Low Carbon Industrial Manufacturing Parks

Smart Future Industrial Parks

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More information
Public LOCIMAP reports will be available through its website at www.locimap.eu

Contact
LOCIMAP Secretariat
E: mail@locimap.eu, T: +31 70 312 39 27, I: www.locimap.eu

1. Summary

This 3rd paper in the series produced by the LOCIMAP project looks at the role of new technologies including Information & Communications Technology (ICT) in achieving energy intensive manufacture in Europe at lowest possible carbon footprint and lowest possible consumption of resources.

For Low Carbon & Resource Efficient Manufacturing on Industrial Parks, the project set out to identified technologies which supported the objectives by:

- Minimising the use of non-renewable, carbon-based feedstocks and energy sources
- Maximum use of otherwise wasted resources including energy and materials.

In addition it has considered the opportunities presented by “Smart” systems and technologies- how these can aid the management, monitoring planning and control of integrated resource efficient manufacture. These technologies provide the tools to allow EU industry to meet the policy goals of substantial carbon emissions reduction but major hurdles still exist to wider deployment of these tools which the earlier white papers in this series have identified (see paper 2 Industrial Symbiosis).

2. The Technologies

2.1 Strategic Background

Typically, process plants have been monitored and controlled in the past to deliver in-specification products in the desired quantities. In many cases, the energy consumed and the waste generated during manufacture and distribution has assumed secondary importance and has simply been rolled up into costs incurred.

With increasing scarcity, escalating costs and environmental considerations, this is no longer strategically or financially acceptable, and the game has moved on. Emphasis is now being placed by regulators and increasingly customers on the amounts and usage efficiency of energy and resources being consumed and their impact on the environment – this on a continuous and ongoing basis.

2.2 Process Technology

Technological developments in the field of energy saving and resource efficiency have been both substantial and diverse in recent times, leading to new capabilities in,

- Designing and implementing low energy systems
- Maintaining operations at minimum energy, even for changing operating conditions
- Recovering energy from waste streams

The project has analysed and listed the technologies available which could substantially improve the carbon performance of integrated parks. Many of these can be deployed now and demonstrations are available for most if not all.

Technology	TRL	Comment
Energy generation (power, heat and cooling)		
Biomass gasification	6-9	Semi-commercial demonstration sites
Biomass torrefaction	6	
Pyrolysis	6	Waste Tyre Pyrolysis is a variation under consideration
Concentrated solar power & thermal	5-6	Rapid development
Plasma gasification of waste	9	Units in operation in Japan. Constructions in USA and UK.

SEVENTH FRAMEWORK PROGRAMME

Technology	TRL	Comment
Oxy-fuel CFB	6	
Second generation bioethanol	6	Demonstration plants in operation.
Algae for fuel & chemicals	4-9	Very case specific
Trigeneration, (CHRP, CCHP)	9	For simultaneous generation of power, heat and cold.
Air cycle refrigeration	9	
Sorption refrigeration	9	
Hydrothermal carbonization	7	
Hydrotreated vegetable oil (HVO)	6-7	
Anaerobic water treatment	6-9	Very case specific
Biogas	9	Depending on substrate
Hydrofaction	8	
Energy storage		
Fuel cells	7-9	Depending on technology
Chemical energy storage	5	H2, NH3, CH4
Flywheel	7	
Thermal energy storage	7	
Liquefied air storage	8-9	
Energy conversion		
Heat to power	4-9	Depending on technology
Expanding heat recovery	4-9	Depending on technology
Kalina cycle	9	Installation in Iceland in 1999
Climeon	5-7	Demonstrator tested.
Stirling engine (also refrigeration)	7	Demonstration plant
Heatcatcher (Organic Rankine Cycle)	7	
Sabatier plant	8	250 kW demonstration plant in Germany 2012
CCS technologies		
Chemical absorption	6-9	
Physical absorption	4-9	
CaO looping	7	
Cryogenic distillation	6-9	
Gas separation	5-9	
Adsorption	5	
Oxyfuel	6-8	
Precombustion	6-9	
Other technologies		
Ion transport membrane air separation	8	
Membrane distillation using waste heat	7-9	

2.3 Total Supply Chain Systems

With the increase in the capability of ICT systems has come the opportunity for reviewing carbon impacts across full supply chain systems.

The life cycle results emerging suggest that traditional break points in the manufacturing process may not be the best ones. Indeed, there is a case for reconsideration of how supply chains operate; where the best break points are located; whether back-to-back manufacturing is feasible and how profitability across the chain may be affected by energy and waste costs.

The implications arising from the overall carbon emissions of a supply chain point to a need for a more holistic approach embracing the activities of the individual operators involved. The development of new business and operational paradigms reflecting more accurately the environmental impacts is the challenge.

2.4 Management and Organisational Structures

Our research reveals a strong opportunity to improve resource efficiency and sustainability through management structures and activities at parks. Informal links are effective at achieving this in specific cases (e.g. Kalundborg) and public sector involvement can encourage it (Kokkola, Wilton, Tarragona). This issue will be further explored in White Paper 4.

2.5 Impact of ICT

The enormous expansion in the capability of ICT systems including the increasing ease of data collection, improved interoperability via common standards and enhanced processing capacity and convenience of processing via cloud-based approaches, provides further options to support co-operation and identification of opportunities.

The project has therefore specifically looked at the scope for achieving major improvements based on a “smart” approach enabled by the developing ICT capability.

Information Level

Software to allow analysis of opportunities for integration at the energy level is now becoming more developed. Based on the original pinch based analysis approach, tools now exist (e.g. the SITE tool developed by our sister project EFENIS) which allow energy systems to be optimised across park complexes.

In addition the LOCIMAP team has applied analysis tools to see how process flows may be integrated in an ideal park in the interests of optimal utilisation of resources and the approach provides a basis to identify opportunities across industry sectors in order to identify how new investments could be located to minimise emissions and improve sustainability long term.

Control Level

The process control industry has a wide range of capabilities (software and hardware) to allow the monitoring and control of complex integrations. For example intelligent benchmarking of operations in real time is being applied (Tarragona) to park operations. Applying these across sector boundaries and between different organisations remains an area for development however – see management above, but examples of sharing information using cloud based applications are emerging (e.g. the Sabisu system employed by a resident at the Wilton complex). There remain however very significant concerns over security which need to be addressed, and further work on open and standard interfaces is required.

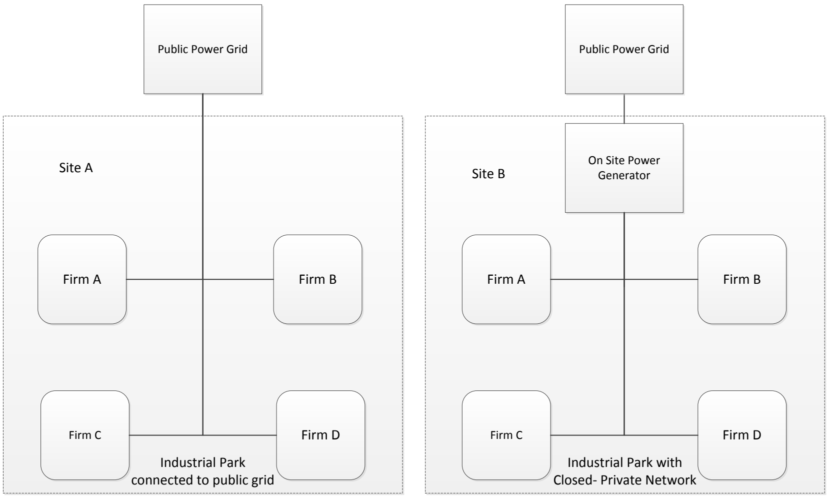
3. The Smart Park

A low carbon future for energy intensive parks requires a view over the fence to the external opportunities for energy and material optimisation.

It is clear that parks could form a backbone of a regional or national smart grid and provide energy in a variety of forms – not just electricity, but in terms of heat or other energy vectors – to communities. They also offer opportunities for managing grid operations in the face of variable supply of renewable electricity and of storing or exploiting energy surpluses. The role of the park in a hydrogen based economy is a clear way forward and thinking is being developed around parks in the UK (Wilton) Germany (the HYPOS Consortium) and in Denmark where surplus renewables are or will become available.

In this way the overall carbon emissions for the population could be reduced whilst sustaining the manufacturing base. In this context parks also offer opportunities for recycling and reuse of waste streams from the community – they are particularly suited as locations for Waste to Energy operations as is the case at Wilton.

The project has also considered how parks might form part of what is called Demand Side Management in the operation of electricity networks, and the opportunity for including industrial heat in the considerations is also clear but underexploited. The diagram shows the different structures if the park is integrated with public electricity networks.



Finally Community Heating extending the efficiency level of the Park's combined heat and power system by utilisation of low grade heat and superfluous power. Again, smart control enables maximum advantage.

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4. Emerging Technologies

The project confirmed the opportunity presented by the advances in mobile ICT for integration of park operations. Provided the security issue can be adequately addressed many gains in efficiency will become available at affordable cost as infrastructure costs are lowered by this approach.

Other key advances are needed in modelling the integrated complex, understanding how it can interact with energy systems and rapidly identifying the benefits to investors across sectors of co-location on existing parks.

Systems of Systems

The complexity of integrating and improving operations from different industrial sectors on the low carbon park of the future cannot be underestimated. Projects such as DYMASOS in the EU FP7 ICT programme are looking at how ICT tools should be developed and deployed.

Process Technologies are also providing new opportunities for reducing emissions and exploiting park locations. These include e.g. Organic Rankin Cycles, Organic Rankine Cycle, Fuel Cells, and Carbon Capture, storage and utilisation. In this latter case parks often have high purity CO2 streams, are situated on the coast for storage access, and if integrated with biomass based processes could produce negative emissions.

5. Training and Development

In examining the opportunities it is also clear from the parks viewpoint that skills availability is a significant concern and that investments are influenced by workforce availability. Parks provide an opportunity to concentrate provision and maximise the benefit from investment in technology education and training.

6. Conclusions & Way Forward

The project has demonstrated that the tools are in place to provide significant opportunities to improve the performance of existing complexes and the returns are significant. ICT provides the essential enabler with integration between manufacturers and supply chain partners now being realistic provided the systems maintain security and confidentiality across a multi owner park.

The main issue is the will to move forward – and the climate for investment to make change affordable. In some regions local conditions are supporting this but elsewhere the cases need to be made for cross sector developments. There remains an essential role for the public sector in promoting and undertaking some of the analysis needed to help parks especially ones with multiple owners make the case to investors.