GAS TECHNOLOGY INSTITUTE

Industry Panel Discussion

Vann Bush
Managing Director, Energy Supply and Conversion
Gas Technology Institute

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Company History

1940 1950 1960 1970 1980 1990 2000 2010

1941

Institute for Gas Technology (IGT) formed at the Illinois Institute of Technology (IIT)

1947 IGT Laboratory
Chicago, Illinois

Dr. James L. Johnson
Pioneer in Coal Gasification

1970 Blue Flame natural gas powered rocket car sets world land speed record of 630 mph

1970 HYGAS® Pilot Plant
Chicago, Illinois

1973

Oil Crisis

Dr. Henry Linden
GRI President

1976

Federal Power Commission approved surcharge on pipeline transmission for research funding and Gas Research Institute (GRI) formed

1991

GRI sponsors Mitchell Energy's first horizontal well in the Barnett shale

George Mitchell

1992

FERC Order No. 636, Restructuring Rule mandated unbundling to separate sales from transportation services

1995 U-GAS® Plant
Shanghai, China

2000

GRI and IGT combined to form the Gas Technology Institute (GTI)

2009 GTI Advanced Gasification Facility
Des Plaines, Illinois

2015

GTI acquires Aerojet Rocketdyne's fossil energy business

Bringing Innovative Energy Solutions to Market

GRI

IH²® technology to produce liquid transportation fuels from renewables

ANDRITZ

RENUGAS® biomass gasification technology

OI

Submerged combustion melting (SCM) technology

SES SYNTHESIS ENERGY SYSTEMS

U-GAS® coal gasification process

Uhde ThyssenKrupp

Morphysorb® process for acid gas removal

ALZETA CORPORATION

Low-NO_x CSB burners

LocusView

Advanced geospatial technology and services

THE LINDE GROUP

Small-scale liquefaction technology

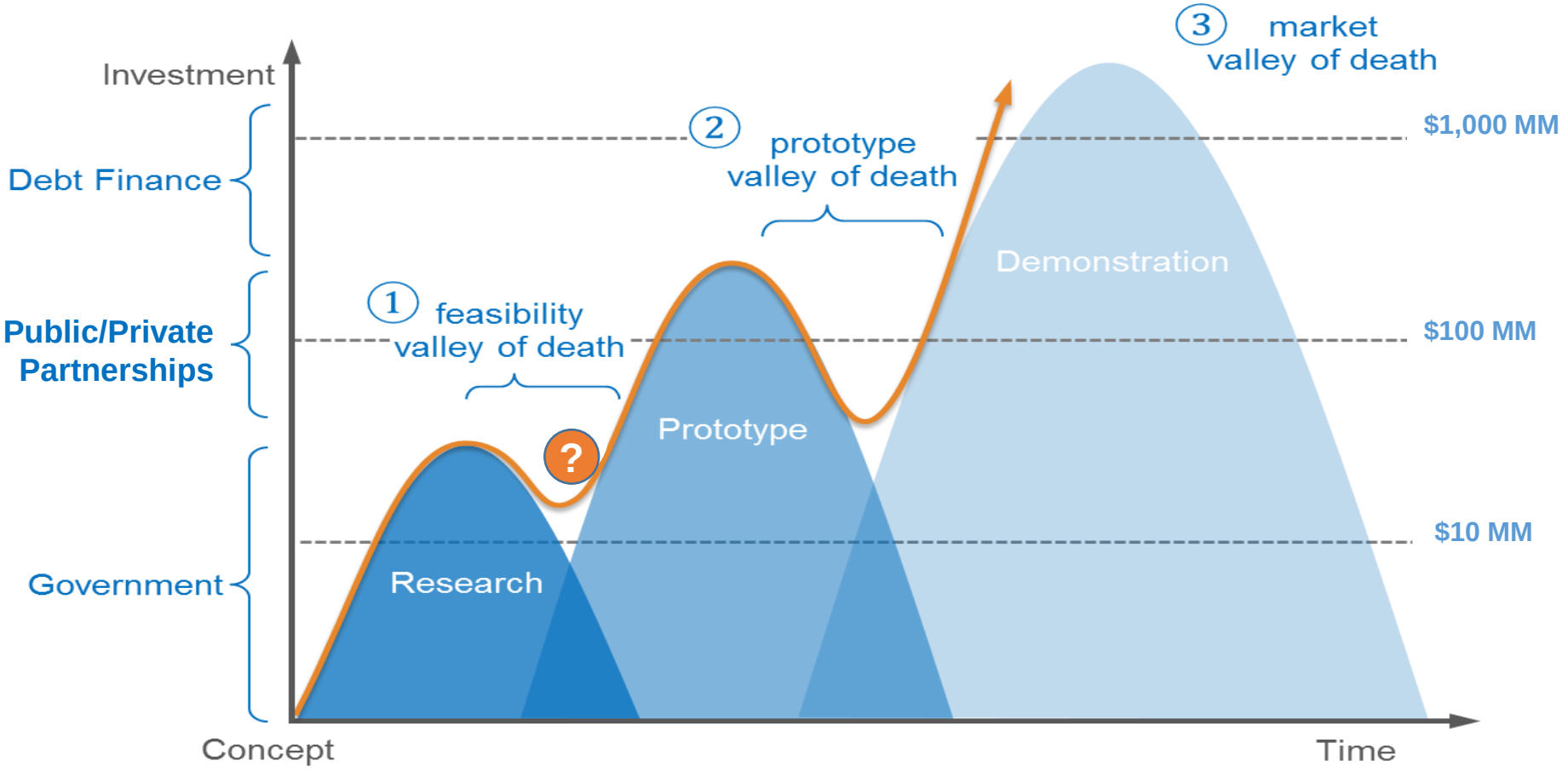
elster Thermal Solutions

ECLIPSE Innovative Thermal Solutions

PrimeFire 400 High Luminosity Burner

"…provide a rational view about what is required for sCO2 power cycles to flourish. …where we are and what to do next."

Where Are We?



Partnerships are essential.

Public/Private Partnership Test Facilities
(Scientists, Engineers, Operators, Technicians)

Energy Development Center

Gasification technology development campus (1951-1996)

Large pilot systems for conversion of coal and biomass to chemicals, syngas, methane, and hydrogen. Operations up to 18 MW_{th} scale and 70 bara pressure.

Advanced Gasification Test Facility

Fully integrated and instrumented test bed for gasification, gas processing, and syngas synthesis technologies. (2004-current)

Coal, biomass, and natural gas gasifiers at 5 MW_{th} scale operating up to 25 bara (syngas up to 70 bara).

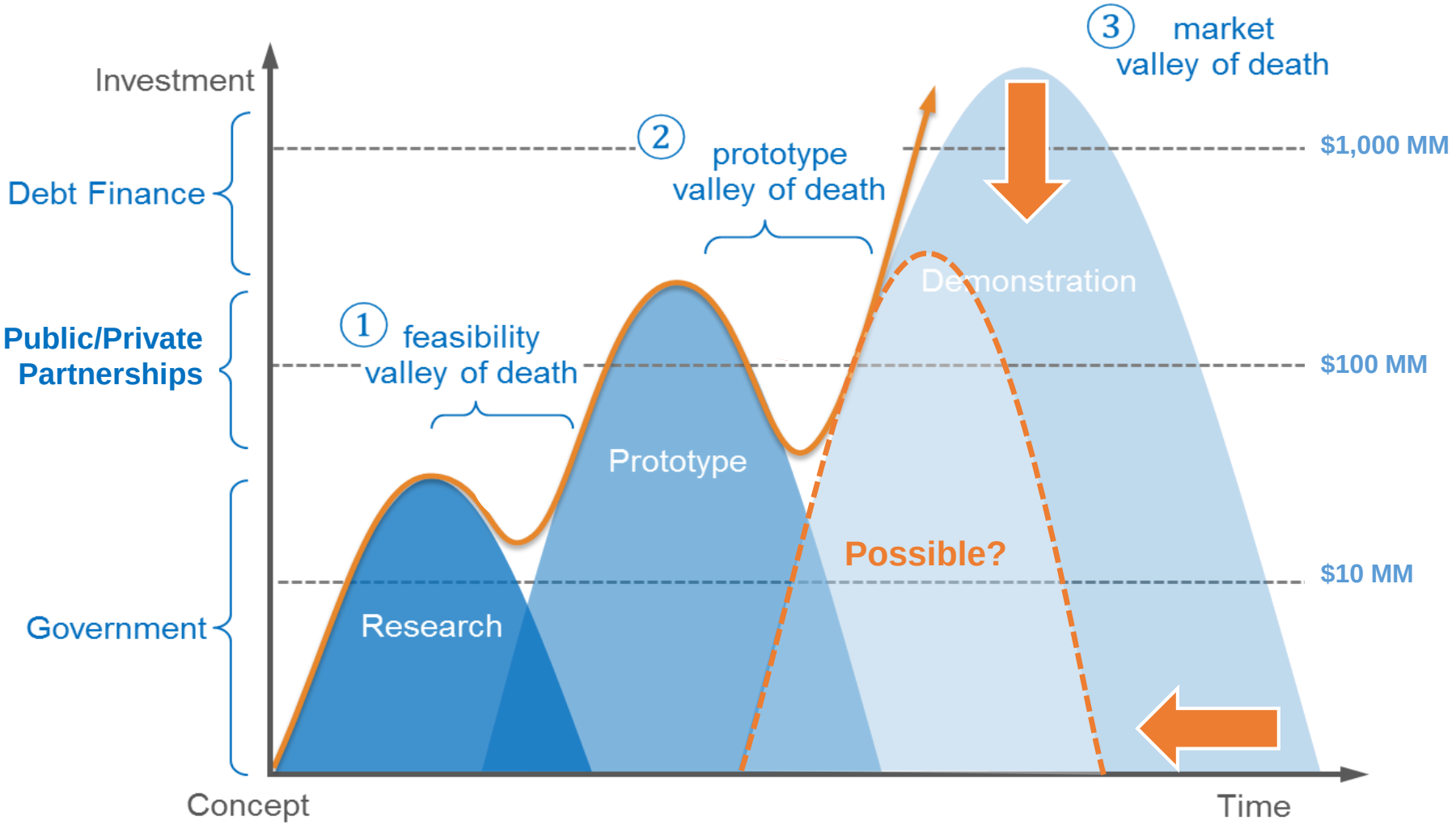
Energy Technology Engineering Center

Home of Liquid Metals Engineering Center (1959-2006)

Development and testing at 35 MW_{th} scale of liquid metal reactor components: steam generators, heat exchangers, pumps, valves, flow meters, piping materials, welds, and instrumentation.

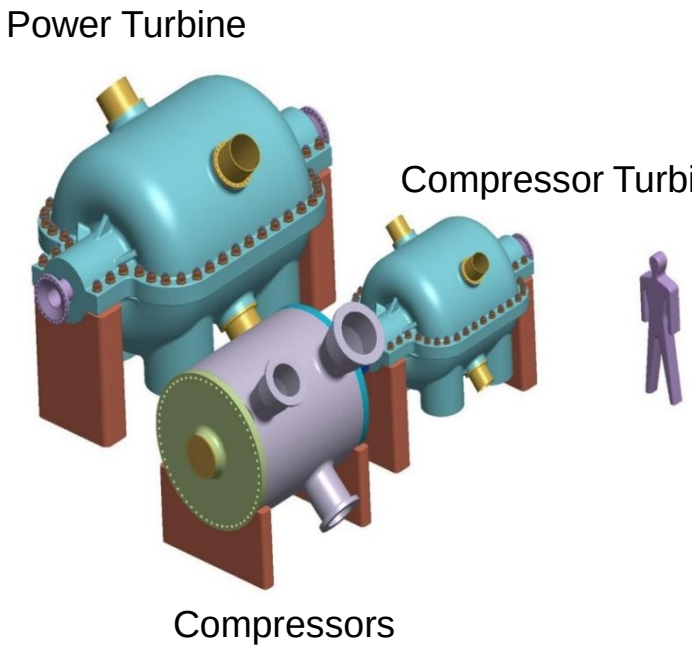
Lowering the Final Peak

Changing the Scale Paradigm Through Technical Innovation

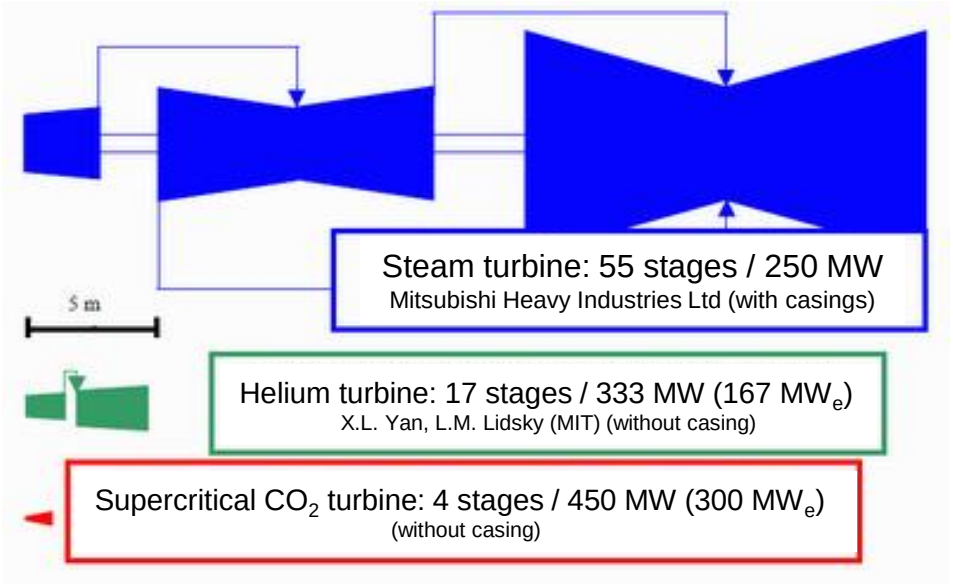


Attack CAPEX and OPEX through compact, smaller-scale, process-intensified solutions.

sCO_2 Turbomachines Are Process-Intensified



sCO_2 Turbine for a 550 MWe Plant



Comparisons with Other Turbines

- Very small systems – high efficiency heat transfer at moderate temperatures
- Allows 2-5x increase in power output for same footprint
- Lowest increase in electricity cost for carbon capture
- Efficiency may allow small-scale (lower-capital-risk) generation

"…provide a rational view about **what is required for sCO2 power cycles to flourish**. …where we are and what to do next."

Good technology, of course. But also,

- Public/private partnerships – international when possible
- Test platforms for components and integrated processes
- Technical and operational expertise working together
- On-going process improvement

VANN BUSH
Managing Director, Energy Supply and Conversion
Gas Technology Institute
Des Plaines, IL

vann.bush@gastechnology.org
O - (847) 768-0973
M - (205) 862-0688