

EFCE Working Party on Process Intensification

AGENDA

1. Opening/amendments to the agenda
2. Introduction of new Delegates and Guest Members
3. Minutes of the previous Business Meeting (Copenhagen, 18-09-2008)
4. Looking back on the developments in the past year
 - EPIC 2007
 - Other events
 - European Roadmap and Action Plan for Process Intensification
 - European Process Intensification Center (EUROPIC)
 - Other initiatives (Process Technology Innovation Group)
5. EPIC 2009 – preparation status
6. First year of “Chemical Engineering and Processing: Process Intensification”
7. Current status and prospects of Process Intensification in FP7
8. Teaching Process Intensification
9. Working Party’s website and technology database
10. Collaboration with other Working Parties
11. Date and place of the next business meeting
12. Any other business



Some statistics:

- 51 papers grouped in 5 thematic clusters:
 - Intensified Hydrodynamics & Structured Environments
 - Alternative Energy Forms & Transfer Mechanisms
 - Multifunctionality
 - Intensified Plants & Process Integration
 - New Concepts
- 45 posters
- 28 countries
- selected papers published in the inaugural issue of *Chemical Engineering & Processing: Process Intensification*
- considerable number of industrial papers

Roadmapping Process Intensification

A regional initiative with European Dimension



Creatieve Energie
EnergieTransitie

- Initiated by 6 ministries including the Ministry of Economic Affairs and Ministry of Housing, Land- Use Planning and Environmental Management (VROM), to drastically cut energy consumption by 2030
- Process Intensification identified as possible “transition path”
- European Roadmap of Process Intensification started in collaboration with EFCE, DECHEMA/VDI and other national organizations
- EUROPIN will set the R&D agenda in PI for the coming years;
- **Goal: establishing of PPP in the field of PI;**



Stakeholders



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Small/large industry, knowledge infrastructure, representative bodies and government are all represented in the Action Group PI

Members Action Group PI

| | |
|--|---|
| Prof. dr. J.H.W. de Wit (Chairman) | Former CTO Corus, former member Board TNO |
| Dr. ir. A. de Groot | ECN |
| Prof. dr. ir. A. Stankiewicz | TU Delft, Chairman of the EFCE WP PI |
| Ir. W.F. de Vries, Ir. F. van der Pas | SenterNovem |
| Dr. H. Schoenmakers (Associate member) | BASF, member of the Steering Board Fachsection Prozessintensivierung (DECHEMA-VDI ProcessNet) |

Senior Advisory Board Action Group PI

| | |
|---------------------------------|--|
| Ir. J.G. Dopper | Chairman Senior Advisory Board, former member Board of Directors DSM |
| Ir. G.J. van Luijk | ex Chairman BoD Technological University Delft, Chairman Platform Chain Efficiency, member Regieorgaan Energy Transition |
| Dr. ir. G.A. van Harten | President DOW Benelux |
| Drs. L.M.L.H.A. Hermans | President SME Netherlands |
| Prof. dr. E.M. Meijer | Senior Vice President Global Unilever Foods R&D |
| Prof. dr. ir. J.T.F. Keurentjes | Director Research & Technology, AkzoNobel Base Chemicals |



Facts and Figures is the technology input for the roadmap

- 73 technologies identified
- 47 technologies described in "technology reports"
- Experts from 13 countries involved

CONTENT OF TECHNOLOGY REPORT

1. Technology

- 1.1 Description of technology / working principle
- 1.2 Types and "versions"
- 1.3 Potency for Process Intensification: possible benefits
- 1.4 Stage of development

2. Applications

- 2.1 Existing technology (currently used)
- 2.2 Known commercial applications
- 2.3 Known demonstration projects
- 2.4 Potential applications discussed in literature

3. What are the development and application issues?

- 3.1 Technology development issues
- 3.2 Challenges in developing processes based on the technology

4. Where can information be found?

- 4.1 Key publications
- 4.2 Relevant patents and patent holders
- 4.3 Institutes/companies working on the technology

5. Stakeholders

- 5.1 Suppliers/developers
- 5.2 End-users

6. Expert's brief final judgment on the technology



The potential benefits from PI for each industry sector are significant

Potential benefits from PI

| <i>Industry sectors</i> | Benefits from PI | Short / medium term potential | Long term potential |
|-------------------------|--|--|---|
| PETCHEM | <ul style="list-style-type: none"> • overall higher energy efficiency | 5% (10-20 years) | 20% (30-40 years) |
| FINEPHARM | <ul style="list-style-type: none"> • overall cost reduction from higher selectivity and process step integration | 20% (5-10 years) | 50% (10-15 years) |
| INFOOD | <ul style="list-style-type: none"> • higher energy efficiency in water removal • lower cost through PI along the value chain | 25% (5-10 years) 30% (10 years) | 75% (10-15 years) 60% (30-40 years) |
| CONFOOD | higher energy efficiency: <ul style="list-style-type: none"> • in preservation process • through capacity increase • through batch → continuous | 10-15% (10 years) | 30-40% (40 years) 60% (40 years) 30% (40 years) |



Several barriers for the implementation of PI are common among the different sectors

Common barriers for the implementation of PI

•Technical / equipment

- Several PI technologies have high potential, but require further fundamental research
- Several PI technologies have been implemented in a limited number of plants, but have a much wider application potential
- Reliability demands (non proven technology)
- Limited pilot possibilities
- Retrofitting PI technologies in current plants difficult

•Economic

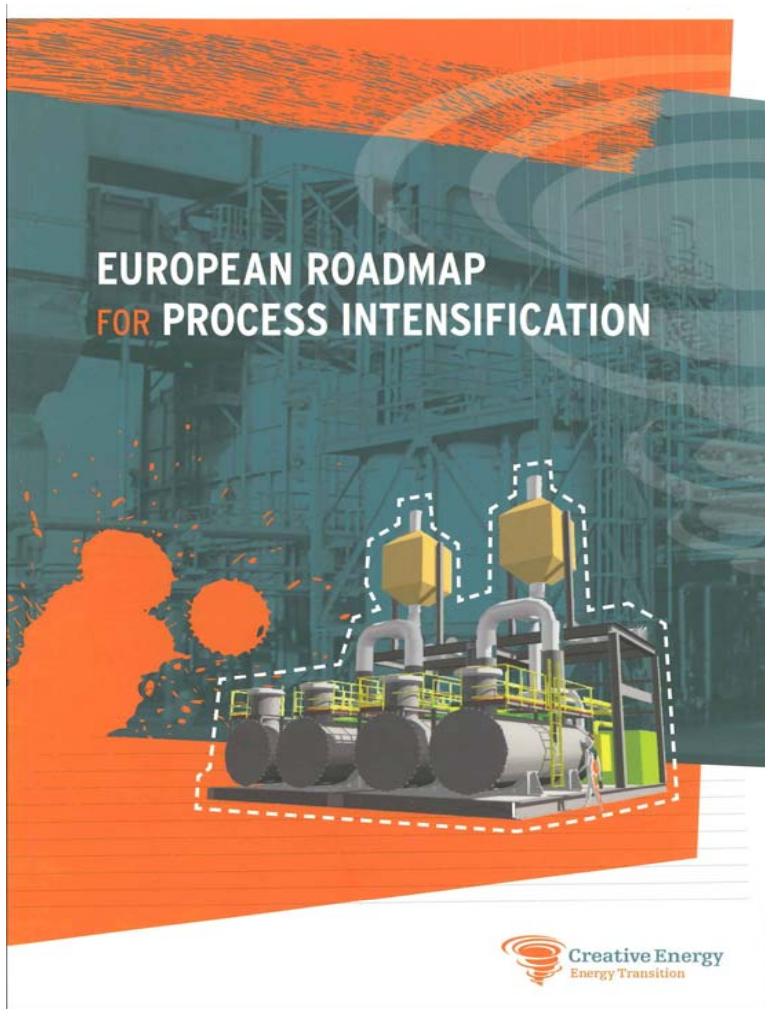
- Insufficient pay-back on new process technology
- Suppliers for industrial applications are lacking – most novel equipment is only suitable for product development

•Culture / organization

- Lack of PI knowledge and know how among industry process technologists
- Lack of chain vision
- IP issues for co-operation during R&D/development

Source: Sector working sessions, October / November 2007





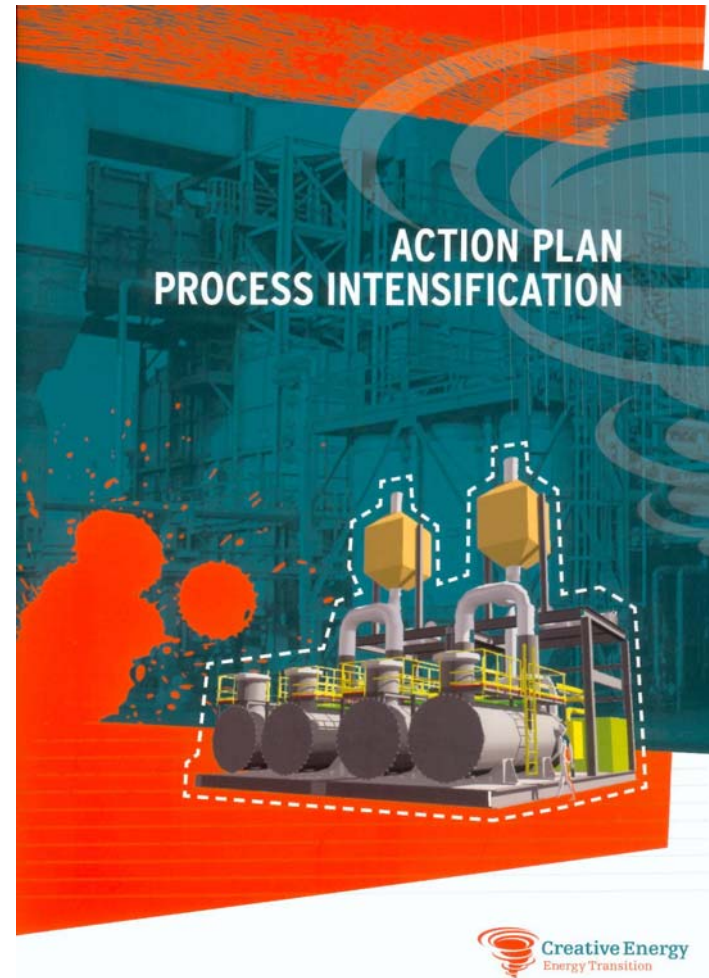
- Document published end 2007
pdf available via the WP PI
website

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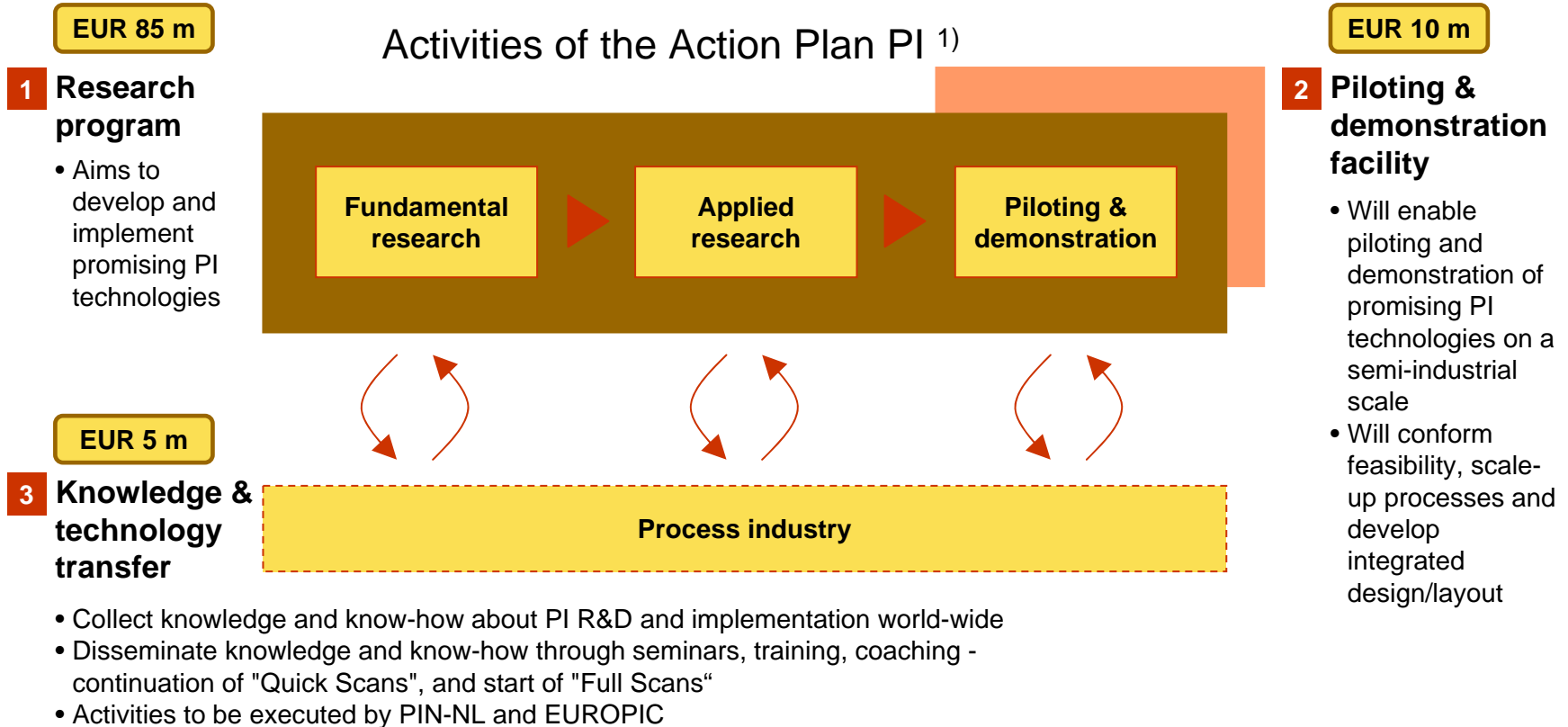
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- Phase 2



The Action Plan PI will consist of a research program, a piloting & demonstration facility and knowledge & technology transfer



 Total funding required for 5 year Action Plan

1) Overhead has been allocated to the research program for simplification

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The research program is organized into 11 program lines – PI thrust areas, PI enabling technologies and PI special themes

PI THRUST AREAS

1. Alternative energy- based operations
2. Membrane-based hybrid separation or chemical conversion
3. Integration of separation and chemical conversion (non-membrane based)
4. Transport-limited processes
5. Preservation
6. Energy efficient water separation throughout the value chain

PI ENABLING TECHNOLOGIES

| 7. PI process analysis tools | 8. PI process modeling & control | 9. PI manufacturing tech. & piloting |
|------------------------------|----------------------------------|--------------------------------------|
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PI SPECIAL THEMES

10. Open theme
11. Skyline theme



The program lines address the general and specific needs of all process industry sectors

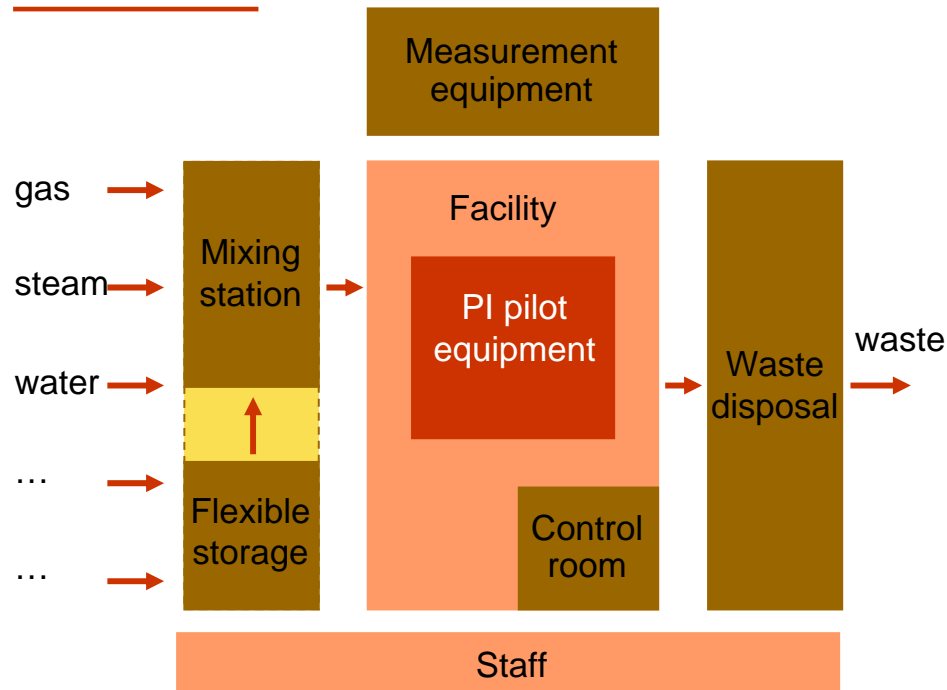
| <u>Program line</u> | <u>PETCHEM</u> | <u>FINEPHARM</u> | <u>INFOOD</u> | <u>CONFOOD</u> |
|---|----------------|------------------|---------------|----------------|
| 1. Alternative energy- based operations | | | | |
| 2. Membrane-based hybrid separation or chemical conversion | | | | |
| 3. Integration of separation and chemical conversion (non-membrane based) | | | | |
| 4. Transport-limited processes | | | | |
| 5. Preservation | | | | |
| 6. Energy efficient water separation throughout the value chain | | | | |
| 7. PI process analysis tools | | | | |
| 8. PI process modeling & control | | | | |
| 9. PI manufacturing tech. & piloting | | | | |
| 10. Open theme | | | | |
| 11. Skyline theme | | | | |

High relevance No relevance



The Action Plan PI will set-up a facility to enable piloting & demonstration of promising PI technologies on a semi-industrial scale

ILLUSTRATIVE



Facility

Infrastructure and staff made available by knowledge institute as in-kind contribution

Tailored infrastructure

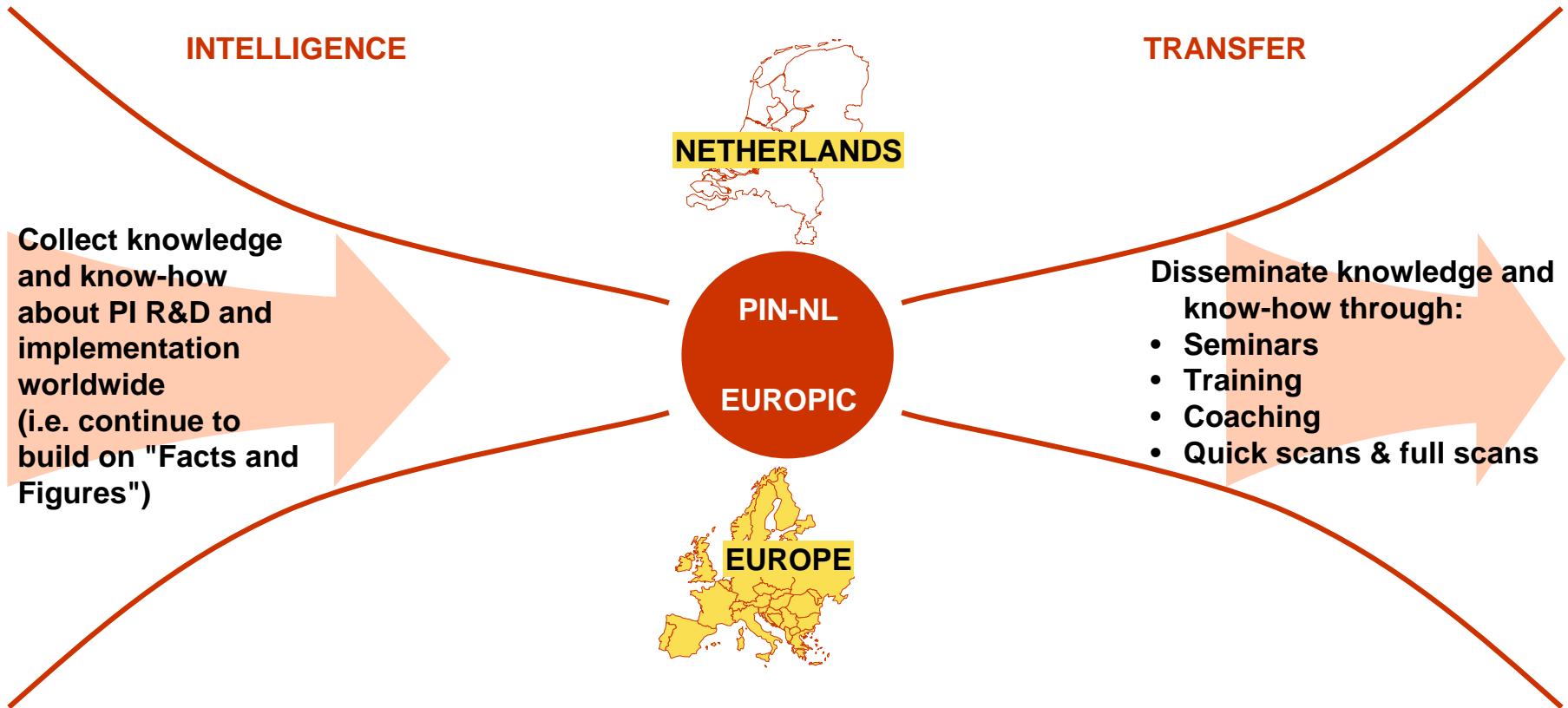
Investment in PI specific infrastructure by Action Plan PI

PI pilot equipment

The novel PI pilot equipment that is developed and funded by the program lines or by individual companies will be tested in the pilot facility



Knowledge & technology transfer aims to support and accelerate the application of existing PI knowledge and technologies



European Process Intensification Centre – strategic industrial platform for PI



Delft - Dortmund - Toulouse



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For a modest fee EUROPIC offers a variety of professional services to its members

- EUROPIC is a NON-PROFIT industrial platform based on annual membership fee (15,000 euro/a).
- Center management and administration is financed by 3 founding universities

EUROPIC offers, among other things:

- information services, including:
 - regular Trend Analysis Reports on developments and applications
 - Position Papers on specific PI-technologies
 - updated information on relevant literature
- shared and contract research based on involvement of best expertise centers worldwide, including preparation and management of FP7 projects
- consultancy by world top experts on one-to-one basis
- information on and access to PI-technology providers worldwide
- tailored trainings and courses (also on-site)
- expert assessment of PI-opportunities in members' production facilities



EUROPIC has a professional Management Team and two-level consultation structure

MANAGEMENT TEAM



Prof. A. Stankiewicz (Delft)
EUROPIC Director
Regional Director Benelux,
UK, Scandinavia



Prof. C. Gourdon (Toulouse)
Regional Director France,
Southern Europe



Prof. A. Górak (Dortmund)
Regional Director Germany,
Central & Eastern Europe



Mr. F. G. Spits, MBA (Delft)
Director Industrial Relations
& Valorization

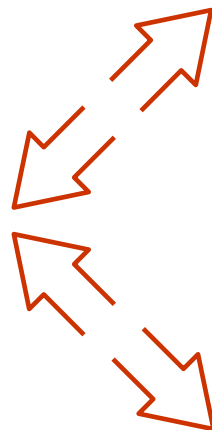
STRATEGIC BOARD

(key companies at executive
management level)



MEMBERS ASSEMBLY

(all member companies at senior
technologist level)



Strategic Board of EUROPIC is currently being formed

- Shell, Akzo Nobel, DSM, BASF, Evonik, Bayer, Rhodia, Sanofi-Aventis and Blue Star Silicones invited to participate
- First plenary meeting of EUROPIC Board in Rotterdam on 18-19 September 2008





For their second edition, the International Green Process Engineering Congress and the European Process Intensification Conference will be held together

E.P.I.C 2009



To enter on the web site click on the logo



Welcome to GPE-EPIC congress

Venice • Italy • 14-17 june 2009

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SCOPE

With the first edition of the EPIC 2007 (European Process Intensification Conference), EFCE (European Federation of Chemical Engineering) Working Party on Process Intensification (PI) has launched a new series of biannual European conferences focused on Process Intensification (PI). "Process Intensification provides radically innovative principles in process and equipment design which can benefit process and chain efficiency, capital and operating expenses, quality, wastes, process safety and more" (from the study "European Roadmap for Process Intensification", 2008).

PI is a new approach to process and plant design that greatly contributes to increase the economic and environmental sustainability through resources minimization (energy and feedstock), improved environmental and safety performance.

EPIC 2009 represents a great opportunity for the participants (scientists, researchers, practitioners, and technology providers) to discuss and share experiences on the current-status of the field, the latest developments, and the future needs. The conference focuses primarily on illustrating and discussing how the interactions among phenomena, equipments, and operations can contribute to enhance the processing performance efficiency. Contributions discussing innovative concepts and ideas, application-oriented technologies, and interdisciplinary research are welcome.

EPIC 2009 will be jointly organized with GPE 2009 because the two conference objectives integrate themselves. While GPE mainly focuses on the processes and technologies that provide the tools for "green chemistry", EPI tackles the methodologies and technologies that result in improved sustainability, efficiency and environmental performance.

Coordinators

G.P. Celata (ENEA, IT) and A. Servida (University of Genoa, IT).





TOPICS

The conference program will be constituted of invited keynote lectures, oral and poster contributions embracing the entire area of PI:

Structured technologies

- Non-reactive (e.g., structured internals for mass transfer operations, static mixers);
- Structured catalyst-based reactors (e.g., catalytic foam reactors, monolith reactors)
- Microreactors (including micromixers)
- Membrane reactors (non-selective)
- Static mixer-reactors

Hybrid technologies

- Multifunctional separations (e.g., reactive distillation, adsorptive distillation, membrane hybrid systems)
- Multifunctional reactors (e.g., membrane selective reactors, reactive adsorption, reactive condensation, reactive crystallization/precipitation)

Energy transfer

- Rotating (e.g., HiGee devices, spinning disk reactors)
- Impulse (e.g., pulsed pressure reactors, sonochemical reactors, ultrasound enhanced crystallization)
- Electromagnetic (e.g., microwave enhanced operations, photochemical reactors)

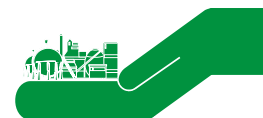
Dynamic operations

- Periodic operations of reactors
- Reverse flow reactors
- Pulsing operations of reactors

Enabling technologies

- Process Analytical Technologies (PAT)
- Process modelling
- Process control

PI education in chemical engineering





TIME TABLE

| | |
|--------------------------|--|
| 10 September 2008 | Deadline for receipt of abstracts |
| 30 September 2008 | Notification to authors Scientific program and conferences |
| December 2008 | Deadline for receipt of full texts and early registration on website |
| February 2009 | Notification of acceptance |
| April 2009 | Deadline for receipt of final manuscripts and deadline for registration |

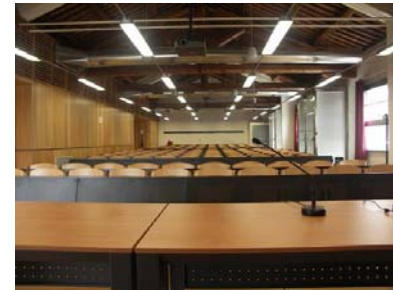
Selected papers will be submitted for publication in **the International Journal of Chemical Reactor Engineering** (GPE), or in **the international journal Chemical Engineering and Processing: Process Intensification** (EPIC)

EPIC 2009 – other information

AIDIC



- Venue: Venice, Dorsoduro - Quartiere Santa Maria – Buildings belonging to Ca'Foscari University and to Architecture University
- Dinner/Welcome cocktail: Ca'Foscari University Head Office, (Venetian palace close to “Canal Grande”)
- Accommodation at conference location: Istituto Canossiano (ca. 60 euro/night incl. breakfast)
- Official event of EFCE (event number 678)

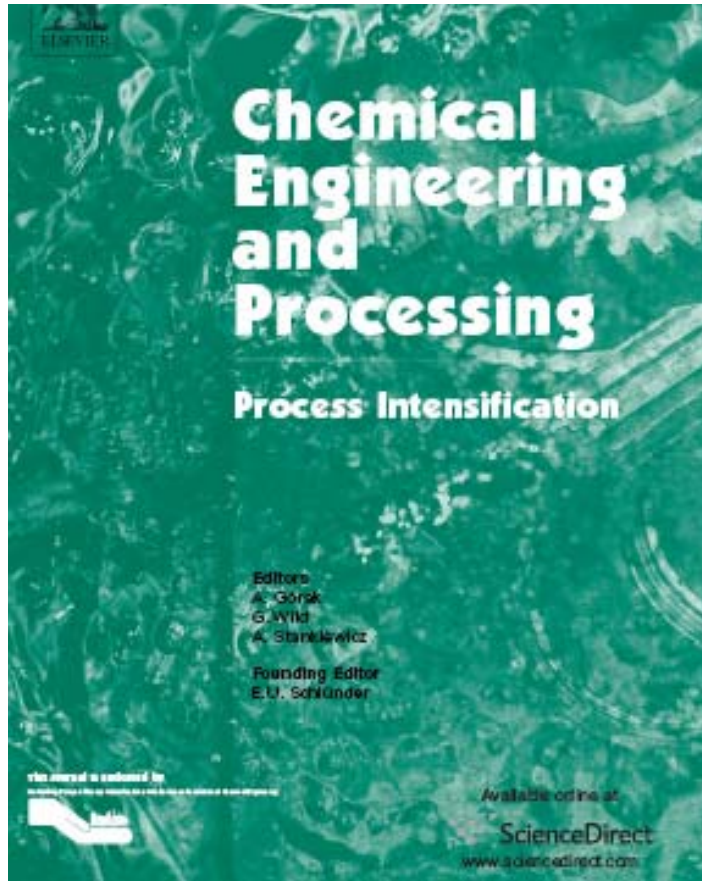


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First year of “Chemical Engineering and Processing: Process Intensification”



- Impact factor 1.156 (2007) – stable

246 articles published in 2007

Rejection rate: 59%

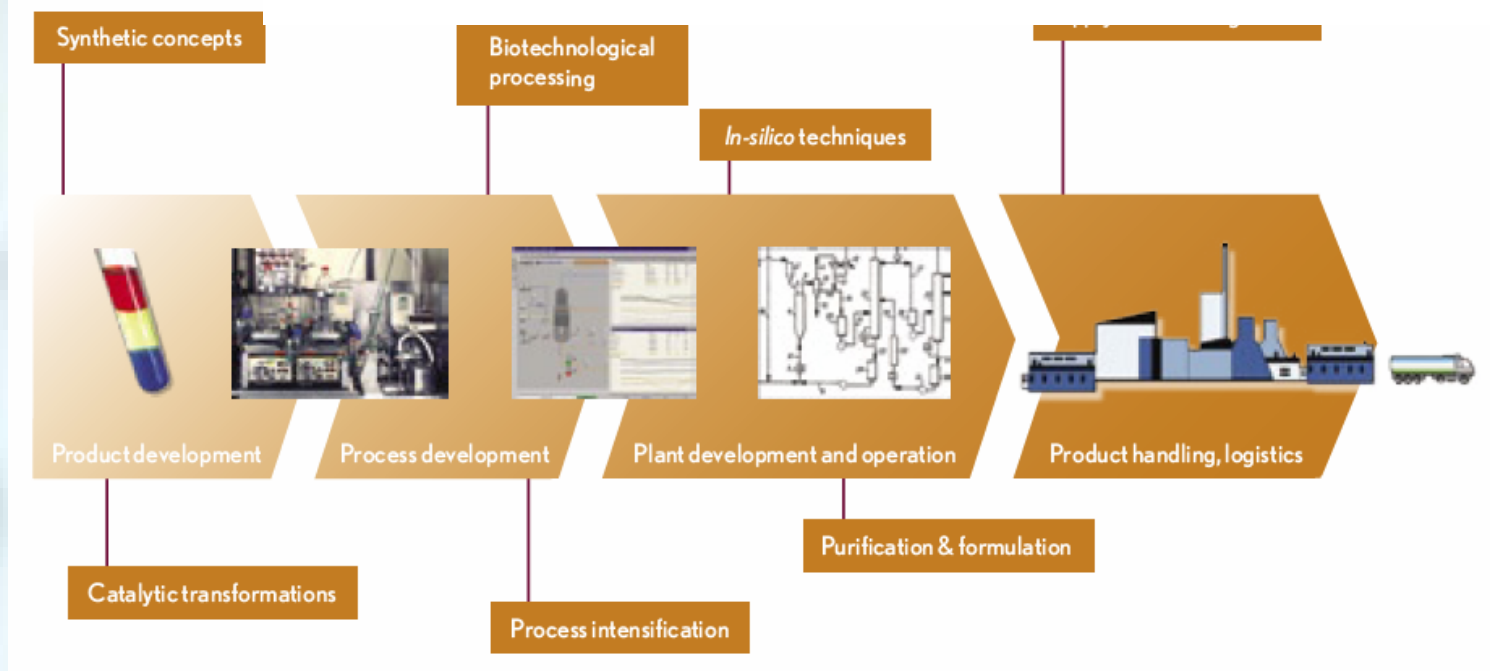
EPIC papers and several invited PI-reviews published

Further focus on PI needed.

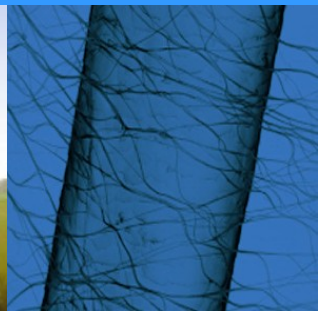
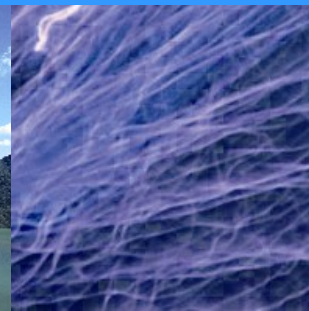
How to attract more PI-contributions?



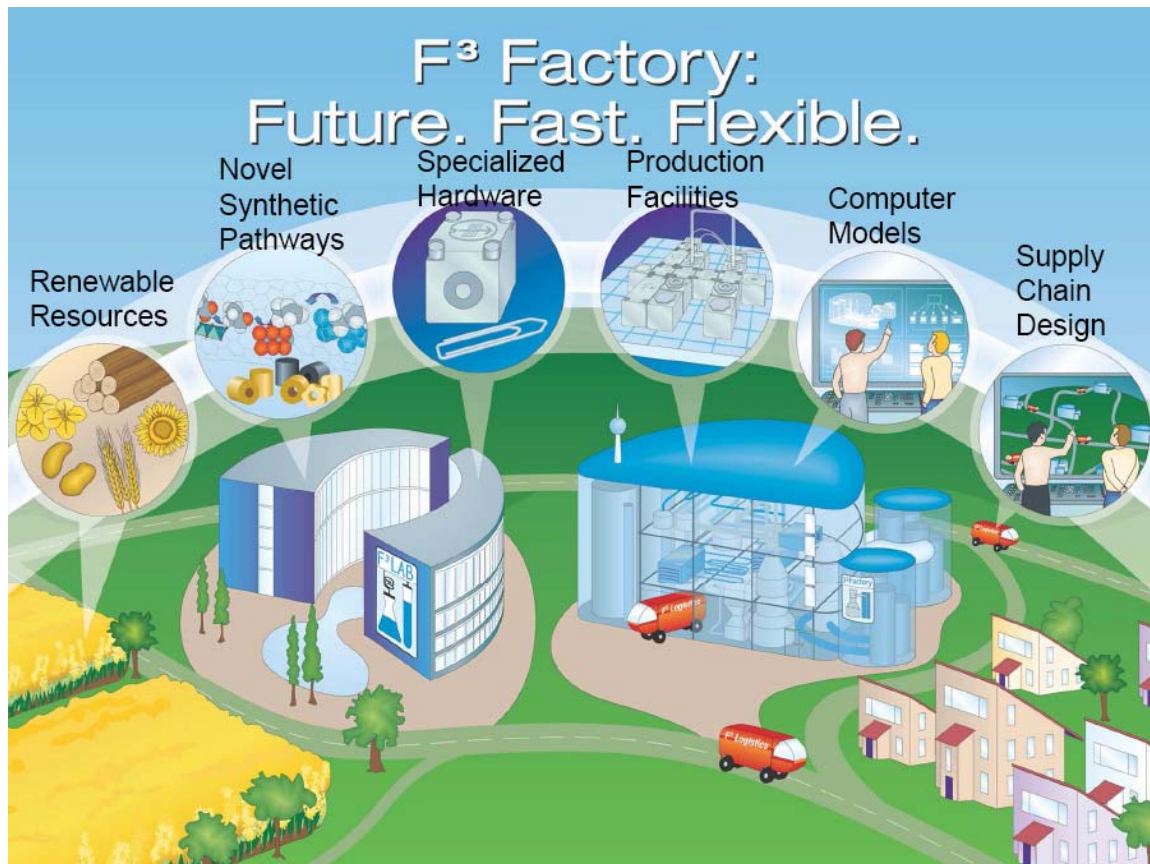
Reaction and Process Design



A European Technology Platform for Sustainable Chemistry



PI in FP7 – 2nd Call, Theme NMP



- Large collaborative project initiated by Bayer Technology Services

Point of concern: no PI-related topics in the 3rd Call

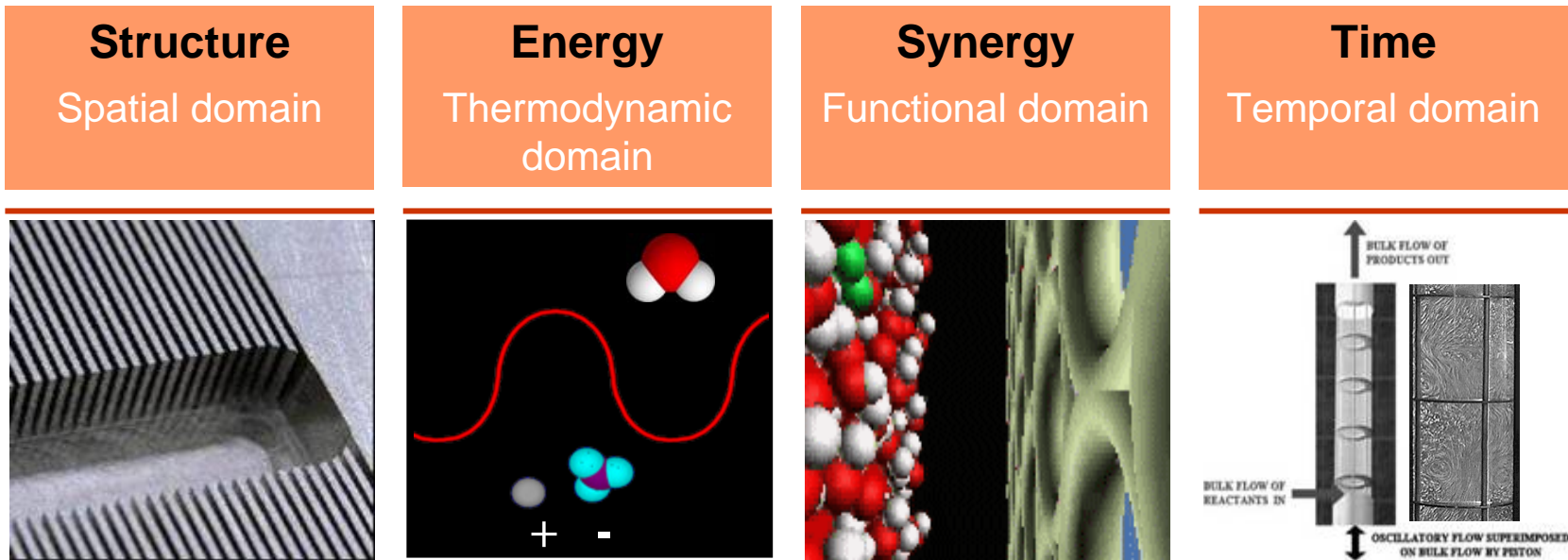
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New M.Sc. International PI Course developed in collaboration between Delft University of Technology and University of Leuven.

Concept based on new fundamental approach to PI:



- Case study projects included

