

PILOT RICARDA INTELLECTUAL CAPITAL REPORT

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Content

| | | |
|----------|--|----|
| 1. | Introduction | 4 |
| 1.1. | The Polymer Competence Center Leoben (PCCL) - a research company and a knowledge intensive network | 4 |
| 1.2. | Intellectual capital reporting | 6 |
| 2. | PCCL RICARDA ICR | 6 |
| 2.1. | RICARDA ICR: methodology | 7 |
| 2.2. | Resource orientation: knowledge resources of the (PCCL-)network | 9 |
| 2.2.1. | Human capital (HC) | 9 |
| 2.2.1.1. | HC 1: Knowledge base (in terms of persons in network) | 10 |
| 2.2.1.2. | HC 2: Individual learning | 11 |
| 2.2.2. | Structural Capital (SC) | 12 |
| 2.2.2.1. | SC 1: Partnerships and networks | 12 |
| 2.2.2.2. | SC 2: Interorganisational learning | 13 |
| 2.2.2.3. | SC 3: Social capital | 14 |
| 2.2.2.4. | SC 4: Innovation capacity | 15 |
| 2.2.2.5. | SC 5: Common infrastructure and services | 17 |
| 2.2.2.6. | SC 6: Management and institution building | 18 |
| 2.2.2.7. | SC 7: Confidence of partner companies in scientific competence of PCCL | 19 |
| 2.2.2.8. | SC 8: Relevant competences in the 9 thematic focus areas | 20 |
| 2.2.3. | Relational Capital (RC) | 21 |
| 2.2.3.1. | RC 1: Sound embedding into regional/national innovation system | 21 |
| 2.2.3.2. | RC 2: Co-operations with other networks/clusters or institutions/ single firms | 23 |
| 2.3. | Outcome orientation: objectives and outcomes | 23 |
| 2.3.1. | Meta-objectives | 24 |
| 2.3.2. | Network objectives and their interrelation with success factors | 24 |
| 2.3.3. | Objective 1: Increase of knowledge creation | 26 |
| 2.3.4. | Objective 2: Improvement of knowledge diffusion | 26 |
| 2.3.5. | Objective 3: Orientation towards flows of new knowledge | 27 |
| 2.3.6. | Objective 4: Establishment of highly qualified labour force with relevant skills for the knowledge intensive network | 27 |
| 2.3.7. | Objective 5: Access to and use of common infrastructure and services (creation of a club) | 28 |
| 2.3.8. | Objective 6: Functioning of the network operation | 28 |
| 2.3.9. | Objective 7: Enhancement of existing infrastructure and resources for pre-competitive research in polymer engineering and science | 28 |
| 2.3.10. | Objective 8: Establishment and consolidation of long term co-operations with relevant enterprises for pre-competitive research in polymer science (especially SME) | 29 |
| 2.3.11. | Objective 9: Establishment and deepening of relevant competences in the area of pre-competitive polymer science within the (PCCL-)network | 29 |
| 2.3.12. | Objective 10: Contribution to sustainable development | 29 |
| 2.3.13. | Objective 11: Improvement of education possibilities in the field | 30 |
| 2.3.14. | Objective 12: Contribution to regional development | 30 |
| 2.4. | Future orientation: environmental framework conditions and consequences | 30 |
| 2.5. | (PCCL-)network intangible assets: status quo | 30 |
| 2.6. | Conclusions | 31 |

List of tables

| | |
|---|----|
| Table 1: Personnel development at the PCCL | 10 |
| Table 2: Share of employees with university degree and average number of employees (autumn 2006) | 10 |
| Table 3: Share of employees involved in further education in addition to employment at the time of the survey | 11 |
| Table 4: Number of bachelor thesis/ master thesis/ dissertations finished by employees of the PCCL in 2005/06 | 11 |
| Table 5: Active and passive participations at conferences of employees of the PCCL in 2005/06 | 11 |
| Table 6: Number of publications of the PCCL in 2005/06 | 11 |
| Table 7: Number of (PCCL-)network partners | 13 |
| Table 8: Share of (PCCL-)network members with existing co-operation agreements with other network members (at the time of the survey) | 13 |
| Table 9: Share of projects with at least three (PCCL-)network members as partners in Phase I | 13 |
| Table 10: Number and volume of single company-/ multi company-partner-projects | 14 |
| Table 11: Share of (PCCL-)network partner companies involved in at least one multi-firm project | 14 |
| Table 12: Share of projects with at least three (PCCL-)network members as partners | 14 |
| Table 13: Number of network members in Phase II of <i>Kplus</i> | 15 |
| Table 14: Share and number of PCCL R&D projects involving external R&D institutions/networks | 15 |
| Table 13: Share of R&D employment (autumn 2006) | 16 |
| Table 14: R&D expenditure per researcher in 2005 | 16 |
| Table 15: R&D expenditure and innovation intensity for the company partners as a share of turnover | 16 |
| Table 16: Key innovation indicators of PCCL company partners | 16 |
| Table 17: Share of (PCCL-)network members taking intellectual property measures in the period from 2003 - 2005 | 17 |
| Table 18: Average number of patents granted at national patent office and EPO in the period from 2003-2005 | 17 |
| Table 19: Investments within PCCL from 2003/04 to 2005/06 | 17 |
| Table 20: Number of existing common infrastructure and services/codified stocks of knowledge in 2005. | 18 |
| Table 21: Number of management decisions based on explicit rules and procedures at the time of the survey | 18 |
| Table 22: Number and volume of <i>Kplus</i> -projects and of additional Non- <i>Kplus</i> -projects | 19 |
| Table 23: Number of network members in Phase II of <i>Kplus</i> | 19 |
| Table 24: Share of (PCCL-)network members satisfied with provision of scientific and technological knowledge within the network in 2005 | 19 |
| Table 25: Number and volume of projects in 9 thematic focus areas | 20 |
| Table 26: Number of publications in 9 thematic focus areas | 21 |
| Table 27: Attendance of representatives of relevant external stakeholders in network activities in 2005/06 | 22 |
| Table 28: Attendance of representatives of relevant external stakeholders in stakeholders in formal decision making process in 2005/06 | 22 |
| Table 29: Number and volume of projects of co-operation partners from the region | 22 |
| Table 30: Share of PCCL company partners participating in industry-relevant bodies and number of participations | 22 |
| Table 31: Share of PCCL R&D projects involving external R&D institutions/networks in 2005/06 | 23 |
| Table 32: Number of co-operations outside the <i>Kplus</i> -programme in 2005/06 | 23 |
| Table 33: PCCL success factors influencing PCCL objectives | 25 |
| Table 34: Share of (PCCL-)network members participating in framework programme of the EU | 27 |
| Table 37: Share of employees with university degree | 28 |
| Table 38: Numbers and volumes of projects in thematic focus area 6 of the PCCL | 29 |
| Table 39: Numbers of publications and events in thematic focus area 6 of the PCCL | 29 |

1. Introduction

The economic importance of intangible assets has long been recognised, as intellectual capital is one important prerequisite for successful R&D. Thus for research networks like the Polymer Competence Center Leoben (PCCL) the strategic management of its intellectual capital is vital for success.

This intellectual capital report (ICR) supports the management of (PCCL-)network by presenting the intellectual capital of the knowledge intensive network PCCL in a structured way, but also by linking the intellectual capital with the objectives of the (PCCL-)network. The ICR thus complements standard controlling and management information and the financial statement and offers valuable information for all stakeholders interested in the (PCCL-)network.

1.1. The Polymer Competence Center Leoben (PCCL) - a research company and a knowledge intensive network

The Polymer Competence Center Leoben GmbH (PCCL) is a cooperative research company, founded in June 2002 within the framework of the *Kplus* program of the Austrian Ministry of Transport, Innovation and Technology. By incorporating and combining the scientific, engineering and methodological competence of leading Austrian polymer research institutions (in total 12 scientific partners), on the one hand, and the technology, application and market-development expertise of the polymer industry and the service sector (in total 40 company partners, see Figure 1), on the other, the PCCL acts as a link that interconnects the science based approach of existing academic institutions with the applied research and product development approach of the polymer industry.

The PCCL is organized with workforces at three sites, namely Leoben (main site and headquarter), Graz and Wels/Linz, which correspond to the locations of the main supporting academic and scientific institutions.

Together with its scientific and its company partners, a main short-term goal of the PCCL is to carry out a joint research program in order to generate novel knowledge and know-how in specific areas of polymer engineering and science, thereby continuously increasing and fostering its own R&D competency as well as the one of its partners. The application of a science based methodology to resolve problems of industrial significance and the transfer of research results and knowledge available and gained shall contribute to the further strengthening of the competitiveness of the PCCL and its partners.

The most important foundation for the cooperation of the PCCL with its company and scientific partners is a 4-year research program (07/2002 - 06/2006, Phase I), defined and evaluated within the framework of the *Kplus* programme. In addition, the PCCL pursues a strategy of carrying out industrial research on a direct contract basis and research projects as well as other research related activities (e.g. organization of symposia, workshops, platform and coordination activities) funded by other programs and instruments (Non-*Kplus* program).

Within the *Kplus* program, in so-called **bilateral projects** (single- or multi-firm projects with direct involvement of one or more company partners and scientific partners) the PCCL performs application related, pre-competitive research. On a more fundamental level strategic research (i.e., strategic projects) is performed together with scientific partners. At the core of the research activities are **structural and functional polymeric materials** along with the **corresponding technologies of production and processing**, as foundation for innovations in a broad field of applications. The spectrum of research topics ranges from the synthesis of polymers (and certain additives) via the characterization of various chemical, physical and engineering properties of polymeric materials to specific processing problems and technologies to novel concepts for the design of components and molds. It includes the development and application of advanced methods for the characterization of the molecular and inner structure of polymeric materials as well as the application and development of novel modelling and simulation tools, particularly for polymer processing and part design problems.

The overall performance and achievements of the PCCL are mainly based upon its well-qualified employees, on the one hand, and on the profound scientific and technological competence along with the available laboratory and technical infrastructure of its scientific partners, on the other. These prime assets are supplemented by the technology and market expertise of the participating company partners.

Key facts and performance figures related to some of the achievements of the PCCL, both for the 4-year *Kplus* programme and the 4th business year (Year 4), are:

4-Year *Kplus* Program (07/2002 - 06/2006)

| | |
|--|--|
| Revenues and sales (Years 1 to 4): | € 14.4 Mio. |
| Employees (06/2006): | 84 (head count) / 64 (full time equivalents) |
| Number of scientific partners: | 12 |
| Number of company partners: | 40 |
| Number of bilateral research projects: | 28 (thereof 13 multi-firm and 15 single-firm projects) |
| Number of strategic research projects: | 14 |

The **annual budget** of the PCCL, which amounts to about € 5 Mio. p.a. is a fundamental prerequisite for the knowledge resources of the (PCCL-)network. 40 % of this budget are financed by the company partners of the PCCL, 60 % are publicly funded within the *Kplus*-programme. The research programme of the PCCL is performed in project teams consisting of employees of the scientific partners and the company partners and researchers of the PCCL. The **number of employees at the PCCL** itself has increased since its foundation in 2002 to about 84 (mainly scientific personnel) in June 2006.

The *Kplus* competence center program attempts to bring together the main research activities of academic institutions with the needs of companies and to use the knowledge of both groups of partners. Thus the Polymer Competence Center Leoben GmbH together with its scientific partners and partner companies can also be considered as a knowledge intensive network with the joint general vision:

- To lastingly establish the *PCCL* as the **leading research institution for science-based, pre-competitive research in *Polymer Engineering and Science*** in Austria, simultaneously becoming one of the leading institutions in this field in Europe.
- With its locations in Styria (Leoben, main location, and Graz) and Upper Austria (Wels/Linz), the *PCCL* envisions a **valuable impact and contribution on the regional development** especially in these two States by enhancing the attractiveness as business locations for domestic and foreign investors, and for spin-offs and start-up companies.


In pursuing the above vision, the **mission of the *PCCL*** encompasses:

- To strengthen and improve the existing infrastructure for pre-competitive research in specific areas of polymer engineering and science in Austria, crucial for the future development of the Austrian polymer industry.
- To perform science-based, pre-competitive research at a high, internationally recognized level in its main fields of research.
- To act as a motor for science-based product and process innovation in key areas of polymer technology, thereby further improving the competitiveness of the Austrian polymer industry and the growing polymer technology and polymer products related service sector.
- To support especially SME's in solving polymer engineering and science related problems.
- To orient its research activities increasingly on the requirements and criteria for a transition towards Sustainable Development and thus to support research in the field of polymers for solar energy applications and on polymeric materials based on renewable resources.
- To development a highly qualified staff of employees (refers to both, scientific and administrative employees) who eventually will continue their career in industry or academia.

Figure 1: Company partners of PCCL (06/2006)

Polymer Competence Center Leoben GmbH

Company Partners



Polymer Competence Center Leoben

40 Company Partners (Date: 06/2006)

| | |
|---|--|
| <ul style="list-style-type: none"> • AGRU Kunststofftechnik GmbH • Airbus Deutschland GmbH • Anton Paar GmbH • APE - advanced polymer engineering GmbH • AT&S AG • Balzers GmbH • BASF Coatings AG • Battenfeld Kunststoffmaschinen GmbH • BMW AG • BÖHLER Edelmetall GmbH • Borealis GmbH • Dow Europe S.A. • ECONOMOS Austria GmbH • EMS-CHEMIE AG • FACC AG • Gabriel-Chemie GesmbH • Goodyear Engineered Products Europe • Hella Fahrzeugteile Austria GmbH • HTP Formenbau GmbH • IB Steiner Ingenieurbüro für Kunststofftechnik | <ul style="list-style-type: none"> • Isosport Verbundbauteile GmbH • Isovolta Österr. Isolierstoffwerk AG • Jutz GmbH • KE KELIT Kunststoffwerk AG • Lenzing Plastics GmbH. & Co KG • MAGNA AUTECA AG • MAGNA STEYR Engineering Center Steyr GmbH • MAHLE Filtersysteme GmbH • Mondi Packaging Frantschach GmbH • MURCHEMIE Leimüller & Komp. GmbH • ÖVGW - Verband Gas & Wasser • Poloplast Kunststoffwerk GmbH & Co KG • SABIC Polyethylene B.V. • Semperit Technische Produkte GmbH & Co KG • SML Maschinengesellschaft mbH • Ticona GmbH • voestalpine STAHL GmbH • Westcam Datentechnik GmbH • Zimmer GmbH • Zizala Lichtsysteme GmbH |
|---|--|

1.2. Intellectual capital reporting

First efforts to measure the intellectual capital and measure its potential started in the 60ies in the framework of "Human Resource Accounting". Parallel accounting and controlling developed. At the end of the 80ies comprehensive management information systems were developed but they encompassed primarily financial figures about the physical resources of a company and the knowledge concerning soft factors and their importance was disregarded. Then in the 90ies in Scandinavia efforts in intellectual capital management lead to the development of intellectual capital reporting (BMW 2005).

The overall goal of intellectual capital reporting is the structured presentation of the intangible assets that contribute to achieving the objectives of an organization. Thus an intellectual capital report is on the one hand an instrument for the strategic management of an organization. On the other hand it is useful for the external communication of the activities and value of an organization.

Target groups for an ICR can be all relevant stakeholders for the organization. For the different internal and external target groups different versions of the ICR can be prepared according to the specific information requirements.

Preparing an ICR is a learning process for the organization. This is particularly the case when an ICR is prepared for the first time. Therefore when prepared for the first time for an organization, an ICR must not be too complicated. It is better to start with a version that concentrates on the main factors and is comprehensible, but try to include every possible aspect at first. Future versions of the ICR can be refined.

2. PCCL RICARDA ICR

This ICR, a pilot application in the wake of the FP6 project RICARDA, will try to offer as much valuable input for the (PCCL-)network as possible but also be as simple as possible. It considers the (PCCL-)network as a knowledge intensive network comprising the Polymer Competence Center Leoben GmbH, its academic partners and partner companies as they jointly represent the intellectual capital that is relevant for the research activities undertaken in polymer engineering

and science. Thus for this ICR the Polymer Competence Center Leoben GmbH is referred to as PCCL whereas (PCCL-)network means the whole network.

The PCCL RICARDA ICR will give a structured overview of the knowledge resource respectively intangible assets (IA) of the (PCCL-)network in 2005/06. It will also try to identify particular strengths and weaknesses concerning the intellectual capital of the (PCCL-)network. The PCCL ICR will also highlight the main objectives of the (PCCL-)network and presents the interrelations of these objectives with the intellectual capital of the (PCCL-)network. The repeated preparation of an ICR will then allow to monitor the development of the (PCCL-)network.

The information provided by the ICR is thus valuable for the (PCCL-)network members, but also for external stakeholders and will meet the expectations the relevant PCCL stakeholders had at the start of the ICR process.

2.1. RICARDA ICR: methodology

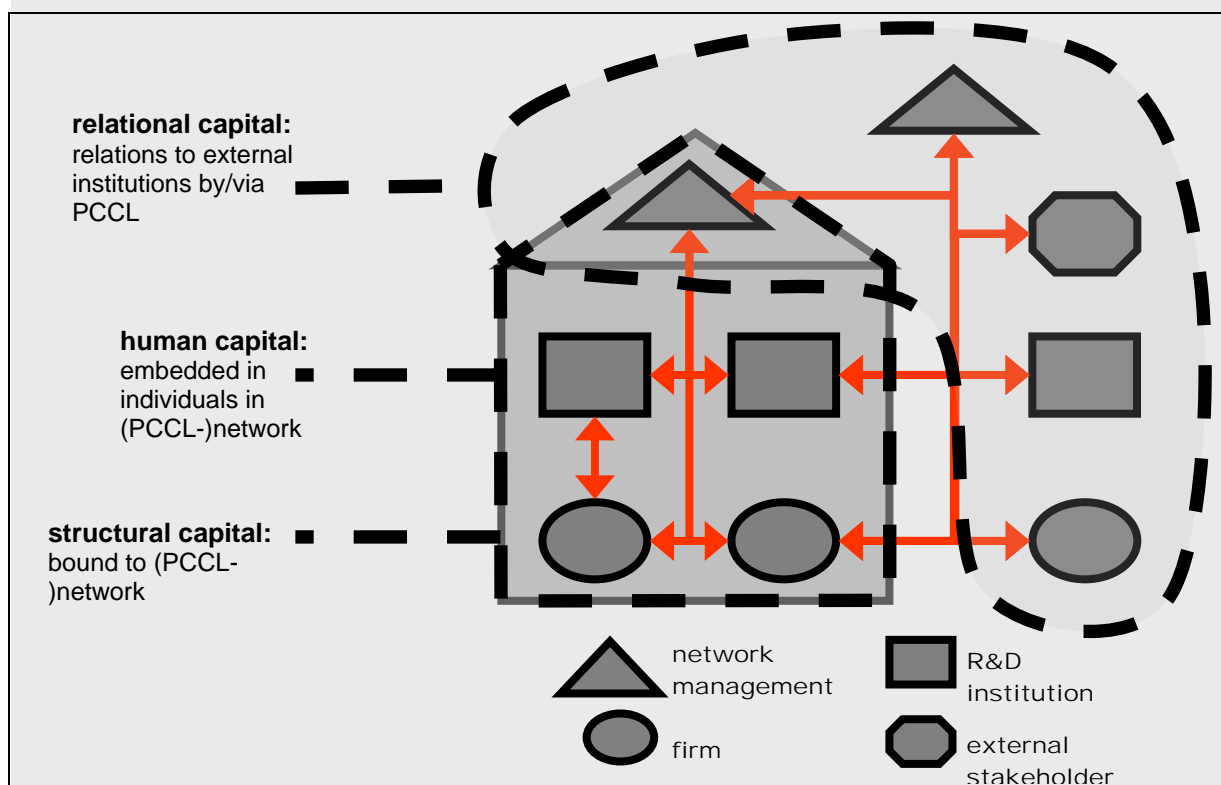
A RICARDA ICR is an ICR prepared according to the guidelines developed within the FP6 project RICARDA. Within RICARDA a methodology was developed to prepare ICRs for knowledge intensive networks.

This intellectual capital report presents the intangible assets of the (PCCL-)network in a structured way. Because knowledge is intangible, it cannot be measured itself. Instead tangible assets are measured that represent knowledge. To make clear that the intangible assets are considered as far as they contribute to valuable knowledge for the considered knowledge intensive network, the intangible assets are referred to as knowledge resources.

Thus using the three typical categories of knowledge resources, these could be defined as follows:

- Human capital is defined as the knowledge that employees bring and take with them when they join or leave the firm (and thus the network). It includes the knowledge, skills, experiences and abilities of people. Some of this knowledge is unique to the individual, some may be generic.
- Structural capital is defined as the pool of knowledge that stays in the network at the end of the working day as well as some physical assets. It comprises the organisational routines, procedures, systems, cultures, databases, etc. It allows to codify knowledge to some extent, so that a certain degree of independence from specific individuals results. Some of them may be legally protected and become Intellectual Property.
- Relational capital is defined as all resources linked to external relationships of the formal network management, the PCCL, such as external R&D-institutions, other clusters or networks, external stakeholders or non-member firms.

Figure 2: Knowledge resources of knowledge intensive network



Source: JR - InTeReg

Considering the knowledge resources within a RICARDA ICR, these include all interactions between network members, and all interactions between network members and the network management. As external stakeholders might also be of high importance they also include interrelations of the formal network management with external organisations. As the focus of a RICARDA ICR lies at the specificities of the network, interrelations of network member organisations with external organisations are not included, as it is not possible to differentiate between those that have an effect on the network and those that are solely relevant for the member organisation. The inclusion of these interrelations would also make it very difficult to prepare a RICARDA ICR.

In general the preparation of an ICR emanates from objectives and the awareness that knowledge contributes to the achieving them.

Intellectual capital reports (ICRs) monitor the development of and the outcomes from knowledge resources. As knowledge itself is intangible, knowledge resources are identified. They allow to monitor stocks of knowledge, their development and contribution to the strategic objectives identified.

Internally, ICRs can act as management tools that contribute to achieving strategic objectives. However they cannot replace organisational development tools. It is also not possible to use ICRs as external evaluation tools, as the process of intellectual capital reporting requires the extensive involvement of network member organisations. Externally ICRs can act as communication tools. Therefore the internal and the external version of the ICR may differ.

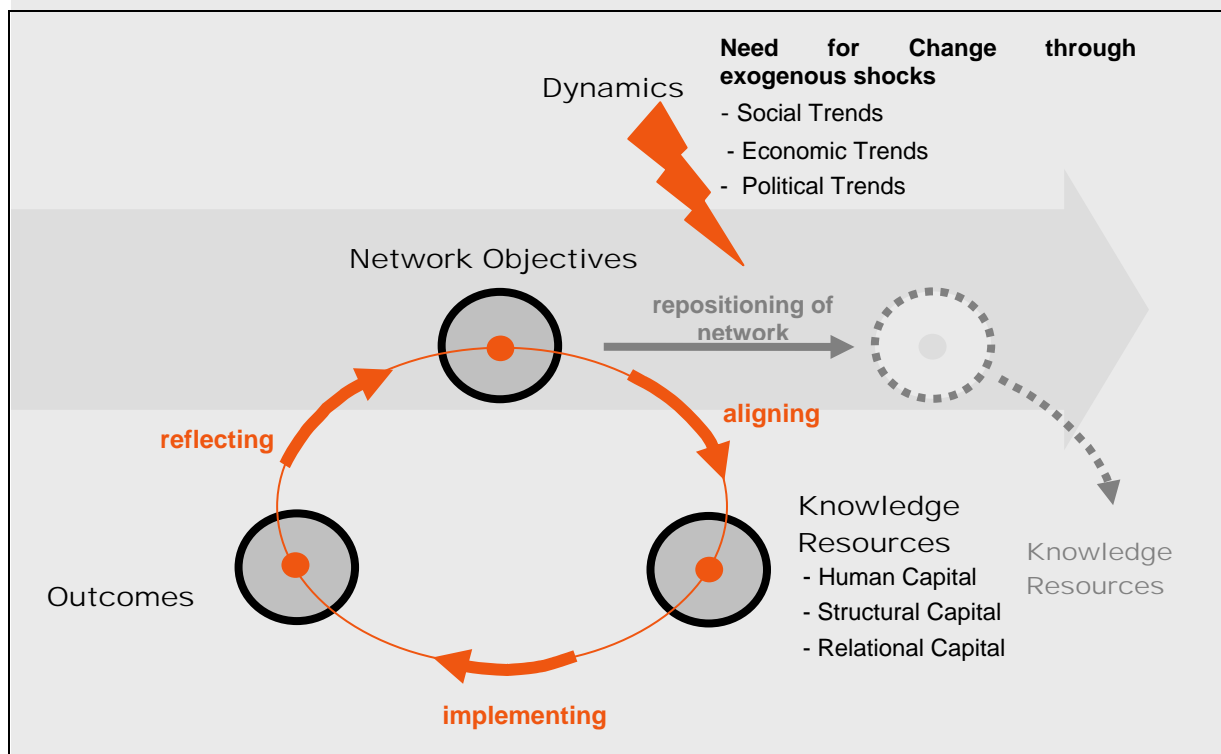
For knowledge intensive networks the ICR might not only provide useful information for the management of the network but also for the regional policy authorities.

An ICR is prepared when the awareness exists that knowledge resources contribute to strategic objectives and that these knowledge resources have to be dealt with similar financial resources, with one part being the preparation of an annual report.

Therefore the starting point when preparing an ICR are network objectives - irrespective whether they are related to knowledge. After that knowledge resources have to be identified that can be aligned to these objectives. The insights gained in this process will lead to the implementation of initiatives and thus lead to outcomes. Outcomes are therefore actual states of the objectives

defined beforehand. The confrontation of outcomes and network objectives (on the basis of the insights from monitoring and evaluating the relevant knowledge resources) will allow assessing the network objectives and strategic priorities. If then also external dynamics are considered, it is possible to reposition the network if required. The according adaptation of network objectives would then again have to lead to a reflection of relevant knowledge resources. The preparation of an ICR can be a contribution to the continuous process of the management of knowledge intensive networks (see Figure 3).

Figure 3: The basic model of the process of intellectual capital reporting



Source: JR - InTeReg

2.2. Resource orientation: knowledge resources of the (PCCL-)network

Excellent achievements require resources. For the (PCCL-)network as a knowledge intensive network to be able to perform its tasks, various resources are required. For the ICR the knowledge resources relevant for the success of the (PCCL-)network are presented in the following sections. They are structured in human, structural and relational capital (see 2.1 for definitions). For each type of capital the relevant success factors i.e. knowledge resources are presented using indicators to describe the state of the art of the success factor. The indicators are therefore just a means to get a picture about a success factor. The same indicator can be used to inform about different success factors.

2.2.1. Human capital (HC)

Definition: For the (PCCL-)network, as a knowledge intensive network, human capital is defined as the knowledge that employees bring and take with them when they join or leave the firm (and thus the network). It includes the knowledge, skills, experiences and abilities of people. Some of this knowledge is unique to the individual, some may be generic.

Although the (PCCL-)network is a knowledge intensive network where the interaction between different organisations and hence individuals is the main characteristic of its specific intellectual capital, it is important to consider also the human capital of the (PCCL-)network.

Learning can only occur in individuals - possibly stimulated by interaction processes with other members of the (PCCL-)network - and this individual dimension of relevant knowledge is illustrated by success factors HC 1 to HC 2:

- HC 1: Knowledge base (in terms of persons in the network)
- HC 2: individual learning

2.2.1.1. HC 1: Knowledge base (in terms of persons in network)

Rationale: Human capital of the (PCCL-)network is primarily defined by the knowledge of the employees of the PCCL and the employees of the scientific and company partners of the (PCCL-)network. According to the new theory of economic growth, stocks of knowledge contribute to economic growth of nations, regions and sectors (Romer, 1990), but also companies or networks of companies. The knowledge base reflects the potential of the (PCCL-)network in terms of the knowledge incorporated in the persons in the network.

Indicators: The knowledge base of the (PCCL-)network is characterised by the following two indicators: (a) personnel development at the PCCL, and (b) share of employees with an university degree and average number of employees at the (PCCL-)network (autumn 2006).

Table 1: Personnel development at the PCCL

| | personnel development | | | |
|----------------------|-----------------------|---------|---------|---------|
| | 2002/03 | 2003/04 | 2004/05 | 2005/06 |
| Employees (number) | 40 | 63 | 77 | 84 |
| Full-time equivalent | 35 | 48 | 57 | 64 |

Table 2: Share of employees with university degree and average number of employees (autumn 2006)

| | employees with university degree | | average number of employees |
|------------------------|----------------------------------|------------|-----------------------------|
| | full time equivalents | head count | full time equivalents |
| PCCL | 64.1 % | 52.4 % | 64 |
| scientific partners | 68.2 % | 63.3 % | 18 |
| partner companies | 15.3 % | 11.9 % | 536 |
| (PCCL-)network overall | 16.1 % | 12.9 % | 346 |

Discussion: For this research intensive network, the number of research staff employed by the (PCCL-)network in addition to the existing human resources at the network partners constitutes the main (additional) knowledge base of the network. Table 1 reflects that the PCCL was able to attract a sufficient number of employees to participate in the research joint research programme. In addition to the employees at the PCCL the scientific partners contribute an average staff of 18 and the company partners of 536 (see Table 2).

Considering the employees of the (PCCL-)network, almost 1/6 has a university degree. This share is considerably higher for the PCCL and the scientific partners, amounting to about 60 % (see Table 2). The high share of employees with university degree at the scientific partners as well as at the PCCL is typical for university institutes and research companies. For the PCCL the amount of employees with university degree is slightly lower as for scientific partners, as a remarkable number of students working on their academic works are employed at the PCCL (see HC 2, Table 4).

2.2.1.2. HC 2: Individual learning

Rationale: The creation of knowledge is tied to individuals, thus individual learning is a prerequisite for growing stocks of knowledge.

Indicators: Individual learning is represented in the (PCCL-)network by the following indicators: (a) share of PCCL-employees involved in further education in addition to employment at the time of the survey, (b) number of bachelor thesis/ master thesis/ dissertations finished and in progress by employees of the PCCL in 2005/06, (c) active and passive participations at conferences of employees of the PCCL in 2005/06 and (d) publications in 2005/06.

Table 3: Share of employees involved in further education in addition to employment at the time of the survey

| | employees involved in further education | dissertations | diploma thesis |
|------|---|---------------|----------------|
| | share | number | |
| PCCL | 70.2 % | 28 | 9 |

Table 4: Number of bachelor thesis/ master thesis/ dissertations finished by employees of the PCCL in 2005/06

| | number of finished academic works | number of academic works in progress |
|-----------------|-----------------------------------|--------------------------------------|
| dissertations | 3 | 28 |
| master thesis | 16 | 9 |
| bachelor thesis | 12 | 17 |

Table 5: Active and passive participations at conferences of employees of the PCCL in 2005/06

| | number of participations at conferences of employees of the PCCL |
|---------------------------------------|--|
| posters at conferences | 29 |
| presentations at conferences | 74 |
| passive participations at conferences | 40 |

Table 6: Number of publications of the PCCL in 2005/06

| | number of publications of employees of the PCCL |
|---------------------------------------|---|
| publications in refereed journals | 16 |
| publications in non-refereed journals | 6 |
| publications in conference papers | 21 |
| publications in books | 2 |

Discussion: Within the (PCCL-)network individual learning is usually combined with further (academic) education by the employees (see Table 3, Table 4 and Table 5). Due to the strong interaction of the PCCL with its university based scientific partners, a significant part of the research activities is carried out by students or graduates working on their theses. The thesis may

be a “bachelor thesis”, a “master thesis” or a “doctoral thesis” (dissertation). For bachelor and master theses, students are employed as junior researchers (usually for about 1 to 6 months), for doctoral theses, graduates with a master degree or equivalent are employed as researchers (usually for 3 to 4 years in full-time positions) at the PCCL. Scope, objectives and the research work program of a thesis are closely matched with those of the respective PCCL project, performed together with scientific and company partners. For the PCCL the considerable amount of students involved in the projects reflects also a considerable potential of researchers for its planned expansion. On the other hand, partner companies also demand for qualified graduates, which already got trained within the (PCCL-)network.

Individual learning may also be measured by its output accounted for in terms of participation and presentations at conferences as well as in publications (see Table 5 and Table 6).

2.2.2. Structural Capital (SC)

Definition: Structural capital is defined as the pool of knowledge that stays in the network at the end of the working day as well as some physical assets. It comprises the organisational routines, procedures, systems, cultures, databases, etc. It allows to codify knowledge to some extent, so that a certain degree of independence from specific individuals results. Some of them may be legally protected and become Intellectual Property.

Structural capital is a main resource of the (PCCL-)network to achieve its main objectives. It allows to use the human capital more efficient and via the exchange with individuals from other institutions it might also contribute to the increase of human capital. It enables the employees of the (PCCL-)network to concentrate on their specific capabilities and thereby increase their competences and contribute to the success of the (PCCL-)network and the respective (PCCL-)network member organisation.

The formation of a knowledge intensive network per definition adds structural capital to the individual network members but also to the network as a whole. It is mainly responsible for the success of the network. SC 1 to SC 8 represent the relevant success factors of the (PCCL-)network:

- SC 1: Partnerships and networks
- SC 2: Interorganisational learning
- SC 3: Social capital
- SC 4: Innovation capacity
- SC 5: Common Infrastructure and services
- SC 6: Management and institution building
- SC 7: Confidence of partners companies in scientific competence of PCCL
- SC 8: Relevant competences in the 9 thematic focus areas

2.2.2.1. SC 1: Partnerships and networks

Rationale: Partnerships and networks arise from repeated co-operations and allow to increase competitiveness by division of labour, knowledge spill-overs and a reduction of risk. This effect lies at the core of the raison d'être of the establishment of knowledge intensive networks.

Indicators: Partnerships and networks are represented by the following list of indicators: (a) number of (PCCL-)network partners, (b) share of (PCCL-)network members with existing co-operation agreements with other network members, and (c) share of projects with at least three (PCCL-)network members as partners in Phase I.

Table 7: Number of (PCCL-)network partners

| | number of (PCCL-)network partners | | | |
|---------------------|-----------------------------------|---------|---------|---------|
| | 2002/03 | 2003/04 | 2004/05 | 2005/06 |
| scientific partners | 12 | 12 | 12 | 12 |
| Company partners | 26 | 34 | 39 | 40 |

Table 8: Share of (PCCL-)network members with existing co-operation agreements with other network members (at the time of the survey)

| | share with co-operation agreements |
|------------------|------------------------------------|
| company partners | 100 % |

Table 9: Share of projects with at least three (PCCL-)network members as partners in Phase I

| | share of projects with | | |
|---------|------------------------|--------------------|-----------------------------|
| | 1 company partner | 2 company partners | at least 3 company partners |
| Phase I | 53.6 % | 25.0 % | 21.4 % |

Discussion: The number of network members continually increased in Phase I from 38 in 2002/03 to 52 in 2005/06 (see Table 7). Whereas the number of scientific partners stayed constant over this period, the number of company partner increased by 153 %. This remarkable increase in the number of cooperation partners reflects the ability of the (PCCL-)network to respond to the needs of industry for pre-competitive research and thus to correspond with its main objective of building long-term cooperation between company and scientific partners within the (PCCL-)network.

To characterise the partnerships and networks of the (PCCL-)network, it has to be emphasised that all (PCCL-)network members have co-operation agreements with other network members, respective the network management (see Table 8). As this is a *condicio sine qua non* for a (PCCL-)network membership this indicator is not relevant for the evaluation of the (PCCL-)network, but clearly demonstrates the high level of institutionalisation of the co-operations within the network.

The share of bilateral projects with two, three or more company partners was 46.4 % in Phase I (see Table 9). This indicates that the (PCCL-)network is characterised by a high degree of interrelations which ensure a high degree of technology and know-how transfer between its members. It has to be pointed out, that within multi-firm projects not only company partners along the supply chain (e.g. material suppliers and polymer processing companies) co-operate, but also competitors work together in certain bilateral projects.

2.2.2.2. SC 2: Interorganisational learning

Rationale: Interorganisational learning contributes to the creation of new knowledge and increases the required adaptability in response to external trends and thus enhances the long-term competitiveness of the knowledge intensive network (Keeble and Wilkinson, 1999).

Indicators: The following indicators reflect the interorganisational learning aspects that takes place in the network of the PCCL: (a) number and volume of single company-/ multi company-partner-projects, (b) share of (PCCL-)network partner companies involved in at least one multi-firm project, and (c) share of projects with at least three (PCCL-)network members as partners.

Table 10: Number and volume of single company-/ multi company-partner-projects

| | single company partner projects | | multi company partner projects | |
|----------|---------------------------------|-------------|--------------------------------|-------------|
| | number | volume in € | number | volume in € |
| Phase I | 15 | 4,212,739.4 | 13 | 5,564,640.6 |
| Phase II | 14 | 3,809,700.0 | 13 | 5,924,075.0 |

Table 11: Share of (PCCL-)network partner companies involved at least one multi-firm project

| | share of partner companies involved in at least one multi-firm project |
|----------|--|
| Phase I | 78 % |
| Phase II | 60 % |

Table 12: Share of projects with at least three (PCCL-)network members as partners

| | share of projects with | | |
|---------|------------------------|------------|---------------------|
| | 1 partner | 2 partners | at least 3 partners |
| Phase I | 53.6 % | 25.0 % | 21.4 % |

Discussion: Due to the high degree of institutionalisation within the (PCCL-)network one important prerequisite for interorganisational learning is completely fulfilled: each network member is involved in at least one interorganisational project team. Due to the structure of the (PCCL-)network, this is a requirement to be member of the network; therefore such indicator itself is not useful. Nevertheless there are differences in the level of complexity of these project teams: The interaction of the company partners within the PCCL is characterised by a remarkable number of multi-firm projects. Table 10 illustrates the percentage of multi-firm projects both in terms of numbers of projects and in terms of project volume (i.e. project budget). In terms of numbers, close to half of the bilateral projects are multi-firm projects, in terms of project volume the corresponding percentage level reached 57 % in Phase I and will even reach 61 % in Phase II.

Also quite remarkable is that of the total of 40 partner companies, 78 % are involved in at least one multi-firm project and only 22 % are involved in single-firm projects only (see Table 11). This ensures a high degree of technology and know-how transfer from large enterprises (even multinational companies) to SME's and vice versa, also including local companies of the service sector (e.g. engineering consultants). As a goal this number should not decrease over time.

2.2.2.3. SC 3: Social capital

Rationale: Social capital enables firms to co-operate closely and thus fosters knowledge diffusion within the network (Dodgson, 1996). An important aspect of social capital is trust. Trust and thus social capital do play a particularly important role for the co-operation in R&D.

Indicators: Social capital is represented by the following indicators: (a) number of network members in Phase II of *Kplus*, and (b) share and number of PCCL R&D projects involving external R&D institutions/networks.

Table 13: Number of network members in Phase II of *Kplus*

| | network members | | | |
|------------------------|-----------------|---|----------|---|
| | Phase I | | Phase II | |
| | number | share of members in Phase I also member in phase II | number | share of members, members in Phase I already) |
| PCCL | 1 | 100 % | 1 | 100 % |
| scientific partners | 12 | 50 % | 6 | 100 % |
| partner companies | 40 | 77.5 % | 38 | 81.8 % |
| (PCCL-)network overall | 53 | 71.7 % | 45 | 84.4 % |

Table 14: Share and number of PCCL R&D projects involving external R&D institutions/networks

| | R&D projects | |
|---|--------------|--------|
| | total number | share |
| Non-Kplus 2005/06 | 45 | 100% |
| Non-Kplus-projects 2005/06 performed with partner companies of the (PCCL-)network | 14 | 31.1 % |
| Non-Kplus-projects 2005/06 performed with external companies | 31 | 68.9 % |

Discussion: Within Phase I of the *Kplus* programme none of the network partners left the (PCCL-)network, which would be possible annually, and also 80 % of the company partner prolonged their participation for Phase II. This share of network members involved in repeated co-operations in R&D indicates trust, as without the existence of mutual trust members would not want to repeat co-operation (see Table 13). In addition to the co-operation within *Kplus*-projects more than 30 % of all Non-*Kplus*-projects within the PCCL were performed with *Kplus* company partners, which reflects the fact that research aspects which cannot be handled within the pre-competitive *Kplus*-programme, are also regularly performed with the PCCL. Thus, the build-up of mutual trust in the institutionalised *Kplus*-(PCCL-)network, also creates the origin for further co-operations in the Non-*Kplus*-area, which are much less institutionalised (see Table 14).

2.2.2.4. SC 4: Innovation capacity

Rationale: R&D and innovation lead to the creation and application of knowledge. New products, processes and services then lead to enhanced competitiveness (Porter, 1990).

Indicators: The innovation capacity of the (PCCL-)network is measured by the following indicators: (a) share of R&D employment, (b) R&D expenditure per researcher in 2005, (c) R&D expenditure and innovation intensity for the company partners as a share of turnover, (d) key innovation indicators of PCCL company partners, (e) share of (PCCL-)network members taking intellectual property measures in the past three years, and (f) average number of patents granted at national patent office and EPO in the period from 2003-2005.

The majority of the indicators are based on the Fourth Community Innovation Survey (CIS 4) in Austria. This allows to compare the results for the (PCCL-)network with other existing innovation data based on the CIS 4¹.

¹ The lacking explanatory power of some of the indicators for university institutes and research companies like the PCCL is reflected by exclusion of these institutions when suited.

Table 15: Share of R&D employment (autumn 2006)

| | R&D employees | |
|------------------------|-----------------------|------------|
| | full time equivalents | head count |
| PCCL | 87.5 % | 84.5 % |
| scientific partners | 76.4 % | 73.3 % |
| partner companies | 7.5 % | 11.0 % |
| (PCCL-)network overall | 9.0 % | 13.0 % |

Table 16: R&D expenditure per researcher in 2005²

| | in-house-R&D expenditure per researcher in 1000€ | |
|-------------------|--|------------|
| | full time equivalents | head count |
| partner companies | 54.6 | 76.8 |

Table 17: R&D expenditure and innovation intensity for the company partners as a share of turnover

| | Key figures in terms of share of turnover | | |
|---|---|-------|-------|
| | 2003 | 2004 | 2005 |
| R&D intensity (in house R&D-expenditures) | 2.7 % | 2.7 % | 3.1 % |
| Innovation intensity | 4.2 % | 4.7 % | 5.7 % |

Table 18: Key innovation indicators of PCCL company partners

| | In percent of PCCL company partners | | |
|--|-------------------------------------|------|------|
| | 2003 | 2004 | 2005 |
| introduction of new or significantly improved goods | 74 % | 68 % | 80 % |
| introduction of new or significantly improved services | 56 % | 69 % | 65 % |
| introduction of new or significantly improved methods of manufacturing or producing goods or services | 70 % | 74 % | 79 % |
| introduction of new or significantly improved logistics, delivery or distribution methods for inputs, goods or services | 33 % | 53 % | 42 % |
| introduction of new or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing | 58 % | 72 % | 68 % |

² Number of researchers based on time of survey (=October 2006)

Table 19: Share of (PCCL-)network members taking intellectual property measures in the period from 2003 - 2005

| | apply for a patent | register an industrial trademark | register a trademark | claim copyright |
|------------------------|--------------------|----------------------------------|----------------------|-----------------|
| PCCL | 100 % | 0 % | 0 % | 0 % |
| scientific partners | 67 % | 0 % | 0 % | 0 % |
| partner companies | 75 % | 29 % | 68 % | 24 % |
| (PCCL-)network overall | 75 % | 24 % | 57 % | 19 % |

Table 20: Average number of patents granted at national patent office and EPO in the period from 2003-2005

| | patents granted | |
|------------------------|--|----------------|
| | per (PCCL-)network member organization | per researcher |
| PCCL | 0.00 | 0.00 |
| scientific partners | 0.67 | 0.05 |
| partner companies | 4.36 | 0.12 |
| (PCCL-)network overall | 3.50 | 0.11 |

Discussion:

The innovation intensity of PCCL partner companies increased by 1.5 percentage points from 2003 to 2005 (see Table 17). The share of innovators of the partners companies is relatively high and all innovations indicators increased in the period from 2003 to 2005 too (see Table 18); the share of companies introducing new or significantly improved products amounts to 80 %.

Intellectual property measures were taken by partner companies primarily, which also lead to a higher number of patents granted (see Table 19 and Table 20). Within the (PCCL-)network 3.5 patents are granted in average within the period 2003 to 2005. For the PCCL no patent could be accounted for in this period, as several patent applications were settled, but granting of them has not yet taken place.

2.2.2.5. SC 5: Common infrastructure and services

Rationale: Common infrastructure and services and thus the provision of club goods - if these are only available to network members - help to foster the creation and diffusion of knowledge and division of labour because they give an incentive to join the network and to intensify the activities within the network.

Indicators: Common infrastructure and services is characterised by the following indicators: (a) Investments within PCCL in from 2003 to 2006 and (b) number of existing common infrastructure and services/codified stocks of knowledge in 2005.

Table 21: Investments within PCCL from 2003/04 to 2005/06

| | 2003/04 | 2004/05 | 2005/06 |
|---------------------------------------|---------|---------|---------|
| investments in (scientific) equipment | 704.000 | 526.000 | 783.000 |

Table 22: Number of existing common infrastructure and services/codified stocks of knowledge in 2005

| | number of existing common infrastructure and services/codified stocks of knowledge | |
|-----------------------------|--|-----------------------------|
| | available for (PCCL-)network members | available for common public |
| access to laboratory | x | |
| website | x | x |
| project management services | x | |

Discussion: The most important common infrastructure of the PCCL is its (scientific) equipment that can be used by all (PCCL-)network members for the joint R&D projects. In 2005/06 the investments in (scientific) equipment of the PCCL amounted for € 783.00 (see Table 21). Furthermore within the (PCCL-)network, partners also gain access to laboratories of the scientific partners (according to detailed regulations within contracts of cooperation). Thus, the (PCCL-)network offers its partners access to a comprehensive selection of outstanding scientific infrastructure by incorporating the existing competence, expertise and laboratory infrastructure of its partners. In addition to access to laboratories, project management service are provided by PCCL exclusively for the network members.

2.2.2.6. SC 6: Management and institution building

Rationale: Management and institution building is not on its own right a relevant knowledge resource but it is important as it ensures effectiveness (=“functioning”) of a network by creating framework conditions for long-term co-operations and hence the potential for sustained competitiveness.

Indicators: The number of management decisions based on explicit rules and procedures at the time of the survey is the indicator that reflects management and institution building in the (PCCL-)network.

Table 23: Number of management decisions based on explicit rules and procedures at the time of the survey

| | formalised management decisions |
|-----------------------|---------------------------------|
| budget | x |
| member fees | |
| investments | x |
| new management staff | |
| new partners | x |
| strategic orientation | x |
| work programme | x |

Discussion: The (PCCL-)network is characterised by a high degree of institutionalisation (as a consequence of its participation in the *Kplus* programme). Thus management and institution building is warranted. This can also be seen by the high number of management decisions based on explicit rules and procedures (see Table 23).

2.2.2.7. SC 7: Confidence of partner companies in scientific competence of PCCL

Rationale: The confidence of partner companies in the scientific competence of PCCL is a prerequisite for joint projects of the (PCCL-)network with partner companies (within *Kplus* or *Non-Kplus*) and thus influences the success of the PCCL and the network as a whole.

Indicators: The confidence of partner companies into the scientific competence of the PCCL is shown with the following indicators: (a) number and volume of *Kplus*-projects and of additional *Non-Kplus*-projects, (b) number of network members in Phase II of *Kplus*, and (c) share of (PCCL-)network members satisfied with provision of scientific and technological knowledge within the network in 2005.

Table 24: Number and volume of *Kplus*-projects and of additional *Non-Kplus*-projects

| | <i>Kplus</i> | |
|------------------------|------------------|---------------------------------|
| | number | volume in € (planned) |
| Phase I (2002 - 2006) | 42 | 11,604,785 (Ø 2,9 Mio. p.a.) |
| Phase II (2006 - 2009) | 47 | 11,826,000 (Ø 3,8 Mio. p.a.) |
| | <i>Non-Kplus</i> | |
| 2005/06 | 45 | 896,988 |

Table 25: Number of network members in Phase II of *Kplus*

| | network members | | | |
|------------------------|-----------------|---|----------|---|
| | Phase I | | Phase II | |
| | number | share of members in Phase I also member in Phase II | number | share of members, members in Phase I already) |
| PCCL | 1 | 100 % | 1 | 100 % |
| scientific partners | 12 | 50 % | 6 | 100 % |
| partner companies | 40 | 77.5 % | 38 | 81.8 % |
| (PCCL-)network overall | 53 | 71.7 % | 45 | 84.4 % |

Table 26: Share of (PCCL-)network members satisfied with provision of scientific and technological knowledge within the network in 2005

| | very satisfied | satisfied | dissatisfied | very dissatisfied |
|---------------------|----------------|-----------|--------------|-------------------|
| scientific partners | 33 % | 67 % | 0 % | 0 % |
| partner companies | 33 % | 67 % | 0 % | 0 % |

Discussion: As the confidence of the partners in the scientific competence of the PCCL is a prerequisite for joint research projects, the development of the number/volume of research projects performed at the PCCL may indicate the confidence of the partners. For the up-coming funding period (Phase II) the number of projects will increase by 12 %, the average annual project volume even by 30 % (see Table 24).

In Phase I no (PCCL-)network member left the network, although this would have been possible in principle. The number of network members and the composition within the partner companies

however changes from Phase I to Phase II and hence there is some fluctuation in the network (see Table 25). The number of partner companies will in the short term decrease to 38, as for the Phase II all contracts of co-operations have to get renewed. It is however intended to increase the number of partner companies - similar to the development in Phase I to more than 40 by year 6. Regarding the scientific partners, the number of 12 scientific partners will be focused on 6 core partners, supplemented by a newly established "scientific supporting group", which consists of more than 10 members.

These figures reflect a considerable stable network structure which enables the establishment of long-term research co-operations together with a reasonable amount of exchange of partners in order to get new competences in the network.

2.2.2.8. SC 8: Relevant competences in the 9 thematic focus areas

Rationale: Competences in the thematic focus areas of the (PCCL-)network are the basis for long-term competitiveness in pre-competitive research in polymer engineering and science and the (PCCL-)network as a network.

Indicators: Relevant competencies in the 9 thematic focus areas are covered by the indicators (a) number and volume of projects in 9 thematic focus areas, and (b) number of publications in 9 thematic focus areas.

Table 27: Number and volume of projects in 9 thematic focus areas³

| | projects | | | |
|--|----------|--------------|----------|--------------|
| | Phase I | | Phase II | |
| | Number | volume in k€ | number | volume in k€ |
| Thematic Focus 1: Polyolefins | 15 | 4.000 | 12 | 3.607 |
| Thematic Focus 2: Elastomers and elastomer composites | 9 | 1.470 | 8 | 2.113 |
| Thematic Focus 3: Thermosets and thermoset composites | 7 | 2.326 | 6 | 2.051 |
| Thematic Focus 4: Functional polymeric materials and applications | 7 | 1.446 | 6 | 1.515 |
| Thematic Focus 5: Structural and functional polymer surfaces | 8 | 2.682 | 9 | 2.610 |
| Thematic Focus 6: Polymeric materials for Sustainable Development technologies | 4 | 969 | 7 | 1.804 |
| Thematic Focus 7: Polymer processing and process modeling | 6 | 2.067 | 8 | 2.253 |
| Thematic Focus 8: Novel design procedures and structural modeling techniques | 4 | 1.207 | 5 | 1.531 |
| Thematic Focus 9: Advanced analysis, characterization and test methods | 17 | 2.830 | 12 | 2.845 |

³ Double counting of projects because the majority of projects is assigned to more than one thematic focus area and the whole project is counted in each thematic focus area it is assigned to. Nevertheless this indicator gives an indication of the diversity of competences and their distribution.

Table 28: Number of publications in 9 thematic focus areas

| | number of publications 2005/06 |
|--|--------------------------------|
| Thematic Focus 1: Polyolefins | 8 |
| Thematic Focus 2: Elastomers and elastomer composites | 3 |
| Thematic Focus 3: Thermosets and thermoset composites | 7 |
| Thematic Focus 4: Functional polymeric materials and applications | 15 |
| Thematic Focus 5: Structural and functional polymer surfaces | 11 |
| Thematic Focus 6: Polymeric materials for Sustainable Development technologies | 14 |
| Thematic Focus 7: Polymer processing and process modeling | 3 |
| Thematic Focus 8: Novel design procedures and structural modeling techniques | 3 |
| Thematic Focus 9: Advanced analysis, characterization and test methods | 17 |

Discussion: The thematic foci of projects and publications are highly diversified reflecting the broad scientific approach (from polymer chemistry via process technologies to component performance and product functionality), the variety of partner companies and the competences of the involved scientific partners (see Table 27). This unique profile of the (PCCL-)network makes the network even more interesting for prospective partners.

2.2.3. Relational Capital (RC)

Definition: Relational capital is defined as all resources linked to external relationships of the PCCL such as external R&D-institutions, other clusters or networks, external stakeholders or non-member firms.

Nowadays a research organisation cannot be successful on its own. Long-run success requires to be integrated in the innovation system and to have good relations to the most relevant stakeholders. This does also hold true for the PCCL as a *Kplus* center.

The relational capital of the (PCCL-)network is characterised by the success factors RC 1 and RC 2:

- RC 1: Sound embedding into regional/national innovation system
- RC 2: Co-operations with other networks/clusters or institutions/ single firms

2.2.3.1. RC 1: Sound embedding into regional/national innovation system

Rationale: Relational capital contributes to value creation in the network as it provides access to relevant external knowledge such as content and funding of new R&D programmes. Therefore the sound embedding into the regional/national innovation system is highly relevant for the (PCCL-)network that conducts mainly basic and pre-competitive research.

Indicators: The sound embedding into regional/national innovation system is described by: (a) attendance of representatives of relevant external stakeholders in network activities in 2005/06, (b) attendance of representatives of relevant external stakeholders in formal decision making process in 2005/06, (c) number and volume of projects of co-operation partners from the region, and (d) share of (PCCL-)network members participating in industry-relevant bodies and number of participations.

Table 29: Attendance of representatives of relevant external stakeholders in network activities in 2005/06

| | Boards |
|--------------------------|--------|
| authorities granting aid | x |
| scientific community | x |
| polymer sector | x |
| regional authorities | x |

Table 30: Attendance of representatives of relevant external stakeholders in stakeholders in formal decision making process in 2005/06

| | Board meeting | Supervisory board meeting | General assembly | Scientific advisory council |
|-------------------------------------|---------------|---------------------------|------------------|-----------------------------|
| Attendance of external stakeholders | x | x | x | x |

Table 31: Number and volume of projects of co-operation partners from the region

| | co-operation partners from the region | |
|-----------------|---------------------------------------|--------------|
| | number | volume in k€ |
| Styria | 11 | 1,467 |
| Upper Austria | 9 | 2,199 |
| Austria (other) | 11 | 1,173 |
| abroad | 9 | 913 |

Table 32: Share of PCCL company partners participating in industry-relevant bodies and number of participations

| | participating in industry-relevant bodies | |
|-------------------|---|----------------------------------|
| | share of members | average number of participations |
| partner companies | 53 % | 5.4 |

Discussion: The most relevant stakeholders for the (PCCL-)network are the polymer industry, the scientific community, funding authorities and representatives of regional authorities. Representatives of all these external stakeholders are part of the main decision making bodies, i.e. Board, Supervisory Board etc. of the PCCL (see Table 29 and Table 30).

The embedding into the regional innovation system(s) can also be seen by the spatial distribution of the co-operation partners (see Table 31). About half of the partner companies are located in Styria and Upper Austria; in terms of financial contribution even 2/3 can be assigned to these two federal states, thus generating valuable impact for the regional development. Multi-national companies located outside Austria make up for about 20 % of the partner companies and substantially contribute to the networks development in terms of (i) broadening the perspective for international developments and demands, (ii) enabling contacts for new international collaborations, and (iii) fostering the networks high profile abroad.

Approximately 50 % of the company partners are represented in industry relevant bodies and do thus also represent the (PCCL-)network (see Table 32).

2.2.3.2. RC 2: Co-operations with other networks/clusters or institutions/ single firms

Rationale: External co-operations can help to get access to stocks of knowledge that do not exist in the network. Therefore co-operations with other networks/clusters or institutions/ single firms present an important knowledge resource.

Indicators: The following indicators reflect co-operations with other networks/clusters or institutions/ single firms: (a) share of PCCL R&D projects involving external R&D institutions/networks in 2005/06, and (b) number of co-operation agreements with other knowledge intensive networks in 2005/06.

Table 33: Share of PCCL R&D projects involving external R&D institutions/networks in 2005/06

| | R&D projects | |
|--|--------------|--------|
| | total number | share |
| Non- <i>Kplus</i> 2005 | 45 | 100% |
| Non- <i>Kplus</i> -projects 2005/06 performed with partner companies of the (PCCL-)network | 14 | 31.1 % |
| Non- <i>Kplus</i> -projects 2005/06 performed with external companies | 31 | 68.9 % |

Table 34: Number of co-operations outside the *Kplus*-programme in 2005/06

| | number of co-operation agreements |
|-----------------------------------|--|
| co-operation outside <i>Kplus</i> | 6 (NANONET-Styria, NanoComp, MATELCOMP, PERFORMANCE, Zukunftsfonds-Steiermark (Solar Technology)) |

Discussion: In 2005/06, in about 69 % of all Non-*Kplus*-projects external partners were involved. This high share guarantees, that also competences outside the network are integrated and contacts to potential new partners are set up.

The PCCL also signed a co-operation agreement with another knowledge intensive network - NANONET-Styria (see Table 34). In addition to the membership of PCCL within the NANONET-Styria, it has also set up a Research Project Cluster on "Performance Optimization of Polymeric Nanocomposites" within the Austrian NANO-Initiative consisting of 8 company partners and 7 scientific partners. Further activities, e.g. coordination of the trans-national programme STRAPAMO with partners in Austria, Hungary and Slovenia as well as the participation in EU-projects reflect the integration in the regional, national and international research and innovation system.

In addition to the direct involvement of the (PCCL-)network via the PCCL, most of the network partners (scientific and company partners) are involved in a array of other clusters, initiatives, networks or institutions and thus also support indirectly the sound embedding into the regional/national innovation system.

2.3. Outcome orientation: objectives and outcomes

Resources are required to be able to achieve objectives. These resources, as far as they concern intellectual capital, are presented in the resource orientation.

In the following section the focus is on the objectives of the (PCCL-)network. They are presented and illustrated with the help of indicators.

2.3.1. Meta-objectives

The (PCCL-)network is a *Kplus* research network with an emphasis on polymer engineering and sciences with the goal to contribute to the continuous development and implementation of scientific knowledge in polymer engineering and sciences and related fields.

The meta-goals of the (PCCL-)network are:

- To lastingly establish the (PCCL-)network as the leading research institution for science-based, pre-competitive research in Polymer Engineering and Science in Austria, simultaneously becoming one of the leading institutions in this field in Europe.
- With its locations in Styria (Leoben, head quarter, and Graz) and Upper Austria (Wels/Linz), the (PCCL-)network envisions a valuable impact and contribution on the regional development especially in these two States by enhancing the attractiveness as business locations for domestic and foreign investors, and for spin-offs and start-up companies.

2.3.2. Network objectives and their interrelation with success factors

By definition, the knowledge resources considered, are “success factors” in the way they were identified to positively influence the objectives of the (PCCL-)network (in a group exercise that was undertaken in the process of preparing the PCCL Pilot RICARDA ICR): Success factors are knowledge resources that positively influence the objectives of the PCCL. So in the previous section not all possible knowledge resources of the (PCCL-)network were presented, but only those were highlighted that contribute to achieving the objectives of the PCCL. This interrelation of success factors, i.e. specific knowledge resources, and objectives lies at the core of the process of intellectual capital reporting according to the RICARDA methodology (see Figure 3).

The PCCL success factors are interlinked with the PCCL objectives in several ways (see Table 35).

Table 35: PCCL success factors influencing PCCL objectives

| Interrelations of success factors and objectives | |
|---|--|
| PCCL objectives | PCCL success factors influencing PCCL objective |
| Objective 1: Increase of knowledge creation | HC 1: Knowledge base (in terms of persons in network) |
| | HC 2: Individual learning |
| | SC 2: Interorganisational learning |
| | SC 4: Innovation capacity |
| | SC 8: Relevant competences in the 9 thematic focus areas |
| Objective 2: Improvement of knowledge diffusion | SC 1: Partnerships and networks |
| | SC 3: Social capital |
| | SC 4: Innovation capacity |
| | SC 5: Common infrastructure and services |
| | RC 2: Co-operations with other networks/clusters or institutions/ single firms |
| Objective 3: Orientation towards flows of new knowledge | SC 3: Social capital |
| | RC 2: Co-operations with other networks/clusters or institutions/ single firms |
| Objective 4: Establishment of highly qualified labour force with relevant skills for the knowledge intensive network | HC 1: Knowledge base (in terms of persons in network) |
| | HC 2: Individual learning |
| | SC 5: Common infrastructure and services |
| Objective 5: Access to and use of common infrastructure and services (creation of a club) | SC 5: Common infrastructure and services |
| | SC 7: Confidence of partner companies in scientific competence of PCCL |
| Objective 6: Functioning of the network operation | SC 6: Management and institution building |
| | RC 1: Sound embedding into regional/national innovation system |
| Objective 7: Enhancement of existing infrastructure and resources for pre-competitive research in polymer engineering and science | SC 5: common infrastructure and services |

Table 35: PCCL success factors influencing PCCL objectives (continued)

| Interrelations of success factors and objectives | |
|--|--|
| PCCL objectives | PCCL success factors |
| Objective 8: Establishment and consolidation of long term co-operations with relevant enterprises for pre-competitive research in polymer science (especially SME) | SC 1: Partnerships and network |
| | SC 2: Interorganisational learning |
| | SC 3: Social capital |
| | SC 5: Common infrastructure and services |
| | SC 6: Management and institution building |
| | SC 7: Confidence of partner companies in scientific competence of PCCL |
| | SC 8: Relevant competences in the 9 thematic focus areas |
| Objective 9: Establishment and deepening of relevant competences in the area of pre-competitive polymer science within the (PCCL-)network | HC 1: Knowledge base (in terms of persons in network) |
| | HC 2: Individual learning |
| | SC 2: Interorganisational learning |
| | SC 8: Relevant competences in the 9 thematic focus areas |
| Objective 10: Contribution to sustainable development | SC 8: Relevant competences in the 9 thematic focus areas |
| | RC 1: Sound embedding into regional/national innovation system |
| Objective 11: Improvement of education possibilities in the field | HC 2: Individual learning |
| | SC 2: Interorganisational learning |
| | RC 1: Sound embedding into regional/national innovation system |
| Objective 12: Contribution to regional development | HC 1: Knowledge base (in terms of persons in network) |
| | SC 1: Partnerships and networks |
| | RC 2: Co-operations with other networks/clusters or institutions/ single firms |

2.3.3. Objective 1: Increase of knowledge creation

Knowledge is the key resource in a knowledge based economy and knowledge creation is the prerequisite for long-term competitiveness. The increase of knowledge creation requires well-educated and -trained employees that work on the increase of relevant knowledge.

The number of R&D employees at the PCCL has doubled within the last four years and the (PCCL-)network itself is characterised by a high share of R&D employees and increasing R&D and innovation intensities (see HC 1 and SC 4). As one output, codified knowledge in form of publications and patents granted are central measures for the network (see HC 2 and SC 4). These indicators are a sign of an increase in knowledge creation.

2.3.4. Objective 2: Improvement of knowledge diffusion

The improvement of knowledge diffusion allows for a better use of existing knowledge, increased adaptability, increased problem solving skills and hence increased competitiveness. It depends on the creation of knowledge (objective 1) but is easier to influence and thus it is particularly important to take measures that increase the improvement of knowledge diffusion.

Knowledge diffusion in a knowledge intensive network occurs mainly when individuals get the opportunity to exchange their knowledge with other experts in their field.

All (PCCL-)network member organisations take part in interorganisational R&D and project teams comprising only network members and are involved in repeated co-operations in R&D. Knowledge diffusion and know-how transfer is fostered by a high number of multi-firm projects, which amount to about 50 % of the total project volume at the PCCL (see also SC 1). The remarkable amount of co-operations of the PCCL outside *Kplus* (f.i. NANONET-Styria, STRAPAMO, see RC 2, Table 34) as well as the involvement of (PCCL-)network members in a variety of other clusters and initiatives do in addition foster the diffusion of knowledge diffusion.

2.3.5. Objective 3: Orientation towards flows of new knowledge

Access to new technologies in the network (that would not have existed for single firms) allows to serve additional markets and improves the competitiveness of the single (PCCL-)network members and hence the (PCCL-)network as a whole.

The orientation toward flows of new knowledge may also get reflected by an increasing share of members taking part in the framework programme of the EU. This share increased from 33 % in 2001 to 57 % in 2005 (see Table 36).

Table 36: Share of (PCCL-)network members participating in framework programme of the EU

| | participation rate | | | | |
|------------------------|--------------------|-------------------|-------|-------|-------|
| | 2001 | 2002 ⁴ | 2003 | 2004 | 2005 |
| PCCL | | 0 % | 0 % | 0 % | 100 % |
| scientific partners | 50 % | 50 % | 100 % | 100 % | 100 % |
| partner companies | 32 % | 42 % | 37 % | 47 % | 47 % |
| (PCCL-)network overall | 33 % | 41 % | 41 % | 50 % | 57 % |

2.3.6. Objective 4: Establishment of highly qualified labour force with relevant skills for the knowledge intensive network

A highly qualified labour force positively affects knowledge creation and diffusion. In a knowledge intensive network like the (PCCL-)network it is established more successful due to labour force mobility, increased co-operation between partner companies and the PCCL but especially due to the co-operation between partner companies and scientific partners (with the support of the PCCL). PCCL's vision is to contribute to the development of highly qualified professionals, which is demonstrated by about 30 academic works finished and more than 50 academic works in progress by employees of the PCCL as of June 2006 (see HC 2, Table 4). Within the overall (PCCL-)network the share of highly qualified employees (university degree) is generally increasing and amounts for 12 % in 2005 starting with 9,9 % in 2002 (see Table 37).

⁴ for PCCL: 2002/03

Table 37: Share of employees with university degree

| | employees with university degree | | | | |
|------------------------|----------------------------------|-------------------|--------|--------|--------|
| | 2001 | 2002 ⁴ | 2003 | 2004 | 2005 |
| | full time equivalents | | | | |
| PCCL | | 52.9 % | 61.5 % | 67.6 % | 64.1 % |
| scientific partners | 54.1 % | 56.9 % | 59.4 % | 60.5 % | 67.4 % |
| partner companies | 9.5 % | 10.3 % | 10.4 % | 10.9 % | 11.5 % |
| (PCCL-)network overall | 9.9 % | 10.7 % | 10.8 % | 11.3 % | 12.0 % |

2.3.7. Objective 5: Access to and use of common infrastructure and services (creation of a club)

Common infrastructure/knowledge allows activities that would not be possible for the single network members; these activities might contribute to increased competitiveness, they increase the incentive to actively participate in the network and thus again indirectly contribute to the creation and diffusion of knowledge.

One of the major objectives of the (PCCL-)network is to strengthen and improve existing common infrastructure and resources for pre-competitive research in polymer engineering and science. The laboratory of the PCCL is used by 95 % of its members, the website and project management services offered by the PCCL by almost 50 % (see SC5, Fehler! Verweisquelle konnte nicht gefunden werden.). A high level of satisfaction with the provision of scientific and technological knowledge within the network partners shows the degree of performance of this objective (see SC 7, Table 26).

2.3.8. Objective 6: Functioning of the network operation

The effective and efficient functioning of the network is a prerequisite for successful co-operation within the (PCCL-)network and thus to achieve the other objectives.

The (PCCL-)network is a highly institutionalised knowledge intensive network. Therefore a comprehensive system of processes and structures guarantees the functioning of the network operation. This can be seen by a high number management decisions based on explicit rules (see SC6, Table 23), a high level of involvement of the most relevant external stakeholders in PCCL meetings (see RC1, Table 29 and Table 30), but also a high level of satisfaction of (PCCL-)network member organisations with the provision of scientific and technological knowledge (see SC 7, Table 26). The fact that no partner left the network within Phase I and an amount of about 80 % of the partners continuing the membership in Phase II highlights the functioning of the network operations.

2.3.9. Objective 7: Enhancement of existing infrastructure and resources for pre-competitive research in polymer engineering and science

The enhancement of existing infrastructure and resources for pre-competitive research in polymer engineering and science is a more specific sub-goal of objective 5. Objective 7 reiterates the importance of infrastructure and resources for pre-competitive research in polymer engineering and science for the (PCCL-)network.

To enhance the infrastructure and resources, investments of € 783.000 in (scientific) equipment took place in 2005/06. The office space of PCCL (without working places at the Universities of Leoben, Graz and Linz/Wels) covers 390 m², which has to be enlarged for Phase II in order to obtain the vision of the (PCCL-)network.

2.3.10. Objective 8: Establishment and consolidation of long term co-operations with relevant enterprises for pre-competitive research in polymer science (especially SME)

Stable and long term co-operations allow the co-operation after the end of Phase II of the *Kplus* activities of the (PCCL-)network and give evidence of the success of the (PCCL-)network.

The continuous extension of the number of (PCCL-)network partners in Phase I and also the prolongation of most of this cooperation for Phase II (see SC 1, Table 7 and SC 7, Table 25) gives evidence of a successful consolidation of the establishment of long term co-operations. This is also supported by the high level of satisfaction of partner companies in the scientific competence of the PCCL (see SC 7). The high amount of multi-firm projects performed, constitutes an even deeper horizontal and/or vertical integration among the company partners and support the consolidation of long term co-operations.

2.3.11. Objective 9: Establishment and deepening of relevant competences in the area of pre-competitive polymer science within the (PCCL-)network

The relevant competences in the area of pre-competitive polymer science within the (PCCL-)network are a prerequisite for the long-term competitiveness of the (PCCL-)network.

The research programme of (PCCL-)network can be structured in 9 thematic focus areas which reflect comprehensive competencies in the field of polymer engineering and science. One output of the competencies in these fields presentations at scientific conferences and publications (see SC8, Table 28). As a main aim of the PCCL, the number of publications especially in refereed, scientific journals should be increased in these areas. This aim is also backed by the success factor HC 2 (individual learning).

2.3.12. Objective 10: Contribution to sustainable development

Sustainable development is a general societal goal to which the (PCCL-)network wants to contribute. Therefore one objective of the (PCCL-)network is to design the R&D activities in a way for them to be compliant to the requirements of sustainable development.

Thematic focus 6 is also devoted polymeric materials for sustainable development technologies. The importance of this focus area almost doubled from Phase I to Phase II (see Table 38 and Table 39, and SC 8). In addition, a considerable number of Non-*Kplus*-projects deals with the use of polymeric materials for solar technology applications.

Table 38: Numbers and volumes of projects in thematic focus area 6 of the PCCL

| | projects | | | |
|--|----------|--------------|----------|--------------|
| | Phase I | | Phase II | |
| | number | volume in k€ | number | Volume in k€ |
| Thematic Focus 6: Polymeric materials for Sustainable Development technologies | 4 | 969 | 7 | 1.804 |

Table 39: Numbers of publications and events in thematic focus area 6 of the PCCL

| | 2005/06 | |
|--|------------------------|------------------|
| | number of publications | number of events |
| Thematic Focus 6: Polymeric materials for Sustainable Development technologies | 14 | 1 |

2.3.13. Objective 11: Improvement of education possibilities in the field

There exists a high demand for highly-qualified professionals in the field of polymer engineering and science. The PCCL can contribute to the education possibilities in the field by offering students the possibility to work on projects and thus gain first work experience in the field while simultaneously continuing their studies at the university (see also HC 2). At the end of business year 2005/06 more than 50 academic works (bachelor and master thesis, dissertations) are in progress and reflect the positive interconnections between academic education and project related R&D-activities within the (PCCL-)network.

2.3.14. Objective 12: Contribution to regional development

The (PCCL-)network is active in a dynamic economic sector with promising outlooks. These opportunities should be taken to contribute to regional development. The (PCCL-)network's aim is to build up and stabilise long-term and pre-competitive R&D-co-operations with relevant companies (particularly SMEs) in the plastics sector and related service industries (engineering companies, consultants etc.) as well as to build and deepen coherent long-term and flexible available competence from the research capability available from partners and partner companies within the network. The (PCCL-)network projects and platform- and network activities have a strong regional focus but do also include an international focus.

The PCCL-projects offer opportunities for students to gain experiences and increase their expertise by jointly working with experts from academia and business (see HC 1 and HC 2). After finishing their studies, these students can be easily integrated in companies or scientific institutions.

2.4. Future orientation: environmental framework conditions and consequences

The (PCCL-)network is a knowledge intensive network working in the fields of plastics engineering, polymer science and related fields. The future developments of the (PCCL-)network members but also of the (PCCL-)network are thus partly dependent on external framework conditions that cannot be influenced by the PCCL or the (PCCL-)network members.

One relevant external fact is the correlation of polymer consumption and societal prosperity. External trends are the increasing shares of markets in Eastern Europe and Asia and the increasing focus on light weight construction. Also in opto-electronics, etc. polymers are increasingly employed as functional materials (material working as information medium). A further important external trend is the increase in energy prices: this makes the application of polymers for solar technology more attractive and also further increases the pressure to use light weight products.

These external trends indicate a positive market development for polymer materials and products and do thus not give a reason to rethink the current objectives of the (PCCL-)network.

Another highly relevant external framework condition for the (PCCL-)network is the future development of regulatory and political framework conditions concerning subsidies for the (PCCL-)network. The support via the *Kplus* program will run out in 2009 and the success in making new sources of subsidies accessible (in addition to the current Non-*Kplus*-activities) will be decisive for the future development of the (PCCL-)network.

2.5. (PCCL-)network intangible assets: status quo

As the current ICR of the (PCCL-)network is the first in its kind it can only monitor the recent status quo; the analysis and discussion of development is not possible at the moment. Nevertheless the analysis offers some first insights on the existing stocks of intangible assets:

- Human capital is at good development stage: The level of employees with university degree is particularly high among the PCCL and its scientific partners. Continuous (academic) education is at high priority within the (PCCL-)network.
- Structural capital: Besides having a strong innovation capacity in terms of input and output indicators also a strong investment into equipment - that is at disposal for the network members - should be noteworthy. Regarding the structure of the partnership and the network, the high number of multi-firm projects as well as the integration of large enterprises and SMEs is remarkable.

- Relational capital: On the one hand the indicators on relational capital show that the (PCCL-)network is at the same time integrated into international knowledge flows as well as into local/regional R&D-activities in Austria, on the other hand the co-operation with the platforms like NANONET Styria reflects the ability to link up with other R&D initiatives on regional level.

2.6. Conclusions

The knowledge intensive network of the PCCL is on good way to establish itself as an important regional knowledge node that is bringing together scientific research and industries needs simultaneously including international developments and trends by incorporating international companies in the network. In particular the existing knowledge base and the innovation potential of the network strongly contribute to these findings.

Key challenges with a strong impact on the intellectual assets of the network can be mainly found in the Austrian national innovation system: Namely the program COMET - a sequel to the *Kplus* funding scheme - with its even stronger emphasis on internationally visibly, scientific excellence and critical masses will very likely influence the future route of the development of the (PCCL-)network.

In particular the role the knowledge base could/ should play a particular important role for the future development of the (PCCL-)network. First it is a key to significant regional impacts in terms of knowledge spill-overs and learning (and thus to an enhancement of the competitiveness of the region's economy), and second the knowledge base can be directly influenced by the PCCL's management and the other members of the network.



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SIXTH FRAMEWORK PROGRAMME



EUROPEAN RESEARCH AREA

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