



**Curtin University**

# The benefits of Industrial Symbiosis

## The Kwinana experience

Nov 2011

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## Sustainable Engineering Group (SEG), Curtin University




A/Prof. Michele Rosano



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## SEG

- ◆ Industrial Ecology Engineering research group
- ◆ Research and teaching
  - Established in 1999 at Curtin University
  - Teaching (u/graduate & graduate)
  - Applied research (multi-disciplinary and inter-disciplinary)
  - Consultancy services (Govt. and industry/SMEs)
- ◆ Research expertise-
  - ◆ Industrial symbiosis
  - ◆ Life Cycle assessment
  - ◆ Engineering process
  - ◆ Eco-efficiency
  - ◆ Sustainability metrics

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## Kwinana Industrial Area

- ◆ Established in 1950s
- ◆ 40 km south of Perth
- ◆ Adjacent to Cockburn Sound
  - Deep water port facilities
  - Sensitive marine environment
- ◆ Co-existence of processing industries:
  - Resource processing: e.g. alumina, nickel, steel, oil refineries
  - Utility: e.g. power, water treatment, co-generation plants
  - Manufacturing: e.g. cement, chemical, fertiliser plants

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## KIC


An incorporated association  
 Funded by members (~\$1m pa)  
 6 key priority areas

- Protection of the environment
- Stakeholder perceptions
- Sustainable development (KIA)
- Community health
- Public safety
- Education

**Mission:** To promote and contribute to the sustainable co-existence of Kwinana industry, the community and the environment.

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## SEG Industrial symbiosis experience

- ◆ Kwinana, Western Australia. (1990)
- ◆ Gladstone, Queensland.
- ◆ Rustenburg, South Africa
- ◆ Geelong, Victoria.
- ◆ Dandenong, Victoria.
- ◆ Whyalla, South Australia (2012)

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## Industrial symbiosis

Industrial symbiosis (often referred to as 'Regional Synergies')

Definition "Capture, recovery and reuse of previously discarded resources from one industrial operation by other, traditionally separate, industries operating in their close proximity"

Categories

- By-product synergies
- Water and energy utility synergies
- Supply chain synergies/management

Kwinana is a world-leading example of regional synergy implementation

48 diverse and matured existing synergies

Success factors


industry diversity, non-competitive, close proximity, KIC

Key role for Kwinana Industries Council

Potential for further synergy development

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## KIA- Triple Bottom Line

**Economic**

- Major source of revenue
- Direct sales \$12B
- 3.3% of WA total income
- Annual worth of A\$ 20 billion

**Social**

Jobs

- ~ 4,800 direct and up to ~ 26,000 indirect and induced jobs
- 64% live locally
- > 50% community activities funding spent locally
- Direct consultation with the community

**Environment**

- Interdependency creates significant environmental benefits
- High level of environmental performance and collective action between industries

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## Kwinana Industrial Symbiosis



- ✦ 47 existing synergies in Kwinana
  - ✦ 32 by-product synergies
  - ✦ 15 utility synergies

Kwinana compares favourably with other international examples of regional synergy development (Bossilkov et al, 2005).

Greatly exceeds 'business-as-usual'

Best-practice example

Maturity, diversity, and number of synergies

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## Examples of By-Product Synergies

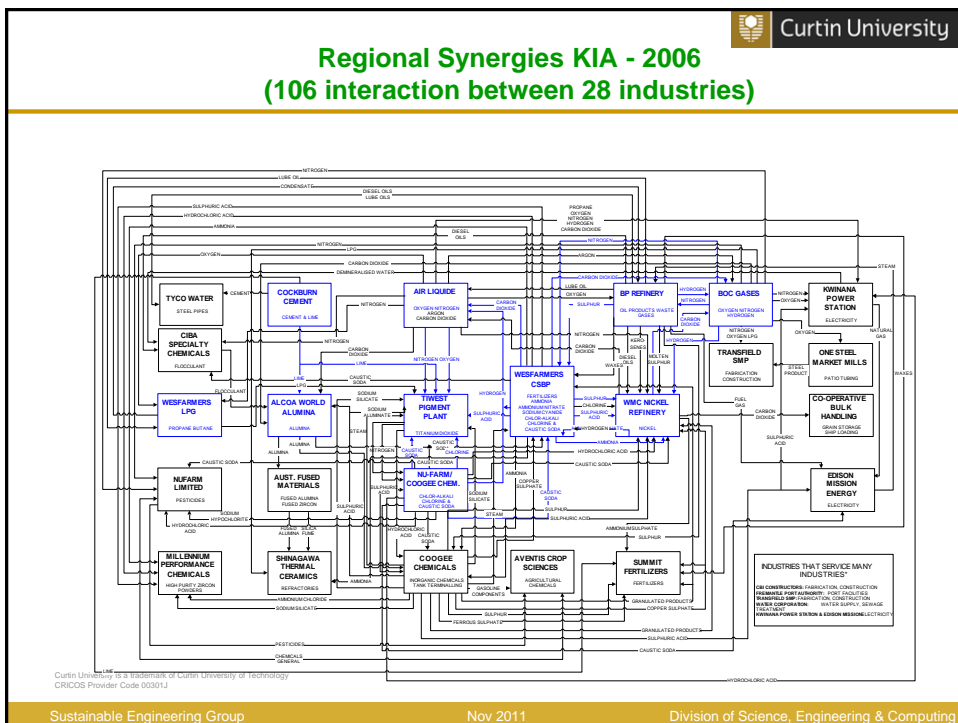
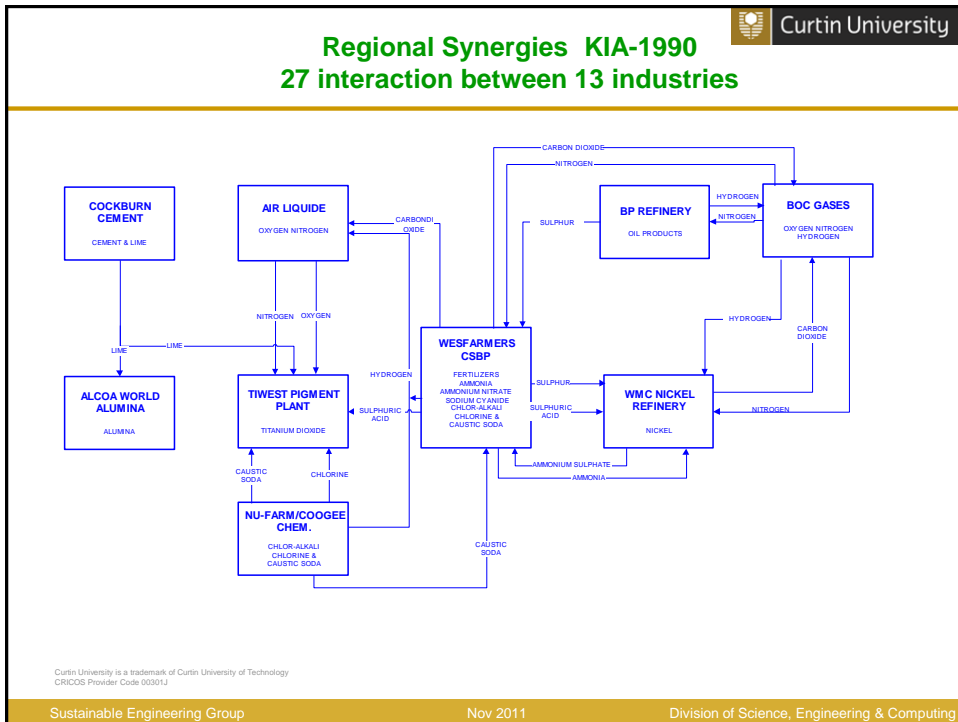


- ◆ Cockburn Cement supply of lime kiln dust to Hlsmelt Pig Iron Plant and Tiwest Pigment Plant

- ◆ CSBP Chemical Plant supplying gypsum to residue area of Alcoa Alumina Refinery to assist in plant growth and soil stability

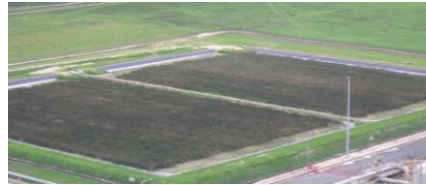


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## Examples of Utility Synergies

- ◆ Artificial wetland treatment at CSBP Chemical Plant
  - On BP Refinery land
  - Some of BP effluent going into wetland cells as well



- ◆ 2 Cogeneration facilities
  - BP Refinery (116 MW)
  - Tiwest Pigment Plant (40 MW)

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## Examples of By-product synergies

### Reuse of slag from smelting

- Road construction, fill material
- Sand blasting
- Insulation (air granulation of slag → slag wool)
- Geopolymers

### Reuse of fly ash from coal-fired boilers

- Road construction
- Geopolymers
- Soil conditioner

### Reuse of gypsum from scrubbing systems


- Plaster board manufacturing
- Cement production
- Soil conditioner

### Reuse of lime kiln dust from cement plant

- Desulphurisation (scrubbing)
- Soil conditioner



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## Current Synergy Focus in Kwinana

**Inorganic By-Products**  
**Focus on high volume residues (bauxite and gypsum)**  
**Link into local construction developments**


**Water**  
**Mapping of company water inputs and outputs**  
**Water synergy scoping study and workshop**  
**Industrial wastewater reuse**

**Energy**  
**Industry energy survey (uses and losses)**  
**Energy scoping study and workshop**  
**Waste heat recovery (use for desalination)**

**Sustainability Roadmap**  
**Development of sustainability indicators and targets**  
**Guide strategic decision making on long-term sustainability**  
**Benchmarking of sustainability performance of the KIA**

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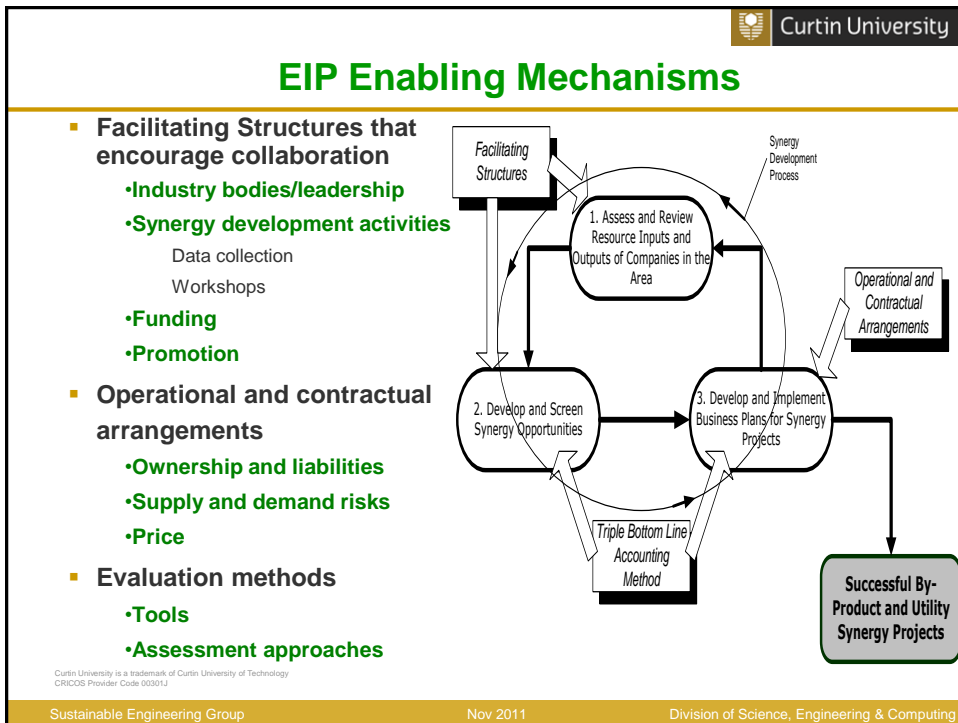
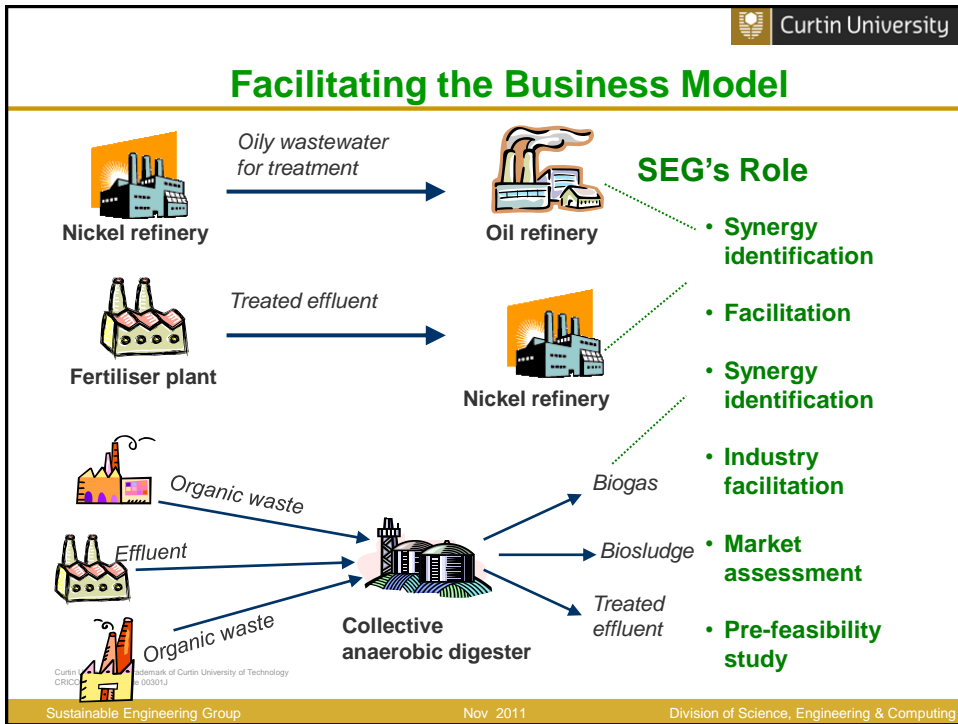
## Benefits of Existing Synergies in the KIA

- ◆ Reduced operational costs
  - Gypsum
- ◆ Increase company income
  - Lime kiln dust
- ◆ Increased water efficiency
  - Kwinana Water Reclamation Plant (KWRP)
- ◆ Increased energy efficiency
  - Cogeneration facilities
- ◆ Water and energy security
  - KWRP, cogeneration facilities
- ◆ Employment generation in the KIA
  - Cogeneration facilities
- ◆ Improved quality of life for neighbouring communities

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## Identifying Drivers & Barriers to synergy development

- ◆ Regulation
  - D: Air, water quality requirements; reporting schemes
  - B: Complicated, approval procedures
- ◆ Economics
  - D: Increased revenue
  - B: Low costs for resources and waste disposal
- ◆ Community
  - D: Improvement of quality of life
  - B: Community opposition and public concerns to waste reuse
- ◆ Technology
  - D: Replacement/decommissioning of old equipment
  - B: Lack of suitable technology to transport/convert by-product
- ◆ Risk and Liabilities
  - D: Reduction of liabilities associated with waste storage
  - B: Dependencies, lack of supply securities


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## Lessons Learnt in Kwinana

- ◆ Existing synergies provide range of sustainability benefits
  - More synergy opportunities exist
- ◆ Business case of synergies
  - Need to understand broader sustainability benefits
- ◆ Regulatory barriers
  - Prevent or delay implementation synergies
- ◆ Industry champions
  - Crucial for synergy development
- ◆ Industry involvement
  - Development of synergies is not core business
- ◆ Kwinana Industries Council has key role
  - Platform for industry collaboration



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## Benefits and Success Factors

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- ◆ **Kwinana is world leading example in regional synergy development**
  - **Historical development of synergies**
  - **Favourable features of Kwinana**
  - **Significant sustainability benefits**
- ◆ **Move beyond 'low-hanging fruit'**
  - **Many more synergy opportunities still exist**
  - **Commitment to further develop synergies**
- ◆ **Need to overcome barriers**
  - **Regulation, demonstrate sustainability benefits**
- ◆ **Need to communicate achievements**
  - **Industries, government, community**

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## Benefits and Success Factors

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**Excellent ongoing positive PR exercise**  
**In addition to the sustainability benefits**


**Assisting with the 'Social licence to operate'**

**Independent research agency needed**  
**Particularly a university research group**  
**(impartial and independent) critical in dealing**  
**with any commercial in-confidence information**  
**exchange between companies.**

**Company champions**  
**Necessary to ensure overall commitment and**  
**provide data inputs and decision making roles**  
**when required.**

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## Australian Government R&D Incentives

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- Low Carbon Australia \$100m
  - invest in carbon abatement, EE, accreditation for C neutral products, provides advice on carbon reduction mechanisms
- Generic R&D Tax Concessions
  - 125% of the amount spent for R&D capital equipment depreciation.
- Renewable Energy (Solar power) Feed in Tariff schemes in each State
- Clean Energy Focus ( but still major exporter of coal.....)
  - Most 'green technology' funding focussed on green energy
  - Australian Renewable Energy Agency
  - Green Energy Fund \$10bn
    - ARENA- Early stage R&D technology
    - Clean Energy Finance Corp- commercial development and roll out

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## Australian Government R&D Incentives

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- **RET- Renewable Energy Targets: 20% of Australian electricity be produced from renewable energy sources by 2020.**
  - REC- Renewable energy certificates
  - Replaced mandatory Renewable Energy Target Scheme of 9500Gwh of extra renewable electricity by 2010 (finished).
- National Research Centres
  - Full Industry funding plus University funding
- Co-operative Research Centres (CRC) (7yr term)
  - Govt. + Industry funding
- Australian research Council (ARC) Linkage and Discovery
- University/CSIRO collaboration

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