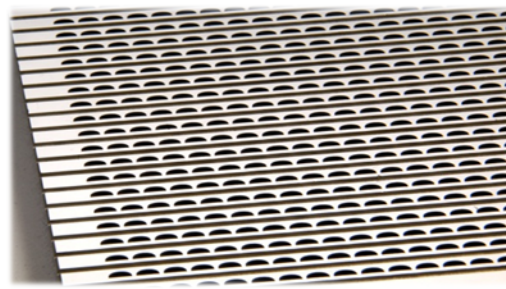
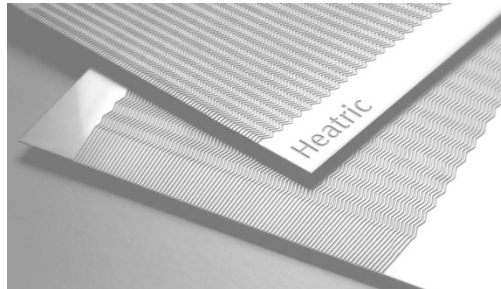


Keynote Speaker – El Mirador Room

Tuesday, March 29<sup>th</sup>

# Nick Johnston Heatric



## Agenda

- » Introduction to Heatric and Meggitt plc
- » SCO<sub>2</sub> – A new Technology
- » Obstacles
- » Commercialisation opportunities
- » Q & A

## Meggitt overview

- » Meggitt PLC is an international engineering group
  - Aerospace, defence and energy



- » Extreme environment experts
  - High technology products and systems on

63,000 aircraft



- » Annual sales of \$2.24 Billion in 2014



■ Aerospace | 48%  
 ■ Defence | 34%  
 ■ Energy | 11%  
 ■ Other | 7%



■ OE | 41%  
 ■ Aftermarket | 59%

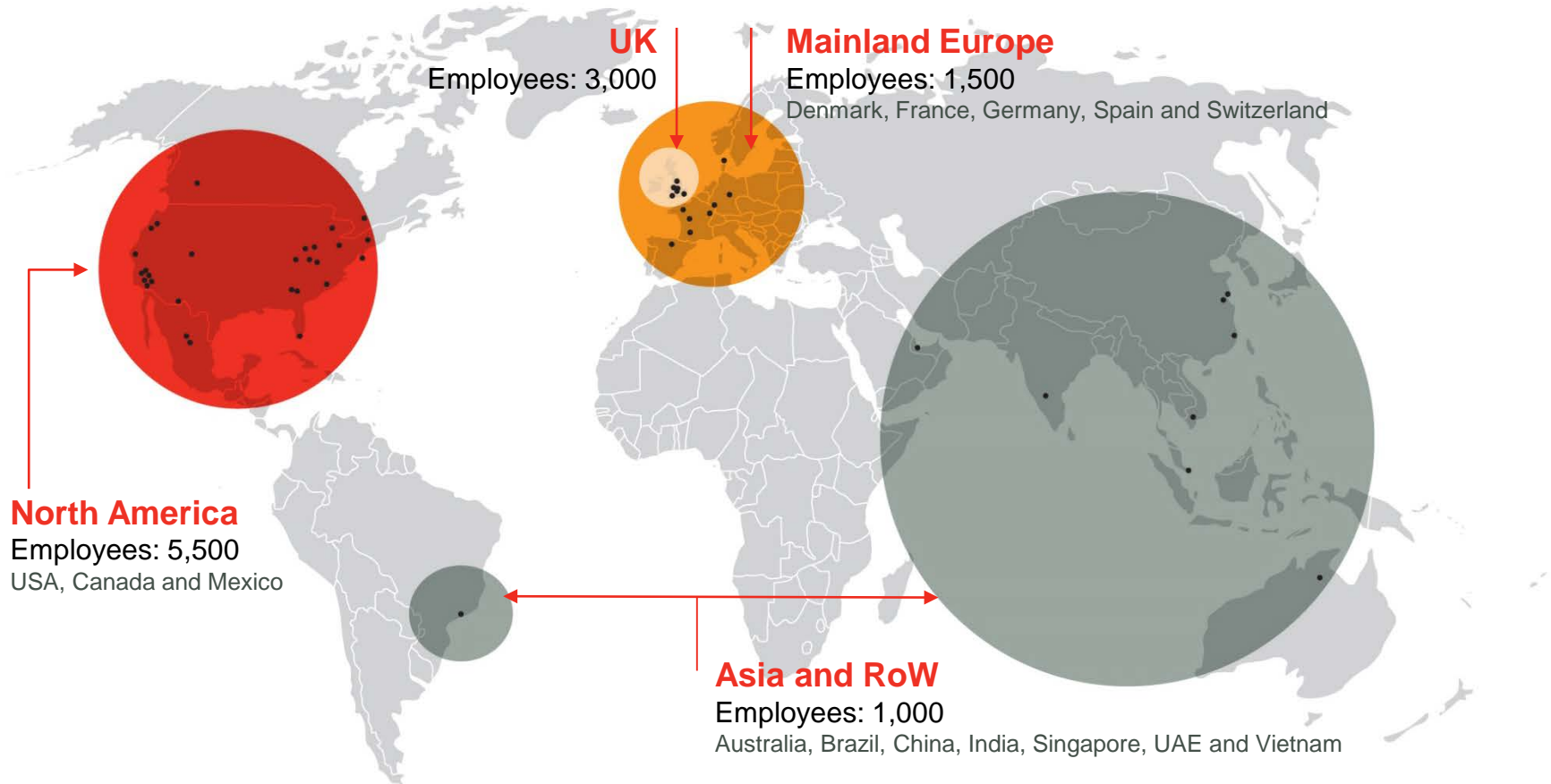
- » Global footprint

c. 11,

employees across Europe, the Americas and Asia

## Global presence

c. **11,000**  
employees worldwide



## Technology

### Core capabilities

Fluid mechanics	Heat transfer	Sensing and monitoring
Materials science	Power	Control

### Key technologies

Printed circuit heat exchangers	High performance carbon fibre	Enhanced seals
Additive layer manufacturing	High temperature systems	Green fire suppression
Modulating valves	Complex composites	Fuel systems
Condition-based monitoring	Common software	Manufacturing technology

## Technology

### Research and development



2014 R&D expenditures up 10% to \$200M

x3

New product introduction running 3X historical average

>1,800

Over 1,800 new part numbers  
being industrialised



15 new platforms to enter service over next five years  
(historical average – 1.5 platforms per year)

# Meggitt business model

## Capturing medium-term growth

- » Smart Engineering for Extreme Environments
  - Invest in industries with long life assets/high certification requirements
  - Where equipment works in harsh environments
  - Aerospace, defence and energy focus
- » Secure enduring/profitable income streams
  - Create proprietary product and manufacturing technology
  - Establish positions on new platforms
  - Win 'life of programme' OE contracts, building a broad installed base
  - Participation in multi-decade spares and repairs cycle
- » Underpinned by ongoing transformation programme:
  - Customer satisfaction
  - Operational excellence
  - Performance culture
  - Advanced Research & Technology

## Heatric Global Operations



○ Sales offices: Rio de Janeiro | Houston | Poole | Singapore

● Sales agents Asia: India | Indonesia | Japan | Korea | Malaysia  
Oman | Qatar | Singapore | Thailand

● Sales agents Europe: Norway | Russia



### Poole, UK - Head Office

- Administration
- Engineering
- Project management
- Bonding
- Assembly
- Testing



### Birmingham, UK

- PCHE Plate etching
- PCHE plate manufacture



## Heatric Headquarters - Poole, UK



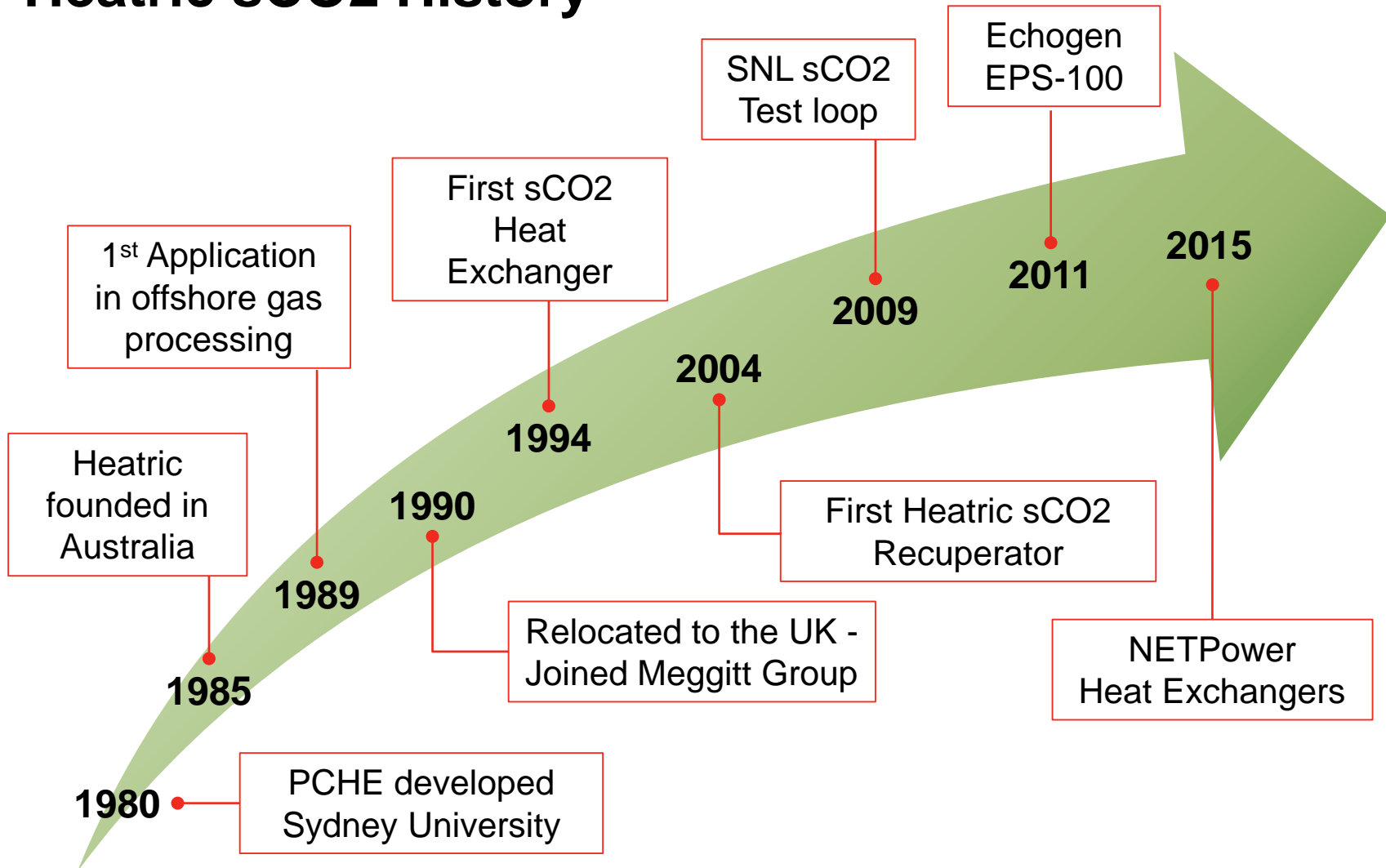
## PCHE Construction and Features

What is a PCHE?

- » Printed Circuit Heat Exchanger (PCHE)
- » Compact plate type heat exchangers
- » Diffusion-bonded – robust construction process
- » Well-established Technology



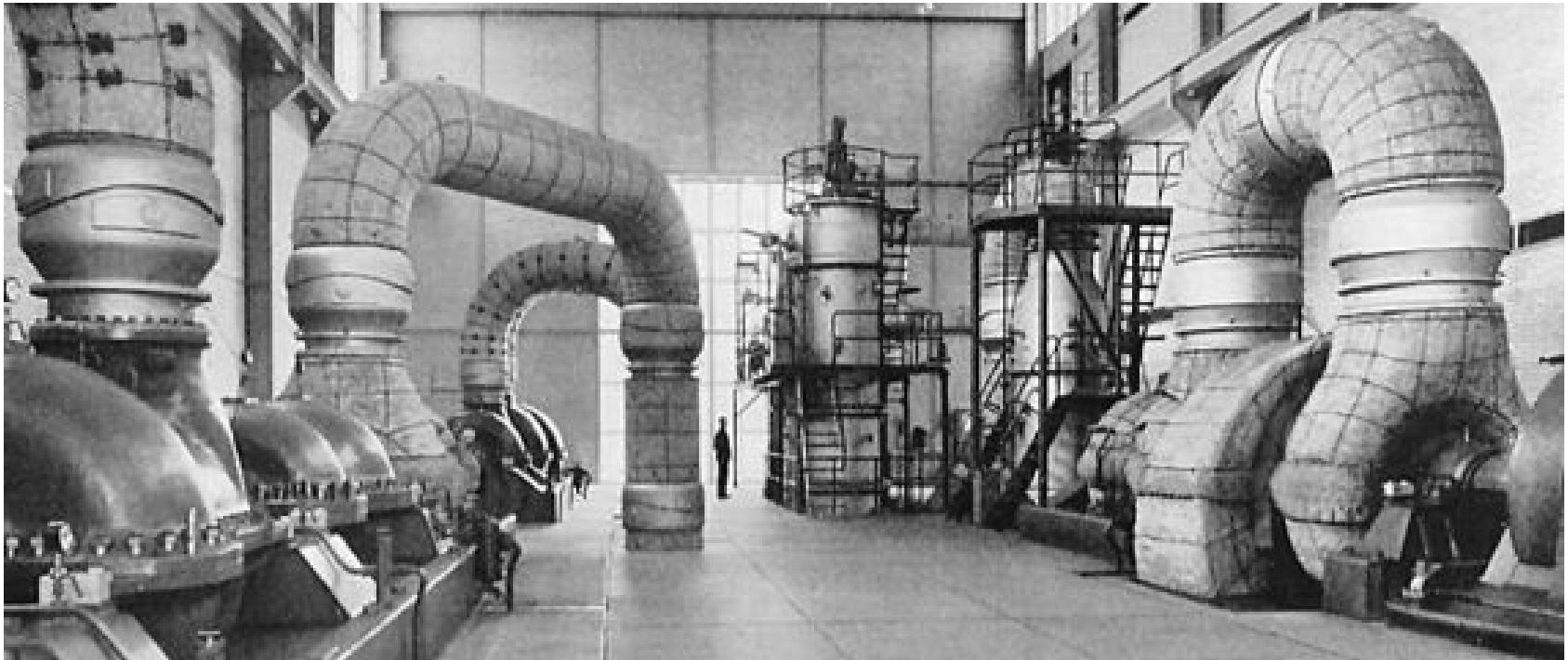
## Heatric sCO<sub>2</sub> History



The 5<sup>th</sup> International Symposium – Supercritical CO<sub>2</sub> Power Cycles

# Supercritical CO2 power cycles are new....

## Sulzer Brothers - 1948



# E. G. Feher - 1968

AD843063

AFAPL-TR-68-100

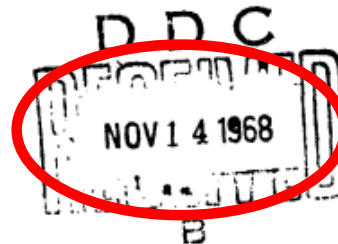
## INVESTIGATION OF SUPERCRITICAL (FEHER) CYCLE

E. G. Feher et al.

Astropower Laboratory, Missile & Space Systems Division  
A Division of McDonnell Douglas Corporation

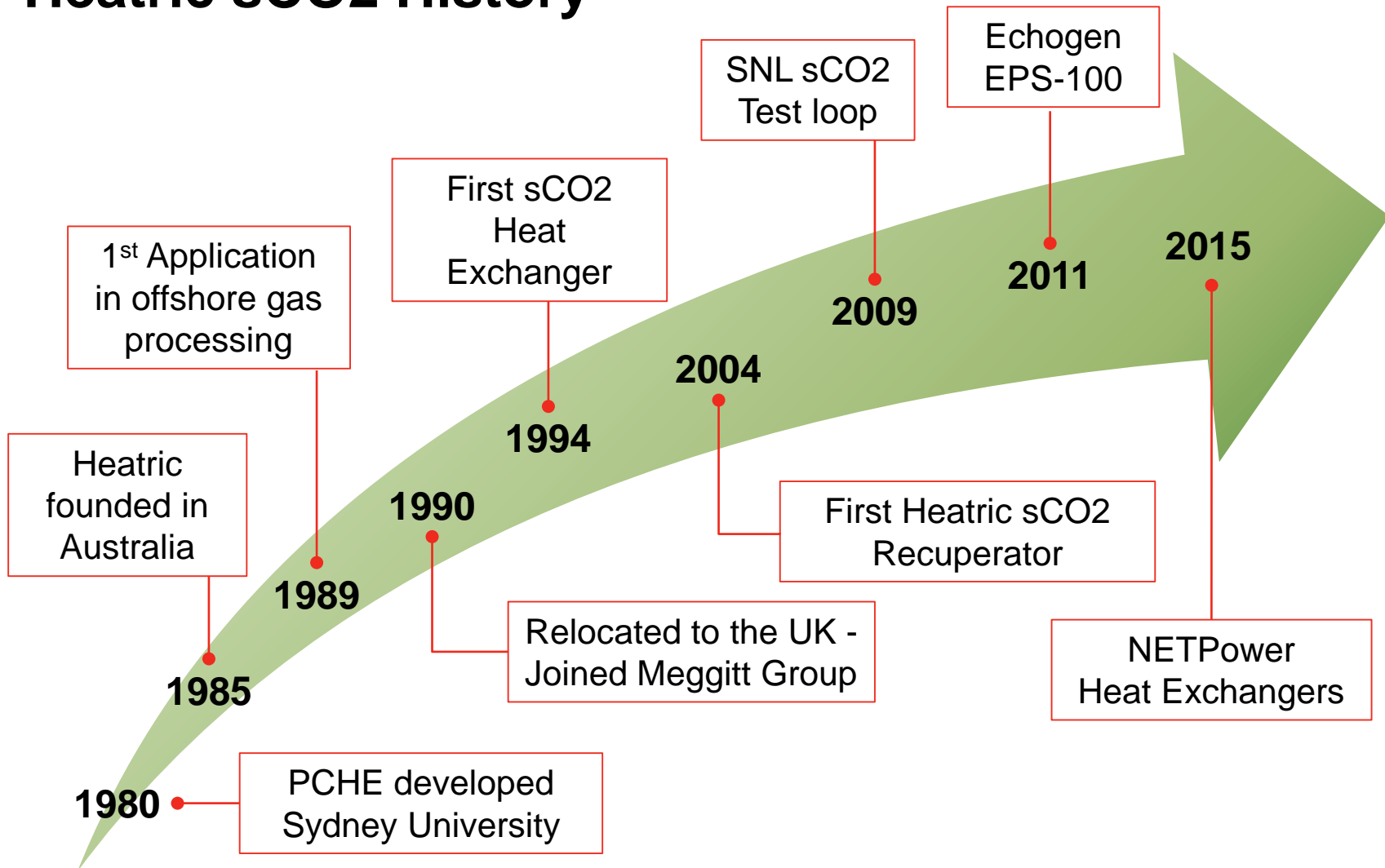
TECHNICAL REPORT AFAPL-TR-68-100

October 1968



Heat exchangers are super-critical to the performance of the SCO<sub>2</sub> cycles being designed, developed, tested and deployed

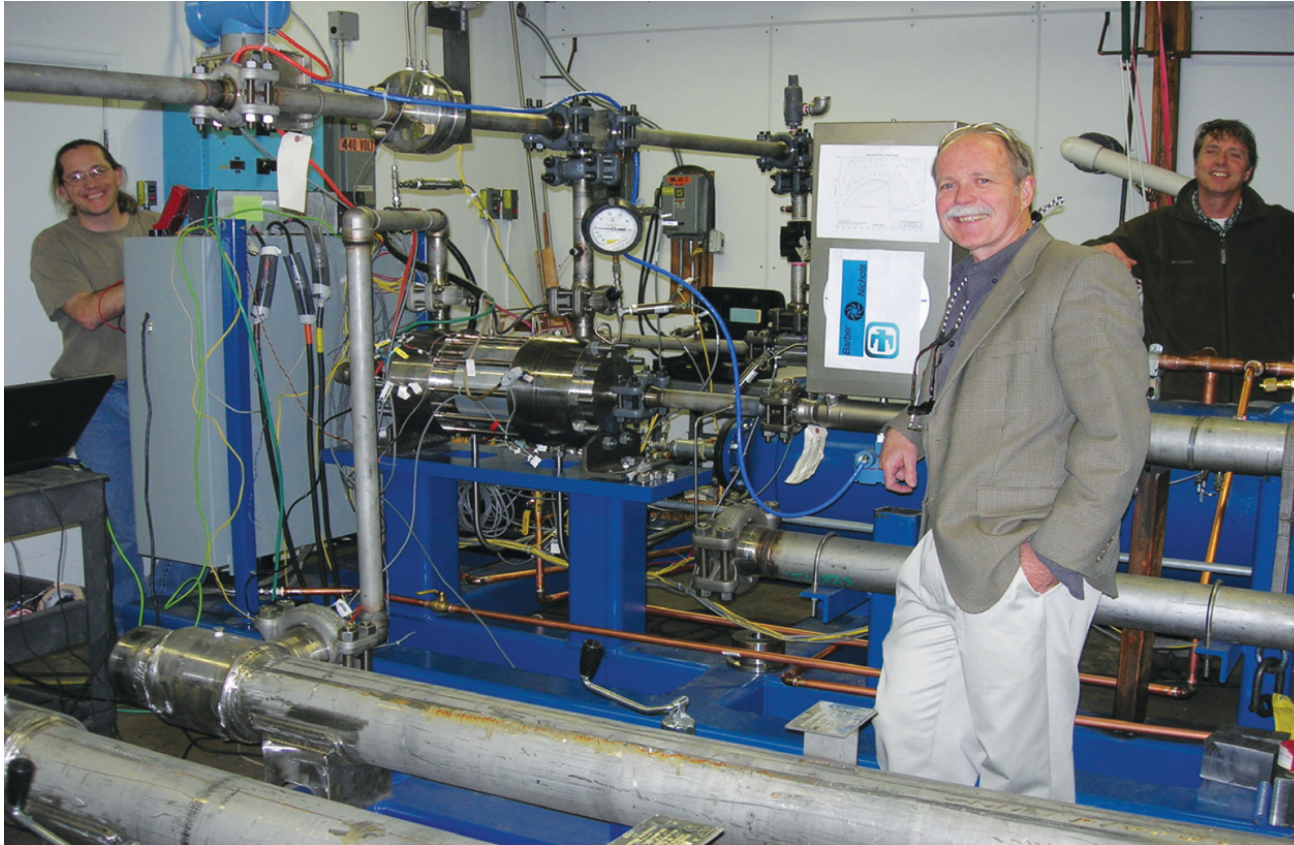
## Heatric sCO<sub>2</sub> History



The 5<sup>th</sup> International Symposium – Supercritical CO<sub>2</sub> Power Cycles



## Standing on the shoulders of giants....



The 5<sup>th</sup> International Symposium – Supercritical CO<sub>2</sub> Power Cycles

What are we here for:

To change the world for the better, reduce emissions to save the planet

## What are some of the obstacles ?

## Regulation will drive the market....



The 5<sup>th</sup> International Symposium – Supercritical CO<sub>2</sub> Power Cycles

Improved cycle efficiency will save money – and everyone knows energy is expensive....

Or rather no it isn't...

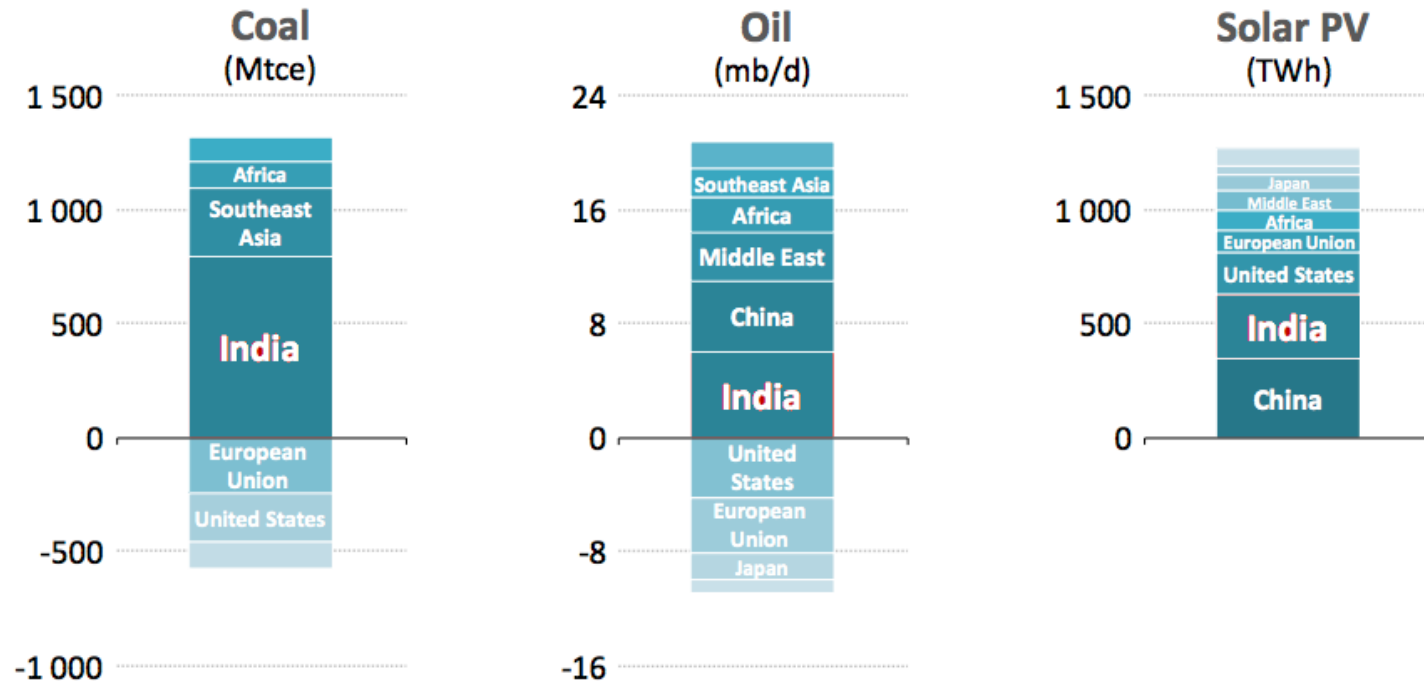
## World LNG Estimated February 2016 Landed Prices



Thinking differently about who might be our customers....

## IEA Energy Market Fuel trends

### Change in demand for selected fuels, 2014-2040





Improved cycle efficiency makes the product more attractive....

No, it makes it more complex, risky and expensive.....

## So Many New Technical challenges

- » Driving the cycle harder and harder
- » Increasing exchanger performance and effectiveness while making them cheaper
- » Finding commercially viable alloys for higher and higher temperatures
- » Utopium and its sister Unobtanium

## What do the customers think ?

- » Introduction of new technologies is an obstacle not an opportunity
- » 10MWe STEP demonstration in 72 months time doesn't prove enough...
- » We don't like change
- » Regulatory uncertainty makes us nervous
- » We need to see it working for "a long period" before we'd roll it out

# Commercialisation opportunities

## So Many Applications

- » Fossil power plant- gas, coal, biomass &c
- » CO2 capture
- » Waste heat recovery from current plant
- » Nuclear power cycles
- » Solar power plant
- » Lots more, and

## Regulation will drive the market....



The 5<sup>th</sup> International Symposium – Supercritical CO<sub>2</sub> Power Cycles

So let us be sure to work with government to frame the right environment

What we need is greater collaboration and international effort



## Some New Challenges

- » Finding out how technology links to cycle optimisation
- » Choosing a cycle efficiency that allows near term deployment
- » Working with customers to find early adopters
- » Adjusting perceptions of risk
- » Focussing on reducing CO<sub>2</sub> emissions- there is a very big risk out there

What we need is greater collaboration and international effort

more focussed research and development

# Questions