report and 5 year engagement plan

- Project roadmap:
  - Further study by simulation and experiment will be carried on
  - Economic and/or Life cycle analysis of LH Cogen system production, transportation and use
  - Control and optimisation of LH Cogen system
  - Application to different low grade heat sources and different applications

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5 year engagement plan:

- Further study by simulation and experiment will be carried on – work with Shanghai Jiaotong, Beijing Institute of Technology
- Economic and/or Life cycle analysis of LH Cogen system production, transportation and use: work with Shanghai Jiaotong
- Control and optimisation of LH Cogen system: work with Shanghai Jiaotong and BIT
- Application to different low grade heat sources and different applications: Shanghai Jiaotong

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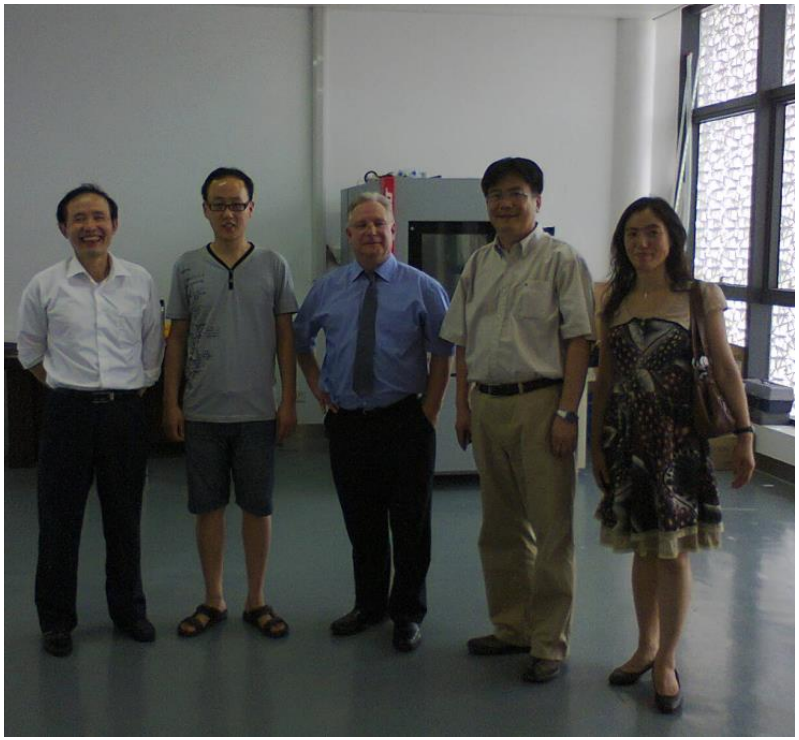

Thank You !

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