Creating Economic and Environmental Value Through Industrial Symbiosis

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Agenda

- Definition of Industrial Symbiosis (IS)
- Natural Resource Examples
- Findings for Improving Economic and Environmental Impacts
- Policy Suggestions

Industrial Symbiosis

- A mechanism in the circular economy
- Exchange, sharing and/or reprocessing of waste from one firm into feedstock for another (Chertow, 2000)
  - Subset of Industrial Ecology with an Ecosystem metaphor
  - Economic and Environmental Value
  - Improvement through Cooperation (Gibbs, 2008)

- Different types of relationships
  - Self-organizing “uncovered” (Chertow, 2007)
  - Eco-industrial Parks
  - Facilitated

<u>Goal</u>: Transforming “Waste” into Resource

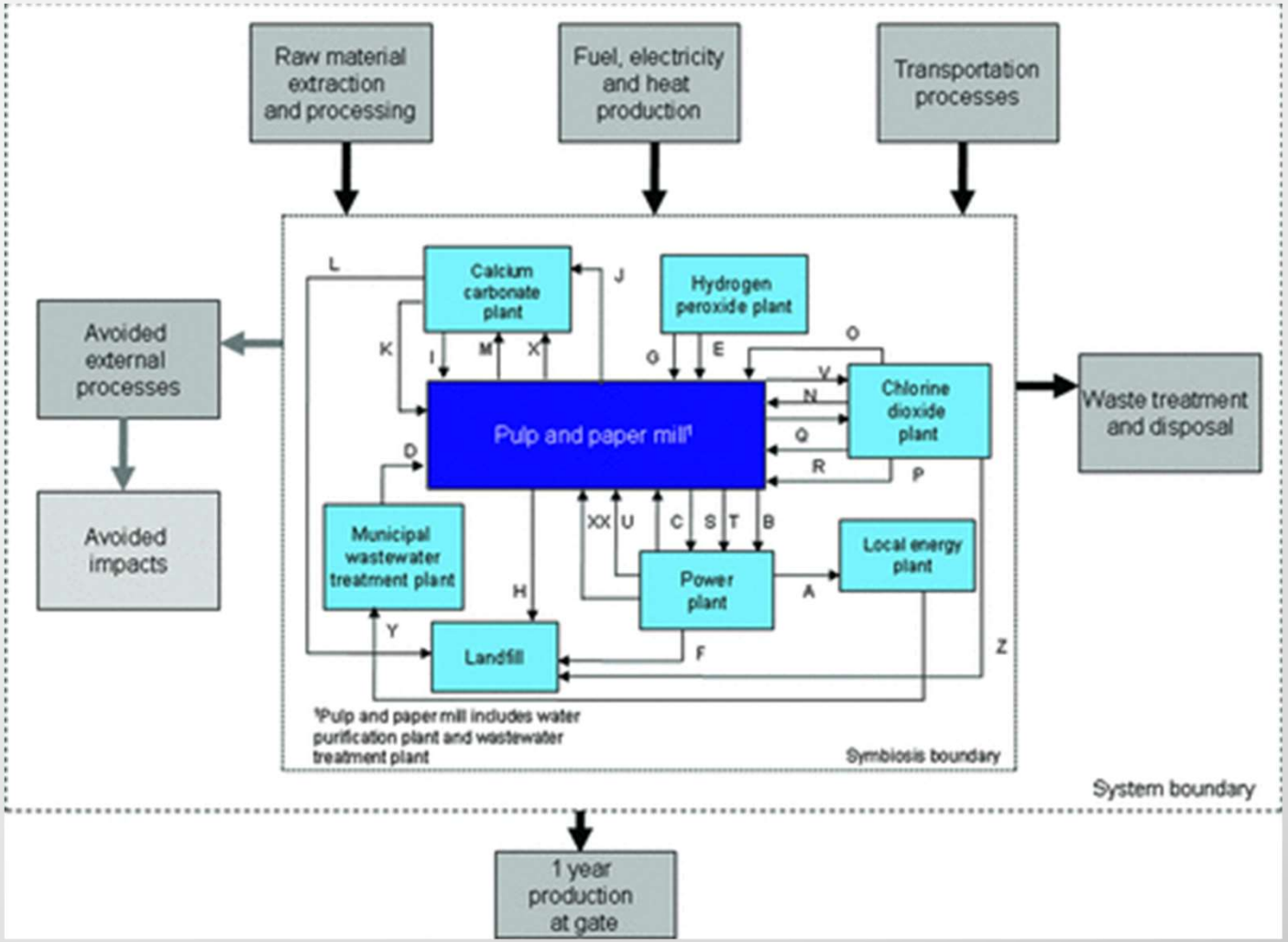
Value of Industrial Symbiosis

- Strategic tool for developing low carbon economies
  (European Commission, 2011)

- *Potential 2$ trillion USD in benefit for global economy*
  (Ellen MacArthur Foundation, 2012)

- IS creates ‘system-level’ economic and environmental benefit
  (Ehrenfeld & Chertow, 2002; Jacobsen, 2006)

Kouvola in southeastern Finland



Sokka et. al. 2011

Australia Kwinana Industrial Area

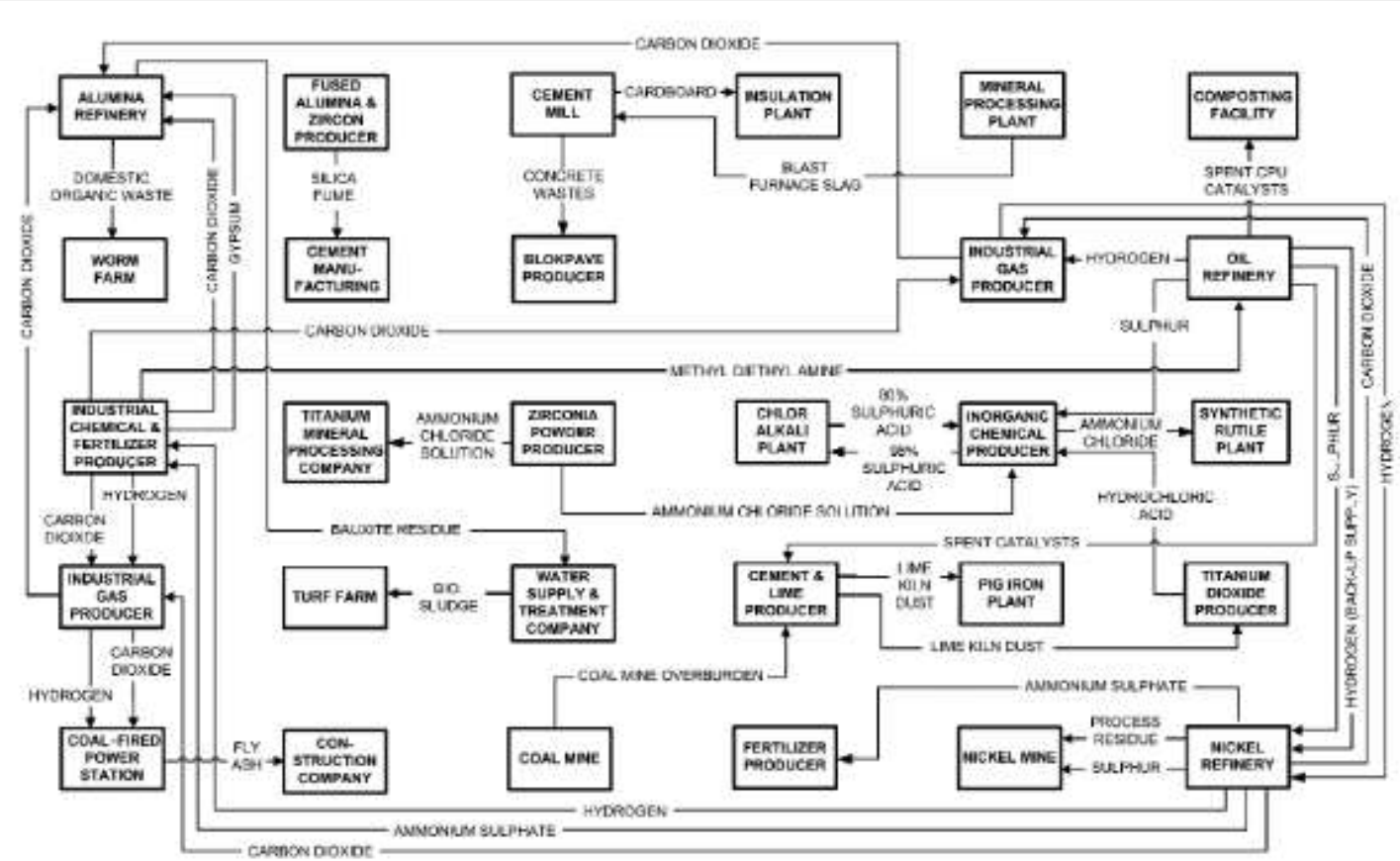


Figure 2 Existing by-product synergies in Kwinana. Figure includes only the Kwinana industries (both members and non-members of the Kwinana Industry Council, KIC) that are involved in regional synergies. *Source:* van Beers and colleagues (2005).

Gladstone Industrial Area

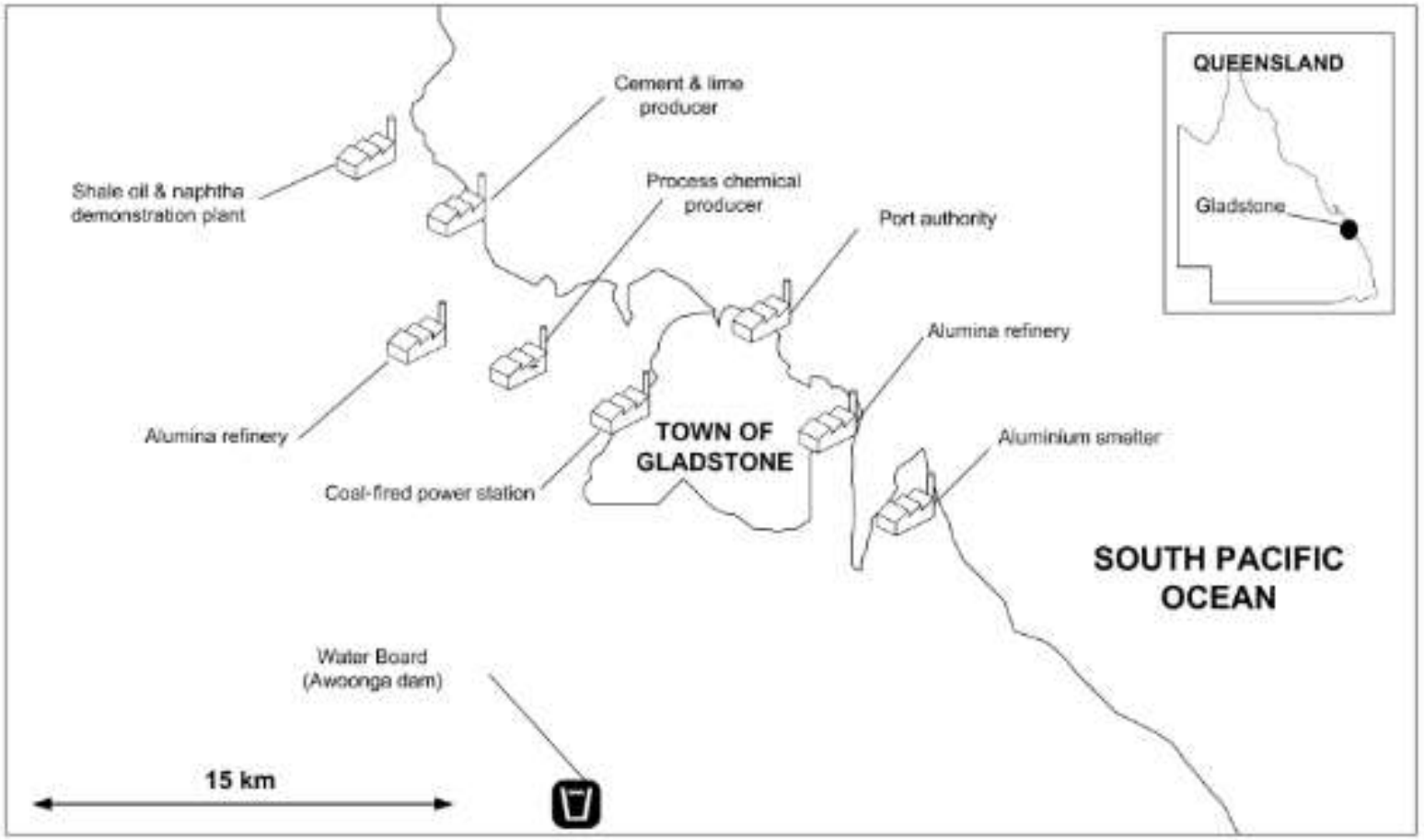


Figure 4 Location of companies in Gladstone Industrial Area (Queensland).

Van Beers et. al. 2007

Empirical Setting - UK National Industrial Symbiosis Programme (NISP)

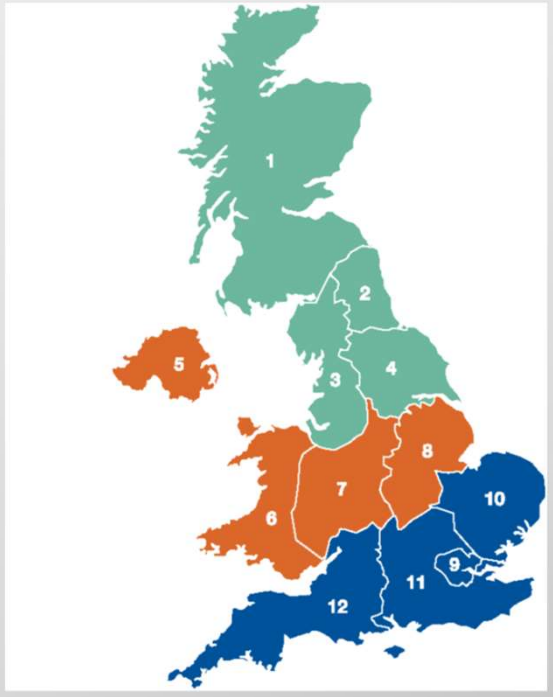
Launched nationally in 2005

- *regionally from 2002*

National industrial Symbiosis Programme (NISP) (NISP & Databuild, 2006)

For Each £1 million spent developing IS exchanges

- Economic Benefit
  - £60+ million in regional economic activity
    - Increased sales, reduced costs, new businesses / jobs, etc
- Environmental Benefit
  - 388K tonnes of industrial landfill waste diverted
  - 342K tonnes of industrial carbon emissions reduced



Economic & Environmental Value

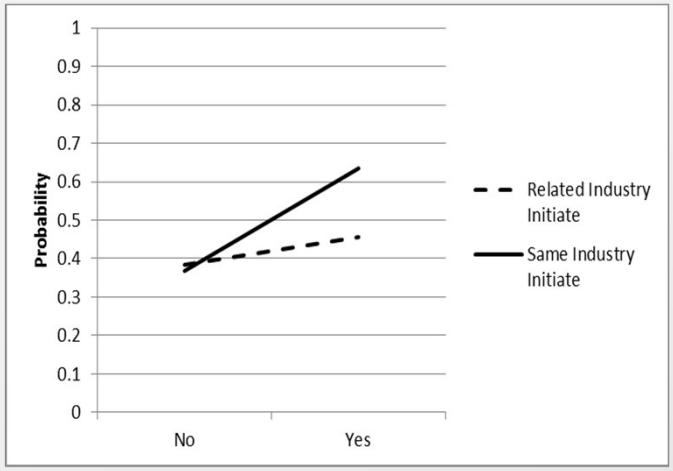
- Economic outcomes
  - Reduced costs for waste disposal
  - Reduction in supply materials costs
  - New revenue sources through sales
- Environmental
  - Diverted waste reduce Co2e and landfill
  - Reduce hazardous waste
  - Reduce virgin material use
  - Decrease energy consumption and Co2e production
- Public sphere
  - New enterprises
    - Co-production opportunities
    - Specialized waste firms
  - Job creation

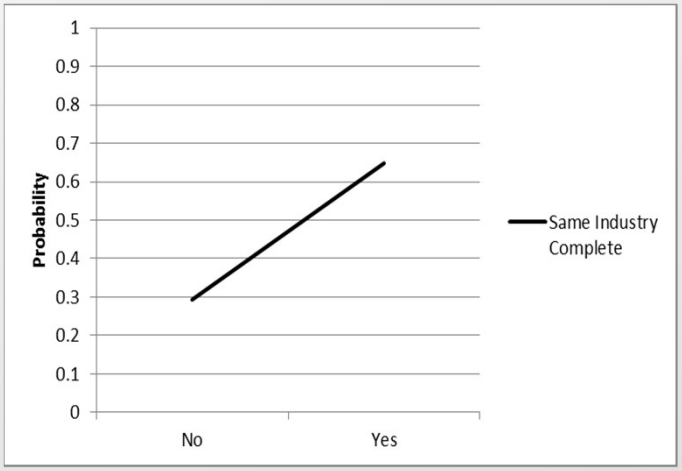
Improving Exchange Success to Capture Environmental & Economic Value

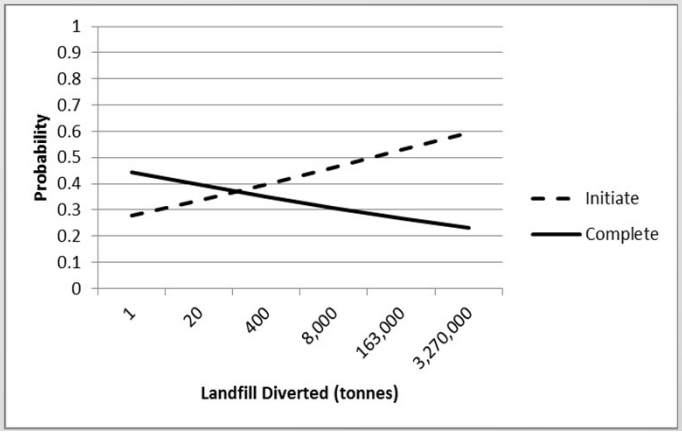
- We expect greater economic value between firms in disparate industry groups
- Trust and Learning are important to success
- Partner experience greatly increases probability of completing an IS exchange
- Exchanges more likely to be initiated with increasing economic gain

Paquin et. al., 2014

Marginal Effects







Eco Efficiency, Environmental and Economic Value

- More IS exchanges support financial over policy benefits
- Over half of IS exchanges provided business or policy benefits *but not* CO2 reduction
- Almost a third captured no benefit
- Most common eco-efficiency combination was achieving $Co2_e$ reductions and Increased Sales
- Landfill & Experience are key for both eco-efficiency and eco-development
- Waste Firms have differential impact
  - Appropriate 'value' from exchanges
  - Create new business opportunities around IS
  - Similar Partners more likely to create IS value
- Material types matter

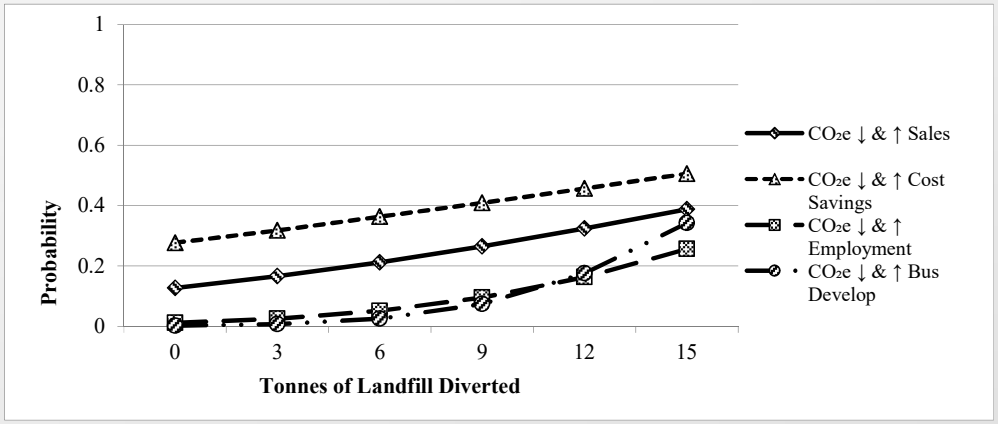
Paquin et. al., 2015

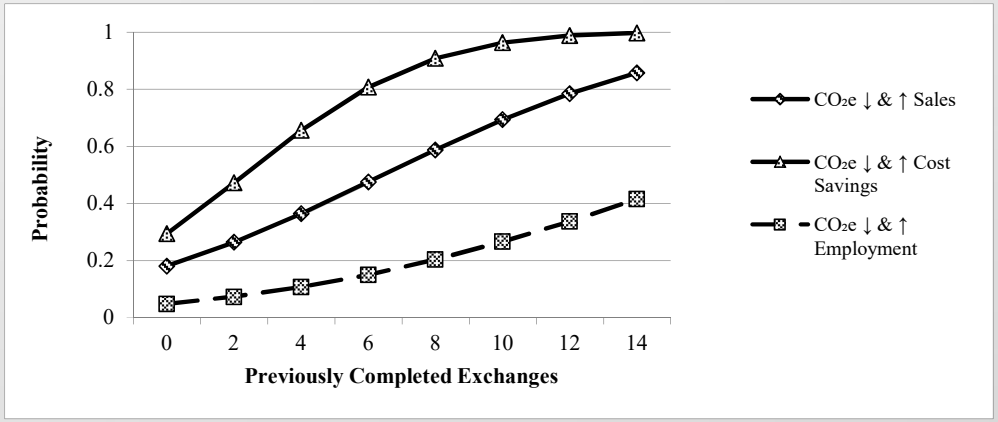
Eco-efficiency Combinations

	CO_2e Reductions &			
	Eco-efficiency		*Eco-development*	
	Increased Sales	**Increased Cost Savings**	**Increased Employment**	**Increased Biz dev't**
Landfill Diverted	Positive**	Positive*	Positive***	Positive***
Prior IS experience	Positive**	Positive***	Positive*	Positive***
Partner Similarity		Positive*	Positive+	
Waste firm as Partner		*Negative***		Positive***
Firm Size		Positive**		
No of Sites		*Negative+*	*Negative**	
Resources	food waste+, glass+, infrastructure*, mixed materials*, wood*	Effluent+, mixed materials*, wood**	*none*	*none*

*** p<0.001, ** p<0.01, * p<0.05, † p<0.10

Marginal Effects of Landfill & IS Experience





Policy recommendations

- Set scope and plan
  - Target environmental/economic/social goals?
- Determine if trying to foster self-organizing, facilitated exchanges, or eco-industrial parks
- Develop institutional framework - Policy license to operate
  - Involve all necessary national, regional departments, and associations
- Compelling business case – expenses and benefits
- Interaction between participants essential
- Be willing to invest in infrastructure requirements and demonstration projects

O'carol et.al., 2017; van Beers, et. al, 2007; van Berkel, 2006

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