
Technology Development and Demonstration for System Transformation

Prof Andrew Garnett
Session 3: Bridging ...

Lessons from an almost “whole system demonstrator”
A case history for discussion...

OECD, Innovation and Technology Policy
Creative Economy & Innovation Center,
Seoul, Korea
7-8 July 2016

Case History

National Electricity Market

- Power stations:
- Coal
 - Gas
 - Hydro
 - Diesel/fuel oil/multi-fuel
 - Wind
 - Biomass/bagasse
- Transmission network
- Power station size:
- > 1000 MW
 - ▲ 500–1000 MW
 - < 500 MW



Source: www.energyone.com.au



ZEROGEN IGCC WITH CCS A CASE HISTORY

A J Garnett • C R Greig • M Oettinger



www.uq.edu.au/energy/docs/ZeroGen.pdf



Create change

Background & Context

- ▶ ZeroGen Pty Ltd was fully owned by the Queensland State Government and sponsored by Federal Government & the Australian Coal Association (ACALET) and supported by MHI. It was established to ...
 - ▶ *“Facilitate the **development and accelerated commercial deployment of low emissions coal technology** to preserve Queensland’s competitive position in power generation and to **ensure the continued mining use and exploration of Australian black coal**”.*
- ▶ Configuration
 - ▶ IGCC with CCS
 - ▶ 530 MW (gross) 391 MW (net)
 - ▶ Capture & Storage
 - ▶ 65% ~ 2 mln tpa
 - ▶ 90% ~ 3 mln tpa

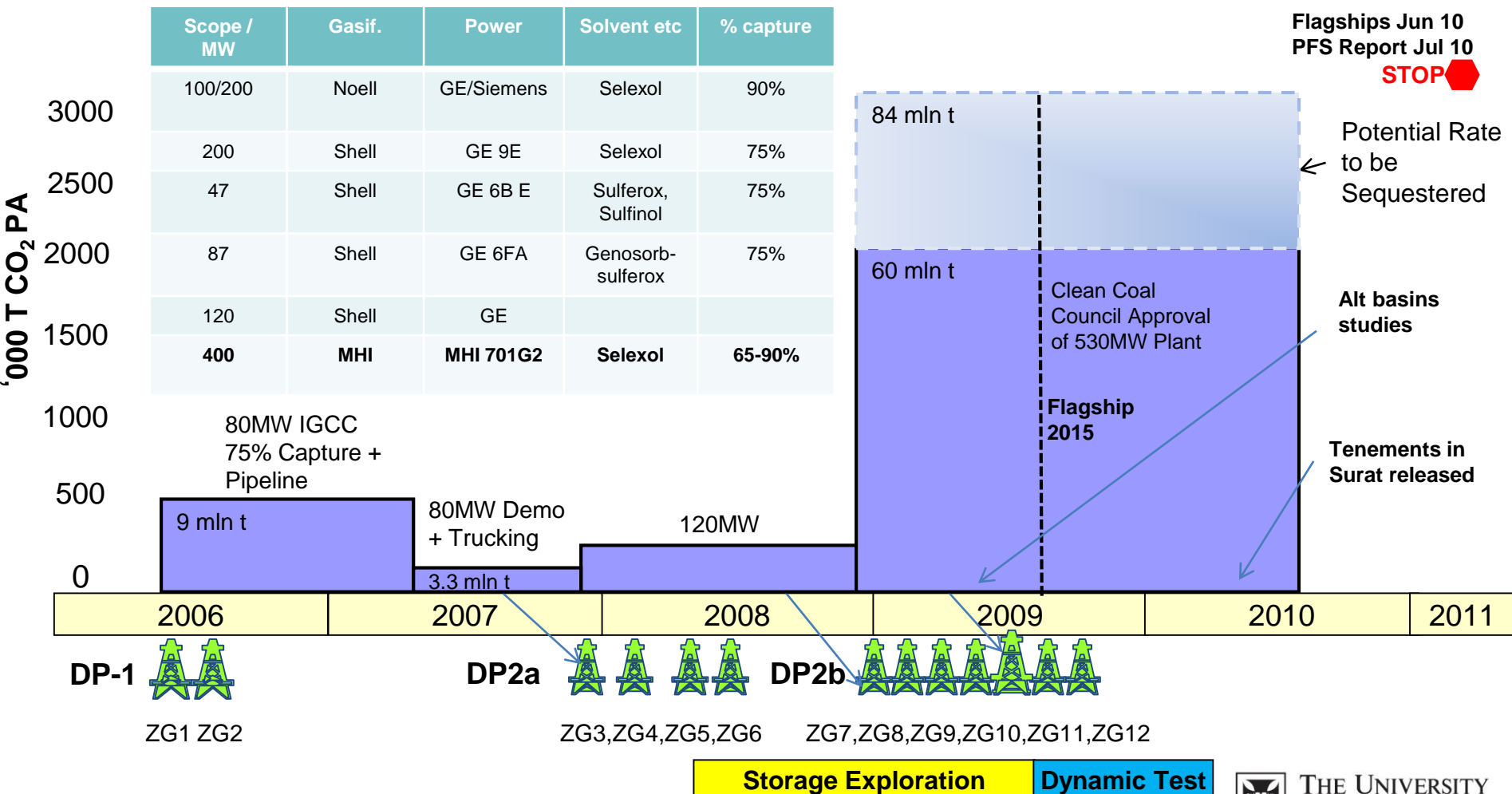


250MW plant at Nakoso constructed by MHI

Location (coal, water, power, storage...)



Clear Goals or Evolving Scope ?



Some innovations that sort of worked

Public Private Partnership (to *extended* Prefeasibility stage)

- Federal + State government + Australian Coal Industry + MHI
 - Australian Coal Industry – Coal 21 Fund .. Voluntary levy on coal production to pay for ‘low emissions technology’
- Public-private funding of site studies and engineering pre-feasibility engineering (alliance with MHI as OEM)
- Public & coal industry funded storage exploration (tech. service agreement with major oil co.)

Full Scope

- Technical, commercial, environmental, regulatory, social..
 - Physical system integration
 - Market system integration
 - Regulatory development mid-project (State, GHG Storage Act)
 - Community engagement from the start (but issues on closure)

Special Purpose Vehicle

- company with one shareholder (State government), industry-experienced management and independent board

Clear a-priori-decision tests for progression to next stage

- Adaptation from common oil industry practice
- Linked to “mission” to accelerate commercial deployment

Project Closure Decision

In November 2010, ZeroGen management advised closure of the ZeroGen commercial scale IGCC with CCS demonstration project due to:

very high capital and operating costs which could not be supported by anticipated revenue streams;

technical risks around the CO₂ capture technology and project integration; and

lack of credible project funding opportunities to achieve financial close.

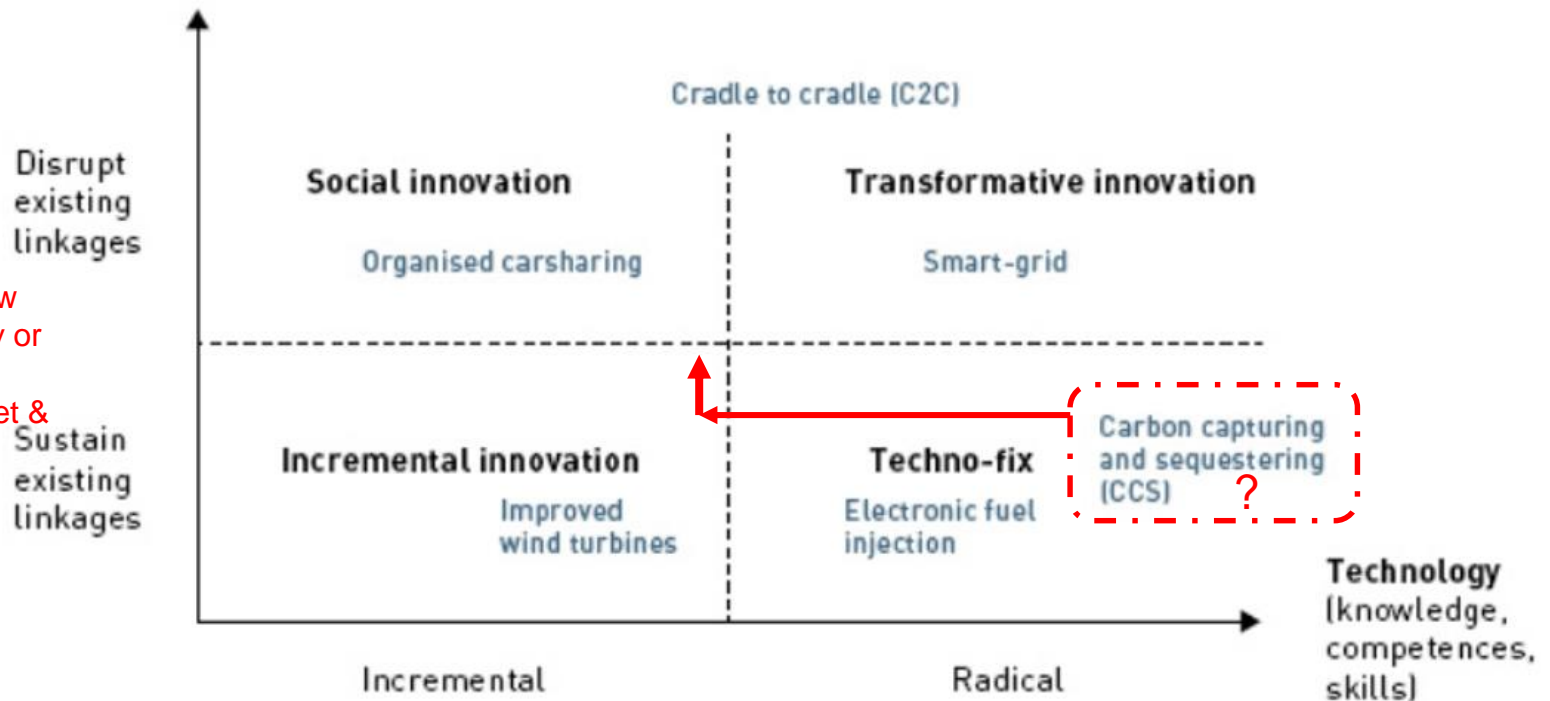
inability of the Northern Denison Trough storage resource to accommodate the sustained injection rates or volumes of CO₂ required by the project;

uncertainty as to the timely award of sufficient tenure and funding necessary to successfully appraise an alternative CO₂ storage resource

CCS Innovation – Markets & Technology

Classification of innovation based on technology and market/user practices (Kemp, 2009)

markets, institutions

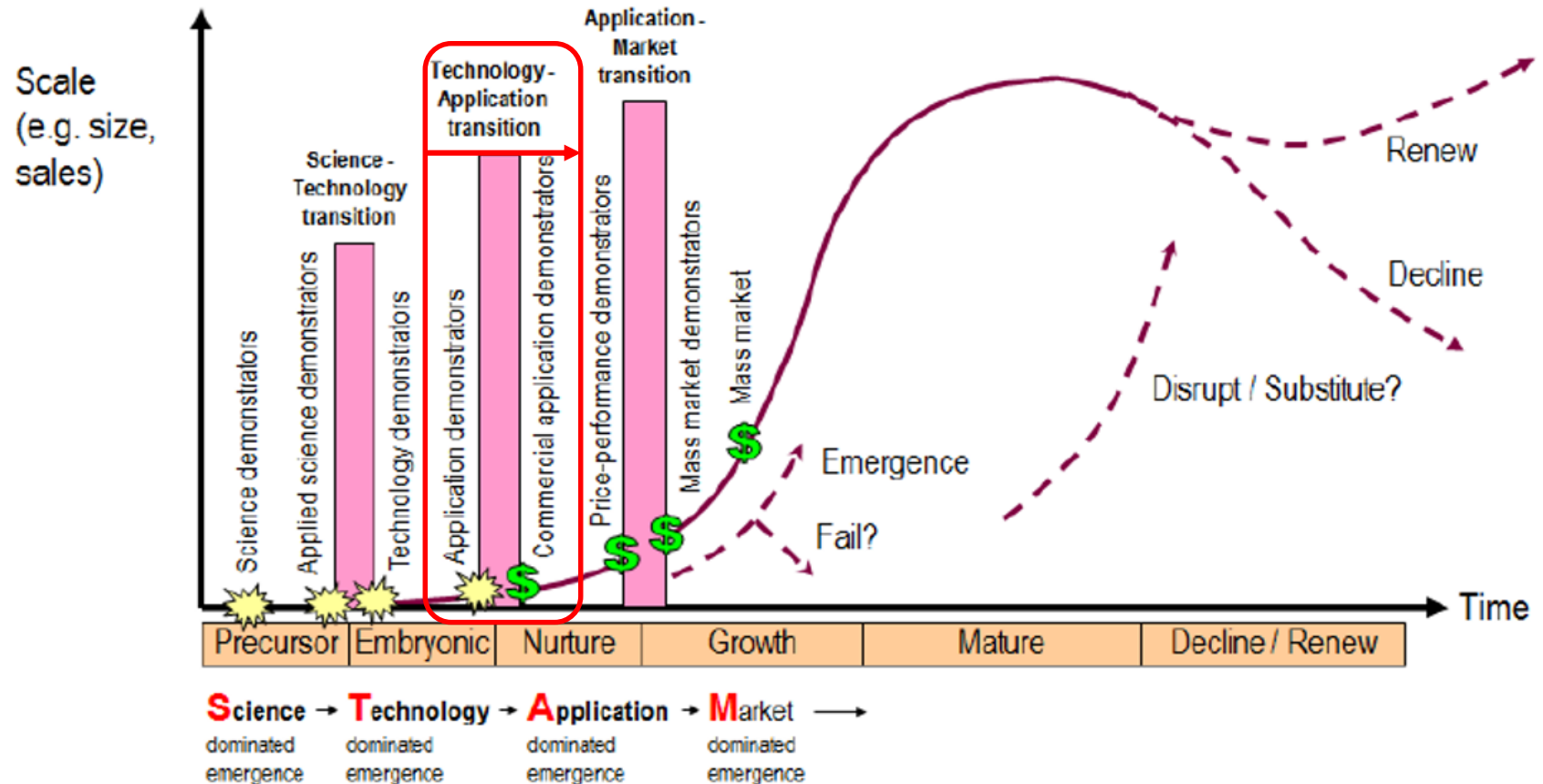


New (demo) CCS needs entirely new linkages to supply or compete in an established market & grid

CCS Technology
Radical ? Really ?

This Case on the Spectrum ...

Missing: re. GHG storage where is *natural resource* discovery & appraisal?



Source: Phaal, R. Cambridge Centre for Technology Management, presented at the OECD/TIP meeting in London 1 April 2015.

Framing key challenges

Ostensibly simple...

Build an industrial scale (500MW), Integrated Coal Gasification Combined Cycle (IGCC) integrated Carbon Capture and Storage within the East Australian power grid?

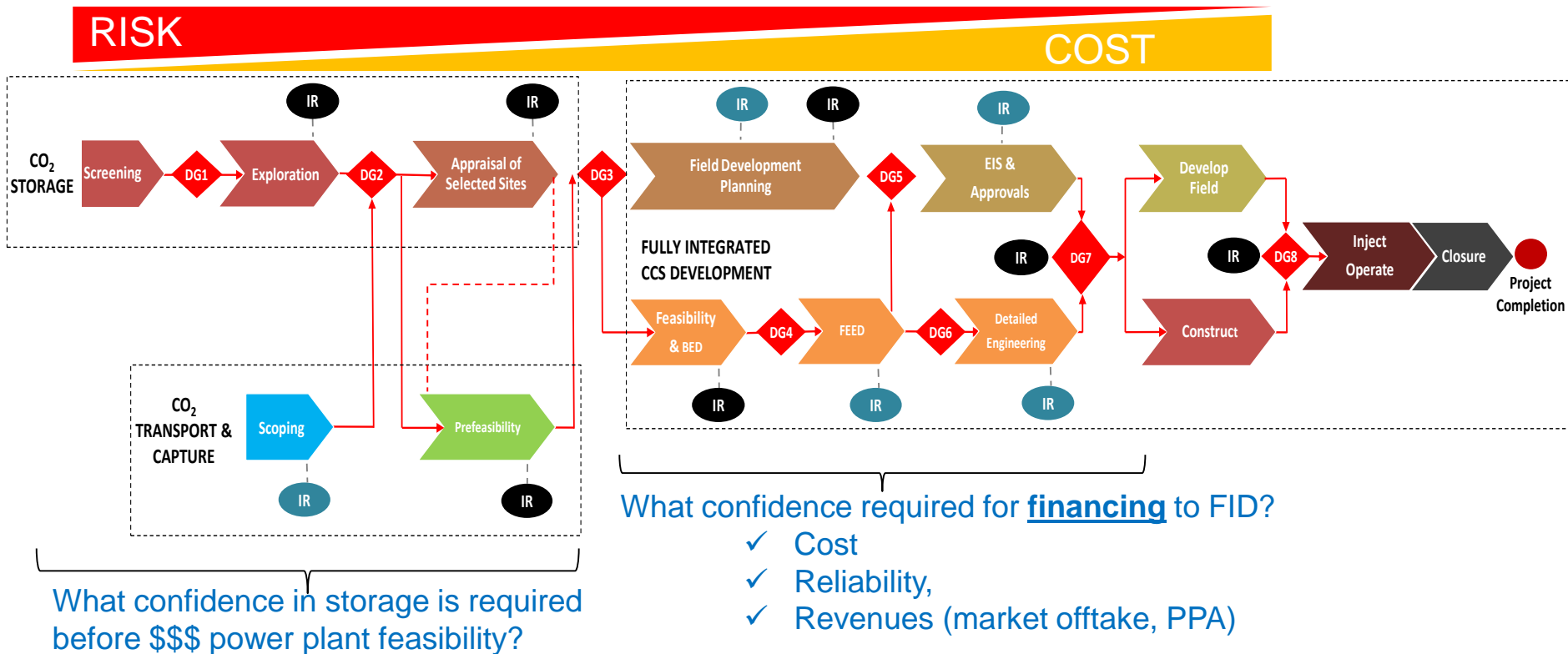
Which became two key questions of investment confidence

A. In what sequence should you invest to support the development of IGCC with CCS Project ... or how much confidence do you need in the storage solution to justify significant engineering spend on the power plant ?

and

B. How do you finance a new expensive, initially 'low reliability', must-send power supplier into a highly competitive national electricity market which has a declining demand?

Investment Sequence



Note: the CO₂ Transport and Capture Prefeasibility stage might also be best delayed until after the Storage Appraisal of Selected Sites, depending on the residual post-Exploration risk and the estimated cost of the Prefeasibility Study.

Scale Dependent Interactions

Many key lessons arise *only* through *attempted* demonstration at industrial scale *and* trying to find an integrated into existing market & physical systems.

Once *critical* risks have been addressed ... consider *precisely* how (locally, commercially & technically) will this “demo” fit with the location (incl. community) and existing supply market & mix?

ZG summary

1. **Markets & Economics:** Industrial-scale in Australia simply not economic or supportable
2. **Scale:** Industrial-scale is not a simple scale-up from demo. scale (real system integration)
3. **Risk Mgmnt:** Careful pace of ‘first’ projects is critical to wider deployment.
4. **Risks Mgmnt :** Pre-FEED and feasibility risks and costs are heavily weighted to the search for storage.
5. **Risks Mgmnt :** Storage is a natural resource, a portfolio exploration and appraisal approach is needed.
6. **Clear Storage Goals:** When defining storage resources requirements it is essential to discuss the consequences and trade-offs between injection rate and/or cumulative volume objectives.
7. **FEL costs:** Very high front-end engineering loading is needed for first-of-a-kind.

Thank you

Wrap up & discussions