Smart Delta Resources
Total Process Technology Assessment (TPTA)

High Level Review & Results for Public Distribution

Middelburg
April 2015
Abstract

- This report completes the project ‘Total Process Technology Assessment’ and includes an overview of the activities, learnings, key priority areas for further review & potential next steps.

- Industrial symbiosis is gaining recognition as a valuable source of energy efficiency and economic benefit. To compliment a number of initiatives already ongoing in the region, the “Smart Delta Resources” industrial innovation platform in the South West of the Netherlands and northern Belgium commissioned a ‘total process technology assessment’ of the participating organisations in order to review the potential for cross-boundary symbiosis.

- The project ran during 2014 and resulted in 186 potential topics which were duly ranked and prioritised – a huge success.
Contents

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2. About the Total Process Technology Assessment
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4. Work Package 2 : Company Visits & Analysis
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8. Conclusion & Summary
9. Team Photo
10. Contact Details
Smart Delta Resources is an industrial innovation platform involving a number of organisations representing the steel, chemicals, food & energy industry in the Delta region (West Brabant, Zeeland, North Flanders).

The four major objectives of SDR are defined as:

- Strengthen competitive positioning for energy & raw materials management for major industry in the region
- Develop ambitious initiatives which will have significant economic and/or ecological impact
- Explore & exploit smart forms of co-operation through the development of new partnerships, initiatives & projects
- Explore European financing opportunities for industrial symbiosis implementation projects
SDR Participating Organisations

ArcelorMittal
Cargill
Delta Verbindt
Dow
AICL
Lamb Weston
Sabic
Suiker Unie
Trinseo
Yara
Zeeland Seaports
Provincie Zeeland
Impuls
SDR Participating Organisations Locations

**Chemical**
- DOW
- ICL IP
- SABIC
- Trinseo
- Yara

**Refinery**
- Zeeland Refinery

**Metal**
- ArcelorMittal

**Food/feed**
- Cargill
- Lamb Weston
- Suiker Unie

**Energy**
- Delta Energy

**Infrastructure**
- Zeeland Seaports

**Locations**
- Ze. R
- LWM,kr
- LWM, BoZ
- EPZ
- SABIC
- Dow
- Tri
- Yara
- ICL
- Carg.
- Arc. M
- Zeeland
- Cargill
- Yara
- ICL
## SDR Participating Organisations Distances

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### Based on internet map driving distances

**0-10KM**

**11-20 KM**

**21-50 KM**

**>50 KM**
TPTA Project Management

• In April 2014, ECN was awarded the contract to carry out a ‘Total Process Technology Assessment’ among the participating SDR partners and in collaboration with the ISPT (Institute for Sustainable Process Technology).

ECN
ECN is a not-for-profit knowledge institute with a mission to work with and for the market to develop knowledge and technologies to enable a transition to a sustainable energy system. ECN’s broad experience & expertise in industrial energy efficiency solutions includes (multi-owner) industrial heat solutions, separation and conversion in both the gas and liquid phase and includes strong links with all of the four major industrial groups represented in the Smart Delta Resources platform.

ISPT
The Institute for Sustainable Process technology is a co-operation between industry, universities, and knowledge institutes, which aims at speeding up sustainable innovation processes and make them more efficient than they are at present. Apart from developing knowledge, the institute aims at the development, demonstration and application of breakthrough technology including elaboration of business models with a special focus on process technology.
TPTA Definition & Objectives

- The project was defined as follows “To carry out an inventory of the potential energy & raw material synergies that (may) exist between the various companies participating in the SDR programme.”
- The objectives were defined as follows:
- A full inventory of the potential synergies between the participating companies in the domains:
  - Materials (by-products, semi-products, residual streams (including CO₂) or off-spec materials)
  - Energy
  - Services
  - Technologies
- Whilst all four domains were to be considered, the emphasis was set on materials & energies.
### TPTA Process

- Getting to know each other
- Inform about process
- High level company presentations of input-process-output
- According to structured format
- Company presentations on processes
- Best practices
- Case by Royal Haskoning

#### Time
- Kick-off May
- TPTA session July
- Data analysis
- Q&A with companies
- Brainstorms with expertgroups

#### ECN
- Companies

#### Company visits

- Thematic approach
- Several experts
- All companies
- Requested for multiple disciplines
- Feedback on findings
- Agree on high level feasibility

- Subgroup discussions on found synergies
- Thematic approach
- Companies chose feasibility
Step 1: SDR - MoU companies

Step 2: Confidentiality Statement

Step 3: Companies Agree on data for Symbioses opportunities

Company Data

Step 4: Cooperation agreements between parties

Companies are grouped in symbiosis opportunities to assess and work out the business cases

- Symbiosis 1
  - 1
  - 2
  - 5
  - 12

- Symbiosis 2
  - 3
  - 9
  - 7

- Symbiosis 3
  - 4
  - 10
  - 8

- Symbiosis ...n
  - 6
  - 11
TPTA Governance Structure

**Customer**
- **SDR Participants**
  - Arcelor Mittal
  - Cargill
  - Delta
  - Dow
  - ICL-IP
  - Impuls
  - Lamb Weston
  - Provincie Zeeland
  - Trinseo
  - Cosun/Suiker Unie
  - SABIC
  - Yara
  - Zeeland Refinery
  - Zeeland Seaports

- **Work Group**
  - 5 representatives with one named PRIMARY CONTACT

**Supplier**
- **Project Manage-ment**
  - 4 named individuals with one named PRIMARY CONTACT

- **Expert Pool**
  - Over 20 different experts available within ECN & ISPT organisations

**Project Board**
- **SDR**
  - 2 participants
- **ECN**
  - 3 participants
- **ISPT**
  - 1 participant

**Over 20 different experts available within ECN & ISPT organisations**
TPTA Kick Off

DELIVERABLES:
• Clarity on the data and information required of each participating organisation
• Criteria / Framework for opportunity evaluation to be used in WP3
• Buy in & commitment from all parties involved

LEARNINGS:
The Kick – Off session was well received and a good start to the project. Preparation of material and a ‘template’ for data gathering took more time than originally anticipated. Ensuring the ‘full’ engagement of all parties also took more time than originally anticipated and resulted in an extra investment (in time). A positive note is that the support of senior management and board members is crucial for the success – and also for internal discussions on time availability of participants.
TPTA Work Packages

1. WP 1: IS best practices
   - Literature study on best practices
   - Interviews to capture learnings
   - Creating the 'opportunity database'
   - Workshop to review potential implications for the rest of the project

2. WP 2: Company visits & analysis
   - Studying available company specific information
   - Agree on data gathering process with each company
   - (Prepare) site visits
   - Reporting of site visits

3. WP 3: Opportunity inventory
   - Create long list of all possible opportunities
   - Brainstorm session on identified opportunities
   - Give qualitative indication on potential impact of discussed opportunities

4. WP 4: Prioritisation & Business cases
   - Rank long list of opportunities against evaluation criteria
   - Discuss suggested ranking with companies
   - Generate high level business case (incl. non technical aspects)

5. WP 5: Feedback and reporting
   - Develop preliminary report to discuss with workgroup
   - Face to face session with workgroup to agree on assumptions and prioritisation
   - Develop final report

A database of relevant IS activities
12 individual docs & Report to Proj. board
Long list of all possible synergies
Ranked list & high level business cases
Draft and final report
Industrial Symbiosis (IS) is defined as

*Engaging traditionally separate industries in a collective approach to competitive advantage involving physical exchange of materials, energy, water and by-products. The keys to industrial symbiosis are collaboration and the synergistic possibilities offered by geographic proximity.*  
(Chertow, 2000)

**Principles of Industrial Symbiosis:**

- “Someone’s waste is another one’s raw material”
- Economically and environmentally profitable
- Partners should be independent (“across the fence”)
WP1 : Best Practices
Industrial Symbiosis

DELIVERABLES:
• A ‘database’ (non formal report) of all relevant industrial symbiosis activities based on literature review, web searches & suggestions of participants
• A summary of key best practices that are relevant for the further development of the project

• Critical Success Factors
  – 39 major success factors identified broadly categorised in 5 headings:
    • Legal
    • Economic
    • Spatial
    • Technical
    • Social

• Review of Industrial Symbiosis including the Netherlands:
  – Zeeland Seaports, Sloegebied
  – Rotterdam, Botlek
  – Biopark Terneuzen, BPT
  – Heineken & district, Zoeterwoude

• Globally:
  – Kalundborg Eco-Industrial Network (Denmark)
  – Ghent Canal Zone (Belgium)
  – Kwinana (Australia)
  – By-Product Synergy (USA)
WP1: Best Practices Industrial Symbiosis

The case most referenced in literature as an example of successful working Industrial Symbiosis is Kalundborg, Denmark. The Kalundborg case has demonstrated that:

- IS can lead to a significant reduction in the environmental impact.
- Reduction in consumption of resources (oil, coal, gas, water, etc.)
- Reduction in waste emissions (CO2, SO2, NOx, etc.)
- Valorization of “wastes” (Sulfur, Calcium Sulfate, fly ash, etc.)
- A more rational utilization of resources can save money.
- IS has cost Kalundborg $75 million. By 1999 revenues had accumulated up to $160 million.

References:
Baas, L., Utilizing excess heat: from possibility to realization on the basis of industrial symbiosis Linköping University, Sweden.
DWA, Valorisatie van reststromen in het Sloegebied, een analyse van vandaag en de kansen van morgen, Oktober 2010.
Rehn, S. Influencing Industrial Symbiosis Development, a case study of Händelø and Northern Harbour Industrial Areas, Linköpings University, June 2013.
Provincie Zuid Holland, Zuid-Holland op St(r)oom! Ruimte voor de energietransitie, 2013.
Work Package 2: Company Visits & Analysis

- Over 20 company visits made by ECN experts to the participating companies

- Iterative process exchanging information on
  - feedstocks in (raw materials),
  - individual processes,
  - utilities associated with each phase of the process & products
  - And residues resulting from the processes

- High level process / data available for sharing within SDR group (see earlier comment on confidentiality)
Work Package 2 : Company Visits & Analysis

DELIVERABLES:

• 12 individual documents outlining the input from each participating organisation.
• Regular reports to the Project Board & work group team on progress & insights
• Discussions with multiple members of each participating organisation in order to understand current & potential future processes
• Workshop held to review individual company data and further develop initial ideas on synergy
• General overviews of certain specific streams like waste heat and hydrogen
• Structured database with all company process data (energy, materials, technology, services)
Work Package 3: Total Opportunity Inventory

**DELIVERABLES**

- Long list of all possible areas of synergy
- Brainstorm session
- Major synergy categories identified:
  - Drying (including sludge / digestate)
  - Gasses (including natural gas)
  - General / Various
  - Hydrocarbons
  - Hydrogen
  - Residual heat / cold
  - Residual streams
  - Waste
  - Water
  - Salts / Acids / Base chemicals
### Work Package 3: Total Opportunity Inventory

- Opportunities sorted into type of synergy and in categories (highest priority = A+)
- Total number of opportunities identified = 186
- Snapshot of the top 30 shown on right

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Work Package 4: Prioritisation & Business Cases

DELIVERABLES

- Framework / Criteria for opportunity evaluation
- Ranked list of opportunities
- High level business case generation for top 5 ideas, including information on technical, economical, informational, organisation, and political barriers.

Business cases chosen:
- LNG case
- Sludge drying with reuse of industrial residual heat
- Hydrogen from COG
- Reuse of industrial residual water
- Reuse of salt
- Mutual waste processing
Work Package 4: Prioritisation & Business Cases

Per business case (potentially sensitive information, therefore not included in detail in this report)

• Description of opportunity
• Companies involved
• Issues
• Regional fit
• High level financial analysis of cost – reward
• Next steps & recommendations
Work Package 5: Feedback, Reporting & Next Steps

DELIVERABLES
- Preliminary Report
- Dissemination / Feedback loop
- Final Report

Infrastructure & Transition
A major learning is that multi-party solutions will necessarily require infrastructure improvements and a broader transition agenda. Involvement of 3rd parties to include utilities & infrastructure developers & responsible governmental stakeholders will be essential in the further development of symbiosis opportunities.
Conclusions

• The TPTA has provided a significant list of opportunities for further, detailed review.
• Priority is now to:
  – Keep Momentum (build on trust and knowledge of each other’s processes)
  – Identify which cases require independent parties for facilitation
  – Resources needed to make business case for other (24) selected cases
  – Maintain environment of mutual confidentiality agreement between involved companies of potential synergy
  – Recruit additional organisations as opportune for defined opportunities, require a ‘fast track mini TPTA’ to get up to speed with the rest of the platform
Summary: Together we can achieve ‘more’ energy & resource efficiency

Through analysis and interaction to a comprehensive database of opportunities

1. Interaction
   - Four 2-day plenary meetings facilitated by ECN with many group discussions around mutual synergies (focus on cross sectoral)
   - Over 20 company visits by ECN experts with in depth analysis of input, processes and output

2. Result oriented
   - Brainstorms facilitated by ECN (company and thematic perspective)
   - All (186) ideas scored on six criteria together with involved companies, resulting in final feasibility scores per idea based on companies commitment

3. Process data driven
   - Agree with companies on confidentiality about data and structured data format
   - Collection and structuring of process data about energy and material streams (also non technical data like services)
   - Q&A’s about process data

Deliverables
- Mutual trust → Lower barrier to contact each other about potential synergies
- Better understanding of each others processes
- Cross sectoral synergies
- Ranked list of 186 potential synergies scored on feasibility
- Selection of 30 potential business cases with high over feasibility of six most promising cases
- Signed confidentiality agreements between companies and ECN
- Database with process (and non technical) data per company (and per plant)
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