Horizon 2020

Call: H2020-SPIRE-2014

Topic: SPIRE-01-2014

Type of action: RIA

Proposal number: SEP-210138358

Proposal acronym: DISIRE

Table of contents

Section	Title	Action
1	General information	
2	Participants & contacts	
3	Budget	
4	Ethics	

How to fill in the forms

The administrative forms must be filled in for each proposal using the templates available in the submission system. Some data fields in the administrative forms are pre-filled based on the previous steps in the submission wizard.

Proposal ID **636834** *Acronym* **DISIRE**

1 - General information

Topic	SPIRE-01-2014	Type of action	RIA
Call identifier	H2020-SPIRE-2014	Acronym	DISIRE

Proposal title* Integrated Process Control based on Distributed In-Situ Sensors into Raw Material and Energy Feedstock

Note that for technical reasons, the following characters are not accepted in the Proposal Title and will be removed: < > " &

Duration in months *36*

Fixed keyword 1 Add

Free keywords *Integrated Process Control, on-ine PAT based IPC, In-situ sensors, machine learning, statistical learning, spatial swarm sensing, optimization, industrial demonstration*

Abstract

The DISIRE project has been inspired by the real existing needs of multiple industrial sectors, including the world leading industrial partners in the non-ferrous, ferrous, chemical and steel industries that are highly connected and already affiliated with the SPIRE PPP and its objectives. The overall clear and measurable objective of the DISIRE project is to evolve the existing industrial processes by advancing the Sustainable Process Industry through an overall Resource and Energy efficiency by the technological breakthroughs and concepts of the DISIRE technological platform in the field of Industrial Process Control (IPC).

With the DISIRE project the properties of the raw materials or product flows will be dramatically integrated by their transformation in a unique inline measuring system that will extend the level of knowledge and awareness of the internal dynamics of the undergoing processes taking place during transformation or integration of raw materials in the next levels of production. In this approach, the Integrated Process Control system, instead of having external experts to tune the overall processes, based on the DISIRE concept will enable the self reconfiguration of all the production lines by the produced products itself.

Specific DISIRE Process Analyzer Technology (PAT) will be able to define quality and performance requirements, that for the first time in the process industry will be able to be directly applied on the physical properties of the developed products and thus enabling the overall online and product specific reconfiguration of the control system. In this way, the whole production can be fully integrated in a holistic approach from the raw materials to the end product, allowing the multiple process reconfigurations and an optimal operation based on the product's properties that can be generalized in a whole product production cycle being spanned in multiple cross-sectorial processes.

Remaining characters 50

Has this proposal (or a very similar one) been submitted in the past 2 years in response to a call for proposals under the 7th Framework Programme, Horizon 2020 or any other EU programme(s)? ○ Yes ◉ No

Proposal ID **636834** *Acronym* **DISIRE**

Declarations

1) The coordinator declares to have the explicit consent of all applicants on their participation and on the content of this proposal.	☒
2) The information contained in this proposal is correct and complete.	☒
3) This proposal complies with ethical principles (including the highest standards of research integrity — as set out, for instance, in the European Code of Conduct for Research Integrity — and including, in particular, avoiding fabrication, falsification, plagiarism or other research misconduct).	☒

4) The coordinator confirms:

- to have carried out the self-check of the financial capacity of the organisation on https://ec.europa.eu/research/participants/portal4/desktop/en/organisations/lfv.html. Where the result was "weak" or "insufficient", the coordinator confirms being aware of the measures that may be imposed in accordance with the H2020 Grants Manual (Chapter on Financial capacity check); or	☒
- is exempt from the financial capacity check being a public body including international organisations, higher or secondary education establishment or a legal entity, whose viability is guaranteed by a Member State or associated country, as defined in the H2020 Grants Manual (Chapter on Financial capacity check); or	☐
- as sole participant in the proposal is exempt from the financial capacity check.	☐

5) The coordinator hereby declares that each applicant has confirmed:

- they are fully eligible in accordance with the criteria set out in the specific call for proposals; and	☒
- they have the financial and operational capacity to carry out the proposed action.	☒

The coordinator is only responsible for the correctness of the information relating to his/her own organisation. Each applicant remains responsible for the correctness of the information related to him and declared above. Where the proposal to be retained for EU funding, the coordinator and each beneficiary applicant will be required to present a formal declaration in this respect.

According to Article 131 of the Financial Regulation of 25 October 2012 on the financial rules applicable to the general budget of the Union (Official Journal L 298 of 26.10.2012, p. 1) and Article 145 of its Rules of Application (Official Journal L 362, 31.12.2012, p.1) applicants found guilty of misrepresentation may be subject to administrative and financial penalties under certain conditions.

Personal data protection

Your reply to the grant application will involve the recording and processing of personal data (such as your name, address and CV), which will be processed pursuant to Regulation (EC) No 45/2001 on the protection of individuals with regard to the processing of personal data by the Community institutions and bodies and on the free movement of such data. Unless indicated otherwise, your replies to the questions in this form and any personal data requested are required to assess your grant application in accordance with the specifications of the call for proposals and will be processed solely for that purpose. Details concerning the processing of your personal data are available on the privacy statement. Applicants may lodge a complaint about the processing of their personal data with the European Data Protection Supervisor at any time.

Your personal data may be registered in the Early Warning System (EWS) only or both in the EWS and Central Exclusion Database (CED) by the Accounting Officer of the Commission, should you be in one of the situations mentioned in:
-the Commission Decision 2008/969 of 16.12.2008 on the Early Warning System (for more information see the Privacy Statement), or
-the Commission Regulation 2008/1302 of 17.12.2008 on the Central Exclusion Database (for more information see the Privacy Statement) .

Proposal ID **636834** *Acronym* **DISIRE**

2 - Administrative data of participating organisations

PIC	***Legal name***
999876874	*LULEA TEKNISKA UNIVERSITET*

Short name: LTU

Address of the organisation

Street	University Campus, Porsoen
Town	LULEA
Postcode	SE97187
Country	Sweden
Webpage	www.ltu.se

Legal Status of your organisation

Research and Innovation legal statuses

Public body	yes	Legal person	yes
Non-profit	yes		
International organisation	no		
International organisation of European interest	no		
Secondary or Higher education establishment	yes		
Research organisation	yes		
Small and Medium-sized Enterprises (SMEs)	no		

Nace code

Proposal ID **636834** *Acronym* **DISIRE**

Department(s) carrying out the proposed work

Department 1

Department name	Computer Science Electrical and Space Engineering
Street	University Campus, Porsoen
Town	LULEA
Postcode	SE97187
Country	Sweden

☒ Same as organisation address

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **636834** *Acronym* **DISIRE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Prof.

Sex: (•) Male ( ) Female

First name: **George**

Last name: **Nikolakopoulos**

E-Mail: **george.nikolakopoulos@ltu.se**

Position in org.: Associate Professor

Department: *Please indicate the department of the Contact Point above in the organisation.*

Street: University Campus, Porsoen

☒ Same as organisation address

Town: LULEA

Post code: SE97187

Country: Sweden

Website: http://www.ltu.se/staff/g/geonik-1.81015

Phone: +46 (0) 920 49 13 67

Phone 2: +46 (0) 70 329 13 67

Fax: +46 (0) 920 49 13 67

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Pär-Erik	Martinsson	par-erik.martinsson@ltu.se	

Proposal ID **636834** *Acronym* **DISIRE**

PIC	***Legal name***
993600004	*LUOSSAVAARA-KIIRUNAVAARA AB*

Short name: LKAB

Address of the organisation

Street VARVSGATAN 45

Town LULEA

Postcode 971 28

Country Sweden

Webpage www.lkab.com

Legal Status of your organisation

Research and Innovation legal statuses

Public body .... no

Non-profit .... no

International organisation .... no

International organisation of European interest ... no

Secondary or Higher education establishment ..... no

Research organisation .... no

Small and Medium-sized Enterprises (SMEs) .... no

Legal person ....yes

Nace code

Proposal ID **636834** *Acronym* **DISIRE**

Department(s) carrying out the proposed work

Department 1

Department name	R&D Department
Street	VARVSGATAN 45
Town	LULEA
Postcode	971 28
Country	Sweden

☒ Same as organisation address

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **636834** *Acronym* **DISIRE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr.

Sex: ◯ Male ◉ Female

First name: **Eva-Lena**

Last name: **Johansson**

E-Mail: **eva-lena.johansson@lkab.com**

Position in org.: Research Engineer

Department: *Please indicate the department of the Contact Point above in the organisation.*

Street: VARVSGATAN 45

☒ Same as organisation address

Town: LULEA

Post code: 971 28

Country: Sweden

Website: www.lkab.se

Phone:

Phone 2: *+xxx xxxxxxxxx*

Fax: *+xxx xxxxxxxxx*

Proposal ID **636834** *Acronym* **DISIRE**

PIC	***Legal name***
957843961	*KGHM POLSKA MIEDZ SA*

Short name: KGHM POLSKA MIEDZ SA

Address of the organisation

Street UL M SKLODOWSKIEJ CURIE 48

Town LUBIN

Postcode 59301

Country Poland

Webpage

Legal Status of your organisation

Research and Innovation legal statuses

Public body .... no

Legal person ....yes

Non-profit .... no

International organisation .... no

International organisation of European interest ... no

Secondary or Higher education establishment ..... no

Research organisation .... no

Small and Medium-sized Enterprises (SMEs) .... no

Nace code

Department(s) carrying out the proposed work

Department 1

Department name	R&D Department
Street	UL M SKLODOWSKIEJ CURIE 48
Town	LUBIN
Postcode	59301
Country	Poland

☒ Same as organisation address

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **636834** *Acronym* **DISIRE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr.

Sex: ◯ Male ◉ Female

First name: **Ewa**

Last name: **Kuzma**

E-Mail: **e.kuzma@kghm.pl**

Position in org.: Chief Specialist in Production Engineering Department

Department: *Please indicate the department of the Contact Point above in the organisation.*

Street: UL M SKLODOWSKIEJ CURIE 48

☒ Same as organisation address

Town: LUBIN

Post code: 59301

Country: Poland

Website: http://www.kghm.pl/

Phone: *+xxx xxxxxxxxx*

Phone 2: *+xxx xxxxxxxxx*

Fax: *+xxx xxxxxxxxx*

Proposal ID **636834** *Acronym* **DISIRE**

PIC	***Legal name***
952787933	*ODYS SRL*

Short name: ODYS

Address of the organisation

Street	via della Chiesa XXXII trav. I 231
Town	Lucca
Postcode	55100
Country	Italy
Webpage	www.odys.it

Legal Status of your organisation

Research and Innovation legal statuses

Public body ....no
Non-profit ....no
International organisation ....no
International organisation of European interest ...no
Secondary or Higher education establishment .....no
Research organisation ....no
Small and Medium-sized Enterprises (SMEs) ....no

Legal person ....yes

Nace code

Proposal ID **636834** *Acronym* **DISIRE**

Department(s) carrying out the proposed work

Department 1

Department name	R&D Department
Street	via della Chiesa XXXII trav. I 231
Town	Lucca
Postcode	55100
Country	Italy

☒ Same as organisation address

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **636834** *Acronym* **DISIRE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr.

Sex: (•) Male ( ) Female

First name: **Daniele**

Last name: **Bernardini**

E-Mail: **daniele.bernardini@odys.it**

Position in org.: R&D Director

Department: *Please indicate the department of the Contact Point above in the organisation.*

Street: via della Chiesa XXXII trav. I 231

☒ Same as organisation address

Town: Lucca

Post code: 55100

Country: Italy

Website:

Phone:

Phone 2: *+xxx xxxxxxxxx*

Fax: *+xxx xxxxxxxxx*

Proposal ID **636834** *Acronym* **DISIRE**

PIC	***Legal name***
999845931	*POLITECHNIKA WROCLAWSKA*

Short name: PWR

Address of the organisation

Street WYBRZEZE WYSPIANSKIEGO 27

Town WROCLAW

Postcode 50370

Country Poland

Webpage www.pwr.wroc.pl

Legal Status of your organisation

Research and Innovation legal statuses

Public body .... yes

Non-profit .... yes

International organisation .... no

International organisation of European interest ... no

Secondary or Higher education establishment ..... yes

Research organisation .... yes

Small and Medium-sized Enterprises (SMEs) .... no

Legal person ....yes

Nace code

Proposal ID **636834** Acronym **DISIRE**

Department(s) carrying out the proposed work

Department 1

Department name	Institute of Mining Engineering
Street	WYBRZEZE WYSPIANSKIEGO 27
Town	WROCLAW
Postcode	50370
Country	Poland

☒ Same as organisation address

Dependencies with other proposal participants

Character of dependence	Participant	

Proposal ID **636834** *Acronym* **DISIRE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Prof.

Sex: (•) Male ( ) Female

First name: **Robert**

Last name: **Krol**

E-Mail: **robert.krol@pwr.wroc.pl**

Position in org.: Professor

Department: *Please indicate the department of the Contact Point above in the organisation.*

Street: WYBRZEZE WYSPIANSKIEGO 27

☒ Same as organisation address

Town: WROCLAW

Post code: 50370

Country: Poland

Website:

Phone: *+xxx xxxxxxxxx*

Phone 2: *+xxx xxxxxxxxx*

Fax: *+xxx xxxxxxxxx*

Proposal ID **636834** *Acronym* **DISIRE**

PIC	***Legal name***
965146412	*SCUOLA IMT (ISTITUZIONI, MERCATI, TECNOLOGIE) ALTI STUDI DI LUCCA*

Short name: IMT LUCCA

Address of the organisation

Street PIAZZA SAN PONZIANO 6

Town LUCCA

Postcode 55100

Country Italy

Webpage https://www.imtlucca.it/

Legal Status of your organisation

Research and Innovation legal statuses

Public body .... yes

Non-profit .... yes

International organisation .... no

International organisation of European interest ... no

Secondary or Higher education establishment ..... yes

Research organisation .... yes

Small and Medium-sized Enterprises (SMEs) .... no

Legal person ....yes

Nace code

Proposal ID **636834** *Acronym* **DISIRE**

Department(s) carrying out the proposed work

Department 1

Department name	Institute for Advanced Studies Lucca
Street	PIAZZA SAN PONZIANO 6
Town	LUCCA
Postcode	55100
Country	Italy

☒ Same as organisation address

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **636834** *Acronym* **DISIRE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Prof.

Sex: (•) Male ( ) Female

First name: **Alberto**

Last name: **Bemporad**

E-Mail: **bemporad@imtlucca.it**

Position in org.: Director

Department: *Please indicate the department of the Contact Point above in the organisation.*

Street: PIAZZA SAN PONZIANO 6

☒ Same as organisation address

Town: LUCCA

Post code: 55100

Country: Italy

Website:

Phone: *+xxx xxxxxxxxx*

Phone 2: *+xxx xxxxxxxxx*

Fax: *+xxx xxxxxxxxx*

Proposal ID **636834** *Acronym* **DISIRE**

PIC	***Legal name***
999495470	*KGHM CUPRUM SP ZOO CENTRUM BADAWCZO-ROZWOJOWE*

Short name: KGHM CUPRUM SP ZOO-CBR

Address of the organisation

Street	gen. Wl. Sikorskiego 2-8
Town	WROCLAW
Postcode	53659
Country	Poland
Webpage	www.cuprum.wroc.pl

Legal Status of your organisation

Research and Innovation legal statuses

Public body .... no

Non-profit .... no

International organisation .... no

International organisation of European interest ... no

Secondary or Higher education establishment ..... no

Research organisation .... no

Small and Medium-sized Enterprises (SMEs) .... no

Legal person ....yes

Nace code

Proposal ID **636834** *Acronym* **DISIRE**

Department(s) carrying out the proposed work

Department 1

Department name	R&D Department
Street	gen. Wl. Sikorskiego 2-8
Town	WROCLAW
Postcode	53659
Country	Poland

☒ Same as organisation address

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **636834** *Acronym* **DISIRE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Prof.

Sex: (•) Male ( ) Female

First name: **Radoslaw**

Last name: **Zimroz**

E-Mail: **rzimroz@cuprum.wroc.pl**

Position in org.: Professor

Department: Minning Engineering

Street: gen. Wl. Sikorskiego 2-8

☒ Same as organisation address

Town: WROCLAW

Post code: 53659

Country: Poland

Website:

Phone: +xxx xxxxxxxxx

Phone 2: +xxx xxxxxxxxx

Fax: +xxx xxxxxxxxx

Proposal ID **636834** *Acronym* **DISIRE**

PIC	***Legal name***
942980360	*Electrotech Kalix AB*

Short name: Electrotech Kalix AB

Address of the organisation

Street	Industrigatan 13
Town	Kalix
Postcode	95231
Country	Sweden
Webpage	www.electrotech.se

Legal Status of your organisation

Research and Innovation legal statuses

Public body .... no
Non-profit .... no
International organisation .... no
International organisation of European interest ... no
Secondary or Higher education establishment ..... no
Research organisation .... no
Small and Medium-sized Enterprises (SMEs) .... no

Legal person ....yes

Nace code

Proposal ID **636834** *Acronym* **DISIRE**

Department(s) carrying out the proposed work

Department 1

Department name: R&D Departmenet

Street: Industrigatan 13

☒ Same as organisation address

Town: Kalix

Postcode: 95231

Country: Sweden

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **636834** *Acronym* **DISIRE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Mr.

Sex: (●) Male ( ) Female

First name: **Juha**

Last name: **Rajala**

E-Mail: **juha@electrotech.se**

Position in org.: R&D Manager

Department: R&D Department

Street: Industrigatan 13

☒ Same as organisation address

Town: Kalix

Post code: 95231

Country: Sweden

Website:

Phone:

Phone 2: +xxx xxxxxxxxx

Fax: +xxx xxxxxxxxx

Proposal ID **636834** *Acronym* **DISIRE**

PIC	***Legal name***
999516907	*FUNDACION CIRCE CENTRO DE INVESTIGACION DE RECURSOS Y CONSUMOS ENERGETICOS*

Short name: CIRCE

Address of the organisation

Street CALLE MARIANO ESQUILLOR GOMEZ 15

Town ZARAGOZA

Postcode 50018

Country Spain

Webpage www.fcirce.es

Legal Status of your organisation

Research and Innovation legal statuses

Public body .... no

Non-profit .... yes

International organisation .... no

International organisation of European interest ... no

Secondary or Higher education establishment ..... no

Research organisation .... yes

Small and Medium-sized Enterprises (SMEs) .... no

Legal person ....yes

Nace code

Proposal ID **636834** *Acronym* **DISIRE**

Department(s) carrying out the proposed work

Department 1

Department name	R&D Department
Street	CALLE MARIANO ESQUILLOR GOMEZ 15
Town	ZARAGOZA
Postcode	50018
Country	Spain

☒ Same as organisation address

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **636834** *Acronym* **DISIRE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr.

Sex: (•) Male ( ) Female

First name: **Enrique** Last name: **Morgades**

E-Mail: **morgades@fcirce.es**

Position in org.: Manager

Department: *Please indicate the department of the Contact Point above in the organisation.*

Street: CALLE MARIANO ESQUILLOR GOMEZ 15 [X] Same as organisation address

Town: ZARAGOZA Post code: 50018

Country: Spain

Website:

Phone: Phone 2: *+xxx xxxxxxxxx* Fax: *+xxx xxxxxxxxx*

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Ignacio	Martin	imartin@fcirce.es	

Proposal ID **636834** *Acronym* **DISIRE**

PIC	***Legal name***
955366484	*DOW CHEMICAL IBERICA SL*

Short name: DOW CHEMICAL IBERICA SL

Address of the organisation

Street	CALLE RIBERA DEL LOIRA 4/6
Town	MADRID
Postcode	28042
Country	Spain
Webpage	www.dow.com

Legal Status of your organisation

Research and Innovation legal statuses

Public body	no	Legal person	yes
Non-profit	no		
International organisation	no		
International organisation of European interest	no		
Secondary or Higher education establishment	no		
Research organisation	no		
Small and Medium-sized Enterprises (SMEs)	no		

Nace code

Proposal ID **636834** *Acronym* **DISIRE**

Department(s) carrying out the proposed work

Department 1

Department name	R&D Department
Street	CALLE RIBERA DEL LOIRA 4/6
Town	MADRID
Postcode	28042
Country	Spain

☒ Same as organisation address

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **636834** *Acronym* **DISIRE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title	Dr.	Sex	(•) Male ( ) Female
First name	**Arias**	Last name	**Alfred**
E-Mail	**aarias@dow.com**		
Position in org.	Manager		
Department	*Please indicate the department of the Contact Point above in the organisation.*		
Street	CALLE RIBERA DEL LOIRA 4/6	☒	Same as organisation address
Town	MADRID	Post code	28042
Country	Spain		
Website			
Phone	*+xxx xxxxxxxxx*	Phone 2	*+xxx xxxxxxxxx*
Fax	*+xxx xxxxxxxxx*		

Proposal ID **636834** *Acronym* **DISIRE**

PIC	***Legal name***
998509853	*ABB AB*

Short name: ABB AB

Address of the organisation

Street Kopparbergsvagen 2

Town VASTERAS

Postcode 72183

Country Sweden

Webpage www.abb.com/se

Legal Status of your organisation

Research and Innovation legal statuses

Public body .... no

Legal person .... yes

Non-profit .... no

International organisation .... no

International organisation of European interest ... no

Secondary or Higher education establishment ..... no

Research organisation .... no

Small and Medium-sized Enterprises (SMEs) .... no

Nace code

Proposal ID **636834** *Acronym* **DISIRE**

Department(s) carrying out the proposed work

Department 1

Department name	Control and Optimization ABB Coorporate Research
Street	Kopparbergsvagen 2
Town	VASTERAS
Postcode	72183
Country	Sweden

☒ Same as organisation address

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **636834** *Acronym* **DISIRE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr.

Sex: (●) Male ( ) Female

First name: **Jan**

Last name: **Nyqvist**

E-Mail: **jan.nyqvist@se.abb.com**

Position in org.: Senior Scientist, Control and Optimization

Department: *Please indicate the department of the Contact Point above in the organisation.*

Street: Kopparbergsvagen 2

☒ Same as organisation address

Town: VASTERAS

Post code: 72183

Country: Sweden

Website:

Phone:

Phone 2: *+xxx xxxxxxxxx*

Fax: *+xxx xxxxxxxxx*

Proposal ID **636834** *Acronym* **DISIRE**

PIC	***Legal name***
999951467	*D'APPOLONIA SPA*

Short name: D'APPOLONIA SPA

Address of the organisation

Street Via San Nazaro 19

Town GENOVA

Postcode 16145

Country Italy

Webpage www.dappolonia.it

Legal Status of your organisation

Research and Innovation legal statuses

Public body ....no

Non-profit ....no

International organisation ....no

International organisation of European interest ...no

Secondary or Higher education establishment .....no

Research organisation ....no

Small and Medium-sized Enterprises (SMEs) ....no

Legal person ....yes

Nace code

Proposal ID **636834** *Acronym* **DISIRE**

Department(s) carrying out the proposed work

Department 1

Department name	R&D Department
Street	Via San Nazaro 19
Town	GENOVA
Postcode	16145
Country	Italy

☒ Same as organisation address

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **636834** *Acronym* **DISIRE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Mrs

Sex: ◯ Male ◉ Female

First name: **Simona**

Last name: **Bruna**

E-Mail: **simona.bruna@dappolonia.it**

Position in org.: Project Manager

Department: *Please indicate the department of the Contact Point above in the organisation.*

Street: Via San Nazaro 19

☒ Same as organisation address

Town: GENOVA

Post code: 16145

Country: Italy

Website: www.dappolonia.it

Phone: +390103628148

Phone 2: *+xxx xxxxxxxxx*

Fax: +390103621078

Proposal ID **636834** *Acronym* **DISIRE**

PIC	***Legal name***
999984059	*FRAUNHOFER-GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V*

Short name: Fraunhofer

Address of the organisation

Street HANSASTRASSE 27C

Town MUNCHEN

Postcode 80686

Country Germany

Webpage www.fraunhofer.de

Legal Status of your organisation

Research and Innovation legal statuses

Public body .... no

Non-profit .... yes

International organisation .... no

International organisation of European interest ... no

Secondary or Higher education establishment ..... no

Research organisation .... yes

Small and Medium-sized Enterprises (SMEs) .... no

Legal person ....yes

Nace code

Proposal ID **636834** *Acronym* **DISIRE**

Department(s) carrying out the proposed work

Department 1

Department name	Technology Adaptation Management
Street	HANSASTRASSE 27C
Town	MUNCHEN
Postcode	80686
Country	Germany

☒ Same as organisation address

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **636834** *Acronym* **DISIRE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Ms

Sex: ◯ Male ◉ Female

First name: **Eleonora** Last name: **Zagorska**

E-Mail: **eleonora.zagorska@moez.fraunhofer.de**

Position in org.: Business Development Consultant

Department: *Please indicate the department of the Contact Point above in the organisation.*

Street: HANSASTRASSE 27C ☒ Same as organisation address

Town: MUNCHEN Post code: 80686

Country: Germany

Website:

Phone: *+xxx xxxxxxxxx* Phone 2: *+xxx xxxxxxxxx* Fax: *+xxx xxxxxxxxx*

Proposal ID **636834** *Acronym* **DISIRE**

PIC	***Legal name***
945781429	*G-Stat Ltd.*

Short name: G-Stat

Address of the organisation

Street Raoul Wallenberg 4

Town Tel-Aviv

Postcode 6971904

Country Israel

Webpage www.g-stat.com

Legal Status of your organisation

Research and Innovation legal statuses

Public body .... no

Non-profit .... no

International organisation .... no

International organisation of European interest ... no

Secondary or Higher education establishment ..... no

Research organisation .... no

Small and Medium-sized Enterprises (SMEs) .... yes

Legal person ....yes

Nace code

Proposal ID **636834** *Acronym* **DISIRE**

Department(s) carrying out the proposed work

Department 1

Department name	R&D Department
Street	Raoul Wallenberg 4
Town	Tel-Aviv
Postcode	6971904
Country	Israel

☒ Same as organisation address

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **636834** *Acronym* **DISIRE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr.

Sex: (●) Male ( ) Female

First name: **Adi**

Last name: **Pasharel**

E-Mail: **adi.pasharel@g-stat.com**

Position in org.: Marketing Manager

Department: R&D

Street: Raoul Wallenberg 4

☒ Same as organisation address

Town: Tel-Aviv

Post code: 6971904

Country: Israel

Website:

Phone:

Phone 2: +XXX XXXXXXXXX

Fax: +XXX XXXXXXXXX

Proposal ID **636834**	Acronym **DISIRE**

PIC	***Legal name***
998221472	*SWEREA MEFOS AB*

Short name: MEFOS

Address of the organisation

Street ARONTORPSVAGEN

Town LULEA

Postcode 971 25

Country Sweden

Webpage

Legal Status of your organisation

Research and Innovation legal statuses

Public body .... no

Legal person ....yes

Non-profit .... yes

International organisation .... no

International organisation of European interest ... no

Secondary or Higher education establishment ..... no

Research organisation .... yes

Small and Medium-sized Enterprises (SMEs) .... no

Nace code

Proposal ID **636834** Acronym **DISIRE**

Department(s) carrying out the proposed work

Department 1

Department name	Process Metallergy
Street	ARONTORPSVAGEN
Town	LULEA
Postcode	971 25
Country	Sweden

☒ Same as organisation address

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **636834** Acronym **DISIRE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr.

Sex: ◯ Male ◉ Female

First name: **Lena**

Last name: **Sundqvist**

E-Mail: **lena.sundqvist@swerea.se**

Position in org.: Group Manager, Reduction Metallurgy

Department: Process Metallugy Department

Street: ARONTORPSVAGEN

☒ Same as organisation address

Town: LULEA

Post code: 971 25

Country: Sweden

Website:

Phone: +46920245226

Phone 2: +46703051610

Fax: +46920255832

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Jan	Niemi	jan.niemi@swerea.se	
Annika	Nilsson	annika.nilsson.me@swerea.se	

Proposal ID **636834** *Acronym* **DISIRE**

3 - Budget for the proposal

Participant	Country	(A) Direct personnel costs/€	(B) Other direct costs/€	(C) Direct costs of sub-contracting /€	(D) Direct costs of providing financial support to third parties/€	(E) Costs of inkind contributions not used on the beneficiary's premises/€	(F) Indirect Costs/€ (=0.25(A+B-E))	(G) Special unit costs covering direct & indirect costs	(H) Total estimated eligible costs/€ (=A+B+C+D+F +G)	(I) Reimburse-ment rate	(J) Max. grant / € (=H*I)	(K) Requested grant / €
LULEA TEKNISKA UNIV	SE	1 135 000	50 000	0	0	0	296 250	0	1 481 250	100	1 481 250	0
LUOSSAVAARA-KIIRUN	SE	92 000	27 000	16 000	0	0	29 750	0	164 750	100	164 750	0
KGHM POLSKA MIEDZ	PL	65 000	14 000	0	0	0	19 750	0	98 750	100	98 750	0
ODYS SRL	IT	120 000	18 000	0	0	0	34 500	0	172 500	100	172 500	0
POLITECHNIKA WROCL	PL	315 920	20 000	0	0	0	83 980	0	419 900	100	419 900	0
SCUOLA IMT (ISTITUZI(	IT	325 125	32 500	0	0	0	89 406	0	447 031	100	447 031	0
KGHM CUPRUM SP ZO(	PL	161 280	20 000	0	0	0	45 320	0	226 600	100	226 600	0
Electrotech Kalix AB	SE	126 000	25 000	0	0	0	37 750	0	188 750	100	188 750	0
FUNDACION CIRCE CEN	ES	260 400	92 500	0	0	0	88 225	0	441 125	100	441 125	0
DOW CHEMICAL IBERI(	ES	159 500	222 500	40 000	0	0	95 500	0	517 500	100	517 500	0
ABB AB	SE	400 000	12 000	0	0	0	103 000	0	515 000	100	515 000	0
D'APPOLONIA SPA	IT	138 000	25 000	0	0	0	40 750	0	203 750	100	203 750	0

Proposal ID **636834** *Acronym* **DISIRE**

Participant	Country	(A) Direct personnel costs/€	(B) Other direct costs/€	(C) Direct costs of sub-contracting /€	(D) Direct costs of providing financial support to third parties/€	(E) Costs of inkind contributions not used on the beneficiary's premises/€	(F) Indirect Costs/€ (=0.25(A+B-E))	(G) Special unit costs covering direct & indirect costs	(H) Total estimated eligible costs/€ (=A+B+C+D+F +G)	(I) Reimburse-ment rate	(J) Max. grant / € (=H*I)	(K) Requested grant / €
FRAUNHOFER-GESELLS	DE	113 400	11 000	0	0	0	31 100	0	155 500	100	155 500	0
G-Stat Ltd.	IL	384 000	54 000	0	0	0	109 500	0	547 500	100	547 500	0
SWEREA MEFOS AB	SE	290 000	44 750	0	0	0	83 688	0	418 438	100	418 438	0
Total		4 085 625	668 250	56 000	0	0	1 188 469	0	5 998 344		5 998 344	0

Proposal ID **636834** *Acronym* **DISIRE**

4 - Ethics issues table

1. HUMAN EMBRYOS/FOETUSES i		Page
Does your research involve Human Embryonic Stem Cells (hESCs)?	◯ Yes ◉ No	
Does your research involve the use of human embryos?	◯ Yes ◉ No	
Does your research involve the use of human foetal tissues / cells?	◯ Yes ◉ No	
2. HUMANS		**Page**
Does your research involve human participants?	◯ Yes ◉ No	
Does your research involve physical interventions on the study participants?	◯ Yes ◉ No	
Does it involve invasive techniques?	◯ Yes ◉ No	
3. HUMAN CELLS / TISSUES		**Page**
Does your research involve human cells or tissues? If your research involves human embryos/foetuses, please also complete the section "Human Embryos/Foetuses" [Box 1].	◯ Yes ◉ No	
4. PROTECTION OF PERSONAL DATA ii		**Page**
Does your research involve personal data collection and/or processing?	◯ Yes ◉ No	
Does your research involve further processing of previously collected personal data (secondary use)?	◯ Yes ◉ No	
5. ANIMALS iii		**Page**
Does your research involve animals?	◯ Yes ◉ No	

Proposal ID **636834** *Acronym* **DISIRE**

6. NON-EU COUNTRIES		Page
Does your research involve non-EU countries?	◯ Yes ◉ No	
Do you plan to use local resources (e.g. animal and/or human tissue samples, genetic material, live animals, human remains, materials of historical value, endangered fauna or flora samples, etc.)?	◯ Yes ◉ No	
Do you plan to import any material - including personal data - from non-EU countries into the EU? If you consider importing data, please also complete the section "Protection of Personal Data" [Box 4].	◯ Yes ◉ No	
Do you plan to export any material - including personal data -from the EU to non-EU countries? If you consider exporting data, please also complete the section "Protection of Personal Data" [Box 4].	◯ Yes ◉ No	
If your research involves low and/or lower middle income countries, are benefits-sharing measures foreseen?	◯ Yes ◉ No	
Could the situation in the country put the individuals taking part in the research at risk?	◯ Yes ◉ No	
7. ENVIRONMENT PROTECTION vi Directive 2001/18/EC - vii Directive 2009/41/EC - viii Regulation EC No 1946/2003 - ix Directive 2008/56/EC x Council Directive 92/43/EEC -xi Council Directive 79/409/EEC - xii Council Regulation EC No 338/97		Page
Does your research involve the use of elements that may cause harm to the environment, to animals or plants?	◯ Yes ◉ No	
Does your research deal with endangered fauna and/or flora and/or protected areas?	◯ Yes ◉ No	
Does your research involve the use of elements that may cause harm to humans, including research staff?	◯ Yes ◉ No	
8. DUAL USE xiii		Page
Does your research have the potential for military applications?	◯ Yes ◉ No	
9. MISUSE		Page
Does your research have the potential for malevolent/criminal/terrorist abuse?	◯ Yes ◉ No	
10. OTHER ETHICS ISSUES		Page
Are there any other ethics issues that should be taken into consideration? Please specify	◯ Yes ◉ No	

I confirm that I have taken into account all ethics issues described above and if any ethics issues apply, I have attached the required documents. ☒

H2020 – SPIRE - 2014

Research and Innovation actions

Integrated Process Control based on Distributed In-Situ Sensors Integrated into Raw Material and Energy Feedstock

DISIRE

1 (Coordinator)	Luleå University of Technology*	LTU	SE
2	Luossavaara-Kiirunavaara Aktiebolag AB*	LKAB	SE
3	KGHM Polska Miedz SA	KGHM	PL
4	ODYS S.r.l.	ODYS	IT
5	Wroclaw University of Technology	WUT	PL
6	IMT Lucca	IMTL	IT
7	KGHM CUPRUM	CUP	PL
8	Electrotech AB	ETEC	SE
9	Research Center for Energy Resources and Consumption*	CIRC	ES
10	Dow Chemicals Ibérica*	DCI	ES
11	ABB AB	ABB	SE
12	D'Appolonia	DAPP	IT
13	Fraunhofer MOEZ	MOEZ	GE
14	Gstat	GST	IL
15	MEFOS*	MEFOS	SE
** The asterisk indicates partners that are members of SPIRE*			

Work Programme Topic addressed: SPIRE 1 – 2014: Integrated Process Control

Name of the Coordinating Person: Dr. Pär-Erik Martinsson
E-mail: Par-Erik.Martinsson@ltu.se

Table of Contents

1. Excellence 3
1.1 Objectives 3
1.2 Relation to the work programme 8
1.3 Concept and approach 13
1.3.1 The DISIRE Concept and Motivation 13
1.3.2 The DISIRE Technological Platform 14
1.4 Ambition 16
1.4.1 Mineral Processing of Ferrous ore (Magnetite) 16
1.4.2 Steel Processing 18
1.4.3 Industrial Combustion Processes 20
1.4.4 Logistics and Transportation of raw materials 23
1.4.5 Integrated PAT sensors and electronics 25
1.4.6 Data Mining and Analysis 25
1.4.7 PAT-based Integrated Process Control 26
2. Impact 27
2.1 Expected impacts 27
2.1.1. European approach of project contribution to expected impacts 27
2.1.2. Enhancing impact through improving innovation capacity 29
2.1.3. Potential barriers and obstacles for achieving the expected impact 30
2.1.4. Impacts from the establishment of DISIRE Technological Platform 31
2.2 Measures to maximise impact 36
2.2.1 Dissemination of project results 36
2.2.2 Exploitation of project results 37
2.2.3 Management of knowledge and intellectual property 39
2.2.4 Communication activities 39
The Project Coordinator and the Management Support Team will be responsible for coordination and implementation of the communication plan described in detail within the WP9. 39
3. Implementation 39
3.1 Work plan — Work packages, deliverables and milestones 39
3.1.1 Overall Strategy 39
3.1.2 Project Planning - GANTT Chart 41
3.1.3 Detailed Work Description 42
Table 3.1a: Work package description 42
Task 5.2 – Online PAT for Transport Processes (WUT, LTU, KGHM, ODYS, IMTL, CUP, GST,) 48
3.1.4 Pert Diagram 62
3.2 Management structure and procedures 62
3.2.1 Management capability of the coordinator 62
3.2.2 Management structure and decision-making structure 63
3.2.3 Implementation of the management 65
3.2.4 Milestones 67
3.2.5 Critical Risks and Associated Risk-Mitigation measures 67

1. Excellence

1.1 Objectives

The DISIRE project has been inspired by the real existing needs of multiple industrial sectors, including the world leading industrial partners in the non-ferrous, ferrous, chemical and steel industries that are highly connected and already affiliated with the SPIRE PPP and its objectives. The primary clear and measurable objective of the DISIRE project is to evolve the existing industrial processes by advancing the European Sustainable Process Industry through an overall resource and energy efficiency paradigm by the technological breakthroughs and concepts of the DISIRE technological platform in the field of Industrial Process Control (IPC).

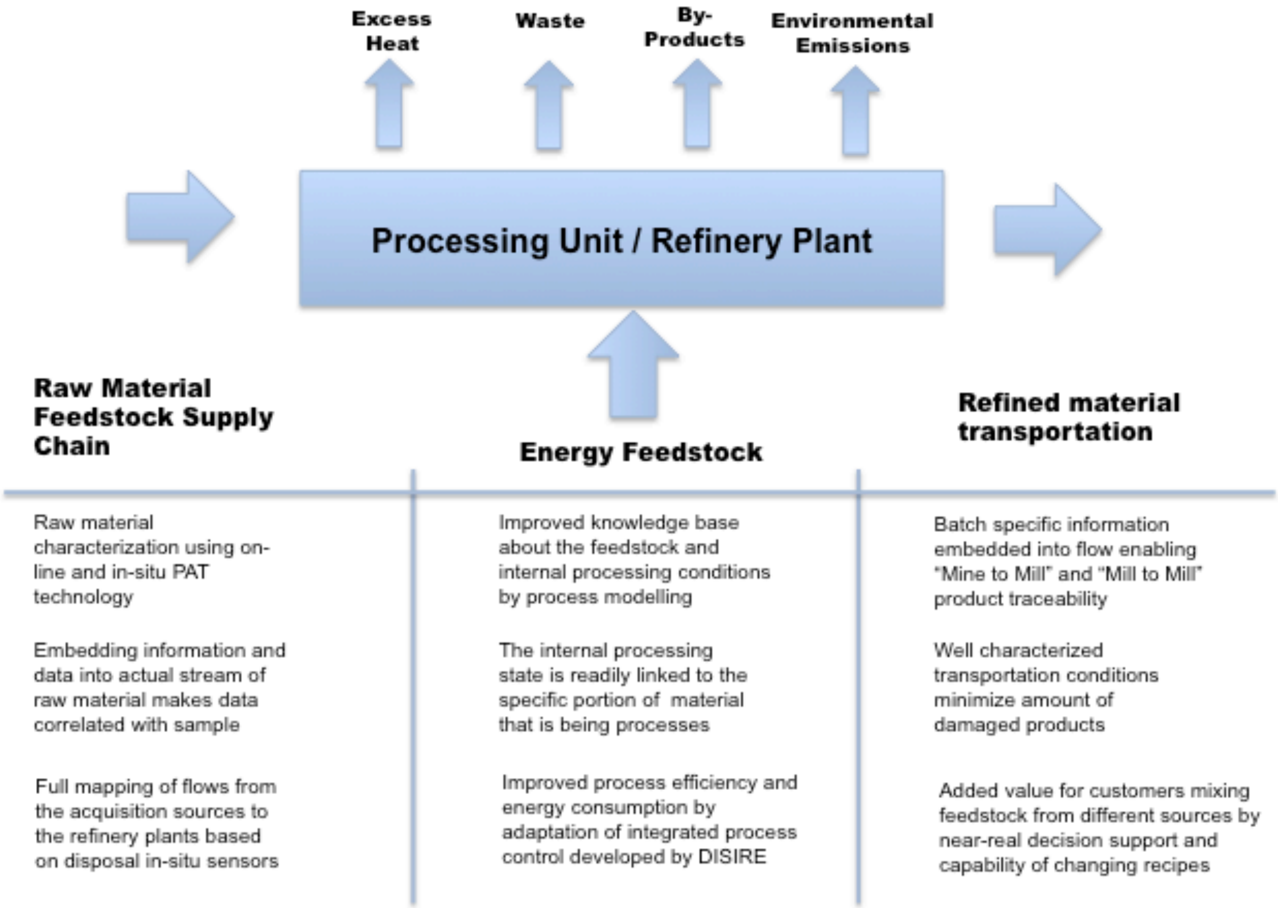


Figure 1: Overview of the DISIRE concept

The technological focus for DISIRE is to develop miniaturized PAT technologies capable of being inserted into flows of raw materials. The concept of "Intelligent Raw materials" presents several advantages in the material handling sectors in order to characterize the material and optimize the processing plants, the possibility to increase the process intensification and energy efficiency in Chemical, Steel, and Mineral processing as well as improve the industrial combustion processes used in virtually all sectors. The DISRIE project will also enable tracing of transportations across value chains such as the one between ferrous mining to steel, non-ferrous mining to cupper and coal to industrial combustion and in many other situations. The generated data presents completely new challenges but also present new opportunities to develop advanced integrated process control strategies for single processing units, interconnected processing plants and complete value chains which is the overall objective of the DISIRE project.

More specifically the application of the DISIRE framework in the industry will have the clear and measurable objective to establish an impact in the following areas:

Impact in a nutshell	Initiated transition
Reduced resource and energy consumption	Improved control strategy of the processes will lead to an

by 2% by 2018	estimated 2% energy savings of electricity and fossil fuels which can corresponds to as much as 12,000 tons of carbon dioxide or 15,000 barrels of oil for a large process industrial plant.
Optimized industrial processes	Shift from offline batches measurement to real-time control situations will provide a more dynamic and flexible solution than current state of the art systems.
Improved quality of products	From a process industry owner's perspective, measuring in previously inaccessible locations will increase their knowledge of the process. This knowledge can be used to improve the calibration of the control systems and hence lead to higher product quality.
Minimized waste	Finer calibration of the control system is critical for optimization of throughput and reduction in waste products such as crushed pellets in the transportation of pellets.
Reduced fossil energy intensity of up to 30% from current levels by 2030	Better understanding of the processes will allow their optimization and even transition of some of these processes away from fossil energy sources.
Reduced greenhouse gas emissions by 20% below 1999 levels by 2020, with further reductions up to 40 % by 2030	Improved knowledge is also fundamental in order to make process modifications. Switching to natural gas reduce CO2 with 46%, corresponding to at least 300,000 tones less greenhouse gas emissions for a large process industry relying on fossil fuel for heat generation.
Expanded impact of the DISIRE project in other cross-sectorial technological transfers such as glass and pulp and paper	The total energy saving potential in the Pulp & Paper Sector sector through improved process efficiency and systems/life cycle improvements has been estimated to be in the range of 2.1-2.4 EJ/year. Hence, application of sophisticated combustion process can significantly enhance the energy efficiency of the SPIRE industrial segment. The SCP potential in the Pulp & Paper industry is estimated to be in the range of 0.3-0.6 EJ/year. Typically, the introduction of SCP can result in fuel savings of about 10-20% and energy savings of 30% compared to traditional technologies.
Ensured subsequent market implementation and established best practices in innovation and commercialization management	Since all technical developments will be made in direct collaboration with the industrial end-users, the innovations from DISIRE fulfil the market demands and expectations on IPC. Additionally, the dynamic innovation and commercialization strategy will generate a wide range of new technology applications and business cases by thinking beyond demonstrations and prototypes.
Secured quality of consortium management	Efficient operation and productivity rather than steps and red tape characterize the managerial body of DISIRE project.

Table 1: Paradigm shift during the Pre and Post DISIRE technological establishment

For achieving the outlined impact and realizing the overall project's objectives, the pillars of the DISIRE project are based on advanced distributed inline measurement techniques and development of new optimization and process control strategies that enables near real-time process reconfiguration based on the generated data from the embedded Process Analyzer Technologies (PAT). It is our ambition to think out of the box and enable a technological breakthrough in the current state of the art in the existing control and monitoring systems in the process industries, while generating a clear transition from a centralized static sensing and control approach into a decentralized, holistic and integrated sensing and control direction.

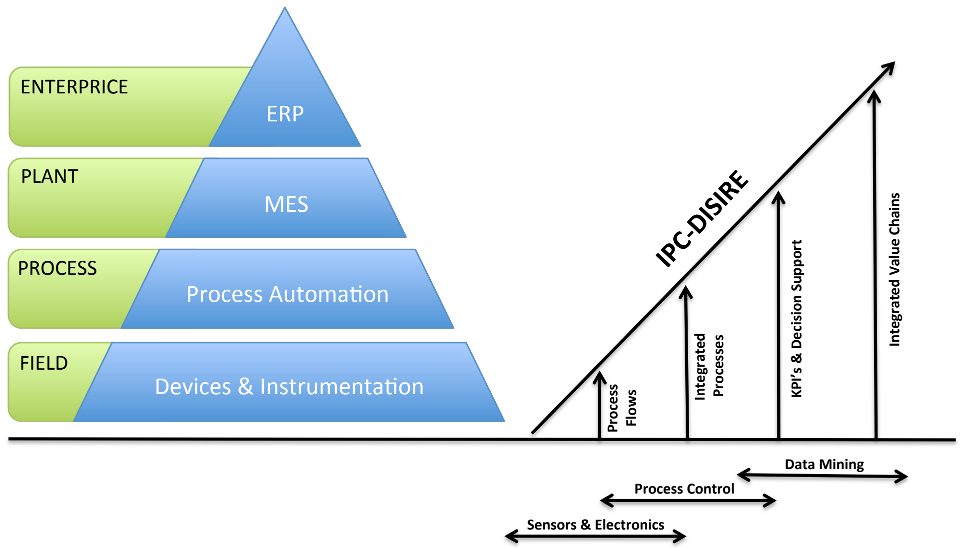


Figure 2 The scientific focus of the project has been specifically designed for generating both horizontal and vertical impact and take into account a holistic approached aimed at develop new integrated control strategies. Different components will be developed in specific industries in order to be functional in real industrial environments. The results from DISIRE will be applicable in several industrial sectors and generate impact outside of the imminent consortia for most process industries handling and processing large quantities of materials.

Under the DISIRE scientific umbrella (Figure 2), multi-disciplinary research activities will be conducted in order to achieve the ambitious challenges proposed, encompassing the fields of IPC, electronics and novel sensor developments, data mining and PAT, communication and sharing of information in a networked environments, process reconfiguration and process optimization. An overview of the DISIRE specific scientific, technological and innovation objectives is provided below.

O1. PAT driven Integrated Process Control The DISIRE project will introduce a novel PAT driven approach on IPC. More specifically, the approach will complement existing Advanced Process Control (APC) systems with innovative online Machine Learning (ML) methods for updating models of the controlled processes from extended inline measurements and PAT analysis, for achieving a near-to-real-time optimal generation of input/output set-points and fine-tuning of controller parameters, and at the same time save substantial offline calibration efforts The core research objective to support this innovation is to devise numerically efficient online convex programming algorithms for solving the ML problems and sequential gradient-based optimization for selecting the set of Model Predictive Control (MPC) design knobs to maximize the performance indicators, so to exploit the largest amount of information available in real time from incoming PAT data. The goal of the proposed IPC scheme is to achieve an optimal adaptation and/or reconfiguration of the multiple MPC loops, such as adaptation of estimator gains/structure for sensor fusion, modulation of trade-off between robustness and performance optimization, on-reconfiguration of MPC with respect to the sensed or estimated inline measurements of the process internal operating environment and/or detection of measured and unmeasured disturbances.

O2. Real Time Sensing & Networking in Industrial Environments DISIRE envisions the creation of a technological platform that will be able to deliver close to real-time measurements of any parameter of interest and anywhere in all the operating industrial processes, in order to increase the knowledge of the underlying processes taking place and to improve the overall process outcome, while minimizing cost and materials utilized. Reliable and accurate sensing and metering are of paramount importance in achieving a better overall performance of a complex industrial process. The combination of the in situ DISIRE compatible novel sensory platform with the existing sensing infrastructure will create an integrated measurement system, with extended miniaturization characteristics and proven robustness in packet losses, packet re-ordering, and adaptability on the available infrastructures network resources.

O3. Multi-objective In line Sensor Technology A common measurement challenge in industrial process plants is the harsh environments, which can include heat, dust, dirt, vibrations dampness and corrosion. Depending on the severity of these conditions, solutions range from the heavy-duty encapsulation of sensors to the use of proximity based technologies such as optical or electromagnetic sensors. In the most extreme environments, it may be beneficial to utilize disposable sensors that are sacrificed during the measurement process, never to be recovered but from the other point of view provide direct inline information of the internal process dynamics. In the case of small-scale disposable sensors one of the most challenging issues is the communication infrastructure that should support the link between the sensors and the rest of the infrastructure. Cables are often expensive and not a flexible solution for small-scale disposable sensors that could move along the process cycle of a product, while the wireless technology introduces fundamental problems and limitations such as EMC disturbances, material barriers, power of links, radio wave propagation, etc. transforming the overall problem of designing advanced inline sensors for different applications into a quite challenging objective.

O4. PAT based on Swarm Sensing and Data Analysis A specific challenge for DISIRE is to combine the existing PAT based analysis of process that is being carried in most of the times off line or in a batch of time samples with the multiple streams of sensory data from the inline measurements of the miniaturized DISIRE disposable sensors, into real time statistically based low–dimensional data, describing the process and product states. The low-dimensional data should acknowledge and be robust against infrequent updates of PAT measurements and missing data, while handling largely varying measurement intervals. The model should also be able to handle the multivariate and auto correlated nature of process data and the high quantities of data from regular on line measurements. Principles from wireless sensor networks, estimation and statistical signal processing will be integrated and evaluated with real process data in order to create a novel and reliable PAT based swarm sensing and data analysis that would drive the changes in the IPC.

O5. Non-Ferrous Processes The focus of DISIRE in the non-ferrous processes includes cross-sectorial processes in Mines, Processing Plants, Mining, Machine Producers, etc. A key objective for the DISIRE project is to improve efficiency and competitiveness related to the copper production. A way to progress towards this objective is to decompose the whole production process into many sub-processes and their identification and better understanding. Such problem formulation corresponds to KGHM's applications related to deploying of advanced measurement systems, data transmission, data warehouse and online PAT tools. In the non-ferrous area, the DISIRE project aims at improving the transportation problem of raw materials by utilizing belt conveyors and processing of the ore in order to achieve an overall reduction of the circulation times and improve the on line PAT information for the further process stages. With the proposed DISIRE approach significant improvements on production efficiency, minimizing of energy consumption, and a general decrease in the amount of waste from flotation process are expected to be achieved. The general methodology is based on exploring existing information from different types of monitoring and control systems and adding required sensors and monitoring systems (especially for mineral processing tasks). Based on available data and information from different sources, it is proposed to build models of processes and optimise real processes to achieve the mentioned goals. Knowledge about processes can be used at different levels and companies, namely in mines to make the transport processes more effective, in the processing plants to increase efficiency of flotation and minimise volume of wastes and for mentioned machine manufacturer (new, optimal design solutions both for transport and processing machines).

O6. Ferrous Processes In this area, the DISIRE project will specifically focus on demonstrations and experiments in real industrial environments in order to establish a rugged sensor platform capable of withstanding the harsh industrial conditions of ferrous mineral processing, constituting of abrasive wear and high temperatures. Ferrous mineral processing presents several challenges that have to be tackled in order to optimize the process intensity and energy consumption of existing processes. Generating additional process knowledge about the raw material and how its properties correlate to the processing state of the mineral processing machines are also fundamental information that is necessary to design the next generation of processing machines.. Embedding sensors into the actual material flow is beneficial since most proximity-based sensor can only generate surface information. A good example where embedded sensor presents great advantages is the transformation of magnetite into hematite that is utilized by gradually increasing the temperature of the material in a continuous processing stage. Generating a high capacity and a high product quality whilst at the same time optimize the usage of fossil fuels is the overall goal but developing an integrated control strategy first requires additional feed-back data. The sensors provided by the activities in the project will give valuable information supporting this development. The specific challenges of the mining industry are generally "worse" but similar to other industrial segments and progresses beyond state of the art in the mining sector will inevitable generate cross-sectorial impact in the field of industrial in-situ measurement systems.

O7. Steel In the steel industry the DISIRE objective is to facilitate and demonstrate the use of sensors in the steel plant and evaluate measured data in combination with existing process data and off/on line existing gathered PAT, as well as to investigate how the overall IPC strategy can be altered based on the introduced DISIRE tools. The activities in the steel sector will aim in conducting pre-tests of sensors in appropriate conditions in terms of tracing them and measuring process values, like temperature and atmosphere (gas composition), while investigating the capability of embedding them in the raw materials flow during preparation, handling, feeding of the blast furnace, operating inside the blasting furnace for measuring moisture, temperature, movement, horizontal and vertical position and pressure in the applications of: a) pellets produced in the mining sector and b) in other burden materials as e.g. fluxed, agglomerates, coke. The DISIRE project will demonstrate in pilot processes the utilization of in-situ proposed DISIRE sensors for tracing materials and to measure temperature, oxygen content and pressure in reheating furnaces for improved IPC based on the produced online PAT, while measuring the resulting impact.

O8. Combustion The DISIRE project pursues the improvement of the combustion processes mainly in the Chemical sector but also in other industrial sectors participating in the consortium. DISIRE envisages a complete characterization of furnaces, defining the most adequate points where instrumentation can be installed, providing the highest accuracy of the measured data, as in particular, in the chemical sector, instrumentation installed in a cracking furnace can be very costly. Prior to installing all kind of sensors, DISIRE plans to perform a complete characterization of the temperatures and flow conditions of the processes. Diagnosis and monitoring techniques based on optical instrumentation will provide on-line non-invasive measurements of variables such as velocity, temperature and gas species concentration. Furthermore, in-situ imaging diagnosis will be applied and developed to generate a map of variables, which will result on a useful tool to be compared with the detailed numerical simulations. Major developments in model and control of the combustion processes will lay the foundation of a substantial increase of energy efficiency of the whole production process as well as reduction of CO_2 emissions, which represents already and within the close future a serious threat for these industries in terms of cost and sustainability.

O9. Innovation and Commercialization of DISIRE Components The DISIRE project aims at specific innovation and commercialization activities in order to bridge the gap between research and market and create value within and beyond the consortium while transforming the DISIRE modules into mature components that can be further integrated in existing DCS. In this context, DISIRE will tackle specific challenges of research commercialization such as time to market, design quality and functionality, manufacturability and cost efficiency in all anticipated user environments by developing one of a kind innovation methodology. Hence, DISIRE consortium will view research results generically without limiting them to product architecture or any aspect of design and make sure that the DISIRE technological platform and its components meet the current and future market requirements. LTU, Fraunhofer MOEZ, ABB and the rest of the partners in the DISIRE consortium ensure that specific innovation; commercialization and technical business development actions will be performed towards this objective.

O10. DISIRE Cross-sectorial Application Developing all the DISIRE components with a generalized architecture that requires negligible effort for being adapted to process outside the scope of DISIRE is a general research objective and overall vision of the DISIRE consortium, in order to strengthen the impact of the project results on the sustainable process industry. The DISIRE's Advisory Board will influence the developments towards this direction.

The DISIRE technological platform will introduce novel inline measurement techniques that will be able to provide online and in-situ sensory data about the process flows, product properties as well as about the product's surrounding environment. The additional information about the product's properties that DISIRE generates will increase the overall knowledge-base about the internal processes taking effect in of ferrous mineral processing, non-ferrous mineral processing, steel manufacturing and industrial combustion. The new concepts of online PAT will enable the proper and direct utilization of the vast amount of data generated by the injected swarm of sensors and thus enabling a total reconfiguration of the IPC strategies in order to meet the current specific needs of the raw materials or products in the process and within their production cycle. The impact of the DISIRE enabling technology and concept will be adapted, aligned and demonstrated into four industrial sectors of ferrous, non-ferrous, chemical and steel industries as it is being indicated in 3. At this point is should be highlighted that it is of the DISIRE consortium's aim and vision to strengthen the impact of all the suggested activities by retaining a TRL level from 3-5 and from a component validation in relevant environment to an analytical and experimental proof of concepts. However, since the DISIRE project is quite ambitious it is expected that further TRL levels of 6 or 7 will be addressed during the execution of the project and mainly during the pure industrial demonstrations of the DISIRE technological platform.

In this light, clear and measurable benefits for the SME members of the DISIRE consortium from the successful implementation of the developed technology should be highlighted. These benefits will not only accrue to process and automation industry sectors but will be transferred directly to consumers who will gain access to the innovative products. The overall impact will be the placing of SMEs within the European Sustainable Process Industry in a highly competitive position in both the European and international markets, thereby creating and protecting jobs, increasing revenues and boost further investment and technological developments. The proposed research is pre-competitive and it is intended that the SMEs continue to drive exploitation of the DISIRE project outcomes by linking the program of demonstration to other technology sectors and companies. The SMEs in the consortium are aware of the broader need to win and sustain the consumer confidence in their products. However, they do not have the resources and know-how to do this directly. Hence, their participation in DISIRE project and cooperation with public R&D organizations will enhance their products through contribution of experienced professionals available within the DISIRE consortium and bring credibility and visibility to their products in the European and global markets. Additionally, in order to generalize the impact of the DISIRE platform into cross sectorial industries, in short-term as well as in the long run, strengthen scientific collaboration and industrial excellence according to the SPIRE directions.

1.2 Relation to the work programme

The DISIRE proposal is addressing the topic **SPIRE 1 – 2014: Integrated Process Control**, while the presented scientific, technological and innovation objectives of the proposal have been selected and tailored with full respect to the exact objectives of the current call. The majority of the DISIRE's partners are existing members of SPIRE and the consortium has on board the biggest industrial partners in Europe in the field of Mining, Chemical, Steel and Industrial Process Automation assuring a high quality research and innovative DISIRE activities that will revolutionize the industry sector in Europe and produce a direct and measurable impact. In Table 2 the overall SPIRE's PPP and H2020 Call specific objectives are being listed with a direct association with the objectives and the activities within the DISIRE proposal.

Table 2: DISIRE objectives in relation to SPIRE work programme

Vision and Strategic Objectives from the SPIRE call	Objectives and properties of the DISIRE proposal
General SPIRE Objectives	
The European process industry is uniquely positioned as it represents the economic roots of the European economy (by transforming raw materials into intermediate and end-user products). It thus sits at the core of most industrial value chains via discrete manufacturing into e.g. automotive and housing sectors. The SPIRE Public-Private Partnership (PPP) brings together cement, ceramics, chemicals, engineering, minerals and ores, non-ferrous metals, steel and water sectors, several being world-leading sectors operating from Europe. These sectors all have a high dependence on resources (energy, raw materials and water) in their production and processing technologies and they all have a clear and urgent interest in improved efficiency and competitiveness which actually leads to driving the implementation of many European policies	The DISIRE proposal brings together some of the biggest world leading industrial partners in the field of chemicals, minerals and ores, non-ferrous metals, steel and engineering such as LKAB, KGHM, and DOW where all of these sectors have a high dependence on recourses in their production and processing technologies and with a clear and direct need of improving efficiency and competitiveness. The DISIRE RTD partners LTU, IMTL, WUT, CIRC, DAP, and GST are strong in cooperation with the technology providers partners ABB, ETEC, ODYS, CUP, and MEFOS, while ensuring an optimum combination of resources and efforts towards the establishment of a direct impact in the sustainable process industry and an overall revolution in the area of Integrated Process Control based on the proposed DISIRE technological platform. The participation of Fraunhofer MOEZ in combination with the technology provider partners will achieve a direct penetration of the DISIRE technology modules in the related industries and a further direct intensive innovation and commercialization of the produced outcomes. In total 5 out of the 15 DISIRE partners are members of SPIRE and have a clear understanding of the objectives and the vision of SPIRE since these partners were participating and working from the beginning in the establishment of the SPIRE PPP.
Resources are becoming scarce, and resource efficiency has become an exceedingly important factor in industry. This is especially true for resource and energy intensive industries such as the process industries. The general goal is to optimise industrial processing, reducing	The overall DISIRE concept is aiming in having a direct impact in the **reduction of the consumed energy and resources by 15% for energy and 10% resource consumption**, while at the same time **minimize waste by a factor of 10%.** The participation of LKAB, DOW, and KGHM confirms the interest of the worldwide resource and energy intensive process industries to the specific and measurable expected impact of the

the consumption of energy and resources, and minimising waste.	DISIRE project.
A reduction in fossil energy intensity of up to 30% from current levels by 2030.	The direct and measurable established goal for the achieved impact of the DISIRE project is **10% reduction in fossil energy intensity by 2030.**
A reduction of up to 20% in non-renewable, primary raw material intensity compared to current levels by 2030.	The direct and measurable established goal for the **reduction of non-renewable, primary raw material intensity of the DISIRE project's impact is 15% by 2030.**
A reduction of greenhouse gas emissions by 20% below 1999 levels by 2020, with further reductions up to 40% by 2030.	The direct and measurable established goal for the **reduction of greenhouse gas emissions based on the DISIRE project's impact is 15%.**
An important part of the horizontal activities in SPIRE are training and business models. The integration of relevant training/learning as well as identify appropriate business models to ensure subsequent market implementation and potential barriers for cross-sectorial technology transfer is expected.	The mixture of partners from multiple operating areas from the pure academic research, through the component developers, system integrators, technology providers supported by world-leading industrial partners and business expertise and guidance of Fraunhofer MOEZ will assure the establishment of DISIRE horizontal activities in the area of training and business models enabling intense market penetration in the level of proof of concept and multiple business spin offs.

SPIRE 1: 2014 Sustainable Process Industries General Challenges	
Process control of the industrial operations has a major role in assuring high quality standards and optimal operations in terms of resource use and economic viability. Technological progresses in this area that could allow measuring properties of process streams and final products, accurately and in real-time could represent a major step forward towards more reliable and sustainable industrial operations.	The DISIRE project will design novel in-situ sensory technologies that will enable the measuring of properties from specific processes and product streams in the ferrous, non-ferrous, chemical and steel industries. Based on the vast amount of data collected and extended PAT, the overall IPC strategy will be reconfigured to optimize the process performance, improve the product's quality, while reducing energy consumption. The in-situ sensory technology will be specifically designed for the processes of grates' heat and hot zones and transportation of ore or raw materials. The scientific components being produced by the DISIRE project will be by design generalized and directly applicable to other cross-sectorial processes in order to increase the impact of the DISIRE activities.
These real time process data (e.g. chemical composition or biological contamination data) could allow the implementation of "near real time" closed-loop process control concepts making it possible to operate industrial processes at their optimum both economically and ecologically while ensuring high level of safety	The DISIRE project will introduce novel in line measuring technologies such as inline optic fibber sensors in combustion processes. Based on multiple measurements a PAT driven approach will be followed to update the static input-output process maps of the controlled processes for achieving an optimal and near to real time operation in both economic and ecological point of view. IPC will assure a stable operation, which is the foundation for increasing the production capacity to its maximum as well as improving the flexibility of the production machines between different grades with minimum production waste during the change. It is general knowledge that stable processes emit fewer pollutants and the results from DISIRE in the field of process control therefore have a direct impact on the environmental footprint from the process industrial segment of mining, steel and chemistry.
To obtain real time process data, the development of reliable fast inline measurements will be fundamental.	The DISIRE project will introduce in-situ measurement technologies for: a) mineral process of ferrous ore, b) mineral process of copper ore, c) processes of combustion, and d) process of transportation of materials and logistics. These sensory systems will be able to measure an extended set of internal processes characteristics such as acceleration, force, temperature, moisture, location, while in combination with the established communication and data analysis schemes it will measure almost everything and everywhere, enabling the concept of the interconnected factory model and allowing the overall IPC based on PAT analysis.

These measurements can easily be integrated into closed loop process control concepts, thus delivering the highest value and near real time process control for industrial operations and decision-making support tools, facilitated, for instance, by integrated databases covering measurements and computational data.	Part of the DISIRE inline measurement techniques will be the establishment of a proper and reliable communication scheme that will be able to gather all the in-situ transmitted data online. The collection of the measurements will be performed from the utilization of swarm of sensors and the principles of wireless sensor networks and their models for propagating the information (e.g. multihop networks). The vast amount of gathered information will be integrated by the DISIRE analytics approach based on extended PAT analysis that will be able to identify the optimal changes in the set points of the IPC for reconfiguring the whole IPC. The design and development of IPC, in-situ sensors and PAT analysis will be focused in specific DISIRE WPs. It is of the DISIRE projects ambition to be able to close the control loop in IPC in real time or in a near real time perspective based on online PAT analysis.
The development of these new "near real time" integrated process control methods is important considering the recently introduced intensified or modularized production concepts, e.g. presenting smaller continuously operated pieces of equipment or integration of process steps that pose new challenges for process analytics in terms of size and speed of analysis	The DISIRE industrial partners LKAB, DOW, and KGHM are in full symphony with the concept of intensified or modularised production concept. The selected demonstration applications in these industries belong to these categories since they represent modular processes that are characterized by a fast flow of a vast amount of materials that needs to be analysed fast. It is estimated that each per cent reduction in over processing (unnecessary high temperature or high flows) would reduce the energy consumption by 15%. It is here estimated that PAT sensor control could reduce over processing by 10%, thus reducing the energy consumption by 20%. Finally, it should be stated that it is the existing intensified and modularized set of processes of the DISIRE industrial partners that envisions the current proposal.
SPIRE 1 – 2014: IPC Specific Scope	
Provision of dynamic information about product properties, stream characteristics and process conditions.	The DISIRE project will provide near to real time in-situ measurements in the mineral processes of ferrous and non-ferrous, in combustion process and in the process of materials transportation. In all the cases specific inline sensors will be developed that will be able to measure the products' properties such as existing temperature, acceleration, vibration, forces applied, oxygen, moisture and by online PAT the specific characteristics of the overall stream of materials or products as well as the process conditions will be identified and in the sequel being fed in the IPC for optimizing the process or streams dynamics. The expected demonstration scenarios will be targeting TRL levels 3-5 with an ambition to reach 6 or 7 in some of the demonstrated DISIRE components.
Provision of spatially resolved process data.	The inline measurement techniques will be able to introduce disposable sensors in the stream of raw or integrated materials thought multiple industrial processes. These sensors will provide an inline spatial knowledge of the processes taking place during the transformation of the raw materials or the integration of the products, while the introduced DISIRE online PAT will be able to change the IPC strategy. The statistical analysis of the data and the formulation of online convex optimization structures would be of paramount importance for the reconstruction of a total process understanding based on spatial sampling of inline process information.
Data management for processes optimization.	The DISIRE's data management structure will be based on extended and online PAT analysis. The PAT analysis will be performed in a centralized but also decentralized computational approach in order to meet the near to real time needs for processing of big amount of data. It is of a specific research objective of the DISIRE project to achieve an extended PAT analysis in a minimum time window in order to enable the sequential PAT based optimization of the process's overall IPC. The data management of the vast amount of gathered data will be based on fast and online statistical learning techniques based on spatial gathered heterogeneous information flows of inline process measurements.
Sensors for intensified process	The DISIRE sensors for the intensified processes, such as pelletizing and

technology	material transportation will be a novel generation of disposable and cheap miniaturized sensors that could be directly inserted in the streams of production, even if it contains operations in harsh environments e.g. combustion, pellets logistics. These sensors will extend the classical definition of sensors as it will be an integrated sensory system with computational and communication characteristics in order to analyse and transmit the inline process information to the upper level of the process where the PAT analysis will take place. The proposed DISIRE sensing platform will be able to be altered and adapted to cross-sectorial industrial processes enabling the generalization and overall applicability of the DISIRE project.
Fast inline measurements (instead of extractive ones).	The DISIRE project envisions altering the current measuring and controlling approaches in the industry and especially the cases where inline measurements have not been possible to be performed. State observation algorithms and estimation of parameters have been incorporated for obtaining "soft measurements" of process parameters that couldn't be measured. DISIRE's clear aim is to build the proposed novel technological concept on advanced inline measurement technologies that would directly improve the level of understanding of the internal process dynamics, while improving the performance of the overall closed loop process, especially in cases that these processes have been characterized by a high complexity and simplified process models.
Robustness and reliability insuring minimum operation and maintenance costs.	The DISIRE produced in-situ measurement technology will not affect the current status of robustness and reliability of the involved processes since the sensors will be integrated in the stream of raw materials and products. The measuring of the internal process dynamics is expected to minimize the time for detecting failures in process components and indirectly have an impact in reducing the operation and maintenance costs.
SPIRE 1-2014: IPC Specific addressed aspects of major importance	
Cross-sectorial application of process analyzer technology (PAT) and product measurement techniques (PPMT) in closed-loop process control capable of inline measurements.	The DISIRE in-situ measurements, the PAT analysis and the PAT based IPC will cover four main industrial processes as it has been stated before. Their characteristics and needs can be directly generalized in other cross sectorial applications, while all the scientific components of DISIRE will be presented in an extended generalizability, adaptability and scalability in order to be adopted by other types of processes.
Integration methodologies within a large number of production conditions.	The DISIRE project will demonstrate its impact in integrated processes coming from four distinct industries and in different production conditions. The DISIRE's expected TRL demonstration will be in 3-5 level, while the extent and the importance of the DISIRE consortium assures for a direct and successful demonstration of the DISIRE concept.
Swarm sensors	The DISIRE in-situ sensing platform will be based on swarm sensing from multiple miniaturized and disposal sensors that can be integrated in the streams of raw materials or products. The swarm of sensors will formulate an extended wireless sensor network being able to stream the gathered information based on routing configuration and path identification properties. The swarm sensors will be of very low cost and will be able to be directly embedded in the industrial process flows.
Development of new soft-sensors and sensing concepts and models for improved process control using PAT data for the measurement of properties and quality of process streams and final products	The DISIRE IPC will be based on inline measurements and PAT analysis. Starting from the existing static models, further definition of the internal process modelling architecture, the workflow will be generated based on further sensing concepts and statistical online machine learning algorithms. A dynamic simulator (virtual plant) as a fast-running surrogate of the real process will be developed in combination with a data-driven system identification of linear and piecewise linear control-oriented models (soft sensing of internal dynamics). Moreover, specific modules will be developed for the batch data-driven estimation of optimal static input output maps, for characterizing and modelling the sensing uncertainty, including communication imperfections in wireless sensing.

	Definition of performance indicators, including those related to product quality and energy efficiency will be defined in order to tune the optimization problems.
Miniaturized PAT- and PPMT-based advanced control for intensified processes.	For intensified processes, DISIRE will demonstrate PAT based advanced reconfiguration of the IPC strategy based on online in-situ measurements, which for example can be the properties of the material handling process (acceleration, forces, size, moisture, etc.) and with control variables such as the rotation speed of drams, heating, etc.
Disposable sensors in batch and in continuous processes	The DISIRE project will develop in-situ disposable sensors for both the batch (e.g. combustion) and continuous (e.g. pelletizing) processes.
Control strategies for flexible processes or disposable sensors using integrated and validated PAT data.	The DISIRE project will extend existing state-of-the-art model predictive control strategies with online machine learning algorithms that update static input-output maps of the controlled processes from collected steady-state data and PAT analysis, for optimal generation of set-points. Thanks to novel numerically efficient online convex programming algorithms, the control strategies will gain reconfiguration capabilities based on exploiting PAT analysis of the inline measurements for close-to-real-time control.
Process and Product life cycle management.	A critical aspect of process life cycle management relates to the inherent difficulties of in-situ measurements of the product and of the processing equipment in important process steps. The measurement difficulty relates to harsh environments such as reactive media such as acids, high temperatures (e.g. in furnaces) or a generally harsh mechanical environment such as in crushes, mills or ball-rolling operations. Lack of measurements in combination with product property variation lead to non-optimal, often too aggressive production settings. The need for over-processing comes from the robustness criterion, that even if current process inputs are unfavourable and if processing conditions are not as expected, the output properties will still be adequate. The DISIRE project will target in-situ measurements. With such measurements, the needed amount of over-processing can be greatly reduced.
Activities expected to focus on Technology Readiness Levels 3-5. A significant participation of SMEs with R&D capacities is encouraged.	The DISIRE project will demonstrate the overall concept in characteristic processes from four industries. All the demonstration will be in the TRL levels of 3-5, while the ambition of the project is to reach levels of 6 or even 7. Under the umbrella of the DISIRE project eight SMEs with R&D capacities and with an existing closed cooperation with the industrial partners have been already integrated in order to strengthen the applicability of the proposed scientific results and the innovation and commercialization aspects of the project.
SPIRE 1 – 2014: IPC Expected Impact	
Improved capabilities for valid, reliable and real-time measurement of the properties and quality of process streams and final products for existing and for more flexible process operation concepts.	The DISIRE project will produce inline measurement technologies: a) for the pelletizing process with an expected TRL level of 6 (LKAB), b) for the transportation of materials and logistics with a TRL level of 6 or 7 (KGHM), for the combustion processes with a TRL level of 4-5. In all the cases the flexibility in reconfiguring the IPC based on extended PAT will be demonstrates and evaluated with respect to specific identified measurable indices and impacts.
More sustainable plant operations due to the extensive usage of all information available from validated PAT and PPMT measurements for model based control.	The DISIRE PAT and PPMT processes will advance the existing model based control configurations since the measuring and understanding of the internal processes dynamics will allow the online tuning and optimization of the applied control schemes. The near to real time operation of the proposed concepts will enable the direct application and demonstration of the DISIRE technology in industrial test cases.
Improved monitoring and control of continuous plants.	The in-situ measuring, online PAT and the proposed PAT-IPC technologies introduced by the DISIRE project is expected to have an overall improvement and impact in the related industries as it will naturally lead to a better knowledge of the processes' internal dynamics and optimization in the adopted IPC strategy.

Improved support of the operators leading to safer, more reliable and sustainable process operation improving process efficiency.	The machine learning algorithms of the DISIRE project will enable the information flow for altering the IPC from the internal dynamics of the processes. The PAT analysis and the suggested reconfiguration of the IPC will be developed in the form of complete modules that can be directly adopted by the existing Distributed Control Systems (DCS). ABB and the related SMEs will ensure the overall compatibility of DISIRE with existing DCS.
Better process operations with respect to resource and energy efficiency.	The DISIRE technology will have a general impact in reduction of resource and energy consumption, in the related industries as it has already been stated and will be analysed in the Impact Section 2. As a short example for the case of only one process sector, it is assumed that through monitoring and optimisation of transport processes in KGHM the current energy consumption could be reduced up to 10%. Additionally, due to better control of mass flow further improvements are expected (minimising of machines operation in idle mode) Optimisation of Mineral Processing processes would results in fewer amounts of industrial wastes, less amount of used water and less energy consumption.
Significant decrease in greenhouse gas emissions.	Reduction in greenhouse gases will be addressed from two angles in the project. Firstly, the direct approach aiming at optimizing the energy usage by introduction of new IPC strategies with specific focus on industrial heat generation. Secondly, by recognising that the process industries are large consumer and producer of excess energy and this sector present great opportunity becoming an agile part of the European energy producing system, for example by increased usage of Combined Heat and Power. However this cross-sectorial approach provides completely new constraints taking into account several different stakeholders.
Strengthening of the competiveness of the European industry both in the domain of PAT technologies and control solutions and with respect to economically sustainable industrial processes.	The DISIRE project will insert worldwide novel concepts that would be able to directly be applied in other cross-sectorial processes in Europe. The overall reduction of resources needed and energy utilization will be fully aligned with the overall vision of the sustainable industrial processes and the overall vision of SPIRE PPP.
Retention and creation of jobs for the European measurement and automation and process industries.	The DISIRE project innovation and commercialization activities focusing in sensor development, PAT software modules and PAT based IPC modules will be further penetrated in the market by DISIRE spin off approaches that will create novel sectors of operations and working needs, while enabling the creation of new jobs. The DISIRE project will not have a reduction impact in the existing number of jobs in the industry from the current status. However, the significant DISIRE based reduction in the resources and consumption will allow the industrial partners to invest in the DISIRE technological areas, an act that will strengthen the innovative part of the project and will generate further jobs.

1.3 Concept and approach

1.3.1 The DISIRE Concept and Motivation

The DISIRE proposal has been inspired by real world application scenarios based on reconfigurable and adaptable to product integrated control strategies, relying on in-situ process measurements and online PAT based IPC reconfiguration in combination with data mining and extended rich information flow characterization that could assure that the right product and in the right quality will reach the right customer in the Mining to Steel value chain. The DISIRE technology at the current state will target the specific processes of Intensification, Pelletizing, Energy Efficiency, cross sectorial combustion processes and transportation of raw materials/logistics. In order to confine the research activities and the technological developments within reasonable boundaries, the project will specifically aim to provide relative solutions and demonstrate its impact in the industrial sectors of Mining, Mineral Processing, Steel and Chemical industry, while during the execution of the project cross-sectorial spin offs of innovation to related industries will be performed.

The DISIRE project aims in developing and introducing novel inline measurement techniques that will enable a significant transition of the current state of the art existing control and monitoring systems, from a static sensing and control in multiple parallel loops perspective, into a product based, online, and in-situ to the process, reconfiguration of the IPC strategies based on extended online and near to real time PAT analysis of a vast stream of data from the internal process dynamics.

With the DISIRE project the properties of the raw materials or product flows will be dramatically integrated by their transformation in a unique inline measuring system that will extend the level of knowledge and awareness of the internal dynamics of the undergoing processes taking place during transformation or integration of raw materials in the next levels of production. In this approach, the Integrated Process Control system, instead of having external experts to tune the overall processes, based on the DISIRE concept will enable the self-reconfiguration of all the production lines by the produced products itself. Specific DISIRE Process Analyser Technology (PAT) will be able to define quality and performance requirements, which for the first time in the process industry will be able to be directly applied on the physical properties of the developed products and thus enabling the overall online and product specific reconfiguration of the control system. In this way, the whole production can be fully integrated in a holistic approach from the raw materials to the end product, allowing the multiple process reconfigurations and an optimal operation based on the product's properties and online streaming information of the processes that can be generalized in a whole product production cycle being spanned in multiple industries.

Overall the DISIRE project will propose: a) a generalized and platform independent Reconfigurable Integrated Process Control technology relying on an online PAT based machine learning approach, b) novel and generalized in-situ measurement techniques for the DISIRE processes, c) PAT analysis methods based on spatially acquired data and in close to real time computational analysis will be introduced for tuning the IPC strategy and optimizing the processes, and d) application specific full demonstration scenarios for enabling and inspiring the further DISIRE concept adoption from other types of industries. It is of the DISIRE's main interest to demonstrate a clear and measurable impact in the process industries that can be directly extended in cross-sectorial industries.

1.3.2 The DISIRE Technological Platform

In achieving the aforementioned objectives, the DISIRE project will introduce a novel IPC approach to the current industrial processes. The DISIRE technological platform will consist of: a) inline disposable sensors that when inserted in the process flows will be transformed to a swarm of sensors, being able to measure in real time the processes' internal dynamics, b) statistical learning, process perception and process model generation by a mixture of classical off line PAT analysis with geospatial information from the inline swarm sensors and with an overall ability to generate process analytics in near real time, c) reconfigurable IPC approaches based on the new concept of online PAT analysis being able to provide an optimal selection of current set points for processes, and d) technology application and demonstration in levels of at least a TRL 3-5 in the related to the DISIRE industries. Within the DISIRE project proposal, the aim is to move one step further the current state of the art technologies and concepts by intense investigations of the proposed scientific challenges and accomplishing the technical breakthroughs for the development of such an advanced and promising integrated system in the process industries.

As a characteristic example of the DISIRE's vision, the application of the pelletizing in the ferrous industry can be utilized as it is being indicated in Figure 3, where in the left part of the figure the current state of the art approach is being visualized and with the DISIRE vision demonstrated in the right part of the figure. More specifically in the case of the iron ore pellets transportation in and out of various processes (e.g. in the drum, the blast furnace, the dram) an external vision based measurement system tries to predict and estimate the process taking place during the transportation of the pellets (e.g. their size and distribution) In the case of the DISIRE based concept, the valuable data are being generated by the process itself (in-situ), where miniaturized PAT with a unique identifier and equipped with sensors is being injected in the stream of raw materials, while being capable of performing and transmitting real time measurements. In this case the process itself generates the information about the stream of materials and it is being propagating in further stages or processes. This concept is a natural and efficient way of analysing the processes based on their internal dynamics, while the proposed on-line PAT based IPC scheme can be directly optimized and adapted to the current characteristics of the processed raw materials or produced products.

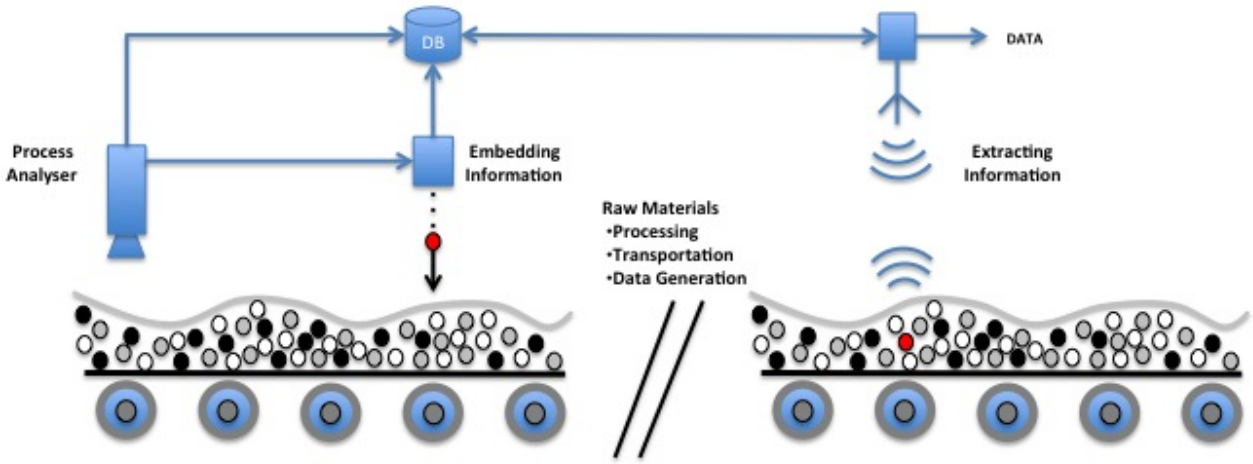


Figure 3: Application of the DISIRE concept in a.u. the pelletizing process (Left: State of the art, Right: DISIRE vision)

We claim that through the development of the DISIRE framework, we will be able to provide a platform that is flexible, robust and adaptable to the industrial processes and to the characteristics of the current raw materials or products, which will be able to fully demonstrate the ability to perform inline measurements, provide PAT in close to real time and optimize the overall process by reconfiguring the existing IPC strategy based on PAT analytics, and thus setting new standards in the area of process dynamics understanding and perception, scalability and adaptability.

The DISIRE technological platform is based on a novel approach in the area of IPC and will have the following attributes:

- **Reconfigurable and Platform Independent Integrated Process Control:** The DISIRE IPC strategy will be able to reconfigure the optimal set points for the controlled processes based on online PAT modelling and analysis. This reconfiguration, while retaining optimality in operation, will be developed in an abstractive and generalized way based on specific process analysing methodologies and required measured objectives, in terms of minimization of energy and consumption, level of production, and available control parameters.
- **Application specific novel inline and distributed extended sensory capabilities:** The basis of the DISIRE project will be the extended in situ measuring capabilities in different process applications. The sensing will not be performed by simple sensors but in the form of integrated miniaturized and disposal sensors, in the form of wireless sensor networks, that will have the necessary computational and communicational capabilities to formulate sensor swarms after being injected in the processes' streams of materials of products.
- **Advanced reasoning and process status cognition** The DESIRE reasoning should be based on a combination of off line PAT analysis and online geospatial streams of information based on swarm sensors. The integration of this multiple sources of information will enable the creation of advanced and novel process analytics that can be utilized for altering the existing IPC strategies.
- **Adaptability:** The proposed IPC should be able to autonomously adapt to the current operation status and desired material or product performance based on advanced online PAT of in situ measurements. The adaptation should be performed online, without the need of a human intervention. Moreover, the adaptation or the reconfiguration to different optimal set points should be performed in a near to real time operation in order to minimize the effect of the transition on the current processing of raw materials or products.
- **Robustness:** The heterogeneity of the industrial processes with their own operating conditions and demands will require from the sensing, analysing and process control technological frameworks of DISIRE to present advanced robustness specifications. The DISIRE system should present robustness against uncertainties, missing information, spatial reasoning, time delays, etc.
- **Scalability:** For increasing the impact of the DISIRE project in the processes under investigation as well as into other cross-sectorial applications and having a major impact in a total reduction of resources and energy consumption, the scalability attribute of the DISIRE project is of paramount importance.

1.4 Ambition

Coherently with the vision, the objectives and the attributes of the DISIRE project, the state of the art will be described as the current technological status in the DISIRE's process in the field of Mineral Processing of Ferrous and Non-Ferrous materials, in Chemical Combustions, and in the Transportation of raw materials. In each of these sectors the ambition of the DISIRE process towards the progress beyond the state of the art will be analysed.

1.4.1 Mineral Processing of Ferrous ore (Magnetite)

1.4.1.1 Introduction to Pelletizing

To purify the ore from naturally occurring but unwanted contaminants such as phosphorous, it is necessary to first grind it to a fine powder called concentrate. Magnetic separation and flotation is then used to separate the iron mineral particles from impurities. The concentrate slurry is pumped to the pelletizing plant. Here, supplementary additives such as binders are mixed into the material after dewatering. The iron ore powder is too fine for use in blast furnaces or direct reduction furnaces and it is thus necessary to first agglomerate the concentrate granulates that are sintered into pellets. The pelletizing process starts with the slurry tanks and ends with product storage silos for finished pellets before the product is further transported and shipped to the customers. The customer processes' blast furnace or direct reduction processes transform the pellets to pig iron. The carbon content of the pig iron is reduced in steel plants, where also alloys are added to create steel, which then is processed into slabs, billets or blooms. Slabs are typically further processed in hot strip mills or plate mills into coils, sheets or pipes; whereas billets and blooms are typically further processed in hot rolling mills into bars, rails or pipes.

1.4.1.2 Hot Process

The process steps of interest for this project reside within what usually is referred to as the hot process. These steps start with the grates, where the green pellets are dried, while this step is integrated with the kiln where the pellets are sintered, and heated by coal and oil, as well as of exothermal chemical reactions of the ore material. After sintering, the pellets enter the cooling zone. The finished pellets should have enough mechanical strength to withstand the transportation stresses generated by conveyors, loadings and interim storages that follow.

Drying and preheating is performed in several zones consisting of two for drying with lower inlet air temperatures and two preheating zones with higher temperatures with temperatures starting at 100-150°C and successively increasing to 1150°C. After drying and preheating in the grates, the pellets are sintered in kilns. The firing temperature is between 1250 and 1290°C depending on the product being produced. Higher temperatures and longer processing time increase the strength of the particle bonds between ore particles in a pellet, but longer times reduces the process throughput and both longer sintering times and higher temperatures increase the wear of the kiln and both temperature and sintering times increases increase the fuel consumption.

Cooling is the final step of the process where the product is cooled to 70-90 ° C in four zones. Air is used as coolant and the flow of heated air from the cooling zone is used in the drying and preheating zones. In fact, in the grate-kiln process, the three first zones consisting of drying and preheating are entirely heated with re-cycled air from the three last cooling zones. However, the recovered heat from the first cooling zone is not enough to uphold the oxidation process and sufficiently high temperature is achieved with coal-injection or oil burners. The total annual usage of energy is equivalent to 150.000 tonnes of coal corresponding to 750.000 barrels of oil.

1.4.1.3 Progress Beyond state of the art in Mineral Processing of Ferrous ore

Benefits from IPC-DISIRE for ferrous mineral processing of magnetite ore in general and LKAB in particular consists of:

- Increased Knowledge about the Integrated Processes, and particularly the heating of the products in the grate zones, and Logistic to Customer
- Optimized and Stabilized Processes through Integrated Process Control based on new measurements in grate process.
- Reduced Environmental Impact
- Improved Energy Efficiency and Increased throughput

- Reduce Waste Products (crushed pellets)
- Reduce Transportation Dust
- Possibility to create Added Value for Customers

Increasing the knowledge base about the processes is the foundation for all kinds of improvements efforts and will have significant impact regarding developments of a future IPC strategy. This is achieved through the developments in WP3 and the practical experimental activities carried out in WP6, which will be actively supported by LKAB. LKAB will give access to their pelletizing plants to evaluate the developed technology in their production processes.

It is important to avoid variation and unnecessary oscillations that occur to reduce the environmental impact from the production facilities. Process oscillations typically origins in interconnected systems and in order to eliminate them a holistic view is necessary in the DISIRE activities. Since the raw material stems from the natural environment, it is not possible to eliminate incoming variations in properties such as chemistry of the ore. Continuous process operations in large interconnected plants are also inevitably subjected to other kinds of process related disturbances. Such disturbance could e.g. stem from equipment breakage such as broken pumps or sensors, of degrading measurements due to residue build-up or wear, as well as to human factor errors. Such variation is usually considered inevitable, and the producers must compensate by adjusting the process so that even if the product properties are less beneficial than what is currently known, the final product will still be good enough. Raising and prolonging the sintering process is such a remedy. However, if the variation is known and traceability is achieved, it is possible to adjust process control to optimize settings for the product being processed at each process step, thus reducing energy and increasing throughput when possible. PAT sensors could also be used to measure in-situ properties of the product, where the process design or environment prohibits stationary measurements. This includes measurements of impacts and moisture of the product during transports such as during unloading of trains or boats, or in-situ measurement of temperature profiles within a straight grate.

The hot stage of the mineral processing at LKAB is the largest consumer of energy. With the embedded sensors measuring temperature inside of the material, rather than measuring the surface temperature, it will be possible to optimise the combustion process. Consideration must be taken that the gas flow is coupled through the process, which will require a holistic view.

A reasonable target for an improved control strategy of the processes **is 2% energy savings of electricity and fossil fuel**. This might not sound much but is equivalent to 12.000 tonnes of carbon dioxide or 15.000 barrels of oil. Improved knowledge about the processes is also fundamental in order to make process modifications. For example, switching from oil and coal, as the major source of energy to natural gas would have a tremendous effect on the CO_2 emissions and can theoretically reduce the greenhouse gas emissions with 46% corresponding to 300.000 tonnes of CO_2.

Before any modifications of the hot process are possible the transportation conditions of the final product must be mapped since a large amount of the material is damaged and the strength of the pellets are directly correlated to the amount of heat added in the grate and kiln. During transportation with rail from the mine site in Kiruna to the harbour in Narvik a considerable amount (in order of several per cent) of the product is damaged and has to be sieved from the premium product that are shipped to the customers.

Considering that the annual production is about 25 million tonnes this corresponds to a significant amount and improved tracing and mapping of the transport conditions using embedded sensors can considerably improve the competitiveness of the business. Every reduction in the percentage not sieved off before shipping reduces energy consumption by the same amount, and more if the losses due to transportation is considered.

Increased traceability also means that the pellets customers will could receive information of the product being processed in their processes, and may lead to improvement there as well if the correct countermeasures are known. Traceability systems should thus have the possibility to follow or mimic how disturbances propagate through the product production and transportation chains. Being able to optimize engineering control and to optimize process settings is not the only, or perhaps even major benefit from a good traceability system.

Intelligent raw materials equipped with sensors will inevitably be shipped to the customers in steel sector. Contamination is not a problem since the mass of the sensors is considerable smaller than the mass of the material and will eventually be destroyed in the blast furnace. However, the fact that the material can be traced all the way from the mine site to the customer is added value for both industries since the process performance can be directly connected to specific properties and a specific portion of the material.

1.4.2 Steel Processing

1.4.2.1 The blast furnace in the integrated steel plant

Steel manufacturing is the next step in the value chain that starts with mining and mineral processing of ferrous ores. Steel is predominantly manufactured in integrated steel plants consisting of numerous energy intensive process stages normally starting with the BF- or the direct reduction process. The purpose of the blast furnace is to transform iron-ore into a molten iron and collect the gangue in a slag that is tapped from the BF for further processing. After desulphurization the hot metal is converted to steel by blowing oxygen into the melt before adjusting the steel composition with additives and correcting the temperature which is necessary in order to cast the manufactured steel into slabs, billets or blooms that are further treated in rolling mills. Strands are often pre-heated before further processing and are finally rolled down to intermediate parts such as plate, sheet, strip, coil, billets, bars and rods. Many of these products will be the starting material for manufacturing operations such as forging, metal working, wire drawing, extrusion, and machining.

The BF is continuously operated and is a shaft furnace with counter-current flow of gas and burden materials. The iron-bearing materials mixed with additives, as e.g. slag formers, scrap and nut coke, are charged in alternate layers with coarse coke. The raw materials often transported with belt conveyers to the BF top and distributed over the radius. Generally, in Europe the ferrous-bearing material consists of iron ore sinter mixed with lump iron ore and iron ore pellets. The Nordic countries use 100% pellets. As there is no sinter plants available when using 100% pellets the in-plant fines have to be recycled via other routes as e.g. cold bonded briquettes that are charged into the BF and some carbon rich dust is injected into the BF.

In order to achieve the necessary temperatures in the blast furnace preheated oxygen-enriched air (blast) is blown through the tuyeres (blowpipes) and pulverized coal is injected and combusted inside the tuyeres and are further gasified with CO_2 beyond the combustion zone. The hot reducing gases ascend and meet the descending raw materials, reduce the iron oxide to metallic iron and supply the necessary heat. The BF gas having a temperature of ~100-150 ºC is finally exiting the process at the BF top. Burden materials charged to the BF increases rapidly in temperature up to ~ 500°C within 1-2 m from the top and further to an almost constant temperature of ~ 900-1050°C in the thermal reserve zone. The theoretical flame temperature in the combustion zone is approximately 1800-2300 °C.

In Europe the use of PC is the dominating injected fuel and large efforts for increasing the injection rates up to levels above 200 kg/tHM. Injection on industrial scale with other materials e.g. oil, gas plastics, grease, BF flue dust and tar are also implemented. From an economical point of view, improving the fuel flexibility and efficiency by using different types of energy sources is important since coking coal is expensive and 1 ton of coke requires ~ 1.4 ton of coking coal. Alternatives to coals are also continuously investigated in order to improve the economic viability and reduce the environmental impact. Variation over time in the blend of PC or of the quality within one delivery of coal results in variation in the carbon input and difficulties to control the heat level of the BF. In worst case severe process disturbances and an excessive use of reducing agents may occur. The use of sensors tracking the grinded coal from source or registering quality parameters correlated to the heat value of coal can contribute to improved control on carbon input, precise heat level control and reduced energy consumption.

The combustion efficiency of the process is directly influenced by the coal plume dispersion and amount of oxygen supplied to it. To be able to achieve this research on modification of injection lance design using CFD modeling is on-going in the RFCS project IMPCO (RFSR-CT-2012-00002). Innovative measurements are important tools for monitoring the coal plume using the modified lance, as e.g. raceway depth measurements based on radar, image analyses using IR and CCD camera and optical fibers installed in a measurement lance for temperature estimation (based on Planck radiation). However, so far there is no method for determining the O_2 content in the coal plume or its surroundings.

1.4.2.3 Combustion for preparation of hot air for the blast furnace

The hot blast is produced in hot stoves that are heated by combustion of BF gas that is an important recycled by-product in integrated steel manufacturing but usually require addition of gas of higher heating value such as natural gas or coke oven gas. To reduce the consumption of energy rich gas research on oxygen enrichment as well as preheating of air or combustion gas is on-going (Optistove RFSR-CT-2012-00003). Important control parameters used are flue gas temperature and composition. Sophisticated control of the hot stoves are used in the industry today as they are constituted of sensitive bricks and dome material but further improvement could be achieved by O_2 sensors for combustion.

1.4.2.4 Combustion for heating steel products

For the manufacturing of steel products (strip, plate and profiles) steel slabs, billets and blooms are heated in large reheating furnaces. For product quality assurance, energy consumption and safety it is important to accurately monitor and control the furnace conditions. Two important parameters to measure are: a) the temperature of the material and b) the furnace atmosphere. Temperature measurements inside reheating or annealing furnaces are very complex, the process conditions are tough and the radiation inside the furnace influence IR pyrometer readings. Steel surfaces both reflect and emit infrared radiation and the radiation intensity effect pyrometer measurements. (Outside the furnace the reflected radiation is much lower and a more accurate temperature measurement is possible.) For tuning purposes accurate temperature measurement are regularly made by using thermocouples drilled into test specimens. The thermocouples are sometimes fed through the furnace feeding the long cables into the furnace or by using a capsuled logger that can stand heat for some time. The logger commonly burns after a few tests due to production stops or other problems. These self-contained devices are often too heavy to use on thin material due to the weight. Recently a better and lighter encapsulation has been developed using a phase changing material as insulation but the cost for the system is high and there is a large risk for burning this system with a high maintenance cost or the cost for a new investment. Measurements of the furnace atmosphere will assure that the combustion is working properly to a minimum cost and with good quality of the material surface. In the furnace O_2, NOx, CO, CO_2 are commonly measured. It is important to keep the O_2 content on the correct level to avoid excess oxide scale growth and degraded surface quality.

1.4.2.5 Progress Beyond state of the art in Steel Processing

Within the DISIRE project, the focus will be in developing in-situ sensors for the measurement of: a) temperature and b) oxygen content of the combustion. Proper temperature measurements inside the furnace can assure a homogenous temperature in the material. This is needed for product quality and process stability as well as optimization of energy consumption. The proper control of oxide content in the various zones in the furnace can minimize losses caused by excessive oxide scale and degraded surface quality and also control combustion and cost for oxygen.

It is expected that an overall DISIRE improvement of will produce a reduction of 3 kg of C from fossil fuels per tonne hot metal produced due to: a) improved gas efficiency with 1 % absolute due to improved burden distribution control, b) improved process stability due to improved moisture control charged burden material and c) improved process control due to early information of in-furnace conditions related to the temperature distribution in upper shaft

The size distribution of the feedstock material and the movement of the burden layers downwards inside of the blast furnace are of great importance for controlling the gas distribution, which in turn has a significant impact on the process efficiency and the energy consumption. The control of the blast furnace process is generally based on externally acquired measurements and the plants are in typically very well equipped and large quantities of data are continuously registered.

However, the use of additional sensors that are embedded in the raw material feedstock presents important additional information about the internal process state such as position, temperature, pressure, and gas composition. This information is necessary for optimization the control strategy beyond state of the art and will most likely influence the principles for charging of material at the top of the furnace. The horizontal and vertical distribution and movement of each individual material type are crucial considerations to be investigated in this project. The individual size-distribution of the raw material as well as the vertical packing distribution is crucial considerations that will be investigated in the project. The feedstock such as pellets, sinter, briquettes coke etc., all have differences in size and have different physical properties that influence their heating rate and the gas flow characteristics differently in the different layers.

More correct recipe calculations can be established in near real time if, for example the moisture content in the burden materials are known when they are continuously feed to the BF. This can be realized by controlling the amount of moisture, especially in coke but also other raw materials, which is directly related to the achievable heat level. Currently, most integrated steel manufacturing process plants has moisture measurement devices installed in the storage bins and silos. The sensors require frequent calibration and adjustments in order to supply reliable data and may nonetheless deliver uncertain data considering that only a small portion of the material is examined and that sample may not represent the whole batch. By frequently measuring the moisture content and tag that particular portion of the feedstock guarantee that the information acquired is correct and is following the process stream and can be re-collected at positions where it generates the highest value.

Since the composition and physical properties of feedstock material is different and varies at the same time as the in-furnace condition also varies, actions in order to maintain the process stability are required. The thermic properties of the materials used are different, which influences the heat transfer from hot reducing gas generated at the bottom of the furnace. In-situ measurement of temperature in the different layers and at different locations, as the burden is slowly moving downwards in the furnace, is valuable for determining changes in process conditions in real-time. The new technological progress that DISIRE presents is the foundation for developing integrated control strategies that compensate for changes in the process state automatically by the taking required actions for maintaining the process stability and which are capable of making correct thermodynamic evaluation of the process state. Even though new DISIRE sensors might not survive the highest temperatures there are several temperature zones below 800 degrees both in the BF and in the reheating furnaces where access to DISIRE measurements would generate considerable added value. For the BF a material tracking system could be of large value for moisture control of input material, material movement in the BF, particle inner temperature, heating rate etc. for material of significant different sizes. Main parameters of interest for the BF application are: a) the moisture content, b) the temperature, c) the position representing both vertical and horizontal movements, and d) the pressure.

1.4.3 Industrial Combustion Processes

1.4.2.1 Combustion processes

One of the most significant studies in combustion processes is the modelling, since it is needed to gain insight into a particular configuration in order to optimize it. Optimization may mean maximizing thermal efficiency, minimizing pollutant emissions, maximizing throughput, minimizing operation costs, or some combination of these. A recent use of modelling is for the control of processes to predict results under some given conditions and then adjust the operating parameters to produce the desired results. An important line of work is to find the most efficient operational input conditions in order to reach an optimized level of efficiency by performing parametric simulations in which some input variables are parametrically modified so that the global behaviour of the furnace is evaluated. This enables to establish correlations between these operational input variables and efficiency, thermal losses, species concentration, temperatures etc. Making this research through simulations allows extending the number of situations of study and obtaining information of more variables without installing new costly instrumentation. Afterwards, during the time in which the simulations models are designed, it is necessary to collect data from the physical instrumentation already installed (fuel flow, temperature probes, O2 concentration analysers) and use it to validate the first results of the computational simulations.

CFD simulation is a useful technique to computationally perform a diagnosis of the conditions and effects that take place in a process. The results can be used as an approach for a complete study and operation optimization. Using this solution it is possible to obtain information of the performance under different operational conditions, saving time and avoiding complex experimental installations, monitoring systems etc. Prior to installing all kind of sensors, the results derived from a comprehensive CFD study of the cracker, will be used to provide a complete characterization of the furnace, defining the most adequate points where instrumentation, which can be very costly, can be installed providing the highest accuracy and representation of the measured data. This factor is important in order to determine the exact locations at which point measurements can be representative of the average values of the flow, avoiding the installation of instrumentation in zones affected by local perturbations that could provide inaccurate information of the average flow conditions. CFD techniques may be useful to make sure that a high economic investment in instrumentation provides accurate information. The two major parts of industrial combustion problems consist of the burners and the combustors. A sampling of references for modelling industrial burners includes: Radiant tube burners, Swirl burners, Oil burners, Pulse combustion burner, etc. Numerous papers have been presented on modelling of industrial combustors, while reviewing the approaches, equations, and solution methods employed for using CFD to model practical combustors, including industrial furnaces[1].

[1]D.G. Lilley, Flowfield modelling in practical combustors, *J. Energy,* 3(4), 193-210, 1979.

On the other hand, the development of diagnostic methods suitable for the monitoring of practical flames is an important objective due to the need to achieve a more precise description of the process and, ultimately, implement efficient and reliable control and optimisation methods as a key step towards the development of more efficient, flexible, reliable and clean combustion systems. The main challenge in this field is the definition of the most representative flame signals and of their subsequent processing to derive the meaningful information required to diagnose the state of a flame or to drive a controller in an effective and safe manner. The permanent supervision and optimization of flames, which are the core of any combustion process, appears as an essential instrument to meet those demands. The importance of these aspects as one of the key technological objectives is recognised in surveys and roadmaps proposed for different combustion applications[2,3,4,5].

The possibilities for permanent optimization of combustion equipment, in contrast with many other industrial processes, are currently very limited, based on the information provided by the gas analysers that constitutes a highly incomplete description of the combustion process in order to act on the burner settings in an effective and safe way. The implementation of advanced control methods in practical combustion systems poses two main difficulties: The lack of reliable flame monitoring tools and models and the risk of bringing the system into unstable regimes. In the absence of reliable predictive methods, the permanent supervision of the flame seems the most rational alternative in order to develop efficient and safe strategies for the control and optimization of practical burners[6].Sensors are necessary for control but also to provide information on the state of the process. Conventional instruments afford a very limited description of the process taking place inside the combustion chamber. A precise diagnostic would require much richer information on the properties of the flame, as the core of the combustion process. Therefore, the development of flame monitoring techniques suitable for practical applications appears as an important prerequisite for the design of ambitious supervision and control strategies of combustion equipment. Numerous and interesting attempts in this respect have been reported, especially during the last decade.

The description of advanced combustion can be found in some comprehensive compilations on both intrusive and advanced optical techniques[7,8,9]. The general concept of flame monitoring actually includes diverse applications and can be based on various types of sensors as well as on widely different approaches for the interpretation and use of sensorial information. In direct monitoring, the monitoring objective is completely fulfilled by the quantification of such parameters, which can be directly used to inform the operators or to drive a control loop. The expression indirect monitoring is used to designate the methods based on the extraction of meaningful parameters of the combustion process from sensorial data not having a direct (or, at least, known) mathematical relationship with them. The result can be expressed in terms of an estimated magnitude or the classification of the monitored flame with respect to states previously defined. Actually, many of the monitoring techniques should be classified as indirect methods by means of a wide variety of correlation methods such as: a) Flame spectroscopy and b) Flame imaging.

Collecting direct information from flames in the form of 2-D or 3-D maps using CCD cameras, in many cases this is only a first step and sensorial information must still be converted into some kind of meaningful information suitable for the diagnostic or the control of a combustion process.. Many of the works there are based on the analysis of some parameters extracted from the flame images, related to their geometry, luminosity or colour. The existence of relationships between combustion conditions and selected image features has been demonstrated in a number of parametric studies[10,11,12] that may enable the development of empirical correlations designed to estimate meaningful process information from flame images.

---

[2]Richards GA, McMillian MM, Gemmen RS, Rogers WA, Cully SR. Issues for low-emission, fuel-flexible power systems. Progress in Energy and Combustion Science 2001; 27:141–69.

[3]US Department of Energy, Industrial Combustion Technology Roadmap – A Technology Roadmap by and for the Industrial Combustion Community, October, 2002.

[4]Sehra AK, Whitlow JR. Propulsion and power for 21st century aviation. Progress in Aerospace Sciences 2004;40:199–235.

[5]Docquier N, Candel S. Combustion control and sensors: a review. Progress in Energy and Combustion Science 2002;28:107–150.

[6]Javier Ballester, Tatiana García-Armingol. Diagnostic techniques for the monitoring and control of practical flames. Progress in Energy and Combustion Science 36 (2010) 375–411.

[7]Kohse-HöinghausK,JeffriesJB,editors. Applied combustion diagnostics. New York: Taylor & Francis; 2002.

[8]Kohse-Höinghaus K, Barlow RS, Alde ́n M, Wolfrum J. Combustion at the focus: laser diagnostics and control. Proceedings of the Combustion Institute 2005;30:89–123.

[9]Marques JS, Jorge PM. Visual inspection of a combustion process in a thermoelectric plant. Signal Processing 2000;80:1577–89

[10]Yan Y, Lu G, Colechin M. Monitoring and characterization of pulverized coal flames using digital imaging techniques. Fuel 2002;81:647–56.

1.4.2.2 Progress Beyond state of the art Combustion Processes

One of the improvement directions in combustion processes resides in combustion monitoring and control by means of new and/or more efficient sensors and control techniques, in what is commonly named "smart burner techniques". The objective is to optimize combustor operation, monitor the process and alleviate instabilities and their severe consequences. As combustion systems have to meet increasingly more demanding air pollution standards[13], their design and operation becomes more complex. The trend towards reduced NOx levels has led to new developments in different fields. Despite its enormous importance, combustion systems are one of the processes with more limited possibilities of regulation and control. The industrial burners are not properly taking advantage of the important benefits provided by IPC strategies, regarding permanent process optimization, minimization of pollutants, operation flexibility, etc. Monitoring and control of the operating point of the process have to be achieved with great precision to obtain the full benefits of the NOx reduction scheme. Research is now carried out to reduce these dynamical problems with passive and active control methods. In addition to a broad range of fundamental problems raised by Active

Combustion Control (ACC) and Operating Point Control (OPC), there are important technological issues. Research efforts in combustion diagnostics are to a certain extent devoted to the development of sensors for control applications. Further developments in IPC will depend critically on the availability of sensors and on their reliability, robustness, immunity to noise and capacity to operate in a harsh environment. Research is needed on the fundamentals of ACC and OPC but it should also address the more technical aspects of the problem.

The availability of a reliable regulation will allow achieving: 1) increase in the efficiency of facilities, very important in a liberalized energy market and for the reduction of greenhouse gas emissions and of the environmental impact, 2) on-going optimization through detection and correction of operating drifts, 3) Greater operation flexibility, with different loads and combustibles, 4) reduce pollutant emissions (including NOx), and 5) incorporate new combustibles to the energy market, whose Lower Heating Value (LHV) and/or properties variability difficult a reliable and efficient combustion.

The main deficiency in this field is possibly the lack of direct information on the process core: the flame. Therefore, a major goal of the DISIRE project is the development of instrumentation capable of providing information on the characteristics of the flame that, at the same time makes feasible its implementation in real systems. This instrumentation, along with conventional gas analysis equipment, provides a comprehensive set of information, which allows the development of systems for monitoring and control of the combustion. One of the work purposes is the development of systems for monitoring and diagnosis of combustion, from the used instrumentation signals. Flame sensors provide an enormous amount of information that is necessary to properly process for the extraction of a reduced data set, oriented to diagnosing the system operation state. Therefore, very different tools, including spectral analyses, multiple correlations between signals, artificial neural networks, etc. are being applied.

From a reliable diagnosis of the combustion state, a real process control can be undertaken acting on the adjustable parameters available in order to achieve specific goals. These objectives can be diverse: minimizing emissions of unburned or contaminants, flame instabilities correction, maximizing some objective function that combines several criteria, or simply maintaining a stable combustion by using alternative fuels with lower heating values (e.g. biomass derived fuels).

The intrinsic value gained by adopting this new DISIRE proposed combustion technology can be summarized by the following points: 1) best industry practices which can only be satisfied with new technology, 2) increased safety because fuel and air as well as many combustion process parameters are continuously controlled, 3) improved thermal efficiency as excess air is always optimized, 4) longer life of some devices, 5) lower greenhouse gases emissions through a more efficient use of fuels, and 6) economic savings due to the reduction of the fuel needed thanks to its efficient use.

[11] Lu G, Gilabert G, Yan Y. Vision based monitoring and characterization of combustion flames. Journal of Physics: Conference Series 2005;15:194–200

[12] Tuntrakoon A, Kuntanapreeda S. Image-based flame control of a premixed gas burner using fuzzy logics. In: Foundations of intelligent systems, vol. 2871/2003. Springer Berlin/Heidelberg; 2003. p. 673–7.

[13] http://ec.europa.eu/environment/air/quality/standards.htm

Table 3: Comparison of benefits from the utilization of the DISIRE technological platform in the combustion processes

Before Combustion Management	After Combustion Management
Higher costs as operators increase O2 flow to avoid a fuel rich atmosphere	Reduced O2 an lower operating costs as the fuel-air mixture is controlled
Unexpected demand for fuel, leading to unsafe combustion conditions	Fuel is limited to the available air to prevent unsafe fuel rich combustion
Greater risk during a process upset	CO and O2 concentrations are safely controlled at the optimum levels
Risk of inadequate air control may not be assessed correctly for process upset	Unburned fuel is detected readily, avoiding unsafe combustion
Wet steam introduced on start up, requiring a steam purge, risking ignition failure	Process upsets are handled with controlled combustion conditions
Shorter life of the finned convection section with afterburning due to presence of combustibles.	Enforced drain removal from purge steam prevents unsafe ignition attempt

1.4.4 Logistics and Transportation of raw materials

The flotation flow sheet used at KGHM Polska Miedz SA for copper ore processing and refining is very multifaceted due to the complex composition of the ore from the mine. The variable characteristic of the copper ore with presence of carbonaceous matter are generally considered hard to process; and require extremely fine grinding of the raw-material in order for the liberation of useful minerals to be utilized efficiently.

In order to stay competitive the mineral processing machines at KGHM are continuously modernized and introduction of novel measurement and monitoring technology that enables improved process control and monitoring are highly prioritized, for example optical inspection of froth properties. The main driving force for improving the process efficiency is that the copper content of the ore is continuously declining. The reason behind this fact is that the easy-to-reach ore has already been mined out leaving the lower grade ore to be processed. Process intensification can be accomplished by introducing a more detailed and more sophisticated monitoring of crucial points of the flow sheet together with a novel IPC strategy.

It is crucial to develop novel in-line measurement technology capable of monitoring supplementary but essential process parameters such as the copper content in order to optimize in the Cu-bearing minerals liberation process as well as characterization of the physicochemical environment of flotation in order to develop a new integrated process control strategy. The liberation process analysis can be accomplished by utilizing automated mineralogical analysis of the ore, while the physicochemical properties of flotation can be achieved by multivariate analysis of process parameters such as pH, redox potential, sulfide minerals potential, oxygen level, pulp density, dose of reagents (collector, frothers). In order to be successful it is necessary to carry out several steps of developments in parallel scientific fields as well as carry out multidisciplinary collaboration that will be provided by the partners in the DISRIE consortia.

The knowledge base about the complete integrated process needs to be increased starting with characterizing and tracing of the mined copper ore as well as optimization of the complex transportation system that is the backbone feeding raw materials to the concentrator plants.

1.4.4.2 Progress Beyond the State of the art in Logistics and Transportation of raw materials

The logistics chain of the finished pellets product can be exemplified through the transport of pellets between the pellets plant in Kiruna through the harbour of Narvik and to customers all over the world. The Kiruna-Narvik distribution chain includes three intermediate storage steps, a longer train transport and several shorter transports on conveyors between storages and the longer transports. Boat transports are then used before the product reaches the customer. The production process and distribution chain together contain a mixture of continuous and batch flows, and can therefore be categorized as a semi-continuous process. The inflow to the buffer silos at the product plant is continuous, while the remaining flows are batch flows. The batch volumes of pellets going into or out of the process sections are determined by the buffer levels and arrival or departures of trains and boats. Every such warehouse and every difference in separating the product into varying sizes makes good traceability harder to archive. Traceability in the distribution process is further complicated by the design of some process steps, where the flow induces differences in the residence time of the pellets.

Batches are per definition not part of a continuous process, but it is sometimes convenient to divide the product flow into discrete objects such as batches. Such a virtual batch may be defined by the product passing a point in the process within an interval. These virtual batches may then be used to discuss, model or measure how products or disturbances propagate, even for complex flows such as warehouses. RFID offers such solutions. The RFID system consists of a transponder (the marker that carries information, typically a serial number), a reader and a system for data retrieval. The reader consists of an antenna and communication electronics, and the read information is then stored in a server.

The logistics process is subjects not only to difficulties related to traceability. The stresses subjected to the pellets are the major cause for pellets breakage before shipping. Currently, it is impossible to measure the acceleration of a pellet subjected during handling, or the stresses or pressures it is subjected to during storage. Pellets, or e-pellets with both communication and sensor possibilities could aid in the design of the logistics chain, so that logistics operations were the pellets are subjected to large stresses are removed. e-pellets carrying pressure sensors or accelerometers, batteries, an internal memory and an RFID transponder could measure properties in situ within warehouses or during transport, and this information could then be accessed at locations where RFID readers can be installed and the e-pellets can be reached.

The underground transport system in the KGHM copper mines depends highly on interconnected and coupled belt conveyors. The transportation chain starts within the production area where the ore is carried out by LHDs (Load-Haul-Dump machine) that is delivering the ore either onto trucks or directly onto a screen. The screen is typically situated over a chute that feeds the belt conveyor via a vibrating feeder. The belt conveyor system consists of conveyors, switched feeding points and storage facilities which main purpose is to increase the flexibility of the whole transportation system and are fundamental for establishing a continuous flow of the material, see figure presenting a selected area of a single production area. The final destinations within the mine are the ore shaft silos before the material is skipped to the surface and reach the concentration plants.

The general objective of the DISIRE project is to develop a multi-criteria optimisation scheme for the belt conveyor transportation system with the goal to: a) eliminate idle running of conveyors through further utilisation of the ore silos, which currently consume large amounts of electricity that is generally generated in coal based power stations, b) improve the reliability and availability of belt conveyors transportation systems through novel condition based maintenance schemes based on data generated by embedded sensors and through data mining of the comprehensive operational and business support data available in various IT systems, and c) increase the belt conveyors efficiency due to modernisation of their key elements (belt, drive units, idlers).

In order to achieve these key-targets, several multidisciplinary activities are necessary. Laboratory and in-situ measurements of selected key parameters in support of enhancing the established methods for belt conveyor analysis efficiency beyond state of the art needs to be developed. A wider spectrum of operational parameters must be considered as well introducing tracing of the material flow in order to create the targeted advanced data mining procedures. Additional information can be realised by introducing embedded sensors into the flows of raw material, which will be complimentary to the already installed PAT systems (including on-line dedicated drive units and conveyor belt diagnostic systems). Integration of process information into the ERP systems is crucial in order to provide specialised data for the needs of optimisations of the whole transportation system from the mine to the concentrator plants.

Implementation of feed-forward control schemes for the preceding mineral processing plant is achieved by the embedded and distributed sensors, which carry information about the product. Through the DISIRE methodology the measurements can be considered highly valid and are associated only to the specific portion of material that is being processed. In order to characterize the necessary properties of the ore and in the long run implement the new holistic control strategies additional sensors and measuring devices will purchased and implemented along the process flow. The obtained data will be processed by especially designed and created “cloud” system for gathering and processing the on-line and off-line data. The surveys and measurement will be conducted periodically several times until the monitoring system is reliable. The most crucial contribution from the project is creation of a flotation model based on essential process parameters and data gathered in the cloud system. The model will be utilized for adjustment and refining based on industrial experimentation within industrially possible variation of flotation parameters. The design and creation of a monitoring system based on essential parameters of flotation will be performed for one of the KGHM concentrator. If successful in improving the selectivity of processes the industrial flotation model and sensors systems will be implemented in other KGHM concentrators.

1.4.5 Integrated PAT sensors and electronics

1.4.5.1 State of the art

While sensor networks have progressed significantly, nearly all applications demonstrated today use the wireless property as a means of replacing cables to facilitate ease of deployment, and typically monitor some parameter at a specific point in a process or monitors a specific piece of equipment. On the other hand, Radio Frequency Identification (RFID) technology, has found wide acceptance for product, equipment and livestock tracking, yet has rarely been combined with sensors industrial process monitoring and control applications. Current work related to mining and continuous processes is focusing on RFID transponders from the SmartTag product line from Metso used for tracking ore from blasting and through crushing operations[14] and investigations where RFID transponders were mixed with iron ore pellets to investigate the residence time of granular products in various stages of a transport chain[15].

A challenge highlighted by these and other works is the difficulty of detecting existing transponders when embedded among dense, wet, or partially ferromagnetic material. This problem is further exuberated by the small transponder, and thus antenna, size required to match the size of materials such as iron-ore pellets in order to minimize segregation of material and transponders. Work on improving the detection rate and reading range of RFID transponders have to date included work on improved antennas and on developing improved circuits that can better utilize available (predominately magnetic) fields used to power the transducer[16,17,18]. Considering temperature measurements, according to the state of the art, thermocouples seem to be the most common devices used for process control. But they have limitations, such as: to be in contact with the measured object, or a slow response time, or to be subjected to electrical and magnetic interference. Fibber optic infrared transmitters overcome these issues.

1.4.5.2 Beyond state of the art

While both sensor networks measuring properties in manufacturing processes, and RFID-transponders used for measurements have long been envisioned, little evidence exists of actual applications where these technologies meet. In this project we aim to build on previous work on robust powering and signalling for low-frequency RFID tags and develop electronics that enable using such systems not only for material tracking, but also for in-situ process measurements using sensors that follow the product through processing steps, thus enabling direct on-line control of processes where measurements are otherwise limited to quality control of the final product.

The utilization of optical fiber as a sensing element can bring advantages in process and plant monitoring as innovative PPMT (product measurement techniques) for improved process control and in-line measurements. Inherent advantages for measurements in industrial and/or harsh environments are: to be unaffected by electromagnetic or radio frequency interference; to be positioned in hard-to-reach or view places and be focused to measure small or precise locations; fibber cables can be run in existing conduit, cable trays or be strapped onto beams, pipes or conduit (easily installed for expansions or retrofits); and, certain high speed fibber optics based temperature detectors can handle temperatures ranges from 200°C to over 1500°C.

1.4.6 Data Mining and Analysis

1.4.6.1 Data Mining and Analysis State of the art

Data mining is the analysis of data for finding relationships and patterns. The patterns are an abstraction of the analyzed data, which reduces complexity and makes information available for the recipient. With the

---

[14] Wortley M, Nozawa E, Riihioja KJ, “Metso SmartTag - The Next Generation and Beyond” in the 35TH APCOM SYMPOSIUM / WOLLONGONG, NSW, 2011.

[15] Kvarnström B, Bergquist B, Vännmanab, “RFID to improve traceability in continuous granular flows: an experimental case study”, Quality Engineering, Volume 23, Issue 4: 343-357, 2011

[16] Nakamoto H, Yamazaki D, Yamamoto T, Kurata H, Yamada S, Mukaida K, NinomiyaT, Ohkawa T, Masui S, Gotoh K, “A passive UHF RF identification CMOS tag IC using ferroelectric RAM in 0.35-um technology”, IEEE J. Solid-State Circuits, vol. 42, 1: 101-110, 2011.

[17] Kotani K, Ito T., ”High efficiency CMOS rectifier circuits for UHF RFIDs using Vth cancellation techniques, in Proc. IEEE 8th ASIC, ASICON: 549-552, 2009.

[18] Rabén H, Borg J, Johansson J, ”A model for MOS diodes with vth-cancellation in RFID rectifiers, IEEE Transactions on Circuits and Systems. Part 2: Express Briefs. 59, 11: 761-765, 2012.

cross-industry changes in data volume and velocity, data mining tools and techniques have evolved rapidly to support big data repositories and real-time collection and preparation methods, mainly for business intelligence purposes. Statistical models are used to support decision making processes by establishing relations between parameters and variables and forecasting outcomes. Examples of widely used methods are analytical regressions, neural network analysis, decision trees etc.

1.4.6.2 Beyond State of the art in PAT Data Mining and Analysis

The aim of data mining in process control is to condense and combine sensory data from PAT measurements from on-line sensors, and laboratory measurements into real time statistically based low–dimensional data describing the process and product state. Data mining and analysis methods in IPC-DISIRE will be uniquely designed in order to handle the variety and veracity of the cross-sectional PAT data, together with its volume and the need for real-time analysis. Conditional and dynamic data models and algorithms will be developed for the data preparation module, whose versatility and flexibility will allow its implementation in cross-sector industries (e.g. minerals, steel etc.), which is a unique feature for the IPC-DISIRE project. The data mining WP also includes the design of innovative predictive analytics models and machine learning algorithms in order to handle the multivariate and the auto correlated nature of process, missing or erroneous data, varies frequencies and high quantities of data from batch or continuous measurements.

1.4.7 PAT-based Integrated Process Control

1.4.5.1 PAT-based modelling and control

The benefits of integrating timely measurements of critical quality and performance attributes of raw and in-process materials and processes from PAT technologies has been recognized as a way to improve final product quality industry for some time, for example in the pharmaceutical industries[19,20,21]. In particular the paper[2] intends PAT in the broad sense of analysis of chemical, physical, microbiological, mathematical, and risk conducted in an integrated manner, highlighting its benefits in both the research and development phase (offline modeling, simulation, and control systems design) and in actual production (online use of PAT data to improve product quality). In particular, the largest benefit of PAT is recognized by its implementation and integration in APC in large manufacturing processes, in particular in MPC schemes. As evidenced in[1], PAT data not only provide additional insight to better understand and model the process, but help detecting and managing critical control points in the process, so that deviations from a required profile are correctly managed and fed back into the high performance control zone, reducing the overall cycle time and quality assurance costs, and improving the overall effectiveness of equipment. This comes at the extra price of managing PAT data, a rather complex task due to the enormous flow of information the variety of data formats. For example, ABB's PAT data manager stores all the data in a single distributed database and can handle huge flows of both scalar and vector data coming from the analyzers, the PCS and SCADA systems.

The integration of data flowing from PAT systems requires quite flexible APC systems that can adjust smoothly and optimally to such new information available in real-time, in addition to the standard measurements used to close the control loops. MPC has such a flexibility, given its capabilities to be reconfigured in real-time whenever changes of (i) the underlying dynamical models, (ii) equipment (wear or faults), (iii) incurring measured disturbances, and (iv) economic/product quality/environmental performance indicators occur during operations. The automatic decisions taken by the MPC control systems are, in fact, not pre-coded a-priori in control laws and gains stored in lookup tables, but rather taken by solving an optimization problem in real-time, with the result that performance (product quality, energy efficiency, etc.) is continuously optimized under the current operating constraints[22,23,24]. In current practice, MPC schemes are

---

[19] T. Buijs, "Process Analytical Technology - Integrated PAT solutions for the Life Sciences industry", Special Report Automation Systems, ABB Review.

[20] M.A. Boudreau, G. McMillan, G. Wilson, "Maximizing PAT Benefits from Bioprocess Modeling and Control", Pharmaceutical Technology, Nov 1, 2006.

[21] G. McMillan, T. Benton, Y. Zhang, and M. Boudreau, "PAT Tools for Accelerated Process Development and Improvement", BioProcess International, March 2008.

[22] D. Mayne and J. Rawlings, "Model Predictive Control: Theory and Design". Madison,WI: Nob Hill Publishing, LCC, 2009

[23] A. Bemporad, "Model-based predictive control design: New trends and tools," in Proc. 45th IEEE Conf. on Decision and Control, San Diego, CA, 2006, pp. 6678–6683.

[24] A. Bemporad, M. Morari, and N. Ricker, "Model Predictive Control Toolbox for MATLAB – User's Guide". The Mathworks, Inc., 1998-2014, http://www.mathworks.com/access/helpdesk/help/toolbox/mpc/

arranged in a two-layer architecture, in which a static (usually nonlinear) optimizer is used for set-point generation, and an optimizer based on (usually linear) models that computes command signals to the actuators in order to track such set-points. Both the static maps and the MPC parameters are usually calibrated off-line (with significant and costly calibration efforts) and very seldom modified on-line.

1.4.5.2 Progress Beyond the State of the art in PAT-based modelling and control

The main goal of IPC-DESIRE is to investigate and validate how to integrate data provided by PAT within MPC schemes for improving process control performance. The concept is depicted in Figure 1 and hinges upon a real-time data-driven IPC module that, based on PAT and measures of various performance indices, adjusts the tuning of the MPC modules embedded in the underlying APC layer. This will be achieved by first developing an architecture, workflow and tools for modeling the physical process and to configure control parameters based on sensor measurements and PAT data, including the estimation of optimal static maps (required by on-line static set-point optimization) and the characterization of uncertainty (including communication imperfections in wireless sensing). The goal is to come up with a fast dynamic simulator and with a baseline tuning of the MPC layer that will be conceived to be amenable for online adaptation on the basis of PAT data. Then, online machine learning (ML) algorithms[25] will be employed for updating static input-output maps of the controlled process from steady-state data collected in real time, using online convex optimization algorithms[26] for numerical efficiency for embedding the algorithms in the DCS. This not only will adapt the maps to the measured operating conditions (therefore improving product quality) but also will alleviate the need to finely calibrate the maps off line. Moreover, algorithms will be devised that exploit PAT-data to optimally fine tune a selected set of MPC design knobs to maximize performance indicators, trading off robustness versus performance on the basis of the sensed changes of the operating environment. A set of testing procedures will be devised to quantify the benefits that the novel PAT-based MPC schemes can provide in improving the quality of products, energy efficiency, and costs with respect to existing control systems.

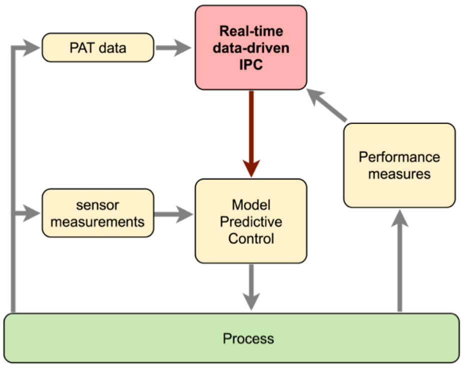


Figure 4: DISIRE PAT data-driven IPC concept

2. Impact

2.1 Expected impacts

2.1.1. European approach of project contribution to expected impacts

The market for industrial automation is an important sector for Europe and is a key-enabler in order to improve the efficiency, energy consumption, and competiveness for the European process industrial segment constituting of Cement, Ceramics, Chemicals, Minerals and Ore, Non-Ferrous Metals, Steel, and Water Sectors. Many European companies are world leaders in terms of systems and applications development, supply, and usage. One of the consortium partners ABB is the world leader in this area with a market share of 22 %, followed by Siemens and Schneider Electric. According to the EU Report on monitoring and control market[27], the major drivers for improved automation (monitoring and control) are energy efficiency, the cost of oil/gas, safety and security, the development of services and reliability. This study indicates that world monitoring and control market is claimed to be 187.9B Euro while the share for the automation of process industries is 26,3B Euro or 14.0 % of the market. Looking at the same figures for Europe we find the market share for process automation to be 10B Euro or 16.3% indicating **Europe's leadership** in this field. The annual growth rate for the European industrial process automation market is estimated at 6.9 % through

[25] S. Shalev-Schwartz, Y. Singer, "Theory & Applications of Online Learning", Int. Conf. Machine Learning, 2008, http://ttic.uchicago.edu/~shai/icml08tutorial/OLtutorial.pdf

[26] T. Suzuki, "Dual averaging and proximal gradient descent for online alternating direction multiplier method", Proc. 30th International Conference on Machine Learning (ICML-13), pp. 392-400, 2013.

[27] EU final report of the study SMART 2007/047 "Monitoring and Control. Today's market and it's evolution till 2020 and the impact of ICT on these".

2020, and the growth rate for manufacturing (including the manufacture of mining machinery) is estimated at 6.3 %. The study also notes that automation services predominate over automation hardware and software. This finding indicates that engineering tools and engineering efficiency will be of utmost importance for both end users and suppliers.

Based on these facts and figures, the European automation industry as a whole shall benefit substantially from the innovative monitoring and control solutions. Thus, **DISIRE technological platform is a truly European approach** rather than a national or a local. Furthermore, it is necessary to act on a European level to create a solution that is going to answer different professional requirements. National research projects alone cannot fulfill the needs of European professional training concepts that should be aimed at multi-linguistic documentation, intercultural communication and different educational structures. The united know-how of this transnational consortium of technology suppliers, industrial end-users, universities and research institutions from six European countries will establish improved capabilities for reliable real-time measurement of the properties and quality of process streams and final products for existing and more flexible process operation concepts towards customer's specific needs. This will result in improved process efficiency, more complex products meeting higher quality requirements, creating the foundations for a knowledge-based process operations capacity in the European automation industry. This strategic relation combines extensive industrial expertise of SMEs and end users with high competence on industrial-led developments by renowned innovative research institutions and universities.

According to the roadmap of SPIRE, the sectors united in SPIRE represent a major portion of the manufacturing base in Europe (EU27), including more than 450,000 individual enterprises. They hire over 6.8 million employees and generate more than 1,600 billion in turnover, representing 20 % of the total European manufacturing industry, both in terms of employment and turnover. However, the industry accounted for more than a quarter of the total European energy usage in 2010, with a significant portion of that use occurring within the process industry. Reducing raw material and fossil energy intensity is the primary objective of the SPIRE program and the **process industry's critical challenges in the automation field** have been identified by ProcessIT.EU and can be summarized as follows:

a. Improved process integration capabilities through IP and SOA architectures,
b. Complex systems optimization
c. Integrated control for increased process intensification and flexibility
d. Increased availability
e. Maintenance.

Several of these stated challenges are directly addressed by the DISIRE project. Improved process integration can only be realized with new IPC strategies and developing of sensor for characterizing the feedstock and capability of transfer this information between processes and sectors and is addressed in WP02, WP03, WP04, WP05, WP06 and WP07. Complex system optimization and integrated control is specifically addressed in WP02 and WP04. Increased availability is generated through optimization of complete value chains and by realizing that the process stages are interconnecting forming a system of systems. Several legal aspects such as proprietary of data are reduced by embedded the information into the flows.

While the US and Europe are experiencing growth problems, Asian economies in particular are rapidly expanding. This is creating new competitive conditions in the global marketplace. European companies and enterprises active in Europe must constantly reinvent themselves by applying greater knowledge, expertise, innovation, technology, and product development to remain at the forefront in terms of competitiveness. This need applies not only to major companies but also to small and medium-sized businesses to ensure that they can evolve into tomorrow's large-scale corporations. It is no exaggeration to claim that process industries have provided a foundation for the rapid rise in the standard of living. Expansion in the industry has delivered export revenues, jobs, new products and world-class research.

The industrial process automation domain is a global marketplace with potential for SMEs to grow by developing and commercializing innovations through corporate, university, college and institutional collaborations. To continue further development and strengthen the competitiveness, the DISIRE project will create and maintain the favorable conditions to ensure that the **process industry's challenges will be turned into opportunities**, considering that:

- The process industry and its suppliers are important for Europe and crucial for the Nordic countries, which make up more that 30% of the DISIRE consortium (LTU, LKAB, ABB AB, Electrotech AB, MEFOS) in terms of export value, employment, investment and sustainable competitiveness.

- Refining Europe's raw materials in an efficient and environmentally friendly way is a vital European and global concern, which will be addressed within the consortium through global players as ABB, KGHM, and Dow Chemicals.
- Globalization manifests ever-increasing demands on productivity, quality, yield, recovery and new products and enhancements. The productivity and quality improvements reached through the DISIRE technological platform can save up to 2 MM Euro per year (Dow Chemicals case study).
- Environmental standards and regulatory frameworks are setting new, challenging and important demands. The regulation and standardization issues will be monitored and addressed by the research organizations as Fraunhofer MOEZ performing innovation and risk management within the DISIRE consortium.

2.1.2. Enhancing impact through improving innovation capacity

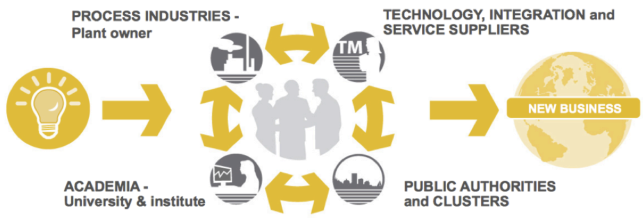


Figure 5:The cooperation of technology suppliers, end users, academia and public authorities for the basic value building model for DISIRE and has been inspired by the methodology developed by ProcessIT.EU

The strategic idea guiding the innovation principles for the DISIRE project is to generate economic growth in the automation technology segment by bringing together plant owners from the selected industry segments, component integrators focusing on specific automation technologies and automation components, and researchers from university and research organizations. The project is thus built on a quadruple helix model comprising end users (plant owners), technology suppliers (in automation technology), research groups, and public authorities. This model is captured in Figure 5. The project is innovation driven since it is oriented towards addressing real industrial challenges that has been presented by the participating industries with both horizontal as well as vertical activities (Figure 2). The goal is to perform demonstration of the developed technology in relevant industrial environments close to the industrial partners ensuring that the project generate new competitive automation technology. In summary, DISIRE is based on four different, mutually reinforcing **value propositions**:

1. Accelerate economic growth and technology development in Europe through increase of competitiveness in related key sectors of European industry
2. Strengthen the competitiveness of the process industries through innovations in automation technology.
3. Strengthen the automation technology suppliers through implementation of strong collaborative R&D activities innovating and developing globally competitive automation solutions.
4. Support the European automation research community to further develop world class research by giving them access to highly challenging industry contexts and involvement in this project.

The value proposition for each of the stakeholder group is illustrated in Figure 6.

Over the years, a constant flow of innovations have emerged and contributed to work opportunities and valuable export earnings from collaboration efforts between the process industry and the automation industry. This indicates that there is significant business potential in the activities addressed in the project for stakeholders throughout the value chain (i.e., end users, machine suppliers, system/ component suppliers and engineering companies), providing all with the absolute best position to exploit business opportunities.

Technology Suppliers

- Potential joint ventures with end users
- Commercial developments of the developed technology
- Knowledge support and assistance from research groups in developing innovative solutions
- In the long run, generating investments for new competitive products and services in the area of measurement technology, IPC and communication

End Users

- New competitive solutions
- Long-term implementation responcibility of the technollogy supliers
- Beyond state of the art knowledge
- Coordination of cross-sectorial automation with other end users and technology suppliers that strongly influence future technology will lead to increased efficency of the processes

Research Organisations

- Access to challenging industrial contexts through the participation of plant owners
- Partners interested in the innovation and commercialization of reserach findings (technology suppliers)
- Basic science and technology competence will strengthen the reserach focus and dissemination capabilities

Public Authorities

- Improved cross-sectorial collaboration along the value chain through
- Generation of new research trends and targets based on the beyond the state of the art project outcomes
- Aktualisation of the enviromental standards and regulatory frameworks due to new knowledge generated during the project duration

Figure 6:Value propositions of DISIRE project to the involved groups of stakeholders

The most crucial and urgent areas for research, development, and innovation have been identified by ProcessIT.EU and have been reported as Ideal Concepts (IC) for increasing the productivity and competitiveness for European process industries: In Figure 7, the estimated levels of impact from the research and development areas are illustrated and DISIRE project is addressing **Real-time Sensing & Networking in Challenging Environments**, IC4 **Process Industry as an Agile Part of the Energy System,** and **IC8 Automation System for Distributed Production.**and will therefore impact several technologies and value chains of high relevance for industry.

Figure 7:Value propositions of DISIRE project to the involved groups of stakeholders

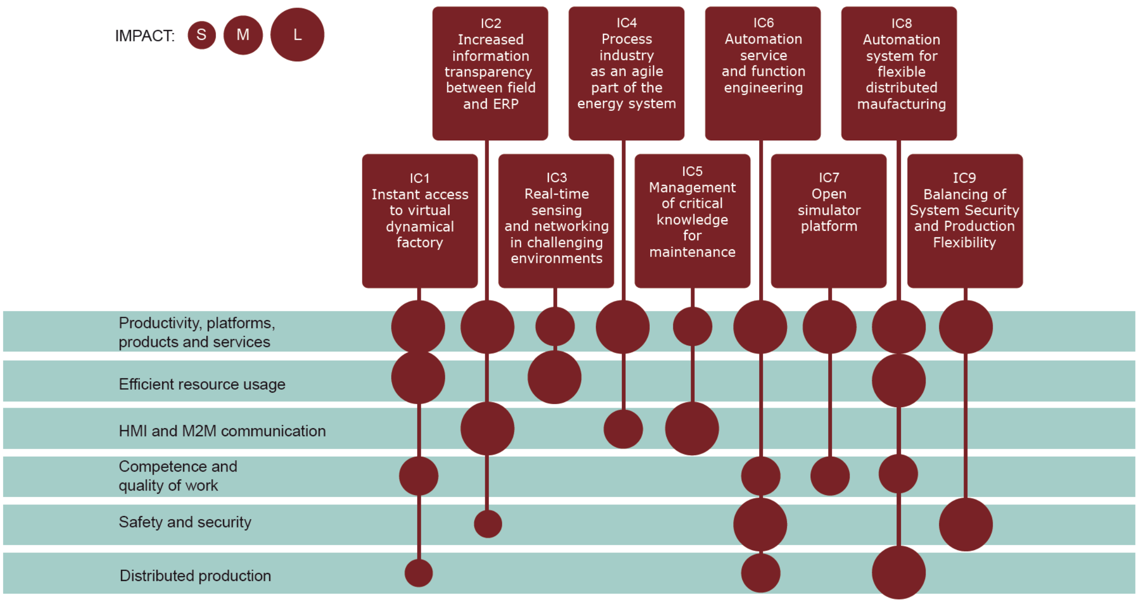


Figure 8:Estimated level of impact from the research and development areas in relation to DISIRE project.

2.1.3. Potential barriers and obstacles for achieving the expected impact

New generation automation solutions will erase the line between automation and information environments in different parts of the process industry supply chains. This process will be accelerated significantly with the Industrial Internet's emergence – especially as technical leaps such as big data, cloud-based services and the internet-of-things meet new ways of organizing people and machines and create new driving forces for research and industry.

This emerging industrial transformation is considered as the third industrial revolution, or the third wave of automation[28]. The automation industry thus faces the pressure on this conversion, which will require a significant increase in innovation ability, higher innovation speed and innovation quality in order to meet the need for changes in the industry. Different paths of changes might lead to adoption of new standards and regulations which should be properly addressed in order to ensure the achievement of the expected impacts.

The DISIRE consortium based on its extended expertise and diverse perspectives of technology suppliers, end users, academia and applied research will take a **dynamic approach towards risk management** (see Figure 8) to anticipate potential changes and barriers in the complex environment. For this purpose a scenario planning methodology will be developed based on economic and environmental outlook and constantly assess and adjust throughout the project duration as part of the task 9.5. in WP9. The process of developing and using scenarios is intended to help consortium partners learn and generate insights, both from exploring each scenario individually and from comparing and contrasting them.

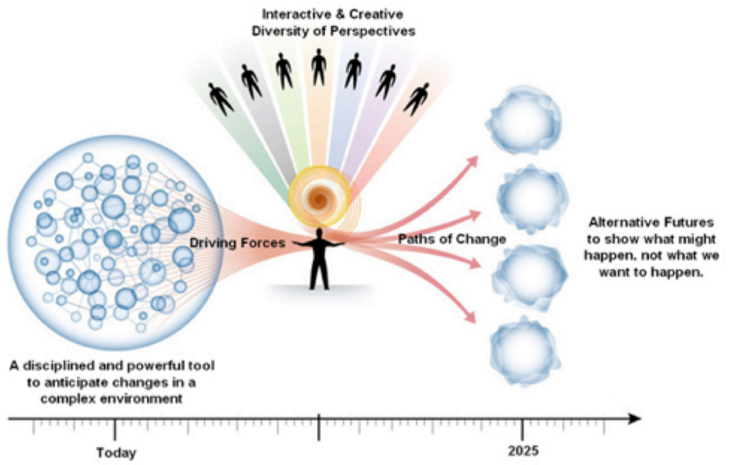


Figure 9:Dynamic approach for risk management within the DISIRE project.

In order to evaluate the new business that the project is representing the methodology developed by Alexander Osterwalder and Yves Pigneur for business model generation and evaluation will be used. This methodology, often referred to as the "Business Model Generation Canvas", has been used successfully in other EU projects such as Arrowhead and is used by many global companies, such as Apple and Ericsson. The basis is identification of value propositions to customer segment as well as identification of market channels, customer relationship, key resources, key activities and partners that are necessary to generate revenue streams and identify the associated costs.

2.1.4. Impacts from the establishment of DISIRE Technological Platform

2.1.4.1. Impact from new sensors

Reliable and accurate sensing and metering are vital components in achieving a better understanding and improving the operation of complex industrial processes. Improved measurements are also important for the continued development of tomorrow's control and maintenance systems. Future measurement systems must be available online and communicate valuable information at a rate sufficient for the application.

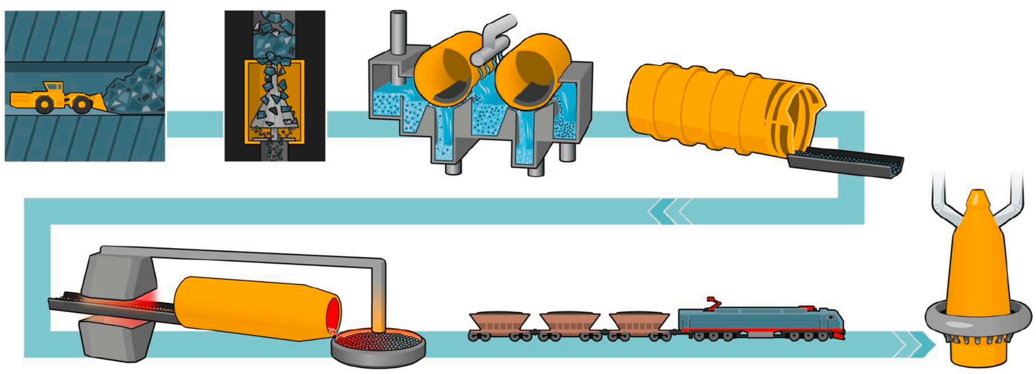


Figure 10 Measuring any parameter of interest, anywhere in an operating industrial process in real-time. Mining and steel manufacturing are examples of processes with high demands on sensor encapsulation and usage of disposable sensors

[28] Jeremy Rifkin, The Third Industrial Revolution: How Lateral Power is Transforming Energy, the Economy, and the World.

A common measurement challenge in industrial process plants is the harsh environment, which can include heat, dust (dirt), vibrations, dampness and corrosion. Depending on the severity of these conditions, solutions range from the heavy-duty (rugged) encapsulation of sensors to the use of proximity-based technologies such as optical or electromagnetic sensors. In the most extreme environments, it may be beneficial to utilize disposable sensors that are sacrificed during the measurement process, never to be recovered. Figure 10 exemplifies this concept for Mining and Steel that are industries with very high demands on heavy-duty encapsulation of sensors and usage of disposable sensors.
Other challenges with process measurement concern communication with the sensing devices. Cables are often expensive and installation costs are high, and in some applications wired solutions may not even be an option. While wireless technology can reduce the installation costs of cables and connectors, it also faces other challenges such as EMC disturbances
and material barriers that limit the throughput of radio-wave propagation. Equipping disposable sensors with wireless communication capabilities will enable new measurement possibilities and support improved process monitoring and control, as measurements from the process core will become available in real time.

Non-disposable wireless sensors will require a long-term energy supply to measure and report relevant information. Because heat, flow and mechanical movements are common in industrial processes, the technologies of energy harvesting and short-term energy storage are prerequisites for the successful deployment and utilization in industrial process monitoring and control systems. Envisioned technological challenges that DISIRE will overcome includes the following (depending on the environment):

- **Device durability**
  Extremely low-powered electronics for long-term deployment.
- **Harch environment**
  Robust/rugged encapsulation and design of electronics (including material parameters).
- **Energy availability**
  Autonomous energy management, using energy scavenging and storage.
- **Metallic barriers preventing RF-signals.**
  Wireless communication in challenging environments.
- **Tracking devices to follow the actual process flow**
  Proximity sensing technology and development of positioning of tools and devices.

Several identified trends in the process industry will directly or indirectly benefit from improved measurement capabilities and network technological advancement, while below are identified trends that the **developments from DISIRE regarding new sensors will have a strong impact on**:

Trend	*Impact of DISIRE*	*Case of Dow Chemicals*
Increased Availability and uptime	Emerging problems can be found at an earlier stage, and planned stops can be used to replace faulty components before they break down, and cause expensive unplanned stops.	Better reliability through a potential better process control of the steam networks will have an impact in reducing the probability of unplanned events (plant upsets) due to steam network disturbances. Economic impact can be evaluated on about 500,000 € every 2 years.
Required management to secure high quality	This can be enabled through the improved measurement technologies that will be developed.	Reducing quality variability by avoiding plant shutdown estimated at 600,000 every 2 years
Low capital-intensive technologies	The price of sensors should be low compared to the overall operating cost, but they should contribute a significant impact/savings.	- 0.01% expected reduction fuel consumption with valued at 500,000€ - 5% expected reduction in emission levels valued at 600,000 €
Improved management during abnormal mode **Shorter product life-cycles**	Early identification of deviations in the process or the products. Online re-configuration of process control, measurement and maintenance systems is directly benefitted by better measurement.	n/a
Rapid technology adaptations	To support the development of increasing numbers of sensors and	n/a

	devices, communication compatibility is a key issue.	
Agile production	With real-time access to more control parameters of the process, the introduction of new operating schemes will require less effort to alternate the production.	n/a
System integration through Zero configurations	Sensors should be designed for easy installation, require a minimum amount of configuration, and be compatible with surrounding equipment/systems.	n/a

Process measurements are often made today in offline batches, thus limiting the possibility for using the information in real-time control situations. In cases where online measurement technology exists, it is primarily founded on conventional static fieldbus technologies that require converters and mediators to make communication between different buses and communication networks possible. This makes the technology expensive and limits the potential of real-time online measurement systems.

A wireless system utilizing the principle of distributed and loosely coupled sensors will provide a more dynamic and flexible solution than current state-of-the-art systems. To achieve this, the development of inter- operable WSN solutions using cloud-computing approaches must continue. Keeping systems open yet secure implies the adoption and continued development of open standards and security mechanisms for low power wireless devices. To establish real-time measurements of parameters that are not accessible using current commercial technology, focused research and development on industrial-purpose sensor equipment is important, along with the adoption of low-cost technologies (originating primarily from the commercial market) and disposable tracking devices for industrial measurement applications.

The energy management of sensor and actuator systems is a key support technology for this concept to reach industrial acceptance and robust functionality. From a process industry owner's perspective, measuring in previously inaccessible locations will increase their knowledge of the process. This knowledge can be used to improve the calibration of the control systems and to improve the operation of the automation process, including the validation of process models and a virtual factory. Additionally, the newly gained information can support the maintenance system.

From a technology supplier's view, the global market for sensors reached $68,2 billion in 2012 and is expected to rise at a CAGR of 7.9% and reach 116.1 billion by 2019. Providing new sensing and energy harvesting and storage technology that can withstand extremely high temperatures and other demanding environmental properties will help European companies to keep their competitive edge and benefit from the potential of the sensor market. In summary, the approach of using online disposable devices as tracking devices will require cheap, small and robust technology that has been validated in the industrial environment.

2.1.4.2. Impact from IPC, data mining and online PAT

In early days of process automation, the goal was to distribute the feedback control and calculation to separate computing units and simultaneously centralize the monitoring and management into control rooms. That concept proved to be efficient because the efficiency of the manpower increased. Even though there are still challenges within local automation systems to solve. Competitive advantage is today often achieved by satisfying customer requirements in a more timely fashion. As a consequence of this development, industries are experiencing volatile demand, fierce competition, and innovation pressure. They have responded by shortening life-cycles and decreasing time-to-market, both of which require flexible production. Industries are moving away from bulk production towards tailored customer-specific products (batches).

To increase flexibility, the requirement for advanced automation, specialized personnel and shorter set-up times at each plant must increase. In other words, the importance of automation increases. Flexibility can also be obtained through economy-of-scale. If the company has several plants and each plant has a different product portfolio, the company is able to flexibly adapt its offerings. Traditionally, economy-of-scale has been understood as a means for decreasing the share of fixed costs, thus decreasing unit costs. In the future, economy-of-scale will also mean increased flexibility and interconnected value chains. Despite this new meaning of economy-of-scale, resources must still be acquired globally. The global simultaneous presence in several markets, the global acquisition of resources and sourcing of raw materials from global sources are all challenging management issues. A company must operate and (at least partially) be managed locally by considering local regulations and culture.

From an international company viewpoint, this implies distributed management. However, the company should still be centrally managed to obtain the benefits of economy-of-scale. While increased automation can provide more information about production, production costs and resources, flexibility can be increased through promoting economy-of-scale. In the future, new players such as venture capitalist (VC) firms can play a more important role in these industries. Automation can enable further development and greater flexibility can attract VCs into manufacturing industries.

Below are identified trends that the **developments from DISIRE regarding integrated process control will have a strong impact on**:

- **Produce to order and not to stock (e.g., Vendor Managed Inventory, VIM)**
  Mass customization and tailor-made products. Dynamic disturbance management in the production planning. Shorter product life-cycles. The trend towards customized tailor-made products limits the production of large stocks of products; more rapid and agile production is required.
- **Increased integration of production and business operations**
  Optimization through cross-layer integration. With improved ICT solutions, a more direct connection between production and business emerges, thus enabling cross-layer integration and production optimization between geographically distributed production facilities.
- **Increased availability and uptime**
  Integrated production and asset management. The importance of production availability and uptime increases with global competition. A reliable and fully integrated automation system will be of increasing importance.
- **Systems of Systems**
  The scope of automation is extended to enterprise systems, forming a System-of-Systems architecture. With cross-layer communication and the introduction of service-oriented architectures, an automation system can expand towards an enterprise-wide system with several subsystems.
- **Integrated value chains**
  Production becomes more geographically distributed, requiring advanced communication solutions. Production is becoming more distributed within large enterprises. Continuing in this direction requires interoperable and integrated ICT-solutions compatible with the Internet.
- **Logistics**
  Expansion in transportation sector provides efficient trading conditions. Efficient transportation is one of the keys for enabling distributed production and integration of value chains.

Increasingly volatile market demand combined with fierce competition requires flexible production facilities that can quickly adjust production volumes and adapt products according to these demands. Mass customization of products is moving from being at the frontier to fast becoming an imperative as each customer requires products with special characteristics. It is, in fact, the next logical step in the evolution of business competition. This can be seen clearly through the framework given in Figure 11. Flexible production lines and dynamic automation systems are key elements in meeting this demand.

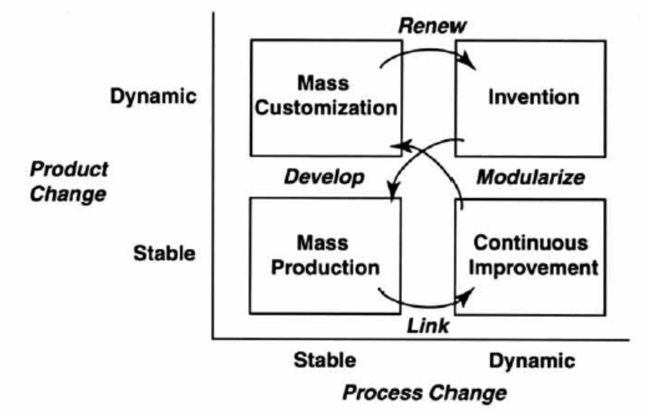


Figure 11: The evolution of business competition

In general, today's implementation of automation solutions relies heavily on the versions of automation systems that replaced manual solutions. New automation functions are primarily achieved by configuring the parameters of standard control structures. This approach has a clear lack of flexibility and was designed to provide automation implementations that, once generated, can and should remain unchanged over the life-cycle of the production process. To improve the flexibility of the production process, recent developments have focused on the integration of digital control loops with both production management systems and planning systems. These development principles are primarily adopted from the field of information sciences (especially from the software industry) and their application to mechatronic units. However, the currently available methods are not flexible enough to provide cost-effective automation solutions for rapidly changing value chains and market demand and development of new integrated process control strategies are crucial in order to go beyond state of the art.

Development of principles and methods to automatically generate the required specifications for distributed automation systems needs to be further industrialized together with methods for automatically generating cost-effective temporal solutions for the rapid replacement of production units and their respective roles that are not stable but dynamically evolve. Providing decision support tools at different organizational levels within an enterprise (and among a network of companies) will increase the flexibility and adaptation of production and create new business opportunities, both from a system supplier and process industry point of view. That is expected to attract new customers by achieving shorter delivery and higher production rates.

In order to achieve higher equipment utilization, new tools and automation systems will enable better production prediction opportunities that provide services in model-based simulations and prediction with multiple scenarios. The enabling tools for global service providers for remote operation, monitoring, managing, audit and approval can be achieved by providing common communication platforms for sales and production: sales can predict resource usage while production can provide timely delivery estimates.

2.1.4.2. Impact combustion

With increasing energy prices and competition from non-European countries, utilizing energy resources in an efficient way is already a crucial factor that will only become more important in the future. By efficiently integrating the energy-intensive process industry with urban energy systems such as district energy systems and electrical grids, large scale collaborative automation can be achieved with increased overall energy efficiency as the primary objective, see Figure 12. This will, however, require that the process and automation industry and the society at large invest in technology and infrastructure that can meet the requirements of tomorrow's energy systems and production facilities. Where possible, the production rates will need to adapt to existing pricing circumstances (e.g., electricity, heat, fuel and raw materials). To adapt production rates such that it matches and fulfill the energy requirements of the society in large, simultaneously as producing the orders in time, will require improved flexibility and adjusted production rates, either in time or in space (several production plants). In some cases, this may imply process overproduction capacity, leading to increased investment costs. Depending on future energy and raw materials markets, it may be beneficial for industries to endure overcapacity during time periods when pricing makes it unprofitable to produce and to compensate with increased production rates during periods when the circumstances are more advantageous.

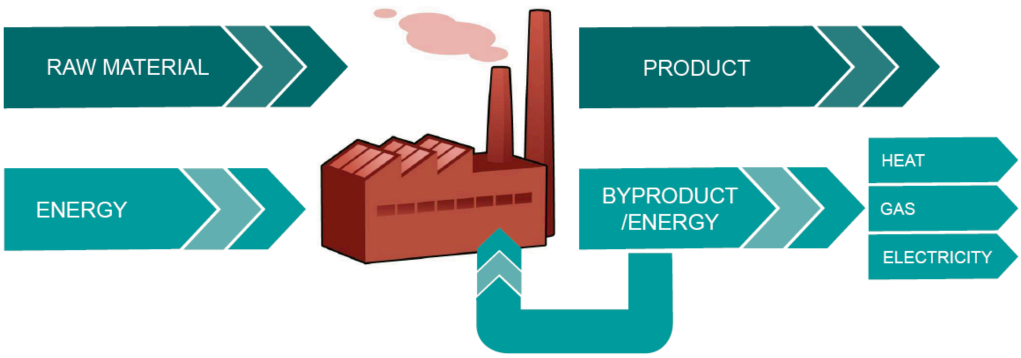


Figure 12: Energy and raw materials are the fundamental resources for producing the main product. Within the production process, excess heat and gas are often considered waste. Improved energy recovery and a better infrastructure for by-product energy usage, primarily gas and district energy systems can significantly improve resource utilization

One step towards higher energy utilization can be through a closer connection with other energy systems. To comply with national and international agreements on sustainability and the environment, process industries must continue to reduce their environmental impact and improve the overall energy usage. The clear distinction between energy providers and users will fade in favor of more integrated energy systems that require improved industrial combustions systems. Dynamic disturbance management in production planning must also be taken into consideration when excess heat is sold for district heating usage. Thousands of homes, offices and industries can rely on this heat for space and tap water heating. This introduces an additional parameter to disturbance management and increases the requirements on disturbance handling and production planning. The scope of the automation therefore extended outside of the enterprise systems into a System-of-Systems architecture. With more system-wide automation, energy supply and usage will be integrated in the large-scale automation and optimization of process plants with increased complex regulations (environment and worker safety) and most likely a more restrictive environmental legislation in order to fulfill the European goals which promote higher resource utilization and improved energy efficiency.

Process industries can contribute with a significant amount to achieve these goals by utilizing a more efficient industrial combustion process that are used for a large variety of heating purposes.

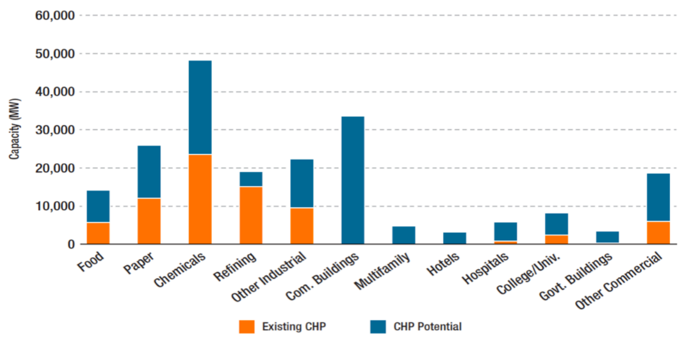


Figure 13: Technical Potential for Additional CHP at Existing Industrial and Commercial Facilities[1]

Large-scale process industries in the Nordic countries are often connected to district heating systems where excess heat can be sold as merchandise, thus creating a win-win solution for industry, energy distributors, customers, the environment and society. To increase the amount of "re-usage" of excess heat generated by industry in countries where district energy systems are not well-established, new infrastructure and distribution systems are required, and these industries may need to reconsider the production schedule to meet the energy needs of the customers. To meet these requirements, a higher level of production flexibility is required from energy users and providers. Industrial control and planning systems for industrial combustion must be adapted to meet short- and long-term variations in energy, fuel and raw material pricing while maintaining "societal" needs such as stable electricity, gas and heat delivery. We foresee that the integration of control, business, ERP, cap and trade and maintenance systems will be vital for reaching these goals, thus requiring more cross-domain communication between embedded systems with different application areas. To maximize the overall utilization of energy and raw materials, an integration of control systems from various sectors is needed. Industries must also be more agile and responsive to energy and raw material price variations. This will require new and improved automation and support systems to maximize overall plant efficiency and integrate it into the larger context of societal functions.

Data about the processes are required to perform correct simulation and consists of the system geometry, materials and boundary conditions. In this cases that incorporates multiphasic reacting flow additional information such as gas composition, inlet flows characteristics (temperature, mass flow rate, turbulence level, density, swirl, air-fuel ratio etc.) are also required together with the thermal properties of the furnace materials, refractory linings and cooling systems. Numerical models will be applied to a comprehensive simulation encompassing the relevant physical phenomena present in the system. Turbulence, heat transfer (diffusion and radiation), multiphase flow and non-premixed combustion models deeds to be defined.

2.2 Measures to maximise impact

2.2.1 Dissemination of project results

The European Commission has stated recently that dissemination of scientific research results should be one of the defining principles for Europe's research landscape. Therefore**, a special effort will be made during this project to disseminate as much as possible the knowledge obtained in DISIRE**.

The DISIRE consortium has identified four groups of target audiences that would potentially benefit from the knowledge acquired during the project:

- **Standard bodies and organisms** that are in charge the definition of standards in the technologies developed within DISIRE.
- **Technical and Scientific Audience**: participants in related EU projects, interested in the technologies and the applications of in-situ measurements, PAT analysis and IPC within the specific industrial sectors of DISIRE or in other related cross-sectorial processes.
- **Target Customers:** Similar industries and SMEs to the DISIRE objectives and main application areas.
- **General public** interested in advanced Process Control technologies.

Due to the interdisciplinary make-up of the project team, the consortium considers both internal and external dissemination as vital. The Management Support Team will ensure that the dissemination activities are carried out with the same level of commitment as technical work. These activities will be monitored by the

Project Coordinator and will receive regular input from the consortia. A major objective of DISIRE is to facilitate Europe-wide benefits from the project outputs and results. The dissemination plan outlined in WP 9 will ensure that the demonstration and RTD outputs as well as the deliverables will be made available to the European process industry as a whole. In order to reach out to the European automation and process industry, a comprehensive dissemination methodology with wide spectrum of measures has been planned.

The **dissemination methodology of DISIRE** will be based on the following issues:

- It will use varied dissemination methods, such as written information, electronic media, and person-to-person contact
- It will include effective quality control mechanisms to assure that information to be disseminated is accurate, relevant and representative
- The dissemination will be based on the continuous collaboration among project partners
- The information will be disseminated in the form and language preferred by the user

Moreover, DISIRE will aim to extend the dissemination results by talks, presentations, and participation in international conferences and journals, activities that are considered as essential. Whenever during the life-time of the project the possibility of publication arises, the partner/s involved will promptly inform the coordinator who will consult all the other partners about the potential publication of DISIRE results and the existence of any objection to this activity. This procedure is foreseen in order to make sure that if IPR issues are involved, partners are informed in good time and can act to protect their knowledge. Practically all intermediate results of the programme can qualify for scientific publications, most of them even as fundamental science. However since the consortium will push for outcomes in terms of patenting, before publishing the results of the project, the Consortium will verify the opportunity of patenting. After clarification of possible patent issues, the consortium will aim at a timely publication of the results.

The following scientific disciplines will be targeted: industrial control, swarm of sensors, machine learning, wireless sensor networks, statistical learning, integrated IPC, model predictive control, spatial modelling and signal analysis, and process optimization. More analytically, during the dissemination activities of the DISIRE project, the following tasks will be targeted;

- A description of the products/services likely to result from DISIRE.
- The target users for these products/services.
- The initial approach envisaged for exploitation.
- The dissemination actions foreseen and a description of how these actions will contribute to the preparation of the exploitation.

2.2.2 Exploitation of project results

By promoting collaboration between the end users in the process industry, technology suppliers (SMEs) and the research organizations the project generates value for all participating partners (see section 2.1.2). Thus, by stimulating knowledge exchange and transfer between the stakeholders with problems (process industry) and stakeholders with solutions (SMEs and research organizations) a powerful innovation engine for creating and demonstrating new processes and solutions in the area of monitoring and process control can be started.

The Technology Exploitation Strategy (TES) will be developed within the WP9 while assigning different roles for exploiting the results from the DISIRE project to each group of the stakeholders:

- The representatives of the process industry (LKAB, KGHM, ABB, Dow Chemicals, Steel) will benefit from the measures for adequate analysis and utilisation of the technological potential achieved through the exploitation of the DISIRE project outcomes. Thus, they will get their resource and energy efficiency problems addressed and solved.
- New business opportunities and competitive advantages will be created for the participating SMEs (MEFOS, Gstat, Electrotech AB) by means of further development of competencies, increase in added value and cost reduction.
- New knowledge and broader visibility will be generated for the universities LTU, Wrozlaw University of Technology and research organisations as Fraunhofer.

The planed dissemination and communication activities will also generate access to new markets, new channels, and new business applications for monitoring and process control technologies explored in the project. Furthermore, the commercialization and product development platform including multiple training activities and consulting panel will be specifically designed to guide and support managers and researchers within the consortium throughout duration of the project and beyond.

The project activities and results will continuously be evaluated from a business perspective using the “business models generation canvas”. This is a methodology that has been specifically designed in order to identify new business opportunities and associated business models. The underlying principle is that business models must evolve and be iterated since it is very hard to make a “correct guess” about the future market potential when working with innovations. This methodology will also be adopted by DISIRE since it is well known and many innovative companies relay on it in order to stay competitive. The mutual **benefit from collaboration and innovation impact** is visualized in Figure 13.

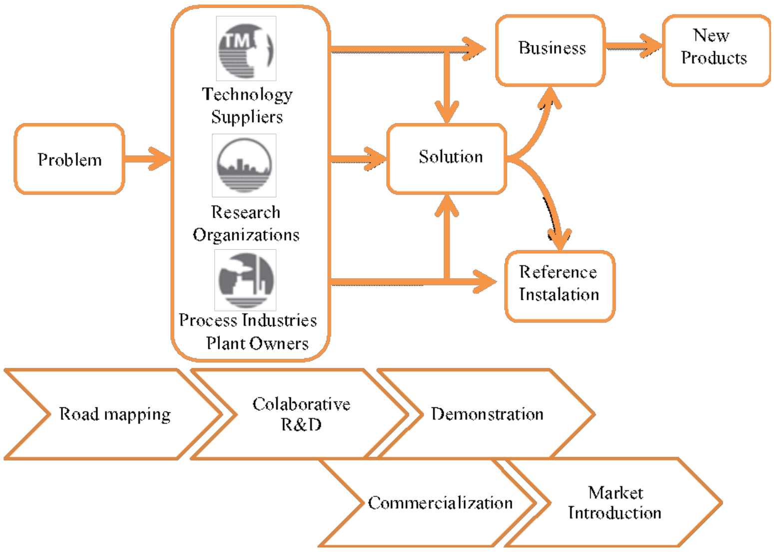


Figure 14: Technology Exploitation Strategy

The TES will be synchronized with the Business Plan and aims to provide recommendations to give the DISIRE technological platform a strategic advantage and improve its market entry potential. The intended structure of the business plan is outlined in the table below:

<table>
<tr>
<td>1. Executive Summary
1.1. Consortium Overview
1.2. Market Opportunity / Objectives
1.3. Relation to work programme
1.4. Capital Requirements, Breakdown of Uses of Funds
1.5. Vision and Mission Statements
1.6. Management board (Profiles of participants)
1.7. Financial Projections (for the next 3 years)</td>
<td rowspan="2">2. Organisational Plan
2.1. Summary Description of the Consortium
2.1.1. Mission (short- and long-term goals)
2.1.2. Business model (description with focus on unique characteristic)
2.1.3. Strategy (overview with focus on short- and long-term objectives)
2.1.4. SWOT Analysis
2.2. Products & Services
2.2.1. R&D process description
2.2.2. Product/services description
2.2.3. Manufacturing process description
2.3. Administrative Plan
2.3.1. IPR Management
o Copyrights, trademarks, patents
2.3.2. Location
o Available facilities
o Costs associated with the available facilities
o Supporting documents
2.3.3. Legal Structure
o Description of legal structure and its advantages
2.3.4. Management Structure
o Corporate officers
o Responsibilities of the consortium management body
2.3.5. Personnel</td>
</tr>
<tr>
<td>3. Marketing Plan
3.1. Market Analysis
3.1.1. Target Market
3.1.2. Competition
3.1.3. Market Trends
3.1.4. Market Research
3.2. Marketing Strategy
3.2.1. General Description
3.2.2. Methods of Sales and Distribution
3.2.3. Pricing
3.2.4. Branding
3.2.5. Database Marketing (personalization)
3.2.6. Sales Strategies
3.2.7. Promotion
3.2.8. Advertising strategies
3.2.9. Public relation
3.2.10. Networking
3.3. Implementation of Marketing Strategy</td>
</tr>
</table>

4. Financial Plan **4.1. Summary of Financial Needs** **4.2. Fund Dispersal Statement** **4.3. Cash Flow Statement** **4.4. Three – Year Budget Projection** **4.5. Projected Balance Sheet** **4.6. Financial Statement Analysis** 4.6.1. Liquidity Analysis 4.6.2. Profitability Analysis **4.6.3.** Measures of Investment	o Number of dedicated personnel per consortium partner o Qualifications of required personnel o Breakdown analysis of man days with corresponding rates as per consortium partner o Future needs for adding employees 2.3.6. Accounting & Legal 2.3.7. Insurance

2.2.3 Management of knowledge and intellectual property

The knowledge management approach of DISIRE will ensure that the project findings will be protected and covered in a separate Consortium Agreement (CA). For this purpose, the Intellectual Property Office (IPO) will be established within the Management Support Team. The main task of the IPR manager will be the development of constant update of the Consortium Agreement as well as a legal consulting of the consortium partners on any issues related to the protection of their know-how. More specifically, the IPO will deal in detail with various legal issues such as:

- access to background knowledge
- joint ownership and use of foreground knowledge
- the transfer of foreground knowledge
- detailed rules for dissemination-related activities and measures
- various access rights.

2.2.4 Communication activities

Communication activities include both internal and external communication channels to promote the project and its results to the public, the scientific community, the European industry and potential business users. The overall objective is to ensure that value is created within the targeted audiences (listed below) and that EC funding leads to further advancements in society and industry. Hence keeping the European process industry at the leading edge within the global marketplace is an essential goal. In summary, the communication plan for the project will be constituted of the following activities:

- Internal communication (bottom-up and top-down) within the consortium
- External communication towards the scientific community
- Communication towards the European society
- Technical dissemination toward the SPIRE community
- Other dissemination activities which aim to provide background education and awareness to society

The Project Coordinator and the Management Support Team will be responsible for coordination and implementation of the communication plan described in detail within the WP9.

3. Implementation

3.1 Work plan — Work packages, deliverables and milestones

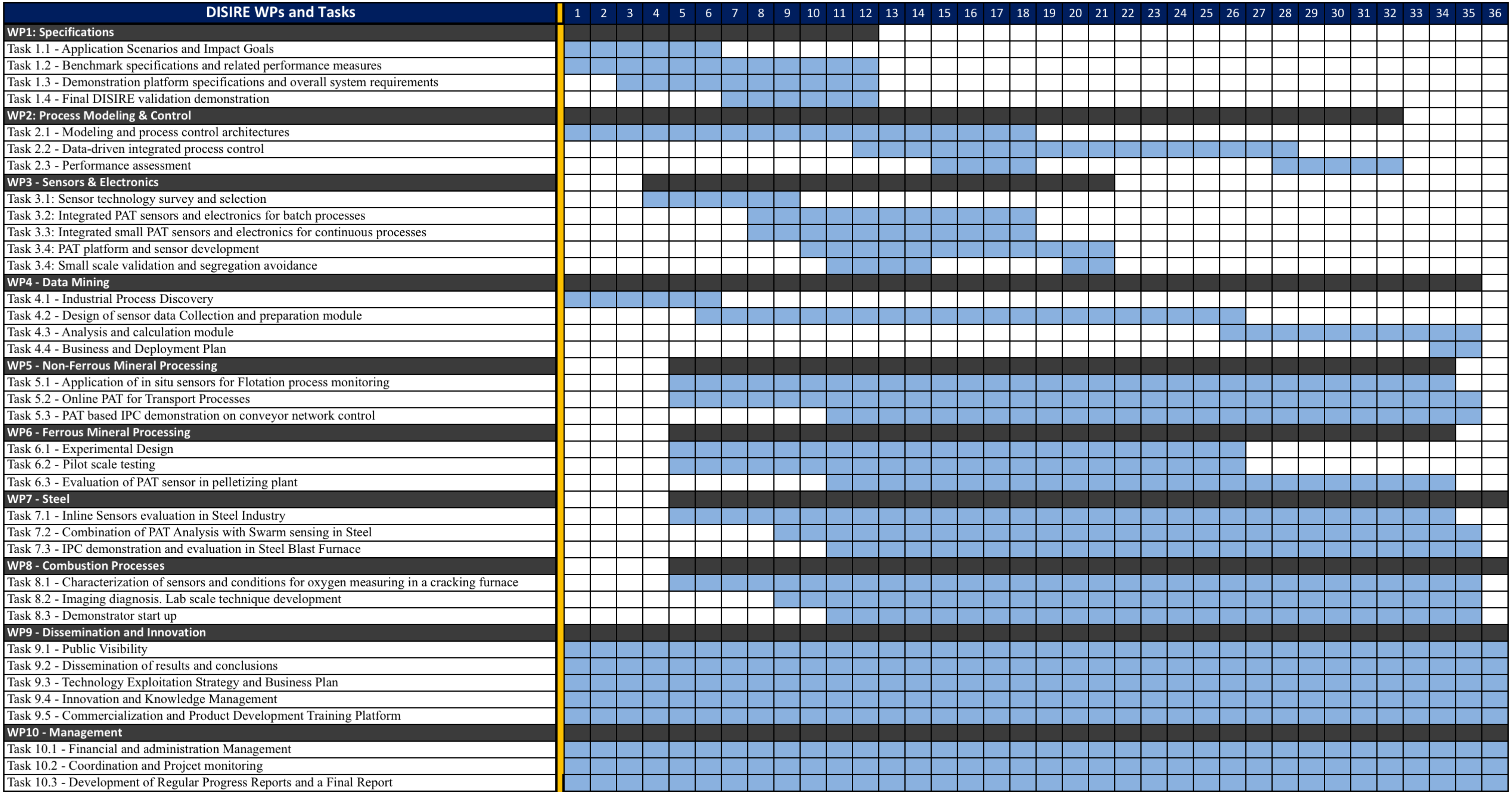
3.1.1 Overall Strategy

The overall work plan is divided into 10 Work Packages (WPs); 1 is dedicated to the project management related necessities (WP10), 4 to direct research and development activities (WP1-WP4) in the area of industrial process control, electronics and sensor development and data mining, 3 to research and demonstration activities with respect to real industrial applications and process (WP5-WP8) that cover the ferrous and non-ferrous mineral processing, the steel and the combustion industries, while 1 is dedicated to dissemination and innovation purposes (WP9). For each WP and for each WP task, one consortium partner is assigned as a leader. The relation between a WP and a Task leader is a hierarchical one. The leader role signifies the final responsibility for the successful execution of the required tasks, achieving the milestones, while abiding by the global time-schedule and the timely provision of the respective results, in terms of project reports and WP deliverables. The milestones set within the timeline of the WPs mark the completion of the critical project progress phases and as such represent clear progress control points.

From all the research and development WPs, WP1 serves a central and highly significant role, namely to establish the common ground upon which the sum of the project's requirements, application scenarios and measurable benchmarks will influence the whole activities of the project. This will be achieved via the full-scale inter-partner involvement, such that the end result is the product of the mutual exchange of application and research-critical information and the achieved consensus reflects a clear picture of all necessary project related specifications and expected impact in their detail. The core research packages consist of WP2-WP4, which are focused on the development of DISIRE's key technological contributions that are expected to dramatically influence the current operations of the involved industrial processes and in full accordance to the common specification basis being set in WP1. The related research activities in these WPs will be performed in a self-contained approach, each fulfilling their own unique research directives and requirements. The work is being properly organized so that each of these WPs contain relatively independent scientific and technological advances and subsystems, which following the proper integration and industrialization activities will allow for the realization and assessment of the final DISIRE technological platform to four key industrial sectors within WP5-8. An important feature of these WPs is the proper incorporation of specifications being set by WP1 in order to enable the reduction of the future integration effort, mainly concerning the technological transformation of these subsystems to the real life industrial processes.

The concept and the overall impact of the proposed DISIRE technological platform will be delivered from the integration of the aforementioned subsystem primitives in the different industrial sectors being addressed specifically from WP5-8, which also contain inter partner collaboration and contribution. The whole developments in WP 2-4 will be directly influenced by WP1 and WP5-8. The challenging goal of multiple full system integration will be addressed by the DISIRE's technology provider partners that will focus on transferring the pure research results in real life industrial processes. Special "Integration weeks" will be organized along the timeline of the project to keep track and aid the proper execution of this goal. During the integration weeks, the produced DISIRE subsystems in the form of hardware, software or systems will undergo a partial integration procedure, where the respective WP leaders from WP2-WP4 and WP5-WP8 will be able to identify and resolve issues that arise in actual industrial scenarios and also profit from the provided cooperation opportunity. Each integration week will be performed to help in the industrial facilities of related preselected partner. This choice will be determined by the final demonstration objectives and measurable key impacts from WP1. The overall management and oversight functions of DISIRE are contained within WP10, with a single leader assigned to it and its respective tasks. The setup of governance bodies and the functions of internal project communication, quality assurance, and economic management are responsibilities which are also located in the context of this WP.

3.1.2 Project Planning - GANTT Chart



3.1.3 Detailed Work Description

Table 3.1a: Work package description

Work package number	**1**		**Start date or starting event:**			**M1-M12**	
Work package title	***Application Scenarios, Impact Goals and Benchmarks***						
Participant number	**1**	2	3	4	5	6	7	8
Participant short name	**LTU**	LKAB	KGHM	ODYS	WUT	IMTL	CUP	ETEC
PMs per Partner	**9**	3	3		4	4	4	3
Participant number	9	10	11	12	13	14	15	
Participant short name	CIRC	DCI	ABB	DAPP	MOEZ	GST	MEFOS	
PMs per Partner	4	2	2	2		2	2.5	

Objectives

The activities within this WP aim in specifying the application scenarios the measurable impact goals and the benchmarks for demonstrating and evaluating the DISIRE concept. Of crucial importance in this process will be the demonstration of the abstraction, scalability and adaptability of the core scientific platforms of DISIRE in the area of inline measurements, PAT analysis and PAT based IPC in the adopted DISIRE processes but also in other related cross-sectorial processes and of course the direct and measurable impact of the proposed technology regarding the general reduction in resources and energy consumption. Based on the application specifications determined within this WP, the necessary industrial process requirements and the related features will be established, with respect to what type of inline measurements are needed, how PAT can be performed and link to an overall IPC reconfiguration and optimization. In this context, the industrial partners will act as the end users and will establish a set of required specifications to be covered by the DISIRE project. The required R&D tasks will be analysed and divided so as to reflect the primitive functionality necessities described by the aforementioned specifications, in terms of processes, sensors, analysis and integrated control. The envisioned benchmarks will be capturing real word industrial processes and will be characterized by scalability and exhibit the capacity for objective performance assessment. The benchmarks will be essentially elaborated in order to reflect a natural evaluation and extended applicability of the DISIRE project with respect to the SPIRE objectives and the cross-sectorial application in other related process industries.

Description of work

Task 1.1 – Application Scenarios and Impact Goals (LTU & all partners except MOEZ**)**

This task will analyse end-user reports and inputs provided from DISIREs' members that describe current methods of existing inline measurements, PAT analysis and IPC concepts independently of the utilized process. The goal is to investigate the best representative and demanding industrial processes and impact that the DISIRE project should target in a short as well as middle-long term. Furthermore, it determines required/expected capabilities of the DISIRE technology as requested by the industrial end-users. Existing methods in the form of state of the art and further expected DISIRE capabilities and characteristics will be further investigated in relation with the applicability of the examined scenarios and the overall TRL demonstration levels that could be achieved. For information gathering a technical questionnaire will be compiled and will be sent to all the partners. Fusion of technical details and end-user requirements and suggestions will result in the detailed specifications.

In this task, the involvement of all DISIRE partners will be crucial. The application industrial demonstration scenarios to be elaborated will have to comply with the specifications of the individual processes. The envisaged operations will undergo a feasibility study by the DISIRE partners that will be responsible for their implementation. Therefore a sketch of modular elementary sensing capabilities, sensor miniaturization, endurance in harsh environments, communication limitations, computational complexity, computational timing, realization efficiency, integration and estimated impact will be investigated. The resulting functional primitives will then be elaborated further in a task below when the benchmark-driven requirements have been identified in detail.

Task 1.2 – Benchmark specifications and related performance measures (LTU & all partners except MOEZ**)**

Using the inputs of the previous task, the requirements, the behaviour and the objectives of the DISIRE project will be further detailed. A progressive strategy will be followed in order to evaluate the capabilities of each of the DISIRE subcomponents, ending with the final benchmark of the project as the most complete and most integrated benchmark.

- *Specification of advanced inline sensing:* This benchmark will specify metrics on the sensing capabilities developed within the DISIRE project. The sensing capabilities should be industrial demonstration specific and will cover target specifically the four industrial sectors in the project. The benchmarking will be general including measuring extended properties of the sensors regarding e.g. the surrounding environment, processing and communicating capabilities, miniaturization, efficiency, accuracy, etc.
- *Specification on PAT analysis:* This benchmark will specify metrics regarding the ability to analyse big amount of data in near to real time timing constraints, while at the same time providing meaningful and useful integrated information that can be utilized by the IPC framework for optimizing the overall process.
- *Specification on PAT based IPC:* This benchmark will focus on evaluating the proposed reconfigurable and adaptable to PAT proposed IPC. Specific starting test cases will be drawn from the area of machine learning but the focus will be clearly in benchmarking the efficiency of the proposed IPC with respect to the adopted industrial processes.
- *Process Specific Demonstration specification:* These benchmarks will produce clear measurable indices for evaluating the impact of the overall DISIRE project into the focused four industrial sectors of ferrous, non-ferrous, combustion and material flow. Specific attention will be also provided: a) in extended experimental demonstration of the overall concept in TRL levels at least 3-5 and b) in order to evaluate the direct impact of the DISIRE platform to the overall SPIRE objectives regarding the sustainable process industry and the direct measurement of the achievable reduction in resources and energy.

Task 1.3 – Demonstration platforms specifications and overall system requirements (LTU & all partners except MOEZ**)**

The detailed specifications for the further integration of the DISIRE components generated form WP2-4 into the adopted industrial processes and their full operability will be further specified in this task. The specification documents will be process specific and the effort will be to further extend the functionalities and the implementation limitations of the pure scientific initial results in the project in the industrial demonstrations of the subcomponents in TRL levels 3-5. All partners will be strongly involved with the definitions of their concern, while the DISIRE mixture of consortium with RTD, SMEs as technology providers and industrial end users will ensure the smooth and in detail specifications for the application of the produced technology in the different industrial processes.

Task 1.4 – Final DISIRE validation demonstration (LTU & all partners except MOEZ**)**

In this Task the specification of operational requirements for the final and integrated DISIRE demonstration benchmark will be established. Being the final benchmark, emphasis will be given to set up a realistic scenario that combines all the developed “primitives” validated in the previous benchmarks, while at the same time will present the overall DISIRE concept in a large extend and most probably in a TRL level 6.

Role of Partners:

All the partners except from MOEZ will contribute in this WP in order to develop a detailed technical implementation plan based on their area of expertise and their current business. LTU will lead all the involved tasks in this WP. Although MOEZ will not be involved in this WP, their work in WP9 that will run in parallel will be also considered regarding the expected innovation actions.

Deliverables	
D1.1: Benchmark specifications and related performance measures for expected Impact (LTU)	M6
D1.2: Application scenarios and demonstration activities specifications (LTU)	M12
D1.3: Report on end-user requirements, and regulations (LTU)	M12

Work package number	**2**			**Start date or starting event:**			**M1-M32**	
Work package title	***Process Modelling and Control***							
Participant number	1	2	3	4	5	**6**	7	8
Participant short name	LTU	LKAB	KGHM	ODYS	WUT	**IMTL**	CUP	ETEC
PMs per Partner	16			3	17	**36**	3	
Participant number	9	10	11	12	13	14	15	
Participant short name	CIRC	DCI	ABB	DAPP	MOEZ	GST	MEFOS	
PMs per Partner	3		10	3			3	

Objectives

The goal of this work package is to develop and validate new concepts and tools for innovative Model Predictive Control (MPC) solutions that integrate and exploit the data obtained from Process Analytical Technologies (PAT) in the Advanced Process Control (APC) system, in order to improve process control performance (product quality, energy efficiency, etc.)

Description of work

Task 2.1 Modeling and process control architectures (**IMTL**, WUT, LTU, ABB, ODYS, CUP, CIRCE, DAPP, MEFOS)

Definition of modeling architecture, workflow and tools: physical modeling and data-driven tuning of model parameters; development of a dynamic simulator as a fast-running surrogate of the real process; data-driven system identification of linear and piecewise linear control-oriented models; data-driven "batch" estimation of optimal static maps; characterization of modeling uncertainty, including communication imperfections due to wireless sensing. Definition of performance indicators, including those related to product quality and energy efficiency. Design of MPC schemes based on (switched) linear models, hybrid dynamical models, stochastic models, and of on-line estimation and data fusion algorithms. Definition of data available on-line from PAT and their relation to models and performance indicators.

Measure of success: Definition of a smooth and consistent modeling and control design workflow that is amenable for data-driven adaptation of MPC from PAT. Effectiveness and generality of the workflow in addressing the industrial case studies defined in Task 1.2.

Task 2.2 Data-driven integrated process control (**IMTL**, WUT, LTU, ABB, ODYS, CUP, CIRCE, DAPP, MEFOS)

Formulation of online machine learning (ML) problems for updating static input-output maps of the controlled process from collected steady-state data, for optimal generation of input set-points. Development of numerically efficient online convex programming algorithms for solving the ML problems. Development of gradient-based optimization algorithms for fine-tuning a selected set of MPC design knobs in real-time from PAT data, such as the data provided by the sensing technologies investigated in WP3 possibly pre-processed with the data-mining techniques of WP4, so to maximize performance indicators and to optimally adapt and/or reconfigure the MPC loops. This includes adaption of estimator gains/structure for sensor fusion, modulation of robustness vs performance (detuning of MPC weights, increase of robustness properties via augmentation of scenarios in stochastic MPC), on-line reconfiguration of MPC with respect to sensed changes of the operating environment and/or detection of measured and unmeasured disturbances. Development of the control software modules implementing the most effective algorithms, for deployment in the DCS.

Measure of success: Online machine learning algorithms allow adaptation of static maps without interfering with process operations, and save substantial offline calibration efforts. Effectiveness of exploiting PAT data for optimizing on line the tuning/structure of MPC controllers to maximize performance indicators. Feasibility of the software modules in terms of memory and throughput.

Task 2.3 Performance assessment (**IMTL**, WUT, LTU, ABB, ODYS, CUP, CIRCE, DAPP, MEFOS) (M24-M36)

Definition of detailed testing procedures for assessing the performance improvements achievable by the overall offline modeling/MPC design and online data-driven adaptation schemes, based on the test cases selected in Task 1.2. Validation in simulation of the modeling and design workflow of Task 2.1 and the online data-driven algorithms developed in Task 2.2. Assessment in simulation of the advantages in using additional PAT data with respect to standard (non-adaptive) process control schemes. Critical assessment of pros and cons of the new PAT-driven MPC technology on the industrial case studies.

Measure of success: Ability to identify a set of testing procedures for assessing performance improvements enabled by the PAT-driven MPC scheme in simulation and on the industrial case studies.

Role of Partners: IMTL as a world leader in the area of industrial control will lead the activities of this WP and will guide the developments of the DISIRE control components. IMTL will be assisted by the Control engineering group at LTU and their expertise in industrial control, networked control systems, estimation and predictive control. Moreover, WUT will also contribute based on their mining expertise in control and signal analysis. The developed IPC modules in this WP will be further integrated and industrialized by the influence of the rest contributing partners such as ODYS, CUP, CIRC and DAPP in connection with the areas of their expertise (mining, combustion, steel). Finally, ABB will directly influence the WP's developments based on their current expertise in industrial automation and will ensure the direct applicability of all the DISIRE IPC modules.

Deliverables	
D2.1: **Mode**ling and process control architectures for data-driven MPC (IMTL)	M18
D2.2: Data-driven MPC algorithms and software (IMTL)	M28
D2.3: Performance assessment of data-driven MPC (IMTL)	M18, M32

Work package number	**3**		**Start date or starting event:**			**M04-M21**	
Work package title	***Sensors & Electronics***						
Participant number	**1**	2	3	4	5	6	7	8
Participant short name	**LTU**	LKAB	KGHM	ODYS	WUT	IMTL	CUP	ETEC
PMs per Partner	**16**	1	2		8	2	4	6
Participant number	9	10	11	12	13	14	15	
Participant short name	CIRC	DCI	ABB	DAPP	MOEZ	GST	MEFOS	
PMs per Partner	2	1		7			1.5	

Objectives

The work package will develop PAT sensor and platform technology for process tracing and measurement in harsh environments, with a focus on continuous processes that involve the movement and treatment of material and internal dynamics of batch processes. For continuous processes, the goal is to be able to dispense the sensor platforms in the process flow. They will follow the flow, constituting markers for moving and stirring as well as allowing measurements in the process and during transport of material. For batch processes the focus will be on advanced sensing in industrial applications. Core objectives for the work package are the development and application of sensor technology, power supply solutions, and signalling solutions.

Description of work

Task 3.1 - Sensor technology survey and selection (LTU & all participating partners)

This task will perform a survey of which physical quantities are critical to monitor and measure to achieve the overall goals of the project. The starting point will be the requirements in WP1 and the processes from WP6 to WP9. The goal is to identify shortcomings of existing sensor technology and identify needs for research towards new types of measurements, as well as to identify application for sensor technology previously not used in continuous industrial process control.

Task 3.2 - Integrated PAT sensors and electronics for batch processes (DAPP, CIRC, DCI, LTU)

This task will develop sensors and electronics for advanced sensing in batch processes in industrial applications. Focus will be on non-contact high speed industrial fibre optic infrared sensing technology enabling real-time sensing through highly integrated in-line optical measurement systems. In this task, such technology will be investigated and developed as a monitoring solution for production lines running temperature dependent process and conveyor belts. Both non-contact infrared thermal monitoring systems and distributed fibre optics solution will be addressed along with dedicated algorithms to analyse incoming signals and measuring the temperature on different channels. Main advantages for measurements in industrial and harsh environments, which will be evaluated, should be: to be unaffected by electromagnetic interference (EMI) from large motors, transformers, welders and the like; to be unaffected by radio frequency interference (RFI) from wireless communications and lightning activity; to be positioned in hard-to-reach or view places; to be focused to measure small or precise locations; does not or will not carry electrical current (ideal for explosive hazard locations); fibres can be run in existing conduit, cable trays or be strapped onto beams, pipes or conduit (easily installed for expansions or retrofits); finally, certain high speed fibre optics based temperature detectors can handle temperatures ranges from 200°C to over 1500°.

Task 3.3 – Integrated PAT sensors and electronics for continuous processes (LTU, WUT, KGHM, CUP)

This task will develop PAT sensors and electronics for distributed measurement in continuous processes. The sensors will be distributed in swarms or as singular units in the process. They will follow the flow, constituting markers for moving and stirring as well as allowing measurements in the process and during transport of material. The task will extend the capability of existing ePellet sensors by adding measurement, computational and increased communication capabilities. The choice of sensor capability to include will relate to the outcome of task 3.1. Foreseen efforts include the ability to measure vibration, force, humidity, and temperature. Furthermore, energy supply to the sensor platforms as well as communication capabilities in harsh environments will be further enhanced. The impact from this this task are applicable to a variety of industrial applications and should answer the following questions:

a) What does the electromagnetic environment where the communication will take place look like?
b) How can improved circuit design for PAT sensors improve readability for small tags in harsh environments?
c) How can a holistic system design help improve the readability of the PAT sensor harsh environments?
d) How should the PAT sensors be assembled and encapsulated to achieve a desired combination of performance/price/robustness?

Task 3.4 - Application specific sensor development (ETEC, LTU, MEFOS)

This task will bridge the gap between the physical sensors and the overlying measurement/control system. This may include the adaption of sensor solutions to include the use of commercially available sensor network solutions as data collection platforms. Thus, the task will enable the measurements required for continuous process monitoring and control by creating measurement solutions tuned to the specific needs of the used overlying system.

Task 3.5 - Small scale validation (LTU)

This task will perform laboratory based validation of batch and continuous sensor solutions as a preparation for inclusion in the live processes. Performance and parameters to be verified include:

- High temperatures influence
- Impulse and pressure (mechanical)
- Radio performance (Electromagnetic)

Role of Partners:

LTU will lead the work package. LTU will also be main responsible for the work on integrated sensors and electronics for continuous processes. Competencies in embedded systems, ASIC design, and sensor technology will be utilized to reach the overall target of small, disposable, and robust sensor platform solutions for continuous processes. DAPP will cooperate during the design and development of the integrated sensors and electronics for batch processes. Competences on fibre optic-based distributed temperature sensing technology and non-contact high speed industrial fibre optic will be exploited in order to develop an advanced sensing platform to be used in harsh industrial environment. MEFOS will contribute with their knowledge about the conditions in measurement techniques, in metallurgical processes, methods for adapting equipment for different harsh condition to the industrial conditions. LKAB, KGHM, CDI will contribute in ensuring the industrialization of all the WP3's activities. WUT and CUP focus in the non-ferrous areas, ETEC will focus in the ferrous areas, MEFOS will focus in the steel area, while CIRC will focus in the combustion processes.

Deliverables	
D3.1: Sensor technology selection report (LTU)	M9
D3.2: Small scale validation report (LTU)	M18
D3.3: Report on batch sensor design solutions (DAPP)	M18
D3.4: Report on sensor solutions for continuous processes (LTU)	M21

Work package number	4		**Start date or starting event:**			**M01-M34**	
Work package title	***Data Mining***							
Participant number	1	2	3	4	5	6	7	8
Participant short name	LTU	LKAB	KGHM	ODYS	WUT	IMTL	CUP	ETEC
PMs per Partner	3		1	1	22	10	3	
Participant number	9	10	11	12	13	**14**	15	
Participant short name	CIRC	DCI	ABB	DAPP	MOEZ	**GST**	MEFOS	
PMs per Partner				3	1	**26**	5	

Objectives

The aim of this WP is to condense and combine sensory data from PAT's, measurements from on-line sensors, and laboratory measurements into real time statistically based low–dimensional data describing the process and product state. The low-dimensional data should acknowledge and be robust versus infrequent updates of PAT measurements, toward missing data, and handle largely varying measurement intervals. The model should also be able to handle the multivariate and auto correlated nature of process data and the high quantities of data from regular on-line measurements. The process and product state data will serve as input to IPC and optimization strategies. An additional important objective of this WP is to incorporate the research findings in an implementation plan for different types process industrial production and thus enabling the cross-sectorial application of DISIRE.

Description of work

Task 4.1 – Industrial Process Discovery **(GSTAT and all participating partners)**

Learning and understanding the types and purpose of the sensory data collected in typical production processes of the process industry. Understanding the data collection and streaming technologies for typical sensory systems. Together with control and industrial experts, define the process and product state data needed for implementing engineering and statistical process control.

Task 4.2 – Design of sensor data Collection and preparation module (GSTAT, WUT, LTU, MEFOS)

Design and develop methods for collecting and preparing PAT sensory data, including PAT position and product and process state data. Phase 1 also incorporates creating updates of states backward in time, since PAT's could be designed with wake-up capacity, reading to local memories that are emptied in bursts downward in the process flow. The data acquisition needs to handle data of various size, types and frequencies. The data collection design phase will, in cooperation with process engineers also and if needed develop collection routines for control data, such as set points and control signals of the controlled objects such as valves and engines. The results will be a generic data and processing model which will be easy to configure and implement in different production lines with different levels of complexities and different types of industries. The model will include data mining methods for cleansing and quality assurance of the data received from sensors.

Task 4.3 – Analysis and calculation module (GSTAT, IMTL, WUT, ODYS, CUP, KGHM)

Design and develop algorithms for calculation the process state required by the process control and optimization module. The algorithms must handle data obtained with different and sometimes varying frequencies, different quality, missing or even erroneous data, and massive cross-correlation and autocorrelation. Outputs will contain the estimated product and process state designed to support real-time alarms, changes and trends, statistical predictions of process and product states and parameters in the future, based on their past values as well as past values of other correlated inputs. The prediction models will be based on regression and machine learning methods.

Task 4.4 – Proposed Deployment Plan (GSTAT, LTU)
Devise a proposed work plan for deployment of the research findings in cross-sector industries. The work plan will include the procedures needed to be carried out within an existing industrial process to ensure a clean, safe and fast implementation of the data mining processes. These recommendations will also include the order of different data modules implementation stages, hardware and software recommendations, implementations risks and data maintenance recommendations.

Role of Partners: GSTAT will lead the activities in this WP based on their expertise in real life data analysis and data mining. The activities in this WP will be supported strongly supported by WUT and their additional expertise in data mining and analysing big sets of data coming from the mine sector. KGHM and CUP will also participate in this WP for securing the compatibility of the presented activities with the real life cases. Moreover, the RTD partners LTU, MEFOS, DAPP, ODYS will participate based on their expertise in logistics and data mining as also in realizing the findings in the related industries. The participation of MOEZ will focus on the deployment of the produced plan in other cross-sectorial areas, while IMTL will participate in order to assure the complete compliance of the activities and produced results from a PAT based IPC point of view.

Deliverables	
D4.1: Industrial Process Discovery Document (GSTAT)	M6
D4.2: Sensor data Collection preparation system design report (GSTAT)	M26
D4.3: Analysis and calculation module Report (GSTAT)	M35
D4.4: Business and Deployment Plan (GSTAT)	M35

Work package number	**5**		**Start date or starting event:**			**M05-M35**	
Work package title	***Non-Ferrous Mineral Processing***						
Participant number	1	2	3	4	5	6	**7**	8
Participant short name	LTU	LKAB	KGHM	ODYS	WUT	IMTL	**CUP**	ETEC
PMs per Partner	2		9	4	33	3	**26**	
Participant number	9	10	11	12	13	14	15	
Participant short name	CIRC	DCI	ABB	DAPP	MOEZ	GST	MEFOS	
PMs per Partner			1			1		

Description of work

Task 5.1 – Application of in situ sensors for flotation process Monitoring (CUP, LTU, KGHM, ODYS, WUT, IMTL, CUP**)**

Design and develop of plan survey details for process control (frequency, dates, spots, parameters, sensors, way of samples collection for additional analysis). Learning and understanding about the industrial process by processing the data collected in the typical process. Designing and creation of a system gathering, processing of data and generating online PAT data from sensors. Construction of the industrial flotation model based on data gathered in the cloud system and finally model adjustment and refining based on industrial experimentation within possible variation of flotation parameters.

Task 5.2 – Online PAT for Transport Processes (WUT, LTU, KGHM, ODYS, IMTL, CUP, GST, **)**

In this WP a determination of the quality and quantity of data available in the operation of the continuous transport system at KGHM will be performed. KGHM is utilizing different data acquisition systems provided by different producers. Depending on the mine or even on conveyor type monitoring and control systems might be different. In this task main efforts will be related to synthesis of existing knowledge about what kind of data, in what format, how often etc. might be available or needed in order to perform an optimal IPC strategy for optimizing the transport process. Apart from monitoring systems, other important information is stored in databases or data warehouses. Procedures for integration of these data, their synchronisation with monitoring system will be also developed in this task.

In the sequel identification and modelling of the random stream of the transported ore will be performed. Mathematical models and appropriate algorithms for copper ore stream modelling for IPC will be provided. In this activity the identification of the resistance to motion of the conveyor belt in a variable stream of transported materials will be also performed. Due to varying numbers of operating idlers and length of conveyor belt, the issues of resistance to motion, phenomena related to belt-idlers contact are critical. Precise identification of such parameters will directly influence energy consumption, degradation processes (wear) and design parameters. Finally, data obtained from monitoring systems will be processed and analysed to build mathematical models of processes. This will be developed by the utilization of time series modelling techniques, data mining techniques and finally different results will be combined (data fusion) to integrate information/knowledge from different sources to achieve holistic model of the modelled system.

Task 5.3 – PAT based IPC demonstration on conveyor network control (CUP, LTU, KGHM, ODYS, WUT, IMTL, ABB**)**
Transport system consists of many conveyors that creates a complex structure with many nodes starting in mining areas (departments) and ending with mining shafts for transporting ore to processing plant. Unfortunately, it happens very often that due to mechanical, electrical or mining reasons (classification used in the mine) one of conveyor should be stopped. Due to serial structure of the node, all conveyors should be stopped too. To re-start whole system, there is a need to synchronise starting of each conveyor and providing a material stream at an appropriate time. It is believed, that this is a crucial element for monitoring, modelling and optimisation and that the DISIRE IPC will have a direct impact on the optimization of this process. In this task novel model-based design solutions for controlling the belt conveyors will be proposed.
Based on identified key parameters of conveyor design and operation, optimisation through simulation will be investigated. As results it is expected to find novel model based design solution that will match specific requirements for particular conveyor localised in the transport system, and will finally provide serious efficiency in terms of energy consumption, effectiveness, lifetime extension etc. The Model Predictive Control that will be proposed as part of the IPC in WP2 will be also utilized and demonstrated in the conveyor belt network in real life test cases. The proposed control scheme will be based on the developed models for conveyors and the online pat measurement methods, resulting from the streaming of the in situ ejected sensors in the flaw of materials. All the recommended solutions will be evaluated and measured/quantified.

Role of Partners: CUP will lead the activities of this WP based on their expertise and cooperation with KGHM. Moreover, WUT will also have a significant role in the WP as leaders in the area of modeling and controlling the network of conveyor belts. The activities in this WP will be assisted by KGHM that will lead the demonstration and will act as the end user. LTU, ODYS and IMTL will focus on developing and applying the proposed control schemes, while GST will focus on the online PAT analysis and modeling procedures in this demonstration process. ABB will ensure the direct applicability and commercialization of the proposed DISIRE technology in the area of non-ferrous mineral processing.

Deliverables	
D5.1: On the modelling and control of belt conveyor network	18
D5.2: Applied PAT and data mining for raw materials transportation system	24
D5.7: PAT based IPC demonstration on conveyor network control	34

Work package number	6		**Start date or starting event:**			**M05-M35**	
Work package title	***Ferrous Mineral Processing***						
Participant number	1	2	3	4	5	6	7	**8**
Participant short name	LTU	LKAB	KGHM	ODYS	WUT	IMTL	CUP	**ETEC**
PMs per Partner	2	4		5		2		**8**
Participant number	9	10	11	12	13	14	15	
Participant short name	CIRC	DOW	ABB	DAPP	MOEZ	GST	MEFOS	
PMs per Partner			2			0.5		

Objectives

The main objective for WP06 is to perform evaluation of the technological developments carried out in WP03 Sensors and Electronics in relevant industrial environments, as well as create a framework for generating data that will be further processed in WP04 Data mining to develop an in situ product and process measurement for iron-ore pellets capable of characterize the transportation conditions. Secondary objective linked to the main objective is to develop strategies for tracking and communicating with the PAT sensors in the product and logistics chain. The overall goal is to generate a fundamental knowledge-base about the product properties and their behaviour in the processing machines and identify the specific measurement conditions and related challenges that are specific to ferrous mineral processing to introduce a integrated process control optimization scheme in the future. The work will predominantly be carried out in pilot scale processes that will be provided by LKAB to minimize interference with the production. However, to generate valid data for tracking and tracing purposes it will be necessary to install DISIRE technology in the pelletizing production plant in Kiruna and alongside the transportation route to the harbour in Narvik in the transhipment areas.

The main goal is to develop a PAT sensor platform that can and will be fitted with suitable off-the-shelf sensors that can be used for in-situ measurements in the production process and logistics flow. This PAT sensor platform will be larger than the pellets to accommodate for large sensors such as loading cells, robust electronics encapsulations, batteries, memories and larger antennas for long-range communication in a harsh environment. The intended use for the platform, that may be tested in the project is:

a) Pressure measurement within product silos,
b) Accelerations in the logistics flow,
c) Friction and wear within the logistics flow,
d) Temperature measurements in the grate, and
e) Other measurements related to atmosphere measurements in the grate such as gas constituents.

A secondary goal is to develop a PAT, without sensors, which is of the same size, geometry, morphology and density as a real iron-ore pellet that is capable of tracking the process- and transportation flows. With such PAT sensors, the following will be accomplished:

a) Segregation tendencies of the larger PAT sensors.
b) Time through production chain can be registered and the information can be used for process control.
c) Increased traceability from manufacturing to end customer.
d) In situ measurements of flow behaviour in warehouses such as silos.

Description of work

Task 6.1 Experimental Design (LTU, LKAB, ETEC, IMTL**)**

The purposes of the experiments will control the experimental designs used. Experiments that are designed to study the flow behaviour of larger PAT sensor platforms in silos and transports can to a large extent be performed in pilot scale silos, (e.g. at the University of Edinburgh). Placing pellets transponders alongside the larger PAT platforms and measuring throughput times will determine the design requirements, e.g. the correct density of PAT platforms to compensate for their larger size. Confirmatory experiments as well as pilot measurements in full-scale warehouses are important, and the location of these will be determined by the location of sieves where the sensor platforms may be retrieved. Such experiments require establishment of acceptable levels of segregation and of choice of number of experimental units to determine statistical confidence intervals. Variables such as detection rate, and abilities to control the experimental environment will determine the sizes and details of these experiments. Experiments with the purpose of studying the radio environment can be performed by broadband transmitters being placed within the product flow, where the signals are read from the outside, such as alongside transporters or in silos. Such experiments will be performed first in laboratory scale, and in the pilot scale product silos, but ultimately, these tests also need to be performed in the full-scale environment.

Task 6.2 Pilot scale testing (ETEC, LKAB**)**

The pilot scale testing will address several aspects of the challenging measurement conditions that are specific to ferrous mineral processing can be investigated in pilot scale processes. Specifically test will be carried out in pilot scale silos, where pellets can be loaded and discharged in a controlled manner. A controlled loading facilitates customized placements of PAT:s and other equipment at various radiuses and depths of a silo. This will facilitate communication tests, segregation tests, tests of in-situ measurements using the PAT sensor platform and so on. Controlled discharge will facilitate retrieval of PATs for repeated measurements, for measurements of mechanical robustness such as wear, and in combination with the controlled filling determine segregation tendencies. Segregation Granular material segregate during processing and transportation and it is important to design PAT sensors of the right size and mass. By comparison of the throughput times of pellets sized PAT:s to test and design (e.g. by adjusting density and geometry) the larger sized PAT sensors so that these will not segregate where such segregation could interfere with the knowledge generation, for instance PAT sensors used to measure pressure build-up in storage vessels exhibiting some flow. This work will be performed in pilot scale before confirmatory experiment in the full-scale environment.

Further more, the mechanical encapsulation must withstand the high impacts and abrasive wear associated with processing and transportation, especially in transhipment zones and silos. The tests performed in a) will also deliver data related to mechanical robustness, since the PATs that survive tests can be retrieved after the experiment. Tests will be performed also regarding the the communication environment, which is characterized by large distances and the communication signal must be able to penetrate the multiphase radio environment. Multiple echoes from caused by the production or transportation process design, such as steel in the form of beams, rotating cylinders and encapsulations, or water such as spray or wetted products must be efficiently cancelled in the telecommunication system design. The complete system consisting of sensors and receiving antennas has to be optimized and adopted to the environment.

Task 6.3 Evaluation of PAT sensor in pelletizing plant (ETEC, LKAB**)**

The main purpose with this activity is to generate feed-back to WP02 regarding the design and construction of the PAT sensor. To develop robust signalling solutions and enable the construction of pellets sized sensors the electromagnetic environment in the pellets flow needs to be mapped. The circuit and system design solutions for the PAT sensor thereby guarantee a robust and reliable communication adopted to this particular environment. The impact from this this task are applicable to a variety of other industrial applications and should answer the following questions:

a) What does the electromagnetic environment where the communication will take place look like?
b) How can improved circuit design for PAT sensors improve readability for small tags in harsh environments?
c) How can a holistic system design help improve the readability of the PAT sensorin harsh environments?
d) How should the PAT sensors be assembled and encapsulated to achieve a desired combination of performance/price/robustness?

Task 6.3 Infrastructure for Product Tracing (ETEC, ABB, ODYS**)**

To facilitate tracking of and in-situ measurements in the flow of pellets, as well as form a technical base for measurements in other areas of the process special focus is given to transportation and this part of the process will be instrumented to perform the full-scale experimental activates in WP04.
The instrumentation will be implemented step-wise where the first step is to use state of the art technology to create a practical base case description and established an infrastructure for the tracing activities in WP04. In the final step distributed sensing monitoring and sensing of the product stream will be demonstrated when the results from WP02 has been fully integrated to the PAT sensor.
Specifically the following will be addressed in this task

a) The PAT sensors function as markers that can be traced in the continuous production process; the markers follow the flow and are identified at antenna stations. The time it takes to pass different parts of the production chain can be registered and the information can be used for process control. Increased traceability of products from manufacturing to end customer is obtained.
b) In situ measurements in the pellets transportation chain. The PAT sensor is in this case equipped with sensors that measure parameters such as temperature, wear, and acceleration during the transportation of the pellets. This information can be used to reduce product degradation during transportation.

Role of Partners: The activities in this work package will be carried out collaborative mainly between LTU, LKAB and Electrotech. The role for LTU is to provide the sensor platform (PAT sensor) and the role for Electrotech is to implement the developed technologies at LKAB. LKAB and LTU will be responsible for the pilot scale tasks and the evaluation of the demonstrated technology will be done by LKAB. IMTL will inspect the application of IPC on the ferrous process, while GST will have the same role for the overall PAT and data mining. Finally, ABB will ensure the direct applicability and commercialization of the proposed DISIRE technology in the ferrous mineral processing.

Deliverables	
D6.1: Base Case Description – Instrumenting the pellet transportation chain (ETEC)	M12
D6.2: Evaluation of PAT based IPC performance in pelletizing plant (ETEC)	M24
D6.3: Product tracing in ferrous mineral processing based on DISIRE technology (ETEC)	M34

Work package number	**7**			**Start date or starting event:**		**M05-M35**	
Work package title	***Steel***						
Participant number	1	2	3	4	5	6	7	8
Participant short name	LTU	LKAB	KGHM	ODYS	WUT	IMTL	CUP	ETEC
PMs per Partner	2			3		2		
Participant number	9	10	11	12	13	14	**15**	
Participant short name	CIRC	DCI	ABB	DAPP	MOEZ	GST	**MEFOS**	
PMs per Partner			2			1	**14**	

Objectives

The main objective of this WP is to facilitate and demonstrate the use of sensors in the steel plant and evaluate measured data in combination with existing process data and off line PAT. More specifically, this WP will aim in conducting pre-tests of sensors in appropriate conditions in terms of tracing them and measuring process values like temperature and atmosphere (gas composition) in order to state their capability to be injected in the raw materials flow during preparation, handling, feeding of the BF, operating inside the BF for measuring moisture, temperature, movement, position and pressure in the applications of: a) pellets produced in the mining sector and b) in other burden materials as e.g. fluxed, agglomerates, coke. It would be further investigating the utilization of the DISIRE in-situ sensors for tracing materials and to measure temperature, oxygen content and pressure in reheating furnaces for improved IPC based on the produced online PAT. MEFOS is a world-leading institute in steel research with access to large piloting facilities and are **managing the worlds only Experimental Blast Furnace** (owned by LKAB) and is highly focused on applied research in benefit for their members. The members of MEFOS come from the whole world with many whom are market leaders in their respective field. Several members have already shown interest in the DISIRE technology and will have access to the results from this WP and will also be a valuable dissemination and innovation channel.

Description of work

Task 7.1 – inline Sensors evaluation in Steel Industry (MEFOS, LTU, ABB**)**

Pellets containing sensors (developed in WP3 for the requirements in WP6 and WP7), are supplied from WP6. Sensors can be introduced also in other raw materials. The sensors have to be developed for the measurements and identification requirements defined by WP7. Initial tests will be conducted in an existing furnace at MEFOS that has ceramic lining and steel shell. The following will be explored;

- **Definition of sensor requirements and evaluation for use in the material handling and BF process**. The requirements includes definition of temperature sustainability, data transfer method, data to be measured and transferred as e.g. identification signals, horizontal and vertical position, temperature, moisture, particle size, gas components etc.
- **Different raw materials containing sensors;** pellets with sensors are supplied from WP6 and other raw materials from the BF (for example pellets, sinter, coke, limestone, cold-bonded agglomerates) are prepared with sensors by MEFOS in WP7 using sensors from WP3.
- **The sustainability of sensors to increasing temperatures and specific gas atmospheres** (CO) are explored by heating raw materials containing sensors in an existing furnace at MEFOS. Both naked sensors and embedded ones are used. The results are explored in cooperation with WP3 to define

required improvements of the sensors.

- **The wireless method of transferring of measured data** will be investigated. A main issue is to find, test and evaluate robust solutions to extract a signal from a process surrounded by an enclosing steel housing. The steel enclosure prevents the signal from reaching the receiver. Means to resolve this will be evaluated and tested in the pilot reheating furnace. Tests with inserted antennas and drilled holes and directed signals will be made. This equipment need to be cooled. In the pilot furnace there will be an evaluation of the performance of various support actions such as interior antennas, directed signals various transmitters and use of repeaters. Another important task is to test different housing of the sensors for performance at high temperatures.
- **The quality of measured and transferred data will be explored** in terms of resolution, precision and accuracy for horizontal position, vertical temperature, moisture content, particle size, gas composition, (O_2, CO, CO_2, H_2) in comparison with conventional methods
- **The temperature development will be compared to possible endothermic reactions** occurring in the materials as e.g. calcination of $Ca(OH)_2$ in cold bonded agglomerates (in-plant material in cold bonded bricks), $CaCO_3$ in limestone, direct reduction in cold bonded agglomerates
- **Definition of possible appropriate implementation in the experimental BF** is made by MEFOS based on the results supplied

Task 7.2 – Combination of PAT Analysis with Swarm sensing in Steel (MEFOS, GSTAT**)**

Stating that the sensor can transfer signals: Naked sensors are added directly to the raw material streams after the method for signal transfer stated to be required in Task 7.1 has been implemented. Sensors are allowed to descend with the vertical probe installed at the LKAB Experimental BF that is used for vertical temperature measurements and thus the results will be validated. The next effort will target the basket samples with raw materials containing sensors. Pellets or other raw material with embedded sensors are filled into baskets and charged into the Experimental BF before quenching. The signal is collected and the movement of baskets in the upper part of the BF are explored. Measurements are also conducted during quenching in order to state the burden movement after stopping the process and contribute with additional information that can improve the understanding of results from evaluation of charged basket samples. Pellets containing sensors are supplied from WP6, while other raw materials are prepared by embedding sensors in them. Raw materials containing sensors. Prepared materials and free sensors are introduced into the raw material handling of the Experimental BF and the materials are traced. Data to be collected in raw material handling plant and in the blast furnace has been defined in Task 7.1 and are e.g. identification of type of material, horizontal and vertical position, temperature, moisture, pressure, gas composition. Transferred data are collected and analysed for further investigation in combination with collected Experimental BF data.

Conventional data exploration, statistical evaluation (SIMCA) visualisation of particle track and heating of materials are conducted. Available thermodynamic and material information for possible endothermic/exothermic reactions are used in the evaluation. The possibly improved control in terms of moisture content in burden material, achieved burden distribution and information about temperature profile is explored by based on available data.

Task 7.3 – IPC demonstration and evaluation in Steel Blast Furnace and a Steel Reheating Furnace (MEFOS, IMTL, ODYS**)**

The use of sensors for improved control of the heating of steel prior to the metal working is investigated in a furnace at Swerea MEFOS, with respect to robust and efficient industrial extended evaluation in a TRL level of 6. The possibility to measure temperature, furnace pressure and O_2 will be explored also in this pilot scale. Measurement results are compared and evaluated relative conventionally measured data, while it will be investigated if sensor failure can be used as a process indicator. A total evaluation of the reduction in resources and energy consumption will be also performed.

Role of Partners:

Swerea MEFOS participate in the development of sensors, transfer of data, measurements in the industrial plant and evaluation of data, supply of evaluation results. GST will focus in the data mining and online PAT, while LTU will participate in the task related to in situ sensors in the steel process, ODYS and IMTL will focus on the applicability and evaluation of the proposed PAT based IPC. Finally, ABB will ensure the direct applicability and commercialization of the proposed DISIRE technology in the steel process.

Deliverables

D7.1: Evaluation of sensors based on pilot tests in the steel process (MEFOS)	M20
D7.2: Evaluation of data analysis and PAT production in the steel process (MEFOS)	M24
D 7.3 Evaluation of the IPC in the steel process (MEFOS)	M34

Work package number	**8**		**Start date or starting event:**			**M05-M35**	
Work package title	***Combustion Processes***						
Participant number	1	2	3	4	5	6	7	8
Participant short name	LTU	LKAB	KGHM	ODYS	WUT	IMTL	CUP	ETEC
PMs per Partner	1			3		1		
Participant number	**9**	10	11	12	13	14	15	
Participant short name	**CIRC**	DCI	ABB	DAPP	MOEZ	GST	MEFOS	
PMs per Partner	**40**	7	1	7				

Objectives

To improve the efficiency combustion in cracking furnaces by means of an advanced characterization of natural gas flames. The methodology involves new concepts of oxygen sensoring on flue gases, computational fluids-dynamics simulations (CFD) of the combustion and Imaging Diagnosis techniques of natural gas flames patterns.

Description of work

Task T8.1: Characterization of sensors and conditions for oxygen measuring in a cracking furnace (CIRC, DOW, DAPP, ABB**)**

CFD simulations will be used to perform a diagnosis of the conditions and processes that take place in a cracking furnace, providing an extensive characterization of temperatures, flow velocity, turbulence and species concentration among other variables. The CFD study will be performed prior to installing new sensors and making sure that a high economic investment in instrumentation provides accurate information. A flow characterization at the outlet of the cracking furnace and the determination of zones with uniform temperature and oxygen concentration is important to find the exact locations at which point measurements can be representative of the average values. CFD simulations can also generate ideas of furnace design technical modifications that could improve the performance of the instrumentation, i.e. installation of deflectors to make the flow gas more suitable to perform accurate measurements. Also simulations can help determine which geometrical modifications can be done to reach better global energy efficiency.

Other line of work is to find the most efficient operational input conditions to optimize the furnace performance. That is, modify input variables such as air-fuel ratio, air inlet temperature, inlet air mass flow rate or fuel composition. Thus it will be possible to establish correlations between operational input variables and efficiency, thermal losses, species concentration and temperatures without installing new costly instrumentation.

Task T8.2: Imaging diagnosis. Lab scale technique development, Design and Engineering (CIRC, DCI**)**

Imaging diagnosis is an on-line non-invasive technique that implies low investment cost and is compatible with high temperature and the harsh environment present in a combustion process. Charge-Coupled Device Cameras (CCD) register radiation emitted by flames in order to detect flicker, temperature, emissivity, and soot concentration. These techniques can be used to enhance the knowledge of combustion, as well as to validate numerical computational results and develop predictive control systems. CIRCE, in Research and Innovation programs, is developing a methodology of imaging flame monitoring applied to a 500 kWt semi-industrial scale research burner with a temperature range of 900-1300ºC and fed by propane, coal, biomass and mixtures. An algorithm to correlate statistical and spectral flame characteristics with CO emissions and diverse operational parameters is being developed.

Tests at lab scale will be performed with the existing imaging diagnosis instrumentation in order to make a feasibility study of the use of this technique in a cracking furnace. Then an algorithm to correlate statistical and spectral flame characteristics with operational parameters must be developed. First studies will be carried out at laboratory scale. Then the algorithms will be adapted to the expected conditions and uses in the cracking furnace. In order to complete and enhance the technical development planned in DISIRE, DOW and CIRCE will study the extrapolation of the proposed task 8.1 and 8.2 to other units at the DOW factory (Octene plant and ethylene cracker boilers), not included originally in DISIRE project and that could also be leveraged and of application to other industrial energy intensive sectors. The basic engineering will provide the first technical drawings based on the results of the design tasks and will establish a first global approach for the construction of the furnace adaptations and the rest of ancillary equipment related to the furnace. This first approach will contain a preliminary approximation of the design needed for the construction, a first schedule for the construction and installation steps, the personnel needed, etc.

Task T8.3: Demonstrator start up (CIRC and all participating partners**)**

Tests with the new and existing instrumentation will serve to validate and adjust the O2 sensors and imaging diagnosis results. Since the development of this new control system based on an innovative technology is a research work, it is necessary to validate the measurements computed from the O2 instrumentation and imaging diagnosis with experimental data in industrial furnaces.

Additionally, O2 sensors and imaging diagnosis will generate a map of variables that will be a useful tool to be crossed with the detailed CFD numerical simulations. That is, interdependency of both techniques can provide complementary information of the processes, improving the accuracy of the information that will be processed and used in the control system. A research line will be to determine set points using on-line imaging diagnosis and new O2 sensors and fed the actual control system. It is possible to develop empirical correlations between images and control. Also artificial intelligence techniques such as neural networks, fuzzy logic or patterns recognition algorithms provide good results in lab installations for the design of control systems.

Role of Partners: CIRC will lead the activities in close cooperation with DCI and in relation with their expertise in the combustion processes. DAPP will focus in the development of new sensors for the combustion process and PAT analysis, LTU, IMTL and ODYS will focus in the control aspects of the combustion process. Finally, ABB will ensure the direct applicability and commercialization of the proposed DISIRE technology in the combustion process.

Deliverables	
D8.1: Report of suitable O2 sensors for cracking furnaces characteristics (CIRC)	M12
D8.2: Technical report of CFD results regarding the optimal localization in furnace for O2 sensoring (CIRC)	M18
D8.3: Technical report for optimizing the combustion efficiency in cracking furnaces (CIRC)	M24
D8.4: Report of flame and combustion characterization by means of optical non-invasive instrumentation. Developments of algorithms for control combustion (CIRC)	M30
D8.6: Report of DEMO-site implementation of control systems based on O2 sensoring and optical non-invasive instrumentation (CIRC)	M34

Work package number	**9**		**Start date or starting event:**			**M01-M36**	
Work package title	***Dissemination and Innovation***						
Participant number	1	2	3	4	5	6	7	8
Participant short name	LTU	LKAB	KGHM	ODYS	WUT	IMTL	CUP	ETEC
PMs per Partner	7	1	2	1	4	5	2	1
Participant number	9	10	11	12	**13**	14	15	
Participant short name	CIRC	DCI	ABB	DAPP	**MOEZ**	GST	MEFOS	
PMs per Partner	1	1	2	1	**17**	1.5	3	

Objectives

This work package aims at collecting the knowledge and the results of the technical work packages of

DISIRE in order to arrange their exploitation as well as the dissemination of new knowledge and spin off innovation activities of the overall work description. The goal is dual: a) to impart the resulted knowledge to new scientists as well as to professional staff and the public and b) to generate multiple new business cases, spin offs, to commercialize the project results and to penetrate DISIRE in cross-sectorial business cases.

Description of work

Task 9.1 – Public Visibility (LTU, MOEZ, MEFOS, CIRCE, LKAB, KGHM, ODYS, WUT, IMTL, CUP, ETEC, CIRCE, DCI, ABB, DAPP, MOEZ, GST, MEFOS**)**

Within this task all the activities that aim to increase the public visibility of the DISIRE project will be scheduled, organized and accomplished. The activities within this contain the dissemination materials of the scientific results as well as non-strictly scientific actions regarding business-oriented activities. More specifically, the following two subtasks will constitute this task:

Online material: The aim of this task is to create and manage a website for public dissemination of results as well as establish other methods of communication. It will consist of six areas, namely:

- Project introduction section, where the partners, their profile, the main objectives as well as a technical analysis of the concepts to be addressed by the project will be presented.
- A web-management tool for quick online management of internal partner information.
- Project update section, where the project current status, main achievements and results will be reported in the form of a timeline slideshow accompanied with links to further dissemination material (publications, videos, articles or presentations in the media).
- Public calendar, so that anyone can track the progress and the main events of the project.
- An open source section, where all the software code and hardware schematics developed from the academic partners during the project will be published and fully documented based on the highest standards of the open-source community.
- A set of tutorial-like presentations that aim to provide an easier way of understanding the main contributions and relations with the bases of inline measuring, integrated process control, pat analysis, machine learning, process optimization, and additional to the DISIRE project scientific activities. Through the utilization of a special series of video presentations – online lectures (2 per year of the project), slides and short accompanying documents and description of industrial test cases, the aim will be to provide the means to help other industrial professionals and industries in related and cross-sectorial processes to strengthen their understanding on the DISIRE challenging vision.

Understanding that the use of internet has changed over the last few years through the introduction of social media, special attention will be paid to use this channel of public dissemination. In that sense Facebook/Twitter accounts will be linked automatically with the website updates.

Dissemination material: The aim of this task is to produce a project coordinated image and dissemination materials, which will be distributed to specific target groups. Through the publication in:

- Scientific Conferences and Journals
- Industrial Conferences and Workshops, showcases and Exhibitions

As well as the organization of:

- Press conferences in the association with some of the main events of the project (kick-off meeting, experimental validation periods, final dissemination workshop)

Task 9.2 - Dissemination of results and conclusions (LTU and all partizipating partners)

The main focus here is related with the scientific publications in **Conferences** (such as IEEE International Conferences from Control Systems Society, Industrial Electronics Society, Robotics and Automation, Mechatronics and etc. To the project special focus specific conferences are the IEEE Conference on Decision and Control (CDC), European Control Conference (ECC), American Control Conference (ACC), Industrial Electronics conference (IECON) and **Journals** (such as IEEE Transactions on Industrial Electronics, IEEE Control Systems Magazine, IEEE Transactions on Industrial Informatics, Control Systems Technology, Elsevier Control Engineering Practice, IET Control Theory and Applications.). A special workshop will be organized in one of the aforementioned conferences with the aim to attract all scientists working in similar fields.

Additionally, the direct channels of the ABB, LKAB, KGHM, DCI and MOEZ will be utilized in order to increase the visibility of the project results in the industrial/commercial sector. Among other ways, the consortium will focus on participating in technological exhibitions.

Task 9.3 – Technology Exploitation Strategy and Business Plan (MOEZ)

The objective of this task is to identify and assess the knowledge generated in the different WPs and ensure the further exploitation of the project outcome. In order to achieve this goal, a Technology Exploitation Strategy (TES) will be outlined to evaluate the market potential and the requirements for commercial applications of the project results as seen from the different perspectives and competence of the involved stakeholder groups within the consortium (technology suppliers, research organisations, plant owners).

A dynamic exploitation plan including tailored solutions for the industrial partners will be developed in order to strengthen the competitiveness and increase resource and energy efficiency and thus maximize the expected commercial and investment benefits of the project.

Finally a comprehensive socio-economic analysis will be conducted to address the social, economic and environmental aspects such as creating new employment and educational opportunities, increasing the working environment security and significant contribution to the EU efforts to decrease the CO2 emissions, hence keeping these European industrial domains at the leading edge within the global market place.

The results of this analysis will be synchronized with the Business Plan using the "business models generation canvas" methodology in order to ensure the optimum exploitation of generated business opportunities and the associated business models.

Task 9.4. – Innovation and Knowledge Management (MOEZ)

Innovation and Knowledge Management will include both internal and external activities. To address the internal dimension of the project, an Intellectual Property Office (IPO) will be established in order to assess the generated knowledge throughout the DISIRE project duration, perform the IP-management (protection of IPR, background and foreground knowledge) and develop and update the Consortium Agreement (CA).

An Innovation Management Office (IMO) will be established to facilitate the innovative approach for commercialization of the DISIRE technological platform and its components. A series of training activities will be implemented throughout the project duration in order to address specific challenges of research commercialization such as time to market, design quality and functionality, manufacturability and cost efficiency in all anticipated user environments.

To deal with the complexity of the external dimension, an Interactive Innovation Toolkit will be developed within the IMO to ensure the quality and progress of commercialization of DISIRE research outcome:

- Monitoring of all existing and emerging technology solutions and applications
- Constant innovation feedback within and beyond the DISIRE consortium
- Dynamic risk management based on scenario approach
- Creating an innovation critical path to transfer the generated knowledge to the consortium partners, to the European process industrial community and finally to the market
- Achieving a maximum market penetration and cross-sectorial impact of the proposed DISIRE technological concept.
-

Task 9.6. – Commercialization and Product Development Training Platform (MOEZ)

This task will include a semi-annual series of workshops and events aiming at:

- Providing training on product development strategy for executives, managers and researchers involved in the consortium (examples for workshop topics: high quality design for low cost, design for lean manufacturing).
- Providing training through a technical business development manager to SME on how to engineer competitive products for manufacturability. This could be applied at the beginning of a venture or to the commercialization of an existing prototype or research.
- Establishing a consulting panel with some commercialization experts together with product development teams to help them with on-going consulting advice to apply the most advanced product development principles and make the best decisions throughout their projects.
- Organizing a "DISIRE training Summer School" on topics relative to the project results and objectives for industrial professionals, postgraduate and PhD students. The summer school

represents the main training event of DISIRE.

- "Final Workshop" will aim in the presentation of the final results and scientific contributions achieved within the project as well as live experimental demonstrations in the selected demonstration process. The workshop will equally focus on academic institutions and industrial end-users.

Role of Partners:

In order to highlight the importance of the DISIRE project to the innovation activities of the project, the overall WP9 will be led by Fraunhofer MOEZ in order to have a direct innovation character in all the related activities. More specifically, LTU will lead the specific tasks of Public visibility (T9.1), dissemination of results (T9.2) and some of the training activities (T9.6). MOEZ will be responsible for all the innovation activities of the DISIRE project results, including the technology exploitation strategy and business plan (T9.3), innovation and knowledge management (T9.4) as well as multiple training activities in the specific to the DISIRE industrial sectors, as long as to other identified cross-sectorial industrial sectors. MEFOS will disseminate the achieved result within the steel sector and in scientific publications.

Deliverables	
D9.1: Project identity and dissemination material schedule (LTU)	M1
D9.2: Project website and overall online presence (LTU)	M1
D9.3: Commercialization and Product Development Workshops, Live Demonstrations, Media Shows (MOEZ)	M4, M12, M18, M24, M30, M36
D9.4: Training Summer School on DISIRE technology (MOEZ)	M30
D9.5: Technology Exploitation Strategy (LTU)	M1-M6
D9.6: Business Plan (MOEZ)	M1-M12
D9.7: Establishing and running an Innovation Management Office (MOEZ)	M1-M36
D9.8: Development of Interactive Innovation Toolkit (MOEZ)	M1-M6

Work package number	**10**		**Start date or starting event:**			**M01-M36**	
Work package title	***Project Management & Coordination***						
Participant number	**1**	2	3	4	5	6	7	8
Participant short name	**LTU**	LKAB	KGHM	ODYS	WUT	IMTL	CUP	ETEC
PMs per Partner	**10**							
Participant number	9	10	11	12	13	14	15	
Participant short name	CIRC	DCI	ABB	DAPP	MOEZ	GST	MEFOS	
PMs per Partner								

Objectives

This work package will cover the overall legal, contractual, financial and administrative management of the DISIRE project, while establishing a reliable contact with the EC throughout the Project duration. The overall co-ordination and control of the international collaborative work will be done by LTU as the coordinating partner, together with the Management Board. Moreover, this work package will ensure that the work is carried out in a timely and cost effective manner and will supervise the preparation and the overall quality of the produced deliverables.

Description of work

Task 10.1 - Financial and administration management (LTU)

The main objective of this task is the overall project management concerning financial and administrative aspects and the effective communication with the EC (e.g. cost statements collection and submission to the EC, establish contact with the Commission Financial Office, advanced payments coordination, final check of deliverables).

Task 10.2 - Co-ordination and project monitoring (LTU)

This task covers the overall project management concerning the coordination of the DISIRE consortium in collaboration with the WP leaders in order to cope with the problems of specifying, integrating, developing and evaluating the concepts, methodologies and technologies within DISIRE. These activities include not only communication within the consortium, but also with other related, existing or emerging projects and initiatives as well as international standardization activities and potential further industrial partners that would like to be aligned with the DISIRE vision and affect the future directions.

Task 10.3 - Development of regular Progress Reports and a Final Report (LTU)

This task is meant to develop the DISIRE Progress Reports (D10.1), which represents the assessment of the project results concerning the acquired concepts and methodologies and software development status. The produced report will be revised and will be considered as an on-going document with 6 months releases throughout the project duration.

The mid-term Progress Report (scheduled for the 18th month) mainly focuses on the evaluation of the DISIRE progress during the first part of the project and includes a detailed outlook for the second part of the project duration. The DISIRE Final Report (D10.2) will focus on representing the final results of the project and the evaluation of the results compared to its initially defined objectives and goals.

Role of Partners:

LTU will lead this WP as the coordinator of the DISIRE proposal.

Deliverables	
D10.1: DISIRE Progress Report releases	M6,M12,M18,M24,M30,M36
This deliverable, will be an ongoing document that embodies the evaluation and estimation of the project results concerning the developed concepts, methodologies and development status. The planned releases are:	
D10.2: DISIRE Final Report	M36
This deliverable will present all the achievements of the DISIRE project, the main contributions and the overall report on financial reporting, while will summarize the results and the impact of all WPs in DISIRE.	

Table 3.1b: List of work packages

WP No	Work Package Title	Lead Participant No	Lead Participant Short Name	Person-Months	Start Month	End month
1	***Application Scenarios, Impact Goals and Benchmarks***	1	LTU	44.5	M1	M12
2	***Process Modelling and Control***	6	IMTL	94	M1	M32
3	***Sensors & Electronics***	1	LTU	50.5	M4	M21
4	***Data Mining***	14	GST	75	M1	M35
5	***Non-Ferrous Mineral Processing***	7	CUP	79	M5	M34
6	***Ferrous Mineral Processing***	8	ETEC	23.5	M5	M34
7	***Steel***	15	MEFOS	24	M5	M34
8	***Combustion Processes***	9	CIRC	60	M5	M34
9	***Dissemination and Innovation***	13	MOEZ	49.5	M1	M36

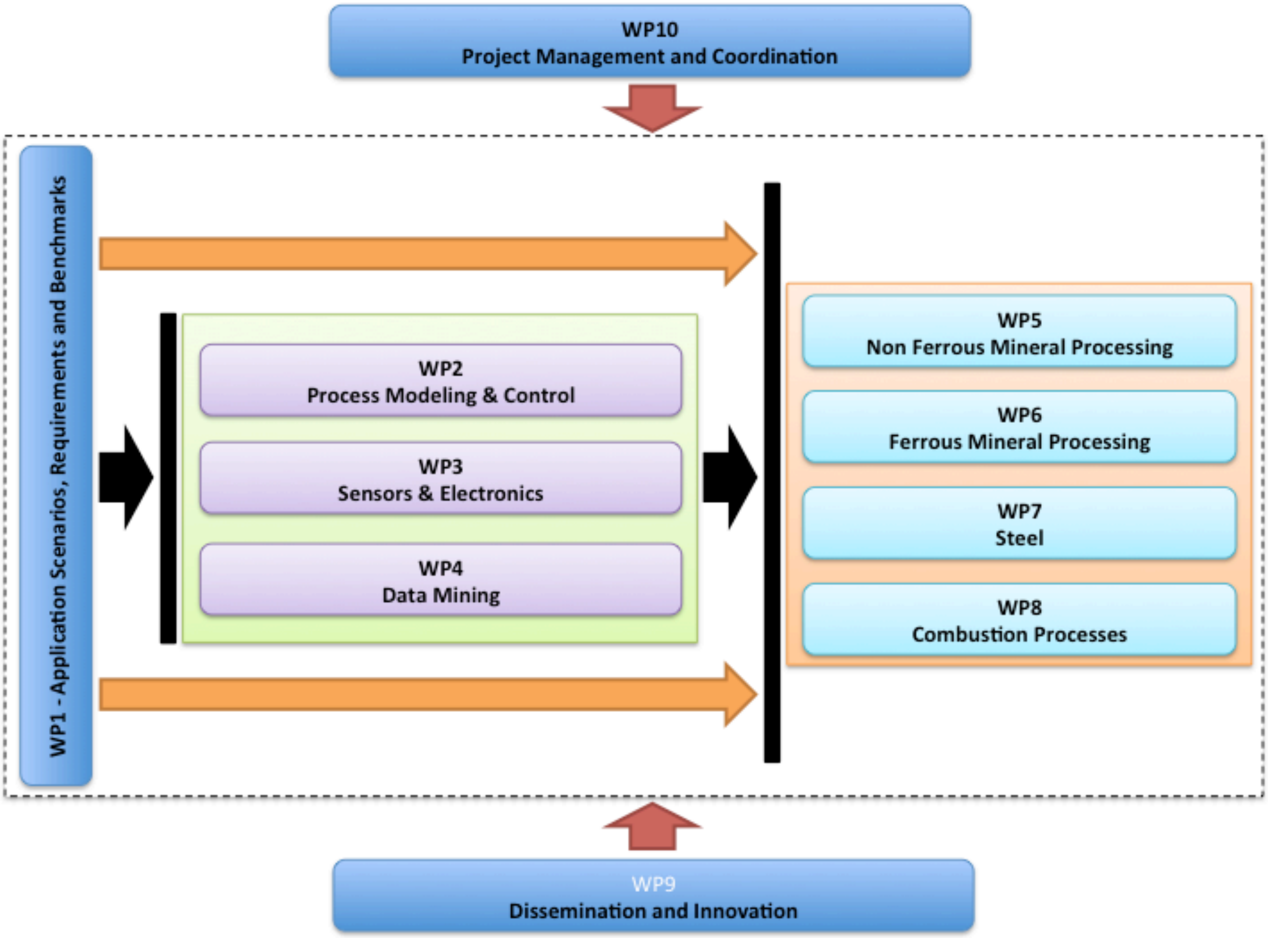
10	***Project Management & Coordination***	1	LTU	10	M1	M36
				510		

Table 3.1c: List of Deliverables

No.	Deliverable name	WP No.	Part	Type	Dissemination level	Delivery date
D1.1	Benchmark specifications and related performance measures for expected Impact	WP1	LTU	R	PU	M6
D1.2	Application scenarios and demonstration activities specifications	WP1	LTU	R	PU	M12
D1.3	Report on end-user requirements, and regulations	WP1	LTU	R	PU	M12
D2.1	Modeling and process control architectures for data-driven MPC	WP2	IMTL	R	PU	M18
D2.2	Data-driven MPC algorithms and software	WP2	IMTL	R	PU	M28
D2.3	Performance assessment of data-driven MPC	WP2	IMTL	R	PU	M18, M32
D3.1	Sensor technology selection report	WP3	LTU	R	PU	M9
D3.2	Small scale validation report	WP3	DAPP	R	PU	M18
D3.3	Report on batch sensor design solutions	WP3	LTU	R	PU	M18
D3.4	Report on sensor solutions for continuous processes	WP3	LTU	R	PU	M21
D4.1	Industrial Process Discovery Document	WP4	GSTAT	R	PU	M6
D4.2	Sensor data Collection preparation system design report	WP4	GSTAT	R	PU	M26
D4.3	Analysis and calculation module Report	WP4	GSTAT	R	PU	M35
D4.4	Business and Deployment Plan	WP4	GSTAT	R	PU	M35
D5.1	On the modelling and control of belt conveyor network	WP5	CUP	R	PU	M18
D5.2	Applied PAT and data mining for raw materials transportation system	WP5	WUT	R	PU	M24
D5.3	PAT based IPC demonstration on conveyor network control	WP5	CUP	R	PU	M34
D6.1	Base Case Description – Instrumenting the pellet transportation chain	WP6	ETEC	R	PU	M12
D6.2	Evaluation of PAT based IPC performance in pelletizing plant	WP6	ETEC	R	PU	M24
D6.3	Product tracing in ferrous mineral processing	WP6	ETEC	R	PU	M34

	based on DISIRE technology					
D7.1	Evaluation of sensors to be used in the steel industry	WP7	MEFOS	R	PU	M20
D7.2	Evaluation of data analysis and PAT production in the steel process	WP7	MEFOS	R	PU	M24
D7.3	Evaluation of the IPC in the steel process	WP7	MEFOS	R	PU	M34
D8.1	Report of suitable O2 sensors for cracking furnaces characteristics	WP8	CIRC	R	PU	M12
D8.2	Technical report of CFD results regarding the optimal localization in furnace for O2 sensoring	WP8	CIRC	R	PU	M18
D8.3	Technical report for optimizing the combustion efficiency in cracking furnaces	WP8	CIRC	R	PU	M24
D8.4	Report of flame and combustion characterization by means of optical non-invasive instrumentation. Developments of algorithms for control combustion	WP8	CIRC	R	PU	M30
D8.5	Report of DEMO-site implementation of control systems based on O2 sensoring and optical non-invasive instrumentation	WP8	CIRC	R	PU	M34
D9.1	Project identity and dissemination material schedule	WP9	LTU	R	PU	M1
D9.2	Project website and overall online presence	WP9	LTU	R	PU	M1
D9.3	Commercialization and Product Development Workshops, Live Demonstrations, Media Shows	WP9	MOEZ	R	PU	M4,12,18,24,30,36
D9.4	Training Summer School on DISIRE technology	WP9	MOEZ	R	PU	M30
D9.5	Technology Exploitation Strategy	WP9	LTU	R	PU	M1-M6
D9.6	Business Plan	WP9	MOEZ	R	PU	M1-M12
D9.7	Establishing and running an Innovation Management Office	WP9	MOEZ	R	PU	M1-M36
D9.8	Development of Interactive Innovation Toolkit	WP9	MOEZ	R	PU	M1-M6
D10.1	DISIRE Progress Report releases	WP10	LTU	R	PU	M6,12,18,24,30,36
D10.2	DISIRE Final Report	WP10	LTU	R	PU	M36

3.1.4 Pert Diagram



3.2 Management structure and procedures

Management and co-ordination tasks are of great importance within the DISIRE project in order to succeed its objectives. The described activities and objectives of the project require a high cooperation and integration level in order to accomplish the project final output. Thus, the management structure has been carefully defined and structured, both from a technical and an administrative point of view. The DISIRE project management deals with the overall management structure and the implementation of the management, that is, the decision rules, conflict resolutions, meetings, internal communication flow and reporting progress.

3.2.1 Management capability of the coordinator

The leading partner of this STREP would be the **Luleå University Technology** (LTU) and **Dr. Pär-Erik Martinsson** will act as the coordinator of the DISIRE consortium. LTU has a significant experience in conducting high value research and undertaking industrial R&D projects. LTU has been involved in large European and National projects with Volvo, LKAB, SAAB, Vidsel, and many more industrial partners. Form LTU three groups namely the control engineering group, the embedded systems and electronics and the data analysis research groups will participate in the consortium. These groups have published more than 400 articles in Journals and Conferences, and have a unique theoretical and practical experience in control systems, industrial processes, sensors and electronics as well as data mining. At his point it should be mentioned that LTU is also coordinating one of the biggest ARTEMIS projects in Europe, the Arrowhead project, which has one of the biggest industrial networks in Europe. LTU has also established 2 institutes directly working in the industrial sector both in a National and International level called ProcessIT[29] and ProcessIT.eu[30].

Dr. Pär-Erik Martinsson is working at the Research and Innovation center ProcessIT Innovation at Luleå University of Technology and has a long experience of managing collaborative projects primarily in industrial automation and sensor technology both national and international. He is currently active in several European initiative such as the SPIRE Working Group Process and the Artemis Center of Innovation Excellence ProcsessIT.EU and has the co-authored the national Swedish Research Agenda (SRA) in process automation and mining.

3.2.2 Management structure and decision-making structure

The DISIRE project's management structure is described in the figure below. At the top of the structure, there is a **Steering Committee**, which is the decision-making and arbitration body of DISIRE concerned with policy and strategy. The **Scientific Committee** forms the second level of the management structure. It has powers delegated to it by the Steering Committee to implement policy and strategy decisions. It is composed of the work package leaders who are responsible for the day-to-day management of the individual work packages. The Scientific Committee is the supervisory body for the project execution and shall report and be accountable to the Steering Committee. The **Project Coordinator** will provide a strong central coordination, performing functions such as the technical coordination, financial administration and internal and external communications, to ensure that DISIRE will operate in a truly integrated manner. Moreover, the **Management Support Team** will assist the Coordinator.

Steering Committee:

Chairman: Project Coordinator.
Members: One representative of each partner that must have the legal authority.
Responsibilities:

- The overall supervision of the political and strategic orientation of the project and the program of activities;
- The management of changes and resolution of conflicts with respect to the programme of activities;
- The execution of deliverables and milestones, the follow-up of the performance indicators and the coordination of the progress reports;
- The approval of deliverables as well as financial statements;
- The agreement to any changes to the technical content;
- The supervision of all dissemination activities, including deciding on protection and access rights to knowledge based upon the Heads of Agreement;
- Management and preparation of the contract with the funding agencies;
- The preparation of the budget and financial allocation to each partner;

Scientific Committee:

Chairman: Project Coordinator.
Members: One representative per partner participating in the relevant WPs.
Responsibilities:

- Monitoring the progress of work packages against the implementation plan;
- Ensuring the coordination of the project activities;
- Implementing the decisions taken by the Steering Committee;
- Reviewing Intellectual Property issues and reports proposed by the Intellectual Property Officer;
- The preparation of progress reports, within each work package;

Project Coordination:

LTU as the **Coordinator** will assume responsibility for the management of the project, which will be carried out by **Dr. Pär-Erik Martinsson**. The Coordinator is responsible for:

[29] http://www.processitinnovations.se/
[30] http://www.processit.eu/

- Administrative coordination and financial management;
- Communication between the Steering Committee, the Scientific Committee and all the partners;
- Acting as spokesperson of DISIRE towards the EC;
- Proposing agenda for consortium meetings;
- The collection, collation and forwarding of progress reports;
- Central document administration;
- Setting up a web-site, with internal and external faces, enabling easy transfer of large data files and documents with the appropriate degree of security, whilst also allowing a summary of the project and its achievements to be viewed by external parties
- The transfer of all deliverables to the Commission;
- Monitoring of the Intellectual Property Plan.

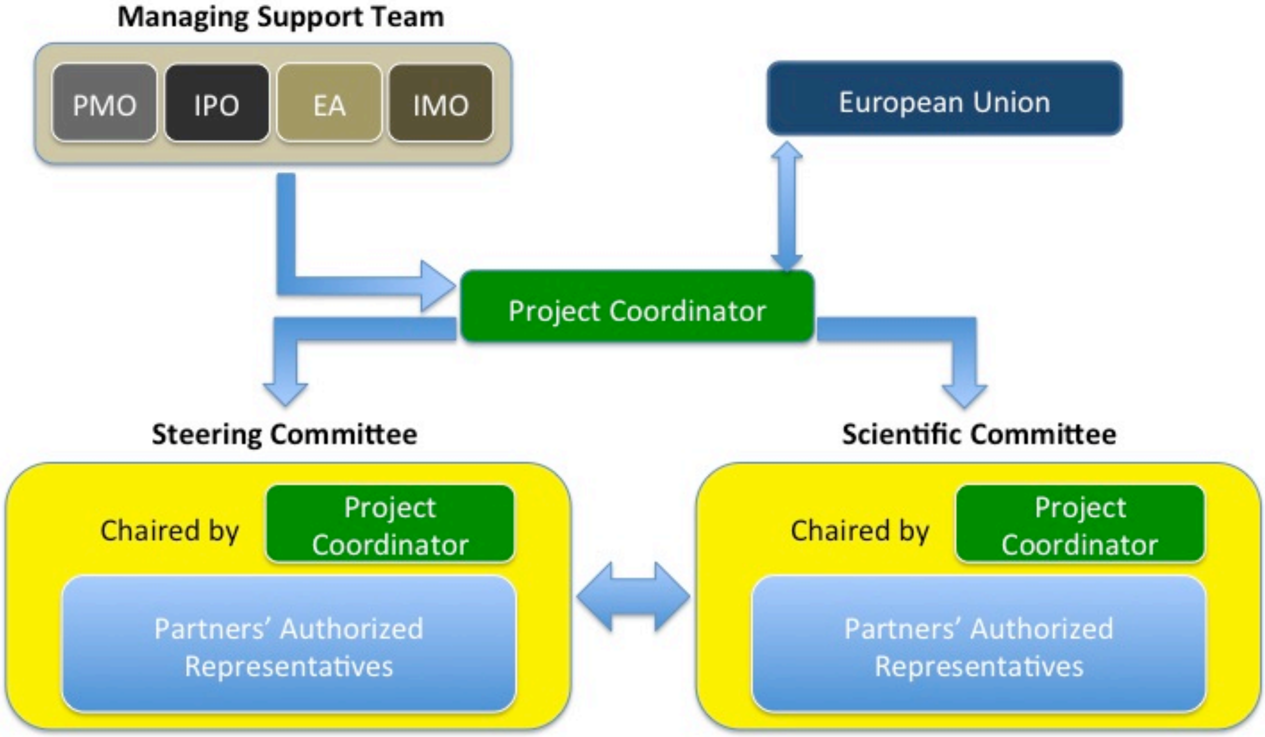


Figure 2.1: Management structure of DESIRE

<u>Management Support Team:</u>

The coordinator, Dr Pär-Erik Martinsson, will be assisted by the **Management Support Team** so as to accomplish all these responsibilities:

<u>Project Management Office (PMO)</u> The PMO is in charge to compare in real time what is actually done to what is due by contract with regard to costs, time schedule and delivery. The PMO report any deviation, ask for proper decisions to be made in case of any deviation, and push the Consortium to update contractual framework toward the Commission (keep in line with the contract or amend it) and toward one another (IPR issues, budget share. etc.) if the project does not evolves exactly as anticipated in the proposal (i.e. the usual scenario). The PMO shall also ensure the quality of work within the project.

Prof. George Nikolakopoulos from **(LTU)** will lead the PMO and support the Coordinator. Prof. Nikolakopoulos will lead the Project Management Office of the project, while he has a long experience coordinating projects and significant technological background and experience with European Union's procedures.

<u>Innovation Management Office (IMO)</u> The IMO will be in charge of series of activities ensuring that the highest innovative potential of the Consortium is realized throughout the entire project duration. With this goal, the IMO will create an innovation strategy to transfer the generated knowledge to the consortium partners, to the European process industrial community and finally to the market. Furthermore, it will establish a consulting panel and provide on-going training on technical business development to managers and researchers within the consortium support the decision-making process and secure the quality and progress of commercialization of DISIRE research outcomes. Finally, IMO will be closely working with other Managing Support Teams and AB to ensure the collaborative and integral innovation approach in the Consortium as a whole.

Ms. Eleonora Zagorska from **(MOEZ)** will lead the IMO and support the Coordinator. Ms. Zagorska has coordinated some European projects while providing technology localization strategies and innovation management solutions to European technology companies expanding into the new emerging markets. Thus, her task will be to provide a constant innovation feedback to the Project Coordinator and other Managing Support Teams.

Intellectual Property Officer (IPO) from XXX will act as IPR manager of the project and will support the coordinator in dealing with legal issues and IPR issues. This person will be responsible for the identification of pre-existing know-how to be protected from each partner, will prepare and regularly update the Consortium Agreement according to the project evolution and will advise partners about knowledge protection.

Ethical Advisor (EA) Lena Sundqvist from **MEFOS** will be the Ethical Advisor and will advise the Scientific Committee on all matters relating to the Ethics of the project.

3.2.3 Implementation of the management

DECISION RULES

The voting rules for the DISIRE project will be the following:

- Each partner (that is not a defaulting partner) will have one vote, independently of their economic or technical contribution
- Decisions in the Steering Committee (minimum quorum 2/3) will be taken upon 2/3 of the votes with some exceptions
- Decisions in the Scientific Committee (minimum quorum 60%) will be taken on a unanimous basis of its members

An intention to publish or patent of results emanating from the project must be declared to the Steering Committee, the principles governing the Steering Committee's decisions being stipulated by the Grant Agreement. The decision-making and conflict resolution processes will be further explained in the Consortium Agreement. Nevertheless, the existence of collaborative ties among the partners and the cohesiveness of the Consortium do not pose the threats of major conflict.

Conflict Resolution:

Conflicts will be solved at the lowest level possible, and preferably amicably. In the event that Consortium Partners have been unable to amicably resolve any dispute arising out of the work on the project (disagreements, strategic divergence and conflicts of interest etc.), the following steps should be carried out:

- Any member of the Consortium may bring up a major problem. A written statement is required which declares the problem as a major problem and clarifies and identifies it properly.
- The Coordinator tries to solve the problem with the concerned member. If the conflict cannot be solved, the following steps apply.
- The Coordinator raises the issue at the next regular Steering Committee meeting, or calls for a special meeting to solve the problem,
- During that meeting, the different solutions of the problem have to be worked out clearly. The problem can be solved at this level if an agreement is found between the partners.
- If not, a formal vote takes place according to Steering Committee's normal procedure.

Quality Assurance:

The project will apply the following reviewing procedure to guarantee the quality of its results:

- All deliverables shall require the approval of the Project Coordinator and PMO prior to transmission to the Project Officer.
- The Work Package Leader shall give his/her initial approval to the draft. Initial drafts of deliverables may be sent to the PMO for initial comments if wished.
- When a final draft is ready, it should be sent by the WP Leader to both the Project Coordinator and PMO in parallel for approval.

- The Project Coordinator will be responsible for the technical content of the deliverable and the PMO will be responsible for its compliance with project standards.
- Important deliverables will additionally be subject to a peer review by an expert external to the project.
- The PMO will be responsible for uploading an approved deliverable to the project management web site. The Project Coordinator will take this version forward to the Project Officer.

For each step of the procedure explained above, corrections will be made to the deliverable until the approval of the reviewers is get.

Meetings:

An important part of the communication protocol will be the face-to-face meetings or videoconferences. Various meetings have been already planned according to the following basis:

- Kick-off meeting, as soon as the project starts.
- Every six-months a consortium meeting will take place.
- Annual meetings with the EU commission.
- As often as the interests of the consortium requires the Steering Committee will be meeting, at least once a year.
- The Scientific Committee will meet at least every six months.
- WP meetings will be held at least once a month.
- Every six months meetings will be held between the technical partners and the partners representing end-users.

An important effort will be made for a confluence of some of these meetings in order to save costs in travel and meeting organisation.

Internal Communication Flow:

A fluent communication among partners is essential to ensure the correct progress of the project. The communication flow will be bottom-up and top-down through the typical communication methods (such as: e-mail, phone, fax, etc.) and more advanced ICT services (videoconferences and/or teleconferences, net meetings etc.). Besides, an email address group will be created to facilitate the communication with the consortium.

DISIRE's website will include a private section that will also help with the communication between consortium members. Passwords will be facilitated to all partners as well as to the European Commission. All participants will be able upload and download information regarding their concrete task according to their role and responsibilities. Besides, project documents (Grant Agreement, Technical Annex, Consortium Agreement, as well as deliverables and working papers) will be available. Another section will be for meetings, events, seminar, etc.

Summary information about the project and public reports will be made available for everybody on the Internet as a means to effectively communicate with parties outside the consortium, such as other European projects or potential users.

Reporting Progress:

The Project Coordinator will be responsible for monitoring the progress of the project, achieving the necessary cooperation and maintaining budgetary control. In addition, the Project Coordinator will be responsible for preparing and distributing all the reports required by the Commission at due time. In order to achieve these objectives, all consortium members will actively participate. The WP participants will report (technical progress, results obtained…) to their respective WP leaders. The WP leaders will write an extended report of the activities in their WP according to the milestones and deliverables tables.

- **GANTT charts** will be used to monitor WP/ tasks progress from a timing point of view. This tool will track delays or advances in the R&D work and help ensure that the project objectives are achieved within the project timeframe.
- **Milestones and Deliverables tables** will be used to evaluate progress. Deliverables refer to the results/information to be provided within a WP. These deliverables will be used as evaluation criteria for assessing the status of the WP (completed or not) and its level of success (assessment of the results or not). This evaluation will be made during the Milestones reviews.
- **Annual report:** The Project Coordinator will collect the different reports sent by WP leaders and will be responsible for preparing a formal report to the EC every year. This report will describe the achievements of the project, critically assess its operation and recommend, as appropriate, further actions. The Project Coordinator will distribute the Annual Report to all partners of the project.

Consortium Agreement:

A Heads of Agreement has been drawn up that will form the basis of a Grant Agreement which will define regulations and procedures of the work as well as the exploitation of results, ownership of intellectual property and rights and duties of the partners in the project. The partners are committed to sign the Consortium Agreement before the date on which the contract with the Commission enters into force. This agreement will cover:

- The list of participants
- The management structure: composition, quorum requirements, responsibilities and role
- Specific arrangements concerning intellectual and industrial property rights to be applied among the participants and their affiliates.
- Provisional list of pre-existing know-how used (according to the description of work)
- Major principles and dissemination issues
- Arrangements for the liabilities of the Work-Share

Promotion of Gender Equality in the Project:

The co-ordinator in collaboration with the Ethical Advisor will be responsible for promoting and overseeing the gender equality plan, while the WP leaders will assist it. The promotion of gender equity will be done through the following actions:

- Inclusion of women in the technical performance of the different WPs and tasks of the project. A 30% of women participation is expected.
- Use of gender free language in reports and other communications.

3.2.4 Milestones

Table 3.2a: List of milestones

No.	Milestone name	Related WP	Date	Means of verification
1	Acceptance of Performance Evaluation Strategy and Targeted Impact Goals	WP1	M06	Clear and measurable performance indexes and Impacts goals are completed and agreed on between the industrial partners in WP01 T1.1. Application work packages (WP05-WP08) and EU officer
2	Approval of RDI activities in the DESIRE's key technological WPs and full compatibility with the Technology Demonstration WPs	WPs 2-4 and WPs 5-8	M12	The specification work in WP01 is completed and the focus in the RDI activities is highly relevant for the participating process industries. The 1st Year Review of the project will verify the achievement of the milestone
3	PAT sensor applicability to DESIRE's demonstration processes	WPs 2-4	M24	Indicates that the development work regarding the distributed PAT sensor is completed and will be evaluated in industrial pilot processes as well as in full-scale scenarios. The 2nd Year Review of the project will verify the achievement of the milestone
4	Demonstration of DESIRE processes and Innovation	WPs 5-8 And WP9	M34	Application work packages are completed and the results have been utilized according to the dissemination and implementation plan. The results will be communicated to the EU officer before the final 3rd Year evaluation of the project

3.2.5 Critical Risks and Associated Risk-Mitigation measures

The DISIRE consortium based on the extended and proven expertise of its consortium has already identified the following critical risks for reducing the expected success and overall impact of the project, the probability of the identified risk occurrence and has already decided proper risk mitigation measures as it is indicated in Table 3.2b.

Table 3.2b: Critical risks for implementation

WP Involved	Description of Risk	Probability of occurrence	Impact	Proposed risk-mitigation measures
WP1 – Application Scenarios, Requirements and Benchmarks				
R1.1	The application and demonstration scenarios are not realistic	Low	The scientific and technological impact of the project will be limited	The PM will, in dialogue with the SPIRE PPP and Project Officers, secure the proper selection of scenarios and demonstrations.
R1.2	The system requirements are not adequate and are misleading	Medium	The project objectives will be either easily reached or too harsh to be achieved	Evaluation of the projects objectives towards the application scenario will be performed, through technical meetings, integration weeks and email exchange.
WP2 – Process Modelling and Control				
R2.1	Not sufficient amount of data and too low data quality for modelling	Medium	Models will be of low quality	The first phase of the project will focus on data quality and integrity and robust data sampling and modelling techniques will be used.
R2.2	Off-line models (virtual plants) do not behave as real processes	Medium	The project will be delayed until models have been calibrated	Constant evaluation of modelling results and comparison and calibration of real process data.
WP3 – Sensor & Electronics				
R3.1	Low quality communication between sensors and readers for some applications	Medium	Some measurement possibilities are lost	The design of the PATs will be enlarged to accommodate larger antennas, wavelengths will be customized for the applications.
R.3.2	Some sensors too fragile or sensitive	Medium	Some measurement possibilities are lost	Increased PAT robustness through robust and thick encapsulations and state-of-the-art sensors .
WP4 – Data Mining				
R4.1	Not sufficient amount of data and too low data quality for modelling	Medium	Models will be of low quality	The first phase of the project will focus on data quality and integrity and robust data sampling and modelling techniques will be used.
R4.2	Data structure too complex and calibration data sets to not sufficient	Medium	Not all available data sources can be used for updating the process state estimation	Start with data streams of high integrity and steady sample frequencies and update state estimation each time PAT sensor data is obtained.
WP5 – Non-Ferrous Mineral Processing				
R.5.1	Not sufficient amount of data and too low data quality for modelling	Low	Models will be of low quality	The first phase of the project will focus on data quality and integrity and robust data sampling and modelling techniques will be used.
WP6 – Ferrous Mineral Processing				
R6.1	No suitable RFID communication of traceable pellets	Low	Traceability of pellets to customer application lost.	Radio environment of furnace conveyors and transporters are analysed. Different radio frequencies may be used.
R.6.2	Segregation tendencies of large PATs will remain large despite adjusting PAT density	Medium	Research objectives such as measurements of physical properties in flowing granular media	Measurements obtained from segregated PATs may not be suitable for on-line measurement but will still be useful for process design such as design of bins and storages.
WP7 – Steel				
R7.2	Not sufficient amount	Low	Models will be of low	The first phase of the project will focus

	of data and too low data quality for modelling		quality	on data quality and integrity and robust data sampling and modelling techniques will be used.
R7.3	High temperature exposure during long time damages the PAT	Medium	Internal state of process will not be monitored as deep as expected	Trial and error using various encapsulations and possibly use lancing.
WP8 – Combustion Processes				
R8.1	Not suitable radio environment for PAT communication	Medium	The possibility of reaching in-situ measurements within the furnaces is reduced. Intelligent Raw Material concept not applicable.	Trials of external as well as internal antenna positions in low temperature locations such as at the top of the blast furnace or intermittent transmission by using antennas during lancing.
WP9 – Dissemination and Innovation				
R9.1	The Dissemination strategy is not working	Low	The scientific impact of the project and the general awareness of the relevant stakeholders will be kept low	Discussion among all the partners for redesigning the strategy for disseminating the produced knowledge.
R9.2	Innovation Strategy not appropriate	Medium	The project outcome will fail to have a direct social and industrial impact	Discussion among all the partners for redesigning the strategy and the impact on the products life cycle for all the exploitable results.
R9.3	Business models not applicable	Medium	Few or no customers interested in DISRE Value proposition.	Rapid prototyping of new innovative business models using the "Business Model Canvas".
WP10 – Project Management and Coordination				
R10.1	Inaccuracies in estimating the work load and time planning.	Medium	Misalignments between the true and the planned partners' efforts. The goals and/or cost target of the project cannot be reached	Constant tracking by the PM of the project will retain delivery times, while predicting delays and proposing alternative plans to overcome these ones.
R10.4	Conflicts and communication problems among the consortium members	Low	Delays and reduced quality in the project deliverables	A democratic and dialectic approach will be applied in all the consortium meetings and correspondence.
R10.5	Loss of key personnel	Low	Key WPs are not completed	Partners will be encouraged to ensure they have a succession planning. All work will be thoroughly documented and internal reviews will take place regularly.

3.3 Consortium as a whole

For achieving the project objectives and the expected impact, a balanced consortium has been brought together, consisting of leading academic, private, and industrial partners, has been formed. The three process industries involved in the DISIRE project – LKAB, DCI, and KGHM than are world wide leaders in their field and will assure the direct applicability and innovation of the projects components in their processes. MEFOS is a world-leading institute in steel research with access to large piloting facilities and are managing the worlds only Experimental Blast Furnace is highly focused on applied research in benefit for their members. The members of MEFOS come from the whole world with many whom are market leaders in their respective field. These partners will heavily cooperate with the technology providers partners like ETEC, DAPP, MEFOS and CUP in order to transform the scientific results of the RTD partners LTU, WUT, IMTL, and GST into realizable technological formulations that can be directly applied, installed and demonstrated to processes. The consortium is being integrated by the world wide leading company in the field of Industrial Process Control, Automation and PAT analysis the ABB, which throughout the whole project duration will provide their industrial expertise in creating fully cutting edge technology that can be directly applied and evolve the current state of the art, while ensuring for an increased TRL level of demonstrations as demanded by SPIRE. In order to emphasise the strong innovation and productization and commercialization character of the DISIRE project, Fraunhofer MOEZ will ensure for a maximum market penetration and cross-sectorial impact of the proposed DISIRE technological concept.

The significance of the world wide leading industrial partners being involved, coming from the field of Mining, Mineral Processing, Steel and Chemical are ensuring that the DISIRE technologies will be applied in the full product cycle and will significantly alter the existing concepts in IPC. Additional to the DISIRE's industrial partners, the top European RTD partners in the field of Industrial Process in collaboration with the specialized SMEs in technology and integrated solutions providers, as well as the Europe's leading industrial control supplier ABB will ensure a direct impact of from the DISIRE project in the current state of the art in the industrial processes.

3.4 Resources to be committed

The consortium set up by the DISIRE project has a clear vision of its objectives and therefore is committed to the right allocation of the financial resources at its disposal. The close nature of cooperation in the project is evident by the coherent program that has a joint focus, while distributing tasks among the different partners that have complementary expertise and resources. The clear combination among the Academic partners, the technology providers and the industrial partners guarantee a proper combination of resources and strong impact on the DISIRE's outcome. All the partners contribute to the project with their industrial processes, their industrial measuring and control equipment and the laboratories in pure combination with each partner's many years of experience in their area. The partners are in agreement, ready and capable of providing the self-financing and additional in kind contribution to the DISIRE project if needed to undertake the extra cost implementation of the project objectives over the three-year duration of the project. In the following table, the person-month (PM) dedication and financial resources per partner for the entire project are summarised:

Table 3.4a: Summary of staff effort.

	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	WP9	WP10	Total PMs
1. LTU	9	16	16	3	2	2	2	1	7	10	68
2. LKAB	3	0	1	0	0	4	0	0	1	0	9
3. KGHM	3	0	2	1	9	0	0	0	2	0	17
4. ODYS	0	3	0	1	4	5	3	3	1	0	20
5. WUT	4	17	8	22	33	0	0	0	4	0	88
6. IMTL	4	36	2	10	3	2	2	1	5	0	65
7. CUP	4	3	4	3	26	0	0	0	2	0	42
8. ETEC	3	0	6	0	0	8	0	0	1	0	18
9. CIRC	4	3	2	0	0	0	0	40	1	0	50
10. DCI	2	0	1	0	0	0	0	7	1	0	11
11. ABB	2	10	0	0	1	2	2	1	2	0	20
12. DAPP	2	3	7	3	0	0	0	7	1	0	23
13. MOEZ	0	0	0	1	0	0	0	0	17	0	18
14. GST	2	0	0	26	1	0.5	1	1	1.5	0	32
15. MEFOS	2.5	3	1.5	5	0	0	14	0	3	0	29
Total PMs	44.5	94	50.5	75	79	23.5	24	60	49.5	10	510

Section 4: Members of the consortium

4.1. Participants

Participant 1	**Luleå University of Technology (LTU)**
Description of the legal entity	The leading partner of this STREP would be the Luleå University Technology (LTU). LTU has significant experience in conducting high value research and undertaking industrial R&D projects. Moreover, LTU has been involved in large European and National projects with Volvo, LKAB, SAAB, SSC, ERICSSON and almost all the major Swedish process industries. LTU is the number one University in Sweden in receiving external grants from the Industrial sector, which proves the leading position of the University in applied and real-life connected research. LTU will enter in the DISIRE proposal with 3 research groups, namely the Control Engineering group, the Electronics and Embedded Systems group and the Quality technology group. In total the members of these groups have published more than 800 articles in International Journals and Conferences. The involved groups from LTU in the DISIRE proposal have a significant experience and reputations in areas such as: Integrated Process Control, sensor development, PAT analysis, wireless sensor networks, condition monitoring, embedded systems, industrial automation, soft sensors, traceability, estimation, and optimization.
Role in the project and main tasks	LTU will lead the consortium and will participate in all the involved WPs. The LTU's profile is fully aligned with a long term and highly successful collaboration with the industry and especially in the field of process and automation. Moreover, LTU has created the Process IT innovation office, which is one of the biggest professional links in Sweden among the research activities and their application to multiple industrial sectors. The contribution of LTU except from the management and dissemination will be also distributed among the rest of WPs based on the expertise of LTU's Departments participating in the DISIRE consortium. More specifically, based on LTU's experience in the industrial sector, LTU will significantly contribute towards the definition of the requirements, demonstration and evaluation scenarios WP1. In WP2, LTU will participate with the Department of Computer Science, Electrical and Space Engineering and more specifically with the subjects of Electronics and Embedded systems that will lead the developments of the DISIRE electronics and sensors and especially driving the developments in the area of miniaturized sensors for pellets. In WP3 LTU will contribute in the IPC strategy formulation, while in WP4 the focus of LTU's participation will be on the data mining and developing advanced close to real time PAT analysis functionalities. LTU will also participate in all the technological and demonstration WPs from WP5 to WP8.
Description of the key persons involved	**Dr. Pär-Erik Martinsson** is working at the Research and Innovation center ProcessIT Innovation at Luleå University of Technology and has a long experience of managing collaborative projects primarily in industrial automation and sensor technology both national and international. He is currently active in several European initiative such as the SPIRE Working Group Process and the Artemis Center of Innovation Excellence ProcsessIT.EU and has the co-authored the national Swedish Research Agenda (SRA) in process automation and mining. **Prof. George NIKOLAKOPOULOS** is leading the Industrial and Autonomous System Group at LTU and has a significantly large experience in Managing European and National big Projects. In the past he has been project manager in Several R&D projects funded from the EU, ESA, Swedish and the Greek National Ministry of Research, with

	some examples such as: a) EU funded projects: FLEXA (IP), C@R (IP), NANOMA (STREP), SYMBIOSIS-EU (STREP), CONFIDENCE (STREP), PROMOVEO (STREP), CommRob (STREP), b) Swedish funded projects: Mine Patrolling Rovers and EQoREF. In year 2003, Prof. Nikolakopoulos have received the Information Societies Technologies (IST) Prize Award for the best paper that Promotes the scopes of the European IST (currently known as ICT). His published scientific work includes more than 150 published International Journals and Conferences in the fields of his interest. Moreover he served as IPC member and Technical Track Chair for multiple conferences, such as ICIT'11, CoDIT'13, CASE'2010, ETFA'2010, ECC'09, MED'09, MIC'09, and MIC'10 international conferences, and has been Associate Editor and Reviewer of Several International Journals and conferences. **Prof. Bjarne Bergguist** is chaired professor of Quality Technology at Luleå University of Technology. Bjarne has worked with traceability issues for process industrial applications, as well as with statistical data analysis for statistical process control, capability and experiments in the continuous process environment. He has a background as project leader for and researcher in projects ranging from the Swedish Scientific Council, the Swedish Foundation for Strategic Research, as well as applied projects funded by the Swedish innovation agency VINNOVA, the European Regional Development Funds or directly by industries such as LKAB. He has published work includes 28 scientific journal articles, and an equal number of scientific conference papers. He is a member of the editorial board of three journals in the operations management field. **Prof. Jonny Johansson** is working within the department of EISLAB, Embedded Internet Systems Laboratory. His research is focused on low power sensor electronics, with recent work performed in RFID technology for distributed miniaturized sensors. His published scientific work includes more than 40 published International Journals and Conferences in the fields of his interest.
List of up to 5 relevant publications, and/or products, services	**[1]G. Nikolakopoulos**, L. Dritsas and S. Sayyaddelshad, "Combined Networked Switching Output Feedback Control with D-Region Stability for Performance Improvement", Accepted in International Journal of Control, Taylor and Francis, 2013. **[2]**A. Tzes, **G. Nikolakopoulos** and I. Koutroulis, "Development and Experimental Verification of a Mobile Client-Centric Networked Controlled System", In European Journal of Control, Vol.11, No. 3, pp. 229-241, 2005. A shorter version (Paper #227) appeared in the Proceedings of the 2003 European Control Conference, Cambridge, UK, September 1-7, 2003. (This article received the IST-prize award from EU in 2003). **[3]**Rabén, H. , Borg, J. & **Johansson**, J, "A model for MOS diodes with vth-cancellation in RFID rectifiers", in IEEE Transactions on Circuits and Systems. Part 2: Express Briefs. 59, 11, s. 761-765. 5 s. 2012. **[4]Bergquist, B.** (2012). Traceability in Iron Ore Processing and Transports, Minerals Engineering. 30(April), 44-51. **[5]**Kvarnström, B. & **Bergquist, B**, Vännman, K. (2011) RFID to Improve Traceability in Continuous Granular Flows. Quality Engineering, 23(4), pp. 343-357.
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal	**[1] Arrowhead** is one of the biggest ARTEMIS project in Europe in the field of Industrial Automation, which is being coordinated by LTU. The overall aim of the project is to address efficiency and flexibility at the global scale by means of collaborative automation for five application verticals. That means production (manufacturing, process, energy), smart buildings and infrastructures, electro-mobility and virtual market of energy. (http://www.arrowhead.eu/) **[2] ePellet** The ePellet project will set a technical base for practical use of small RFID tags in harsh environments. The research project develops signaling solutions to enable the construction of pellets sized RFID tags (ePellets) for use within the mining industry.

	The solutions are demonstrated in prototype ePellets with size and weight comparable to ordinary iron ore pellets. The results will facilitate tracking of the flow of pellets, as well as form a technical base for in-situ measurements in the process. **[4] EQoREF: Energy and Quality Oriented Modeling and Control of Refiners.** The aim of the project was to derive methods and tools for the energy and quality optimization of refining in the pulp and paper industry. Several pilot processes were selected to apply the developed methodology andevaluate the feasibility, namely the bark boiler at SCA Obbola AB, the secondary heating systemat Billerud Karlsborg AB, and most importantly the HC refiner at Mondi Dynäs AB. The project has been funded by the SCOPE EU, European Union Regional Development Funds. **[5] Smart Mine of the Future – SMIFU I and II** The conceptual study "Mine of the Future" brought together major Swedish and Polish mining companies, several major global suppliers and the Academia to develop a common vision for future mining. The study has been executed within the framework of the agreement between VINNOVA and MITU concerning the Swedish Mining Research Programme. The work is limited to the production system for a deep (1500m-2000m) underground mine from the ore and its characterisation to the finished raw material or product, ready for transportation to the customer (for example a smelter or a pelletizing plant). **[6] RFID Based Traceability Systems.** The aim of the project was to create stydy if ePellets, in this case pellets with encapsulated RFID markers could be used to create traceability in the iron ore pellets logistics chain. Two logistic chains incorporating warehouses, conveyor belt systems and train transports were selected, and several applied experiments were performed. The results were that many of the initial opstacles were overcome, and that new research questions were posed, such as how the read rate of RFID circuits could be improved, research questions that later inspired the formulation of the ePellet project. Vinnova and LKAB financed the project.
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work;	LTU will contribute to the DISIRE with the laboratory infrastructure and technical equipment in the field of embedded systems and electronics and in the Control and Automation. Since the focus of the project would be to demonstrate technologies in TRL 3-5 and beyond these labs will be utilized only for initial proof of concepts and validations before the application to the industrial processes.

Participant 2	Luossavaara-Kiirunavaara AB (LKAB)
Description of the legal entity	LKAB is a high-tech international minerals group, world leading producer of processed iron ore products for steelmaking, and a growing supplier of mineral products for other industrial sectors. LKAB supplies highly processed iron ore products for blast furnaces and direct reduction, services to the steel industry, customized minerals for other industries and mining products and technologies.
Role in the project and main tasks (explanation of how its profile matches the tasks in the proposal)	LKAB will work with innovation and research and be a partner for product and technology development that leads to efficiency throughout the value chain. Our customer offer is Performance In Ironmaking and climate-friendly Green Pellets. LKAB is a high-tech minerals group renowned for its internationally world-class R&D. The focus of our research is directed at developing and strengthening LKAB's leading position within pelletization, the application of industrial minerals, reduced climate impact and increased knowledge in rock mechanics and mining technology.
Description of the key persons involved	PhD Eva-Lena Johansson has been working as a research engineer at LKAB since 2009. She has a Doctors degree in Experimental Mechanics from Luleå University of Technology.
List of up to 5 relevant publications, and/or products, services (including widely-used datasets or software), or other achievements relevant to the call content	
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal;	**[1] ePellet** The ePellet project will set a technical base for practical use of small RFID tags in harsh environments. The research project develops signaling solutions to enable the construction of pellets sized RFID tags (ePellets) for use within the mining industry. The solutions are demonstrated in prototype ePellets with size and weight comparable to ordinary iron ore pellets. The results will facilitate tracking of the flow of pellets, as well as form a technical base for in-situ measurements in the process.
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work;	LKAB will contribute to the DISIRE WP06 with application to the industrial processes in pelletizing.

Participant 3	KGHM Cuprum	KGHM Cuprum Centrum Badawczo-Rozwojowe
Description of the legal entity	KGHM CUprum is one of daughter companies of KGHM Group responsible for research, development and innovation in mining industry mostly focused on underground copper mines belonging to KGHM. Cuprum has significant experience in conducting high value research and undertaking industrial R&D projects. Cuprum has been involved in large European and National projects various academic and industrial partners both in Poland and Europe.	
Role in the project and main tasks (explanation of how its profile matches the tasks in the proposal)	KGHM Cuprum is a R& Center that belongs to KGHM Group. In DISIRE project KGHM will participate in WP5 related to nonferrous minerals transport and processing. KGHM Cuprum has developed many solutions in this field and participated in several EU-founded and other international projects. The contribution of KGHM Cuprum is based on the expertise of KGHM Cuprum's Departments participating in the DISIRE consortium. They are: Mechanical and Electrical Department and Systems Analysis and Process Management Department.	
Description of the key persons involved	**Dr. Leszek Zietkowski – head of M&E Eng. Deparment (MEE)** Leszek Ziętkowski graduated from Department of Mechanical Engineering at Wroclaw University of Technology. He received his PhD in the field of mining from Mechanical Engineering and Robotics Department at AGH in Krakow, Poland. He started his career in 1980 at Wroclaw University of Technology in the Institute of Materials Science and Technical Mechanics. He has been working in KGHM Cuprum since 1985. In 2000-2002, he served as Vice-President for research and development in KGHM Cuprum. From 2003 he has been working as manager of Mechanical & Electrical Engineering Department. He is author and co-author of many research and development works for mining. **Dr Janusz Mlynarczyk (MEE)** Janusz Młynarczyk graduated from Department of Mechanical Engineering at Wroclaw University of Technology. In 2006 he has received his PhD from the Deparment of Mechanical Engineering and Robotics, AGH in Kraków, Poland. He completed postgraduate studies in the field of plastic materials in mechanical engineering. He has been working in KGHM Cuprum for 22 years in Mechanical & Electrical Engineering Department. His field of interest embraces design of mining machinery and equipment. He is author and co-author of many research and development works for mining. **Mateusz Sawicki, PhD Student (MEE)** Mateusz Sawicki graduated from Department of Engineering and Economics in faculty of management and production engineering at Wroclaw University of Economics. He also graduated from Department of Management, Computer Science and Finance in faculty of computer science and econometrics at Wroclaw University of Economics in parallel to his major faculty. He is a PhD student on Department of Geoengineering, Mining and Geology. He has been working as assistant in KGHM Cuprum since 2011 in Mechanical & Electrical Engineering Department. He deals with economic and technical analyses, build systems and design and technological mechanics solutions for mining. He is also costs draftsman.	

	<u>Prof Przemysław Borkowski</u> Head of Systems Analysis and Process Management (SAPM) Department Prof. Przemyslaw BORKOWSKI is leading the System Analysis and Process Management Dept. at KGHM Cuprum Research and Development Centre and his scientific background is connected with development of high-pressure water jetting technologies utilized for different industrial applications, e.g. supporting mining technologies with unconventional drilling approach, comminution processes, surface preparation, etc. He has been a project manager in R&D projects funded from the EU and several national from Ministry of Science and Higher Education of Poland as well as have good practice in implementation of scientific achievements directly in economy. All over, he is an author and co-author of 8 books, over 200 scientific publications, 8 patents, and has been reviewer of several international journals and conferences. Prof. Borkowski have received many scientific awards from the university, was honored with the title of Western Pomerania Nobel Prize in Szczecin, founded by the Club of Science Leaders, honorable title Master of Technique from the Polish Federation of Engineering Associations (NOT) as well as Individual Scientific Award of Department IV of Technical Science of the Polish Academy of Science (PAN), and completed the professional development program in the field Science Management and Commercialization at Stanford University, USA. **<u>Prof Radoslaw Zimroz</u> (SAPM)** Author of more than 200 works (h-index=11) related to monitoring, modeling, data analysis including signal processing and data mining. He was Guest Co-Editor of special issue of Applied Acoustics and two books published by Springer. He was director or principal investigator of several project founded by Ministry of Science, he led 2 commercial project developed for Polish Mining companies. Now is responsible for WP1/I2Mine in Cuprum. **<u>Dr Robert Krol</u> (SAPM)** Author of many papers related to belt conveyor transport. His PhD thesis and recently published book was focused on identification, instrumentation, optimization of belt conveyor operation and design. He was principal investigator in numerous project for Polish Mining industry
List of up to 5 relevant publications, and/or products, services (including widely-used datasets or software), or other achievements relevant to the call content	**[1]** R. ZIMROZ , R.KRÓL, P. SLIWINSKI and P. STEFANIAK *Self Propelled Mining Machine Monitoring System- Data Validation, Processing and Analysis*, **Proceedings of Mine Planning Equipment Selection 2014, Dresden** **[2]** R ZIMROZ W Bartelmus T Barszcz J Urbanek Diagnostics of bearings in presence of strong operating conditions non-stationarity - a procedure of load-dependent features processing with application to wind turbine bearings **Mechanical Systems and Signal Processing (2013), in press, DOI 10.1016/j.ymssp.2013.09.010** **[3]** Edyta Brzychczy, Piotr Lipinski, Radoslaw Zimroz, Patryk Filipiak Artificial Immune Systems for Data Classification in Planetary Gearboxes Condition Monitoring Proc. Of CMMNO 2013, Ferrara **Lecture Notes in Mechanical Engineering 2014, pp 235-247** **[4]** Bartkowiak A, Zimroz R. Dimensionality reduction via variables selection – Linear and nonlinear approaches with application to vibration-based condition monitoring of planetary gearbox. **Appl Acoust (2013), http://dx.doi.org/10.1016/j.apacoust.2013.06.017** **[5]** Obuchowski J.Wyłomańska A.Zimroz R. Stochastic modeling of time series with application to local damage detection in rotating machinery. **Key Engineering Materials. 2013, vol. 569/570, pp. 441-448.**
List of up to 5 relevant	[1] I2Mine, Work Package 1 (SAMP and MEE)

previous projects or activities, connected to the subject of this proposal;	[2] Smart Mine of the Future – SMIFU (MEE Department) [3] Many commercial project developed for Polish mining industry, especially for KGHM [4] PROCMAN (Process Management) – project developed for KGHM
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work;	KGHM Cuprum will contribute to the DISIRE with their knowledge and expertise in the field of mechanical systems and process analysis.

Participant 4	ODYS Srl (ODYS)	ODYS OPTIMIZATION & CONTROL ENGINEERING
Description of the legal entity	ODYS is a private company specialized in developing mathematical models, algorithms and software for the design of control and decision support systems based on numerical optimization. The company was founded in 2011 by a group of researchers of IMT Lucca. Applications of interest are in a variety of domains, ranging from automotive and aerospace to smart grid management and advanced process control, with a special emphasis on problems that relate to resources efficiency and require feasible real-time implementation. ODYS has contracts with companies such as DENSO Automotive Deutschland GmbH and ASTRIUM GmbH to develop control-oriented models and algorithms based on Model Predictive Control (MPC) for problems related to vehicle dynamics and powertrain in cars, and guide, navigation and control in spacecraft. Moreover, ODYS is a supplier of software for embedded MPC to an American automotive OEM.	
Role in the project and main tasks (explanation of how its profile matches the tasks in the proposal)	ODYS will be mainly involved in WP2, where it will contribute to the software implementation of efficient MPC algorithms, their integration with adaption/reconfiguration modules, and the assessment of their performance either in simulation and in experimental validation. ODYS will especially focus on efficient software implementations of the mathematical models and algorithms proposed by the academic partners. This perfectly matches ODYS expertise and is fully aligned with its commercial mission, which is to bring state-of-the-art control theory to industrial production, and to develop software tools that provide the desired control functionalities while meeting the industrial requirements.	
Description of the key persons involved	**Dr. Daniele Bernardini** is a co-founder and the R&D director of ODYS. He received his master's degree in Computer Engineering in 2007 and his Ph.D. in Information Engineering in 2011 from the University of Siena, Italy, specializing in optimization and control. In 2010 he visited the Department of Electrical Engineering, Stanford University, CA. In 2010-2011 he held a postdoctoral position at the Department of Mechanical and Structural Engineering of the University of Trento, Italy. In 2011 he joined IMT Lucca as a research collaborator and co-founded ODYS. Since 2008 he has been involved in several EU funded projects related to the development of optimization-based, real-time control algorithms, such as WIDE and E-PRICE. His main areas of expertise are model predictive control, stochastic control and hybrid systems, with applications to problems in the automotive, aerospace and energy domains, and special focus on embedded implementations. **Dr. Federica Maria Piras** is a co-founder and the CEO of ODYS. She received her degree in Chemistry in 1996 from the University of Cagliari (Italy) and her Ph.D. in Materials Science in 2002 from the Swiss Federal Institute of Technology, ETH, Zurich, Switzerland. She spent a semester in 2002/2003 at the National ESCA & Surface Analysis Center for Biomedical Problems (NESAC/BIO), University of Washington, Seattle (WA, USA), as a visiting researcher. In 2002-2003, she held a postdoctoral position at the Department of Chemical and Biosystems Science and Technology, University of Siena, Siena, Italy. In 2003-2007 she was with the Faculty of Pharmacy of the University of Siena as adjunct professor ("Brain gain" program). In 2008-2010 she was with the Department of Pharmaceutical and Applied Chemistry of the University of Siena as contract researcher. In 2010-2011 she was with the Center for Materials and Microsystems at the FBK - Bruno Kessler Foundation as contract researcher. She co-founded ODYS in 2011, where she is chief executive officer.	
List of up to 5 relevant publications, and/or products, services	**[1] D. Bernardini** and A. Bemporad, "*Stabilizing model predictive control of stochastic constrained linear systems*", IEEE Transactions on Automatic Control, vol. 57, no. 6, pp. 1468-1480, 2012. **[2] D. Bernardini** and A. Bemporad, *"Energy-aware robust model predictive control*	

(including widely-used datasets or software), or other achievements relevant to the call content	*based on noisy wireless sensors,"* Automatica, vol. 48, no. 1, pp. 36-44, 2012. **[3]** S. Di Cairano, **D. Bernardini**, A. Bemporad, and I.V. Kolmanovsky, *"Stochastic MPC With Learning for Driver-Predictive Vehicle Control and its Application to HEV Energy Management,"* IEEE Transactions on Control Systems Technology, 2013. In press. **[4]** G. Ripaccioli, **D. Bernardini**, S. Di Cairano, A. Bemporad, and I.V. Kolmanovsky, *"A stochastic model predictive control approach for series hybrid electric vehicle power management,"* in Proc. American Control Conference, Baltimore, MD, 2010, pp. 5844–5849. **[5]** A. Bemporad, **D. Bernardini**, F.A. Cuzzola, and A. Spinelli, *"Optimization-based automatic flatness control in cold tandem rolling,"* Journal of Process Control, vol. 20, no. 4, pp. 396-407, 2010.
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal;	**[1] Simulation and control of a Virtual Power Plant** is an R&D activity carried out by ODYS within Crisalide II, a project funded by the province of Trento, Italy (http://www.retecrisalide.it/). The goal is to develop control-oriented models, MPC algorithms and a software environment to simulate and control in real-time a set of energy generators and storage devices, in the presence of uncertain customer load and production from renewables. **[2] MPC for thermal management of cabin heat** is an R&D activity carried out by ODYS in partnership with DENSO Automotive Deutschland GmbH. The goal is to develop and implement MPC schemes for optimally distribute the workload between available components in hybrid vehicles, in order to achieve multiple objectives such as fuel efficiency and heat-power reference tracking, while enforcing constraints related to passengers comfort and physical bounds of the actuators. **[3] MPC for attitude control of an upper stage** is an R&D activity carried out by ODYS in collaboration with ASTRIUM GmbH. The goal is to develop MPC formulations and software for the attitude control of spacecraft with large sloshing interaction, where the actuators are subject to a minimum impulse bit and their usage must be minimized.
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work;	ODYS will contribute to the DISIRE project with its laboratory and technical equipment, which will be used to test and tune the devised MPC algorithms in simulation before their experimental validation in the considered industrial processes.

Participant 5	Wroclaw University of Technology, Faculty of Geoengineering, Mining and Geology, Mineral Processing Laboratory	
Description of the legal entity	**Wrocław University of Technology (WrUT)** is a public institution which was founded in 1945, but its academic legacy dates back over 160 years to the Lviv University. Wrocław University of Technology belongs to the best technical universities in Poland – over 33 000 students study here under the guidance of ca. 1900 academic teachers, at 12 faculties. It rates high in the annual rankings of the Polish universities. Recently, the position in the research and teaching field places WrUT among the best three technical universities in Poland. The university ranked first in the modern technologies group (disciplines: computer science, electronics, materials science) of the *Where to study?* ranking. In the world perspective, the university is ranked 430. in 2011 Webometrics Ranking of World Universities, 185. in Europe and 9 in the Central & Eastern Europe. It is worth mentioning that Wrocław University of Technology is on the first place among Polish Universities in the category of *innovation* which takes into account inter alia the number of patents. 430 didactic and 80 computer aided laboratories are available for students at the university. Academic Incubator of Enterprise Spirit, acting at the university, cooperates with 33 companies. WrUT is a member of the European University Association T.I.M.E. Association. There have been put into practice 420 international agreements. The high level of research carried out, matching the world's best, and the well-equipped laboratories result in a wide co-operation with the Polish and international companies, e.g. Philips Lighting Poland S.A., KOGENERACJA S.A., Toyota, LG, WABCO, EnergiaPro, KGHM Polska Miedź S.A., Whirlpool. As part of these agreements, joint research projects are carried out. Wrocław University of Technology, as the only technical university in the region, has become a leader of the active co-operation with the industry. Collaboration with the economy allows to provide a comprehensive offer for companies looking for innovative solutions. The network of accredited laboratories that is being organised will allow to enhance the offer for the industry. Each laboratory offers examinations of products introduced to the market for compliance with the "CE marking" requirements. Some of the laboratories have accreditations with a European authorisation. The educational standards offered at the university are closely connected with its dynamic scientific work and industrial experience. Research and education are strongly influenced by the international cooperation with over 250 partner universities all over the world. Over 1000 scientists from European, American, Asian and Australian universities and several dozens of international students pass through our university every year. The university was/is involved in the research and educational programmes: 6th Framework Programme (50 projects), 7th FP (56 projects), CIP Framework Programme, Coal and Steel Fund, COST, EUREKA, SOCRATES-ERASMUS, SOCRATES-MUNDUS and Leonardo da Vinci and other.	
Role in the project and main tasks (explanation of how its profile matches the tasks in the proposal)	The participation of the Wroclaw University will be disseminated among all the technological WPs of DISIRE. More specifically, WUT will participate in the specification of the demonstration and evaluation test cases, with a direct focus on the processes connected to KGHM. WUT will also participate in the WPs for the development of process modelling and control, sensors and electronics and data mining and will also try to adapt the activities in these WPs towards the application of raw material transferring in the mining sector. Moreover, WUT will participate in the demonstration of the DISIRE concept in WP5 and in the dissemination activities in WP9.	

Description of the key persons involved	**<u>Prof. Jan Drzymala, Mineral Processing Laboratory (MPLab)</u>** Jan Drzymala graduated from the Department of Chemistry at the Wroclaw University of Technology, Poland, in 1973. He received his PhD in the field of mineral processing from the same Department in 1977 and DSc in 1991. He has spent 35 years in Poland and altogether about 5 years in foreign institutions, including Department of Material Science and Mineral Engineering, University of California Berkeley, USA; Chemical Engineering Department, Iowa State University, Ames, Iowa, USA; LEM, Nancy, France, doing research in mineral processing and surface chemistry. He is either author or co-author of 160 scientific papers and numerous research reports dealing with mineral engineering and physical chemistry of interfaces. Prof. Drzymala is the editor-in-chief of the Physicochemical Problems of Mineral Processing journal **<u>Prof. Przemyslaw B. Kowalczuk (MPLab)</u>** Przemyslaw B. Kowalczuk is an assistant professor of mineral engineering and physicochemistry of surfaces at the Wroclaw University of Technology (Poland). During his research work he has published several scientific papers and participated in many research and development projects carried out at the Wroclaw University of Technology and University of Exeter. Dr Kowalczuk received many scientific awards and completed a professional development program in the field of Science Management and Commercialization at Stanford University, USA. His scientific interest is development of new technologies and ideas in mineral processing. He is an editor of the Physicochemical Problems of Mineral Processing international journal and reviewer of international journals and R&D projects. **<u>Prof. Andrzej Luszczkiewicz (MPLab)</u>** Andrzej Luszczkiewicz is a head of the Mineral Processing Laboratory, Faculty of Geoengineering, Mining and Geology, Wroclaw University of Technology. He graduated as a MSc in mineral processing from Silesian Technical University, Department of Mineral Processing, Gliwice, Poland. In 1976 he received his PhD from the Wroclaw University of Technology and his DSc in 2002 from AGH in Krakow, Poland. He works in the field of mineral processing, flotation of sulfide and non-sulfide minerals, beneficiation of noble metals from various type of ores, separation of dispersed and trace components, heavy minerals, evaluation of ore beneficiation results based on laboratory tests as well as plant operations and applied mineralogy. He is either author and co-author of over 150 research and development works for mineral industry and 5 patents. He is an associate editor of the Journal of the Polish Mineral Engineering Society and Physicochemical Problems of Mineral Processing journal. **<u>Prof. Danuta Szyszka (MPLab)</u>** Danuta Szyszka graduated from the Wroclaw University of Technology (WUT), Faculty of Chemistry with specialization in Technology and Physical Chemistry of Polymers in 1998. She obtained her PhD degree from WUT, *Faculty of Geo-engineering, Mining and Geology,* in 2004. Presently she is an assistant professor of mineral engineering and physical chemistry of surfaces at the WUT. Her research work concentrates on *mineral processing, particularly on upgrading of ores by flotation.* She is an editor of the international journal Mining Science. **<u>Dr Alicja Bakalarz (MPLab)</u>** Alicja Bakalarz graduated from the Faculty of Chemistry at the Wroclaw University of Technology. In 2012 she received her PhD in the field of mining and geology from the Faculty of Geoengineering, Mining and Geology at Wroclaw University of Technology. She was a principal investigator of two grants founded by the Polish Ministry of Science and Higher Education and currently she is a head of R&D project developed for mineral processing company. She is an assistant in the Mining Engineering Institute, Wroclaw

	University of Technology. She is the author and co-author of a few research works for mineral processing. She deals with research of sulfide minerals flotation, kinetics, chemistry and electrochemistry. **Dr Magdalena Duchnowska (MPLab)** Magdalena Duchnowska graduated from Faculty of Earth and Environmental Science at the University of Wroclaw. In 2013 she received her PhD from the Faculty of Geoengineering, Mining and Geology at the Wroclaw University of Technology. She has been working as an assistant at the Wroclaw University of Technology. She deals with research of flotation of sulfide minerals and processing of heavy minerals.
List of up to 5 relevant publications, and/or products, services (including widely-used datasets or software), or other achievements relevant to the call content	Drzymala, J., Kowalczuk, P.B., Oteng-Peprah, M., Foszcz, D., Muszer, A., Henc, T., Luszczkiewicz, A., 2013, Application of the grade-recovery curve in the batch flotation of Polish copper ore. Miner. Eng. 49, 17–23. Iyakwari, S., Glass, H., Kowalczuk, P.B., 2013, Potential for near infrared sensor-based sorting of hydrothermally-formed minerals. J. Near Infrared Spectrosc. 21(3), 223–229. Duchnowska, M., Drzymala, J., 2012. Self-similarity of upgrading parameters used for evaluation of separation results, International Journal of Mineral Processing, t. 106-109, 50-57. Tasdemir, A., Kowalczuk, P.B., 2014, Application of statistical process control for proper processing of the Fore-Sudetic Monocline copper ore. Physicochem. Probl. Miner. Process. 50(1), 249–264. Bakalarz A., 2011. Flotation of components of Polish copper ores using n-dodecane as a collector. Physicochemical Problems of Mineral Processing, 47, 229-236.
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal;	Luszczkiewicz A., Drzymala J., Foszcz D., Duchnowska M., Bakalarz A., Szyszka D., Tumidajski T., Konopacka Z., Niedoba T., Kowalczuk P., Hupka J., Niewiadomski M., Karwowski P., Ksiezniak K., Rogala A., Determination of flotation reagents investigation procedure taking into account their practical properties, Report No. I-11/2013/S-30, Instytut Gornictwa Politechniki Wroclawskiej, Wroclaw, December 2013 (in Polish) Collective work, Grant founded by the Polish National Centre for Research and Development (IniTech Programme), Technology of hydro-metallurgical processing of and copper concentrates semiproducts, 2010-2013, (in Polish) Luszczkiewicz A., Drzymala J., Duchnowska M., Comparison of effectiveness of MF-25 and MF-22 flotation machines working at ZWR Rejon Rudna, KGHM, Report No. I-11/2011/S-053, Instytut Gornictwa Politechniki Wroclawskiej, Wroclaw, December 2011, in Polish. Foszcz D., Luszczkiewicz A., Drzymala J., Tumidajski T., Trybalski K., Muszer A., Niedoba T., Henc T., 2009. Determination of the influence of upgradeability of ore on quality of copper concentrates for optimization of copper production, AGH Report 5.5.100.390/2009, Dep. of Mining and Geoeng. Krakow, December 2009, in Polish Kowalczuk, B.P, Grant founded by the Polish Ministry of Science and Higher Education "Theoretical and experimental determination of the maximum size of floating particles in different flotation cells", May 2011-May 2012.
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work;	WUT will contribute to the DISIRE their knowledge, expertise and typical equipment in the field of mineral processing

Participant 6	IMT Institute for Advanced Studies Lucca (IMTL)	IMT INSTITUTE FOR ADVANCED STUDIES LUCCA
Description of the legal entity	The IMT Institute for Advanced Studies Lucca (IMTL) is a public Ph.D. school and research university. IMT (Institutions, Markets, and Technologies) strives to merge theoretical research and practical relevance and is based on two multidisciplinary research areas (computer science and engineering, economics and institutional change), with a main focus on modelling and analysis of computing, economic, and engineering systems. The research unit DYSCO (DYnamical Systems, Control, and Optimization) directed by Prof. Alberto Bemporad, focuses on real-time optimization for control of dynamical processes. With about 20 years of experience, the group is one of the leaders worldwide in model predictive control (MPC) theory, algorithms, software tools, and applications with major companies, including Ford Motor Company, Centro Ricerche Fiat, European Space Agency, Danieli Automation, The Mathworks, ENEL S.p.A., ABB, Denso Automotive GmbH among others. The group has participated in several European projects since FP5, and coordinated the past FP7 project WIDE "Wireless and Decentralized Control of Large-scale Systems".	
Role in the project and main tasks (explanation of how its profile matches the tasks in the proposal)	Leadership of WP2. Control-oriented modelling of physical processes. Linear/stochastic/hybrid MPC design methodologies. Machine learning algorithms for data-driven adaptation and reconfiguration of MPC. Embedded optimization algorithms for MPC and for online machine learning. Technical assessments of the benefits of data-driven MPC. Contributions to the definition of the case studies. Dissemination of scientific results.	
Description of the key persons involved	**Prof. Alberto Bemporad** Alberto Bemporad received his master's degree in Electrical Engineering in 1993 and his Ph.D. in Control Engineering in 1997 from the University of Florence, Italy. He spent the academic year 1996/97 at the Center for Robotics and Automation, Department of Systems Science & Mathematics, Washington University, St. Louis, as a visiting researcher. In 1997-1999 he held a postdoctoral position at the Automatic Control Laboratory, ETH Zurich, Switzerland, where he collaborated as a senior researcher in 2000-2002. In 1999-2009 he was with the Department of Information Engineering of the University of Siena, Italy, becoming an associate professor in 2005. In 2010-2011 he was with the Department of Mechanical and Structural Engineering of the University of Trento, Italy. In 2011 he joined as a full professor the IMT Institute for Advanced Studies Lucca, Italy, where he became the director in 2012. He has published about 300 scientific contributions (Google Scholar H-Index: 51) in the areas of MPC, hybrid systems, automotive control, multiparametric optimization, computational geometry, robotics, and finance. He is author or coauthor of various MATLAB toolboxes for MPC design, including the Model Predictive Control Toolbox (The Mathworks, Inc.). He was an Associate Editor of the IEEE Transactions on Automatic Control during 2001-2004 and Chair of the Technical Committee on Hybrid Systems of the IEEE Control Systems Society in 2002-2010. He received the IFAC High-Impact Paper Award for 2011-14. He is IEEE Fellow since 2010. **Prof. Panagiotis Patrinos** received the M.Eng. degree in chemical engineering, the M.Sc. degree in applied mathematics, and the Ph.D. degree in control and optimization, all from the National Technical University of Athens, Athens, Greece, in 2003, 2005, and 2010, respectively. He is currently an Assistant Professor at the IMT Institute for Advanced Studies, Lucca, Italy. Previously, he was a Postdoctoral Fellow at IMT Lucca and at the University of Trento, Italy. His current research interests are focused on devising efficient algorithms for distributed and nonsmooth optimization	

	with applications in embedded model predictive control (MPC) and machine learning. He is also interested in stochastic, risk-averse and distributed MPC with applications in the energy and power systems domain. **Prof. Giorgio Gnecco** received the "Laurea" (M.Sc.) degree cum laude in Telecommunications Engineering and the Ph.D. degree in Mathematics and Applications, both from the University of Genoa, in 2004 and 2009, respectively. From 2009 to 2013 he worked as a Postdoctoral Researcher at the University of Genoa. He is currently an Assistant Professor in Control Systems at IMT Lucca. He has been an Associate Editor for IEEE Transactions on Neural Networks and Learning Systems since 2013. His current research topics include: machine learning, operations research, optimal control, team theory and game theory, telecommunications networks, neural networks, statistical learning theory, machine learning applications. **Prof. Massimo Riccaboni** received his master's degree in Economics in 1996 from Bocconi University, Milan, Italy and his Ph.D. in Economics and Management of Innovation in 2000 from the Sant'Anna School of Advanced Studies, Pisa, Italy. He held visiting positions at the Heinz College at Carnegie Mellon University, Pittsburgh, PA, at SCANCOR, Stanford University, CA, and at the Department of Physics of Boston University, Boston, MA. In 2002-2008 he was with the Department of Management of the University of Florence, and in 2008-2011 with the Department of Computer and Management Science of the University of Trento, Italy. Since 2011 he is an associate professor at the IMT Institute for Advanced Studies Lucca, Italy and part-time visiting professor at the Department of Managerial Economics, Strategy and Innovation (MSI) of the Katholieke Universiteit Leuven.
List of up to 5 relevant publications, and/or products, services (including widely-used datasets or software), or other achievements relevant to the call content	[1] **A. Bemporad**, M. Morari, "Control of systems integrating logic, dynamics, and constraints", Automatica 35 (3), 407-427, 1999 [1822 citations] [2] **A. Bemporad**, M. Morari, V. Dua, E.N. Pistikopoulos, "The explicit linear quadratic regulator for constrained systems", Automatica 38 (1), 3-20, 2002 [1564 citations] [3] **P. Patrinos** and **A. Bemporad**, "An accelerated dual gradient-projection algorithm for embedded linear model predictive control," IEEE Trans. Automatic Control, vol. 59, pp. 18–33, 2014. [4] **G. Gnecco**, M. Sanguineti, "The weight-decay technique in learning from data: An optimization point of view", Computational Management Science 6 (1), 53-79, 2009 [5] A. Bemporad, M. Morari, and N.L. Ricker, *Model Predictive Control Toolbox for MATLAB – User's Guide*, The Mathworks, Inc., http://www.mathworks.com/access/helpdesk/help/toolbox/mpc/.
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal;	[1] EU project WIDE "Decentralized and Wireless Control of Large-Scale Systems", European Commission, FP7-ICT (2008-2011 coordinator) (http://ist-wide.dii.unisi.it/) [2] EU project E-PRICE "Price-based Control of Electrical Power Systems", European Commission, FP7-ICT (2010-2013) [3] EU Network of Excellence HYCON2 - Highly Complex and Networked Control Systems, European Commission, FP7-ICT (2010-2014) [4] EU project EFFINET "Efficient Integrated Real-time Monitoring and Control of Drinking Water Networks", European Commission, FP7-ICT (2012-2015) [5] EU project MOBY-DIC "Model-based synthesis of digital electronic circuits for embedded control", FP7-ICT (2009-2013)
Description of any significant	IMTL will contribute to the DISIRE project with its computer laboratory

infrastructure and/or any major items of technical equipment, relevant to the proposed work;	infrastructure. This includes CUDA computational facilities (a workstation with 4 cards Nvidia Tesla M2090 and a workstation with 4 cards Nvidia Tesla M2075) equipped with Python and MATLAB environments, and three network servers with multiple multi-core processors and some cluster facilities for big data processing and parallel computations.

Participant 7	**KGHM Cuprum**
Description of the legal entity	KGHM CUprum is one of daughter companies of KGHM Group responsible for research, development and innovation in mining industry mostly focused on underground copper mines belonging to KGHM. Cuprum has significant experience in conducting high value research and undertaking industrial R&D projects. Cuprum has been involved in large European and National projects various academic and industrial partners both in Poland and Europe.
Role in the project and main tasks (explanation of how its profile matches the tasks in the proposal)	KGHM Cuprum is a R& Center that belongs to KGHM Group. In DISIRE project KGHM will participate in WP5 related to nonferrous minerals transport and processing. KGHM Cuprum has developed many solutions in this field and participated in several EU-founded and other international projects. The contribution of KGHM Cuprum is based on the expertise of KGHM Cuprum's Departments participating in the DISIRE consortium. They are: Mechanical and Electrical Department and Systems Analysis and Process Management Department.
Description of the key persons involved	**Dr. Leszek Zietkowski – head of M&E Eng. Deparment (MEE)** Leszek Ziętkowski graduated from Department of Mechanical Engineering at Wroclaw University of Technology. He received his PhD in the field of mining from Mechanical Engineering and Robotics Department at AGH in Krakow, Poland. He started his career in 1980 at Wroclaw University of Technology in the Institute of Materials Science and Technical Mechanics. He has been working in KGHM Cuprum since 1985. In 2000-2002, he served as Vice-President for research and development in KGHM Cuprum. From 2003 he has been working as manager of Mechanical & Electrical Engineering Department. He is author and co-author of many research and development works for mining. **Dr Janusz Mlynarczyk (MEE)** Janusz Młynarczyk graduated from Department of Mechanical Engineering at Wroclaw University of Technology. In 2006 he has received his PhD from the Deparment of Mechanical Engineering and Robotics, AGH in Kraków, Poland. He completed postgraduate studies in the field of plastic materials in mechanical engineering. He has been working in KGHM Cuprum for 22 years in Mechanical & Electrical Engineering Department. His field of interest embraces design of mining machinery and equipment. He is author and co-author of many research and development works for mining. **Mateusz Sawicki, PhD Student (MEE)** Mateusz Sawicki graduated from Department of Engineering and Economics in faculty of management and production engineering at Wroclaw University of Economics. He also graduated from Department of Management, Computer Science and Finance in faculty of computer science and econometrics at Wroclaw University of Economics in parallel to his major faculty. He is a PhD student on Department of Geoengineering, Mining and Geology. He has been working as assistant in KGHM Cuprum since 2011 in Mechanical & Electrical Engineering Department. He deals with economic and technical analyses, build systems and design and technological mechanics solutions for mining. He is also costs draftsman. **Prof Przemysław Borkowski Head of Systems Analysis and Process Management**

	(SAPM) Department Prof. Przemyslaw BORKOWSKI is leading the System Analysis and Process Management Dept. at KGHM Cuprum Research and Development Centre and his scientific background is connected with development of high-pressure water jetting technologies utilized for different industrial applications, e.g. supporting mining technologies with unconventional drilling approach, comminution processes, surface preparation, etc. He has been a project manager in R&D projects funded from the EU and several national from Ministry of Science and Higher Education of Poland as well as have good practice in implementation of scientific achievements directly in economy. All over, he is an author and co-author of 8 books, over 200 scientific publications, 8 patents, and has been reviewer of several international journals and conferences. Prof. Borkowski have received many scientific awards from the university, was honored with the title of Western Pomerania Nobel Prize in Szczecin, founded by the Club of Science Leaders, honorable title Master of Technique from the Polish Federation of Engineering Associations (NOT) as well as Individual Scientific Award of Department IV of Technical Science of the Polish Academy of Science (PAN), and completed the professional development program in the field Science Management and Commercialization at Stanford University, USA. **Prof Radoslaw Zimroz (SAPM)** Author of more than 200 works (h-index=11) related to monitoring, modeling, data analysis including signal processing and data mining. He was Guest Co-Editor of special issue of Applied Acoustics and two books published by Springer. He was director or principal investigator of several project founded by Ministry of Science, he led 2 commercial project developed for Polish Mining companies. Now is responsible for WP1/I2Mine in Cuprum. **Dr Robert Krol (SAPM)** Author of many papers related to belt conveyor transport. His PhD thesis and recently published book was focused on identification, instrumentation, optimization of belt conveyor operation and design. He was principal investigator in numerous project for Polish Mining industry.
List of up to 5 relevant publications, and/or products, services (including widely-used datasets or software), or other achievements relevant to the call content	**[1]** R. ZIMROZ , R.KRÓL, P. SLIWINSKI and P. STEFANIAK *Self Propelled Mining Machine Monitoring System- Data Validation, Processing and Analysis*, **Proceedings of Mine Planning Equipment Selection 2014, Dresden** **[2]** R ZIMROZ W Bartelmus T Barszcz J Urbanek Diagnostics of bearings in presence of strong operating conditions non-stationarity - a procedure of load-dependent features processing with application to wind turbine bearings **Mechanical Systems and Signal Processing (2013), in press, DOI 10.1016/j.ymssp.2013.09.010** **[3]** Edyta Brzychczy, Piotr Lipinski, Radoslaw Zimroz, Patryk Filipiak Artificial Immune Systems for Data Classification in Planetary Gearboxes Condition Monitoring Proc. Of CMMNO 2013, Ferrara **Lecture Notes in Mechanical Engineering 2014, pp 235-247** **[4]** Bartkowiak A, Zimroz R. Dimensionality reduction via variables selection – Linear and nonlinear approaches with application to vibration-based condition monitoring of planetary gearbox. **Appl Acoust (2013), http://dx.doi.org/10.1016/j.apacoust.2013.06.017** **[5]** Obuchowski J.Wyłomańska A.Zimroz R. Stochastic modeling of time series with application to local damage detection in rotating machinery. **Key Engineering Materials. 2013, vol. 569/570, pp. 441-448.**
List of up to 5 relevant previous	[1] I2Mine, Work Package 1 (SAMP and MEE) [2] Smart Mine of the Future – SMIFU (MEE Department)

projects or activities, connected to the subject of this proposal;	[3] Many commercial project developed for Polish mining industry, especially for KGHM [4] PROCMAN (Process Management) – project developed for KGHM
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work;	KGHM Cuprum will contribute to the DISIRE with their knowledge and expertise in the field of mechanical systems and process analysis.

Participant 8	ElectroTech AB	
Description of the legal entity	ElectroTech is a SME in the field of measurement technology in harsh environments. The company was founded 2001 by 3 former colleagues, Marie Laestander, Juha Rajala and Stefan Nordmark, all had moved on from leading positions in electronic companies. Today ElectroTech employs a staff of 18 where 8 engineers are in R&D and the rest in manufacturing and overhead. Turnover for 2013 was around 7.5 million Euros. ElectroTech is certified to ISO-9001 and ISO-14000. Key technology is RFID (Radio Frequency Identification) where ElectroTech designs and manufactures RFID readers and transponders (Tags). Along with the own trademark Craycom, the products are also made as OEM to several customers. The products are designed to operate in a heavy industrial environment such as mining industry and steel plants.	
Role in the project and main tasks	ElectroTech will mainly contribute to WP6 with their experience and equipment in implementing transponders in mining industry to verify the electronic sensors that are output from WP3. Moreover, ElectroTech will contribute in WP1 for the specifications of the DISIRE platform and demonstrations, and in the innovation activities of the project.	
Description of the key persons involved	**Juha Rajala** is technical manager at ElectroTech with >30 year experience in electronic acquisition and communication systems. Juha is the chief designer of RFID products and systems developed at ElectroTech. He has a worldwide network of RFID competences in both sales and supply chains. Juha has been project managing several RFID implementation projects into heavy industry. He is also member of the ePellet steering group.	
List of up to 5 relevant publications, and/or products, services	**[1] Bergquist, B.** (2012). Traceability in Iron Ore Processing and Transports, Minerals Engineering. 30(April), 44-51. **[2]** Kvarnström, B. & **Bergquist, B**, Vännman, K. (2011) RFID to Improve Traceability in Continuous Granular Flows. Quality Engineering, 23(4), pp. 343-357. **[3]** Åhs M. (2011). Wireless temperature sensors embedded in concrete (TVBM-7211). **[4]** Flodin J. (2009). KAP Kontinuerlig Automatisk Provsågning (Continuous Automatic Sawmill-sampling) (Träcentrum Norr www.ltu.se/ske/tcn). **[5] Rajala J**. (2010). Patent US7796051 Measuring device activated at inspection rounds for condition monitoring of rotating machinery.	
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal	**[1] ePellet** The ePellet project will set a technical base for practical use of small RFID tags in harsh environments. The research project develops signaling solutions to enable the construction of pellets sized RFID tags (ePellets) for use within the mining industry. The solutions are demonstrated in prototype ePellets with size and weight comparable to ordinary iron ore pellets. The results will facilitate tracking of the flow of pellets, as well as form a technical base for in-situ measurements in the process.	
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work;	ElectroTech will contribute with all the technical equipment and engineers needed for transponder verification on site and at out lab.	

<table>
<tr><td>Participant 9</td><td>CIRCE Foundation (CIRCE)</td><td>circe
RESEARCH CENTRE
FOR ENERGY RESOURCES
AND CONSUMPTION</td></tr>
<tr><td>Description of the legal entity</td><td colspan="2">CIRCE Foundation (Centre of Research for Energy Resources and Consumption) was established in 1993 as an independent Research Centre. In year 2001, CIRCE was recognized as National Centre of Innovation and Technology. CIRCE´s main activities are related to R&D&i and technical training for postgraduates and professionals in the energy sector, focusing in energy efficiency, sustainability of energy resources, and renewable energy. CIRCE has a staff of over 190 full time people with multidisciplinary profiles including researchers and collaborating professors. Since 1993, CIRCE has conducted more than 2.500 projects proving its self-financing capacity. CIRCE maintains a national leadership position in the field of Energy Efficiency, being the 3rd national research centre getting more projects in competitive calls during period 2004-2007 in Spain.

CIRCE belongs to the Board of Directors and chair of process working group within SPIRE. As a proof of its experience in international projects, CIRCE has participated in 63 European projects. Currently CIRCE is involved in 23 FP7 projects, being the coordinator of 6 of them.</td></tr>
<tr><td>Role in the project and main tasks (explanation of how its profile matches the tasks in the proposal)</td><td colspan="2">CIRCE is leading the WP8 (Combustion Processes). It is also planed to collaborate in other WP's such as WP2 and WP7 as well as in the management activities of the project. CIRCE, in other Research and Innovation programs has developed a methodology of imaging flame monitoring. An algorithm to correlate statistical and spectral flame characteristics with CO emissions and diverse operational parameters has been developed. The results of these research lines have been deemed satisfactory and it is possible to apply the lessons learned to industrial applications in the DISIRE project such as;

1. On-line measurements
2. Process control
3. Comparison between imaging, instrumentation and simulations:

Data obtained from existing oxygen sensors and other instrumentation will serve to validate and adjust the imaging diagnosis results. Since the development of this new control system based on an innovative technology is a research work, it is necessary to validate the measurements computed from imaging diagnosis with experimental data. Additionally, imaging diagnosis will generate a map of variables that will be a useful tool to be compared with the detailed numerical simulations. That is, interdependency of both techniques can provide complementary information of the processes, improving the accuracy of the information that will be processed and used in the control system. CIRCE has experience in applying CFD simulations in processes involving different models. In this work package, CFD simulations will be used to simulate the physics existing in a cracking furnace.</td></tr>
<tr><td>Description of the key persons involved</td><td colspan="2">Prof. Cristóbal Cortés is the director of the Thermal Division of Fundación CIRCE since 1993. He has simultaneously pursued a university career: tenured Professor since 1995; Chair Professor of Energy Systems in the University of Zaragoza since 2003. Participation in R&D projects: national funds: 9; EU framework: 7; EU coal and steel: 8; non- competitive and private funding: 24. Publications: peer-reviewed journals: 36; conference proceedings: 43. Advised PhD theses: 7.</td></tr>
</table>

	Dr. Antonia Gil is professor in Thermal Engineering and Applied Thermodynamics in the School of Engineering and Architecture of the University of Zaragoza (Spain). She also manages at present the Laboratory of Biomass Co-firing at CIRCE. Her main research activities are focused on experimental heat transfer, biomass pre-treatment, coal and biomass boilers, gas cleaning of combustion gases and ash deposition related problems. She has also work experience in coal power plants. She is the authoress of several technical papers in conference proceedings and international journals such as Power Technology, Energy and Progress in Energy and Combustion Science. **Mr. Ing. Miguel Gil**, Mechanical Engineer since 2006 and master on Thermoelectric Generation since 2013 both by the University of Zaragoza. Since 2005, he works in the Thermal Process Area of CIRCE Foundation as professional researcher and project manager and since 2012 as area manager. Main research work has been done in the characterization and experimental studies on handling and milling behaviour of solid biomass, including particle size and shape characterization by image analysis, fracture models of biomass particles and industrial modelling of milling process. He has participated in 6 research projects. As a result, he published five peer-reviewed journals, as well as other different participation in conference proceedings.
List of up to 5 relevant publications, and/or products, services (including widely-used datasets or software), or other achievements relevant to the call content	<u>Publications;</u> 1) Numerical simulation of a secondary aluminium melting furnace heated by a plasma torch Carmona, M., Cortés, C. Journal of Materials Processing Technology, 214 (2), pp. 334-346 (2014). 2) Emissions during co-firing of two energy crops in a PF pilot plant: Cynara and poplar. C. Bartolomé, A. Gil Fuel Processing Technology, vol 113, pp 75 - 83 (2013) 3) Characterization of PF flames under different swirl conditions based on visualization systems. A. González-Cencerrado, A. Gil, B. Peña. Fuel (2013); Vol. 113, pp. 798-809. 4) Prediction of Flow Instabilities in an Atmospheric Low Swirl Burner Using URANS Models. Juan A. Ramírez, Cristóbal Cortés, Alberto Carrión, Mauricio Carmona & Mathieu Legrand. Numerical Heat Transfer, Part A: Applications: An International Journal of Computation and Methodology, 62:6, 479-498, 2012 5) Coal flame characterization by means of digital image processing in a semi-industrial scale PF burner. A. González-Cencerrado, B. Peña, A. Gil. Applied Energy (2012); Vol. 94, pp. 375-84. <u>Conferences;</u> 1) Analysis of The Thermal Behavior of a Metal Holding Furnace Using CFD M. Carmona, C. Cortés. "International Conference on Power Engineering-13 (ICOPE 2013)" Wuhan (China), October 24-27, 2013. 2) Digital image processing for analysis of flame characteristics and stability. A. González-Cencerrado, B. Peña, A. Gil, C. Bartolomé. Proceedings of the 5th International Conference on Clean Coal Technologies (2011), Zaragoza (Spain).
List of up to 5 relevant previous projects or	1) **TOP-REF** - Innovative tools, methods and indicators for optimizing the resource efficiency in process industry. TOP-REF is a European project, recently started and coordinated by CIRCE, which will develop and demonstrate a robust, resource-efficiency-focused and cross-sectorial methodology. This methodology will be

activities, connected to the subject of this proposal;	implemented in three non-invasive, real time and on-line monitoring and control (M&CS) tools adapted to three continuous energy and resource intensive processes: Fertilizer, Refining and Chemical. The three tools will be validated under real conditions in three pilots, one in each sector. CIRCE will be leading the detailed diagnosis of the three processes, finding out the main attributes that represent their most relevant constraints and requirements, defining their boundary conditions, the Key Resources Indicators and the synergies between sectors. This way CIRCE will play an active role in the Characterization and Optimization of the process by Modelling & Simulation. It will also contribute to the development of the Monitoring and Control System (M&CS) and to its implementation and demonstration, elaborating guidelines for its cross-sectorial replicability. 2) **EDEFU -** New Designs of Ecological Furnaces This project creates and implements a methodology for researching, designing and constructing multisectoral furnaces (ceramics, cement, glass and nonferrous metals, primarily aluminium) that should lead to an improvement of 20% in the energy efficiency. CIRCE's work on the project focuses on one hand in modelling and simulation of aluminium furnaces, both, in the small size demonstrator, as well as in the industrial full-size extrapolation. This includes physical modelling and numerical rendering of the differential equations of transport, mass, momentum, energy and chemical species in fluids, solids and cast pieces, using and developing appropriate approaches to complex phenomena such as turbulence, chemical reactions, thermal radiation and special means of heating. http://www.edefu.eu 3) **NIWE -** New induction wireless manufacturing efficient process for energy intensive industries NIWE project will demonstrate a new production process able to decrease the embodied energy of the foundry products by over 25%, reducing drastically its carbon footprint. The demonstration will be performed in the aluminium, iron and steel sectors. CIRCE is in mainly in charge of developing the Inductive Coupling Power Transfer System (ICPT) for the new processes and equipment in NIWE project. It is also involved in the training and dissemination issues and the monitoring activities, as well as carrying out the LCA and LCC studies. http://www.niweproject.eu/ 4) **BIOSWIRL -** Development of advanced measurements for studying the flow in swirl burners for solid biomass. The aim of the project is to use advanced experimental measurement techniques and numerical predictions to increase our knowledge of the flow that takes place in these combustion devices. More specifically, the aim is to identify oscillations and instabilities in swirl burners and propose possible solutions regarding operation and/or design to improve their performance. 5) **O2GEN**; "Optimisation of oxygen-based CFBC technology with CO2 capture. The project is coordinated by CIRCE and deals with the Oxyfuel combustion which is based in the combustion of coal within a controlled atmosphere of pure oxygen, obtaining a gas flow composed exclusively by CO2 and water steam. CIRCE will be in charge of the coordination and supervision of the project during its 3 years of execution, in order to carry out simulation tests for the identification of inefficiencies and possible improvements in the 1st generation oxyfuel combustion systems. It will participate in both, the design of new equipment, and the processes integration and optimization. http://www.o2genproject.eu
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work;	CIRCE has various tools and equipment for monitoring and simulation of systems to be used in the DISIRE Project with the focus on analysis and improvement of Combustion processes; • Commercial software for CFD analysis and system modelling FLUENT 6.2 licenses. • Parallel computing cluster, Beowulf type, for Linux computer. • Simulation plant with different tools including Aspen engineering Suite 12.1.

Participant 10	Dow Chemical Ibérica S.L. (DCI)	
Description of the legal entity	The Dow Chemical Company (TDCC) combines the power of science and technology to passionately innovate what is essential to human progress by providing sustainable solutions to its customers. The Company connects chemistry and innovation with the principles of sustainability to help address many of the world's most challenging problems such as the need for clean water, renewable energy generation and conservation, and increasing agricultural productivity. Our goal is to eliminate all injuries, prevent adverse environmental and health impacts, reduce wastes and emissions and promote resource conservation at every stage of the life cycle of our products Dow Chemical Ibérica S.L. (DCI) is the subsidiary of The Dow Chemical Company (TDCC) in the Iberian Region (Spain and Portugal). The company has manufacturing and R&D premises in Tarragona (Spain), Ribaforada (Spain) and Estarreja (Portugal) with the headquarters located in Madrid (Spain), employing approximately 825 direct people and 650 people from service providers companies.	
Role in the project and main tasks (explanation of how its profile matches the tasks in the proposal)	Dow Chemical Ibérica S.L. (DCI) will contribute as industrial partner of the petrochemical industry sector in the DISIRE Consortium bringing its premises in Tarragona (Ethylene Cracker and Octene Plant) to test and demonstrate innovative and breakthrough improvements in the field of the combustion process technology (analyzers, sensors, process control strategies, simulation techniques, etc...) (Objective 8) in order to achieve a significant progress from the energy efficiency and environmental impact point of view by testing them in the existing fired equipment (cracking furnaces and boilers) of the Tarragona Site. In WP1, DCI will participate in the identification of scenarios and providing input in setting Impact Goals and Benchmarking. In WP2, DCI will provide its expertise and past experience in helping SME's to define the process modelling and control. In WP4, DCI will provide available real industrial data in helping the Data Mining gathering process. In WP8, DCI will play a pivotal role in supporting the testing and demonstration of the potential innovative solutions developed as result of DISIRE implementation. In WP9, DCI will contribute in the dissemination of the obtained results to further support the achievements of the SPIRE Goals.	
	Ignasi Torra Master Degree in Chemistry (Universitat de Barcelona) with more than 35 years of experience in the petrochemical industry (Olefins Plant, Octene Plant and Polyethylene Technologies), 27 of them in the Ethylene Manufacturing Technology (Technology Associate). During his professional career, Ignasi performed different roles as Process Engineer, Production Engineer, Improvement Engineer, Project Engineer, Project Manager and Turnaround Manufacturing Representative. **Alfred Arias** Master Degree in Chemical Engineering (Institut Quimic de Sarría – Barcelona -) and in Industrial Engineering (Universitat Ramon Llull – Barcelona -) and Applied Petrochemical Post-Degree (Universitat Politècnica de Catalunya – Barcelona). 15 years of experience in the Ethylene Technology, performing roles as Production Engineer, Improvement Engineer, Project Engineer, Project Manager and Operations Leader. Currently, he is responsible for Innovation Support and Learning in Dow Chemical Ibérica S.L.	

List of up to 5 relevant previous projects or activities, connected to the subject of this proposal;	**TOP-REF Consortium (Innovative tools, methods and indicators for optimizing the resource efficiency in process industry).** Call FP7-NMP-2013-SMALL-7. Participation as the chemical industrial partner in the Consortium. **Energy Efficiency and Environmental Improvements in the Ethylene Technology** (Individual R&D project. CDTI Spanish R&D Program. **Octene production reaction optimization (new ligand).** (Individual R&D project. CDTI Spanish R&D Program.
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work;	DCI will contribute to the DISIRE Consortium with the existing fired equipment (cracking furnaces and boilers) and its ancillary infrastructure of its Ethylene Cracker located in Tarragona to test and demonstrate the innovative solutions developed during the DISIRE project life in the combustion technology and process field.

Participant 11	ABB	
Description of the legal entity	ABB (www.abb.com) is a leader in power and automation technologies that enable utility and industry customers to improve their performance while lowering environmental impact. The ABB Group of companies operates in around 100 countries and employs about 150,000 people	
Role in the project and main tasks (explanation of how its profile matches the tasks in the proposal)	ABB will mainly participate in WP 2 developing process control methods applied on ore production flow. ABB has long experience in developing and industrialize process control methods and apply on different industrial process. Relevant to DISIRE is i.e advanced process control zinc flotation process and grinding control. ABB will also participate in WP1 in specification work and WP9 business models	
Description of the key persons involved	**Jan Nyqvist**, Senior Scientist, Control&Optimization. He has and is responsible for advanced process control projects towards mining industry. Curently also work package leader in EU project I2Mine (www.i2Mine.eu). **Dr Michael Lundh**, Principal Scientist, Control&Optimization. He has developed several advanced process control methods applied on different industrial process, i.e flotation control of zinc process. He has also developed an advanced process control platform for easy implementation. **Rickard Lindkvist**, Senior Scientist, Control&Optimization. Developed a framework for material tracking in mining processes. **Daniel Lewandowski**, Senior Scientist, Control&Optimization. He is responsible for developing process control system for optimization of mining circuit.	
List of up to 5 relevant publications, and/or products, services (including widely-used datasets or software), or other achievements relevant to the call content		
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal;	**[1] I2Mine,** Innovative Technologies and Concepts for the Intelligent Deep Mine of the Future, project marks the start of a series of activities designed to realise the concept of an invisible, zero-impact mine. A ongoing EU project.	
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work;	ABB will contribute with an advanced process control platform for implementation of relevant control methods.	

Participant 12	D'Appolonia S.p.A. (DAPP)
Description of the legal entity	D'Appolonia S.p.A., part of the RINA Group, is the largest fully independent Italian firm providing consulting & engineering services to Clients belonging both to the public and the private sector. The company operates in the markets of Energy, Transport and Infrastructures, Industry and Investor Support. With a staff of about 700 engineers, scientists and associated professionals located in 20 offices worldwide, D'Appolonia offers high-end services to investors, promoters, operators and contractors, as well as to insurers and public administrations, to support their initiatives. All D'Appolonia services are performed at the highest professional level, understanding and complying with Client's needs and requirements while taking into due consideration sustainability and health, safety and environmental targets. D'Appolonia a team of engineers, consultants, designers, planners and specialists supporting public and private Clients from concept to decommissioning, through consultancy, design, management, operation and maintenance. The company provides a wide range of services covering the whole project life cycle from feasibility and specialized technical studies to conceptual and detailed design, prototyping and testing, project management, site engineering as well as operation and maintenance management. Innovation is a key element in all our projects; D'Appolonia has over twenty years experience in helping its clients in developing their new products and services as well as managing their collaborative innovation processes. The activity of D'Appolonia in the System Engineering, coupled to design and system integration, has led to significant capabilities. D'Appolonia engineers have acquired in particular a strong basic knowledge of integration of complex systems, comprising HW and SW optimisation.
Role in the project and main tasks (explanation of how its profile matches the tasks in the proposal)	DAPP long term competences on advanced sensing technologies and data analysis and treatment (Condition Based Maintenance approach), both applied on different industrial sectors, are aligned with the project technical requirements. DAPP will mainly participate in technical WPs dealing with the development of the integrated sensor platform (WP3), data analysis (WP4) and combustion processes (WP8). DAPP will also contribute towards the definition of the requirements, demonstration and evaluation scenarios (WP1), in the definition of the process modelling and control (WP2) and in dissemination (WP9).
Description of the key persons involved	**Bruna Simona** graduated in Electronic Engineering at the University of Genoa and got a PhD, with a thesis titled "Interaction between physical forces and biological systems". Following a couple of years of experience in the telecommunication sector (Marconi Communications as system engineer and Fortress Technology as project engineer), she joined D'Appolonia team in 2003. Her main fields of activity include management and organization of research projects, including applied research, both at national and European level, management of information technology networks, teaching activities and cooperation with Professor J.J. Kaufman's laboratory at the Mount Sinai School of Medicine in New York. The years of experience in the field of research have led to the publication of dozens of articles and reports, some of which have won recognition at international level. **Ivo Maria Cassissa** His main expertise is related to SW and HW design and development of electronic and control systems. Mr. Cassissa graduated in Electronic Engineering at University of Genoa. He has acquired relevant competence in research oriented to multimedia system design and electronic system design. His expertise ranges from system architecture design to development, testing and validation of integrated HW&SW equipment. His latest interest regards wireless protocols and wireless

	applications by designing of wireless control system for the upgrade of traditional wired control loops. **Domenico Donisi** Domenico Donisi was born in Rome on January 14th, 1980. He received the B.Sc. and M.Sc. degrees cum laude in Electronics Engineering both from University of Rome "La Sapienza". He then also received the Ph.D. degree on February 15th, 2008. In 2009 he joined D'Appolonia S.p.A., as consultant in the Surveillance and Monitoring Systems Unit. In D'Appolonia he is involved in SHM (Structural Health Monitoring) projects focused on the real-time monitoring of assets in different areas (civil, space, marine, oil & gas, etc…) with ad-hoc sensors solutions. He is also involved in national and european projects focused on the implementation of surveillance systems based on acoustic arrays both for civil and military applications.
List of up to 5 relevant publications, and/or products, services (including widely-used datasets or software), or other achievements relevant to the call content	**[1]** Services of design and development of real-time sensing systems for industrial processes monitoring and control **[2]** Condition Based Maintenance (CBM) services to industrial sector in order to continuously monitor the status of the process and eventually act with ad hoc feedbacks in case of failures or other **[3]** Services of management of large amount of data coming out from sensing networks
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal;	**[1] BURBA** research project (FP7) on waste, developing a real-time management system for an intelligent urban waste collection. Intelligent waste containers (IWACs) were developed including the most innovative sensing technology for automatically detect waste and citizen during disposal (RFID applications). **[2] Hispim-Glass** research project (FP5) on glass recycling, developing an high-speed infrared camera able to recognize and select glass cullets on an industrial conveyor belt during ceramic-glass separation process. **[3] EDY** research project (FP6) developing an on-line monitoring and control system for textile dyeing process. Parameters such as pH, temperature were constantly monitored in order to control the entire industrial dyeing process. **[4] VIPS and PROVIPS** research project (FP5 and FP7) developing an on-line system for monitoring the industrial process generating polished stone and slabs. The quality of the produced slabs were monitored, according to production requirements. **[5] Roboclimber** research project (FP6) on robotic rock drilling, aiming at defining and testing movement algorithms and drilling automated functions such implemented in an on board system. A number of parameters were constantly monitored though sensing on-board equipment. During testing in real environment rock drill trials up to 20 m depth have been performed.
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work;	DAPP will contribute to the DESIRE project using its laboratory infrastructure for any initial validation on the chosen sensing technology which might be necessary before the application to the industrial process.

Participant 13	Fraunhofer MOEZ (MOEZ)	Fraunhofer MOEZ
Description of the legal entity	As a part of Fraunhofer-Gesellschaft, Europe's largest organization for applied research, Fraunhofer MOEZ focuses on questions regarding the internationalization of research, development and innovation. The institute highlights the potential for innovation-based growth and transnational knowledge transfer, making its research findings available to the economy and politics and providing support to clients and customers. As an application-oriented institute, Fraunhofer MOEZ is in a position to act within a broad context in a way that is interdisciplinary and cross-thematic. The basic conditions for research, development and innovation are analyzed in an international context in order to improve, and thereby promote, the transfer of knowledge and technologies as well as the development of globalized value creation. Fraunhofer MOEZ assists with the transfer of knowledge from science to the economy and supports small- and medium-sized enterprises (SMEs) with a specific focus on innovative production and service industries in their innovation management and internationalization efforts.	
Role in the project and main tasks (explanation of how its profile matches the tasks in the proposal)	Fraunhofer MOEZ will contribute to the DISIRE consortium with its know-how in innovation management and participate in the WP9 "Dissemination and Innovation". The institute has a long track-record in successfully bringing innovative products and services to different markets. Based on its portfolio of scientific methodologies and tools, Fraunhofer MOEZ identifies and analyses new markets and user groups, develops business models, innovation an internalization strategies for technology and service companies, research institutions and political players. Within the WP9 Fraunhofer MOEZ will perform a series of innovation and commercialization activities in order to ensure the maximum market penetration and cross-sectorial impact of the proposed DISIRE technological concept. For this purpose, MOEZ will develop the technology exploitation strategy, an interactive innovation toolkit and design a series of commercialization and product development training activities for managers and researches involved in the consortium and beyond to make sure the DISIRE research outcomes will reach the market and generates new cross-sectorial business cases. Furthermore, Fraunhofer MOEZ will be a part of the Management Support Team and assist the Project Coordinator as an Innovation Management Office, which will be in charge of innovation strategy aiming at transfer the generated knowledge to the consortium partners, to the European process industrial community and finally to the market. Furthermore, it will establish a consulting panel and provide on-going training on technical business development to managers and researchers within the consortium support the decision-making process and secure the quality and progress of commercialization of DISIRE research outcomes.	
Description of the key persons involved	**Rajesh Shankar Priya** heads the group Technology Adaptation Management at Fraunhofer MOEZ. In his 15 years of work experience, he has worked in several technology domains including Aerospace, IT and Robotics with international institutions and industries in Europe, America and Asia. Rajesh Shankar Priya has a comprehensive experience in coordinating public funded technology and collaborative projects. I. a. he has coordinated such European projects as RapidFormingDie and Learning Form. His main research interests are in the area of technology adaptation and localization concepts for European technology houses entering Asia. Rajesh Shankar Priya graduated in Computer Science and Mechatronics from Moscow State University and University of Ravensburg-Weingarten. He has also spent significant time at Stanford University, University of Tokyo and several Asian universities for different research stays. **Eleonora Zagorska** is a research fellow in the group Technology Adaptation	

	Management. She studied business administration and economics in University of Leipzig and State University of New York as well as international project management in Paris XII and has gained profound experience in working on European projects. For instance, she has assisted and coordinated some projects while providing technology localization strategies and innovation management consulting to European technology companies expanding into the emerging markets like India.
List of up to 5 relevant publications, and/or products, services (including widely-used datasets or software), or other achievements relevant to the call content	**[1]** Technology Localization Model - a model developed by Fraunhofer MOEZ to support European technology in all aspects of their internalization, innovation and technology adaptation processes into the new markets. **[2]** Rau, C., Neyer, A. - K., & Möslein, K. M. 2012. Innovation practices and their boundary-crossing mechanisms: a review and proposals for the future. Technology Analysis & Strategic Management, 24(02): 181–217. **[3]** Abdelkafi, N./Makhotin, S./Posselt, T.(2013): Business Model Innovation for Electric Mobility – What Can be Learned from Existing Business Model Patterns? International Journal of Innovation Management, Vol. 17, No 1, pp. 1-41. **[4]** Neyer, A.K./Abdelkafi, N. (2013). Educating open innovation ambassadors. In: Huff, A.S., Möslein/K.M./Reichwald, R. (Hrsg.), Leading open innovation. MIT Press. **[5]** Blecker, Thorsten, Nizar Abdelkafi, Gerold Kreutler und Gerhard Friedrich. (2006) Dynamic Multi-Agent Based Variety Formation and Steering in Mass Customization. Enterprise information systems VI. :116-126.
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal;	**[1] RapidFormingDie** RapidFormingDie (Digital Die Production for Metal Forming Processes using Rapid Beam Melting Technologies) is a project which was developed with European and South African partners to solve Rapid Manufacturing issues. The innovative approach has been taken to provide superior properties and added value to tooling for metal forming processes by using Beam Melting Technologies to manufacture forming die inserts. Whereas existing research and development has been limited to prototype and pre-series tooling for low impact processes like plastic injection moulding (Rapid Tooling), this proposal aims instead on fully functional large scale production tooling for Metal Forming as a high impact process. Fraunhofer was involved in Innovation management and dissemination of results to different markets. **[2] Learning Form** LearnForm is a Collaborative European Project to develop a self learning production system. The Proposal was initiated and coordinated by Fraunhofer along with 8 European academic and industrial partners. LearnForm's overall objective was a radical substitution of today's trial and error procedures in deep drawing by a knowledge-based, self-learning production system. The self-learning sheet metalforming system LearnForm aims at an innovative deep drawing process with integrated multi sensors and actuators for adapting the control system strategy to changed material properties and product variants. Fraunhofer was involved in several technical WP as well as Management, Dissemination and Exploitation of Results. **[3] EBTC (European Business and Technology Centre)** EBTC is a reference point for promoting European clean technologies in India and a program co-funded by the European Union and implemented by EUROCHAMBRES, the Association of European Chambers of Commerce and Industry. Fraunhofer is one of the 23 European partners combining business organizations, academic and research institutes from all over the EU, all of them with a successful track record in their

	respective field. Within the scope of cooperation with the European Business and Technology Centre (EBTC) in India, researchers from Fraunhofer MOEZ initiated and implemented eight projects in the field of clean technologies since 2012. The main aims of these project activities are initially to develop technology adaptation and commercialization strategies for European technology companies who aim to enter the Indian market and to support them with innovative technology localization, business intelligence and IP management strategies. **[4] Technology Development Support for Lakshmi Machine Works Limited (LMW), India** Fraunhofer MOEZ implemented this industrial project in two stages. In the first stage, it facilitated B2B meetings with companies and freelancers offering CNC machining technology for LMW technology managers in Europe. Upon completion of the technology meetings in Europe, Fraunhofer MOEZ held a one-to-one meeting with the management and R&D of LMW to discuss further steps of the project. At the end of this stage, a comprehensive report was handed over to LMW. In the second stage, after successfully initiating technology cooperation, Fraunhofer MOEZ supported LMW with regards to legal, administrative, communication, project management and IPR issues. Furthermore, a technology consultant from the machine tool sector, who deals with technology issues was provided to LMW and its partners. **[5] EFFESUS: EU Energy Efficiency for Historic Districts' Sustainability** The Member States of the EU have committed themselves to saving of 20 percent of their primary energy consumption by 2020, and thus reduce CO2 emissions. The EU project EFFESUS (EU Energy Efficiency for Historic Districts' Sustainability) has been initiated with a total budget of 6.7 million Euros and 23 partners from 13 European countries (timeline: 09/2012 – 08/2016). The focus is both on the energy efficiency of individual buildings, building ensembles and districts, as well as their energy supply from renewable sources. The overall objective is to develop and demonstrate, through seven case studies, a methodology and criteria for selecting and prioritizing energy efficiency interventions in historic districts. The role of Fraunhofer MOEZ is, firstly, to devise a market launch strategy for the technologies and services that will be newly developed in the project. Secondly, the institute is working out target-group-specific concepts for an ongoing dialogue between the various actors involved.
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work;	MOEZ will contribute to the DISIRE project with its expertise in innovation activities and extensive networks in Europe to promote the project and create awareness and visibility about DISIRE technological platform in the broad range of research, industry and policy stakeholders.

Participant 14	G Stat Ltd. (GST)	
Description of the legal entity	The partner responsible for the data mining part of this STReP would be G-Stat Ltd, SME. G-Stat is the data science and business analytics leading provider in Israel with significant experience and proven track record of hundreds of successful projects through extensive professional services and beyond state of the art software solutions. With over 15 years of experience within a multi-vertical environment and strong collaboration with academic advisors, G-Stat has positioned itself as a natural and preferred partner for a variety of data science and business analytics projects. G-Stat was established in 1998 by Mr. Ephraim Goldin, as a data mining and statistical services company. The firm grew rapidly and developed top notch software solutions for predictive analytics and automatic modeling, which are widely used nowadays in various industries in Israel and abroad. In 2013, the company created an innovation division joining data scientists, integrators and software developers to address BIG Data needs and create new value proposition to organizations who wish to harness the power of new forms of data. This division is led personally by the company's C.E.O, Mr. Goldin.	
Role in the project and main tasks (explanation of how its profile matches the tasks in the proposal)	G-Stat will lead WP4 – data mining. G-Stat's profile is perfectly aligned with the necessary tasks required for creating beyond state of the art processes through research and innovation. Using its expertise in data collection and ETL processes, G-Stat, together with other WP leaders related to sensor technology, will lead the design of sensor data collection and preparation module required as a first step of the data handling process, including PAT position and product and process state data. The model will include data mining methods for cleansing and quality assurance of the data received from sensors. G-Stat's experts are experienced in working with many data mining methods, and the innovation team has the ability of adjusting and altering existing methods to create new and more suitable ones for process control, if necessary. G-Stat will also lead the development of the analysis and calculation module that processes the data and delivers the necessary KPI's required for optimization and process control. This will be done by using different types of statistical models, data handling algorithms and machine learning methods. G-Stat's will use its own software capabilities, wide experience with statistical analysis and automated modeling to handle BIG data challenges in the process industry, such as large volume, uncertainty and real-time calculations. This part will be in collaboration with the optimization WP leader, to define the right KPI's, and other relevant data for both real-time decision making and batch oriented long-run ones. Since G-Stat was involved in numerous implementations of BI and data analysis platforms, its experts have the adequate skill set to devise the appropriate deployment plan of the different modules that will be developed in the project, and recommend on certain procedures for a short, safe and clean implementation in an actual industrial process.	
Description of the key persons involved	**Mr. Ephraim Goldin, C.E.O** Ephraim Goldin is the founder, owner and CEO of G-Stat Ltd. As company president, Mr. Goldin is the chief architect and the drive behind the vision of the company's solutions. Before founding G-Stat, Mr. Goldin held senior management posts at Israel's central bank and lectured in econometrics and statistics at the Hebrew University in Jerusalem. Mr. Goldin holds a bachelor's degree in economics and statistics and an M.A in economics from the Hebrew University. Over the last 15 years, Mr. Goldin has served as senior consultant for some of the leading organizations in the world in fields such as: • Development and implementation of data mining and analytical solutions,	

	- implementation of quantitative models, credit risk, statistical forecasts, actuary, econometrics, inventory management, analysis of service systems and queuing systems, development of OLAP systems, planning and implementation of data warehouses, bio-statistics and statistical quality control. - Consulting for companies in implementing analytical solutions in complex IT environments including DWH, CRM applications, Credit Risk applications and marketing Campaign Management systems . Mr. Goldin is Chief Architect in development of G-Stat's Analytical and Predictive Platform, an advanced real-time analytical solutions package for various industries.
List of up to 5 relevant publications, and/or products, services (including widely-used datasets or software), or other achievements relevant to the call content	**[1] Automated Data-Mining Software Solutions** G-Stat had developed cutting edge software solution for automated statistical modeling for predictive analytics purposes such as Next-Best-Action, Churn Prediction and Risk Scoring as well as for general and specific statistical models that are usually done by coding. Using a simple interface, users can create thousands of sophisticated statistical models and deploy the results quickly without the need for IT assistance. Designed to handle BIG Data and perform in real-time, the unique technology positioned G-Stat as an innovative leader in the field. Widely deployed in Israel's top accounts as well as several world leading international customers. **[2] Professional Services for Powerful BIG Data Solutions** The professional services unit at G-Stat specializes in providing implementation, analysis and support services and delivering end to end data science solutions to Israel's largest enterprises. G-Stat's experts use a unique know-how and powerful software solutions, such as G-Stat's own software or partners' software like IBM, NICE and Tableau. The unit consists of data integrators, statisticians, industrial engineers, data scientists and more. These experts can advise on proper data collection, manipulation and analysis required for WP4. **[3]Software Development Team** G-Stat's software development experts are experienced and highly skilled software engineers who constantly strive for new innovative achievements within G-Stat's software offering. They are constantly developing beyond state of the art algorithms to tackle the demands and challenges of BIG Data analysis, such as the increasing volume of data, the speed of analysis required and new types of data. These experts can advise on proper algorithms required for the different phases of data handling in WP4.
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal;	**[1]** Development of automated statistical quality control systems for Bromine Compounds Ltd, Negev Ceramics, Intel Israel and others. **[2]** Process Optimization by using statistical controlled experiments designed by DOE tools – Teva Pharmaceutical, NILIT Fibers Division, Motorola and others **[3]** Reactor sensors data analysis - Bromine Compounds Ltd.
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work;	Being a fully functional software company, G-Stat owns a software development lab with test and production servers, which will be used to test, simulate and demonstrate different stages of WP4.

Participant 15	Swerea MEFOS (MEFOS)
Description of the legal entity	Swerea MEFOS is a research institute in the area metallurgy, heating, metalworking, environment and energy technology with customers in the steel, iron, alloy and base metal industries, environmental companies and equipment suppliers. MEFOS carry out applied research to meet customer needs for technology and expertise and contribute to economic and competitive production. The proposed project extends the area of metallurgy (in the blast furnace) and metalworking (in reheating furnaces). Robust measurements are requested for better process control, improved energy efficiency and improved product quality. In this project the experience from measurement technique and the large scale pilot equipment facilities for process metallurgy and reheating will be of large value.
Role in the project and main tasks (explanation of how its profile matches the tasks in the proposal)	MEFOS contribution is in the area of WP7 (steel) and WP8 (combustion). Measurements in this harsh environment will give valuable information that can be used for better for process control in the activities in WP2, WP4, WP6 as well. MEFOS's have been active in steel research for more than 50 years hand has contributed to the development in collaborative projects with the industry, several involving the implementation and testing of new measurement techniques to improve production conditions. The projects have been confidential assignments, governmental financed projects as well as EU financed project such as in RFCS. MEFOS has 34 member companies Outokumpu, SSAB, Ruukki, SSAB and SMT are some of them. In this project MEFOS will study the conditions at two process stages in the steel manufacture process, in the blast furnace as well as the downstream pre heating of the steel slabs. MEFOS preheating furnace is a suitable environment for early tests for temperature range and atmosphere. It is expected that the tests can be verified with existing measurement devices.
Description of the key persons involved	**<u>PhD. Lena Sundqvist</u>** Lena Sundqvist is currently working mainly in research project in the iron making area on raw materials, process modifications, measurements and data evaluation. Before joining MEFOS Lena worked at the BF No. 3 of SSAB in Luleå and finalized her PhD as in the area of injection, combustion and slag formation in the BF. Lena has experience from participation in and coordination of European projects within the Research Fund for Coal and Steel as well as from evaluation and monitoring of on-going projects in the same program. **<u>PhD. Jan Niemi</u>** Jan Niemi is currently working at Swerea MEFOS focusing on developing measurement system and other technical computing products for the steel industry. Before joining Swerea MEFOS, Jan was an application engineer at Damill AB building measurement system for the industry. He received a Ph.D. and a Masters in industrial electronics from Luleå University of technology, Sweden. His PhD work resulted in a patent "Apparatus for measuring the concentration and properties of particles in a fluid and a method thereof" the work also received an annual automation reward from the "Instrumenttekniska föreningen- för industriell automation". **<u>PhD. Annika Nilsson</u>** Annika Nilsson has long experience in the area of metalworking processes involving measurement in the rolling mill environment and problem solving in the strip and plate rolling process. The reheating of slabs is a source for process deviations therefore the control of furnaces is a very important task. Annika have a PhD in the area of simulation and modelling of metal working processes. Annika has worked with complex sensors for measurements inside the roll gap during rolling.
List of up to 5 relevant publications,	**[1]** A Nilsson, N-G Jonsson, J Lagergren, T Luks, A transducer for normal pressure, friction stress and contact length measurements in hot and cold flat rolling of metals. 30th JSI, Paris (2012)

and/or products, services (including widely-used datasets or software), or other achievements relevant to the call content	**[2]** Design and Application of a Spreadsheet-based Model of the Blast Furnace Factory, Lawrence Hooey, A Bodén, C Wang, C-E Grip B Jansson, ISIJ International, Vol. 50 (2010), No. 7, pp. 924–930 **[3]** Industrial Trials Using A Tunable Diode Laser to Measure Furnace Gas Temperatures and Oxygen Concentrations, Donald Malmberg, John Niska and Anders Rensgard, AFRC-JFRC Combustion Symposium, Maui, 2004 **[4]** L. Sundqvist Ökvist, A. Dahlstedt, M. Hallin: The Effect on Blast Furnace Process of Changed Pellet Size as a Result of Segregation in Raw Material Handling ISS 60th Ironmaking Conf. Baltimore March 2001 **[5]** E. Sandberg, Condition monitoring in the steel industry, PhD. Thesis, University of Manchester, 2008
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal;	**[1]** RFSR-CT-2009-00008 Advanced Roll Gap Sensors for Enhanced Hot and Cold Rolling Processes. In the project measurements of temperature evolution and pressures and friction inside the roll gap during rolling was measured. A telemetric data transfer was used. New information was extracted that have contributed to better process understanding and can be used for further improvement of process models. New small wireless sensors would be very useful in process studies. **[2]** RFSR-CT-2003-00005 Minimising NOx emissions from reheating furnaces. At MEFOS NOx emissions and other elements were measured for different burner types and different burner operations. New types of sensors or material tracking would bring added value in these kind of evaluations. **[3]** RFSR-CT-2006-00008 CO2 Reduction in reheating furnaces. In the project measurement of temperature and emissions were made to analyse different flameless combustion technologies for reducing CO2 and NOx emissions. New types of sensors for measurement or material tracking would bring new opportunities for optimisation of energy efficiency and environmental aspects. **[4]** RFCR-CT-2009-00002 ULCOS top gas recycling blast furnace process, the second of two projects involving topgas recycling into the BF. The projects that were closely related to the FP6 project ULCOS, involved significant equipment modification, Hazop studies and successful operation of the new process. **[5]** RFSR- CT-2008-00001, FLEXINJECT, Flexible injection of alternative carbon materials into the blast furnace, development and implementation of injection of BF flue dust was conducted in the project that contained the used of raceway depth measurement technique and optical fibres for temperature measurements in the raceway.
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work;	MEFOS will contribute to the DISIRE with a large industrial process experience, the pilot plant equipment and the measurement equipment and experience for doing measurements in this harsh environment. LKAB has their Experimental BF located within the MEFOS area. Due to a close cooperation it will be possible for MEFOS to use sensors in the Experimental BF. Tis intermediate step is of crucial importance for development of technique to be used within the industrial BF plants. The Experimental BF is equipped as an industrial BF, are operated similarly and offers extensive data collection during trials. MEFOS has very good knowledge within BF technology in industrial and pilot scale. The knowledge about the process in combination with skills in thermodynamic modelling, CFD modelling, process analyses and evaluation using statistical tools as e.g. SIMCA

4.2. Third parties involved in the project (including use of third party resources)

4.2.1 Luleå University of Technology (LTU)

No third parties involved

4.2.2 Luossavaara-Kiirunavaara Aktiebolag AB (LKAB)

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	Y
Subcontracting is necessary for LKAB to do construction and assembly work in the plants. For example cable and electrical installations and mechanical design and constructions in order to introduce the DISIRE technology.	
Does the participant envisage that part of its work is performed by linked third parties	N
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N

4.2.3 KGHM Polska Miedz SA (KHGM)

No third parties involved

4.2.4 ODYS S.r.l.

No third parties involved

4.2.5 Wroclaw University of Technology (WUT)

No third parties involved

4.2.6 IMT Lucca (IMTL)

No third parties involved

4.2.7 KGHM CUPRUM (CUP)

No third parties involved

4.2.8 Electrotech AB (ETEC)

No third parties involved

4.2.9 Research Center for Energy Resources and Consumption (CIRC)

No third parties involved

4.2.10 Dow Chemicals Ibérica (DCI)

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	Y
Subcontracting corresponds to engineering & construction (EPC) costs associated to the design and installation of the proposed improvements / equipment by RTD partners, as EPC services are not Dow owned ones but Service Provider external to Dow.	
Does the participant envisage that part of its work is performed by linked third parties	N
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N

4.2.11 ABB AB (ABB)

No third parties involved

4.2.12 D'Appolonia (DAPP)

No third parties involved

4.2.13 Fraunhofer MOEZ (MOEZ)

No third parties involved

4.2.14 GSTAT (GST)

No third parties involved

4.2.15 MEFOS (MEFOS)

No third parties involved

Section 5: Ethics and Security

5.1 Ethics

Not Applicable

5.2 Security[1]

Please indicate if your project will involve:

- activities or results raising security issues: NO
- 'EU-classified information' as background or results: NO

[1] Article 37.1 of Model Grant Agreement. *Before disclosing results of activities raising security issues to a third party (including affiliated entities), a beneficiary must inform the coordinator — which must request written approval from the Commission/Agency;* Article 37. *Activities related to 'classified deliverables' must comply with the 'security requirements' until they are declassified; Action tasks related to classified deliverables may not be subcontracted without prior explicit written approval from the Commission/Agency.; The beneficiaries must inform the coordinator — which must immediately inform the Commission/Agency — of any changes in the security context and — if necessary —request for Annex 1 to be amended (see Article 55)*