Platform Chain Efficiency

Manual of the Subsidy Procedure for the first phase of Action Plan Process Intensification (APPI), within the framework of the Energy Innovation Program 2008/2009 of the Ministry of Economic Affairs

Handleiding Subsidieregeling
eerste fase actieplan procesintensificatie (APPI)
in het kader van het Innovatieprogramma Energie 2008/2009
van het Ministerie van Economische Zaken

EXECUTIVE SUMMARY (DUTCH)

Dit document beschrijft de procedure voor het aanvragen van subsidie in het kader van de eerste fase van de uitvoering van het "Action Plan Process Intensification" (APPI).

Het APPI heeft als doel om het implementeren van procesintensificatie in Nederland te versnellen. Het plan werd in juni 2008 gepubliceerd onder auspiciën van het Platform Ketenefficiency van de Regiegroep Creatieve Energie en bouwt voort op de "European Roadmap for Process Intensification". Het actieplan is onderdeel van de Energie Innovatieagenda, die bijdraagt aan het realiseren van de doelen van het "Schoon & Zuinig Programma" van de Nederlandse overheid.

Het APPI bevat een onderzoeksprogramma met elf programmalijnen. In de eerste fase worden vier programmalijnen uitgevoerd, met een totale omvang van EUR 14 m. Voor deze fase heeft het Ministerie van Economische Zaken in juli 2009 50% van het budget (EUR 7 m) ter beschikking gesteld. Drie van deze programmalijnen worden opengesteld voor projectvoorstellen vanuit consortia van partijen uit het bedrijfsleven en de kennisinfrastructuur. De vier programmalijnen uit de eerste fase zijn:

- Programmalijn 1 – "Alternative energy-based operations"
- Programmalijn 4 – "Transport-limited processes"
- Programmalijn 7 – "PI process analysis tools"
- Programmalijn 11 – "Skyline Theme" (niet geopend voor projectvoorstellen)

Projectvoorstellen dienen te voldoen aan eisen met betrekking tot de partners, hun financiële bijdragen en de omvang van het project. Voorstellen die aan deze eisen voldoen worden door een onafhankelijke evaluatiecommissie vergeleken op basis van wetenschappelijk niveau en valorisatiepotentieel.

Onderstaande tabel geeft een samenvatting van de belangrijkste momenten tijdens de aanvraagprocedure. Alle benodigde documentatie, inclusief verplichte sjablonen en voorbeeld intentieverklaringen, is te vinden op www.dsti.nl/appi.

	Datum
Informatiebijeenkomst voor aanvragers	18 augustus 2009
Deadline ronde 1 (beknopte projectbeschrijvingen en intentieverklaringen)	**25 september, 17.00u**
Terugkoppeling op projectbeschrijvingen en uitnodiging om projectvoorstel in te dienen	Uiterlijk 23 oktober
Deadline ronde 2 (volledige projectvoorstellen)	**18 december, 17.00u**
Definitieve terugkoppeling op projectvoorstellen	Uiterlijk 15 januari 2010

Het indienen van stukken dient schriftelijk te gebeuren per bovenvermelde deadlines bij het kantoor van DSTI. Ter wille van de efficiëntie worden ook elektronische versies verzocht.

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A. INTRODUCTION

This document describes the procedure for project consortiums applying for subsidies in the first phase of the execution of the Action Plan for Process Intensification.

The Action Plan Process Intensification (APPI) aims to accelerate the implementation of process intensification in the Dutch process industry. The APPI was built on the European Roadmap for Process Intensification and was published in June 2008 under the auspices of the Platform Chain Efficiency and the Energy Transition Board. The Action Plan is part of the Energy Innovation Agenda, which contributes to the realization of the targets of the Dutch Government's Clean & Efficient program.

The Action Plan includes a research program of eleven program lines, based on a program duration of five years and a budget of EUR 100 m. The first phase of the Action Plan concerns four program lines, for a total of EUR 14 m: Alternative energy-based operations, Transport-limited processes, PI process analysis tools, and "the Skyline Theme". The former three will be open for projects that are proposed by consortiums of organizations from both industry and knowledge infrastructure. The fourth program line will start later this year and will not be open for proposals.

The Action Plan is part of the Innovation program Chain Efficiency of the Ministry of Economic Affairs. The Ministry has granted EUR 7 m for the execution of the first phase of the Action Plan Process Intensification.

The public-private partnership Dutch Separation Technology Institute Foundation (DSTI) functions as the legal and administrative entity for the execution of the Action Plan Process Intensification. DSTI has arranged for APPI representation at the level of its Executive Committee. The preparation of the program execution, including the organization of the project call, is in the hands of the "Taskforce APPI". An independent committee of experts will evaluate project proposals and advise DSTI's Executive Committee on proposed final decisions.

This manual of the subsidy procedure for APPI's first phase provides the necessary background and practical information for applicants. The next section of this document (section B) provides background information on the Action Plan PI. Section C presents an overview of the program lines that will start in the first phase. The subsidy program and the submission and evaluation procedures are introduced in section D. Section E describes important aspects of project execution. The final section (F) gives practical information for project applicants, including required documentation and submission deadlines.

B. ACTION PLAN PROCESS INTENSIFICATION – BACKGROUND

This section summarizes the Action Plan Process Intensification. For more information, please refer to the documents "European Roadmap for Process Intensification" and "Action Plan Process Intensification". These can be downloaded from www.dsti.nl/appi.

B.1 The impact of Process Intensification

The process industry is of significant importance to the Dutch economy, accounting for 28% of industrial employment, 5-6% of GDP directly and more than 10% of GDP when indirect effects are included. The process industry is also a major consumer of energy. The program described in this document addresses the impact of Process Intensification (PI), which is defined as a set of often radically innovative principles (“paradigm shift”) in process and equipment design. Such principles can bring significant benefits in terms of process and chain efficiency, capital and operating expenses, quality, wastes, process safety and more.

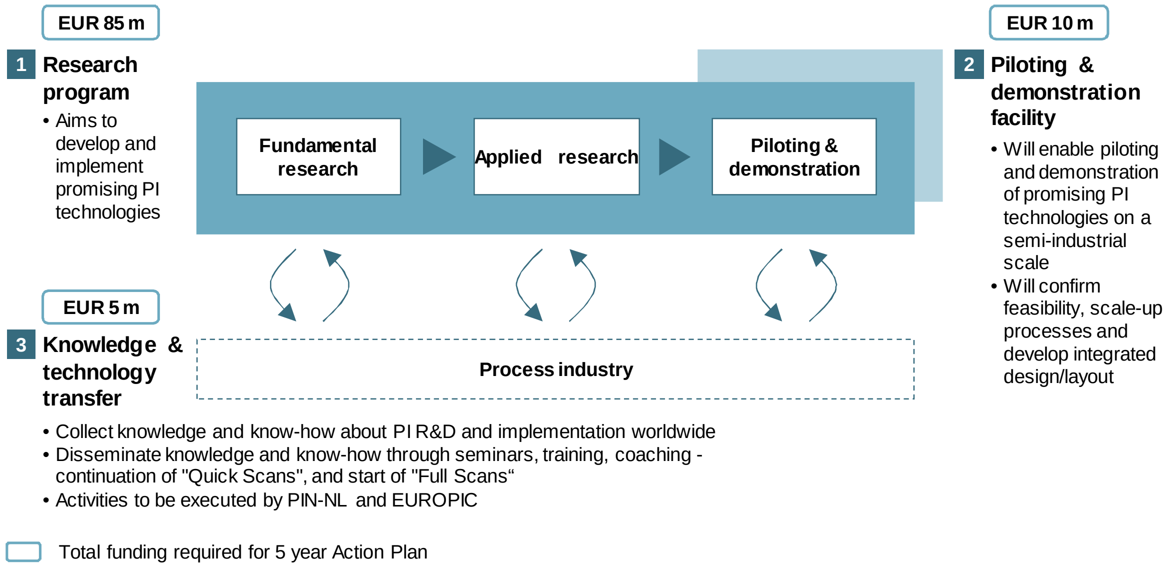
Process Intensification will therefore contribute significantly to the competitiveness of the Dutch and European process industries by making industrial processes faster, more efficient and less damaging for the environment. Accelerating the implementation of Process Intensification (PI) will help realize the goals of the Dutch Energy Transition while also realizing a sustainable and economically strong process industry.

Process intensification addresses the need for energy savings, CO_2 emissions reduction and enhanced cost competitiveness throughout the process industry. The potential benefits of PI are significant:

Petro and bulk chemicals (PETCHEM): Higher overall energy efficiency – 5% (10-20 years), 20% (30-40 years)
Specialty chemicals, pharmaceuticals (FINEPHARM): Overall cost reduction (and related energy savings due to higher raw material yield) – 20% (5-10 years), 50% (10-15 years)
Food ingredients (INFOOD): Higher energy efficiency in water removal – 25% (5-10 years), 75% (10-15 years); Lower costs through intensified processes throughout the value chain – 30% (10 years), 60% (30-40 years)
Consumer foods (CONFOOD): Higher energy efficiency in preservation process – 10-15% (10 years), 30-40% (40 years); Capacity increases – 60% (40 years); Transition from batch to continuous processes – 30% (40 years)

The Action Plan PI will accelerate the implementation of PI in the Dutch process industry, aiming to realize PI technologies in the factories through three interrelated activities: a research program, a piloting & demonstration facility and knowledge & technology transfer. The activities of the research program are fully integrated along the R&D value chain, from fundamental/applied research to piloting & demonstration (Figure 1).

Figure 1 - The activities of the Action Plan PI

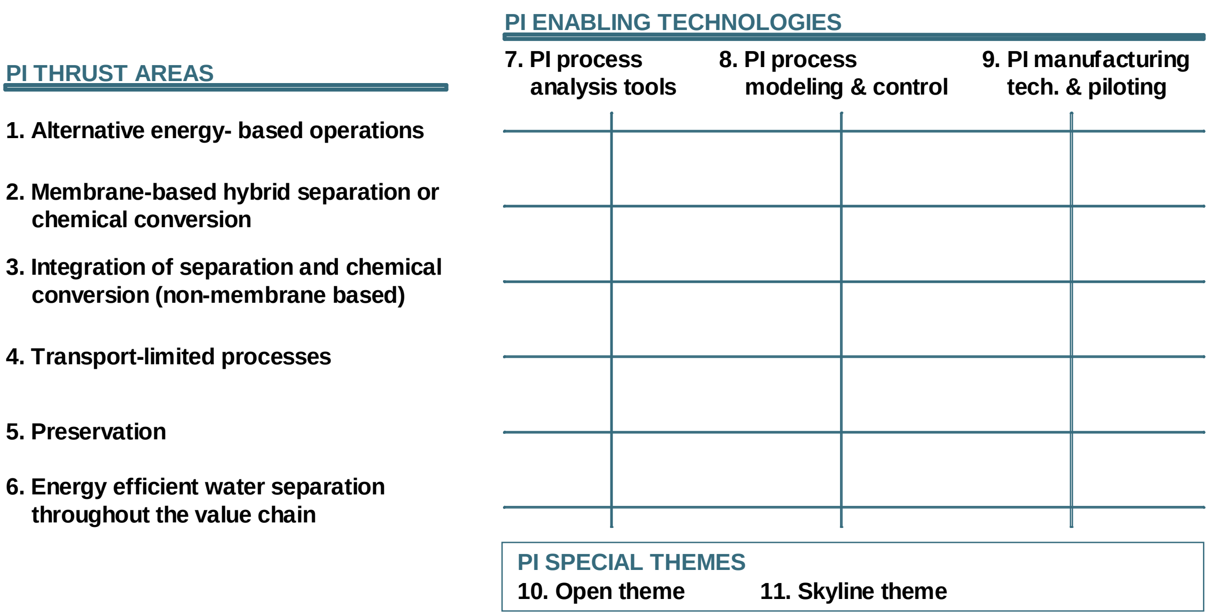


1) Overhead has been allocated to the research program for simplification

B.2 The full program

The research program aims to develop and implement PI technologies through steering and bundling research and development activities. The research program is organized into eleven program lines along three axes: PI Thrust Areas, PI Enabling Technologies and PI Special Themes (Figure 2). Each program line integrates fundamental/applied research and piloting & demonstration activities, and is thus focused on getting PI technology into the factory.

Figure 2 - Overview of program lines of the research program



The research program is based on the PI Roadmap. The Roadmap identifies promising PI technologies and the barriers to their implementation. Several individual technology roadmaps, specifying actions needed and potential benefits, were developed and are outlined in the PI Roadmap. The PI Roadmap recommends several activities, including non-technical actions that must be taken to accelerate PI implementation. An overview of the PI Roadmaps is provided in Figure 3.

Figure 3 - PI Technology Roadmaps

PETCHEM

- Heat-limited reactions
- Mass-transfer-limited reactions
- Cracking
- Ammonia
- Energy efficient separation

FINEPHARM

- PI Technologies for series production
- Process Analytical Technology
- Manufacturing Technology
- Process Control

PI Technology Roadmaps[1)]

CONFOOD

- Preservation processes
- Increased capacity of food production equipment
- Making batch processes continuous
- Emulsions and dispersions
- High throughput product/process development
- Water removal processes

INFOOD

- Water removal processes
- Advanced process control
- Primary process intensification
- Capacity increase
- Batch to continuous

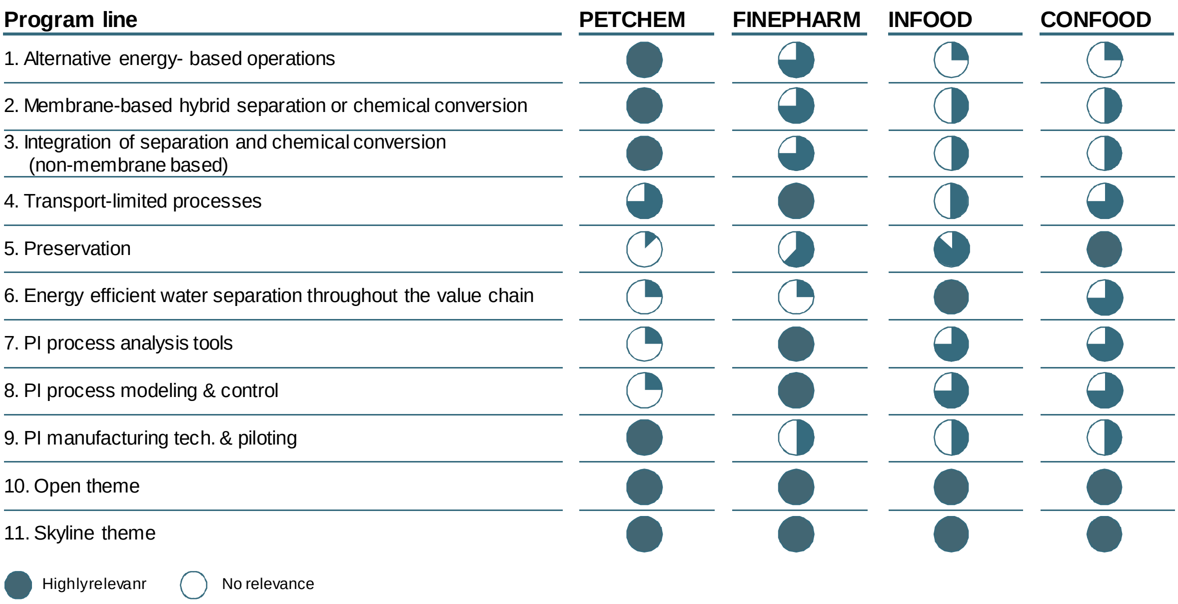
1) PI also has important benefits in other process industries like paper/pulp, steel and others.
For example, a roadmap for process intensification for the steel industry was developed with Corus

Based on the PI Roadmap, the most applicable PI technologies were selected and assigned to the program lines.

The initial selection of PI technologies was based on the number of times a PI technology was mentioned in the PI Roadmap. To ensure focus on specific process industry sector needs, the program lines also incorporate the themes identified in the PI technology roadmaps developed by sector teams which represented specific industrial sectors. The resulting program lines address the general and specific needs of all process industry sectors, as presented in Figure 4.

The program lines have been outlined using a common structure. The problem statement and approach chapter describes the scientific and/or economic problem that will be addressed and elaborates on the approach that will be used to solve the problem(s). The character of activities and the scientific/technological innovativeness of the program line in light of international developments are then specified. If the program line also includes fundamental research, the scientific excellence of the participating knowledge groups is detailed. The goals chapter then describes the milestones and deliverables of the program line. It also indicates any risks which may stand in the way of achieving the objectives of the project, and which measures will be taken to minimize these risks. The cost estimate specifies estimated costs of the program line for the total running period of five years.

Figure 4 – Relevance of program lines per process industry sector



B.3 Four program lines to be launched in 2009

In July 2009, the Ministry of Economic Affairs announced that funds would be made available to start four program lines. These funds amount to 50% of the program line budgets. The remaining balance will be provided by industrial partners and knowledge infrastructure partners of the program lines. The total budget available for the first five years is EUR 14 m, allocated to the program lines as:

Program line 1 – Alternative energy-based operations	4.0
Program line 4 – Transport-limited processes	6.5
Program line 7 – PI process analysis tools	3.0
Program line 11 – "Skyline Theme" (for year 1 only; not open for projects)	0.5
Total	EUR 14.0 m

This budget for the first phase for these program lines is lower than the APPI originally anticipated. The budget in this manual has been adopted accordingly.

C. PROGRAM LINE DESCRIPTIONS

This section describes the four program lines that will be started in Phase 1. These program lines (1, 4, 7 and 11) were chosen for their urgency and take the range of industrial sectors into account. The following chapters outline each program line, including project examples.

C.1 Program line 1 – Alternative energy-based operations

1.1 Problem statement

Process operations can be intensified when we remove or reduce performance limitations or enhance the driving forces behind processes. The latter is sometimes related to the way "energy" is transferred to the system, but our understanding and mastery of certain phenomena – which can potentially serve as "alternative energies" – are at varying stages of maturity. More mature technologies may simply require new or better equipment, while embryonic technologies must struggle to convince the industry of the worth behind their development in the first place.

Several technologies are applicable here. Based on the difference in density between two phases, processes driven by gravity can be enhanced by applying a centrifugal field. Chemical rate, which is traditionally enhanced by increasing the mean energy of the molecules (Arrhenius), can also be affected by directly transferring a quant of energy to the electron in the molecular bond (photochemistry). This transfer even leads to new results that are not possible through conventional methods. Microwave heating, for example, does not rely on convection or conduction and is able to heat viscous or solid materials without the need for high temperature gradients. It can also make use of differences in absorbance, enabling it to heat (catalyst) specific particles that absorb microwaves well. Next to such traditional examples, the PI sector is also exploring a number of phenomena (e.g. ultrasound, electromagnetic fields) which are less understood but which hold significant promise. The maturity of the field of alternative energy technologies ranges widely.

Alternative energy-based operations must achieve the following milestones:

1. Deliver undisputed evidence of its advantages by proving technical and economic feasibility
2. Determine the range of applications where the advantages can meet their potential
3. Develop equipment and methods that meet industrial standards (e.g. robustness, scale, economy)

1.2 Type of projects

Due to the range of technological maturity, a uniform approach cannot be adopted for all alternative energy technologies. Embryonic technologies will require many years (>10) of fundamental research. Even after delivering evidence of their usefulness, they may still face opposition due to limited ranges of application.

Therefore, those alternative energy technologies that have not reached the first two milestones (above) fall outside the scope of this program, though they could be actively monitored should breakthroughs occur. Technologies that show enough potential and which could reach industrial demonstration (i.e. pilot) in the near future (<5 years) will be targeted for further development. The early involvement of equipment suppliers is considered to be crucial for success.

Program line budget

The budget and targeted distribution for activities in program line 1 are shown in the table below.

Table 1 – Program line 1 budget [EUR m] – indicative

Fundamental research	Applied research	Piloting/ demonstration	Total
0.6	2.8	0.6	**4.0**

1.3 Example project approach[1]

A project aimed at alternative energy-based operations could have a structure of three stages. A possible timetable and milestones for this approach are shown in Figure 5.

Stage 1: Position papers on selected technologies

The first stage centers on investigating the status of the technologies in this area. This involves research, evaluation and analysis and developing hypotheses for each technology considered. Fundamental research results and information will therefore be measured and tested against applied research and industry. Making the selection will require tapping into the knowledge base of the world's leading R&D groups in specific fields. Since the number of alternative energy-based operations is large, the list may be narrowed down based on maturity and industry attractiveness. The deliverable of this activity will be position papers (milestone A in Figure 5) on each of the selected technologies within one year.

Preselected technologies may include:

- Centrifugal field (RPB, SDR, rotating plant concept, multi-stage separator)
- Microwave (viscous systems, biphasic, catalyst particles)
- Plasma (DBD)/photo (radicals generation at low temperatures)
- Supersonic gas dispersion

Stages 2 and 3: Development of a conceptual design for demonstration and piloting

The second stage will see a selection of the most promising technologies. For each of these technologies, an R&D program will be started to prepare it for an industrial pilot (milestone C). This will take about three years. The deliverable at the end of this stage will be a conceptual design for a demonstration of each of the technologies.

The final stage will be the actual demonstration in an industrial pilot of the most promising technology (in cooperation with an equipment supplier).

[1] This paragraph describes a possible approach for projects within this program line. This approach is not required.

The translation of fundamental know-how into an industrial application is a multidisciplinary task. It requires close cooperation between academia, industry partners and future equipment suppliers. Early and close involvement of project partners is crucial.

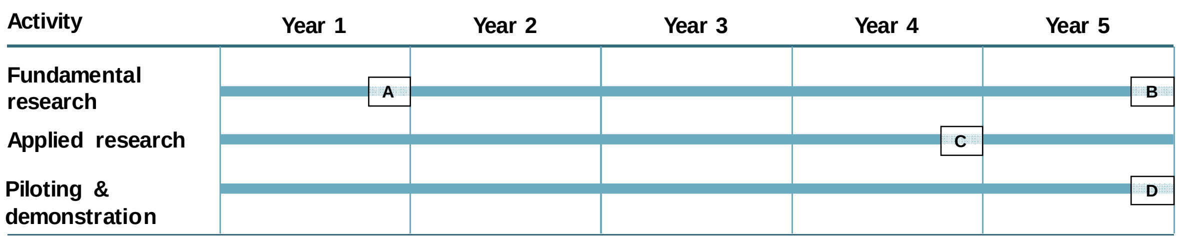
Concurrent monitoring of technologies

Since developments in the world continue, the project may actively monitor other technologies during the five year period. This concurrent stage will deliver an updated position paper on these technologies at the end of the project (milestone B).

Technologies that may be monitored:

- Ultrasound (dispersion, reactor, crystallization)
- Hydrodynamic cavitation reactor
- Electric field enhanced operations
- Pulsed compression
- Impinging streams
- Plasma (GlidArc)

Figure 5 - Example project timetable (Program line 1)



Milestone	Deliverable	Milestone	Deliverable
A	Position paper on status of preselected alternative energy-based technologies	C	Conceptual design of a demonstration pilot for the three most promising technologies
B	Updated position paper on status of all alternative energy-based technologies	D	Demonstration of one technology in an industrial pilot (in cooperation with equipment supplier)

C.2 Program line 4 – Transport-limited processes

2.1 Problem statement

In the bulk chemical, petrochemical and food sectors, continuous processing is an established manufacturing method thanks to the availability of dedicated production units. In the case of fine chemicals and pharmaceuticals, the situation is different. These sectors are characterized by the production of many different products in relatively small volumes, synthesized by multiple-step processes. Optimization in terms of lower operational costs resulted in the batch-operated, multipurpose plant becoming the dominant production facility.

Recent developments in PI technologies could revolutionize the way we approach process development, technology utilization and facility design in these sectors. Here we are dealing with mass transfer-limited reactions, so continuous, highly productive PI modules in synthesis and downstream processing will result, in principal, in substantial reduction of development time, production costs, waste production, raw material consumption (because of improved selectivity of the chemical conversions) and increased safety, while maintaining flexibility and reconfigurability. The production facility would become a multipurpose, serial production train.

The majority of PETCHEM processes with high heat production or consumption in the reactor are categorized as heat transport-limited reactions. This sector needs:

- Increased energy efficiency
- Complete temperature control, which will increase safety (runaway prevention), improve selectivity, reduce fouling and better utilize the catalyst
- Capital cost reduction, lower running cost and longer runtime

PETCHEM faces the following technological limitations/bottlenecks:

- Radial and axial temperature gradients on the reactor-scale to address insufficient heat transfers. Current inefficiencies directly impact reactor performance, leading to lower selectivity, more byproducts and catalyst deactivation
- The high heat flux reactors available are too expensive and have proven to be unstable; they must also be tuned each time to the desired reaction. They usually contain the catalyst in the form of a coating and, as a result, traditional commercially available catalysts cannot be used and a large catalyst synthesis program is needed
- Catalyst performance (i.e. activity, selectivity and stability) is often unsatisfactory at “easy” temperatures

The main technical hurdles faced by FINEPHARM are:

- Structured reactors allowing high mass transfer rates are too expensive and not a proven technology (e.g. catalyst coated reactors)
- Reactors/devices should be multifunctional/multipurpose (e.g. in terms of residence time distribution). The residence time distribution in continuous processing is often unfavorable compared to that of batch systems

The overall objective of the program line is the development and implementation of structured devices that have proven (with technical, economic evidence) that they offer advantages over existing continuous or batch technologies. An additional objective is the testing of the adequacy of process modeling and control tools available which are not sufficiently used on an industrial scale.

2.2 Type of projects

The program aims to implement structured devices within five years. The actual development of separation devices (DSP) will be an activity of the DSTI program, and will not be included in this program line.

The heart of a process is the reactor; in many cases, its design and operation will be the location of innovation. It is not the purpose of this program line, however, to limit its work to the reactor alone. Process design and experimental demonstration of the process will be the ultimate objective. Scale-down of the reactor and other components is essential.

The program could include:

- Development of structured reactors, including micro reactors (and anti-fouling measures)
- Investigation into selection catalysts, elucidation kinetics, stability, window of operation
- The study of the potential of increased selectivity of existing reactors in other operating windows
- Design of multi dispersion/injection systems
- Evaluation of pipe-reactors and/or multi-tube, loop reactors
- Assessment of the introduction of inerts to improve mixing and heat transfer without "metal"
- Application of vibration to enhance mixing and heat transfer
- Design and construction of mini-plants

Program line budget

The budget and targeted distribution for activities in program line 4 are shown in the table below.

Table 2 – Program line 4 budget [EUR m] – indicative

Fundamental research	Applied research	Piloting/ demonstration	Total
1.0	4.2	1.3	**6.5**

2.3 Example project approach[2]

A project within program line 4 could consist of three consecutive stages, supported by concurrent monitoring of technological developments. Figure 6 is an example timetable, including potential milestones.

Three project stages

The first activity will be the selection of promising devices. This requires information gathering, evaluation and development of a shared position between academia, industrial partners and equipment suppliers. The deliverable of this activity will be a position paper on each of the selected technologies.

In the second phase, an R&D program will be started to develop the selected devices towards an industrial pilot. In the third year, an intermediate selection will be made of one or two of the most promising devices. The deliverable at the end of the fourth year is the realization of a pilot. The final stage will be the actual demonstration in an industrial pilot of these technologies (in cooperation with equipment suppliers).

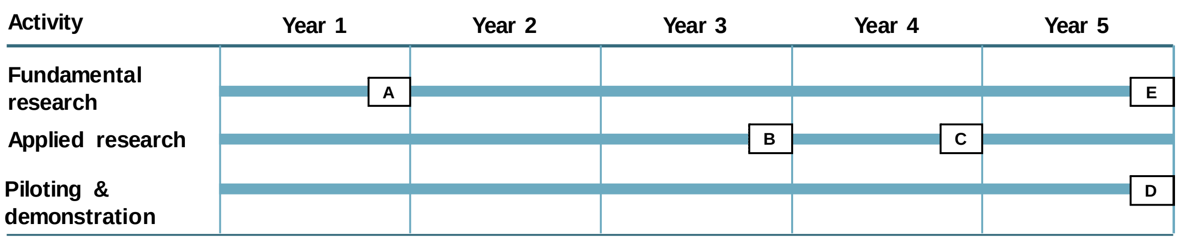
Innovation can be realized for equipment suppliers when the fundamental know-how is translated into industrial application. The translation of fundamental know-how into industrial application is a multidisciplinary task requiring close cooperation between academia, industry partners and future end-users. Early and close involvement of end-users is crucial.

[2] This section describes a possible approach for projects within this program line. This approach is not required.

Concurrent monitoring of technologies

Since technological developments are continuous and occur at an increasingly fast pace, all devices will be actively monitored during the five year period of this project. Attention should be paid to developments outside of the Dutch network, as there is substantial activity in this area in Europe. Interesting developments outside the network may require the program to be adapted accordingly (to prevent duplication and identification of new breakthroughs). This concurrent stage will deliver an updated position paper on these structured devices at the end of the project.

Figure 6 – Example project timetable (Program line 4)



Milestone	Deliverable
A	Position paper on selection of 3-5 promising devices
B	Development of 3-5 promising candidates towards industrial demonstration, with selection of one or two most promising in three years
C	Conceptual design of demonstration pilot for the most promising technologies

Milestone	Deliverable
D	Demonstration of one or two technologies in an industrial pilot (in cooperation with equipment suppliers)
E	Updated position paper on status of all structured devices

C.3 Program line 7 – PI process analysis tools

3.1 Problem statement

Contrary to large PETCHEM processes, many INFOOD, CONFOOD and FINEPHARM production processes are not optimized, resulting in decreased capacity utilization (10-20%) and a portion of the end-product falling outside of specifications (10-20%). Costs of non-optimized production amount to 1-2% of total turnover, which represents EUR 100-200 m per year in the Dutch dairy industry alone. This excludes the costs of those products that are deliberately produced at a quality level above specifications in order to avoid rejects.

Reasons to maintain non-optimized production include:

- Unknown fluctuations in raw material quality (e.g. seasonal effects, different suppliers, variations in composition of intermediate chemicals production processes)
- The absence of an adequate physico-chemical model describing the relationship between process parameters and product quality
- The suboptimal design and control of processes

New and improved sensor techniques would negate these excuses. Current sensory systems are too slow, inaccurate or not robust enough for industrial processes. Fast, accurate and robust online sensors are needed to determine whether products are within specification and whether processes are running optimally. This will enable advances such as the transition from batch to continuous processing. Continuous processing of particularly pharmaceuticals will only be FDA-approved if the end-product is continuously analyzed with sufficient accuracy and reliability.

The need for adequate sensors is also evident from a process control point of view. Without accurate sensors, product quality cannot be steered by adjusting process parameters. The development of current sensor techniques is therefore required. This would also include more sophisticated signal analysis techniques to improve the amount of data obtained from the sensors. What's more, many parameters that determine product composition cannot be measured online: color, turbidity, taste, odor, low concentrations of reactants and intermediates and microbiological components (contaminants like penicillin, viruses and pesticides). To this end, completely new sensor techniques need to be developed.

In-situ characterization through spectroscopy

The demand for fast in-situ characterization is clear; offline (lab) characterization of produced samples is laborious and time consuming, and consequently cannot provide real-time feedback on product quality. Optical analysis techniques, such as spectroscopies (UV, VIS, (N)IR, Raman) and refractive index detection, are intrinsically powerful because of their extensive usability in combination with "non-contact" (remote) sensing characteristics. The application of standard "bulky" equipment is an option in some cases, but not preferred due to performance concerns, complexity of applicability and the residence time needed for analysis next to the residence time needed for production.

The advantage of spectroscopies is that they can be performed using optical fibers, requiring only a small measuring spot (volume). In-situ and online analysis using fiber optic spectroscopic techniques allows for real-time adjustment of operating conditions based on current data, maintaining process optimization.

The integration of optical techniques for analysis of small volumes already functions to some extent ("TriPlex" microchip, Lionix BV). Microchips have led to innovative sensing principles such as the exploitation of the properties of micro ring resonators and interferometric principles, in addition to the optimization of "straightforward" evanescent wave and spectrometric (absorption) detection. This technology also makes it possible to integrate a number of sensing windows into one sensor, allowing characterization at different phases of the synthesis process simultaneously.

State-of-the-art research into new sensor techniques that meet these needs is being conducted at several Dutch universities. The challenge is to bring these techniques to industry. The development of this new generation of sensors will facilitate the transition from batch to continuous processing and will enable the control and optimization of production process.

3.2 Type of projects

In the development of new sensor techniques, especially in the fields of (micro)biology and microchip sensors, research is at a fundamental stage. A huge diversification in different (bio)chemical compounds can be achieved within the next five years. New techniques need to be made suitable for industrial use, which primarily requires applied research and development. The increases in sensitivity and response times of more standard spectroscopic measurement techniques (UV/VIS, (N)IR, Raman) primarily require applied research and development. These techniques can be further developed to increase the amount of information obtained from measured spectra. Ultimately, the developed prototype sensory systems need to be tested in industrial processes.

Program line budget

The budget and targeted distribution for activities in program line 7 are shown in the table below.

Table 3 – Program line 7 budget [EUR m] – indicative

Fundamental research	Applied research	Piloting/ demonstration	Total
0.5	2.0	0.5	3.0

3.3 Example project approach

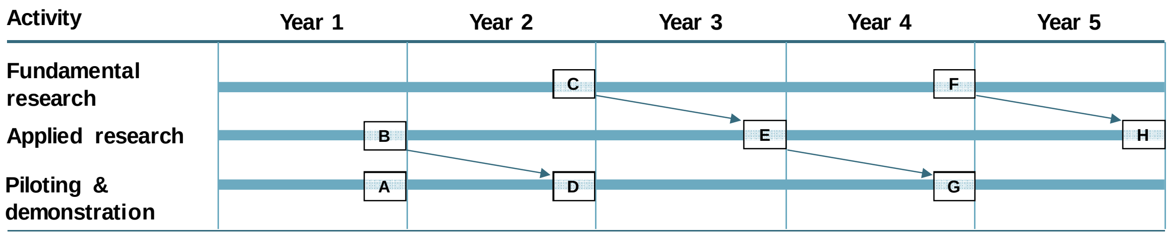
The rapid development and availability of new and more accurate analysis modules means fast implementation and testing within five years. Sensors will be developed within academic institutes in close cooperation with sensor manufacturing companies to ensure the valorization of the knowledge that is developed. Model experiments will be performed at academic institutes. Once proof of concept of a type of microanalysis module has been demonstrated, additional experiments on "real" reactions and systems will be performed in industrial conditions. The sensors will mature in functionality and performance, starting with "straightforward" detection of physicochemical properties and eventually integrating extra novel functions. These novel functions are especially seen in the field of (micro) biology; fundamental research is rapidly developing supersensitive, fast sensory systems and techniques for complex target components.

The translation of fundamental know-how into industrial application is a multidisciplinary task requiring close cooperation between academia, industry partners and future end-users. A close cooperation between universities and Dutch research institutes (three TUs, WUR, Radboud, TNO, NIZO), sensor producers and industry ensures the innovation of current industrial production processes, how they are run and how they are designed. Early and close involvement of end-users is crucial for valorization.

Project approach

During the first two years, new sensory systems will be applied in industrial conditions. Some will require significant development efforts to become functional. Others can be more readily applied and could already be piloted. Fundamental research into new sensory systems will have its first results after two years. These systems will be developed into applicable sensor systems which will be tested in industrial conditions.

Figure 7 – Example project timetable (Program line 7)



Milestone	Deliverable
A	Evaluation of currently available sensory systems with or without improved sensory capacity
B	Industrial pilot sensor available based on currently available sensory system
C	**First** new sensory system from fundamental research
D	Evaluation of existing pilot sensor system (milestone B)

Milestone	Deliverable
E	**First** new industrial pilot sensor available (based on deliverable C)
F	**Second** new sensory system from fundamental research
G	Evaluation of **first** new pilot sensory system (milestone E)
H	**Second** new industrial pilot sensor available (based on deliverable F)

C.4 Program line 11 – Skyline Theme (not open for proposals)

The "Skyline Theme" aims at the development of a long-term vision for the process industry, with Process Intensification as a central issue but not necessarily incorporated in the existing processes. It will study the total value chain from stock feed to consumers. Real out-of-the-box thinking is more important than optimizing the existing process industry. This program line can therefore be considered the first update of the PI Roadmap, eventually leading to new APPI programs.

Because of its unique character, this program line is not open for proposals.

4.1 Problem statement

The process industries are becoming more and more aware of the necessity of radical modernization of the old processes and development of new energy-saving and environmentally-friendly technologies. Recent scientific reports and publications have driven the social urgency surrounding the limited availability of nonrenewable natural resources and the changing climate.

The aim of program line 11 is to extend the PI Roadmap with a scientific “dream” which addresses the sustainability of process industries beyond 2050 and which envisions technological developments in Process Intensification that will be needed to realize that “dream”.

Some questions in which Process Intensification can and will play an important role include: How can we utilize solar or wind energy in chemical processing? What can

Process Intensification do to make "White Biotech" processes or production of fuels from renewable raw materials economically and technically feasible? What can PI do to control complex reaction pathways in such a way that the amount of by-products is brought to a theoretical minimum?

4.2 Expected results and program setup

The final deliverable of the first stage of the "Skyline Theme" will be a published vision document that includes recommendations for the relevant long-term R&D programs in the field of Process Intensification. The vision document will encompass an extensive value chain optimization.

The program will be organized by the "PI Skyline Team", which will be set up and led by Prof. Andrzej Stankiewicz from Delft University of Technology, Chairman of the Working Party on Process Intensification at the European Federation of Chemical Engineering (EFCE) and Director of EUROPIC, the European Process Intensification Centre.

The program will consist of a series of workshops aimed at developing a clear vision of the changes and processing challenges to overcome until 2050 and at identifying concrete themes that will give direction to fundamental research starting in 2010. These workshops will see heavy involvement from internationally renowned experts, including both academics and (ex-)industrialists who are known for their visionary thinking and ability to look beyond the horizons of current R&D developments.

It can be expected that the PI Skyline Team will examine developments in disciplines other than chemical and process engineering, such as applied physics, materials science, electronics, (bio)chemistry and (bio)catalysis, nanotechnology, etc. The team will determine those areas in which interdisciplinary collaboration will benefit the development of the new generation of intensified processes.

D. SUBSIDY PROGRAM

This section describes the subsidy program for APPI program lines 1, 4 and 7. The first chapter outlines the program budgets. Chapter D.2 introduces the eligibility and evaluation criteria that are the basis for funding decisions. Chapter D.3 provides an overview of the application procedures and a timetable.

D.1 Program budget

The total budget of the program equals EUR 14 m. Table 4 shows how this budget is distributed over the program lines and types of research activities. Available subsidies, funding requirements and calculations can be found in E.3 (page 24).

Table 4 – Program line budgets [EUR m] – indicative

	Fundamental research	Applied research	Piloting/ demonstration	Total
1 – Alternative Energy-based Operations	0.6	2.8	0.6	4.0
4 – Transport-limited Processes	1.0	4.2	1.3	6.5
7 – PI Process Analysis Tools	0.5	2.0	0.5	3.0
11 – Skyline Theme (year 1 only)				0.5
Total	2.6	9.0	2.4	**14.0**

D.2 Project criteria

Projects for the APPI program lines must meet certain eligibility criteria and will be assessed using evaluation criteria.

2.1 Eligibility criteria

To ensure project viability and its network effects for the Dutch processing knowledge infrastructure and industry, applicants must meet the following criteria:

Partnership: The project has a minimum of three different partners to strengthen network formation, including at least one knowledge infrastructure partner and one industrial partner which conduct R&D and/or manufacturing in the Netherlands. This condition ensures direct interaction between these two partner types in the Netherlands. Letters of Intent signed by prospective partners must be available.
International partners: Foreign (non-Dutch) companies may participate in consortiums at their own expense. Their contributions are eligible for APPI funding if shown to be essential for the project.
Financial contributions: The ratio of total financial contributions (cash plus in-kind) from industrial and knowledge infrastructure partners should be 1:1. The total subsidy request cannot be more than 50% of the total project funding.

Critical mass: To ensure critical mass, the size of a project needs to be at least EUR 2 m for five years, or EUR 400 k per year.

2.2 Evaluation criteria

The evaluation and selection of projects will be based on four scientific criteria and four criteria related to deployment potential. All criteria carry equal weight. In the final evaluation, projects will be scored on each criteria using a scale of 1 (poor) to 5 (excellent). In order to be eligible for funding, a project must score at least 3 on each of the criteria, and have a minimum total of 28 points.

Scientific criteria

Innovativeness: The project addresses scientific challenges that go beyond the global state-of-the-art in research.
Research method: The proposed research method is of an indisputable scientific nature.
Coherence: The project proposal demonstrates internal coherence between activities and external coherence with respect to other (research) projects, both within the APPI Program and elsewhere.
Scientific excellence: Knowledge infrastructure partners have demonstrated the ability to conduct excellent, groundbreaking research, and are considered among the international top-players within their fields.

Evaluation criteria related to deployment potential

The objective of the Action Plan PI is to bring PI technologies from fundamental research to demonstration in pilots that are the basis for full-scale deployment. Deployment potential is therefore paramount.

R&D value chain planning: The project demonstrates how fundamental research (if necessary) leads to the pilot/demonstration of the novel PI technology.
Prospective commercial valorization: The project proposal shows and quantifies future economic value, for example through the development of intellectual property or the realization of energy cost savings.
Involvement of equipment supplier(s): The project has significant involvement from equipment supplier(s) for the establishment of a piloting facility and the assessment of future scaling opportunities.
Entrepreneurial track records: Consortium partners have demonstrated experience in setting up new ventures in the chosen areas of the project and have proven organizational capabilities.

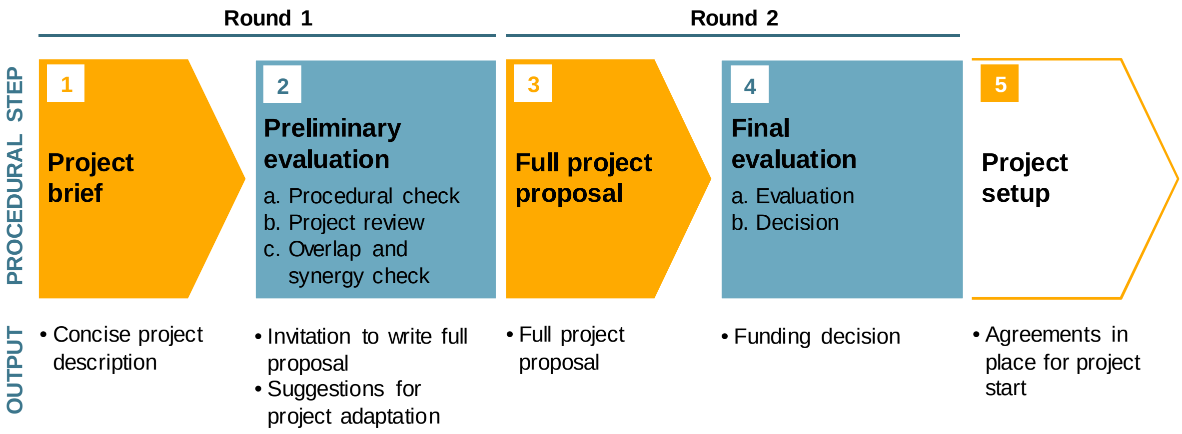
D.3 Application procedure

3.1 Overview of application procedure and timetable

Figure 8 summarizes the two-tiered application procedure for projects. The first round consists of the writing and evaluation of a concise project brief. In the second round, applicants of accepted project briefs are invited to write a full project proposal for final evaluation. Step 5 in the figure below denotes the arrangements to be made in order for projects to start as soon as possible.

Applicants must appoint a project coordinator for the duration of the application period. Once the project has been approved, the consortium partners will choose a project leader.

Figure 8- Overview of application procedure



Timetable

The following timetable lists the key deadlines and communication dates in the application procedure.

	Date
Information session for applicants	August 18, 2009
Deadline for submission of project briefs and Letters of Intent	**September 25; 17:00**
Feedback on project briefs, and invitation to write full proposal, no later than	October 23
Deadline for submission of full project proposals	**December 18; 17:00**
Final decisions communicated to project coordinators, no later than	January 15, 2010

3.2 Round 1: Project briefs

The first round is a bottom-up, open process to gather as many ideas as possible for project proposals.

Step 1 – Project brief: A relatively small amount of information is asked from prospective projects at this stage. The required information will cover no more than five pages, according to a prescribed format. Templates may be downloaded from www.dsti.nl/appi.

Step 2a – Preliminary procedural check: The project briefs will first be checked by the Taskforce APPI against the general eligibility criteria (paragraph 2.1). Only if the project meets these criteria, it will be submitted to the Evaluation Committee for preliminary project review.

Step 2b – Preliminary project review: If proposals comply with the eligibility criteria, the Evaluation Committee will conduct a preliminary project review based on the evaluation criteria. This review will be a qualitative evaluation of the potential in the project brief.

Step 2c – Adaptation (where appropriate): The Evaluation Committee, supported by the Taskforce APPI, will also investigate possible overlap between promising proposals. Based on identified overlaps, and possibly relevant gaps between projects, the Evaluation Committee may propose consolidation of overlapping projects and extension of consortia. These proposed adaptations to projects will be arranged in close consultation with the Taskforce APPI and project coordinators.

Applicants with promising proposals will be invited to write a full proposal irrespective of budgetary restrictions. Other applicants will be advised to abstain from submitting a full proposal.

3.3 Round 2: Full proposals

The second round follows a top-down process to build coherent program lines. While applicants are not obliged to submit project briefs in round 1, it is strongly advised that applicants use the first round to receive preliminary feedback. This will significantly increase their chances of success in round 2. In its effort to build a balanced project portfolio, the Evaluation Committee reserves the right to advise the invitation of new consortiums to submit proposals for program lines that lack high-quality project briefs from the first round.

Step 3 – Full project proposal: The project coordinators will write and submit full-length proposals, including balanced project budgets, according to a prescribed format. A template for the proposal and budget calculations may be downloaded from www.dsti.nl/appi. Consortium partners must demonstrate their commitment to the project by co-signing the proposal.

Step 4 – Final evaluation: In the final evaluation, the Evaluation Committee will score eligible projects as outlined in paragraph D.2.2. The committee may request advice from third parties to reach a well-informed recommendation. The Evaluation Committee will then formulate a funding proposal based on the project scores and on portfolio (budget) considerations. The final decisions will be made by the Executive Committee (EC) of DSTI.

Project coordinators will be notified of the outcome by the Taskforce APPI.

3.4 Project setup

Once an application has been accepted, consortiums need to make the necessary arrangements to set up the project. All project partners will sign Project Agreements and final budgets will be specified. In addition, the consortium needs to establish administrative procedures for project progress reporting, financial reporting and time registration in accordance with DSTI's processes (subject to accountant review).

This stage will take approximately six weeks and must be completed before projects can start. Further details on project execution can be found in section E.

3.5 Evaluation Committee, EC of DSTI, and Taskforce APPI

The Evaluation Committee will consist of 5-7 independent members from diverse backgrounds in academics and industry. Evaluation Committee members are highly recognized for their contributions to their respective fields and will be appointed by the EC of DSTI. They will avoid any suggestion of conflicts of interest with the proposed projects and may consult with external advisors where deemed appropriate. The Evaluation Committee will prepare advice for the EC of DSTI, which will make the final decisions on subsidies. The Executive Committee will only deviate from the Evaluation Committee's advice with well-supported and documented reasons.

The administration of the subsidy procedure will be executed by the Taskforce APPI. The Taskforce APPI will also provide advice to the Evaluation Committee.

Confidentiality

Only members of the EC of DSTI, Taskforce APPI and Evaluation Committee will have access to submitted project documents. All have signed a non-disclosure agreement. Any advisors consulted by the Evaluation Committee for evaluation purposes will also sign a non-disclosure agreement before documentation is shared.

E. PROJECT EXECUTION

This section details the expected execution of projects by applicant consortiums. The first chapter presents an overview of the APPI program management. Chapter E.2 addresses the establishment of knowledge transfer and intellectual property agreements. Financial arrangements are described in chapter E.3.

E.1 General structure

Execution of the APPI Program will be administered by the Dutch Separation Technology Institute (DSTI). Once projects are underway, all communication between the APPI and project consortiums will be conducted through the Program Administration at DSTI. An Operational Program Manager will be appointed to coordinate APPI related activities.

Consortiums will report to the Program Administration quarterly. Reports will cover both project progress and project financials. The Program Administration will provide templates for the submission of project information that minimize the administrative burden for consortiums. As such, APPI will use existing DSTI procedures and infrastructure.

E.2 Knowledge transfer and intellectual property

Funded projects will need to comply with DSTI's policies related to knowledge transfer and intellectual property rights. Each project of the APPI will be treated as an independent industrial sector according to DSTI's policies. These policies may be downloaded from www.dsti.nl/appi.

Consortiums may choose to deviate from these policies if the nature and characteristics of the research, development and valorization require them to do so. Any alternative IP agreement will need to adhere to (European) regulation. It is the consortium's responsibility to obtain approval for its IP agreement from the Ministry of Economic Affairs.

E.3 Financial setup

This chapter summarizes the financial structure of projects and details the rules for the calculation of budgets (paragraph 3.1). Paragraph 3.2 details project funding, and the final paragraph describes the setup of invoicing and payments.

3.1 Rules for project cost calculations

For reason of consistency, APPI will apply the calculation rules of DSTI. This paragraph describes these rules in a nutshell.

The calculation of project cost first depends on the type of partner:

1. Industrial partner
2. Partners from universities
3. Technological institutes as ECN and TNI (“GTIs”)

Technological institutes ("GTIs")

GTIs should use their integral cost prize fees as yearly approved by their independent auditors. These fees will be recognized for 50% as in kind contribution. The remaining 50% will be reimbursed. The hourly rate for a GTI employee is derived from the annual fee divided by the effective hours per year per employee.

Industrial partners and partners from universities

The industrial partners and partners from the universities should apply the following calculation rules that can be broken down in four types of project cost:

- Cost of man hours (researchers)
- Cost of third parties
- Cost of usage of infrastructure
- Investments

Cost of man hours (industrial partners and universities only)

The cost of man hours should be calculated on the basis of actual cost of wages. Depending on the type of labor contract (temporary versus (semi) permanent) the wage cost can be increased with either 50% and/or an annual bench fee.

The table below summarizes the DSTI calculation rules for these cost components

	Temporary staff	Permanent staff
Wage costs	Yes	Yes
50% markup on wage costs	No	Yes
Bench fee	Yes	No

Wage cost should be calculated including employers' cost of social security and pension plans. The definition of wages follows “kolom 14 fiscale loonstaat” of the Dutch tax authorities.

If the specific researcher on a project has a *permanent labor contract*, wage cost should be increased with a 50% markup to cover indirect cost (including coaching).

If a researcher has a *temporary contract*, a bench fee can be calculated which covers the cost of creating a working environment within the partner organization. This bench fee amounts:

2010	2011	2012	2013	2014
EUR 23,000	EUR 25,000	EUR 25,000	EUR 25,000	EUR 25,000

The *bench fee per FTE* for costs directly related to the additional project costs covers the following items:

- Out-of-pocket expenses like standard consumables, services, software and minor investment (less than € 2,500)
- Costs of publications
- National & international travel and lodging (conferences are included, but not commuting)
- Training & Courses (not provided for by APPI/DSTI)

- Administrative support (not provided for by APPI/DSTI)
- Use of Laboratory and Office facilities such as Desktop Computer, Copier, Printing, Inter-/Intranet, Library, Sundries.

The *basis for the calculation of the hourly rate* (for (semi)permanent staff at industrial partners and universities only) is 1650 hours/year spent to project related activities on a full time basis (40 working hours per week and 20 vacation days; a so called 100% contract). The formula below will be used to calculate the number of hours per year for employees that deviate from these working hours and vacation days.

$$weekly\ hours\ in\ contract * \left(\frac{1650}{40} - \frac{(vacation\ days\ per\ year - 20)}{5}\right) = annual\ hours$$

For example, employee "A" has a 36 hour working week and 25 vacation days. He will have an annual base of 1449 hours/year: 36 * (1650/40 – (25-20)/5) = 1449. If employee "A" receives the same wage as a employee "B", who has a contract of 40 hours and 20 vacation days, employee "A" will have a higher rate per hour.

Cost of third parties (industrial partners and universities only)

Consortium partners may source materials and services from third parties that do not have a partner agreement with APPI. These materials and services may be invoiced to APPI at cost (market price) – i.e. without mark-ups or margins added by consortium partners.

Use of partners' infrastructure (industrial partners and universities only)

Partners can charge the usage of infrastructure to APPI only if the respective equipment is not considered "standard" for a lab environment. (and there covered by either the 50% mark-up on cost of wages or the bench fee)

Under these circumstances, the consortium partner can charge APPI according to the fees it uses internally. These fees must be based on a sound economic valuation method and must be common practice for internal transfer calculations. The fee calculations are subject to (government) accounting audits.

Investments (industrial partners and universities only)

The mutual use of research facilities amongst consortium partners is encouraged. If new infrastructure or equipment is needed for a project, partners can purchase the equipment to be installed within the existing infrastructure. These investments can be fully integrated against actual project cost into the project budget and will thus be subsidized by 50% of the full amount of actual project cost in the year of investment. Actual project cost should be calculated as the difference between the investment amount and the residual value at the end of the project.

Equipment financed by APPI is available for usage by all partners in the respective consortium without any restrictions or cost.

Contribution to program/office cost

The total project research cost will be marked up to cover indirect costs related to the execution of the Action Plan PI. This mark-up will amount to 8.7% of project research costs, thus equaling 8% of the total APPI budget.

3.2 Project funding

After calculation of the total project cost using the calculation rules of the previous paragraph, the project should be funded. The first 50% of the total project cost are covered by the APPI subsidy. The remaining 50% should be covered by funding via the partners, either in kind or in cash. Within each project the “cash balance” should be checked: cash income (cash contribution industry plus total APPI subsidy) should cover cash expenses (total project cost (including mark-up for office cost) minus in total kind contribution).

GTIs contribute in kind by way of 50% of the integral cost price tariffs as stated above.

University partners contribute 100% of the man-hours spent on activities directly related to the coaching of PhD students and 50% of the man-hours spent in execution of a specific project tasks. Both components are in kind contributions.

Industry contributes a minimum of 50% in cash and the remainder in kind. SMEs can apply a lower cash percentage in their contribution.

3.3 Invoicing and payments

Funding of the project will be executed through invoicing. Figure 9 shows the annual invoicing process and its three components. The process minimizes the flow of money by offsetting (in-kind) contributions against expense invoices.

1. The Program Administration will invoice the project partners twice a year. The first invoice will be an advance payment based on the project budget.

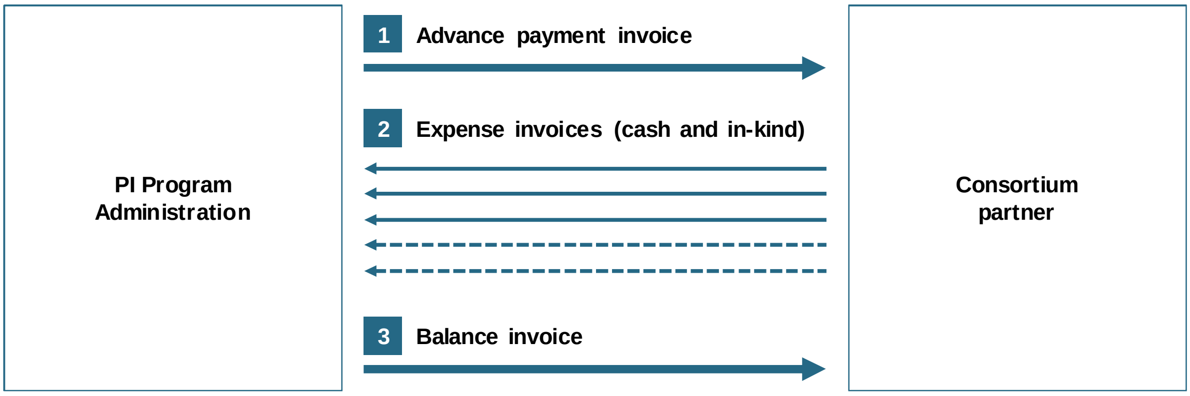
2. Consortium partners will invoice APPI for their incurred costs (both cash and in-kind). For in-kind costs, partners will apply the same calculation rules as stipulated in the previous paragraph.

3. At the end of the year, the Program Administration will balance the expenses and funds and will combine these into annual project statements. Project partners will subsequently receive a balance invoice that is based on approved contributions and actual costs.

VAT

The Action Plan PI is run on commercial conditions with respect to VAT. Partners will include VAT in their invoices to APPI, as required by law. The tax authorities will refund the VAT to the APPI Program Administration. Consequently, partners can budget projects at cost base excluding VAT.

Figure 9 – Annual sequence of invoices



F. PRACTICAL INFORMATION

The final section of this manual presents an overview of the required documentation and stepwise instruction for applicants.

F.1 Overview of required documentation

The following files are referred to in this manual.

1.1 Documents for round 1

In the first round, applicants need to complete, sign and submit the following documents:
- Template for project briefs
- Concise template for budgeting
- Letters of Intent of all prospective project partners

The templates and an example Letter of Intent may be downloaded from www.dsti.nl/appi.

1.2 Documents for round 2

In the second round, applicants need to complete, sign and submit the following documents:
- Template for full project proposals
- Extended template for budgeting
- Letters of Intent of all prospective project partners (only required in case of changes to the scope of the project and/or the prospective project partnership)

The templates and an example Letter of Intent may be downloaded from www.dsti.nl/appi.

1.3 Documents for project setup

For accepted projects, project participants need to detail and sign one document:
- Project Agreement (including intellectual property agreement for consortiums)

F.2 Stepwise approach for project applications

2.1 Round 1 (Project brief)

1. Appoint a project coordinator for the duration of the application period. The project coordinator will be the contact person for the Taskforce APPI.
2. Check that your project and envisaged project partners match with the APPI program line objectives (section C) and the eligibility criteria (chapter D.2).
3. Notify the Taskforce APPI of your intention to submit a project brief (contact details are found below). This allows the Taskforce APPI to keep you informed about the program and the application procedure.
4. Attend the APPI Information Session on August 18, 2009. You can use this session to raise any questions you may have regarding the program and the application procedure.
5. Write the project brief according to the provided format. Make sure to include a proposed consortium, with Letters of Intent from all partners, and a preliminary balanced budget.
6. Submit the project brief, budget plan, and Letters of Intent in hardcopy no later than September 25, 2009, 17:00 hours to the Taskforce APPI at the address below. For efficiency purposes, also send electronic versions of all documents to appi@dsti.nl, but note that the timeliness of submissions is based on the hardcopy only.
7. During the preliminary project review, you may be contacted by the Evaluation Committee or Taskforce APPI for additional information or to discuss possible project adaptations.
8. The Taskforce APPI intends to communicate its advice to project coordinators not later than October 23. This advice will either be an invitation to submit a full project proposal in round 2 or to abstain from doing so. The advice may also include suggestions for the consolidation of projects and consortiums or adjustments to their scopes.

2.2 Round 2 (Full project proposal)

9. If applicable, adapt your project and consortium according to advice from the Taskforce APPI.
10. Write the full project proposal according to the provided format. Include detailed budgets, IP agreements, etc.
11. Submit the project proposal, detailed budget, and additional, or adapted Letters of Intent (if applicable) in hardcopy no later than December, 18, 2009, 17.00 hours to the Taskforce APPI at the address below. For efficiency purposes, also send electronic versions of all documents to appi@dsti.nl, but note that the timeliness of submissions is based on the hardcopy only.
12. The EC of DSTI intends to communicate its final decision to project coordinators not later than January 15, 2010.

2.3 Project setup

13. Finalize the necessary agreement between the DSTI/PI and the consortium partners.
14. Set up project administration in coordination with the program administration.
15. Begin the project

F.3 Submission information and contact details

Documents need to be submitted in hardcopy before the respective deadlines.

	Date
Round 1 deadline	**September 25; 17:00**
Round 2 deadline	**December 18; 17:00**

The hardcopy can be mailed, or delivered in person to:

DSTI, i/z APPI
Stationsstraat 77
3811 MH Amersfoort

In case of personal delivery, please submit the documents at the reception desk in the central hallway. A receipt will be provided.

In addition, please send electronic versions of the project documents to appi@dsti.nl, but note that the submission time of the *hardcopy* determines the timeliness of the submission.

For further information, contact the Taskforce APPI.
Mail: DSTI, i/z APPI, Stationsstraat 77, 3811 MH Amersfoort
E-mail: appi@dsti.nl
Tel.: +31 20 7960 600 (Maarten de Vries or Jaron Weishut at Roland Berger Strategy Consultants)