Please check our wiki for help on navigating the form.

Horizon 2020

Call: H2020-MSCA-ITN-2020

(Marie Skłodowska-Curie Innovative Training Networks)

Topic: MSCA-ITN-2020

Type of action: MSCA-ITN-ETN

Proposal number: 956433

Proposal acronym: InnoCyPES

Deadline Id: H2020-MSCA-ITN-2020

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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 steps in the submission wizard.

1 - General information

Topic	MSCA-ITN-2020	Type of Action	MSCA-ITN-ETN
Call Identifier	H2020-MSCA-ITN-2020	Deadline Id	H2020-MSCA-ITN-2020

Acronym	InnoCyPES
Proposal title	Innovative Tools for Cyber-Physical Energy Systems

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

Duration in months	*48*
Panel	ENG - Information Science and Engineering (ENG)

Please select up to 5 descriptors (and at least 3) that best characterise the subject of your proposal, in descending order of relevance. Note that descriptors will be used to support REA services in identifying the best qualified evaluators for your proposal.

Descriptor1	Energy systems, smart energy, smart grids, wireless energy tra
Descriptor2	Machine learning, data mining, statistical data processing and
Descriptor3	Scientific computing and data processing
Descriptor4	Electrical and electronic engineering: semiconductors, compon
Descriptor5	Networks (communication networks, sensor networks, network
Free keywords	*Digitalization, Interconnected Energy Systems, Policy*

*Abstract**

The principal goal of the InnoCyPES ITN is to provide world-leading and transferable scientific training to a new generation of 15 high-achieving early stage researchers (ESRs). In the course of their training, they will study, investigate and improve various facets of digitalized and interconnected energy systems. Supervised by a consortium of prominent and experienced academic institutions, research institutes and industrial partners, they will collaboratively develop a cutting-edge system management platform that covers the entire lifecycle of data for energy system planning, operation and maintenance, based on an understanding of the energy system as a cyber-physical system.

The increasing volume, velocity, and variety of data from a massive number of dispersed “Internet of things” sensors in the energy system offers opportunities for improved operational efficiency and reliability – but it also results in threats in the form of computational burden and cyber-attacks. The transformation towards a fully digitalized energy system requires substantial improvements in coordinated design of cyber and physical systems, end-to-end data processing tools, and enabling changes in policy, incentive and regulatory mechanisms. Their absence acts as a barrier for the energy industry in translating the fast-accumulating data into actionable knowledge. The ESR projects will target key bottlenecks for this digital transformation. The tools that will be developed will be released as an open source platform for maximum impact.

In InnoCyPES, the ESRs will be enrolled in an intensive doctoral training program that is both intersectoral – involving key stakeholders – and interdisciplinary, including information science, energy systems engineering and social science. Moreover, each ESR has both academic and industrial advisors. It will thus provide ESRs with skills that are in high demand by industry and academia, preparing them for thriving careers in this burgeoning area.

Remaining characters 7

Has this proposal (or a very similar one) been submitted to a previous ITN call in the last two years? (•) Yes ( ) No

Please give the proposal reference or contract number	
860804	

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 http://ec.europa.eu/research/participants/portal/desktop/en/organisations/lfv.html or to be covered by a financial viability check in an EU project for the last closed financial year. 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.	

Note:

For **multi-beneficiary applications**, the coordinator vouches for its own organization and that all other participants confirmed their participation and compliance with conditions set out in the call. If the proposal is retained for funding, each participant will be required to submit a formal declaration of honour confirming this.

False statements or incorrect information may lead to administrative sanctions under the Financial Regulation 2018/1046.

Personal data will be collected, used and processed in accordance with Regulation 2018/1725 and the **Funding & Tenders Portal privacy statement**.

Please be however aware that, to protect EU financial interests, your data may be transferred to other EU institutions and bodies and be registered in the EDES database. Data in the EDES database is also subject to Regulation 2018/1725 and the EDES privacy statement.

2 - Participants & contacts

#	Participant Legal Name	Country	Action
1	DANMARKS TEKNISKE UNIVERSITET	DK	
2	UNIVERSITEIT UTRECHT	NL	
3	ELECTRICITE DE FRANCE	France	
4	UNIVERSITA DEL SALENTO	IT	
5	TECHNISCHE UNIVERSITEIT DELFT	NL	
6	NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU	NO	
7	IMPERIAL COLLEGE OF SCIENCE TECHNOLOGY AND MEDICINE	UK	
8	Dansk Energi	DK	
9	AIT AUSTRIAN INSTITUTE OF TECHNOLOGY GMBH	AT	
10	SIEMENS GAMESA RENEWABLE ENERGY AS	DK	
11	TAJFUN HIL DRUSTVO SA OGRANICENOM ODGOVORNOSCU ZA ISTRAZIVANJE, PROIZVODNJU, TRGOVINU I USLUGE NOVI SAD	RS	

Information on partner organisations

Partner Organisation number	PIC Search PIC	Organisation legal name	Country	Academic Sector	Role of associated: Provide training	Role of associated: Host secondmends	
1	999511572	COMMONWEALTH SCIENTIFIC AND	Australia	No	Yes	Yes	
2	917829230	DEPSYS SA	Switzerland	No	Yes	Yes	
3	992448032	EQUINOR ENERGY AS	Norway	No	Yes	Yes	
4	999979015	EIDGENOESSISCHE TECHNISCHE H	Switzerland	Yes	Yes	Yes	
5	940764492	ESMART SYSTEMS AS	Norway	No	Yes	Yes	
6	999613325	INESC ID - INSTITUTO DE ENGENHA	Portugal	Yes	Yes	Yes	
7	909509346	NARI Technology Co., Ltd.	China (People's R	No	Yes	Yes	

8	998090910	UNIVERSITY OF NEW SOUTH WALE	Australia	Yes	Yes	Yes	
9	986083862	SIEMENS AS	Denmark	No	Yes	No	
10	952875136	ORSTED WIND POWER A/S	Denmark	No	Yes	Yes	

2 - Administrative data of participating organisations

Coordinator

PIC	***Legal name***
999990655	*DANMARKS TEKNISKE UNIVERSITET*

Short name: DTU

Address

Street ANKER ENGELUNDSVEJ 1 BYGNING 101 A

Town KGS LYNGBY

Postcode 2800

Country Denmark

Webpage www.dtu.dk

Specific Legal Statuses

Legal person .....yes
Public body .....yes
Non-profit .....yes
International organisation .....no
International organisation of European interest .....no
Secondary or Higher education establishment .....yes
Research organisation ……yes

Academic Sector .....yes

Enterprise Data

Based on the below details from the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

SME self-declared status.....2013 - no
SME self-assessment ..... unknown
SME validation sme..... unknown

Department(s) carrying out the proposed work

Department 1

Department name: Department of Electrical Engineering ☐ not applicable

☐ Same as proposing organisation's address

Street: Elektrovej, Building 325

Town: Kgs. Lyngby

Postcode: 2800

Country: Denmark

Department 2

Department name: DTU UNEP Partnership ☐ not applicable

☐ Same as proposing organisation's address

Street: Marmorvej 51

Town: Copenhagen

Postcode: 2100

Country: Denmark

Dependencies with other proposal participants

Character of dependence	***Participant***	

Person in charge of the proposal

Title: Dr. Sex: (•) Male ( ) Female

First name: **Guangya** Last name: **YANG**

E-Mail: **gyy@elektro.dtu.dk**

Position in org.: Senior Scientist

Department: Electrical Engineering ☐ Same as organisation name

☐ Same as proposing organisation's address

Street: Elektrovej building 325

Town: Kgs. Lyngby Post code: 2800

Country: Denmark

Website: https://www.elektro.dtu.dk/

Phone: +4553273699 Phone 2: +4545255619 Fax: *+xxx xxxxxxxxx*

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Emmanuel	Ackom	emac@dtu.dk	*+4545335289*
Faton	Avdijaj	proposal@adm.dtu.dk	*+4593511970*
Thomas	Estrup	thoest@elektro.dtu.dk	*+4545253815*

Participant

PIC	***Legal name***
999985805	*UNIVERSITEIT UTRECHT*

Short name: UU

Address

Street HEIDELBERGLAAN 8

Town UTRECHT

Postcode 3584 CS

Country Netherlands

Webpage www.uu.nl

Specific Legal Statuses

Legal person .....yes

Public body .....yes

Non-profit .....yes

International organisation .....no

International organisation of European interest .....no

Secondary or Higher education establishment .....yes

Research organisation .....yes

Academic Sector .....yes

Enterprise Data

Based on the below details from the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

SME self-declared status.....2007 - no

SME self-assessment ..... unknown

SME validation sme.....2007 - no

Department(s) carrying out the proposed work

Department 1

Department name: Copernicus Institute of Sustainable Development ☐ not applicable

☐ Same as proposing organisation's address

Street: Princetonlaan 8a

Town: Utrecht

Postcode: 3584 CB

Country: Netherlands

Dependencies with other proposal participants

Character of dependence	***Participant***	

Person in charge of the proposal

Title: Prof. Sex: ○ Male ◉ Female

First name: **Madeleine** Last name: **Gibescu**

E-Mail: **m.gibescu@uu.nl**

Position in org.: Chair, Integration of Intermittent Renewable Energy

Department: Copernicus Institute of Sustainable Development ☐ Same as organisation name

☐ Same as proposing organisation's address

Street: Princetonlaan 8a

Town: Utrecht Post code: 3584 CB

Country: Netherlands

Website: https://www.uu.nl/en/research/copernicus-institute-of-sustainable

Phone: +31627543089 Phone 2: +31302532704 Fax: *+xxx xxxxxxxxx*

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Tess van de	Voorde	t.f.j.vandevoorde@uu.nl	*+31302533730*

Participant

PIC	***Legal name***
999926829	*ELECTRICITE DE FRANCE*

Short name: EDF

Address

Street AVENUE DE WAGRAM 22

Town PARIS 08

Postcode 75008

Country France

Webpage www.edf.fr

Specific Legal Statuses

Legal person .....yes

Public body .....no

Non-profit .....no

International organisation .....no

International organisation of European interest .....no

Secondary or Higher education establishment .....no

Research organisation .....no

Academic Sector .....no

Enterprise Data

Based on the below details from the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

SME self-declared status.....2007 - no

SME self-assessment ..... unknown

SME validation sme.....2007 - no

Department(s) carrying out the proposed work

Department 1

Department name: MIRE-Measurement and Information System for Electrical Network ☐ not applicable

☐ Same as proposing organisation's address

Street: 7, Boulevard Gaspard Monge

Town: Palaiseau

Postcode: 91120

Country: France

Dependencies with other proposal participants

Character of dependence	***Participant***	

Person in charge of the proposal

Title: Dr.

Sex: (•) Male ( ) Female

First name: **Jose** Last name: **Sanchez Torres**

E-Mail: **jose.sanchez-torres@edf.fr**

Position in org.: Research engineer

Department: MIRE-Measurement and Information System for Electrical Network ☐ Same as organisation name

☐ Same as proposing organisation's address

Street: 7, Boulevard Gaspard Monge

Town: Palaiseau Post code: 91120

Country: France

Website: www.edf.fr

Phone: +33 1 78 12 32 11 Phone 2: +xxx xxxxxxxxx Fax: +xxx xxxxxxxxx

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Melaine	Rousselle	melaine.rousselle@edf.fr	+xxx xxxxxxxxx
Sylvie	Perrin	sylvie.perrin@edf.fr	+xxx xxxxxxxxx

Participant

PIC	***Legal name***
999863585	*UNIVERSITA DEL SALENTO*

Short name: UNILE

Address

Street PIAZZA TANCREDI 7

Town LECCE

Postcode 73100

Country Italy

Webpage www.unisalento.it

Specific Legal Statuses

Legal person .....yes

Public body .....yes

Non-profit .....yes

International organisation .....no

International organisation of European interest .....no

Secondary or Higher education establishment .....yes

Research organisation .....yes

Academic Sector .....yes

Enterprise Data

Based on the below details from the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

SME self-declared status.....2013 - no

SME self-assessment ..... unknown

SME validation sme..... unknown

Department(s) carrying out the proposed work

Department 1

Department name: Dipartimento di Ingegneria dell'Innovazione ☐ not applicable

☐ Same as proposing organisation's address

Street: Via per Monteroni

Town: Lecce

Postcode: 73100

Country: Italy

Dependencies with other proposal participants

Character of dependence	***Participant***	

Person in charge of the proposal

Title: Prof. Sex: (•) Male ( ) Female

First name: **Massimo** Last name: **Cafaro**

E-Mail: **massimo.cafaro@unisalento.it**

Position in org.: Associate professor

Department: Dipartimento di Ingegneria dell'Innovazione ☐ Same as organisation name

☐ Same as proposing organisation's address

Street: Via per Monteroni

Town: Lecce Post code: 73100

Country: Italy

Website: http://www.ingegneria.unisalento.it/home_page

Phone: +390832297371 Phone 2: *+xxx xxxxxxxxx* Fax: *+xxx xxxxxxxxx*

Participant

PIC	***Legal name***
999977366	*TECHNISCHE UNIVERSITEIT DELFT*

Short name: TU Delft

Address

Street STEVINWEG 1

Town DELFT

Postcode 2628 CN

Country Netherlands

Webpage www.tudelft.nl

Specific Legal Statuses

Legal person .....yes

Public body .....yes

Non-profit .....yes

International organisation .....no

International organisation of European interest .....no

Secondary or Higher education establishment .....yes

Research organisation .....yes

Academic Sector .....yes

Enterprise Data

Based on the below details from the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

SME self-declared status.....2018 - no

SME self-assessment .....2015 - no

SME validation sme..... unknown

Department(s) carrying out the proposed work

Department 1

Department name: Department of Electrical Sustainable Energy ☐ not applicable

☐ Same as proposing organisation's address

Street: Mekelweg 4

Town: Delft

Postcode: 2628 CD

Country: Netherlands

Dependencies with other proposal participants

Character of dependence	***Participant***	

Person in charge of the proposal

Title: Prof. Sex: (•) Male ( ) Female

First name: **Peter** Last name: **Palensky**

E-Mail: **peter@palensky.org**

Position in org.: Professor

Department: Department of Electrical Sustainable Energy ☐ Same as organisation name

☐ Same as proposing organisation's address

Street: Mekelweg 4

Town: Delft Post code: 2628 CD

Country: Netherlands

Website: https://www.tudelft.nl/staff/p.palensky/

Phone: +31-15-27-88341 Phone 2: +31-6-28314464 Fax: +xxx xxxxxxxxx

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Simon	Tindemans	s.h.tindemans@tudelft.nl	*+31-15-27-84487*
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Margo	Weerdenburg	m.weerdenburg@tudelft.nl	*+31-15-27-81184*

Participant

PIC	***Legal name***
999977851	*NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU*

Short name: NTNU

Address

Street HOGSKOLERINGEN 1

Town TRONDHEIM

Postcode 7491

Country Norway

Webpage www.ntnu.no

Specific Legal Statuses

Legal person .....yes

Public body .....yes

Non-profit .....yes

International organisation .....no

International organisation of European interest .....no

Secondary or Higher education establishment .....yes

Research organisation .....yes

Academic Sector .....yes

Enterprise Data

Based on the below details from the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

SME self-declared status.....1995 - no

SME self-assessment .....2011 - no

SME validation sme..... unknown

Department(s) carrying out the proposed work

Department 1

Department name: Department of Electric Power Engineering ☐ not applicable

☐ Same as proposing organisation's address

Street: Hogskoleringen 1

Town: Trondheim

Postcode: 7491

Country: Norway

Department 2

Department name: Department of Geoscience and Petroleum ☐ not applicable

☐ Same as proposing organisation's address

Street: HOGSKOLERINGEN 1

Town: TRONDHEIM

Postcode: 7491

Country: Norway

Dependencies with other proposal participants

Character of dependence	***Participant***	

Person in charge of the proposal

Title: Prof. Sex: ○ Male ◉ Female

First name: **Elisabetta** Last name: **Tedeschi**

E-Mail: **elisabetta.tedeschi@ntnu.no**

Position in org.: Professor

Department: Department of Electric Power Engineering ☐ Same as organisation name

☐ Same as proposing organisation's address

Street: HOGSKOLERINGEN 1

Town: TRONDHEIM Post code: 7491

Country: Norway

Website:

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

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Sina	Prestmo	sina.prestmo@ntnu.no	+xxx xxxxxxxxx
Ida	Lerheim	ida.lerheim@ntnu.no	+xxx xxxxxxxxx
Alexey	Pavlov	alexey.pavlov@ntnu.no	+47 97415395
Marzena	Ewa Grindal	marzena.grindal@ntnu.no	+xxx xxxxxxxxx
Andreas	Møllerløkken	andreas.mollerlokken@ntnu.no	+xxx xxxxxxxxx
Ingunn	Syrstad Bøgeberg	ingunn.syrstad.bogeberg@ntnu.no	+xxx xxxxxxxxx
Filip	Jessen	filip.jessen@ntnu.no	+xxx xxxxxxxxx
Damiano	Varagnolo	damiano.varagnolo@ntnu.no	+4748128922

Participant

PIC	***Legal name***
999993468	*IMPERIAL COLLEGE OF SCIENCE TECHNOLOGY AND MEDICINE*

Short name: Imperial

Address

Street SOUTH KENSINGTON CAMPUS EXHIBITION

Town LONDON

Postcode SW7 2AZ

Country United Kingdom

Webpage www.imperial.ac.uk

Specific Legal Statuses

Legal person .....yes

Public body .....yes

Non-profit .....yes

International organisation .....no

International organisation of European interest .....no

Secondary or Higher education establishment .....yes

Research organisation .....yes

Academic Sector .....yes

Enterprise Data

Based on the below details from the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

SME self-declared status.....2009 - no

SME self-assessment ..... unknown

SME validation sme..... unknown

Department(s) carrying out the proposed work

Department 1

Department name: Department of Electrical and Electronic Engineering ☐ not applicable

☐ Same as proposing organisation's address

Street: South Kensington Campus Exhibition Road

Town: London

Postcode: SW7 2AZ

Country: United Kingdom

Dependencies with other proposal participants

Character of dependence	***Participant***	

Person in charge of the proposal

Title: Prof. Sex: (•) Male ( ) Female

First name: **Bikash** Last name: **Pal**

E-Mail: **b.pal@imperial.ac.uk**

Position in org.: Professor

Department: Department of Electrical and Electronic Engineering ☐ Same as organisation name

☐ Same as proposing organisation's address

Street: South Kensington Campus Exhibition Road

Town: London Post code: SW7 2AZ

Country: United Kingdom

Website: https://www.imperial.ac.uk/people/b.pal

Phone: +44 20 7594 6172 Phone 2: +xxx xxxxxxxxx Fax: +xxx xxxxxxxxx

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Shaun P	Power	s.p.power@imperial.ac.uk	+xxx xxxxxxxxx

Participant

PIC	***Legal name***
989788001	*Dansk Energi*

Short name: Dansk Energi

Address

Street Rosenoerns Allé 9

Town Frederiksberg

Postcode 1970

Country Denmark

Webpage www.danskenergi.dk

Specific Legal Statuses

Legal person .....yes

Public body .....no

Non-profit .....yes

International organisation .....no

International organisation of European interest .....no

Secondary or Higher education establishment .....no

Research organisation ……no

Academic Sector .....no

Enterprise Data

Based on the below details from the Beneficiary Registry the organisation is an SME (small- and medium-sized enterprise) for the call.

SME self-declared status.....2011 - no

SME self-assessment ..... unknown

SME validation sme.....2011 - yes

Department(s) carrying out the proposed work

Department 1

Department name: Grid Technology ☐ not applicable

☒ Same as proposing organisation's address

Street: Rosenoerns Allé 9

Town: Frederiksberg

Postcode: 1970

Country: Denmark

Dependencies with other proposal participants

Character of dependence	***Participant***	

Person in charge of the proposal

Title: Dr.

Sex: (•) Male ( ) Female

First name: **Philip**

Last name: **Douglass**

E-Mail: **pdo@danskenergi.dk**

Position in org.: Consultant

Department: Grid Technology

☐ Same as organisation name

☒ Same as proposing organisation's address

Street: Rosenoerns Allé 9

Town: Frederiksberg

Post code: 1970

Country: Denmark

Website: http://www.danskenergi.dk

Phone: +4535300787

Phone 2: *+xxx xxxxxxxxx*

Fax: *+xxx xxxxxxxxx*

Participant

PIC	***Legal name***
999584128	*AIT AUSTRIAN INSTITUTE OF TECHNOLOGY GMBH*

Short name: AIT

Address

Street GIEFINGGASSE 4

Town WIEN

Postcode 1210

Country Austria

Webpage http://www.ait.ac.at/

Specific Legal Statuses

Legal person .....yes

Public body .....no

Non-profit .....yes

International organisation .....no

International organisation of European interest .....no

Secondary or Higher education establishment .....no

Research organisation .....yes

Academic Sector .....yes

Enterprise Data

Based on the below details from the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

SME self-declared status.....2015 - no

SME self-assessment ..... unknown

SME validation sme.....2007 - no

Department(s) carrying out the proposed work

Department 1

Department name: Center for Energy ☐ not applicable

☒ Same as proposing organisation's address

Street: GIEFINGGASSE 4

Town: WIEN

Postcode: 1210

Country: Austria

Dependencies with other proposal participants

Character of dependence	***Participant***	

Person in charge of the proposal

Title: Dr. Sex: (•) Male ( ) Female

First name: **Johannes** Last name: **Stöckl**

E-Mail: **johannes.stoeckl@ait.ac.at**

Position in org.: Thematic Coordinator "Power Electronics & System Components"

Department: Center for Energy ☐ Same as organisation name

☒ Same as proposing organisation's address

Street: GIEFINGGASSE 4

Town: WIEN Post code: 1210

Country: Austria

Website: https://www.ait.ac.at/ueber-das-ait/researcher-profiles/?tx_aitpr

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

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Veronica	Vana	veronica.vana@ait.ac.at	*+43505506678*

Participant

PIC	***Legal name***
986360215	*SIEMENS GAMESA RENEWABLE ENERGY AS*

Short name: SIEMENS GAMESA RENEWABLE ENERGY AS

Address

Street BORUPVEJ 16

Town BRANDE

Postcode 7330

Country Denmark

Webpage

Specific Legal Statuses

Legal person .....yes

Public body .....no

Non-profit .....no

International organisation .....no

International organisation of European interest .....no

Secondary or Higher education establishment .....no

Research organisation .....no

Academic Sector .....no

Enterprise Data

Based on the below details from the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

SME self-declared status.....2010 - no

SME self-assessment ..... unknown

SME validation sme..... unknown

Department(s) carrying out the proposed work

Department 1

Department name: Offshore Technology Development - Grid Compliance Department ☐ not applicable

☒ Same as proposing organisation's address

Street: BORUPVEJ 16

Town: BRANDE

Postcode: 7330

Country: Denmark

Dependencies with other proposal participants

Character of dependence	***Participant***	

Person in charge of the proposal

Title: Mr.

Sex: (•) Male ( ) Female

First name: **Frank** Last name: **Martin**

E-Mail: **frank.martin@siemensgamesa.com**

Position in org.: Team Lead Grid Compliance Testing

Department: Offshore Technology Development - Grid Compliance Department ☐ Same as organisation name

☒ Same as proposing organisation's address

Street: BORUPVEJ 16

Town: BRANDE Post code: 7330

Country: Denmark

Website: https://www.siemensgamesa.com

Phone: +4530375363 Phone 2: +xxx xxxxxxxxx Fax: +xxx xxxxxxxxx

Participant

PIC	***Legal name***
919150758	*TAJFUN HIL DRUSTVO SA OGRANICENOM ODGOVORNOSCU ZA ISTRAZIVANJE, PROIZVODNJ*

Short name: TAJFUN HIL LIMITED LIABILITY COMPANY

Address

Street BAJCI ZILINSKOG BB

Town NOVI SAD

Postcode 21000

Country Serbia

Webpage https://www.typhoon-hil.com/

Specific Legal Statuses

Legal person .....yes

Public body .....no

Non-profit .....no

International organisation .....no

International organisation of European interest .....no

Secondary or Higher education establishment .....no

Research organisation .....no

Academic Sector .....no

Enterprise Data

Based on the below details from the Beneficiary Registry the organisation is an SME (small- and medium-sized enterprise) for the call.

SME self-declared status.....2009 - yes

SME self-assessment ..... unknown

SME validation sme..... unknown

Department(s) carrying out the proposed work

No department involved

Department name: *Name of the department/institute carrying out the work.* ☒ not applicable

☐ Same as proposing organisation's address

Street: *Please enter street name and number.*

Town: *Please enter the name of the town.*

Postcode: *Area code.*

Country: *Please select a country*

Dependencies with other proposal participants

Character of dependence	***Participant***	

Person in charge of the proposal

Title: Mr.

Sex: (•) Male ( ) Female

First name: **Damjan** Last name: **Tomanek**

E-Mail: **damjan.tomanek@typhoon-hil.com**

Position in org.: Business Developer

Department: TAJFUN HIL DRUSTVO SA OGRANICENOM ODGOVORNOSCU ZA ISTRA ☒ Same as organisation name

☒ Same as proposing organisation's address

Street: BAJCI ZILINSKOG BB

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Country: Serbia

Website: https://www.typhoon-hil.com/

Phone: +381213010476 Phone 2: *+xxx xxxxxxxxx* Fax: *+xxx xxxxxxxxx*

3 - Budget

Researcher Number	Recruiting Participant (short name)	Planned start month	Duration (months)
1	UU	5	36
2	EDF	5	36
3	TU Delft	5	36
4	UNILE	5	36
5	TU Delft	5	36
6	NTNU	5	36
7	NTNU	5	36
8	Imperial	5	36
9	Dansk Energi	5	36
10	Imperial	5	36
11	AIT	5	36
12	SIEMENS GAMESA RENEWABLE ENERGY AS	5	36

Researcher Number	Recruiting Participant (short name)	Planned start month	Duration (months)
13	TAJFUN HIL LIMITED LIABILITY COMPANY	5	36
14	DTU	5	36
15	DTU	5	36
Total			540

Participant Number	Organisation Short Name	Country	IOEI	No of researchers	Number of person.months	Researcher Unit Cost			Institutional Unit Cost		TOTAL
						Living allowance	Mobility Allowance	Family Allowance	Research, training and networking costs	Management and overheads	
1	DTU	Denmark	no	2	72	317844,00	43200,00	18000,00	129600,00	86400,00	595044,00
2	UU	Netherlands	no	1	36	127019,88	21600,00	9000,00	64800,00	43200,00	265619,88
3	EDF	France	no	1	36	136202,04	21600,00	9000,00	64800,00	43200,00	274802,04
4	UNILE	Italy	no	1	36	122899,68	21600,00	9000,00	64800,00	43200,00	261499,68
5	TU Delft	Netherlands	no	2	72	254039,76	43200,00	18000,00	129600,00	86400,00	531239,76
6	NTNU	Norway	no	2	72	307484,64	43200,00	18000,00	129600,00	86400,00	584684,64
7	Imperial	United Kingd	no	2	72	329145,12	43200,00	18000,00	129600,00	86400,00	606345,12

Participant Number	Organisation Short Name	Country	IOEI	No of researchers	Number of person.months	Researcher Unit Cost			Institutional Unit Cost		TOTAL
						Living allowance	Mobility Allowance	Family Allowance	Research, training and networking costs	Management and overheads	
8	Dansk Energi	Denmark	no	1	36	158922,00	21600,00	9000,00	64800,00	43200,00	297522,00
9	AIT	Austria	no	1	36	125607,24	21600,00	9000,00	64800,00	43200,00	264207,24
10	SIEMENS GAMESA RENEWABLE ENERGY AS	Denmark	no	1	36	158922,00	21600,00	9000,00	64800,00	43200,00	297522,00
11	TAJFUN HIL LIMITED LIABILITY COMPANY	Serbia	no	1	36	79225,56	21600,00	9000,00	64800,00	43200,00	217825,56
Total				15	540	2117311,92	324000,00	135000,00	972000,00	648000,00	4196311,92

4 - Ethics

1. HUMAN EMBRYOS/FOETUSES		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	12,26
Are they volunteers for social or human sciences research?	◉ Yes ○ No	12,26
Are they persons unable to give informed consent?	○ Yes ◉ No	
Are they vulnerable individuals or groups?	○ Yes ◉ No	
Are they children/minors?	○ Yes ◉ No	
Are they patients?	○ Yes ◉ No	
Are they healthy volunteers for medical studies?	○ Yes ◉ No	
Does your research involve physical interventions on the study participants?	○ Yes ◉ No	
3. HUMAN CELLS / TISSUES		**Page**
Does your research involve human cells or tissues (other than from Human Embryos/ Foetuses, i.e. section 1)?	○ Yes ◉ No	
4. PERSONAL DATA		**Page**
Does your research involve personal data collection and/or processing?	◉ Yes ○ No	11,26
Does it involve the collection and/or processing of sensitive personal data (e.g: health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	○ Yes ◉ No	
Does it involve processing of genetic information?	○ Yes ◉ No	
Does it involve tracking or observation of participants?	○ Yes ◉ No	
Does your research involve further processing of previously collected personal data (secondary use)?	○ Yes ◉ No	
5. ANIMALS		**Page**
Does your research involve animals?	○ Yes ◉ No	

6. THIRD COUNTRIES		Page
In case non-EU countries are involved, do the research related activities undertaken in these countries raise potential ethics issues?	○ 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?	○ Yes ◉ No	
Do you plan to export any material - including personal data - from the EU to non-EU countries?	○ Yes ◉ No	
In case your research involves low and/or lower middle income countries, are any benefits-sharing actions planned?	○ Yes ◉ No	
Could the situation in the country put the individuals taking part in the research at risk?	○ Yes ◉ No	
7. ENVIRONMENT & HEALTH and SAFETY		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		Page
Does your research involve dual-use items in the sense of Regulation 428/2009, or other items for which an authorisation is required?	○ Yes ◉ No	
9. EXCLUSIVE FOCUS ON CIVIL APPLICATIONS		Page
Could your research raise concerns regarding the exclusive focus on civil applications?	○ Yes ◉ No	
10. MISUSE		Page
Does your research have the potential for misuse of research results?	○ Yes ◉ No	
11. 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 that, if any ethics issues apply, I will complete the ethics self-assessment and attach the required documents. ☒

How to Complete your Ethics Self-Assessment

5 - Call-specific questions

Extended Open Research Data Pilot in Horizon 2020

If selected, applicants will by default participate in the Pilot on Open Research Data in Horizon 2020[1] , which aims to improve and maximise access to and re-use of research data generated by actions.

However, participation in the Pilot is flexible in the sense that it does not mean that all research data needs to be open. After the action has started, participants will formulate a Data Management Plan (DMP), which should address the relevant aspects of making data FAIR – findable, accessible, interoperable and re-usable, including what data the project will generate, whether and how it will be made accessible for verification and re-use, and how it will be curated and preserved. Through this DMP projects can define certain datasets to remain closed according to the principle "as open as possible, as closed as necessary". A Data Management Plan does not have to be submitted at the proposal stage.

Furthermore, applicants also have the possibility to opt out of this Pilot completely at any stage (before or after the grant signature). In this case, applicants must indicate a reason for this choice (see options below).

Please note that participation in this Pilot does not constitute part of the evaluation process. Proposals will not be penalised for opting out.

We wish to opt out of the Pilot on Open Research Data in Horizon 2020.	○ Yes	◉ No

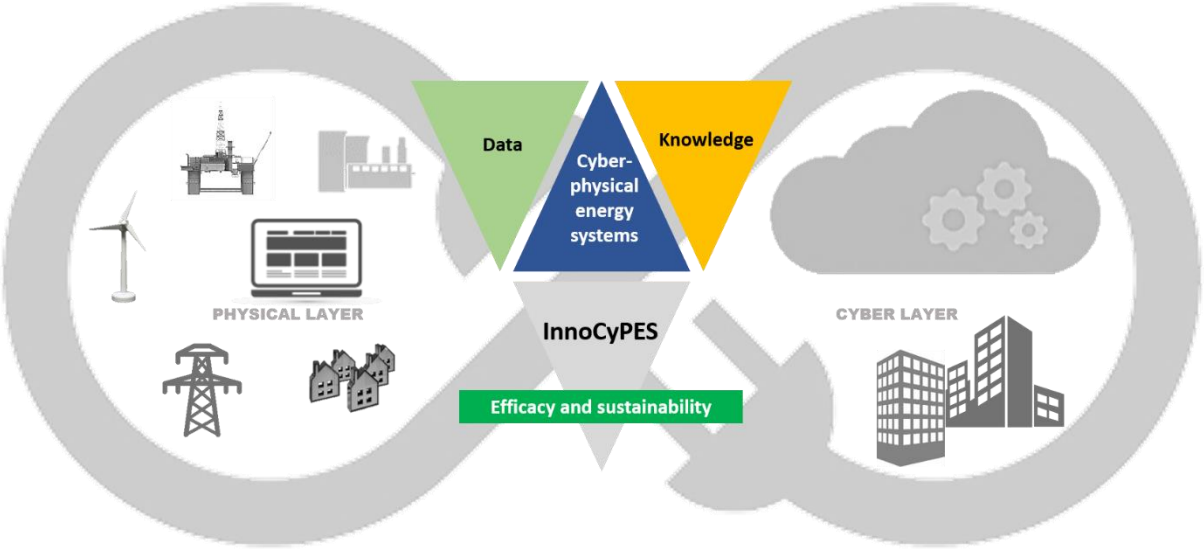
Further guidance on open access and research data management is available on the Funding & Tenders portal: http://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/open-access-dissemination_en.htm and in general annex L of the Work Programme.

[1] *According to article 43.2 of Regulation (EU) No 1290/2013 of the European Parliament and of the Council, of 11 December 2013, laying down the rules for participation and dissemination in "Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020)" and repealing Regulation (EC) No 1906/2006.*

MARIE SKŁODOWSKA-CURIE ACTIONS

Innovative Training Networks (ITN)
Call: H2020-MSCA-ITN-2020

PART B



InnoCyPES

Innovative Tools for Cyber-Physical Energy Systems

This proposal is to be evaluated as:

[ETN]

Table of Contents

List of participating organizations

#	Consortium Member	Short Name	Academic	Non-academic	Awards Doctoral Degrees	Country	Dept./Div./lab.	Contact	ESR No.	Role
Beneficiaries										
B1	**Technical University of Denmark**	**DTU**	X		X	Denmark	Department of Electrical Engineering Department of Technology, Management and Economics	Dr. Guangya Yang Dr. Emmanuel Ackom	14 15	Hiring, Supervision, Lecturing, Hosting secondment
B2	**University of Utrecht**	**UU**	X		X	Netherlands	Copernicus Institute of Sustainable Development	Prof. Madeleine Gibescu	1	Hiring, Supervision, Lecturing, Hosting secondment
B3	**Électricité de France**	**EDF**		X		France	Information and measurement	Male Dr. Jose Sanchez Torres	2	Hiring, Supervision, Lecturing, Hosting secondment
B4	**Technische Universiteit Delft**	**TUD**	X		X	Netherland	Department of Electrical Sustainable Energy	Prof. Peter Palensky	3 5	Hiring, Supervision, Lecturing, Hosting secondment
B5	**University of Salento**	**UNILE**	X		X	Italy	Department of Engineering for Innovation	A/Prof. Massimo Cafaro	4	Hiring, Supervision, Lecturing, Hosting secondment
B6	**Norges Teknisk-Naturvitenskapelige Universitet**	**NTNU**	X		X	Norway	Department of Electric Power Engineering Department of Geoscience and Petroleum	Prof. Elisabetta Tedeschi Prof. Alexey Pavlov	6 7	Hiring, Supervision, Lecturing, Hosting secondment
B7	**Imperial College of London**	**ICL**	X		X	United Kingdom	Department of Electrical and Electronic Engineering	Prof. Bikash Pal	8 10	Hiring, Supervision, Lecturing, Hosting secondment
B8	**Dansk Energi**	**DE**		X		Denmark	Department of Grid Technology	Dr. Philip Douglass	9	Hiring, Supervision, Lecturing, Hosting secondment
B9	**Austrian Institute of Technology**	**AIT**		X		Austria	Center for Energy	Dr. Johannes Stöckl	11	Hiring, Supervision, Lecturing, Hosting secondment
B10	**Siemens Gamesa Renewable Energy**	**SGRE**		X		Denmark	Offshore Technology Development – Grid Compliance department	Frank Martin	12	Hiring, Supervision, Lecturing, Hosting secondment
B11	**Typhoon HiL**	**THiL**		X		Serbia		Damjan Tomanek	13	Hiring, Supervision, Lecturing, Hosting secondment
Partner organizations										
P1	**Commonwealth Scientific and Industrial Research Organisation**	**CSIRO**		X		Australia	Data61	Dr. Shiping Chen		Supervision, Lecturing, Hosting secondment

P2	**DEPSYS SA**	**DEP**		X		Switzerland		Dr. Omid Alizadeh-Mousavi		Supervision, Lecturing, Hosting secondment
P3	**Equinor Energy AS**	**EQN**		X		Norway	Process Technology Electrical Technology	Dr. Børre Tore Børresen Dr. Francesco Marra		Supervision, Lecturing, Hosting secondment
P4	**Eidgenössische Technische Hochschule**	**ETH**	X		X	Switzerland	Department of Information Technology and Electrical Engineering	Dr. Florian Dörfler		Supervision, Hosting secondment
P5	**eSmart Systems**	**eSS**		X		Norway		Dr. Stig Ødegaard Ottesen		Supervision, Lecturing, Hosting secondment
P6	**INESC-ID Instituto de Engenharia de Sistemas e Computadores - Investigação e Desenvolvimento**	**INESC**	X		X	Portugal		Prof. Hugo Morais		Supervision, Lecturing, Hosting secondment
P7	**NARI Technology Co., Ltd**	**NARI**		X		China	Power Grid Security & Stability Control	Prof. Yusheng Xue		Supervision, Lecturing, Hosting secondment
P8	**University of New South Wales**	**UNSW**	X		X	Australia	School of Electrical Engineering and Telecommunications	Prof. Joe Dong		Supervision, Lecturing, Hosting secondment
P9	**Siemens**	**SIEMENS**		X		Denmark	Digital factory	Henrik Ruff		Lecturing
P10	**Ørsted Wind Power A/S**	**Ørsted**		X		Denmark	Offshore wind	Dr. Lukasz Kocewiak		Supervision, Lecturing, Hosting secondment

Data for non-academic beneficiaries

Name	Location of research premises (city/country)	Types of R&D activities	No. of full-time employees	No. of employees in R&D	Website	Annual turnover (in Euro)	Enterprise status	SME status
Électricité de France	Paris, France	Information and measurement	151,073	2.200	https://www.edf.fr/	€ 71 b	Yes	No
Dansk Energi	Frederiksberg, Denmark	Development of safe and efficient distribution system operations.	85	17	www.danskenergi.dk	€ 18.5 m	No	Yes
Siemens Gamesa Renewable Energy	Brande, Denmark	Controls and grid compliance for wind turbines and wind power plants (including testing and modelling), world-wide grid code requirements and grid code compliance	> 20.000	> 1.000	http://www.siemensgamesa.com/en/	€ 9 b	Yes	No
Austrian Institute of Technology	Vienna, Austria	Research Institute with focus on innovative infrastructure related solutions (e.g. energy)	> 1300	> 1300	www.ait.ac.at	€ 163 m	No	No
Typhoon Hil	Novi Sad, Serbia	Real-time simulator development and manufacturing	40	40	www.typhoon-hil.com	€ 2.7 m	Yes	Yes

1 Excellence

1.1 Quality, innovative aspects and credibility of the research programme

The principal goal of the InnoCyPES ITN is to provide world-leading and transferable scientific training to a new generation of 15 high-achieving early stage researchers (ESRs). In the course of their training, they will study, investigate and improve various facets of digitalized and interconnected energy systems. Supervised by a consortium of prominent and experienced academic institutions, research institutes and industrial partners, they will collaboratively develop a cutting-edge system management platform that covers the entire lifecycle of data for energy system planning, operation and maintenance, based on an understanding of the energy system as a cyber-physical system.

The increasing volume, velocity, and variety of data from a massive number of dispersed "Internet of things" sensors in the energy system offers opportunities for improved operational efficiency and reliability – but it also results in threats in the form of computational burden and cyber-attacks. The transformation towards a fully digitalized energy system requires substantial improvements in coordinated design of cyber and physical systems, end-to-end data processing tools, and enabling changes in policy, incentive and regulatory mechanisms. Their absence acts as a barrier for the energy industry in translating the fast-accumulating data into actionable knowledge. The ESR projects will target key bottlenecks for this digital transformation. The tools that will be developed will be released as an open source platform for maximum impact.

In InnoCyPES, the ESRs will be enrolled in an intensive doctoral training program that is both intersectoral – involving key stakeholders – and interdisciplinary, including information science, energy systems engineering and social science. Moreover, each ESR has both academic and industrial advisors. It will thus provide ESRs with skills that are in high demand by industry and academia, preparing them for thriving careers in this burgeoning area.

1.1.1 Introduction, objectives and overview of the research programme

To harness the intermittent renewable energy and ensure the security of energy supply, the energy system needs to be interconnected at different scales. This is particularly the case for cross-border energy sectors, where electric power systems and other vectors of energy are merging to play the central role for energy production, transmission, exchange and delivery. EU has set forth energy policies aiming for an integrated energy system[1], and has identified the electric power system as one of the key areas for the application of cyber-physical system (CPS), setting comprehensive recommendations for research and actions[2]. A significant number of Internet of Things (IoT) devices and Information Communication Technologies (ICT) infrastructure are being rolled out[3]. The energy system, as an area of a high degree of automation, is on the list of pressing priority[4]. This digitalization trend will further tie the security and efficiency of the physical system to the availability and performance of the information system[5], and through performance-driven development the energy system will eventually become a cyber-physical energy system (CPES).

IoT, ICT, cloud-based databases, with lowered costs and improved capabilities, are changing the way of development. In this wave, "low-hanging fruits" are being plucked first. However, unless advanced knowledge can be extracted that unpacks the full capacity of the cyber-physical infrastructure, the development of digitalization can stagnate. In the energy sector, complaints are often heard from industry on poor data quality and lack of tools to handle various data sources and the huge volume of data that can enhance the business. Taking the statements literally, one might think that the problem might lie in well-known issues with data - missing values or a lack of cohesion of data across data points and databases. Instead, the underlying problem lies in the gaps between data acquisition, management, processing, and regulation. Massive use of sensing devices and interoperability in the data acquisition system raises both privacy and cybersecurity concerns. In 2018, EU implemented the General Data Protection Regulation (GDPR)[6] and Cybersecurity Act[7] to strengthen the privacy and cybersecurity across EU member states. The challenge is emerging, and actions must be taken to guarantee the triad of confidentiality, integrity and availability[8]. Furthermore, policy support in facilitating digitalization of energy sector has been long overlooked[9].

The challenge of building a modern CPES is a manifold development of technology, business, and policy. To realize the full potential of CPES, the project draws on the efforts from information science, energy systems engineering, and social science to address the fundamental issues underneath the challenges,

- ✓ An end-to-end data handling workflow;
- ✓ Data analytics covering system development lifecycle;

[1] "Energy Policy," European Commission - European Commission. [Online]. Available: https://ec.europa.eu/info/strategy/energy_en.
[2] Cyber-Physical European Roadmap & Strategy (CyPhERS), "Research agenda and recommendations for action."
[3] "Connecting to New Opportunities Through Connected Devices," BSA Foundation, 11-Jul-2017.
[4] MindSphere: the cloud-based, open IoT operating system," Siemens.com Global Website. [Online]. Available: https://new.siemens.com/global/en/products/software/mindsphere.html.
[5] "Digitising European Industry," Digital Single Market. [Online]. Available: https://ec.europa.eu/digital-single-market/en/policies/digitising-european-industry.
[6] EU General Data Protection Regulation (GDPR). https://eugdpr.org/.
[7] "European Commission - EU negotiators agree on strengthening Europe's cybersecurity." [Online]. Available: http://europa.eu/rapid/press-release_IP-18-6759_en.htm.
[8] "Engineering Principles for Information Technology Security (A Baseline for Achieving Security), Revision A" NIST, June 2004.
[9] Nikos Hatziargyriou: 'Clear direction of management for network modernization and encouragement via incentives by regulatory authorities the most important lessons in the digital journey for customer benefits. Twitter. [Online]. Available: https://twitter.com/nh_nikos/status/1063080024914513920.

- ✓ Business cases and policies incentivizing digitalization;

InnoCyPES will seek to find solution to these set of problems by adopting a collaborative approach to establish a management tool for supporting the investment and applications. Relying on the harmony of the academic and non-academic partners, InnoCyPES will train 15 highly skilled early stage researchers (ESRs) for the positions as data scientists, digital system design specialists, and energy system analysts for the digitalized and transformative future energy sector.

State-of-the-art

Cross-border energy systems have relied on supervisory control and data acquisition (SCADA) system for real time operation since the 1960s. Offshore renewable plants, O&G platforms, transmission and distribution systems, use proprietary SCADA systems running on closed private networks. SCADA measures necessary quantities for operation such as voltages, power flows, pressure, speed, to name a few. In addition to SCADA, the energy system is monitored by millions of sensors through the deployment of smart meters and IoT[4]. For example, smart meters have increased from 7 to 70 million in the past 10 years in the USA and are expected to reach 90 million by the end of 2020[10]. EU has set a goal to reach at least 80% of consumers by 2020[11]. Similar developments are emerging across energy sectors[12]. The communication technologies are however diversified, where no silver bullets can be expected[13,14]. Viable means include radio frequency meshed networks, power line carrier, 5G wireless, or point-to-point wire-media such as copper wires and optic fibres. Recent development in supporting protocols, e.g. IEC61850[15], ZigBee[16], WiMax[17], DLMS/COSEM[18], ANSI C12, PLC PRIME[19], together with wide area monitoring systems[20], enables collection of measurements from hourly energy consumption all the way up to microsecond scale transient disturbances[21].

Upgrading sensing infrastructure entails accumulating massive quantities of data. A distribution system operator with 225000 consumers in Denmark received over 2.4 billion datasets in one month from the smart meters[22]. Data from offshore wind power plant SCADA system is in proportion to the number of turbines. Data cleansing is a critical process for removing the outliers, duplicate data and erroneous inputs and imputing the missing data points to create coherent datasets for further processing. Very large databases (VLDBs) techniques (e.g., indexing, compressing, replication and clustering) are used to store and query terabytes of data rapidly from the database, while in-memory database technology is used for real time data analytics. As data is also often collected by fence-off databases, data ingestion process is needed to merge data sources into one database to reestablish index for efficient processing. Cloud and edge computing are incorporated to facilitate data processing and ingestion[23].

Data security depends on privacy, integrity, confidentiality and availability[24]. However, cyber and physical energy systems are intertwined where disturbances in one affects the other. This is a known fact, testified by previous catastrophic events[25,26,27]. The recent development in IoT and database technologies leverages further integration of cyber and energy systems. In this context, we see the upcoming industrial challenges in digitalization. First, the communication process is **complex**. It starts from sensors, moves to gateways, to communication networks and finally reaches the databases. Compromising any link in the chain going wrong would render the data useless. As IoT devices have limited computing power, memory, and energy budget, they are vulnerable to the ambient environment. On the other hand, increased requirement of interoperability of sensors raises cybersecurity concerns. However, due to the limited processing power, it is challenging to achieve a common security protocol against threats such as eavesdropping, unauthorized access, falsified data injection, and denial-of-service attacks. The resiliency of cyber systems against cyber-attacks and failures in the data acquisition system is becoming critical.

Furthermore, the symbiosis of cyber and physical system has never been achieved in the past, as the information systems were developed on **empirical** and ***ad hoc*** approaches[28]. This is because the development has been driven by use cases. Service

[10] Cooper, A.: 'Electric company smart meter deployments: foundation for a smart grid'. The Institute for Electric Innovation (IEI) Report, October 2016
[11] "Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC," European Union, 14th of August 2009
[12] "Smart meters: a guide," Department for Business, Energy & Industrial Strategy, UK [Online]. Available: https://www.gov.uk/guidance/smart-meters-how-they-work
[13] "What communications technologies are in your utility's five-year plan?" LandisGyr. Whitepaper, 2013
[14] "The role of communication technology in Europe's advanced metering infrastructure," Accenture, 2014
[15] "International standard IEC 61850 and its application to Smart Grid," in Introduction to the Smart Grid: Concepts, Technologies and Evolution, Institution of Engineering and Technology, 2017, pp. 103–120.
[16] "Zigbee Alliance," Zigbee Alliance. [Online]. Available: https://www.zigbee.org/.
[17] W. Forum, "WiMAX Forum | AeroMACS, WiGRID, and WiMAX Advanced Technologies." [Online]. Available: http://www.wimaxforum.org.
[18] "DLMS/COSEM," DLMS/COSEM. [Online]. Available: https://www.dlms.com/
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[20] G. Y. Yang, K. E. Martin, and J. Østergaard, "Investigation of PMU performance under TVE criterion," 5th International Conference on Critical Infrastructure (CRIS), 2010.
[21] M. Farajollahi, A. Shahsavari, and H. Mohsenian-Rad, "Location identification of high impedance faults using synchronized harmonic phasors," IEEE Power Energy Society Innovative Smart Grid Technologies Conference (ISGT), 2017.
[22] Siemens, "Data analytics leads to grid load predictions." [Online]. Available: https://www.siemens.com/customer-magazine/en/home/energy/power-transmission-and-distribution/digital-secrets-from-the-grid.html.
[23] C. L. Philip Chen and C.-Y. Zhang, "Data-intensive applications, challenges, techniques and technologies: A survey on Big Data," Information Sciences, vol. 275, pp. 314–347, Aug. 2014.
[24] A. Siddiqa et al., "A survey of big data management: Taxonomy and state-of-the-art," Journal of Network and Computer Applications, vol. 71, pp. 151–166, Aug. 2016.
[25] G. Andersson et al., "Causes of the 2003 major grid blackouts in North America and Europe, and recommended means to improve system dynamic performance," IEEE Transactions on Power Systems, vol. 20, no. 4, pp. 1922–1928, Nov. 2005.
[26] S. V. Buldyrev, R. Parshani, G. Paul, et al, "Catastrophic cascade of failures in interdependent networks," Nature, vol. 464, no. 7291, p. 1025, Apr. 2010.
[27] SANS and Electricity Information Sharing and Analysis Center (E-ISAC). "Analysis of the cyber attack on the Ukrainian power grid; Mar. 18, 2016." [Online]. Available: https://ics.sans.org/media/E-ISAC_SANS_Ukraine_DUC_5.pdf.
[28] J. Sztipanovits et al., "Toward a science of cyber-physical system integration," Proceedings of the IEEE, vol. 100, no. 1, pp. 29–44, 2012.

providers, consumers, and system operators deploy communication links and data storages separately. The entire system is decentralized and point-to-point. Only recently has industry noticed the issue and started to look at centralized solutions[29]. In the scientific community, previous research projects on CPES have either lacked a systemic approach or only focused on one aspect or stage in the system development. The recent ITN project Ensystra[30] focuses on the energy system modelling, technology interactions, and the related policy and business models, however, the impact of the information system on energy system security and efficiency is completely ignored. Erigrid[31] focuses only on developing cyber-physical testing environments. oCPS[32] and UnCoVerCPS[33] consider a general aspect of the design of CPS but the focus is not energy system only, and only online applications such as control and validation are emphasized, where offline data analytics and planning is missing. Mantis[34] addresses data-driven predictive maintenance, but only for distribution grids. United-Grid[35] looks merely at electric distribution grids with a focus on operation and simulation. Economic feasibility and policy incentives towards CPES are not addressed in any of the mentioned projects. Instead, InnoCyPES takes a **holistic approach** to CPES. The full development lifecycle of CPES is addressed from design, modelling, planning, to operation, and maintenance, considering policy support schemes, cf. Figure 1.1.1.

The energy sector has a strong motivation to use data to aid product development, as shown in the recent report from ETIP report[36]. The report categorizes digital tools for control and monitoring as an immediate priority. The concept of Digital Twin has emerged where the importance has been identified[37,38]. The technology bridges virtual and physical systems through historical and real time data streams, which makes possible to accelerate the product development cycle, addressing the ever-shifting customers' needs from design, prototyping, type tests, compliance tests, manufacturing, to market integration. The existing norms and workforces that have been long established in industry will be challenged, which makes it critical to consider the customer acceptance at the beginning. A recent Mckinsey survey revealed that **only 4-11% companies** in traditional industrial sectors including power and energy sector have seen performance improvement after digitalization efforts[39]. It sheds lights on that digital transformation is not only a process of technology development and deployment but intertwined also with the institutional and social efforts to transform the way of operation, with and by data. A cost and risk reflective policy roadmap at EU level could stimulate fast yet robust development, which has not been studied and developed in place.

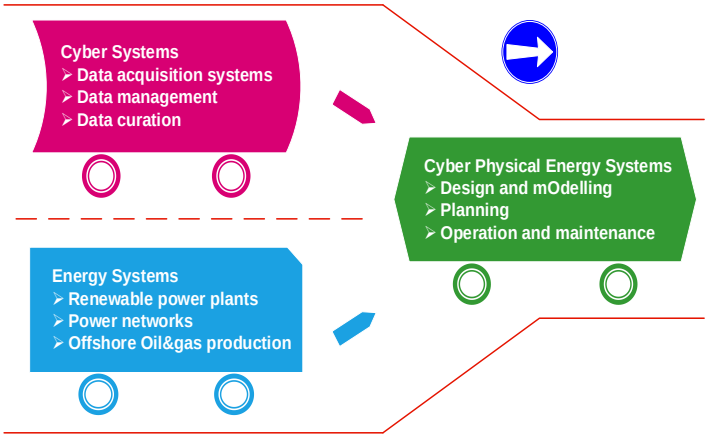

Figure 1.1.1. Integrate "Cyber" and "Physical" aspects in a management platform.

InnoCyPES will develop a robust data handling workflow for acquiring and processing the vast data for the energy system operation. The workflow covers data acquisition, management, storage, and application. Methods will be developed to help the energy companies to design the cyber and physical networks, acquire data securely from the sources, handle the large volume of data efficiently, with enhanced performance through data usage and acceptability from the market and society.

Through the developed data workflow, InnoCyPES delivers a management platform that encompasses the system development lifecycle. The project takes a holistic approach, considering the cyber system is an integral part of the energy system, where the operation and security of the sensing networks, information model, communication, and data management are taken at the same level as the physical system applications. We use model-based design approaches where the models are developed based on the competence and data from the consortium. The model will support real time and co-simulation environments. Different models, numerical models, process models, component models, will be integrated under one environment. Through the model-based approach, different configurations of the cyber system and cybersecurity impact on the management of the physical system can be tested. Methods and metrics will be developed to evaluate the system resiliency uniting cyber and physical systems.

The project will act as a booster and a role model for the energy sector in developing and deploying digital solutions, as activities are anchored directly in the core business of production, asset management, and service provision, considering the acceptability

[29] Energinet, "Introduktion til datahub og engrosmodellen", 2016. https://energinet.dk/-/media/Energinet/El-RGD/El-CSI/Dokumenter/DataHub/Introduktion-til-DataHub-og-Engrosmodellen.pdf?la=da
[30] ENSYSTRA – the ENergy SYStems in TRAnsition. EU MSCA ITN project, 2018. Project website: https://ensystra.eu/
[31] "ERIGrid – H2020 Research Infrastructure Project." https://erigrid.eu/.
[32] oCPS – Optimized Cyber Physical Systems. EU MSCA ITN project, 2015. Project website: https://ocps-itn.eu
[33] UnCoVerCPS, "Unifying Control and Verification of Cyber-Physical Systems (UnCoVerCPS) | CPS-VO." H2020 project. Website: https://cps-vo.org/group/UnCoVerCPS
[34] "MANTIS Collaborative Proactive Maintenance Reference Architecture – Cyber Physical System based Proactive Collaborative Maintenance," MANTIS Collaborative Proactive Maintenance Reference Architecture.
[35] "Solutions for intelligent distribution grids," UNITED-GRID. https://united-grid.eu/
[36] European Technology & Innovation Platform on Wind Energy, "ETIPWind Roadmap," Nov. 2019. https://etipwind.eu/files/reports/ETIPWind-roadmap-2020.pdf
[37] "Industry 4.0 and the Digital Twin technology | Deloitte Insights." https://www2.deloitte.com/insights/us/en/focus/industry-4-0/digital-twin-technology-smart-factory.html.
[38] "Digital Twin Power Grid - Power Transmission and Distribution - Energy - Home - Siemens Global Website." https://www.siemens.com/customer-magazine/en/home/energy/power-transmission-and-distribution/digital-twin-power-grid.html.
[39] "The keys to a successful digital transformation | McKinsey." https://www.mckinsey.com/business-functions/organization/our-insights/unlocking-success-in-digital-transformations.

from technical, business and social perspectives. Through interdisciplinary and intersectoral work, the project will deliver a pool of well-trained immediately employable researchers in CPES with strong and relevant skill set required by future digital energy system for secure and efficient energy transition.

Project concepts and objectives

The overarching goal of InnoCyPES is to deliver a system management platform applicable to the CPES development lifecycle. The following research objectives (**RO**) are targeted,

RO1. Develop a robust data handling workflow for energy systems;
RO2. Architect a management platform tuned on field data encompassing the entire energy system development lifecycle;
RO3. Develop economic models and policy recommendations towards digitalization of the energy sector;

The RO are addressed through ESR projects anchored in four sectors, including renewable energy generation, O&G production, power transmission and power distribution. Led by the ROs, the following sub-objectives (**SO**) are formulated and organized into work packages (**WP**) (cf. Table 1.1.1),

SO1. Establish models for sensor networks operation and information exchange, for applications in the offshore environment and power networks, considering cybersecurity aspects (ESR1, ESR2, ESR3), addressing **RO1, RO2** (WP1);
SO2. Establish data management and integration solutions, to enhance the accessibility and usability of a large amount of data from different data sources through improved data management and quality (ESR4, ESR5), addressing **RO1, RO2** (WP2);
SO3. Develop data analytic methods for cross border energy networks for improved operation, system stability, and maintenance (ESR6, ESR7, ESR8, ESR9, ESR10), addressing **RO1**, **RO2**, **RO3** (WP3);
SO4. Develop methods to incorporate real time and offline data from multi-physical and multi-timescale domain to achieve deep integration of data in the design of products and systems (ESR11, ESR12, ESR13), addressing **RO1**, **RO2, RO3** (WP4);
SO5. Develop economic models and policy recommendations for cross energy sector digitalization (ESR14, ESR15). The work enhances the business, environmental and social acceptability of the entire project, addressing **RO3** (WP5);

The key **scientific questions** answered here are,

1. How do the dynamics of the system impact CPES observability and controllability (ESR1, ESR5, ESR6, ESR8, ESR10)?
2. What are the stability conditions and value addition to the energy systems by enhanced ICT dynamism (ESR8)?
3. Are there general definable network properties across CPESs, which we can use to assess the design (ESR1, ESR10, ESR14)?
4. How and to what extent governmental as well as institutional policies and propositions, environmental sustainability and social acceptability could accelerate the digital technology deployment (ESR15)?

Table 1.1.1. Overview of the research programme and the roles of the non-academic sector.

Work package	ESR no.	ESR topic	Technological area distribution			Host	Secondments	Non-academic involvement
			Data & Information Science	Energy System Engineering	Social, Economic & Policy			
WP1: Data acquisition system design and security	1	IoT network design and reliability evaluation for energy sector	60%	30%	10%	UU	Ørsted, EDF	Ørsted, EDF
	2	Information model development for multiple actors' coordination	50%	30%	20%	EDF	UU	EDF
	3	Cyber-physical smart grid intrusion detection	50%	40%	10%	TUD	EDF, CSIRO, UNSW	EDF, CSIRO
WP2: Data accessibility and usability	4	Large scale data management and integration	70%	20%	10%	UNILE	DE, TUD	DE
	5	Enriching system measurements for machine learning applications	60%	30%	10%	TUD	DEP, UNILE	DEP
WP3: Innovative data analytic methods	6	Operation, maintenance and investment strategy for offshore energy hub	30%	40%	30%	NTNU	EQN, ICL, SGRE	EQN, SGRE
	7	Real-time analytics on high fidelity synchronized measurements	30%	60%	10%	NTNU	INESC, AIT, SGRE	AIT, SGRE
	8	Data-driven stability enhancement for cross border electric networks	30%	70%	0%	ICL	THiL, NTNU, NARI	THiL, NARI
	9	Condition monitoring and predictive maintenance of distribution grids	40%	40%	20%	DE	DTU	DE
	10	Privacy preserved data pattern identification for improved network observability	40%	40%	20%	ICL	AIT, DEP, eSS	AIT, DEP, eSS
WP4: Cyber and Physical symbiosis	11	Digitalized power converter design for fast prototype and control appraisal	40%	60%	0%	AIT	ETH	AIT
	12	Digitalizing wind turbine subsystems for fast prototyping and grid compliance	40%	50%	10%	SGRE	DTU	SGRE
	13	Development of Digital Twin models for power grids	40%	60%	0%	THiL	DTU	THiL

WP5: CPES planning appraisals	14	Cost benefit assessment to inform on competitiveness of increased digitalization in energy sector	20%	20%	60%	DTU	NTNU, INESC, NARI, UNSW, CSIRO	NARI, CSIRO
	15	Sustainability, enabling framework, and policy roadmap towards increased digitalization in energy sector	20%	20%	60%	DTU	NTNU, EDF, NARI, UNSW, CSIRO	EDF, NARI, CSIRO

The results can find **immediate use** in the following industries,

1. Learning from traditional O&G platforms to current renewable energy systems notably offshore wind as these are critical infrastructures yet also vulnerable to cyber-attacks. Intrusion detection method can be used to identify the abnormalities of critical measurements such as speed, pressure, voltage (ESR1, ESR3, ESR6);
2. The condition monitoring algorithms developed on historical data can help asset managers to obtain the reliability status of the system in time to ensure better maintenance and planning (ESR6, ESR9, ESR11);
3. For grid-connected generation units, the product development cycle (design, prototype, and test) can be greatly accelerated (ESR11, ESR12, ESR13);

The project encompasses United Nations (**UN**) Sustainable Development Goal (**SDG**) 7 (Energy), 9 (Environment), and 13 (Climate), and align closely with **OECD** call on digital transformation [40] of society. Through the training, ESRs will acquire skills demanded by EU [41] in digitalization in the area of energy sector, supported by the necessary theoretical and practical knowledge across cyber and physical energy systems.

Gender equality are considered key in the full project value chain from hiring to execution.

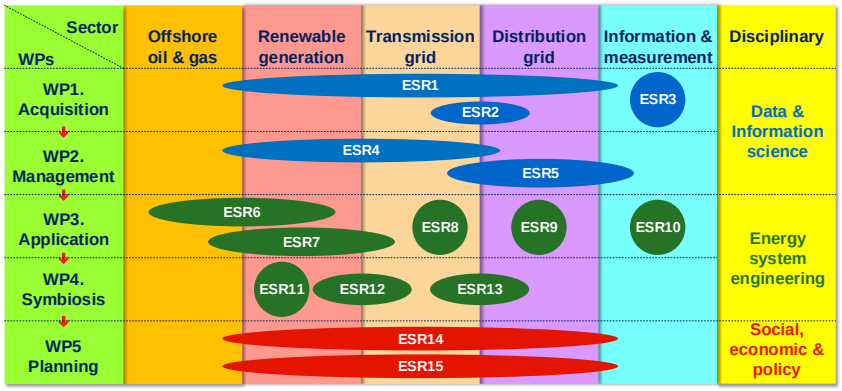

Figure 1.1.2. Interdisciplinary and intersectoral aspects of InnoCyPES.

1.1.2 Research methodology and approach

To achieve the ROs, 5 technical WPs have been defined (Table 1.1.1 and Figure 1.1.2). The approaches are detailed in the section below. WP6-8 address the training, dissemination and exploitation, and management issues related to the training.

WP1 Data acquisition system design and security (addressing RO1, RO2, SO1)

Due to the increasing reliance on IoT devices, the reliability of the data acquisition system and data quality is critical to the real time operation. Furthermore, data also needs to be shared and exchanged among different parties when controls and services are across jurisdictions, which calls for standardized, transparent yet flexible information models and communication architecture. Cybersecurity has a cut-across effect. This WP aggregates the elements covering the whole process in data acquisition. The consortium offers strong expertise from industrial sectors (e.g. SGRE, EDF, Ørsted) and state-of-the-art research facilities (DTU, TUD, INESC, NTNU, and UNSW), ensuring the access to the state-of-the-art metering and communication technologies. In particular, EDF has been involved in IEC61850 standardization that addresses the ICT architecture and information models.

ESR1 IoT network design and reliability evaluation for energy sector

IoT and Cloud based architectures augment the traditional SCADA by having more flexibility in data acquisition and more variety in data types. However, data from IoT is influenced by ambient conditions and quality of communication technologies. Cellular networks have been used outside the standard SCADA; however, the communication is limited by bandwidth and strength. The project will model and design the IoT network architecture, taking into account the dependency of the electronic sensors and their performance in sensing, communication, and ambient conditions. The work will deploy software defined networks (SDN) to extend the work from C. Wu[42] by establishing new reliability assessment metrics. The metrics can be used to design and verify the IoT system resilience and reliability, identify and verify the bottlenecks in communication, and provide specifications for control and protection functions design. The applications are in offshore wind plants, O&G platforms, and onshore transmission grids.

ESR2 Information model development for multiple actors' coordination

The work focuses on the communication architecture and information model design to facilitate the activation of services based on use cases. A use case describes the activation of services from distributed energy resources (DERs), where the model should coordinate transmission system operators and distribution system operators and the service providers to compromise different operating aims of the actors. As the services can be provided by different control approaches (centralized, decentralized, market based), the required information model to be exchanged between the actors can be different. The coordination between actors

[40] "Going Digital - Organisation for Economic Co-operation and Development." OECD. [Online]. Available: http://www.oecd.org/going-digital/going-digital-shaping-policies-improving-lives-9789264312012-en.htm.
[41] The Digital Skills and Jobs Coalition, European Commission, 2018
[42] C. Wu, B. Lin, H. Hung, S. Tseng, and C. Chen, "Symbiotic system models for efficient IOT system design and test," in 2017 International Test Conference in Asia (ITC-Asia), 2017, pp. 71–76.

implies the need for more and flexible exchange of information allowing the participation simultaneously of multiple actors, and the treatment and analysis of large amounts of data and the assurance of data quality. Communication architecture and information model based on CIM, IEC61850 and DLMS/COSEM will be established based on use cases defined in IEC 62559. The ESR will also interact with INESC regarding new distribution system information architecture.

ESR3 Cyber-physical smart grid intrusion detection

Keeping a smart grid stable, robust, and secure, requires secure data flows. Although the complexity of cyber-physical systems can be challenging to manage, their cross-domain nature provides advantages for devising advanced intrusion detection schemes. An intrusion can be detected and classified, based on physical- and on cyber-patterns. Most physical phenomena cannot be easily bluffed, and modern data acquisition systems can be upgraded with contextual intrusion detection systems (IDS). The project is to extend on the work reported in K.Pan[43] to develop highly accurate integrated cyber-physical smart grid (CPSG) IDS. Both analytical and numerical methods will be used to develop and validate the CPSG IDS. A co-simulation setup, that includes Modbus, IEC61850 and IEEE C37.118 (developed partially in the Dutch national URSES project[44] and reported in M.Naglic[45]), will help to simulate various types of attacks on CPSG and to validate the implemented detection algorithm.

WP2 Data accessibility and usability (addressing RO1, RO2, SO2)

The industry faces challenges in managing and utilizing various data sources and types across departments and stakeholders, as well as establishing and maintaining collective logs from various kinds of historical data that were utilized for products and customers. The WP addresses data accessibility and usability issues by providing distributed data management solutions and preprocessing techniques. Use cases are established and embedded together with Industrial partners. Two challenges are to be solved. The first one is related to the management of a very large amount of data coming from different sources and databases and the need to establish a common query system for logging and knowledge extraction. A second challenge comes from the use of various sensors with different characteristics, accuracy and time resolutions. There can be systematic differences in the values measured. Preprocessing techniques are therefore required for cross data source extraction to improve the data cohesion. The partners (SGRE, Ørsted, DEP, EQN, eSS) have vast historical data and experiences that can be exploited in this WP.

ESR4 Large scale data management and integration

The sheer quantum of data being created and collected across jurisdictions requires a carefully planned and proactive approach to data management. The need for fusion and integration of multiple data sources characterized by fragmented data ownership is driving innovative approaches to large scale distributed data management and integration to avoid inconsistent and inaccurate data. The aim is to investigate, design and implement a fully decentralized solution to provide efficient management of dynamically updated information and support for distributed queries. One or more domain specific use cases shall be identified within the context of the project, considering both the current and future needs of some of the involved partners. These nicely fit into the ESR research plan, owing to the need of surveying the user's requirements to begin with; simultaneously, the uses cases can also be thought of as sources of advanced data management challenges.

ESR5 Enriching system measurements for machine learning applications

Data-driven analysis and prediction methods typically assume measurements are abundant, but this is rarely the case. The ESR will develop methods to process data from heterogeneous measurement devices to boost their value for machine learning applications, using a three-pronged approach: 1) common grid events, observed by multiple sensors, will be used to align observations, for example to offset hidden clock drift; 2) synchronized pseudo-measurements will be synthesized using state-of-the-art-schemes, such as LSTM recurrent neural networks; 3) unsupervised learning approaches such as Generative Adversarial Networks (GANs) or Variational Autoencoders (VAEs) will be used to learn salient properties of whole-system snapshots and/or time-series. These can be used to generate data with similar statistical properties, thus replacing original measurements (for sensitive applications) or augmenting the original dataset. A test case will be investigated with industrial partner DEPsys.

WP3 Innovative data analytic methods (addressing RO1, RO2, RO3, SO3)

Data will not give added value to a business if it cannot be processed efficiently by problem-specific methods. The scope here moves from WP2 to the processing stage. The WP aims to integrate analytic methods on monitoring, control, and operation and maintenance (O&M) functions of electric and O&G systems. The work includes both offline (maintenance) and online (monitoring and control) applications. The consortium has several system operators who own large databases from different monitoring systems with time resolution from waveform measurements at 50 kHz (500th harmonics) to hourly values from smart meters. Those datasets make it possible for the ESRs to develop and validate analytic algorithms. As consumer data is used here, the effect of GDPR must be considered in the method development.

ESR6 Operation, maintenance and investment strategy for offshore energy hub

The integration of offshore wind power and O&G platforms offers environmental benefits. However, the intermittent wind power cannot provide scheduled and reliable power to the O&G platforms. A battery energy storage system (BESS) can be needed. The cooperation needs to count for the uncertainties in wind and O&G production processes. The ESR will integrate different

[43] K. Pan, A. Teixeira, M. Cvetkovic, and P. Palensky, "Cyber Risk Analysis of Combined Data Attacks Against Power System State Estimation," IEEE Transactions on Smart Grid, early access, 2018. doi: 10.1109/TSG.2018.2817387

[44] Uncertainty Reduction in Smart Energy Systems -URSES, https://www.tudelft.nl/protection-centre/research-projects/urses/urses/

[45] M. Naglic, M. Popov, M. A. M. M. van der Meijden and V. Terzija, "Synchro-Measurement Application Development Framework: An IEEE Standard C37.118.2-2011 Supported MATLAB Library," IEEE Transactions on Instrumentation and Measurement, vol. 67, no. 8, pp. 1804-1814, Aug. 2018.

sources and types of information (e.g., time series, images, results from numerical models based on finite elements approaches) into operations-oriented models, to devise novel control and health monitoring algorithms for the management of hybrid offshore energy hubs. The ESR will also develop the techno-economic study of system design that considers both capital and operational costs, along with the possibility for economic benefits from fuel savings and CO_2 emission reductions.

ESR7 Real-time analytics on high fidelity synchronized measurements

High-frequency disturbances from power converters on system operation call for high fidelity measurements. Synchronized waveform monitoring (SWM) is an emerging technology that extends the scope of synchrophasor technologies by providing wider bandwidth measurements including harmonics and electromagnetic transients across wide geographical areas. Today with the help from 5G wireless and fibre optics, it is possible to acquire waveform measurements from the meters in real time. The technology has great potential however the application is in its infancy. The ESR will develop a real time data analytic workflow for offshore wind and O&G platforms, and through historical and formulated disturbance patterns, the algorithm will detect disturbances and identify the root cause. Both field and simulated measurements will be exploited through real time data platform and stream data analytics. Applications will be developed for monitoring and protection of weak AC systems and O&G platforms.

ESR8 Data-driven stability enhancement for cross border electric networks

The retirement of conventional power plants in the electric grid reduces the system inertia[46,47,48]. Lower inertia will increase the heterogeneity among the subnetworks of the system as the system will not behave as an integrated “rigid body” but separate units subject to external disturbances. A polynomial fitting approach will be used on the data to obtain equivalent H and D parameters in the swing equation. To characterize the diverse system properties, data-driven methods can provide a way forward utilizing the synchrophasor technology, while based on the system characteristics, more adaptive control methods need to be developed to improve the system stability. This ESR project aims to propose system-wide control algorithms to damp the observed oscillations among subsystems, generation, and loads, based on wide area data while adaptive to the system properties.

ESR9 Condition monitoring and predictive maintenance of distribution grids

Reliability models of distribution networks for shorter time scale have never been established in the past due to lack of data. Over the years DE has collected extensive data from the distribution grid operators in Denmark that records the steady state and fault events in the distribution grids. Other data sources are also available, such as weather observations, GIS, and digging permits, which may influence the likelihood of component failure. This provides an opportunity to build a reliability model of the network and explore the correlations between data. The model can be used to predict the probability of future events, and hence plan the grid maintenance schedule optimally. The work will further explore the cost and benefit of different options for the grid operators, such as where to add sensors or automated systems to isolate and recover from faults. The model will be created using deep reinforcement and unsupervised learning techniques from the databases, which extends the work of Silver D. et al (2017).

ESR10 Privacy preserved data pattern identification for improved network observability

At consumer-side system operators suffer from lack of operational and situational awareness. The current practice of consumption estimation is based on consumption profiles formulated in planning. This method is not sufficiently accurate. As the energy supply infrastructure is more stressed by high use of distributed generation (DG), an increasing number of unexpected disruptions can occur, which in turn increases the cost of integration[49]. Though smart meters are available for monitoring the consumption, due to GDPR, the application is restricted. The ESR will develop methods to estimate the system condition from the available information while fulfilling the privacy constraints. The work will identify and update the statistical patterns and correlations among the historical data, while scenarios can be derived without breaching the consumer's privacy. Variants clustering will be used to identify the cluster. Kalman smoothing will be used for missing, unsynchronized or tampered data.

WP4 Cyber and physical symbiosis (addressing RO1, RO2, RO3, SO4)

Thousands of full-scale type tests are required before the product is delivered to the market. Pressed by more customized requests, manufacturers need to shorten the time to the market. The concept of Digital Twin has been proposed in industry[37,38], and this is an area energy technology providers are just starting to explore. A Digital Twin of a sub- or full-scale physical component created through the symbiosis of historical data and experience can greatly shorten the development cycle. The WP aims to develop Digital Twins for renewable generators and power grids. AIT, SGRE and THiL are technological leaders in manufacturing, testing, and simulation. The idea is to take a modularized and step-by-step approach, through digitalizing the sub-systems gradually towards the full system. Software/Hardware-in-the-loop (S/HiL) will be the main method. The WP unifies the previous WPs work in data handling and integrated into a simulation environment across virtual and real systems. User perspectives are incorporated in the development to ensure the market acceptability of the new technologies.

ESR11 Digitalized power converter design for fast prototype and control appraisal

The ESR will develop a virtual hardware testing environment and characterize the stability of different control strategies for power electronic converters through the deployment of hardware modular power converters and the implementation of communication protocols. Tests to be carried out in a laboratory microgrid environment to assess system reliability aspects in a Digital Twin

[46] SCAPP, “Synchronous Condenser Applications in Low Inertia Systems,” www.scapp.dk, 2014.
[47] Phoenix, “Phoenix – System Security and Synchronous Compensators,” funded by NIC, Ofgem, 2017.
[48] H2020 Migrate, “The Massive Integration of Power Electronic Devices,” https://www.h2020-migrate.eu/, 2016.
[49] E. Shlatz, N. Buch, and M. Chan, “Distributed generation integration cost study,” Navigant Consulting, Consultant report CEC-200-2013-007, Nov. 2013.

environment. The work will assess the control stability and provide a comparison of different control strategies on their efficiency and cost, propose guidelines for field implementations of the power electronic control and establish an integrated system assessment with links to system reliability. The ESR will collaborate with simulation tool provider THiL and system operator (EDF) to ensure the compliance of the new design under different grid conditions and find synergy with the work from ESR12.

ESR12 Digitalizing wind turbine subsystems for fast prototyping and grid compliance

The wind industry is facing more customized needs on the turbine design and manufacturing, due to various onshore/offshore conditions and grid code requirements. The ESR will build digital signatures of wind turbine subsystems including auxiliary systems based on the current DD Flex model[50], type test data and field measurements, combining whitebox, blackbox, and greybox types of models, incorporating Bayesian statistical models. The developed Digital Twin system will be used to enrich the testing and grid compliance methodologies for both wind turbine and wind power plant. Another objective is to develop methodologies based on the operational data for evaluating the performance of wind power plants according to grid codes and validate wind power plant simulation models through data mining and event extraction. The work should reduce the cost and time in product development cycle by highly innovative and transferable tests. The work is in close cooperation with the potential clients from the consortium (EQN, Ørsted and EDF) to ensure high customer confidence and acceptance of the new workflow.

ESR13 Development of Digital Twin models for power grids

The increasing complexity of the power grids due to the increasing use of renewable generation and information technologies calls for efficient simulation environment of cyber-physical power systems (CPPS). The ESR will develop the CPPS model libraries and supporting functions for a real time simulation platform to enable creating Digital Twin simulation of an actual power grid and cyber-physical HiL testing. The ESR will 1) Implement the latest communication protocols embedded into models including IEC61850; 2) develop customizable component protection and control functions and system protection functions; 3) establish real time power flow tools; 4) develop a programming environment for incorporating artificial intelligence methods.

WP5 CPES planning appraisals (addressing RO3, SO5)

The WP aims to find solutions that serves as motivating factors and incentivize cross-border digitalization of energy sectors, addressing the acceptance from economic and social levels of digitalization efforts. The first aspect is to establish integration of the cyber aspects into traditional system expansion policies, where cost-benefit analysis model of cyber investment will be developed together in the investment portfolio. The second aspect is to look at the environmental sustainability of the impact of increased digitalization, on the environmental sustainability, possible social structure, and enabling framework including governance, regulatory and policies necessary to facilitate the transformation of the energy sector toward digitalization. Lessons from O&G sector development will be explored for learning and enhanced adoption to the renewable energy sector hence facilitating transitions to green energy. The consortium has extensive knowledge in system planning, technology adoption, and policy, where business and policy drivers can be identified based on historical trends and results from WP1-WP4.

ESR14 Cost benefit assessment to inform on competitiveness of increased digitalization in energy sector

Digitalization brings better controllability and observability of the system, hence enhance the utilization and efficiency of the physical infrastructure. Expansion of digital infrastructure has not been considered in the past system planning studies, due to the challenge in quantify the tangible and intangible benefits. The ESR will develop quantitative assessment methods for cost benefit assessment (CBA) of ICT investment and establish a cyber-physical co-planning model based on net present value calculations according to future scenarios. Analytic hierarchy process (AHP) will be used to support decision-making process. The methods will be built on uses cases from consortium members.

ESR15 Sustainability, enabling framework, and policy roadmap towards increased digitalization in energy sector

Environmental sustainability/carbon footprint associated with increased digitalization needs to be carefully studied to inform businesses and government decision makers. Digitalization can be facilitated in part by market needs and in other part via enabling framework that is policy. This ESR will investigate effects of the enabling framework conditions such as policies and regulations towards an accelerated transition to a digitalized energy system and its longevity. A policy dialogue forum (PDF) through relevant consortium members, respective governments, the UN and EU associations will be run by the ESR to ensure better buy-in of findings by all parties, i.e. governments, industry and society. The ESR will develop a decision-support tool to inform on the environmental sustainability and prepare the policy roadmap for the sector to year 2030, that UN SDG target year.

Table 1.1.2 Work package list

WP no.	Title	Lead beneficiary no.	Starting month	End month	Activity type	Lead beneficiary short name	ESR involvements
1	Data acquisition system design and security	2	5	41	Research	UU	ESR1-3
2	Data accessibility and usability	5	5	41	Research	UNILE	ESR4-5
3	Innovative data analytic methods	6	5	41	Research	NTNU	ESR6-10
4	Cyber and physical symbiosis	9	5	41	Research	AIT	ESR11-13
5	CPES planning appraisals	1	5	41	Research	DTU	ESR14-15
6	Training	7	1	48	Training	ICL	All
7	Dissemination, exploitation and Communication	4	1	48	Dissemination	TUD	All
8	Project management	1	1	48	Coordination	DTU	All

[50] "New Siemens Gamesa DD Flex concept increases capacity on its largest offshore wind turbine to 11 MW." Siemens Gamesa Renewable Energy, 19-Nov-2019. https://www.siemensgamesa.com/en-int/newsroom/2019/11/191126-siemens-gamesa-flex-turbine-presentation

1.1.3 Originality and innovative aspects of the research programme

InnoCyPES contains several innovative aspects beyond the state-of-the-art on the research program and training. The key innovative research aspect is establishing a data workflow combining scientific tools to provide added value to the industry. This is necessary for the energy sector, to move from the historical well-established conventional practices to digitalized ones. Another aspect is the full-scale integration of cyber system in system operation, control and planning. The energy sector is a challenging domain to be digitalized due to the critical and highly specialized nature of the domains. There are very few researchers today who have high competences on both datasets handling methods and energy system knowledge.

Table 1.1.3 Originality and innovative aspects

	Current state-of-the-art in industry	InnoCyPES objectives
Overall	*No work has taken a holistic approach to CPES.*	Covers the lifecycle of CPES considering social-economic-technical aspects.
Training	*Data handling skills covering the whole data cycle with understanding of the operation of energy sector are in high demand.*	InnoCyPES will provide a comprehensive training framework including technical and transferable skills required by industry.
WP1	*Current SCADA relies on legacy designs. Information model has not been established for interactions among TSO, DSO, and market actors. Cybersecurity in IoT/Cloud is a known risk, but no integrated solutions exist.*	The performance of the data acquisition system is addressed. Standardized information model will be established. Intrusion detection will be developed for safe operation of IoT devices.
WP2	*Lack of technologies enabling efficient management of the data of different places and types over time. Quality of datasets have not been taken care of properly, resulting in challenges in analysis and learning.*	A distributed data management system with unified queries will be designed and implemented. Fast data preprocessing technique will be developed and applied to improve the data quality and to support real time analytics.
WP3	*Applications based on data outside standard SCADA in the energy sector are rare. Data collected in the industry are providing little added value due to the lack of processing tools and knowledge. General analytic techniques face problems when dealing with complex data types for problem-solving.*	New applications utilizing new and heterogeneous data sources to improve system operation and management beyond the traditional SCADA system. The consortium has specific domain knowledge including user aspects to develop customized solutions for the industry and maximize the impact of the work.
WP4	*Product development needs several years to reach the market.*	Digital Twin technology will be developed for renewable technology providers.
WP5	*There are no planning metrics that integrate the cyber system. Influence from policy and institutional impact has not been investigated in detail. Experience from O&G development has not been tapped for renewable energy sector.*	The project will include ICT indicators and impact in the planning model, take learning points from O&G sector, establish a robust policy roadmap to benefit all stakeholders including the private sector, governments and society at large.

1.2 Quality and innovative aspects of the training program

The existing PhD training programmes in EU universities operate in silos in the domains of electric power, petroleum, wind energy, telecommunications, and computer science, including the scientific methods from information science, engineering, and social science. Application-oriented studies in the proposed field have not yet taken off. The industry suffers from a lack of highly skilled engineers who have data handling skills and domain knowledge while the academia lacks the data and insights on the challenges in industry. In line with the pressing demand, the candidates passing the training will obtain deep knowledge from the involved engineering disciplines. The ESRs will enjoy a great degree of exposure in the training network which ensures their competences developed at the highest level in academic and industry.

The training program adheres to the Principles for Innovative Doctoral Training and the relevant policies of EU[51,52,53,54]. With research excellence as the key, InnoCyPES will deliver studies that have highest possible acceptance level by industry and society. The problems and methods defined in this action have strong linkage to the current challenges in industry, and the entire training program will benefit from the high relevance of the ESR projects to all the partners. All ESR projects can benefit from the use cases provided by consortium members that ensures the availability of data, pro-art knowledge, and user aspects. Compared to previous ITN projects[30,55] , InnoCyPES has strong focus on data and CPES lifecycle as well as cross sector innovation.

Table 1.2a Recruitment deliverables per beneficiary

ESR no.	Hiring partner	Awarding entity	Start month	Duration (months)
1	UU	UU	5	36
2	EDF	UU	5	36
3	TUD	TUD	5	36
4	UNILE	UNILE	5	36
5	TUD	TUD	5	36
6	NTNU	NTNU	5	36
7	NTNU	NTNU	5	36
8	ICL	ICL	5	36
9	DE	DTU	5	36
10	ICL	ICL	5	36
11	AIT	ETH	5	36
12	SGRE	DTU	5	36
13	THiL	DTU	5	36
14	DTU	DTU	5	36
15	DTU	DTU	5	36
Total	Hosted by 11 beneficiaries			540

1.2.1 Overview and content structure of the training

All ESRs will be enrolled in a doctoral program. The goal of InnoCyPES is to provide "Triple I" (International, Intersectoral and Interdisciplinary) training programme for a group of researchers who can perform cutting-edge research and innovation, provide solutions to challenges independently and collaboratively upon exit. A guiding motive of training is to facilitate the ESRs to grow personally and professionally through their training programme, eventually, reaching **self-expression** in research and innovation. This is done through high quality guidance from the supervisors, augmented by intensive training programmes and assessment of relevant preferences, to identify the type of research that would motivate them, whether they are prone to abstract

[51] "Doctoral Training Principles," *EURAXESS*, 30-Jun-2016. https://euraxess.ec.europa.eu/belgium/jobs-funding/doctoral-training-principles.
[52] "European Charter for Researchers," *EURAXESS*, 17-Jul-2015. [Online]. Available: https://euraxess.ec.europa.eu/jobs/charter/european-charter.
[53] "Innovation Union | EIC pilot - Research and Innovation - European Commission." http://ec.europa.eu/research/innovation-union/index.cfm?pg=home.
[54] Directorate-General for Employment, Social Affairs and Inclusion (European Commission), *An Agenda for new skills and jobs*. EU, 2011.
[55] "European Commission: CORDIS: Projects and Results: Innovative tools for offshore wind and DC grids." http://cordis.europa.eu/project/rcn/211663_en.html.

ideas, logical proofs, technology development, or experiment validation. The results will be used to define their individual education and research training portfolio. The programme is committed to achieve the training objectives below (TOs),

TO1. ESRs gain an overview of the data lifecycle management and physical system operation;
TO2. ESRs gain insights in one step in the data handling process and several energy system applications;
TO3. ESRs obtain skills in managing complex programming, simulation and testing environment;
TO4. ESRs obtain skills in assessing the economic and social aspects of technology development;
TO5. ESRs obtain a set of personalized transferable skills for employability and lifelong research and innovation capabilities;

The action offers a cutting-edge training programme combining technical as well as transferable skills. Every ESR will be assigned an International Supervisor Team (IST). The quality of the training will be ensured by IST and the Supervisory Board (SB, cf. Section 3.2.2). The training is quantified by ECTS (European Credit Transfer and Accumulation System) points. The 3-year training programme for each ESR is equivalent to 180 ECTS points comprising research and education training. Every ESR takes 30 ECTS on technical and transferable skills courses. On top of it the research training takes 150 ECTS comprising training activities at the host and secondment institutes.

In cooperation with IST, every ESR will set up a personal career development plan (PCDP) in the first two months. The plan will include career development perspectives of the next 5 years and the expected skill sets to be acquired. The plan also designates the steps to be taken in the training. Alongside the PCDP, ESRs will make a study plan, containing the research description, task list, course list (and ECTS), secondment place(s), and expected communication and dissemination plan. The timeline will be settled through a Gantt Chart. The progress in training and career development will be monitored through biannual study reports. Any update of the plan will need to be reported and approved (cf. Section 3.2.2, Training Coordination Committee).

The training of the transferable skills comprises research methods, ethics and integrity, GDPR, communication and presentation skills, project management, UN SDG goals, data management, innovation and entrepreneurship. Every ESR will receive the schedule of a list of transferable skills courses provided by the training programme before the start, where each ESR will set up a portfolio of courses and incorporate them in the study plan. The acquisition of the skills will be ensured by,

- ✓ Participating in transferable skill courses from or beyond the training network;
- ✓ Disseminating research results through international working group and committee meetings organized such as IEC and IEEE, and internationally organized conferences/exhibitions (cf. Section 2.3.1);
- ✓ Participating in local and internationally organized events addressing broader audience, such as European Researchers Night, and university open day;
- ✓ Participating in ESR committee and SB activities;
- ✓ Participating in training material preparation for the organized summer school at the end of the project;
- ✓ Participating in MSc project and internship project supervision for local or partner institutes;

In general, the educational and research training activities provided by InnoCyPES include three categories,

- ✓ **Local training:** refers to the participation in local courses and research meetings from a local beneficiary;
- ✓ **Network-wide training:** refers to activities offered by the project in the form of training schools, workshops, secondment(s), summer school, and final conference that provide knowledge and skills to all ESRs;
- ✓ **External training:** refers to external courses and research guidance offered outside the training network;

1.2.1.1 Training through research

The ESRs will receive a world-class research training programme from InnoCyPES. The supervisor team consists of highly qualified and committed academic and industrial experts, all being highly experienced in research, technology, training, and commercialization. The ESRs will enjoy high exposure to world-class research teams and their research environment. Every ESR will take intersectoral and interdisciplinary secondment(s) to perform research in partners' premises with complementary competencies and focuses (cf. Table 1.4.1, Table 3.1d). This ensures the knowledge transfer between the academic and non-academic partners. Every ESR will do at least one international secondment (if allowed by the enrolled PhD programme), to enhance the exposure of the ESRs to international environments and the collaboration among the partners and the ESRs, so that the effects of the training network will last long after the project.

InnoCyPES will enforce a common physical seminar every half year, rotating in place, for about one day, where the ESRs will join physically to meet each other and discuss their projects, as well as socialize and bond as a team. Supervisors will join either physically or through video to provide comments and inputs. The location of the ESRs in InnoCyPES centres around 3-4 countries around the North Sea, which makes it convenient for them and their supervisors to meet frequently and collaborate.

1.2.1.2 Training through education

Educational training comprises local, network-wide, and external training sources. Local training courses are the courses tailored for individual ESRs' research and career preferences. In case of one topic having no suitable courses offered locally, the project will support the ESRs to attend the courses openly offered by the partners or external sources. For example, most of the courses from DTU are open to guest PhD students[56]. Typically, local training encompasses tailored technical courses and transferable

[56] "Registering for courses as a guest PhD student - DTU," [Online]. Available: https://www.dtu.dk/english/Education/PhD/Intro/Guest-PhD/Guest_courses.

skill courses. The local technical specialization courses typically cover modelling and analysis of energy systems, sustainability, operations research, economic and policy analysis, digital and wireless communication, modern SCADA systems, database technologies, distributed systems, machine learning, and uncertainty modelling. Local training also includes project management, leadership, and start-up training programmes for choice. External training covers short PhD courses and tutorials offered by institutes outside the network, which are typically on highly specialized topics relevant to one ESR's project.

Local and external courses together make up 7,5 ECTS in one ESR's educational training plan. The network-wide training offers 22,5 ECTS in total and is organized into four training schools (TSs) and one summer school, with a focus on cutting edge scientific and technical training (cf. Table 1.2c). Key transferable skills include research methods and ethics, scientific writing, presentation, patenting, GDPR, UN SDG goals, and FAIR data management are offered in the network-wide training to all ESRs. The training schools are organized in different themes, where in total 6 workshops (WSs) planned for the ESRs work together as a team. The training schools cover wind, O&G, cyber-physical modelling, and data technologies, aiming to provide the ESRs the state-of-the-art of the problems and the solutions in energy operation and the data analytics. The composition of the scientific courses is multi-disciplinary and intersectoral, and each of them has strong involvement from the non-academic sector, which closes the gaps in the current doctoral training in EU within the energy technology field as well as ensures the relevance of the programme to the real-world challenges and practices. The transferable skill courses give a grasp of the fundamental skills needed for both academic and non-academic sector, which enhances the adaptability of the ESRs to different sectors upon finish.

An effective way of training of ESRs is through teaching activities. In InnoCyPES, ESRs will be exposed to teaching activities, where they will be involved in preparing and developing learning materials for the summer schools. Further, each ESR will prepare several MSc topics related to their own project, and setup joint supervision plans with their local supervisors.

Table 1.2b. Main network-wide training events and host (SC: Scientific course; WS: workshop; TC: Transferable skills course)

Events	Research-based Courses	ESR activities	Days	ECTs	Place	Lead inst.	Project month
Training School no. 1: Offshore wind	**SC1:** Offshore wind: grid codes, ancillary services, and compliance; **SC2:** Hybrid power plant applied to grid-connected offshore wind farms; **SC3:** Opportunities of IoT/Cloud for offshore wind; **TC1:** Introduction to research methods and integrity; **TC2:** Publication – How to write a scientific paper; **WS1:** Programming on an industrial IoT platform;	**1.** Present the research projects, problem formulation, hypotheses, methodology, and collect use cases from the consortium members; **2.** Architect the programming environments and interfaces among the projects; **3.** Every ESR make a 1 min video for their research topic; **4.** Nominates two ESRs to the SB;	10	5	CPH, DK	DTU	8
Training School no. 2 Offshore O&G	**SC4:** Offshore grids: operation, control, and protection; **SC5:** Monitoring and control of offshore O&G platforms; **SC6:** Modelling offshore O&G production process; **TC3:** How to give a technical presentation; **TC4:** Pop-science communication; **WS2:** Develop interfaces between the modules;	**1.** Present the concurrent research results, questions, and plans; **2.** Consolidate the research plan for synergy generation between ESRs; **3.** Develop proposals for collaborative projects (incl. MSc and internship project proposals);	10	5	TRD, NO	NTNU	14
Training School no. 3: Cyber-physical power systems	**SC7:** Cyber-physical electric network modelling; **SC8:** Standardization, interoperability, and cybersecurity; **SC9:** Digital Twin development and product lifecycle management; **TC5**: How to handle GDPR in research and innovation? **TC6:** Protecting business innovations through patent; **WS3:** HiL tests for cyber-physical microgrids;	**1.** One-year confirmation seminar for all the ESR projects; **2.** Practice pop-science communication, a video shot of 5 mins for YouTube. **3.** Prepare tutorials of a particular method used in their research for sharing with other members; **4.** Renew 2 ESR members in the SB;	10	5	QND, SRB	THiL	20
Training School no. 4: Data handling	**SC10:** State-of-the-art in databases and data management; **SC11:** Advanced data analytic methods; **TC7:** United Nations Sustainable Development Goals; **TC8:** FAIR data management**;** **WS4:** "Plug-fest" – Integration of software modules;	**1.** Mid-term evaluation of the project; **2.** Renew the 2 ESR members in the SB; **3.** Experience sharing on dissemination and exploitation of results; **4.** Plan research collaboration activities within and across the WPs;	10	5	DEL, NL	TUD	26
Workshops	**Biannual workshops** continue the activities from the previous workshops embedded in the training schools, where ESRs work together to on the interoperability and cross-validation of the modules.		–	–	VIE, LEC	AIT, UNILE	33, 39
General Assemblies	In cooperation with the kick-off meeting (M1), training schools (M8, M14, M20, M26), and workshops (M33, M39), and the final conference (M48)		–	–	–	–	–
IAB meeting	In cooperation with training school no. 2 (M14) and the training school no. 4 (M26). (IAB: International Advisory Board)		2	–	TRD, DEL,	NTNU, TUD	14, 26
Kick-off meeting	The members of different management units are appointed. The responsibility of the supervisors is introduced and appointed. The recruitment strategy is aligned. Basic procedures in training and collaboration are agreed.		–	–	DTU DK	DTU	1
Summer school	In cooperation with the workshop on M33, **Tutorials:** Each WP organizes a tutorial where typical methodologies are presented and demonstrated; **Hackathon:** Coding applications using the InnoCyPES platform. Open to all internal and external participants;		10	2,5	VIE	AIT	33
Supervision meetings	Weekly meeting with the local supervision team; Meeting with IST every 1.5 months;		–	–	All	All	–
E-training materials	The training material of the InnoCyPES tool will be developed at the end of the project and archived in the project portal accessible to the public;		–	–	–	–	45
Final conference	Open to all participants; ESRs present their work; Invited keynotes from internal and external experts; Open public meeting with the press where ESRs present;		2,5	–	DTU DK	DTU	48

Table 1.2c. The detailed programme of the scientific courses and workshops in the training schools

Training school 1 (Theme: offshore wind)		
SC1	**Offshore wind: grid codes, ancillary services, and compliance (1 day; Lead: SGRE; Contributors: DTU, Ørsted, UNSW)**	**1 ECTS**
The course introduces global grid codes, compliance testing and verification of services from wind power plants. It aims to introduce ESRs the present and upcoming ancillary service requirements on offshore wind, the test, validation, and certification process for wind turbine manufacturers. Opportunities/ideas in research are illustrated.		
Skills obtained	knowledge of grid codes; types of ancillary services; present testing systems; offshore wind farm structure; communication functions of wind turbines; field data acquisition and model validation process; testing procedures; instrumentation requirements	
SC2	**Hybrid power plant applied to grid-connected offshore wind farms (2 days; Lead: DTU; Contributor: SGRE, Ørsted)**	**1 ECTS**
The course provides training on recent innovations in offshore wind sector that combines battery, power to gas, and other technologies such as flexible ac transmission systems and synchronous condensers to offer a wide range of ancillary services and provide critical power system functions from operation, emergency, and restoration.		
Skills obtained	hybrid power plant design, control, and operation; system stability; state-of-the-art storage technologies; ancillary service provision	
SC3	**Opportunities of IoT/Cloud for offshore wind (2 days; Lead: DTU; Contributor: Siemens, UU, TUD)**	**2 ECTS**
The course will introduce SDN technologies and IoT systems. The history and evolution of SDN will be introduced, and the opportunity of SDN offers and tradeoffs of different designs will be explained. Network virtualization principles and ideas for applications in offshore wind will be provided. Further, Siemens developed an IoT operating system "Mindsphere"[4]. The course will also introduce the basics of the MindSphere system, the system functionality, and examples of developed applications.		
Skills obtained	software defined networks; network virtualization; Industrial IoT systems; IoT/cloud architecture; network programming environment	
WS1	**Programming on an industrial IoT platform (3 days; Lead: Siemens; Contributor: DTU)**	
ESRs will work in groups based on the WPs, where each group design and develop an application based on use cases provided by industrial partners. The ESR groups make brainstorming on possible solutions and develop solutions through the workshop.		
Training school 2 (Theme: Offshore O&G)		
SC4	**Offshore grids: operation, control, and protection (1 day; Lead: NTNU; Contributor: EQN, THiL)**	**1 ECTS**
The course aims at introducing the power supply system of the offshore O&G platforms in terms of the design and operation. The challenges in power supply system reliability and protection in the O&G platform in an islanded environment are provided. The course also covers recent research in offshore LVDC systems and storage.		
Skills obtained	Physical structure of O&G platforms; O&M of offshore platforms; O&G production process; low-voltage DC networks design and control	
SC5	**Digitalization and automation in offshore O&G operations (1 day; Lead: NTNU; Contributor: EQN)**	**1 ECTS**
The course overviews how to apply the most modern digitalization and automation methods to offshore O&G drilling, production and transport systems and operations for the purpose of increasing safety, operational efficiency and reduced environmental footprint. Alongside the technologies, another aim of the course is to pass on the experiences and solutions from O&G sector to the renewable sector, to inspire the ESRs to develop solutions through the existing learnings.		
Skills obtained	Structure of O&G systems; petroleum cybernetics, automation in drilling and production processes, monitoring and automatic control in O&G	
SC6	**Modelling and optimization of uncertain processes – experience transfer from O&G applications (2 days; Lead: NTNU; Contributor: EQN)**	**2 ECTS**
This course aims at presenting the state-of-the-art methods for modelling and optimizing uncertain processes using equations-based, data-driven and hybrid modelling approaches. The course will focus on practical examples from O&G industry and involve complex, heterogeneous, and highly uncertain systems & processes.		
Skills obtained	Data-driven modelling, uncertainty modelling, model predictive control, extremum seeking control, optimization in O&G	
WS2	**Develop data interfaces between the software modules (3 days; Lead: ESR Committee)**	
The WS aims to link the ESRs work into an integrated platfom. In the WS the interfaces of the modules are to be developed according to defined requirements. The work from individual ESR's project start to merge from this WS.		
Training school 3 (Theme: Cyber-physical power systems)		
SC7	**Cyber-physical electric network modelling (2 days; Lead: THiL; Contributors: EDF, UU, UNSW, NARI)**	**1 ECTS**
Examples of real time modelling of power grids are presented. The course compiles tutorials on cyber-physical modelling of power grids as well as the latest advancement in simulation technologies. The course will be given in combination with a workshop, where the ESRs will work on examples of cyber-physical models of power grids, real-time simulation, implementing communication protocols and develop customized component models and controls.		
Skills obtained	Hardware-in-the-loop tests; communication protocol implementation; power system modelling; smart grid functions of DERs	
SC8	**Standardization, interoperability and cybersecurity (1 day; Lead: EDF; Contributors: SIEMENS, TUD, UNSW, INESC)**	**1 ECTS**
The course will give ESRs an introduction to IEC61850 and the relevant data models, from an overview of standard to details about implementation, such as logic nodes programming, modelling tool (SCL), Goose message, and information model validation. An application example on substation automation and DER interoperability will be presented. The course also includes the latest developments in cybersecurity with respect to cybersecurity norms (IEC62443), the new EU Act, and industrial practices.		
Skills obtained	IEC61850 overview; logic nodes; client setup; information model validation; cybersecurity measures; communication of DERs	
SC9	**Digital Twin development and product lifecycle management (1 day; Lead: THiL; Contributors: SGRE, SIEMENS, AIT)**	**2 ECTS**
The ESRs will learn the latest generation Digital Twin technology used to validate the performance on the component, subsystem and system level. The course will introduce the principles of creating a virtual simulation environment substituting part of the physical system. Application examples of using Digital Twin technology for verifying system design will be presented. ESRs will have hands-on experience in creating their own virtual environment. Product lifecycle management is introduced in the course as well.		
Skills obtained	Multi-timescale data flow simulation; data sampling and resampling; component virtualization	
WS3	**HiL tests for cyber-physical microgrids (3 days; Lead: THiL; Contributor: NTNU, AIT)**	
A complete testbed for microgrid control and protection will be presented to ESRs, who will work on the testing suite to get hands-on experience on the state-of-the-art real time simulation and hardware-in-the-loop testing[57]. The ESRs will work on formulated tasks of modelling cyber-physical system at distribution grids and microgrids and design hardware-in-the-loop tests and validation of communication systems and information model.		
Training school 4 (Theme: Data handling)		
SC10	**State-of-the-art in databases and data management (2 days; Lead: UNILE; Contributors: eSS, DEP, CSIRO)**	**2 ECTS**
The course introduces the internals of modern database management systems covering the core concepts used in high-performance transaction processing systems (OLTP) towards real time analytics. Topics include data management architectures (centralized and distributed databases, distributed ledgers (e.g. blockchain-based)), database queries (basic to advanced) and an introduction to platforms and file formats for data sharing.		
Skills obtained	database management technologies; data center networks; setting up databases; data query techniques	
SC11	**Advanced data analytic methods (2 days; Lead: TUD; Contributors: INESC, UU, UNILE, INESC, CSIRO)**	**2 ECTS**
The course familiarizes students with common methods and novel advances in data analytics and data mining (supervised classification and regression, unsupervised learning, Bayesian decision theory, deep neural networks, adversarial training). It also introduces software engineering aspects, including elements of data processing pipelines, software versioning, collaborative methods.		

[57] T. HIL, "Microgrid Testing." https://www.typhoon-hil.com/applications/microgrid-testing.

Skills obtained	ability to select recognise problem structure and select appropriate analytical method; apply common machine learning methods; define data analytics pipeline for their projects; code versioning and collaborative editing.
WS4	**"Plug-fest" – Integration of software modules (5 days; Lead: ESR Committee)**
The workshop aims to develop further the interoperability of the ESRs' work to make them together form a robust data workflow. Through specific use cases, the modules should be able to process data flows from the acquisition phase to the final application. Another aim is validation, where tests can be performed based on selected benchmark examples. By the workshop, the ESRs will gain an overview of the platform and their work. The workshop also aims to stimulate further collaboration activities.	

Table 1.2d. Core elements of transferable skills courses offered in the training schools

Themes of transferable skills training courses		
TC1	**Introduction to research methods and integrity (1 day; Lead: DTU)**	**0,5 ECTS**
The course introduces how to formulate research problems and methodologies and manage the hypotheses. Code of conduct for research ethics and integrity is introduced.		
Skills obtained	Formulation of research problems; research hypotheses; knowledge of principles and best practices in scientific conduct	
TC2	**Publication – How to write a scientific paper (1 day; Lead: ICL)**	**0,5 ECTS**
The course introduces standards and practices for efficient writing of high-quality manuscripts for periodicals. The content covers how to identify a journal within a scope, prepare the manuscript, choose proper language, as well as prepare rebuttal letters. The course gives a few real examples of how a manuscript will go through a peer-review process and eventually be accepted for publication. Different open access licenses are introduced too.		
Skills obtained	presentation of scientific problems and methods in formal writing; knowledge of peer-review process; ethics in publications; copyright of the publications under different licenses	
TC3	**How to give a technical presentation (1 day; Lead: NTNU)**	**0,5 ECTS**
The course aims to prepare the ESRs to give a professional presentation of their research to professionals or for teaching. This includes the preparation of presentations, the material, emotion management, time control, and techniques to stimulate interactions with the audience.		
Skills obtained	presentation styles; preparation techniques, training methods; content planning; use of body language	
TC4	**Pop-science communication (1 day; Lead: NTNU)**	**0,5 ECTS**
The course aims to give the basics of the journalistic method and help the ESRs to apply in a real situation. The ESRs are expected to get hands-on experience from the course with instruction so that they can give an interview with a journalist about their research problems.		
Skills obtained	give an elevator speech; describe research work in layman terms; link research problems to real life examples	
TC5	**How to handle GDPR in research and innovation? (1 day; Lead: DE)**	**0,5 ECTS**
The course introduces the regulation of GDPR, focusing on the legal aspects and the best practices of handling GDPR issues in research and commercial activities.		
Skills obtained	GDPR requirements; personal data identification; GDPR handling process; data protection;	
TC6	**Protecting business innovations through patent (1 day; Lead: TUD)**	**0,5 ECTS**
The course will equip the ESRs the knowledge on the normal patenting process, including patentability analysis of ideas and technologies, prior art search, draft of patent application, and the evaluation process. The course also includes the process of patent review, maintenance and exploitation.		
Skills obtained	intellectual property right; patentability assessment; patent application procedure; licensing options	
TC7	**United Nations sustainable development goals (1 day; Lead: DTU, UU)**	**0,5 ECTS**
The course introduces the concepts of UNEP SDGs and some experiences of UN projects with focuses on the implementation of the SDGs. The course will cover the UN strategy and policies in achieving the goals and the formulation of sustainability of a society.		
Skills obtained	knowledge of sustainable development goals; UN renewable energy policies	
TC8	**FAIR data management (1 day; Lead: TUD)**	**0,5 ECTS**
The principle of FAIR data management from EU is introduced. Data classification, archiving, and platforms that support research data management are introduced.		
Skills obtained	FAIR principles; best practices for data management; knowledge of data management platforms;	

1.2.2 Role of non-academic sector in the training programme

All the non-academic partners (beneficiaries and partner organizations) participate in the training programming intensively. Non-academic sector hires 5 ESRs in total and offers secondment and training courses to all the ESRs. Non-academic sector helps to identify and provide use cases to ensure problem-oriented research and innovation, as well as interface to the internal development initiatives in digitalization. InnoCyPES partners from the non-academic sector in the project represent the highest standard and state-of-the-art. Table 1.1.1, 1.2b, and 1.4.1 provide an overview of the participation of the non-academic sector in the research and education training. Specifically, the following principles are adopted in the proposal,

- Non-academic partners among partner organizations (except Siemens) will accommodate secondment and offer main or co-supervision (cf. Table 1.1.1 and 1.3.1b).
- Non-academic partners among beneficiaries arrange additional local supervisors from the organization aside from the official supervisors to support local training to the ESRs with resource commitment and management support (cf. Section 4);
- Non-academic partners ensure the acceptance level by providing use cases and feedback to the development, e.g. Ørsted to ESR1, DE to ESR2&4, SGRE to ESR11&12, EDF/DE to ESR2/3/10, EQN to ESR6/7. ESR14/15 have cut-across effect and will engage all partners to formulate the hypotheses for institutional motivations and benefits in ICT deployment.
- Non-academic partners provide access to the field data to support the ESRs' training (subject to NDA). EQN has stored a large amount of O&G system data (ESR6), SGRE has vast wind power plant data (ESR7/11/12), eSS, DE have access to large amount of distribution system operational and consumption data (ESR3/5/9/10).
- Non-academic partners including both beneficiaries and partner organizations participate in the network-wide training by delivering training materials and host workshops (see Table 1.2c);
- Non-academic partners are involved in dissemination and exploitation. The non-academic partners will ensure the results are presented to the industry by joining exhibitions, presentations to standardization bodies and working groups, as well as deployment of the results for commercial exploitation (cf. 2.3.3).

1.3 Quality of the supervision

1.3.1 Qualifications and supervision experience of supervisors

The team of main supervisors contain senior academic and industrial researchers, who will mentor the ESR fellows on a weekly basis. Formal co-supervisors of each ESR will be from the beneficiary and/or partner organizations, following the 3"I" principle. Supervisors from academic institutions are highly qualified experts with a great amount of experience in PhD education and scientific publications. The supervisors from the non-academic sectors are senior professionals in their fields and all have many years of experience in research and development. The overall supervisor team possesses extensive academic and industrial leadership experience: as Editor-in-Chief and Editorial Board Members of prestigious periodicals, R&D Team Lead, senior scientists, and standardization working group members. The qualifications of the key experts are elaborated in Table 1.3.1a. The citation and H-index are based on Google scholar registration. The supervisory team has together supervised more than 50 PhDs in the respective fields and will ensure the principles of the European Charter for Researchers are followed. All the main supervisors will contribute at least 10% FTE (Full-time Employment) to the project. Details of the involved researchers (including main, co-supervisors, managers, and additional local supervisors) participating in the training programme are given in Section 4.

Table 1.3.1a Qualification of the main supervisors in the supervisory team

Madeleine Gibescu (UU) (10% FTE) (Prof.; ~220 papers; ~3200 citations; h=27) (ESR1) is an expert in smart and sustainable energy systems, specialized in IoT system applications, machine learning (esp. deep reinforcement learning), and mathematical optimization, with applications oriented toward electric and multi-vector energy systems. She holds the Chair of Integration of Intermittent Renewable Energy research at UU. She graduated 10 PhDs and is currently supervising 5 PhDs and 2 Post-Doctoral Fellows.
Bhargav Swaminathan (EDF) (10% FTE) (Dr.) (ESR2) is a researcher in operational planning working in industrial and research projects on tools, methods and optimisation of distribution networks. He works on the integration of advanced methods in the French DSO's network operations tools, on innovative industrial solutions for network reconfiguration, and on the flexibility of electric vehicles and new end-uses of electricity for the distribution network.
Peter Palensky (TUD) (10% FTE) (Prof.; ~280 papers; ~4600 citations; h=26) (ESR3+5) is full Professor for intelligent electric power grids at TU Delft, and Principal Investigator at the Amsterdam Metropolitan Solutions (AMS) Institute. He is experienced in modelling hybrid energy systems, consisting of a variety of energy carriers, interacting with markets and other sectors via controls and ICT. He supervised 14 PhD students and currently supervises 9. He is Editor in Chief of the IEEE Industrial Electronics Magazine, Assoc. Editor for several ISI journals (e.g. IEEE Tr. Ind. Informatics) and member of the IEEE IES publication board. He is an IEEE IES Adcom Member-at-large, Scientific director of TU Delft's PowerWeb Institute, and Chair of the Academic Advisory Board of European Network for Cyber Security.
Massimo Cafaro (UNILE) (10% FTE) (A/Prof.; ~150 papers; ~1300 citations; h=22) (ESR4) is an expert in parallel, distributed and Grid/Cloud/P2P computing. He holds a patent on distributed database technologies. He is interested in the design and analysis of sequential, parallel and distributed algorithms in the context of data mining, security and cryptography, resource, data and information management in Grid/Cloud/P2P environments.
Alexey Pavlov (NTNU) (10% FTE) (Prof.; ~110 papers; ~2800 citations; h=29) (ESR6) is Professor in Petroleum Cybernetics at NTNU, with expertise in automatic control and optimization and wide industrial experience in several fields, including automation for oil and gas applications. He is the manager of NTNU Research and Innovation Program on Digital and Automation Solutions for Oil and Gas industry (BRU21) and past Associate Editor of IEEE Transactions on Control Systems Technology.
Elisabetta Tedeschi (NTNU) (10% FTE) (Prof.;~110 papers; ~ 1281 citations; h=19) (ESR7) was Marie Curie fellow and is an expert in the fields of control of grid-connected power converters, offshore power grids, power quality and conditioning, and renewable energy integration. She has been doing research on design and control of energy conversion systems for marine energy applications, and distributed compensation and cooperative control in non-sinusoidal electric networks and micro-grids. She is currently the supervisor of 5 PhD fellows and 2 Post-Doctoral Fellows.
Bikash Pal (ICL) (10% FTE) (Prof.; ~120 papers; ~9400 citations; h=48) (ESR8+10) is an internationally recognized for his expertise in electric power system control and stability. He has contributed to stability issue for bulk power systems and grid estimation techniques incorporating data analytic methods for distribution grids. He was a pioneer in the application of robust control theory in power system control design and stability enhancement. His expertise covers statistical representation and modelling of consumers. He is Power and Energy Society (PES) Vice President (Publications) and chairs IEEE Working Group on state estimation for power distribution applications.
Philip J. Douglass (DE) (10% FTE) (Dr.) (ESR9) is key expert in ICT systems and distribution system analysis in Dansk Energi (Danish Energy Association). He is dedicated to the development of new distribution system ICT infrastructure, energy market, applications of smart meters, regulations on DERs, tariff models, and demand management for DSOs. He is an expert in embedded system programming and microprocessors. He has publication record in leading journals in the field.
Johannes Stöckl (AIT) (10% FTE) (Dr.) (ESR11) is an expert in power electronic components, IGBT technologies, and topology layout design and tests. He has more than 15 years of research experience in industry and research. His work has been dedicated to the development of smart inverters for smart grids, ranging from power electronic valves, topology layout, and control systems. He is currently Thematic Coordinator for Power Electronics and System Components in Austrian Institute of Technology. He has been acting as a company supervisor for PhD and MSc thesis. He will contribute 10% of his time in the project.
Frank Martin (SGRE) (10% FTE) (ESR12) is specialist in grid codes, grid compliance standards and type testing, and has been leading all mayor grid compliance test campaigns for SGRE offshore WT's with Direct Drive technology. He has been involved in ENTSO-E's NC RfG and HVDC development, NGET and VDE FNN national implementation, and has participated in many grid connection requirements working groups in IEC, CENELEC and ENTSO-E. Frank Martin is a trainer for Grid Code Compliance within SGRE (25+ training sessions) and was an external trainer for Grid Code Compliance for ForWind-Academy and Haus der Technik in Germany.
Dušan Majstorović (THiL) (10% FTE) (Dr.) (ESR13) is an expert in embedded systems, real time systems, hardware design, simulation technologies, and signal processing and conditioning. He is the key member of the development team in THiL who developed the world's first 1-microsecond real time simulator for power electronic components design, prototyping, and system simulation. He is currently the chief architect of Typhoon's real time device. He is also an assistant professor at the University of Novi Sad.
Guangya Yang (DTU) (20% FTE) (Dr; ~130 papers; ~1600 citations; h=19) (ESR14) is a specialist in power system operation and economics. He is known for his work on the application of synchronous condensers for renewable energy integration and transactive energy application in distribution grids. He is leading the net present value and cost benefit analysis of solar PV and storage systems for households in Denmark. He is in the expert pool of EU ETIP PV and deeply involved in standardization work with IEC in TC88 (Wind) and TC8 (System operation). He has supervised 5 PhDs, 3 postdocs and 50+ MSc projects. As coordinator, he will contribute 20% FTE to the project.
Emmanuel Ackom (DTU) (10% FTE) (Dr; ~100 papers; ~500 citation; h=14) (ESR15) is a scientist in energy and climate policy with DTU UNEP (United Nations Environment Program) partnership. He was Team Lead for the Global Network on Energy for Sustainable Development which was a collaborative project involving 10 countries. He is known for the pioneering policy work to provide clean energy to the urban slums in 8 countries. He is editor of Carbon Management (Taylor & Francis) and Sustainability (MDPI) journals. He has been providing expert energy and climate advisory services and reports to governments and mentoring energy policy professionals.

Table 1.3.1b Joint supervision arrangement (The main supervisor is indicated in bold)

ESR no.	Academic	Non-academic	Co-supervisor	ESR no.	Academic	Non-academic	Co-supervisor
ESR1	**M. Gibescu, UU**	J. Sanchez Torres, EDF	KH Andersen, Ørsted	**ESR9**	GY Yang, DTU	**P. Douglass, DE**	M. Cafaro, UNILE
ESR2	M. Gibescu, UU	**B. Swaminathan, EDF**	H. Morais; INESC	**ESR10**	**B. Pal, ICL**	D. Roverso, eSS	J. Stöckl, AIT
ESR3	**P. Palensky, TUD**	SP Chen, CSIRO	A. Stefanov, TUD	**ESR11**	F. Dorfler, ETH	**T. Strasser, AIT**	D. Majstorović, THiL
ESR4	**M. Cafaro, UNILE**	P. Douglass, DE	S. Tindemans, TUD	**ESR12**	GY Yang, DTU	**F. Martin, SGRE**	J. Stöckl, AIT
ESR5	**P. Palensky, TUD**	O. Alizadeh-Mousavi, DEP	S. Tindemans, TUD	**ESR13**	GY Yang, DTU	**D. Majstorović, THiL**	E. Tedeschi, NTNU
ESR6	**A. Pavlov, NTNU**	BT Børresen, EQN	D. Varagnolo, NTNU	**ESR14**	**GY Yang, DTU**	F. Martin, SGRE	J. Dong, UNSW
ESR7	**E. Tedeschi, NTNU**	F. Marra, EQN	R. Henriques, INESC	**ESR15**	**E. Ackom, DTU**	Y. Xue, NARI	P. Nielsen, DTU
ESR8	**B. Pal, ICL**	Y. Xue, NARI	D. Varagnolo, NTNU	**NB:** Co-supervisors information can be found in Section 4.			

All ESRs have made a joint supervision agreement (cf. Table 1.3.1b). Every ESR will have one main supervisor and two co-supervisors. Every ESR project has one supervisor anchored in the non-academic sector. The members of the supervisor team are highly skilled in scientific writing and technology development, which ensures the ESRs disseminate the research results on top-level journals or patent applications. Given the experience of the supervisor team, every ESR is expected to publish/submit 2-5 scientific papers on top journals in their project period and beyond and participate in at least three international conferences in 3-year time. To ensure the efficiency of supervision, the following supervision model is adopted:

- Informal meetings with local supervisors on a weekly basis following open-door policy (cf. Table 1.2b);
- Formal supervision meetings with IST every 1.5 months (telephone conference) involving local supervisors (if any);
- Formal biannual meetings involving IST and interested partners from the training network (incorporated in the training school, workshops, and general assembly when most supervisors will be present);

Every half year ESRs prepare a study report regarding the progress in research, dissemination, and education, in cooperation with their supervisor team. The main supervisors take full responsibility in research and training and are the signatory of the study plan and study report of the ESRs.

1.4 Quality of the proposed interaction between the participating organizations

The proposed network training programme requires deep involvement of all the partners (cf. Table 1.1.1, 1.2c, 1.2d). All the ESRs will receive most of their training from the program. Through the training events, all participating organizations will have interactions at a very high scientific and innovative level. Through the ESRs training, the interactions are ensured by:

- ESR supervision meetings, network-wide training events, and general assembly (cf. Table 1.2b);
- Each ESR will go on secondment(s) during their 3-year study period. The total period of secondment for each ESR is typically 8 months with a minimum of 6 months during the 3-year period. The ESRs of non-academic beneficiaries will follow the rule of the enrolled PhD programme for secondment (cf. Table 3.1d).
- Non-academic sector covers a long value chain in industry, where multiple provider-customer relations exist (cf. Table 1.4.2). Inspired by the ESR projects and leadership of the project, the organizations can enhance their technological and business understandings and better cooperate in their future R&D efforts.

As most of the organizations is clustered around the North Sea region, frequent short-term visit and meetings can be made easily for ESRs, alongside with their training plans. This stimulates further the synergy of the network and strengthens the network and the interactions among the partners.

1.4.1 Contribution of all participating organizations to the research and training programme

It is a fundamental requirement that all the partners contribute to an integrated research and training programme. Therefore, it is important that all the ESRs are working together as a team to create such a common platform and avoid fence-off ecosystems. All ESRs will take intersectoral secondment. That means, if the ESR is hired by an academic partner, the secondment will be done at least at one industrial organization, and vice versa. One of the strengths of InnoCyPES is that partner organizations are actively involved in the training as illustrated in Table 1.4.1.

Table 1.4.1. Illustration of the partners' involvement in network-wide training (: Lead; : Contribute; : Main supervisor; : co-supervisor; SC: secondment)

Partners	Network-wide training activities																				ESR no.														
	SC1	SC2	SC3	TC1	TC2	WS1	SC4	SC5	SC6	TC3	TC4	SC7	SC8	SC9	TC5	TC6	WS3	SC10	SC11	TC7	TC8	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DTU																													SC			SC	SC		
UU																							SC													
EDF																						SC		SC												SC
TUD																									SC										
UNILE																										SC									
NTNU																																		SC	SC
ICL																										SC									
DE																									SC										
AIT																												SC							
SGRE																											SC	SC							
THiL																													SC						
CSIRO																								SC										SC	SC
DEP																									SC					SC					
EQN																										SC									
ETH																															SC				
eSS																														SC					
INESC																											SC							SC	
NARI																												SC						SC	SC
UNSW																								SC										SC	SC
SIEMENS																																			
Ørsted																						SC													

1.4.2 Synergies between participating organizations

The WPs nests all the partners closely forming a solid base for research and knowledge exchange and sharing. The academic partners have complementary research skills across information science, engineering and social science studies. The synergy is forged by the WP setup, where WP1 to WP4 follows the sequence of data handling. The policy and planning work in ESR14 and

15 crosscuts the topics of all the other ESRs. Synergies exist in the non-academic partners, as they cover long value chain in the energy sector. Through the network, it will help to enhance the business relations and common understanding of the technologies and standards, enhance the business trust, and eventually enhance the growth of the business and competence of EU. Specifically, below are a few business interactions the consortium encompasses.

Table 1.4.2 Interactions of non-academic partners

Interaction pairs	Relationship	Interaction links
SGRE – EQN/Ørsted	Wind turbine manufacturer and renewable power investor and operator	ESR7, ESR12
THiL – EQN/Ørsted	System simulation technology provider versus system operator	ESR13
THiL – SGRE/AIT	Component simulation technology provider versus component manufacturer	ESR10, ESR11
SGRE – NARI	Wind turbine manufacturer versus key national lab on compliance testing	ESR12, ESR14, ESR15
DEP/Siemens/eSS – DE/EDF	ICT/IoT technology providers versus consulting/ICT solution user	ESR2, ESR3, ESR5, ESR9
AIT–SGRE – THiL – eSS	Common interest in Digital Twin technology applied to components	ESR10, ESR11, ESR12

1.4.3 Exposure of recruited researchers to different (research) environments, and the complementarity thereof

Strong involvement of non-academic sector gives the ESRs chances of experiencing both academic (theoretical) and industrial (applied) research environment. The non-academic sector is represented by well-established companies in the field covering long value chain, from manufacturers, ICT solution providers, service providers, to system operators in the energy industry, which provides a unique opportunity to the ESRs to experience complementary research environments and makes the training programme unique, attractive, and effective. The programme is further enhanced by the involvement of world-leading research institutes from both industry and academia outside EU, where the non-EU partners give a global dimension to the training and exposure to the project, provide ESRs chances to access the top research environments at the highest international level. Moreover, the consortium partners contain several pairs of potential business partners (cf. Table 1.4.2), which makes the competences complementary and exploitable for further collaboration and research.

2 Impact

Cyber-physical energy systems will play a dominant role to deliver the energy transition. For an efficient and sustainable transition to a digitized energy sector, we need to maximize the data value to integrate communication technologies and physical systems. This requires superior digital skills from the next generation of researchers and workforces. However, as reported in the EU Commission Digital Single Market policy, currently, 37% of people in the labour force lack sufficient digital skills, despite the increasing need for such skills in all jobs[41]. The key impacts of InnoCyPES are thus to 1) reduce the current skill gap in EU job market by training, enhance the deposition of knowledge in the field and eventually the competitiveness of the economy; 2) stimulate international research on CPES through joint academia and industry programme; 3) leverage ESRs' effort through dialogues with the key industrial stakeholders; 4) empower the ESRs to take an active role in technological developments and policy discussions.

On the technological side, given the increasing use of automation and digitalization of processes in the energy sector, along with the demand for efficient tools on data, InnoCyPES will achieve a "unified platform" for management and planning of cyber-physical energy systems. This is achieved by covering the entire data curation process, from data acquisition and storage to analytics for operation and condition monitoring. The project will address the need of how to perform data curation in a cross-sector digital energy era by a holistic approach. The ultimate ambition of InnoCyPES is to scale the research findings up at a European scale, where academia and industries adopt the same concept.

Through close collaboration with the industry, the research will provide an integrated tool developed from a few solid user cases and with highest acceptance level as possible. The project is strongly relevant to the initiatives around the North Sea and Baltic Sea regarding the integration of energy systems and the infrastructure[58,59]. The ESRs will benefit from the challenge-based problem-solving research experience and cutting-edge intersectoral and interdisciplinary research environments and will be equipped with the skills demanded by energy sector after their graduation.

2.1 Enhancing the career perspectives and employability of researchers and contribution to their skills development

The project offerings are in line with European Commission Digital Skills and Jobs coalition. The future employees are required to be able to exploit different type of information from the ICT systems and develop innovative solutions to the end users. By performing a preliminary job market analysis, we have studied the industrial job openings relevant to InnoCyPES. The employability of the ESRs is reflected by the type of skill profiles needed in the coming 10 years in Europe. In summary, the non-academic partners in InnoCyPES are not the only potential employers of the ESRs. For example, when it comes to the O&G sector, large EU companies like Shell and Total are also following the digital innovation development as EQN, thus similar job

[58] North Sea Wind Power Hub. [Online]. Website: https://northseawindpowerhub.eu/.
[59] "Ørsted proposes 5-GW wind energy island linking Baltic states", REVE News of the wind sector in Spain and in the world. Nov. 2019. Website: https://www.evwind.es/2019/11/25/orsted-proposes-5-gw-wind-energy-island-linking-baltic-states/71999

positions will be required. In the sector of renewables, generation technology suppliers have already started their mission within digitalized product design, manufacturing and condition monitoring of their technologies. Companies like SGRE, Vestas, SMA, ABB, Schneider, GE and others will be interested in Digital Twin technologies. Data companies like Google, Oracle, SAP, and IBM can also find a match with the ESRs profile. ESRs can also exploit the results and utilize the patenting, innovation and entrepreneurship knowledge gained through the InnoCyPES training programme and choose to start their own business, which can be supported by the business development programmes provided by the consortium partners and beyond[60,61]. The specific skills gained will make the ESRs fit for a future position in academia and/or industry. By performing a preliminary job market analysis, we have identified the industrial job openings relevant to InnoCyPES, cf. Figure 2.1. The employability of the ESRs in the different partner industries of the consortium is reflected by the job title and descriptions that reflect the type of skill profiles needed in the coming 10 years in Europe. Table 2.1 gives an overview of the key competences and the perspective employers.

InnoCyPES adheres to EU 2020 Flagship Initiatives – agenda for new skills and jobs[62] by the following elements,

- ✓ The provided interdisciplinary skills to ESRs are anchored in real challenges. This closes the gap between early stage researcher education and the need of the job market;
- ✓ ESRs will experience cross-sector research environments through and international hiring and secondment that enhances their mobility, adaptability and employability across the EU;
- ✓ The partners outside EU enhances the exposure of the ESRs to world class research institutes and supervisors, which enhances global perspective of the field and hereby their professionality;
- ✓ The transferable skills training will drive the maturity of the ESRs professionally and develop sustainability-oriented mindset;

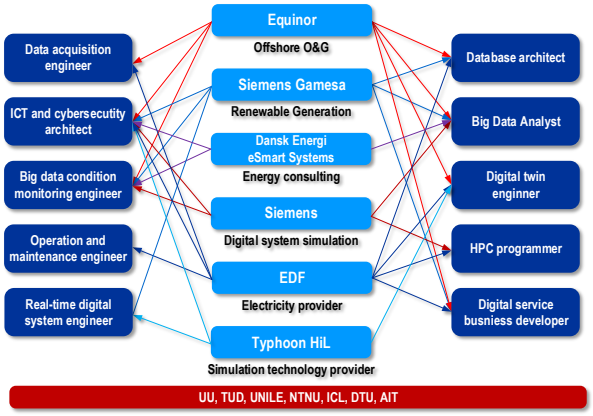

Figure 2.1. Jobs and skills wanted from key stakeholders.

Table 2.1. Interdisciplinary skills acquired by the ESRs in groups

ESRs	Interdisciplinary Skills Acquired	Key employer matching	ESRs	Interdisciplinary Skills Acquired	Key employer matching
1, 2, 3	IoT/cloud technologies, communication standards, cybersecurity, data models, system simulation, system resiliency	Monitoring, ICT and security solution providers	**11, 12, 13**	Component design, grid connection requirements, testing and compliance, Embedded systems, real time systems	manufacturers, certification bodies, smart grid and energy system technology providers
4, 5	Database O&M, data management system design, data quality, data acquisition systems, synchronization	ICT solution providers, data analytic solution providers	**14, 15**	CBA analysis, system planning and optimization, policy modelling and analysis, sustainability, social acceptance	System operators, digital solution investors, Governmental bodies, United Nations
6,7,8, 9,10	Energy system O&M, uncertainty handling, data modelling, system monitoring, GDPR, smart meters	System operators, data analytic solution providers, smart service providers			

2.2 Contribution to structuring doctoral/early-stage research training at the European level and to strengthening European innovation capacity

The diversity of the competences and backgrounds in the consortium will bring the best training programme to the ESRs. Given the network, the original doctoral training programmes offered in silos by local institutions will be interconnected and stretched in multiple dimensions, which is in line the Erasmus Mundus Handbook of Excellence – Doctoral Programmes[63].

2.2.1 Contribution to structuring doctoral/early-stage research training at the European level

InnoCyPES aims to be a permanent reference model in doctoral training in the field of digitalization in energy sector. The proposed programme fully supports the EU vision and initiative in doctoral education[64] and adheres to the seven principles for innovative training for early-stage research training[51]. The quality of the training will be assured by periodical reviews on the procedure transparency, result transferability, and feedbacks from partners and ESRs. It enhances the doctoral training at European level on top of the existing excellence of individual institutes. Positive impacts are rooted from the following aspects:

- ✓ Long lasting network is established for both academic and industrial researchers through the project activities. New initiatives and partnership will be generated from the project, which promotes the intersectoral exchange and secondment of staff involved in InnoCyPES through funding schemes from the national or the EU level (e.g. COST action and RISE).
- ✓ The cohesion of the work packages and the interconnection of the ESR projects glues the ESR projects and the advances of the partners within the EU and beyond, leverages the interdisciplinary and intersectoral competences of the consortium.
- ✓ The developed collaborative tool will be open for further exploitation and collaboration by the partners after the project that potentially facilitates long-term collaboration;

[60] "Business Development - DTU Tech Transfer," http://www.tt.dtu.dk/for-dtu-start-ups/business-development.
[61] "Equinor Technology Ventures - equinor.com." https://www.equinor.com/en/how-and-why/equinor-technology-ventures.html.
[62] "Agenda for new skills and jobs", European Parliament resolution of 26 October 2011 on the Agenda for New Skills and Jobs (2011/2067(INI))
[63] "EMQA–Erasmus Mundus Quality Assessment 2012, Handbook of Excellence – Doctoral Programmes". EACEA. https://eacea.ec.europa.eu/sites/eacea-site/files/handbook_of_excellence_2012_doctoral_en.pdf
[64] "Doctoral Education - Taking Salzburg Forward: Implementation and new challenges." [Online]. Available: https://eua-cde.org/reports-publications/51:doctoral-education-taking-salzburg-forward-implementation-and-new-challenges.html.

- ✓ The beneficiaries come from different countries and backgrounds, including research institutions, utilities, manufacturers, UN partnership, as well as SMEs. This ensures manifold quality measures of the outcome and addresses both short- and long-term perspectives, while strengthens the integrity and innovation capacity at EU level;
- ✓ The exposure to the highly international and intersectoral research environment widens the ESRs experience and enhances their adaptability and employability in both academic and non-academic sectors after graduation;
- ✓ The training plan on transferable skills covers a wide spectrum of skills needed for a successful career in innovation, research, and entrepreneurship in both academia and non-academia sectors, following the best practices identified by LERU[65];

2.2.2 Meaningful contribution of the non-academic sector to the doctoral/research training

All the non-academic partners are strongly involved in hiring and provide training, since the objective and the defined research problems are well anchored in their strategy and business models, and they clearly see the possibility to hire skilled researchers at the completion of the programme. Four ESRs are hired in the non-academic sector, while all the ESRs will be provided training by co-supervision, secondment plan, and courses (cf. Table 1.2c, Table 1.3.1b) from non-academic sector. The secondment of ESRs in the non-academic sector has sufficient duration to ensure the quality and collaboration. ESRs will also be supported by non-academic sector on the necessary data, field experiences, lessons learnt, as well as timely feedback, which ensures the quality, relevance and transferability of the results to the real world (cf. Section 1.2.2). This intersectoral experience boosts the quality of the project as well as the career perspectives of the ESRs in both academic and non-academic sectors.

2.2.3 Strengthening European innovation capacity

InnoCyPES glues the forerunners in academia and non-academia in the field digitalized power and energy field, where under the project the institutes leverage their efforts and competences in the ESRs training. The complementarity and diversity of the partners ensure the quality of the interdisciplinary and intersectoral training of ESRs, as well as the immediate usability of the research outcome in products, services, requirements and regulations. The innovation capacity will be further enhanced by

- ✓ The ESRs topics are ambitious and disruptive to the non-academic sectors. The learnings from the ESR projects will enhance the experience and knowledge of the non-academic sector in the forerunning fields of digitalization;
- ✓ The strong intersectoral aspect of the training will enable ESRs move comfortably between academia and industry, which brings up long lasting collaborations established by the project and intersectoral innovation.
- ✓ The open access modules for CPES and test datasets generated from the project will provide valuable inputs to SMEs as well as larger organizations for continuous development that strengthens the EU's vision as an innovation union[53];
- ✓ InnoCyPES promotes the acceptability of the research problems, methodologies and outcomes from user, market and society perspectives, which ensures the ESRs to develop innovative and problem-solving-based mindset;
- ✓ The training structure will remain after the project, which can be reused for national or international wide training programmes such as industrial researcher programmes at national level[66];

2.3 Quality of the proposed measures to exploit and disseminate the results

InnoCyPES adopts a stage-wise strategy in dissemination according to the maturity of the outcome of the project. The approach is to consider 4 stages, each for every year the project is running. At the earliest stage of the project, the dissemination focuses on attracting awareness and interests from the research and industry communities, and on establishing contacts with relevant stakeholders and association groups to the ESR projects within and beyond the project network. When the project is going deeper into the execution, the targeted platforms and audience groups will be more focused and specific, according to the focus of each ESR project and targeted users. Different dissemination platforms and activities will be involved according to the progress of the project. The dissemination method addresses both internal and external dissemination channels. Implementation of the strategy will be secured by WP7 (cf. Table 3.1a) and the Dissemination and Exploitation Committee (DEC, cf. section 3.2.2).

2.3.1 Dissemination of the research results

Each year the dissemination targets are divided into academic and non-academic communities as to different preferences in dissemination channels and methods. The dissemination will aim at acceptance of the results in technological, economical, as well as social domains. The potential users of the developed tools and methods will be invited through the project course for meetings by the respective ESRs and IST for collecting inputs to the development and enhance the relevance of the work to the industry and society at large. Alongside of the channels and methods listed in the table, ESRs will continuously be working on open access scientific publications throughout the project period. Every ESR is expected to lead 2-4 periodical publications and 3-5 conference publications during the 3-years' training in the respective field, with primary targets on IEEE journals hosted by Power and Energy, Control systems, and Industrial Electronics Society. All publications will be made open access to reach all potential audience of the work. In the last phase of the project, the consortium will secure a book publication where the project results will be collectively organized with source codes released. Table 2.3.1 gives an overview of the dissemination steps and methods planned for preserving short- and long-term impact. The project partners are highly competent and familiar with all the dissemination channels in the respective fields.

[65] "Good Practice Elements in Doctoral Training," LERU. https://www.leru.org/publications/good-practice-elements-in-doctoral-training.
[66] "Industrial Researcher | Innovationsfonden." https://innovationsfonden.dk/en/programmes/industrial-researcher.

Table 2.3.1. Dissemination strategy divided into years and audiences

Yr	Focused groups	Methods	Impact
1	Universities and research institutes	✓ Presentation of the project concept to identified academic research groups outside of the consortium; ✓ Presentation in IEEE conferences on the elaborated individual ESR project plans and approaches, e.g. IEEE PES General Meeting 2020/2021, IEEE Powertech 2021;	Identification of the key scientific research groups, professors, and Industrial R&D departments, and potential users. Invite for inputs to the ESR topics and identify synergies in research.
	Industry oriented associations and policy making bodies	✓ Establish contacts to working groups under International Electrotechnical Commission, EU Big Data Value Association (BDVA)[67] and European Research Institute for Gas and Energy Innovation; ✓ Establish contacts with policymaking bodies, participate in existing forum and organize new ones;	
2	Universities and research institutes	✓ Drafts for distinguished journals in the field of computer science, data analytics, wind, and energy systems. Preprints stored in online open repositories (cf. 2.3.2); ✓ Continue conference publication process, aiming at top international conferences for increased exposure of the work and awareness from the community;	Increasing engagement with scientific community, start to attract the interests for users of the InnoCyPES tools.
	Key non-academic stakeholder associations	✓ Presentation at events and workshops organized by European Technology & Innovation Platforms (ETIP) and BDVA; ✓ Presentation at the annual meetings in standardization and regulation bodies, e.g. IEC general meeting, CENELEC working group meetings, and IEEE general meetings;	Exploit the key non-academic stakeholder platforms, share results and experiences across the EU.
3	Scientific researchers and users of tools from scientific community	✓ Establish an interest group of potential users of the developed tools from scientific community to be involved in testing, summer school participation, and joint development; ✓ Summer school to the new PhD students in this field. The summer school will be open to internal and external researchers inside and outside EU;	Attract an increasing number of students and trainees in Europe for using InnoCyPES results.
	International technical and governmental organizations	✓ Involve in writing of technical specifications and standards in IEC, CENELEC, and IEEE; ✓ For policy studies, participate in meetings organized by IEA (International Energy Association) and IRENA (International Renewable Energy Agency) high-level meetings through UNEP (UN Environmental Programme) and UNEP DTU partnership;	Increasing awareness of the policy gaps in the digitalization area, Increase chances of utilization in new policies.
4	Secure Long-term impact preservation: book(s), open-access repositories in academia	✓ One publication in Nature Scientific Data with respect to the InnoCyPES platform as well as the related publishable dataset useful for energy sector; ✓ One book published by the consortium to preserve long-term impact in the community; ✓ All preprints of the publications and research data will be uploaded to online research data repositories following the practices recommended by OpenAire[68];	Use data management as an instrument to preserve long-term impact in the area of digitalization and energy system at large after the project.
	Demonstrate results at stakeholder events	✓ Key events such as European Utility Weeks, Wind Europe, Intersolar, and Adipec; ✓ Summary of the project findings by a series of presentations in the final conference;	Project results demonstrated and reflected by new solutions.
All	Internal network	✓ Biannual workshops, general assemblies, where ESRs can present the work to the partners; ✓ Review of journal, conference and patent application papers; ✓ Project SharePoint: the project will create a SharePoint where the documents, data, meetings of meetings are shared across the network whenever appropriate;	Increased exposure of the ESR(s) work internal the project organizations.

2.3.2 Data management

Data management is a central part of research integrity[69], and the project takes it as an essential instrument for dissemination and long-term impact. The project supports the Open Science principle, and will set up a data management plan covering data collection, formulation, archiving and sharing, following the best practices in the EU context[68]. A data management plan will be established before the ESR projects start, and the plan will be updated frequently according to the nature of the generated data so that the data and the associated intellectual property are updated as the project progresses. Data will be categorized according to copyright, ethics, and use (including the derivatives). Data from non-academic partners will be considered as business information; therefore, a standard agreement template for the project must be established (agreed by lawyers from the consortium members) before the project starts. However, data regulated by GDPR will be covered by a separate agreement as standard NDA agreements will not be able to cover the full legal and ethical aspects and the use of the derivatives[70]. Aspects like documentation, backups, access to different types of data will be considered besides archiving the generated models, source codes, and datasets. Considerations will also be given to the ownership of the data and long-term preservation, data repositories and publication. The data generated from the project will be managed according to three general categories, 1) **Public**: information can be shared across the network and also externally, 2) **Restricted**: information can be shared internally to the network for non-commercial and non-derivative use, and 3) **Confidential**: information requires NDA to be accessed even within the network, such as models and data related to consumers. The project will receive data classification and management support from the legal and data management team at DTU.

2.3.3 Exploitation of results and intellectual property

The results from the project will be exploited through a variety of means. The manufacturers (THiL, SGRE) would like to convert the results to their new Digital Twin solutions and hence improve their product features and design lifecycle. Monitoring technology providers DEP and eSS would like to develop new technologies in monitoring, cybersecurity, and Digital Twin technologies. The system operators Ørsted, EQN, EDF and DE would use the results to generate specifications and requirements to their suppliers to create added value for their customers and members. The exploitation will be based on bottom-up approach and the possibility of exploitation is embedded in the study report of individual ESR's and followed up by DEC. InnoCyPES embraces different

[67] European Big Data Value Association. Website: http://www.bdva.eu/.
[68] H2020 project "OpenAIRE." Project website: https://www.openaire.eu/.
[69] "The European Code of Conduct for Research Integrity." https://allea.org/code-of-conduct/.
[70] "Standardkontraktsbestemmelser vedtaget af Datatilsynet." https://www.datatilsynet.dk/presse-og-nyheder/nyhedsarkiv/2019/dec/standardkontraktsbestemmelser-vedtaget-af-datatilsynet/.

exploitation channels aiming at maximization of the acceptance of the results. The project participants will actively participate in local and international working groups (e.g. IEC/ISO/CENELEC working groups) on developing specifications, standards, and requirements. The innovative aspects of the project and the software modules of the management platform developed by the project are listed (cf. Table 2.3.3). IPR issue is further detailed in Section 3.2.6.

Table 2.3.3 Innovation aspects of each ESR and exploitation methods

ESR	Tangible results	WP	Leading beneficiary	Exploitation strategy
1	IoT data acquisition system design tool	1	UU	Prototype software module
2	Information model for data exchange	1	EDF	Input to CIM, IEC61850 and DLMS/COSEM
3	Intrusion detection technology	1	TUD	Prototype software module; Input to cybersecurity white paper
4	Multiple source energy data management tool	2	UNILE	Prototype software module
5	Energy data preprocessing technology	2	TUD	Prototype software module
6	Data driven control technology for hybrid energy hub	3	NTNU	Prototype software module
7	High fidelity flowing data processing tool	3	NTNU	Prototype software module
8	Data aided CPES stability assessment tool	3	ICL	Prototype software module
9	Distribution grid condition monitoring tool	3	DE	Prototype software module; Input to DSO regulation in DK
10	Statistic data assessment tool	3	ICL	Prototype software module
11	Data aided design platform for power converter control	4	AIT	Hardware/Software testbed for future prototype
12	Data augmented testing method for wind turbines	4	SGRE	Licensed testing technology; Benchmarking with full-scale test
13	CPES simulation of power grids	4	THiL	Software/Hardware module for commercial adaptation
14	Decision support CPES planning tool	5	DTU	Prototype software module
15	Policy summary for incentivizing digitalization	5	DTU	Input to policymakers through channels mentioned in 2.3.1

2.4 Quality of the proposed measures to communicate the activities to different target audience

Communication of the research to the general public is defined by the European Charter for Researchers. InnoCyPES fully supports and abides by the EU strategy and believes that it is a vital skill for the ESRs to be able to communicate their work in a simple, logical and effective way to people of different backgrounds. Therefore, InnoCyPES highly values the training of ESRs on pop-science communication and will apply it directly through the communication activities in the project. The project management team will define and implement a well-rounded plan for public engagement at the beginning of the project.

2.4.1 Communication and public engagement strategy

The communication plan will promote the scientific discoveries, the ITN programme, the project, and gender balance, through different communication channels and methods (cf. Table 2.4.1). The communication methods are divided according to the targeted groups, where ESRs will be actively involved in communication activities. The impact will be evaluated according to the feedback received from the targeted groups in terms of the number of online views, questionnaires to event attendants, and the number of student projects including thesis projects and internships the project participants have hosted over the project period. One aspect worth mentioning is the striving to attract the younger generation to the field, where the project will establish contacts with local representatives of European Youth programme such as Erasmus+ to create internship projects associated with the ESRs' activities. Cooperating with the IST, the ESRs will be encouraged in defining MSc and internship projects and being involved as co-supervisors for Erasmus exchange student projects within the scope of InnoCyPES, to effectively enhance the outreach. In turn, the supervision experience can effectively enrich the ESRs training of the transferable skills.

Table 2.4.1. Communication and public engagement strategy

Channels	Implementation strategies	Targeted audience
Website	Acts as a repository for publications, videos, and newsletters, including links to shared data and models. Every ESR is responsible to maintain the information in relation to their progress. It also announces the schedules of the training activities.	Researchers and scientific community. Bring attention to the project's best practices/results.
Brochure	Includes the concept and ESR topics of the project, distributed at open areas in partners to bring attention of the researchers to MSCA-ITN and InnoCyPES research, taking advantage of the project network.	
Proactive communication	Proactive communication will be implemented by newsletter, industry briefs, direct mailings, invitations to project events and training/summer schools, setting up InnoCyPES account on e.g. LinkedIn.	
Social media	The development will be released through social networks such as LinkedIn, Twitter, and ResearchGate. The partners can receive support for the project from their local supporting staff who manages the company social network accounts.	
Press release	Contact journalists from science and/or technology-oriented newspapers to introduce the project.	General public, to promote ITN, the project, and ESRs.
Interviews	The ESRs interviewed by the local press, one at the beginning and one at the end of the project. The goal is to describe the InnoCyPES project, the uniqueness, as well as to promote the individual ESR project activities and results.	
Researcher's night	ESRs will participate or co-organize a "NIGHT" event in the local or neighboring cities, to give hands-on experiments, science shows with public participation, workshops for children, guided lab visits, etc. Each ESR will join at least once the researchers' night to communicate their research to other researchers, to practice public presentation and pop-science communication.	Establish ESRs network through Marie Curie alumni events, as well as outreach to the public sectors.
Marie Curie Alumni	The project will subscribe to the Marie Curie Alumni Association (MCAA) through registering the mailing list and/or following the twitter account, assuring the presence and contribution in the Marie Curie Alumni Conference or any open events organized. This provides opportunities to the ESRs to expand their network and form collaborations beyond the network.	
MSCA ambassadors	Each ESR will schedule one event to visit high schools, universities or companies outside the network, or any community organizations to promote their research area, and illustrate the needs of the industry in the area. They will promote the project and the research field by showing how the research work can affect the daily life and environment.	Youth and gender outreach. Promote the research field to younger generations.
Outreach programmes	Participate in local and EU youth development programmes to attract **young as well as women talents** for internships hosted by ESRs[71],[72]. Establish contact and open positions in collaboration with local agencies associated with Erasmus+ programmes.	

[71] "Talents – the programme | FFG." https://www.ffg.at/en/talents.
[72] "IEEE Women in Engineering." https://www.ieee.org/membership/women-in-engineering.html.

3 Quality and efficiency of the implementation

3.1 Coherence and effectiveness of the work plan, including appropriateness of the allocation of tasks and resources

3.1.1 Work packages description

Table 3.1a Description of work packages

WP1	Data acquisition system design and security	Start M5	End M41	Lead beneficiary	UU
Objective: To develop a software module for information system modelling and design, covering the elements of 1) an IoT network modelling tool; 2) information model(s) required for data exchange; 3) an intrusion detection system to keep a secure data/information flow.					
Description of work and the role of specific beneficiaries/partner organizations WP1 will be executed by three organizations UU, EDF and TUD. They will work in continuous collaboration in the WP and at the same time interact with other WPs for effective conduct of the research. WP1 contains 4 main tasks, where ESR1 will contribute to task 1.1, ESR2 hosts task 1.2, and ESR3 is responsible for task 1.3 and 1.4. **Task1.1 (UU) Design and model the performance of the IoT network.** The main complexities of IoT system are the uncertainties and heterogeneous behaviour of the sensing network, due to the low-cost design of the sensors. To fully understand the dynamics of the data acquisition, it is necessary to model the reliability and degradation of the sensor and network characteristics and build a reliability versus cost model, through applications of software defined networks, Markov processes and the method by C. WU[42]. This area is emerging and important for industry. The task will create a design tool for the IoT network, considering the reliability aspects of missing data, delayed packets, impulsive errors, and accuracy drift. This task is instrumental in understanding and designing of the IoT/Cloud system. This work has never been tried and will have a strong interaction with other tasks in WP1, WP2 and Task 3.2 where data acquisition system dynamics need to be included. **Task1.2 (EDF) Establish information model for data exchange among operators conforming to CIM/IEC61850.** The need for data exchange among multiple operators and service providers requires a reliable information model where information can flow and be shared across geographically dispersed jurisdictions, for services procurement and verification. The standardized information model does not exist. An example is EV fleet charging, where several stakeholders, including consumers, fleet operators, DSOs, and TSOs need information exchanged to allow grid services activated and provided simultaneously to DSO and TSO. The task will develop information models compatible with CIM and IEC61850 DER standards which can be further tailored for different operational scenarios and new standardization. A harmonization among information protocols is crucial to allow an automatic mapping of the applications. The model can be incorporated into the model developed by Task 1.1 and Task 1.3, as well as Task 3.6. **Task1.3 (TUD) Develop a compatible co-simulation environment.** A high-fidelity validation platform is important to integrate and test the developed models in this WP. ESRs will deliver a test environment for validation of short- and long-term issues of the data acquisition system. Data network and traffic patterns created by Task1.1 will be incorporated in the environment to emulate the data flow in the acquisition system. Information model from Task 1.2 together with communication protocols Modbus, IEC61850, and IEEE C37.118 will be implemented. This environment will also be used for validating intrusion detection algorithm of Task 1.4 and WP2 tasks. **Task1.4 (TUD) Specification of workflow in intrusion detection method.** Obscuring data content (false data injection) or by blocking the message delivery (data availability attack) are the two most common ways to perform cyber-attacks. Launched together, they formed the so-called combined attacks. These attacks can be launched from multiple geographically dispersed locations. Their triggering is often synchronized and follows the patterns that result in the highest impact on the system. This task will develop an intrusion detection system (IDS) based on the initial work on intrusion detection of combined attacks[43]. The new cyber-physical smart grid IDS should supplement the capabilities of the existing IDS for industrial control systems, which currently do not have means of detecting combined data attacks.					
Description of deliverables: D1.1 Information model design for data exchange **(M14); D1.2** IoT data acquisition system design method **(M19); D1.3** Co-simulation testbed established **(M23); D1.4** Intrusion recognition method **(M30);**					
WP2	**Data accessibility and usability**	**Start M5**	**End M41**	**Lead beneficiary**	**UNILE**
Objective: Develop a data management, integration, and validation module for merging multiple and dispersed data sources with improved accessibility and quality.					
Description of work and the role of specific beneficiaries/partner organizations The WP will be executed by UNILE and TUD. UNILE will deal with data management and integration including ingestion and extraction, whilst TUD will work on data preprocessing to remove the inconsistencies and errors of the data, incorporating physical system knowledge. Task 2.1 and 2.2 are hosted by UNILE, Task 2.3 by TUD. **Task 2.1 (UNILE) Design of distributed data storage.** This task will provide the design of a Distributed Data Storage system essential for data processing work. The task will provide specifications of using P2P networks, leveraging a structured overlay built on top of a Distributed Hash Table and Web Services, with security provided by TLS/SSL and data managed/stored initially by a relational database back-end with support for SQL distributed queries on a common schema. The task is linked to Task 3.5 and 3.6 on offline data processing. **Task 2.2 (UNILE) Implementation of distributed data storage.** This task will provide the P2P software related to the Distributed Data Storage, which will be incrementally refined and extended in order to fully support its intended functionalities according to the technical specifications defined in Task 2.1. The task will be verified by a use case on integration of data sources with respect to the energy consumption and reliability with support from DE's members. It will be tested in Task 3.4 and 3.6. **Task 2.3 (TUD) Enriching system measurements for machine learning applications.** Data-driven analysis and prediction methods (such as those deployed and developed in WP3-4) typically assume that measurements are abundant, that they represent synchronized snapshots of the system state and no data dropouts, but this is rarely the case in practical cyber-physical systems. This task will interpolate, impute and align heterogeneous measurements to provide coherent data streams for further processing. It will also make use of deep neural network approaches to learn salient properties of whole-system snapshots and/or time series and generate data with similar properties. Where possible, methods will use knowledge of the physical system, and the physical laws governing it, instead of relying only on general purpose machine learning approaches.					
Description of deliverables: D2.1 Specifications of the distributed data storage tool for multiple sources **(M15); D2.2** Energy data preprocessing technology including source code release **(M25); D2.3** Distributed data storage management tool **(M33); D2.4** ESR4 PhD thesis **(M41);**					
WP3	**Innovative data analytic methods**	**Start M5**	**End M41**	**Lead beneficiary**	**NTNU**
Objectives: Develop data processing methods for monitoring, control, and management functions for energy systems, considering the uncertainties in data acquisition.					
Description of work and the role of specific beneficiaries/partner organizations In the WP each ESR will develop a unique data analytic approach towards the real challenges in operation. The information flow is compatible with WP1 and WP2 results. **Task 3.1 (NTNU) Uncertainty modelling of offshore energy hub.** To enable efficient handling of complexity and uncertainties in offshore wind and O&G production process, it is necessary to develop novel uncertainty model integrating data-driven and model-based methods. The methods should be sufficiently robust to allow for implementation in an offshore environment considering the complex process of the production process. The years of learning of O&G sector to operational maintenance through predictive control, dynamic SCADA for monitoring will be extended to wind farm power production monitoring and control. The model will be used as input for later optimization of the energy hub operation for enhanced energy efficiency and reduced CO2 emission. Validation will be made through field measurement provided by EQN. The task finds synergy with Task 2.3, 3.2 and 3.3 on real time data (pre)processing system monitoring, control and preventive maintenance. **Task 3.2 (NTNU) Synchronized waveform processing workflow.** To enable efficient use of the waveform measurements from different locations for disturbance analytics, it is necessary to establish a workflow for data processing. The workflow should enable a real time disturbance pattern recognition and alignment to process the synchronized waveform measurements from different locations. Efficient algorithm needs to be developed to deal with high fidelity flowing data (100-500 microsecond time resolution). The workflow includes root cause analysis of the disturbance based on the recognized pattern. Validation will be made on a real time simulation platform and real field data. **Task 3.3 (ICL) Benchmark system for low inertia system stability study.** The study of low inertia system has started recently due to the increasing amount of renewable generation. Previous stability was governed by the behaviour of synchronous machines, in the frequency range between 0.01 – 3Hz and 45 – 55 Hz (50 Hz system). However, the new stability issue involves inter-harmonics and low frequency arising from converter control and synchronization. The task will consolidate the stability issue with industrial partners based on the field experience and develop a benchmark system for the scientific community for new stability analysis and improvement. Existing tools in O&G for plant disturbance analysis and control will be replicated to wind farm context. The task can find synergy with Task 3.1 in O&G process and Task 4.3 on system simulation.					

Task 3.4 (DE) Reliability prediction method of distribution grids. Reliability prediction method of distribution grids. The recording of the faults is reflected by smart meter readings, SCADA measurements, and other monitoring equipment. The data needs to be first gathered into a common format, and then robust methods will be developed to mine the data and identify the correlations between fault frequency/duration and other operational parameters, such as loads, weather, and topology. The model can be used to predict the future reliability conditions of a distribution grid by testing on future scenarios. The task will find synergy with Task 2.2.

Task 3.5 (DE) Optimize data collection for reliability predictions. Optimize data collection for reliability predictions. This task builds on the results of task 3.4 to consider the quantity, quality, and velocity of data, as well as the cost of measuring and communicating it to recommend which data sources should be prioritized to give the highest value to the system operator. The task can find synergy with Task 2.3 regarding the practicality of the data collection.

Task 3.6 (ICL) Time-dependent statistical representation of energy consumption. The effect of GDPR will prevent the direct use of the data from smart meters or any personal electronic devices on energy consumption and location. Using time-varying statistical distribution can effectively avoid the violations of GDPR since no identifiable personal data within. The task will develop an advanced data processing approach combining the historical and online measurements, and cross-domain information received internally and externally (input from Task 1.2). The efficacy is validated through smart meter data. It will also leverage various feature extraction methods from large volume of data through robust on principal component analysis or expectation maximization.

Description of deliverables: D3.1 Dataset for DSO O&M studies **(M12); D3.2** Stability assessment benchmark system model **(M17); D3.3** Stationary and non-stationary signal recognition method **(M20); D3.4** Uncertainty modelling method for offshore energy production **(M26); D3.5** Statistical representation model of consumer patterns **(M33); D3.6** ESR6 PhD thesis **(M41); D3.7** ESR7 PhD thesis **(M41); D3.8** ESR8 PhD thesis **(M41); D3.9** ESR9 PhD thesis **(M41); D3.10** ESR10 PhD thesis **(M41);**

WP4	Cyber and physical symbiosis	Start M5	End M41	Lead beneficiary	AIT

Objectives: Hybridize cyber and physical system in the product design process. Develop Digital Twin technologies for components and systems design and operation.

Description of work and the role of specific beneficiaries/partner organizations

The WP aims to integrate real world data from various dimensions in product design and validation process. The work utilizes the results and outcomes from WP1-WP3.

Task 4.1 (AIT) Develop a virtual hardware testing environment. Prototype testing requires full-scale installation and involves high risk for equipment, especially for sensitive power electronic devices. This happens exactly when testing the stability of innovative active and reactive current control strategies of power converters during severe grid transients. To minimize the high risk of equipment damage in full-scale tests here is proposed a modularized design and testing protocol taking advantage of cyber-physical environment. An innovative virtual testbed will be developed for prototyping new power electronic controls. The task finds synergy with Task 4.2 on grid connection issues;

Task 4.2 (SGRE) Definition of wind turbine subsystems and testing specifications. As the power ratings of offshore wind turbines are becoming higher for deep sea deployment, type test of wind turbines is increasingly challenging and costly. Instead, wind turbines can be divided into several subsystems based on the conversion process, blade, generator, converter, including their control and protection systems. If wind turbine type tests can be faithfully replaced by a series of coordinated tests of subsystems, shorter product development cycle can be achieved with less investment in testing facility upgrade. The task will propose innovative testing procedures on subsystems based on the manufacturer's knowledge and Digital Twin technology. Digital Twin technologies are developed for wind turbine through advanced modelling methods.

Task 4.3 (THiL) Modelling cyber system in real time system studies. Cyber system dynamics has not been included in energy network simulation, as previously the adequacy and security of energy network were considered only on the physical system side. This prevents further study of the interdependency between the cyber and physical system. The task will develop a software module in a real time digital simulator that integrates data acquisition and commercially available communication protocols. There has not been such simulation system available for the research community to fully exam the design and operational functions of CPES. Task links with Task 1.1-1.3.

Description of deliverables: D4.1 Test platform specifications for power converter control **(M18); D4.2** Digital representation model of wind turbine subsystems **(M23); D4.3** Application examples for real time simulation of CPES **(M30); D4.4** ESR12 PhD thesis **(M41); D4.5** ESR13 PhD thesis **(M41);**

WP5	CPES planning appraisals	Start M5	End M41	Lead beneficiary	DTU

Objectives: Develop economic metrics and policy suggestions to facilitate the deployment of digital solutions.

Description of work and the role of specific beneficiaries/partner organizations

The tasks will be carried out by two departments at DTU. The research cuts across all the other WPs and extend the other WPs work with economic and regulation perspectives.

Task 5.1 (DTU) Cost benefit assessment model for cyber system expansion. The cost benefit analysis is usually done in physical system expansion, while the benefit of cyber system expansion has never been considered by the energy system operator. This is because the gain of the cyber system has not been clearly formulated and treated as part of the physical assets. This potentially reduces the willingness of energy sector to strive for digital solutions. The task will instead establish a novel and comprehensive cost benefit assessment model to quantify the value of the investment on cyber infrastructure, where the benefits are from deferred physical system expansion. Inputs will be taken from other ESRs with respect to the technical benefits and associate the information with monetary gains.

Task 5.2 (DTU) Investigate the role centrality of policy and support needed for digitalization. The task will be built on interviews and analyses of digitalization practices in the member countries and the partners, and the incentive schemes and policies in the energy sector. Policy and best practices examination will be carried out for technology transfer for IoT and digitalized energy systems among partners between 1990 to 2020, where collaboration gaps between partners with the period will be analyzed. Policy summary will be developed to inform policy makers and industry partners on the technological opportunities and institutional and policy gaps. The task will be built on interviews and dialogs with the partners in the consortium and governmental agencies with respect to the institutional effort, motivation, and experience in digitalization.

Description of deliverables: D5.1 Summary of best practices in digitalization in energy sector **(M17); D5.2** Cost benefit analysis method for digitalization **(M25); D5.3** Policy recommendation for incentivizing digitalization **(M33); D5.4** ESR14 PhD thesis **(M41); D5.5** ESR15 PhD thesis **(M41);**

WP6	Training	Start M5	End M48	Lead beneficiary	ICL

Objectives: Improve the conventional doctoral programmes offered by individual universities by an interdisciplinary, intersectoral, and personalized training programme. This work package ensures the proposed training plan is executed as described in Section 1.2-1.4 and Section 3.2.4.

Description of work and the role of specific beneficiaries/partner organizations

The WP is linked to the training tasks of the project management. The WP will implement the network-wide training plan including the four training schools, two workshops, and one summer school, as well as monitor the progress of the ESRs through half-year study report to make sure the fulfillment of study plan and PCDP. The WP will conduct the actions defined in Section 3.2.4 regarding progress monitoring. The WP will ensure the best practices in training benefit all ESRs. The WP will also suggest ESRs the relevant seminars, tutorials, and PhD courses, outside the training schedule. The WP will work closely with PC and SB to ensure the training is executed as planned.

Description of deliverables: D6.1 Templates of study plan, PCDP, and study report **(M1); D6.2** Conduct the plan of training schools (cf. Table 1.2b – 1.2d) **(M8, M14, M20, M26); D6.3** Conduct the plan of the summer school (cf. Table 1.2b) **(M33); D6.4** Conduct the plan of the workshops (cf. Table 1.2b) **(M39);**

WP7	Dissemination, exploitation and communication	Start M1	End M48	Lead beneficiary	TUD

Objectives: Ensure the planning and implementation of the dissemination, exploitation, and communication strategies. Maximize the impact of the project.

Description of work and the role of specific beneficiaries/partner organizations

Ensure development, execution, review and update of the two plans, communication plan and dissemination and exploitation plan. Implement the methods listed in Section 2.3-2.4. The WP also includes internal communication with IST and the ESRs based on the periodical study reports to update the activities in the two plans. The WP will be responsible in identification and classification of stakeholders, setting up stakeholder engagement method, and setting up dissemination activities together with the support and contribution of the consortium members. In addition, the WP will be responsible in suggesting stakeholder events at different locations across Europe to ensure the project is presented at the most relevant national and international forums and workshops, to disseminate the projects results, mobilize stakeholders and establish deep ties with relevant entities. The WP will keep close look at the IP generation possibilities and provide suggestions and assists in patenting process and exploitation methods whenever needed. All project results will be thoroughly scrutinized for possible protection and commercial exploitation.

Description of deliverables: D7.1 Project website **(M3); D7.2** Promotional materials (flyer, social media account) **(M3); D7.3** Communication plan and dissemination and exploitation plan **(M8); D7.4** Summary of the dissemination, exploitation and communication activities **(M22, M46);**

WP8	Project management	Start M1	End M48	Lead beneficiary	DTU

Objectives: Guarantee a smooth running of the project, ensure the interaction between the project management units and sufficient resources for the planned activities.

Description of work and the role of specific beneficiaries/partner organizations

The WP will produce consortium agreement, prepare guidelines for recruitment, ensure ESR recruitment and training, set consortium meeting schedules, ensure secondment plan, and manage stakeholders' engagement activities including internal and external activities. The WP has the overall responsibility for the execution of the project plan, which includes preparing consortium agreement according to the best practice, preparing and support implementing of recruitment strategy, hiring and gender composition of the ESRs, as well as the training and research deliverables. The WP is also responsible for the communication with the European Commission and organizing international advisory board meetings. The WP will prepare and ensure the implementation of the data management plan for data archiving, integration, and internal and external sharing. As the project will exploit real smart meter data, which contains sensitive personal information involving ethical issues, as well as proprietary datasets from the commercial sector, the WP will ensure the procedure in accessing and exploitation of the data follows and fulfilling the EU ethic and national rules. One part-time (15 hours/week, 40% FTE) **project manager** will be hired at DTU for this WP. The PM will provide the project coordinator all logistic support to lead the consortium activities.

Description of deliverables: D8.1 Consortium agreement **(M0); D8.2** Overall recruitment finished **(M4); D8.3** Data management plan **(M8); D8.4** Annual financial reports **(M12, 24, 36, 48); D8.5** Final project report **(M48); D8.6** Sustainability plan **(M48); D8.7** Education programme report **(M48);**

3.1.2 List of major deliverables

The scientific deliverables listed here can be associated with a PDF description.

Table 3.1b. Deliverables list

Scientific deliverables						
Deliverable	**Deliverable title**	**WP**	**Lead beneficiary**	**Type**	**Level**	**Due date**
D1.1	Information model design for data exchange	1	EDF	PDE	PU	M14
D1.2	IoT data acquisition system design method	1	UU	PDE	PU	M19
D1.3	Co-simulation testbed established	1	TUD	R/PDE	PU	M23
D1.4	Intrusion recognition method	1	TUD	R/PDE	PU	M30
D2.1	Specifications of the distributed data storage tool for multiple sources	2	UNILE	R/PDE	PU	M15
D2.2	Energy data preprocessing technology including source code release	2	TUD	PDE	PU	M25
D2.3	Distributed data storage management tool	2	UNILE	PDE	PU	M33
D2.4	ESR 4 PhD thesis	2	UNILE	R	PU	M41
D3.1	Dataset for DSO O&M studies	3	DE	PDE	CO	M12
D3.2	Stability assessment benchmark system model	3	ICL	PDE	PU	M17
D3.3	Stationary and non-stationary signal recognition method	3	NTNU	PDE	PU	M20
D3.4	Uncertainty modelling method for offshore energy production	3	NTNU	PDE	PU	M26
D3.5	Statistical representation model of consumer patterns	3	ICL	R/PDE	PU	M33
D3.6	ESR 6 PhD thesis	3	NTNU	R	PU	M41
D3.7	ESR 7 PhD thesis	3	NTNU	R	PU	M41
D3.8	ESR 8 PhD thesis	3	ICL	R	PU	M41
D3.9	ESR 9 PhD thesis	3	DE	R	PU	M41
D3.10	ESR 10 PhD thesis	3	ICL	R	PU	M41
D4.1	Test platform specifications for power converter control	4	AIT	R/PDE	CO	M18
D4.2	Digital representation model of wind turbine subsystems	4	SGRE	R/PDE	CO	M23
D4.3	Application examples for real time simulation of CPES	4	THiL	R/PDE	PU	M30
D4.4	ESR 12 PhD thesis	4	SGRE	R	CO	M41
D4.5	ESR 13 PhD thesis	4	THiL	R	PU	M41
D5.1	Summary of best practices in digitalization in energy sector	5	DTU	R	PU	M17
D5.2	Cost benefit analysis method for digitalization	5	DTU	PDE	PU	M25
D5.3	Policy recommendation for incentivizing digitalization	5	DTU	R/PDE	PU	M36
D5.4	ESR 14 PhD thesis	5	DTU	R	PU	M41
D5.5	ESR 15 PhD thesis	5	DTU	R	PU	M41
Management, training, recruitment and dissemination deliverables						
Deliverable	**Deliverable Title**	**WP**	**Lead beneficiary**	**Type**	**Level**	**Due date**
D6.1	Templates of study plan, PCDP, and study report	6	ICL	R	CO	M1
D6.2	Conduct the plan of training schools (cf. Table 1.2b – 1.2d)	6	ICL	ADM	PU	M8, M14, M20, M26
D6.3	Conduct the plan of the summer school (cf. Table 1.2b)	6	ICL	ADM	PU	M33
D6.4	Conduct the plan of the workshops (cf. Table 1.2b)	6	ICL	ADM	PU	M39
D7.1	Project website	7	TUD	ADM/OTHER	PU	M3
D7.2	Promotional materials (flyer, social media account)	7	TUD	ADM/OTHER	PU	M3
D7.3	Communication plan and Dissemination and exploitation plan	7	TUD	R	CO	M8
D7.4	Summary of the dissemination, exploitation and communication activities	7	TUD	R	CO	M22, M46
D8.1	Consortium agreement	8	DTU	R	CO	M0
D8.2	Overall recruitment finished	8	DTU	ADM	PU	M4
D8.3	Data management plan	8	DTU	R	CO	M8
D8.4	Annual financial reports	8	DTU	ADM	CO	M12, M24, M36, M48
D8.5	Final project report	8	DTU	R	PU	M48
D8.6	Sustainability plan	8	DTU	R	CO	M48
D8.7	Education programme report	8	DTU	R	PU	M48

(NB: The ESR1, 2, 3, 5, 11 will enroll in a 4-year doctoral programme. It means they will not finish their PhD before the project finishes.)

3.1.3 List of major milestones

Table 3.1c. Milestones list

No	Title	WP no.	Lead	Date	Means of verification
1	Consortium agreement signed	WP8	DTU	M0	Signed agreement
2	ESR recruitment process finished	WP8	DTU	M4	ESRs individual contract signed
3	Dataset for DSO O&M studies	WP3	DE	M12	D3.1 finished
4	IoT data acquisition system design method	WP1	UU	M19	D1.2 finished
5	Digital representation model of wind turbine subsystems	WP4	SGRE	M23	D4.2 finished
6	Mid-term evaluation, all training schools completed	WP6	ICL	M26	D6.2 finished
7	Application examples for real time simulation of CPES	WP4	THiL	M30	D4.3 finished
8	Summer school organized	WP6	ICL	M33	D6.3 finished
9	Policy recommendation for incentivizing digitalization	WP5	DTU	M36	D5.3 finished

10	Delivery of the PhD theses of ESRs except ESR1, 3, 5, 11	WP1-WP5	Beneficiaries of the ESRs	M41	D1.5, D2.4, D3.6-3.10, D4.4-4.5, D5.4-5.5
11	InnoCyPES E-training materials ready	WP1-WP5	DTU	M45	Training materials are online

3.1.4 Fellows' individual projects

Table 3.1d. Individual research projects

Fellow	Host Institution	PhD enrollment	Start date	Duration	Deliverable
ESR1	UU	UU	M5	48 months	D1.2
Project title and work package(s) to which it is related: IoT network design and reliability evaluation for energy sector (WP1)					
Objectives: Provide design and modelling methods for IoT data acquisition and communication network reflecting short-term and long-term performance. The data quality and the traffic can be emulated by the model with respect to the heterogeneity, uncertainty, and long-term reliability of the sensing system.					
Expected results: 1) Developed IoT sensing system model describing the working states of sensors reflecting the reliability and heterogeneity of the performance. **2)** Drift of accuracy and reliability of sensors over long time horizon are modelled**. 3)** Use SDN to design the communication network. 4) The uncertainty effects including latency, latency with jitter, bit error, loss of packets, can be simulated; **4)** Develop reliability indices for the IoT sensor network that can be used to evaluate the long-term behaviour of the IoT data quality**. 5)** Establish use cases from offshore wind farm and distribution networks**. 6)** Model is linked to a CPES co-simulation environment and cloud computing					
Planned Secondment(s): ***Host, Supervisor, Timing, Length, and Purpose***					
1) **Ørsted, Dr. K. H. Andersen, M14-M19**, **6 months,** obtain training on SCADA systems in offshore wind sector, share knowledge on IoT system design with ESR9, collaborate with ESR14 on cost modelling of IoT/cloud system;					
2) **EDF, Dr. J. Sanchez-Torres, M20-M23, 4 months,** obtain training on resiliency management systems and information system modelling, share knowledge and method on communication network modelling and simulation, collaborating with ESR2 on data modelling;					
Fellow	**Host Institution**	**PhD enrollment**	**Start date**	**Duration**	**Deliverable**
ESR2	EDF	UU	M5	48 months	D1.1
Project title and work package(s) to which it is related: Information model development for multiple actors' coordination (WP1)					
Objectives: Develop a viable information model for information and data exchange among multiple actors in an energy system, to facilitate coordination of individual operational objectives in, e.g. procurement of services from neighboring systems while fulfilling the security requirements of both systems.					
Expected results: 1) Develop an information model. The structure can be tailored towards different coordination schemes. The information model should fulfil the requirements of CIM and IEC61850 and can be directly implemented in real DERs or substations conforming to the latest standard**. 2)** Use cases of the information model are developed. The use cases will explore different coordination schemes centralized, decentralized, distributed, direct, and indirect. The efficacy of the information model will be tested on a cyber-physical co-simulation environment. **3)** Harmonization between standards (CIM and IEC61850) to distributed generation, storage and electric vehicles allowing the automatic mapping of standards and the automatic generation configuration files.					
Planned Secondment(s): ***Host, Supervisor, Timing, Purpose***					
1) **UU, Prof. M. Gibescu, M5-M14, 10 months,** obtain training on machine learning and mathematical optimization and fulfil local requirements from the PhD programme required by UU, meantime collaborating with ESR1 to incorporate IoT/cloud perspectives;					
Fellow	**Host Institution**	**PhD enrollment**	**Start date**	**Duration**	**Deliverable**
ESR3	TUD	TUD	M5	48 months	D1.3, D1.4
Project title and work package(s) to which it is related: Cyber-physical smart grid intrusion detection (WP1)					
Objectives: Develop a highly accurate integrated cyber-physical smart grid (CPSG) IDS.					
Expected results: 1) Defined threat models and cyber-physical attack scenarios, state-of-the-art research. **2)** Setup of the co-simulation environment, the definition of the test cases, requirement specification of the CPSG IDS. **3)** Pattern classification, clustering of attack signatures, design of the CPSG IDS. **4)** Implementation of the CPSG IDS and test cases. **5)** Validation of the CPSG IDS against the test cases, sensitivity study against model/system parameters.					
Planned Secondment(s): ***Host, Supervisor, Timing, Purpose***					
1) **EDF, Dr. Jose Sanchez-Torres, M20-M23, 4 months,** obtain training information and communication standards, share knowledge on cybersecurity standard with ESR2, collaborate with ESR1 and ESR2 at EDF on combining IoT design, cybersecurity measures and interoperability concerns;					
2) **CSIRO, Dr. Shiping Chen, M24-M26, 3 months,** obtain training on blockchain and cybersecurity techniques applied for industrial areas other than energy sector, further develop intrusion modelling and detection techniques in more general terms;					
3) **UNSW, Prof. J. Dong, M27-M28, 3 months** obtain training on smart grid technologies, as well as cyber physical system modelling and simulation;					
Fellow	**Host Institution**	**PhD enrollment**	**Start date**	**Duration**	**Deliverable**
ESR4	UNILE	UNILE	M5	36 months	D2.1, D2.3, D2.4
Project title and work package(s) to which it is related: Large scale data management and integration (WP2)					
Objectives: Design and implementation of a Distributed Data Storage tool for multiple source energy data management.					
Expected results: 1) Specification of a common scheme related to multiple source energy data. **2)** Design of a secure, P2P Distributed Data Storage tool providing support for complex, distributed queries. **3)** Implementation of the Distributed Data Storage tool. **4)** Deployment of the Distributed Data Storage tool. **5)** Validation and test of the Distributed Data Storage tool.					
Planned Secondment(s): ***Host, Supervisor, Timing, Purpose***					
1) **DE, Dr. P. Douglass, M12-M15, 4 months,** obtain training on smart grids, interacting with ESR9 and ESR12 on data management, integration and query programming, collaborate with ESR14 regarding the cost estimation method of distributed data management system;					
2) **TUD, Prof. P. Palensky, M21-M24, 4 months,** obtain training on cybersecurity, data preprocessing techniques, help to develop and test the distributed data management on the co-simulation platform, share database and query techniques, collaborate with ESR5 on data storage and preprocessing;					
Fellow	**Host Institution**	**PhD enrollment**	**Start date**	**Duration**	**Deliverable**
ESR5	TUD	TUD	M5	48 months	D2.2
Project title and work package(s) to which it is related: Enriching system measurements for machine learning applications (WP2)					
Objectives: The project develops methods for interpolation, imputation and augmentation of system measurements using machine learning and physical system knowledge. Electrical networks are used as a motivating case, tackling the following challenges: 1) Different sampling rates and data dropouts. Whereas PMUs or waveform monitoring systems measure electrical properties at a rate of many kHz, smart meters may report values only once every 30 minutes. Interpolation and imputation are required to generate synchronized pseudo-observations, subject to uncertainty; 2) Non-alignment of timestamps. High-end measurement devices have GPS-synchronized clocks, but that is often not the case for low-cost infrastructure. Collectively, the measurements, along with a grid model, can be used to identify and offset drift in clocks of individual sensors, e.g. using a Kalman filter to infer a hidden clock offset. This research paves the way to highly accurate low-cost sensing; 3) Limited availability of training data. Machine learning algorithms usually benefit from large training datasets, but the number of available measurements may be limited or subject to confidentiality. Deep learning approaches such as Generative Adversarial Networks (GANs) or Variational Autoencoders (VAEs) will be used to learn salient properties of data. These representations are combined with physical network models to generate virtual measurements with similar statistical properties. The methods developed will be combined into a flexible, open source data preprocessing library.					
Expected results: 1) Development of method to merge grid data from synchrophasor or waveform measurement systems, SCADA and smart meter sources. **2)** Method to augment training databases using generated measurements. **3)** Implementation as part of an open source, extensible software platform.					
Planned Secondment(s): ***Host, Supervisor, Timing, Purpose***					
1) **DEP, Dr. O. Alizadeh-Mousavi, M14-M17, 4 months,** obtain training on "GridEye" technology, distribution grid real time monitoring, share knowledge on data preprocessing techniques, collaborate with ESR10 who visits DEP at the same time linking data preprocessing to application;					
2) **UNILE, Prof. M. Cafaro, M26-M29, 4 months,** obtain training on data management technologies, collaborate with ESR4 to link preprocessing with data storage systems;					
Fellow	**Host Institution**	**PhD enrollment**	**Start date**	**Duration**	**Deliverable**

ESR6	NTNU	NTNU	M5	36 months	D3.4, D3.6

Project title and work package(s) to which it is related: Operation, maintenance and investment strategy for offshore energy hub (WP3)

Objectives: The goal of the project is in the design of methods for efficient and robust control and optimization.

Expected results: 1) Models for offshore production system and uncertainties corresponding to its operation. **2)** Methods (combined data-driven and model-based) for automatic control and optimization of wind and O&G production system, as well as for O&G system health monitoring. **3)** Methods for health-monitoring and health-aware control for offshore system installations. **4)** Validation of the methods based on field data and advanced production models.

Planned Secondment(s): *Host, Supervisor, Timing, Purpose*

1) **EQN, Dr. Jan Henrik Borch, M12-M14, 3 months,** obtain training on offshore O&G production process and its control and monitoring systems;
2) **ICL, Prof. B. Pal, M18-M20, 3 months,** obtain training on system dynamic control and oscillation damping techniques, collaborate with ESR8 regarding offshore system stability studies, sharing knowledge on offshore wind and O&G platform monitoring and uncertainty modelling techniques;
3) **SGRE, F. Martin, M21-M24, 4 months,** obtain training on offshore wind farm operation and control, sharing knowledge on O&G platform operations, collaborate with ESR12 on offshore energy hub modelling, and ESR14 on establishing cost benefit assessment model for digitalization programmes in O&M in offshore sector;

Fellow	Host Institution	PhD enrollment	Start date	Duration	Deliverable
ESR7	NTNU	NTNU	M5	36 months	D3.3, D3.7

Project title and work package(s) to which it is related: Real-time analytics on high fidelity synchronized measurements (WP3)

Objectives: Develop an efficient data analytic workflow to identify power disturbances and their root cause based on synchronized waveform measurements.

Expected results: 1) Developed an efficient algorithm that can recognize power quality issues based on waveform data. The algorithm can analyze high fidelity flowing data. The disturbance patterns can be classified based on offline analysis and mining of different types of power disturbances, while through processing the data received from different locations, the disturbance can be quickly characterized, and the root cause can be identified. **2)** A real time simulation environment for testing the algorithm.

Planned Secondment(s): *Host, Supervisor, Timing, Purpose*

1) **INESC, Prof. Rui Henriques, M15-M17, 3 months,** obtain training on advanced data analytic methods applied in general fields other than energy sector;
2) **AIT, Dr. Johannes Stöckl, M18-M20, 3 months,** obtain training on power converter hardware and its grid connectivity, share knowledge on power quality assessment methods, collaborate with ESR10 (visiting AIT at the same period) and 11 on signal processing techniques for waveform data;
3) **SGRE, F. Martin, M21-M24, 4 months,** obtain training on state-of-the-art offshore wind operation, collaborate with ESR12 on real time data processing;

Fellow	Host Institution	PhD enrollment	Start date	Duration	Deliverable
ESR8	ICL	ICL	M5	36 months	D3.5, D3.8

Project title and work package(s) to which it is related: Data-driven stability enhancement for cross border electric networks (WP3)

Objectives: Develop data aided stability assessment algorithms that can be used both for online and offline assessment of the renewable energy system.

Expected results: 1) Identified stability problems of low inertia systems through empirical studies of different system models. **2)** Benchmark test system for scientific community studying the characteristics of low inertia systems. **3)** Innovative controls using wide area signals, through control of the power converters and the controllable devices such as FACTS devices and generators interfaced through power converter, and in a combination of voltage control, load shedding schemes, to improve the system stability after a disturbance. **4)** Data-driven models assessing the grid inertia distribution and heterogeneity, adaptively change the control system settings for coordinated reactions.

Planned Secondment(s): *Host, Supervisor, Timing, Purpose*

1) **THiL, Dr. Dušan Majstorović, M23-M25, 3 months,** obtain training on power converter modelling, collaborate with ESR13 on Digital Twin representation of energy systems;
2) **NTNU, Prof. A. Pavlov and Prof. D. Varagnolo, M26-M28, 3 months,** obtain training on offshore O&G power system and its operation, continue the collaboration with ESR6 with respect to offshore energy system operation and control after its secondment;
3) **NARI, Prof. Y. Xue, M29-M30, 2 months,** obtain training on cyber physical system architecture and emerging stability concerns in other power grids outside the EU;

Fellow	Host Institution	PhD enrollment	Start date	Duration	Deliverable
ESR9	DE	DTU	M5	36 months	D3.1, D3.6

Project title and work package(s) to which it is related: Condition monitoring and predictive maintenance of distribution grids (WP3)

Objectives: Develop data analytic methods to improve the efficiency of asset management of DSOs through better condition monitoring and minimum investment.

Expected results: 1) A data integration tool to DSOs. **2)** Established benchmark datasets to train and test data analytic tools. **3)** Pattern recognition method of the fault frequency, location, type and severity. **4)** Developed predictive models using the datasets for maintenance/planning schedules to improve the reliability. **5)** Suggested data management and analytic guidelines for the best practices for distribution grid operators in Denmark as well as countries share similar types of distribution grids.

Planned Secondment(s): *Host, Supervisor, Timing, Purpose*

1) **DTU, Dr. GY Yang, M5-M11, 8 months,** obtain training on distribution grid analysis and planning methods and data analytic method, collaborate with ESR14 to establish the benefit model of the work from an economic point of view, and ESR9 on data integration;
2) **DTU, Dr. E. Akrom, M11-M14, 2 months,** obtain training on energy policy, sustainability, energy efficiency, and UN SDG, collaborate with ESR15 regarding policy and digitalization programmes for distribution systems. The length of the secondment is required by DTU Doctoral Programme.

Fellow	Host Institution	PhD enrollment	Start date	Duration	Deliverable
ESR10	ICL	ICL	M5	36 months	D3.5, D3.10

Project title and work package(s) to which it is related: Privacy preserved data pattern identification for improved network observability (WP3)

Objectives: Develop data aided methods using statistical models to achieve real time monitoring of the distribution system while avoiding the use of private consumer data.

Expected results: 1) Techniques that can synthesize sensitive consumer information and data into statistical models. **2)** Methods that synthesize statistic consumer information with the data of no privacy concerns. The data can then be used as input to an online estimation model. **3)** Developed time-dependent scenarios. **4)** New observability measures for distribution systems for evaluation of improved observability. **5)** Evaluation of the privacy impact on data accessibility, system observability, security and planning issues.

Planned Secondment(s): *Host, Supervisor, Timing, Purpose*

1) **DEP, Dr. Omid Alizadeh-Mousavi, M14-M17, 4 months,** obtain training on “GridEye” technology, distribution grid real time monitoring, sharing state estimation techniques, collaborate with ESR5 who is visiting DEP at the same time on data preprocessing techniques;
2) **AIT, Dr. Johannes Stöckl, M18-M20, 3 months,** obtain training on low voltage system operation and component design and modelling, share data representation method, collaborate with ESR7 and 11 on distribution system representation;
3) **eSS, Dr. D. Roverso, M21-M24, 4 months,** obtain training on distribution grid components and system condition monitoring;

Fellow	Host Institution	PhD enrollment	Start date	Duration	Deliverable
ESR11	AIT	ETH	M5	36 months	D4.1

Project title and work package(s) to which it is related: Digitalized power converter design for fast prototype and control appraisal (WP4)

Objectives: Develop a combined virtual environment for design and testing of wind turbine grid functions that can be used to characterize the stability of different grid interactive functions with wind turbines through deployment on hardware modular power converters and implementation of communication protocols.

Expected results: 1) Implementation of control algorithms in reference applications, combination of reference smart grid converter and hardware-in-the-loop implementation of the power electronic controls. **2)** Implemented communication interfaces (IEC61850, Sunspec, and Modbus) for testing centralized/networked power converter control system. **3)** Stability assessment of implementation of hardware in the loop test at laboratory level, with comparison of different control strategies on their efficiency and cost. **4)** Guidelines for field implementations of the power electronic control.

Planned Secondment(s): *Host, Supervisor, Timing, Purpose*

1) **ETH, Dr. Florian Dorfler, M5-M14, 10 months,** training on virtual synchronous machine control design and the latest power converter control methods. The length of the secondment period is required by ETH Doctoral Programme.

Fellow	Host Institution	PhD enrollment	Start date	Duration	Deliverable

ESR12	SGRE	DTU	M5	36 months	D4.2, D4.4
Project title and work package(s) to which it is related: Digitalizing wind turbine subsystems for fast prototyping and grid compliance (WP4)					
Objectives: Develop Digital Twin technology on wind turbines for reduced time for prototyping and investment in wind turbine test equipment and facilities.					
Expected results: 1) Definition of wind turbine subsystems including their control and protection, as well as auxiliary systems. **2)** Develop new testing methods combining Digital Twin technology to enhance the testing flexibility with reduced cost. **3)** Suggestions for new testing protocols with improved clarity on testing procedures for the key control functions, considering the current and upcoming grid requirements worldwide. **4)** Pattern recognition model that can be used for operational grid compliance observation. **5)** Developed Digital Twin test platform based on real time simulation tool for testing of wind turbine subsystems. **6)** Suggestions on verification method of the new testing procedure.					
Planned secondment(s): *Host, Supervisor, Timing, Purpose** 1) **DTU, Dr. GY Yang, M5-M11, 8 months,** obtain training on power system operation, collaborate with ESR14 to establish the digitalization CBA model of offshore wind farms; 2) **DTU, Dr. E. Akrom, M12-M14, 2 months,** obtain training on international renewable energy policy, collaborate with ESR15 on establishing the digitalization practices in the current wind turbine manufacturing and the possible improvement. The length of the secondment is required by DTU Doctoral Programme.					
Fellow	**Host Institution**	**PhD enrollment**	**Start date**	**Duration**	**Deliverable**
ESR13	THiL	DTU	M5	36 months	D4.3, D4.5
Project title and work package(s) to which it is related: Development of Digital Twin models for power grids (WP4)					
Objectives: Develop software modules to achieve full-blown simulation of CPPS for HiL and interoperability tests of power components and grids.					
Expected results: 1) Developed communication system and measurement equipment libraries and supporting functions based on the current technology. **2)** Developed new functions on DER and converter protection for HiL tests. **3)** Real time power flow simulation. **4)** Developed simulation control method to connect different hardware components in HiL test. **5)** Programming environment for embedded artificial intelligence and data analytics to enhance the flexibility of the environment. **6)** Improved interoperability of the simulator, including both software and hardware.					
Planned secondment(s): *Host, Supervisor, Timing, Purpose* 1) **DTU, Dr. GY Yang, M5-M14, 10 months,** obtain training on power system monitoring and analysis, collaborate with ESR9 on distribution system modelling and operational challenges, and ESR12 regarding Digital Twin technology development and wind turbine modelling. The length of the secondment is required by DTU Doctoral Programme.					
Fellow	**Host Institution**	**PhD enrollment**	**Start date**	**Duration**	**Deliverable**
ESR14	DTU	DTU	M5	36 months	D5.2, D5.4
Project title and work package(s) to which it is related: Cost benefit assessment to inform on competitiveness of increased digitalization in energy sector (WP5)					
Objectives: Establish a decision support tool for the energy sector for cyberinfrastructure expansion. Integrating cyber facilities into the system planning model.					
Expected results: 1) A CBA appraisal framework developed for cyber system expansion. **2)** Established risk-based cost evaluation model for different use cases across the energy sector. **3)** Established planning to integrate cyber and physical infrastructure planning. **4)** Proposed a decision-making matrix to evaluate the risk and the performance using scenario-based calculation, and meanwhile draw pieces of evidence from the ESR projects from WP1-4 on the performance. **5)** Established cost library of cyber infrastructure based on the knowledge from the partners.					
Planned Secondment(s): *Host, Supervisor, Timing, Purpose* 1) **NTNU, Prof. V. Hagspiel, M12-M13, 2 months,** obtain training on investment management and decision-making study methods and quantitative analysis 2) **INSEC, Prof. Hugo Morais, M14-M15, 2 months,** obtain training on operational planning tools used by DSOs and hardware agnostic solutions based on IEC standards to be used in power substations and to control distributed energy resources; 3) **NARI, Y. Xue, M16-M17, 2 months,** obtain training on cost benefit analysis method developed in different context other than EU; 4) **UNSW, Prof. J. Dong, M21-M22, 2 months**, obtain training on system planning method, obtain information on digitalization practices outside EU context; 5) **CSIRO, Dr. Shiping Chen, M23-M24, 2 months,** obtain training on benefits of digitalization in different sectors, improve the CBA model from international perspectives;					
Fellow	**Host Institution**	**PhD enrollment**	**Start date**	**Duration**	**Deliverable**
ESR15	DTU	DTU	M5	36 months	D5.1, D5.3, D5.5
Project title and work package(s) to which it is related: Sustainability, enabling framework, and policy roadmap towards increased digitalization in energy sector (WP5)					
Objectives: This ESR will analyze different levels of government (i.e. municipal and or national) policies and engage with relevant stakeholders with the goal of identifying key barriers and opportunities in a fully digitalized energy system operation scenario. It will explore both top-down and bottom-up policy mechanisms.					
Expected results: 1) Analysis results of the technology gaps between collaborating countries between 1990 to 2018**; 2)** Summary of the policy support needed for IoT infrastructure development in energy sector; **3)** Assessment of monitoring and evaluation capacity aids and public-private partnerships; **4)** Analysis of the potential impact of GDPR on technology diffusion;					
Planned Secondment(s): *Host, Supervisor, Timing, Purpose* 1) **NTNU, Prof. V. Hagspiel, M12-M13, 2 months,** obtain training on optimal subsidy assessment, policy uncertainty modelling, and capacity investment and planning; 2) **EDF, Dr. Jose Sanchez-Torres, M14-M15, 2 months,** obtain training on renewable sector and distribution system sector ICT design and digitalization programmes adopted in EDF, interview key experts with respect to the history and current regulations, incentives, and barriers, establish use cases and policy assessment model; 3) **NARI, Y. Xue, M16-M17, 2 months,** obtain training on questionnaire-based incentive analysis and regulatory sandbox for renewable policy impact study towards 2050, interview key experts in China with respect to governmental policy and technological priority areas; 4) **UNSW, Prof. J. Dong, M21-M22, 2 months,** obtain training on quantitative analysis methods and optimization, build quantitative analysis model for policy impact assessment; 5) **CSIRO, Dr. Shiping Chen, M23-M24, 2 months,** interview with key experts on the history and evolution of policies in AU;					

3.2 Appropriateness of the management structures and procedures

3.2.1 Network organization and management structure

The programme is coordinated by DTU. DTU has efficient and experienced legal, financial, communication, and business support teams and has coordinated several ITN projects. The **Project Coordinator (PC)**, Senior Scientist Guangya Yang, has a strong academic background in the renewable integration related control, stability and optimization issues, and distinct industrial cooperation research experience[46,47]. The PC will take the overall responsibility of delivering the programme. He will be assisted in office by a dedicated **Project Manager (PM)** devoting 15 hours/week (40% FTE) in executing the project plan. The PM will manage the ESRs' secondment plan and support the PC to coordinate and communicate within the network. The PC will,

- ✓ Ensure the consortium agreement is signed in a timely manner and following the EU principles and best practices[73];
- ✓ Ensure the project practices and results abide by the European Code of Conduct for research integrity;
- ✓ Be the intermediary between the programme and the European Commission, take overall responsibility for intermediate technical and financial reporting, final reporting and funding administration;

[73] "Good agreements make good friends: A LERU model contract for European Training Networks," *LERU*. [Online]. Available: https://www.leru.org/news/good-agreements-make-good-friends-a-leru-model-contract-for-european-training-networks.

- ✓ Develop transparent procedures for recruitment, supervision, career development, and secondment. Make certain that gender balance is considered in both decision-making and implementation process;
- ✓ Oversee the project economy, make sure there are sufficient resources to deliver the planned activities;
- ✓ Report to the Supervisory Board for significant plan changes, and take initiatives proactively in acting and finding solutions;
- ✓ Ensure data management follows the EU best practices;
- ✓ Act as the mediator to find solutions in the case of conflicts;

To ensure a smooth management of the project throughout the period, a **Deputy PC (DPC)** role is created. The role of DPC is to follow the project management process and provide strategic advice and to act when PC is away/travelling. The **DPC** of the project is Senior Scientist Emmanuel Ackom, who has strong social and economic perspectives on the digitalization technology and sustainability. The overall network management (cf. Figure 3.2) will deal with the concerns and problems of ESRs in a collective manner, by exploiting the competences of the participants and the resources of the network. This will help to harvest the synergies across the network.

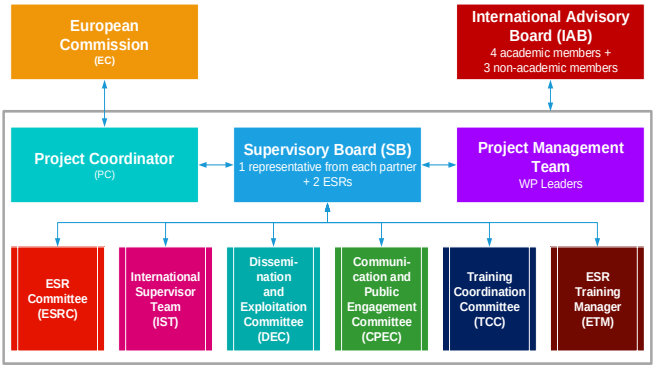

Figure 3.2. Project management structure.

Financial management strategy: The PC will be supported by experienced legal and financial experts from DTU as well as a financial control team at the department. The team will help the PC on budgeting, reviewing and financial reporting. DTU has considerable experience in managing complex national and international projects and high expertise in EU funding rules, with well-established practices in funding management, allocation and reporting conforming to local and H2020 regulations.

The cost incurred by organizing the project-wide events will be covered by the allowances provided to the beneficiaries from the EC. All beneficiaries agree to contribute 400 €/month/ESR to the central consortium to cover the expenses. The financial management plan that defines the details of the cost contribution of the participants towards the training courses will be included and signed as part of the consortium agreement. As all ESRs will be enrolled in a Doctoral Programme, for partners (UU, TUD, NTNU, ETH) that have 4-year doctoral programme the additional period outside the funding period will be managed through internal and external funding from other sources.

Strategy for dealing with scientific misconduct: Every ESR must sign a declaration on the *Code of Scientific Conduct* practised by the enrolled university at the beginning. There will be an agreement among the supervisors defining the scientific misconduct, co-authorship, information handling within the network, and data management. The aim is to protect the ESRs, the supervisors, the partners and the research community. For any draft publication to be submitted, the authors must at the same time send an abstract to the Supervisory Board. Foreground data will be made available for the entire network. This will help the PC and the Supervisory Board to identify potential irregularities beforehand. If an ESR is accused of scientific misconduct, the case will be first evaluated by the ESR Training Manager (ETM). If ETM cannot decide on the case alone, it will be sent to the Supervisory Board for evaluation and necessary actions based on voting according to simple majority principle. A transparent protocol will be defined in the consortium agreement to resolve the scientific misconduct issue incorporating local regulations.

3.2.2 Supervisory Board (SB)

The Supervisory Board includes one representative from every partner. SB is responsible for all important decisions. Biannual meetings are organized by the board members for a review of the progress as well as planning activities for the next phase. The Supervisory Board will,

- ✓ Agree on the members in the management units (cf. Figure 3.2);
- ✓ Support the PC in preparing the meetings with the European Commission (EC) and financial statement;
- ✓ Prepare the content and timing of press releases and joint publications by the consortium;
- ✓ Approve the templates of study plan, PCDP, and study report at the beginning of the project;
- ✓ Approve annually and support the implementation of the dissemination and communication plan;
- ✓ Approve annually and support the implementation of the data management plan;
- ✓ Build active and continuous communication within the consortium for synergy and exchange of best practices;
- ✓ Explore and establish dissemination channels with external relevant stakeholders and associations;
- ✓ Oversee the project technical and training deliverables;
- ✓ Oversee the quality of the training programme and career development of the ESRs, ensure an adequate balance in training among technical and transferable skills, and approve actions proposed by TCC;
- ✓ Oversee and coordinate the research work across WPs and ESR projects;
- ✓ Evaluate and explore possible Intellectual Property applications and commercial exploitation;
- ✓ Set procedures for dealing with cases of scientific misconduct;

SB will make the final decision on conflicts among partners through professional support from legal and financial departments. Voting will take place if appropriate, and decision will be made by simple majority voting. The SB will be chaired by Dr. Emmanuel Ackom who is experienced in managing stakeholder networks.

International Advisory Board (IAB) The international advisory board includes 4 experts from academic and 3 from non-academic organizations outside the consortium. IAB will review the project training and research activities through Advisory Board meetings, and provide feedback on the technical development as well as dissemination, communication, and exploitation. There will be two IAB meetings organized in the project to hear the feedback and enhances the exposure of the ESRs work.

Training coordination Committee (TCC) The committee includes 3 academic and 2 non-academic beneficiaries and the PM. TCC will develop the templates of PCDP, study plan, and study report to the consortium upon project start, and will be in charge of implementing the training activities designated in Table 1.2b-1.2d, supported by SB and the PC. TCC will also assist the ESR training manager in reviewing the study plans and PCDP plans. TCC organizes questionnaires to the ESRs for their feedback periodically. Training and project achievements and challenges will be reported through the questionnaire to better monitor ESRs' status, and related actions will be identified and proposed to SB for approval. This ensures a closed-loop feedback on training throughout the project that guarantee the training offered to the ESRs is quality assured and in accordance with their study plan and PCDP. Assisted by IST and PM, TCC will also prepare the training report to the SB on a yearly basis. TCC will be led by Prof. Bikash Pal who has extensive experience in PhD and professional training activities.

ESR Training Manager (ETM) This designated management role has been included to ensure the quality and coherence between the training performed at different locations and between work packages. This assures close involvement of each individual ESR and their supervisors in his/her training process. The ETM reviews and approves the study report and any updates in the PCDP and study plan of each ESR. The ETM will monitor and coordinate the training between the host organizations and individual ESRs through close communication with the PC and PM. Prof. Bikash Pal is appointed as the ETM.

Project Management Team (PMT) PMT includes all WP leaders including 5 technical WPs and 3 non-technical WPs and the project manager (PM). The technical WPs will follow the ESRs work within their WPs and ensure the tasks and deliverables are implemented according to the planned schedule (cf. Table 3.1a). The PMT works closely with the ESRC and IST to implement the plans and coordinate the ESRs activities as well as relevant decisions from the supervisory board. The PMT will be chaired by Prof. Madeleine Gibescu.

Dissemination and exploitation committee (DEC) The committee will include the 2 academic and 2 non-academic beneficiaries and the project manager. DEC will develop and update the dissemination plan annually to fulfill the strategy of Section 2.3. DEC will also follow up with IST to monitor and assess the implementation. DEC will also identify the exploitation possibilities and oversee the development according to Table 2.3.3. The committee will be led by Prof Peter Palensky under WP7.

Communication and Public Engagement Committee (CPEC) The committee includes 2 academic beneficiaries, 2 non-academic beneficiaries, and 2 ESR representatives and the PM. CPEC is responsible for developing and updating the communication plan annually, as well as ensure the implementation of the plan. The committee is under WP7 and will be led by Prof. Massimo Cafaro.

International Supervisor Team (IST) The team is formed taking into account the principles of internationality and intersectorality (cf. Table 1.3.1b). The IST works closely with ESRs on their research training, and help them to prepare and review study plans and PCDP. It also approves biannual study reports and submits to ETM for further approval. The team will organize regular meetings (every 1,5 months) with the ESRs to discuss the research and training progress, and plan for the next step's work. The IST has the full responsibility for the training schedule and progress of the ESRs.

ESR Committee (ESRC) All ESRs are members of this committee. ESRC is a forum for discussions, knowledge and information sharing, social networking, and experience sharing. ESRC will establish a communication platform among the ESRs to exchange their results and ideas quickly and organize seminars outside Table 1.2b for co-development of their work. ESRC will elect two ESRs to serve as liaison between the SB and ESRs, where the 2 ESRs will make a general feedback summary of the training and exchange experience to the SB, and provide the best practices and ideas to the SB to enhance the integration of the ESRs network as well as the partner network.

3.2.3 Recruitment strategy

The recruitment of the ESRs will follow the principle of European Charter and Code for Researchers. Upon grant approval from the EU the positions will be advertised on the beneficiary's websites and circulated through professional networks, such as Naturejobs, IEEE job site, EURAXESS, etc. The advertisement will include all the positions and their locations, with the same requirement on the application documents, and applicants can indicate their interests in more than one position by one submission. Minimum requirements on the technical field of specialties are set in the advertisement to encourage more applicants. The deadline for application will be set on the same date for all beneficiaries to synchronize the selection process. On the **gender balance** front, a search committee will be established to identify potential female candidates through the consortium internal and external networks. Contact with Women professional associations such as IEEE Women in Engineering will be established by the search committee as part of the strategy. Cooperating with the local HR departments, invitation letters will be sent to the potential candidates for application. Upon screening, interviews will be conducted by IST members across sectors and gender groups. **Simplicity** is considered as the key in the recruitment process to attract the best talent to this project. A good applicant will be offered a position as quick as possible, while a bridging position like part-time or full-time research or teaching assistant can be offered before the official start of the training programme. Suitable candidates that could not be offered certain positions may be recommended to the positions with fewer applicants.

3.2.4 Progress monitoring and evaluation of individual projects

All the beneficiaries need to provide updates on the recruitment status on a monthly basis before month 5. All the ESRs should submit their study plans and PCDPs through the supervisor team to the ETM and TCC in the first two months of their study. All ESRs need to submit their study reports every half year, with the first study report sent in M9 and the last sent in M39. The study report will contain the information regarding research progress, training, supervision, dissemination and communication activities, and research and dissemination plan for the next 6 months. The progress of the ESRs will be reviewed by ETM. Justification needs to be provided in the case of update of the study plan and the PCDP. Reports that are not adequately reflecting the activities or deviate from the plan will be followed up by the ETM. ETM and PC work closely with the IST to find solutions for any deficiency.

Table 3.2a A list of network-wide event for monitoring and interacting with the ESRs.

Events	Month	Description
E1	**M7**	ESRs finalize the study plan and PCDP in cooperation with the IST. IST sends the plans to the ETM within M7 for final approval.
E2	**M8**	ESRs will present their initial research plan in the first training school. This includes the research objective, hypotheses, and the starting position.
E3	**M20**	Confirmation seminar. The ESR will present their research to the whole project team including the initial results and plan for the rest of the study.
E4	**Biannual**	ESRs will provide ETM and TCC the study report, updates of the plans, and feedbacks through SB meetings.
E5	**M26**	ESRs will receive feedback comments from IAB regarding the innovativeness and significance of their research.

Table 3.2b. Document control process.

Documents	Prepared by	Received by	Cooperated by	Approved by	Review freq.	First submission	First approval
Study plan	**ESRs**	**ETM + TCC**	**IST**	**SB**	**Biannual**	**M7**	**M8**
PCDP	**ESRs**	**ETM + TCC**	**IST**	**SB**	**Biannual**	**M7**	**M8**
Data management plan	**PC+PM**	**SB + PC/PM**	**SB**	**SB**	**Annual**	**M1**	**M8**
Communication plan	**CPEC**	**SB + PC/PM**	**IST**	**SB**	**Annual**	**M8**	**M8**
Dissemination and Exploitation plan	**CPEC**	**SB + PC/PM**	**IST**	**SB**	**Annual**	**M8**	**M8**

3.2.5 Risk management at consortium level

Table 3.2c. Risks in implementation and contingency plan

No.	Type of risk	Description of Risk	WP	Proposed mitigation measures
R1	Recruitment	Delay of recruitment therefore the activities	ALL	The first screening must finish before M1. First round interviews finish by M2. Some positions may be re-advertised. Recruit applicants through invitation through personal and professional networks.
R2	Management/ Internal	A beneficiary partner leaves the consortium	ALL	The SB will report to the EC to figure out the best possible mitigation measures within the regulation. An external partner may be recruited to fill in the competence, or elevate one partner organization to be a replacement.
R3	Management/ External	Brexit	ALL	If ICL cannot maintain as beneficiary, the respective ESRs will be transferred to another beneficiary or partner organization. If it only creates delays in financing, the ESRs' work will be compensated by other projects hosted by ICL.
R4	Management/ Internal	Shortage of budget	ALL	PC and PM will closely follow the project economy. ESRs will be encouraged to seek local travel grants. Minimize the number of face-to-face meetings. Training courses can be converted to online courses based on, e.g. WebEx. Secondment plan may be changed by reduced duration or less expensive countries;
R5	Management/ Internal	Delayed reporting	6	The PC will sets-up reporting schedule together with the supporting offices at DTU. Reminder will be sent 1 month before the submission deadline to ensure the work is done in a timely manner.
R6	Training	ESR resigns	6	A new ESR will be hired at the beneficiary though may not be enrolled in a doctoral programme, depending on the finance and the schedule. Some ESR tasks will be formulated into MSc projects shared across the network.
R7	Training	A main or co-supervisor leaves the job	6	A replacement will be found within the host institute for the main supervisor. Co-supervisor replacement can be from the same or different partners who are equally qualified.
R8	Scientific	Ethical issues	1-5	Agreements and documentation procedure will be defined to protect personal data and human participants in research.
R9	Scientific	ESRs progresses are slow or delayed	1-5	As the scope of each ESR is sufficiently wide that alternative methods can be explored, to ensure the deliverable deadlines are met. Certain tasks of the ESR projects can be formulated into MSc project to explore alternative methods.
R10	Scientific	Limited access to equipment or data	1-5	The issue will be solved by SB. External stakeholders will be contacted for support. Additional secondment of relevant ESRs hosted by external stakeholders can be arranged for gaining access.
R11	Scientific	Workflow is not working	1-5	Iterate the prototype tool with the industrial partners and consider the industrial constraints or specifications.
R12	Scientific	Secondment plan cannot be implemented	1-6	If secondment for an ESR cannot be fulfilled due to partner or any other issues, a revised secondment plan will be proposed and implemented based on the relevance of the study, synergy, and exposure for the affected ESR.

Through risk assessment on the risks listed in Table 3.2c, the highest impact is from R1. Therefore, it is important that the recruitment process starts as early as possible and the invitations to applications reach as many candidates as possible. Partner organizations, personal contacts, and websites will be used to actively support the recruitment process.

3.2.6 Intellectual property rights (IPR)

It is the original institute's responsibility to apply for the legal protection of Intellectual Property (IP). IPR generated by ESRs primarily belong to the hiring institutes, however, joint ownership is possible if critical background knowledge or resources (tangible or intangible) are provided by external institutes. The allocation of IP ownership and research results will be clarified in the consortium agreement before ESR's work starts. Details on how the IPR is owned including the procedure of negotiation among the partners are defined in the consortium agreement as well, including the right of purchasing and the price model. In case of one partner asking for priority in purchasing the IPR from another partner on the derivatives of their work, a separate agreement on the market terms and purchasing price will be entered between the relevant partners. The background knowledge should always remain with the partners. The DEC will continuously monitor the IPR generation and establish a network-wide procedure and forms for invention reporting, patentability analysis, and application.

3.2.7 Gender aspects

Gender balance has not been reached in this field but has been addressed to the extent possible in the project management that includes two prominent female researchers. Measures will be taken in the recruitment (cf. Section 3.2.3) as well as in the selection. At least 1 female SB member will be present at the interviews. We prioritize the minority group during the recruitment for gender parity and aim at **no less than 40%** for each gender group in the ESRC.

3.2.8 Data management plan

InnoCyPES will manage the data according to the EU FAIR principles. The project data includes all background and foreground data including measurements, system information, source codes, models, documents and their derivatives. A data management template will be created by the PC and PM, assisted by DTU library, to help with classification of the data ownership, classification, and accessibility (cf. Section 2.3.2), upon approval from the SB. Assistance will be sought from DTU library regarding the template. The template will be filled in by the ESRs and the IST on their deliverables. Additional agreements between the partners can be entered for data access and application with commercial values. As InnoCyPES uses smart meter data that contains personal information, a clear procedure for data access will be established in the consortium agreement and training will be offered on how to use the data under the EU General Data Protection Regulation (GDPR) 2016/679 and country-specific regulations. The background data from the partners with strong commercial values will be strictly managed within the network according to the confidentiality requirements from the non-academic partners, consortium agreement, and the EU and local legislation.

3.3 Appropriateness of the infrastructure of the participating organizations

The key infrastructure for the project is described in Section 4. All the academic partners in the network have the state-of-the-art laboratory setup and background experience in managing and operating simulation environment and testing equipment. UNSW has an 18-rack RTDS system, commercial scale digital wind power controller and grid connection verification facilities. For the non-academic partners, SGRE will share the data from the new wind turbine tests and historical measurements from the installed wind turbines in the world for the project. DE, being the association representing the distribution system operators of Denmark, can establish access to all the Danish distribution system data including the network, SCADA, fault records, smart meters, etc. THiL is a manufacturer of real time simulators, who has a development lab for embedded systems and is highly skilled in simulation and developing interfaces for hardware/software. EDF owns a large laboratory for testing communication standards interoperability and harmonization for smart grids, and a co-simulation platform for cybersecurity. On the partner organizations, EQN is one of the Europe's largest asset owners of offshore systems who will contribute data and operational experiences to the project. CSIRO carries world-class research on blockchain with proven track records & deep international involvement on blockchain standards, with strong competence on software architecting and development. NARI has wide range of power system modelling and dynamic security assessment equipment and real cases. All beneficiaries have established onboard programmes for international employees to resettle in a new country. Several have earned HR Excellence in Research (UU, TUD, NTNU, ICL). The dissemination and communication channels of all partners can be exploited to fulfill the strategy (cf. Section 2.3, 2.4).

3.4 Competencies, experience and complementarity of the participating organizations, their commitment

3.4.1 Consortium composition and exploitation of participating organizations' complementarities

The consortium is well balanced between academic and non-academic sector. In the ESRs, 1/3 will be hired by the non-academic sector and the rest is employed by the academic sector. The non-academic partners are all forerunners in technology innovation, production, and standardization, while the academic partners are elite innovative universities in technology and science and technology. The complementarity between technology, science, and social studies among the consortium partners gives a unique environment for the ESRs to explore different dimensions at the highest level. The complementarity of the non-academic partners in the project action has been addressed previously (cf. Section 1.4.2). Many synergies have been identified, particularly seen from the non-academic partners, which certainly fulfils the goal towards growth in this programme. For the academic sector, the competence of the academic partners covers electric network, O&G, control, computer science, communication, and policy. The consortium members have both sufficient diversity and overlap that guarantees the programme is interdisciplinary and robust.

3.4.2 Commitment of beneficiaries and partner organizations to the programme

All beneficiaries have committed at least 10% of one FTE. All the beneficiaries are fully committed to hosting and supervising the ESRs, as well as to actively participate in training, dissemination and communication activities. All beneficiaries contribute to network-wide training by hosting events, lecturing, and secondments. The partner organizations have all signed the LoC and commit on the activities defined in the proposal. Apart from Siemens, all the rest of the partner organizations will participate in the training network by co-supervision and hosting secondments. Siemens will instead provide training courses and workshops on the latest IoT operating systems, as well as access to their tools. This will give ESRs the best state-of-the-art in the area of IoT and digitalization. Apart from ETH, the rest of the partner organizations are providing lectures to the training schools. EQN contributes data to support several ESRs work. Ørsted will provide insightful knowledge on offshore wind power plant SCADA system design and implementation, as well as use cases to the ESRs to explore. It is worth mentioning that UNSW has offered to organize training in Australia for the ESRs hosted by experts from research institutions and industry to share Australian experience in both scientific research findings and real industrial practices.

4 Participating Organizations

Beneficiary Legal Name: Danmarks Tekniske Universitet (DTU), B1	
General Description	DTU is a leading technical university in Nordic countries as well as in Europe. Department of Electrical Engineering has established track record in Denmark in the areas of smart energy systems, grid-connected renewable energy integration, and energy economics. The Center for Electric Power & Energy (CEE), formed in 2012, legally organised under the Department, holds competences in digital energy solutions, interconnected energy systems and optimized electric energy technologies, supported by its state-of-the-art testing facilities PowerLabDK. PowerlabDK is established as a national green lab under the Danish Energy Agency and the facilities contain real time power system simulation, high-end testing facilities, and a complete full-scale power distribution system on the island of Bornholm. CEE is one of the strongest research centers in its field and has hosted several activities in the area of cyber-physical energy systems, including modelling, security, and its protection, incorporating hardware in the loop test method. UNEP DTU Partnership (UDP) is a leading international research and advisory institution on energy, climate and sustainable development. As a UN Environment Programme (UNEP) Collaborating Centre, it is an integral part of UNEP's Economy division and an active participant in both the planning and implementation of UNEP's Climate Change Strategy and Energy Programme. UNEP DTU Partnership comprises two Centres: Centre on Energy, Climate and Sustainable Development, and the Copenhagen Centre on Energy Efficiency. It is organisationally a part of the Department of Management Engineering at DTU. UDP collaborates with other international agencies including but not limited to United Nations Framework Convention on Climate Change (UNFCCC), International Energy Agency (IEA), UNOPS, UNDP etc.
Role and Commitment of key persons (including supervisors)	Senior Scientist Dr. Guangya Yang (20% FTE) will be Project coordinator and the main supervisor of ESR14 in the project. He will also act as academic supervisor for externally enrolled Doctoral project ESR9, ESR12 and ESR13 include hosting of their secondment. He will contribute 25% of his time to the project, including providing and organizing local and network-wide research training to the ESRs as planned, and administrative work defined in section 3.2.1. He will also provide lecture in Training School 1. Senior Scientist Dr. Emmanuel Ackom (10% FTE) will be the main supervisor of ESR15 and will lecture in training course TC7 on UN sustainable development goals to the ESRs. He will also facilitate the ESRs in the project in the dissemination of the project results through high level climate meetings in UN, IRENA, and IEA. With over 15 years in energy policy, he has published in key journals including Nature Energy, Energy Policy, Renewable and Sustainable Energy Review, Energy for Sustainable Development, Energy and Environment Senior Scientist Dr. Per Sievert Nielsen (5% FTE) is expert on energy modelling and policy at DTU Management Engineering department. He has over 50 peer-reviewed papers and had supervised 3 PhD students. He will be co-supervisor of ESR15 in the project, where he will provide local research training to the ESR.
Key Research Facilities, Infrastructure and Equipment	Center for Electric Power and Energy runs a leading power system laboratory Powerlab.DK (www.powerlab.dk). In PowerLab there is one of the largest Real Time Digital Simulator installations in EU, which is capable of simulation of utility-scale power transmission grids. The lab has also an installation of a Utility-standard SCADA system for monitoring the operation of the various power amplifiers, distributed generators, loads for emulating the actual grids. UNEP DTU Partnership (http://www.unepdtu.org/) comprises two Centres: namely, Centre on Energy, Climate and Sustainable Development, and the Copenhagen Centre on Energy Efficiency (http://www.energyefficiencycentre.org/). Copenhagen Centre on Energy Efficiency is the Energy Efficiency Hub under the SEforALL initiative. All the facilities are fully accessible for the ESRs in the project.
Status of Research Premises	All research facilities and premises are owned and operated by DTU. The conditions of the facilities are normal. All the facilities are fully accessible for the ESRs in the project.
Previous Involvement in Research and Training Programmes	[1]. MEDOW, Multi-terminal DC grid for offshore wind, Marie Curie Initial Training Networks, under FP7-PEOPLE, 2013-2017.
Current Involvement in Research and Training Programmes	[1]. H.C. Ørsted Fellows Programme – co-funded by Marie Skłodowska Curie Actions (COFUNDfellowsDTU), 2017-2021; [2]. MSCA-ITN-ETN project, Fora, Fog Computing for Robotics and Industrial Automation, 2017-2021; [3]. MSCA-ITN-ETN project, Mummering, MUltiscale, Multimodal and Multidimensional imaging for EngineeRING , 2018-2022; [4]. MSCA-ITN-ETN project, InnoDC, Innovative tools for offshore wind and DC grids, 2017-2021
Submission of similar proposals under the same H2020-MSCA-ITN-2020 call	N/A

Relevant Publications and/or Research / Innovation Product

[1]. Broto,V., Stevens, L., Ackom, E.K., Tomei, J., Parikh, P., To, L.S., Kirshner, J., Mulugetta, Y. 2017. A research agenda for a people-centred approach to energy access in the urbanizing global south. Nature Energy, 2, 776–779.
[2]. Singh, R., Wang, X., Ackom, E.K., Reyes, J. (2014). Energy access realities in urban poor communities of developing countries: Assessment and Recommendations. Global Network of Energy for Sustainable Development (GNESD). Summary for Policy Makers, UNEP publication, 18 pages.
[3]. TB Rasmussen, GY Yang, AH Nielsen, ZY Dong, "Application of functional modeling for monitoring of WTG in a cyber-physical environment", IET-Cyber Physical Systems, DOI:10.1049/iet-cps.2017.0109. (Open Access)
[4]. JJ Hu, GY Yang, Y Xue, "Economic Assessment of Network-Constrained Transactive Control for Managing Flexible Demand in Distribution Systems", Energies, vol. 10, no. 5, 2017. DOI: 10.3390/en10050711. (Open Access)
[5]. JJ Hu, GY Yang, K. Kok, Y. Xue, Henrik W. Bindner, "Transactive Control: A Framework for Operating Power Systems Characterized by a High Penetration of Distributed Energy Resources", Journal of Modern Power Systems and Clean Energy, vol. 5, no. 3, pp. 451-464, May 2017. (Open Access. Best paper award.)

Beneficiary Legal Name: Universiteit Utrecht, B2	
General Description	Established in 1636, Utrecht University (UU) has evolved into a leading modern comprehensive research university with a growing international reputation. On the 2017 Shanghai Academic Ranking of World Universities, Utrecht University ranks first in the Netherlands, 14th in Europe and 47th in the world. UU has an annual turnover of over 750 million euro, 34% of which from external funding. UU has state-of-the art research facilities and excellent research training through graduate schools. In 2016 Utrecht University was ranked Global Nr. 1 by Times Higher Education on the list of environmental science research with the greatest impact between 2011 and 2015. The Faculty of Geosciences offers research and education concerning the geosphere, biosphere, atmosphere and anthroposphere. With a population of 2,600 students (BSc and MSc) and 600 staff, the Faculty is a strong organisation. Under the faculty, the Copernicus Institute of Sustainable Development is ranked the "best research-institute in the Netherlands in the field of environmental and sustainability sciences". The research focus of the institute is in investigating and developing processes and opportunities for innovative change towards sustainability. The institute has a very good international reputation and its leaders are active at a high-quality level in international Organisations, NGOs, national bodies. UU has made sustainability one of its academic spearheads and the Copernicus Institute has a key role in realizing UU's ambitions in this respect. One of the institute's largest research groups is the Energy & Resources group, staffed by 5 full professors, working in various aspects of the energy and materials transition to a low-carbon society. The Integration of Intermittent Renewable Energy Chair focuses on modelling, design, and optimization of nearly 100% renewable energy systems, with special emphasis on the application of digital solutions. In this area, the chair collaborates with the Software Technology chair from the Department of Information and Computing Sciences, Faculty of Science. The chair brings in expertise on energy-efficient, high-performance computing on multi-core CPU and GPU architectures.
Role and Commitment of key persons (including supervisors)	Prof. Madeleine Gibescu (12% FTE) will be the main supervisor for ESR1 and academic supervisor for ESR2, as organize/lecture in training courses in training school 1 and 3. She will ensure the planned research training is provided to the hosted ESRs throughout the project. She will also be WP1 leader and member in the Executive Committee of the project, helping the Project Coordinator in research training and output monitoring as defined in section 3.2.2. She has graduated supervised 10 PhDs and is currently working with 54 PhDs and 2 post-doctoral researchers. During her previous employment at Eindhoven University of Technology, Prof. Gibescu has been co-supervising one PhD student from the MSCA-ITN-ETN project, MEAN4SG, 2016-2020. Prof. Gabrielle Keller (5% FTE) will be local co-supervisor of ESR1 and provide expertise in the area of parallelization of computationally intensive algorithms related to grid restoration. She will also contribute to training school 4. She is an expert in the development of programming languages for high-performance computing. Prior to her joining Utrecht University per Sept. 1, 2018, she was the founder of the Programming Language and Systems Group at the University of New South Wales in Australia, where she had over 15 years' experience of PhD supervision.
Key Research Facilities, Infrastructure and Equipment	Utrecht University (UU) has state-of-the-art research facilities and excellent research training through graduate schools. Each year, some 300 new PhD candidates begin their research. Around 25% of our PhD candidates come from outside the Netherlands. PhD students at UU are part of the research team. They have their own workspace, access to excellent ICT infrastructure, excellent lab equipment as well as to the outstanding library and online journals. The Complexity Lab Utrecht (CLUe) aims to reduce the barriers among scientists by providing easy access to powerful computational and data visualization software. The UU supports all new employees (including PhD students) with HR-issues, but also with such practical issues as housing and immigration.
Independent Research premises	Yes, the university has its own premises, i.e. as described above.
Previous Involvement in Research and Training Programmes	In the EU Research FP7 scheme, Utrecht University was awarded 265 grants of which 91 within the "People" work programme: 63MCA IF and 28 for MCA ITN.
Current Involvement in Research and Training Programmes	The Copernicus Institute for Sustainable Development is currently participating in the MSCA-ITN-ETN project EcoRisk2050, 2018-2022. In the Horizon 2020 funding scheme, Utrecht University is involved in more than 152 projects of which 64 projects related to the MSCA programme: 34 individual fellowships and 26 ITNs (of which 4 as coordinator), plus 4 RISE actions. To date, the UU totals 62 prestigious ERC laureates.
Submission of similar proposals under the same H2020-MSCA-ITN-2020 call	No

Relevant Publications and/or Research / Innovation Product

[1]. RM González, FD Wattjes, M Gibescu, W Vermeiden et al., "Applied Internet of Things Architecture to Unlock the Value of Smart Microgrids" - IEEE Internet of Things Journal, 2018.
[2]. DC Mocanu, E Mocanu, P Stone, PH Nguyen, M Gibescu, A Liotta, "Scalable training of artificial neural networks with adaptive sparse connectivity inspired by network science", Nature Communications, 9 (1), p. 2383, 2018.
[3]. E Mocanu, DC Mocanu, PH Nguyen, A Liotta, ME Webber, M Gibescu, JG Slootweg, "On-line building energy optimization using deep reinforcement learning", IEEE Transactions on Smart Grid, 2018.
[4]. RS Singh, S Cobben, M Gibescu, H van den Bron et al., "Medium Voltage Line Parameter Estimation Using Synchrophasor Data: A Step Towards Dynamic Line Rating", pp. 1-5, IEEE Power & Energy Society General Meeting, 2018.
[5]. TL McDonell, MMT Chakravarty, G Keller, B Lippmeier, "Optimising purely functional GPU programs" - ACM SIGPLAN Notices, 2013.

Beneficiary Legal Name: Électricité de France, B3	
General Description	The EDF Group is the world's leading electricity company and it is particularly well established in the European Union. Its business covers, through its different affiliate companies, all electricity-based activities from generation to retail, including energy transmission and distribution, trading activities and energy services. The EDF Group also has activities in the design and operation of heat networks, as well as in the gas business, e.g. in France (more than 1M residential customers) and in Italy (22% of the Italian gas demand). The EDF group is present in 22 countries, where it supplies 37.6 million customers. More than 160 000 employees contribute to the activity (619TWh), generating consolidated sales of 75G€. In the European Union, EDF is the first producer of renewable energy. In 2015, EDF Group's CO2 emission fell below the 100g/kWh mark. Before 2030, EDF plans to double the Group's net installed power in the field of renewable energies, thus increasing from 28 GW today to over 50 GW. EDF R&D employs 2200 people (1/3 women) mainly located in the European Union including 1200 scientists and 220 PhD students. A growing share of EDF R&D's research activities is led through partnerships with industrials and academic entities worldwide. Regarding the integration of high share of renewables, EDF R&D aims at identifying both technology and market design solutions to meet the evolving electricity system needs.
Role and Commitment of key persons (including supervisors)	Dr Bhargav Swaminathan (10%FTE) will be the main supervisor for ESR2. He will ensure ESR2 have access to the necessary research facilities and participate in the internal and external activities regarding CIM and IEC61850 development and harmonization. Dr Jose Sanchez Torres (10% FTE) will be the industrial supervisor of ESR1 and host the secondment ESR3 and 15. He is a member of several international working groups (CIGRE, CIRED) related with the resilience in the Distribution Networks, and contributes to a number of projects that relates with the interdependencies between power systems and communication networks. Eric Lambert (5% FTE). He is a senior scientist in EDF, an expert in IEC (who is the leader of 61968-13 of WG14), and member of IEEE. He is the coordinator of SUNRISE project and was the administrator of Smart Energy Group of EDF until 2015. He is also responsible for iTECH courses in EDF related with the use of standards in smart grids and invited professor in Centrale Supélec. He will assist the preparation of training courses in Training School 3.
Key Research Facilities, Infrastructure and Equipment	The participant in the project is EDF Research and Development (EDF R&D), a business unit of EDF SA. EDF SA main activities cover electricity generation, supply and trading. In particular EDF SA is a provider of flexibility services to the electricity system through its portfolio of generation assets, storage facilities and aggregation of decentralized resources, such as demand response of its customer base. Department MIRE has several platforms, including INTEROP platform which main objective is to develop and model new information system architectures, including data analytics tools for electric networks, standardization of exchanges, data models, pivot format and interoperability. As well, an Advance Network Automation platform, which is used to test and validate the interoperability between equipment and applications for supervisory control, monitoring and telecommunications to be deployed within the electrical grid.
Independent Research premises	All research facilities and premises are owned and operated by EDF. The conditions of the facilities are normal. The facilities are open to credited ESRs.
Previous Involvement in Research and Training Programmes	[1]. "Nice Grid : Un quartier solaire intelligent" [2]. "Grid4EU" FP7 project, #268206, 52.26 MEUR (25.55 MEUR EU financent)
Current Involvement in Research and Training Programmes	[1]. "Pan-European system with an efficient coordinated use of flexibilities for the integration of a large share of RES" EU-SysFlex, H2020 project, #773505, 20 MEUR [2]. "Coordination of Transmission and Distribution data eXchanges for renewables integration in the European marketplace through Advanced, Scalable and Secure ICT Systems and Tools", TDX-ASSIST, H2020 project, #774500, 4.18 MEUR [3]. "Bringing flexibility provided by multi energy carrier integration to a new MAGNITUDE", MAGNITUDE, H2020 project, #774309, 3.99 MEUR [4]. "PV Module life time forecast and evaluation", SOLAR-TRAIN, H2020 project, #721452 (Financing 14 Marie Sklodowska Curie Fellowships) [5]. "Synergistic Approach of Multi-Energy Models for an European Optimal Energy System Management Tool" PLAN4RES, H2020 project, #773897, 3.88 MEUR.
Submission of similar proposals under the same H2020-MSCA-ITN-2020 call	No.

Relevant Publications and/or Research / Innovation Product

[1]. Hugo Morais, et. al "Agreed models, Use Case list, and Use Case description in UML", TDX-ASSIST European Project Report D1.2, 2018
[2]. Tiago Soares, Ricardo Bessa, Pierre Pinson, Hugo Morais, "Active Distribution Grid Management based on Robust AC Optimal Power Flow", IEEE Transactions on Smart Grid, vol. 10, no. 2, 2017
[3]. Junjie Hu, Hugo Morais, Morten Lind, Henrik W. Bindner, Jacob Østergaard, "Multi-agent based modeling for electric vehicle integration in a distribution network operation", Electric Power Systems Research, Volume 136, pp. 341-351, July 2016
[4]. Hugo Morais, Tiago Sousa, João Soares, Pedro Faria, and Zita Vale, "Distributed Energy Resources Management using Plug-in Hybrid Electric Vehicles as a Fuel-Shifting Demand Response Resource", Energy Conversion and Management, Vol. 97, pp. 78-93, June 2015
[5]. Hugo Morais, Peter Kadar, Pedro Faria, Zita Vale, Hussein Khodr, "Optimal Scheduling of a Renewable micro-grid in an Isolated Load area using Mixed-Integer Linear Programming", Renewable Energy, Vol. 35, Issue 1. pp. 151-156, Elsevier, January 2010

Beneficiary Legal Name: Università del Salento (UOS), B4	
General Description	The Università del Salento is a young dynamic university, keen to expand and to prove itself at a national and international level. Since 1955 the Università del Salento has had the aim of promoting knowledge, skill and merit and has offered a large range of educational opportunities. From law to science, economics to engineering, humanities to media studies, the university provides academic pathways to a range of professions as well as post-graduate and specialist courses tailor-made to meet the needs of the workplace. There are six Faculties - hubs for the eight Departments - providing services and information for students, as well as thirty-three Research Centres throughout the Salento area. The Università del Salento has grown rapidly in recent years, consolidating and reinforcing its role as the keystone of the local cultural and social system. It also has a PhD. School and Post-graduate schools for Cultural Heritage and for the Legal Professions. The prestigious ISUFI Grandes écoles school offers high-level undergraduate and postgraduate courses for scholarship students to promote excellence.
Role and Commitment of key persons (including supervisors)	**Prof. Massimo Cafaro** (10% FTE): the main supervisor of ESR4, cosupervisor of ESR9, WP2 leader. He will organize/lecture training courses for SC10 and SC11 and host secondment of ESR5. Massimo Cafaro is Associate Professor at the Department of Innovation Engineering of the University of Salento. His research covers Parallel and Distributed Computing, Cloud and Grid Computing, Data Mining and Big Data. He received a Laurea degree (MSc) in Computer Science from the University of Salerno and a PhD in Computer Science from the University of Bari. He is a Senior Member of IEEE and of IEEE Computer Society, Senior Member of the ACM, Vice Chair of Regional Centers and Coordinator of the Technical Area on Data Intensive Computing for the IEEE Technical Committee on Scalable Computing. He serves as an Associate Editor for IEEE Access. He is the author of more than 100 refereed papers on parallel, distributed and cloud/grid computing. He holds a patent on distributed database technologies. He focuses his research on Parallel, Distributed and Grid/Cloud/P2P Computing. In particular, he is interested to the design and analysis of sequential, parallel and distributed algorithms in the context of data mining, security and cryptography, resource, data and information management in Grid/Cloud/P2P environments. **Dr Italo Epicoco** (0.1 FTE): acts as local co-supervisor of ESR4. He will assist the preparation of training course SC10 and SC11 in training school 4. Italo Epicco received the PhD degree in computational engineering from the University of Lecce, Italy. He is currently an Assistant Professor at the University of Salento, Lecce, Italy. He is also an Affiliate Researcher at the Euro-Mediterranean Center on Climate Change (CMCC). He has authored over 40 papers in refereed books, journal, and conference proceedings. His research interests include high performance, distributed, grid, and cloud computing, with particular emphasis on parallel data mining. During his past research activities, he addressed issues related to the optimization of numerical methods for solving PDEs applied to Earth system models and to fluid dynamics models on high-end parallel architectures, including heterogeneous architectures made of accelerators (NVIDIA GPU and Intel MIC). Relevant activities also included optimized management of a huge amount of data produced by the climate models.
Key Research Facilities, Infrastructure and Equipment	The Department of Engineering for Innovation has hosted over 150 PhD students and post-doctoral researchers. Students have access to state-of-the-art computational facilities through an agreement with CINECA (www.cineca.it), including the MARCONI machine (NeXtScale cluster): **Model:** Lenovo NeXtScale **Architecture:** Intel OmniPath Cluster **Nodes:** 1.512 **Processors:** 2 x 18-cores Intel Xeon E5-2697 v4 (Broadwell) at 2.30 GHz **Cores:** 36 cores/node, 54.432 cores in total **RAM:** 128 GB/node, 3.5 GB/core **Internal Network:** Intel OmniPath **Disk Space:** 17PB (raw) of local storage **Peak Performance:** 13 PFlop/s
Status of Research Premises	All the research premises are fully owned and independent.
Previous and Current Involvement in Research and Training Programmes	The University of Salento was involved in many H2020, Interreg, FP7 and FP5 projects. In particular, prof. Massimo Cafaro was involved in the GRIDLAB, EESI II, EGEE, INTERSTORE, and TREASURE (ongoing, ITN) projects.
Submission of similar proposals under the same H2020-MSCA-ITN-2020 call	No.

Relevant Publications and/or Research / Innovation Product

[1] M. Cafaro, I. Epicoco, M. Pulimeno, “Mining frequent items in unstructured P2P networks”, to appear in Future Generation Computer Systems, Elsevier
[2] M.Cafaro, P. Pelle’, “Space-efficient Verifiable Secret Sharing Using Polynomial Interpolation”, IEEE Transactions on Cloud Computing, IEEE, vol. 6, no. 2, pp. 453-463, April-June 2018, DOI 10.1109/TCC.2015.2396072, ISSN: 2168-7161, http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7018923&isnumber=8372844
[3] M. Cafaro, M. Pulimeno, I. Epicoco, "Parallel mining of time-faded heavy hitters", Expert Systems With Applications, Elsevier, Volume 96, 2018, Pages 115-128, ISSN: 0957-4174, DOI: 10.1016/j.eswa.2017.11.021
[4] M. Cafaro, I. Epicoco, S. Fiore, D. Lezzi, S. Mocavero, G. Aloisio, “Near Real-Time Parallel Processing and Advanced Data Management of SAR Images in Grid Environments”, Journal of Real-Time Image Processing, Special issue on architectures and techniques for real-time processing of remotely sensed images, Volume 4, Number 3, 2009, pp. 219-227, Springer-Verlag, DOI 10.1007/s11554-009-0119-z, Print ISSN 1861-8200, Online ISSN 1861-8219
[5] Y. Yang, O. F. Rana, D.W. Walker, R. Williams, C. Georgousopoulos, M. Cafaro, G. Aloisio, "An agent infrastructure for on-demand processing of remote-sensing archives", Int. J. on Digital Libraries Volume 5, Issue 2, pp 120-132 (2005), Springer-Verlag, DOI 10.1007/s00799-003-0054-8, Print ISSN 1432-5012, Online ISSN 1432-1300

Beneficiary Legal Name: Technische Universiteit Delft, B5	
General Description	Delft University of Technology (TU Delft) is the oldest, largest and most comprehensive technical university in the Netherlands. The University was awarded HR Excellence in Research award by the European Commission in 2013. TU Delft ranks 50th on the 2020 QS World University Rankings (17th on the sub list for Engineering and Technology), and 67th on the Times Higher Education World University Rankings list. The Faculty of Electrical Engineering, Mathematics and Computer Science (EEMCS) has departments for Applied Mathematics, Intelligent Systems, Microelectronics, Software & Computer Technology, and Electrical Sustainable Energy. The latter focuses on sustainable generation, transmission, distribution, and use of electric energy.
Role and Commitment of key persons (including supervisors)	Prof. Peter Palensky (0.1 FTE), Chair of the Intelligent Electrical Power Grids (IEPG) research group, will take the main responsibility for ESR3 and ESR5, and host secondment of ESR4. He will lecture in training course SC3 and co-organize SC11. He has supervised 14 PhD students and currently supervises 9. He is Principal Investigator at the Amsterdam Metropolitan Solutions (AMS) Institute, Editor in Chief of the IEEE Industrial Electronics Magazine, Associate Editor for several ISI journals (e.g. IEEE Tr. Ind. Informatics) and member of the IEEE IES publication board. He is an IEEE IES Adcom Member-at-large, Scientific Director of TU Delft's PowerWeb Institute, and Chair of the Academic Advisory Board of European Network for Cyber Security. Dr. Alexandru Stefanov (0.1 FTE), Assistant Professor in the IEPG group, will co-supervise ESR3 and will lecture in course SC8. He conducts research in cyber security and resilience of cyber-physical smart grids. He is currently co-supervising 2 PhD students on cyber security for power systems. He holds the registered professional title of Chartered Engineer from the Institution of Engineers of Ireland. He is the secretary of the Working Group on Cyber Security in Power Systems in the IEEE PES Analytic Methods for Power Systems Committee. He has previously worked as Senior Engineer at NovoGrid Ltd. in Dublin, Ireland. He was responsible for the resilience of NovoGrid's cyber-physical systems that include remote terminal units, communication systems, databases, and applications. Before joining NovoGrid, he worked as Professional Engineer at ESB Networks; the distribution system operator in Ireland. He managed the power quality monitoring infrastructure in the Irish distribution system and its cyber-physical system resiliency and cyber security. Dr Simon Tindemans (0.1 FTE), Assistant Professor in the IEPG group, will co-supervise ESR4&5, and will co-organize and lecture for training courses SC11, TC6 and TC8. He was previously a Marie Curie Intra-European Fellow (personal grant) and Research Fellow at Imperial College London. His research focuses on robust statistical methods for modelling and control of electrical power grids, and applications of machine learning. He is an active member of the IEEE Risk Reliability and Probability Applications sub-committee, including as a member of the '859 standard working group and as secretary of the PACME working group. He has supervised 5 PhD students to successful attainment of their PhD degrees.
Key Research Facilities, Infrastructure and Equipment	TU Delft owns a state-of-the-art, large Real-Time Digital Simulator (RTDS) for electrical grids. The Real-Time Digital Simulator is the most widely accepted and used simulation tool for hardware-in-the-loop tests, and it enables highly accurate interactive simulations of the power system. This facility is hosted by the IEPG group, and will be used by ESR3 as a testbed for intrusion detection of cyber-attacks on the electricity grid, and by ESR5 to generate synthetic for test cases. The RTDS facility is among the largest in Europe, with 8-racks hosting 28 PB5 computing cards (each PB5 able to handle 90 single phase nodes) and 2 NovaCor units. From Summer 2020, the RTDS will become part of TU Delft's Electrical Sustainable Power Lab. This unique facility will enable research on the system integration of new technologies and components, by including whole-system simulation, microgrids, high-voltage equipment and materials research in an integrated lab setting. Training for the TUD-based ESRs is overseen by the Graduate School of TU Delft's Faculty of EEMCS. The ESRs will also take part in activities organized by the TU Delft PowerWeb Institute, and the (national) 4TU Centre for Resilience Engineering (ESR3).
Status of Research Premises	All the research premises are fully owned and independent.
Previous Involvement in Research and Training Programmes	TU Delft has been involved in more than 60 H2020 projects, of which more than 20 as coordinator. In recent years, the IEPG group has participated in: UMBRELLA (FP7 ENERGY.2011.7.2-1), GridSens (JRP NUMBER: ENG63) MIGRATE (691800; H2020-LCE-06-2015), INCITE (675318; H2020-MSCA-ITN-2015)
Current Involvement in Research and Training Programmes	The IEPG group at TU Delft is currently involved in the following projects: ERIGrid (654113; H2020-INFRAIA-2014-2015), EASY-RES (764090; H2020-LCE-2017-RES-RIA) ERIGrid 2.0 (870620, H2020-INFRAIA-2019-1), TradeRES (864276, H2020-LC-SC3-ES-6-2019)
Submission of similar proposals under the same H2020-MSCA-ITN-2020 call	N/A

Relevant Publications and/or Research / Innovation Product

[1]. P. Palensky, A. Van Der Meer, C.D. Lopez, A. Joseph, K. Pan, "Cosimulation of Intelligent Power Systems: Fundamentals, Software Architecture, Numerics, and Coupling", IEEE Industrial Electronics Magazine, vol. 11, no. 1, pp. 34-50, Mar 2017.

[2]. A. Stefanov, C.-C. Liu, K. Liyanage, "ICT Modeling for Cosimulation of Integrated Cyberpower Systems," in A.-S. K. Pathan (Editor): "Securing cyber-physical systems," CRC Press, Taylor & Francis Group, Oct 2015.

[3]. K. Pan, A.H. Teixeira, M. Cvetkovic, P. Palensky, "Cyber Risk Analysis of Combined Data Attacks Against Power System State Estimation", IEEE Transactions on Smart Grids, vol. 10, no. 5, pp. 3044-3056, May 2019.

[4]. J. Cremer, I. Konstantelos, S.H. Tindemans, G. Strbac, "Data driven Power System Operation: Exploring the balance between Cost and Risk", IEEE Transactions on Power Systems, vol. 34, no. 1, pp. 791-801, Jan 2019.

[5]. I. Konstantelos, M. Sun, S.H. Tindemans, S. Issad, P. Panciatici, G. Strbac, "Using Vine Copulas to Generate Representative System States for Machine Learning", IEEE Transactions on Power Systems, vol. 34, no. 1, pp. 225-235, Jan 2019.

Beneficiary Legal Name: Norges Teknisk-Naturvitenskapelige Universitet (NTNU), B6	
General Description	The Norwegian University of Science and Technology (NTNU) is Norway's university for higher education in technology and the natural sciences. NTNU has 7 faculties and 52 departments and more than 100 laboratories, many of which are national resources used in research and teaching. NTNU has a consolidated leading international position in the fields of Offshore Renewable Energy and Smart Grids. Its staff is actively involved in the supervision of PhD students and Post Docs for the prestigious Norwegian projects NOWITECH and PETROSENTER, as well as for BRU21 – Research and Innovation Program on Digital and Automation Solutions for Oil and Gas Industry – a program with up to 40 multidisciplinary PhD/PostDoc projects funded by industry and NTNU. NTNU has leading roles in several research projects funded by the European Commission, the Norwegian Research Council as well as by industrial partners. Moreover, NTNU has allocated strategic resources to a smart grid "lighthouse project" in 2010 by granting 11 PhDs and Post Docs spread across different departments at the Faculty of Information Technology, Mathematics and Electrical Engineering.
Role and Commitment of key persons (including supervisors)	Prof. Elisabetta Tedeschi (10% FTE, supervisor of ESR 7) is Full Professor in offshore grids at NTNU since 2014, with a core competence in the design and control of energy conversion and transmission systems. She has led and/or contributed to more than 15 national and international projects. She is super-vising 8 PhD and Post-Doc researchers, and she was the main supervisor of more than 30 MSc Theses. She was international lecturer within the Master in offshore renewable energy at the University of the Basque Country and in the FP7-Wavetrain2 project. She is author or co-author of 2 book chapters and more than 20 journals and 80 conference papers. She will be main supervisor of ESR7 and cosupervisor of ESR13. She will lead SC4 and contribute to WS3, TC3 and TC4. Prof. Alexey Pavlov (10% FTE, supervisor of ESR 6) is Full Professor in Petroleum Cybernetics at NTNU since 2017 with core competence in digital and automation technologies for petroleum industry. He is leading NTNU BRU21 program on digital and automation solutions for O&G industry with 30 PhD/PostDoc projects (www.ntnu.edu/bru21). He has (co-) authored a book, 26 journal publications, 60 refereed conference publications, 4 book chapters, 3 patents and 3 patent applications (pending). He received IEEE Control Systems Technology Award (2015) and IFAC World Congress Best Application Paper Prize (2011). He will be main supervisor of ESR6, lead SC5, and contribute to TC3 and TC4. Prof. Damiano Varagnolo (10% FTE, co-supervisor of ESR 6,8) is Full Professor at the Department of Engineering Cybernetics at NTNU, with competences in system identification and automatic control for distributed / large scale systems. He has led and/or contributed to more than 15 national or international research projects, is currently supervising 6 PhD students, has co-authored 2 book chapters, more than 15 journals and 55 conference articles on data analysis & systems modelling. He will be co-supervisor of ESR 6 and ESR8, lead SC6, and provide support to TC3 and TC4. Prof. Verena Hagspiel is a Professor of Investment and Finance in the Department of Industrial Economics and Technology Management at the Norwegian University of Science and Technology. Her primary fields of interest are quantitative finance, industrial organization, microeconomics and operations management. Specifically she applies financial and operational methods for analyzing investment decisions under uncertainty. She is interested in how dynamics and uncertainty affect the firm's investment and innovation behavior. She will host secondment of ESR14 and 15.
Key Research Facilities, Infrastructure and Equipment	NTNU's National Smart Grid Laboratory (NSGL) is a flexible infrastructure where passive electrical components, electrical machines and power electronic converters up to the 70 kVA power range, with associated control and protection systems, can be tested under controlled conditions. The NSGL is a system-oriented lab. providing state-of-the-art infra-structure for R&D, demonstration, verification, and testing over a wide range of smart grid use cases and is used by researchers in national and international research projects, test and verification projects, in industry projects and by PhD candidates, Post Docs, visiting researchers and master students.
Status of Research Premises	NTNU and SINTEF Energy jointly operate the National Smart Grid Laboratory, which is funded by the Research Council of Norway and NTNU.
Previous Involvement in Research and Training Programmes	Wavetrain2: Initial Training Network for Wave Energy Research Professionals, (3.6 MEUR) funding: EU, FP7-PEOPLE (ITN) Sea2Grid: Grid connection of Wave Energy Converters: investigation on storage requirements and solutions, (166 kEUR), funding: EU, FP7- PEOPLE (IEF)
Current Involvement in Research and Training Programmes	BRU21: Digital and Automation Solutions for Oil and Gas Industry (135MNOK/13MEUR), Industry/NTNU funded program (www.ntnu.edu/bru21) LowEmission: Research Centre for a Low-Emission Petroleum Industry on the Norwegian Continental Shelf (350 MNOK/35 MEUR) https://www.sintef.no/en/projects/lowemission-research-centre/ International Master in Renewable Energy in the Marine Environment, co-funded by the Erasmus+ programme of the European Union https://www.master-rem.eu/
Submission of similar proposals under the same H2020-MSCA-ITN-2020 call	AMORES: Accelerating econoMic and grid-friendly Offshore Renewable Energy Systems.

[1]. Tedeschi, Elisabetta; Taffese, Abel A.: 'Electrical power transmission and grid integration' (Energy Engineering, 2019), 'Renewable Energy from the Oceans: From wave, tidal and gradient systems to offshore wind and solar', Chap. 8, pp. 321-343,
[2]. Sanchez, Santiago; Tedeschi, Elisabetta; Silva, Jesus; Jafar, Muhammad; Marichalar, Alexandra: 'Smart load management of water injection systems in offshore oil and gas platforms integrating wind power', IET Renewable Power Generation, 2017, 11, (9), p. 1153-1162, DOI: 10.1049/iet-rpg.2016.0989
[3]. G. Pillonetto, L. Schenato, D. Varagnolo, Distributed multi-agent Gaussian regression via finite-dimensional approximations. IEEE Transactions on Pattern Analysis and Machine Intelligence, pp.2098-2111, 41(9), 2019
[4]. A. Pavlov, M. Haring, K. Fjalestad Practical extremum-seeking control for gas-lifted oil production, IEEE 56th Conference on Decision and Control (CDC), 2017

Beneficiary Legal Name: Imperial College of Science, Technology and Medicine (ICL), B7	
General Description	Imperial College is a research-intensive institution with a global focus that is consistently ranked among the top ten universities worldwide. The Department of Electrical and Electronic Engineering has about 50 research-active academic staff with strong expertise in power system, control, communications, and signal processing, robotics and information systems. In the 2013 Research Excellence Framework, it was the highest-ranked Electrical & Electronic engineering department in the UK. The department has long-standing collaborative links with industry, including ABB, GE, National Grids, and BAE Systems.
Role and Commitment of key persons (including supervisors)	Bikash Pal is a Professor of Power Systems at the Control and Power Group within the Electrical and Electronic Engineering Department of Imperial College London (http://www3.imperial.ac.uk/people/b.pal). He is committing **10% FTE** as the main supervisor for ESR8 and ESR10, where he will provide academic guidance and research training to the ESRs in the area of system stability assessment and numerical algorithms. He will organize/lecture in training courses SC2 and TC2 and TC8, lead the training coordination committee, and perform the role of ESR training manager. With support from the EPSRC SUPERGEN programme and local distribution network operator (DNO) with his students, he has delivered strong research activity in power transmission control, state estimation, cyber security in energy network control and computation, and integration of solar energy to power network [1-3]. He has received IET best journal paper prize [4] and IEEE Transactions on Power Systems in [5] His research group has received 2016 President Award for Outstanding Research. Prof Pal has graduated 20 PhDs and published about 100 technical papers in IEEE Transactions and IET journals. He has co-authored three books and two award winning IEEE Task Force/Working Group reports. He chairs an IEEE Working Group in state estimation for power distribution applications. He was Editor-in-Chief of IEEE Transactions on Sustainable Energy and Series Editor of Elsevier series on Sustainable Energies and Fellow of IEEE for his contribution to power system stability and control. He was Mercator Professor sponsored by German Research Foundation (DFG) at University of Duisburg-Essen in 2011. He holds a Visiting Professorship at Tsinghua University, China, and Otto Mønsted Visiting Professorship to Technical University of Denmark.
Key Research Facilities, Infrastructure and Equipment	The department hosts over 150 doctoral researchers and about 50 postdoctoral researchers. Researchers have access to the state-of-the art computational facilities, Energy Integration Lab, Energy Futures Lab and Digital Energy Demonstration lab.
Status of Research Premises	Yes. All research facilities are owned and operated by Imperial College.
Previous Involvement in Research and Training Programmes	PV Control and Integration (PVCI): European Commission: H2020-MSCA-IF-2016 Marie Curie programme: £ 158k 2017-2019; Ref 746638 Stability and Control of Power Networks with Energy Storage (STABLE-NET) UK-China Grid Scale Storage, EPSRC, UK, £1.1M, (01/07/2014- 30/06/2016. Prof. Pal led this three-university consortium. Reliable and Efficient System for Community Energy Solution- RESCUES, UK-India Smart Grid programme, EPSRC, UK; (01/01/2014-31/12/2016) (£953k); PI of the consortium with share of (£315k). Advanced Communication and Control for the Prevention of Blackouts (ACCEPT), UK-India Smart Grid programme, (01/01/2014-31/12/2016), EPSRC, UK; (£310k); PI from Imperial. PV2025 - Potential Costs and Benefits of Photovoltaics for UK-Infrastructure and Society, (01/07/2013-31/03/2016), EPSRC, UK, (£308k); PI from Imperial. Stability and Performance of Photovoltaics (STAPP), Funded by EPSRC under UK-India Solar Energy programme (EP/H040331/1), Dr Pal as Co-I with a share of £571K (01/1/2011-31/12/2013) Modelling and control of AC-DC system with significant generation from wind, top up funding National Grid, UK, P33528 (£45K),01/10/2010-30/09/2013 REAL-SMART: Using real-time measurements for monitoring and management of power transmission dynamics for the Smart Grid, CEC: FP7-PEOPLE-2009-IAPP programme. £178K,01/10/2010-30/09/2014. Grant Ref 251304
Current Involvement in Research and Training Programmes	WinGrid: European Commission: H2020-MSCA-ITN-2019 €606k, 2019-2023: Ref 861398 Estimation in PV dominated power network for stability and control, EESC P78479, EPSRC, UK, £100k, 2019-2020. A Novel Hybrid Microgrid Control Framework Including Multi-Mode Large Scale EVs Integration, TGOOD, Hong Kong, £500k, 2018-2022. Joint UK-India Clean Energy Centre (JUICE): EP/P003605/1: £5M, 2016-2020. Prof leads Imperial on this multi-university programme with Imperial's share of £1M.
Submission of similar proposals under the same H2020-MSCA-ITN-2020 call	I am part of another ITN consortium under this call but the topic is totally different.

Relevant Publications and/or Research / Innovation Product

[1]. R. Singh, B. C. Pal and R. B. Vinter, "Measurement Placement in Distribution System State Estimation," in IEEE Transactions on Power Systems, vol. 24, no. 2, pp. 668-675, May 2009.
[2]. A. Majumdar and B. C. Pal, "Bad Data Detection in the Context of Leverage Point Attacks in Modern Power Networks," in IEEE Transactions on Smart Grid, vol. PP, no. 99, pp. 1-1, 2016.
[3]. Majumdar, Y.P. Agalgoankar, B.C. Pal and R. Gottschalg, "Centralized Volt-Var Optimization Strategy Considering Malicious Attack on Distributed Energy Resources Control," IEEE Transactions on Sustainable Energy, vol. PP, no. 99, 2017,
[4]. B. C. Pal and F. Mei, "On the modeling Adequacy of the DFIG for Small Signal Stability Studies in Power Systems," IET Renewable Power Generations, vol. 2, no. 3, pp. 181-190, September 2008, IET RPG best journal paper award in 2008.
[5]. E. Barocio, B. C. Pal, N. F. Thornhill and A. R. Messina, "A Dynamic Mode Decomposition Framework for Global Power System Oscillation Analysis," IEEE Transactions on Power Systems, vol. 30, no. 6, pp. 2902-2912, Nov. 2015.

Beneficiary Legal Name: Dansk Energi (DE), B8	
General description	Dansk Energi (Danish Energy, The Danish Energy Association) is an association managed and financed by its members, mainly the electricity distribution system operators (DSOs) of Denmark. It works to secure for them the most favourable conditions for operating distribution grids to support competition and development of market products, in order to ensure development, growth, and well-being in Denmark. Dansk Energi's Department of Grid Technology performs research and development for the benefit of all Danish DSOs. The department disseminates best-practices and software tools to the industry and regularly gathers feedback from the industry about topics where more research is needed.
Role and Commitment of key persons (including supervisors)	Philip J. Douglass (10% FTE), PhD Electric power engineering, an expert in power systems analysis. He will be the main supervisor for ESR9 by providing research training and day-to-day supervision of the ESR. He will also be the cosupervisor and host secondment of ESR4, and lead TC5. Jens Zoëga Hansen (5% FTE), M. Sc., Electric power engineering. He will assist the main supervisor in providing technical knowledge from the field to the ESR. He is the leading Danish expert in the analysis of component lifetimes and has been responsible for publishing numerous technical reports covering methods and results of data analysis of historical fault data. Louise Carina Jensen (5% FTE), M. Sc., Electric power engineering, an expert in data collection and liaison to Danish DSOs. She will assist the main supervisor in providing technical knowledge from the field to the ESR. She is responsible for coordinating the collecting of fault data with Danish DSOs. She is currently involved in a project to automate the collection of fault data and increase the quantity and quality of data available for analysis.
Key Research Facilities, Infrastructure and Equipment	DE has a fleet of measurement devices that are installed at critical nodes in Danish distribution systems, but our primary source of data is our members who report their findings directly to DE. Previously we have used our contacts to Danish DSOs to collect comprehensive data on component failures and have used this data to provide insight into component failure rates (see publications).
Status of Research Premises	DE has full ownership and control over all data and infrastructure related to the project.
Previous Involvement in Research and Training Programmes	DE has a long track record of participation national and international research projects, such as IDE4L, iPower and EcoGrid 2.0, that seek to gain new knowledge about efficient distribution grid planning and operation. In addition to publishing in peer-reviewed fora, Dansk Energi also has a central role in spreading this knowledge to our members, the Danish DSOs, through print publications, professional seminars, and conferences. No other organization offers Danish-language reports on the topics DE covers. From 2016 to 2019 DE hosted an industrial postdoc from Copenhagen University who investigated the role of sustainable biomass in the future Danish energy mix.
Current Involvement in Research and Training Programmes	DE is a secondment partner is the WinGrid ITN ("Wind farm - Grid interactions: exploration and development" - Project nr. 861398). This project started in 2019. DE is a full beneficiary in the HONOR ("Holistic flexibility market integration of cross sectoral energy sources" - RegSys18 91363) project, funded by ERA-NET. This project also started in 2019. Both of these projects include DE and DTU as partners, as part of international consortia.
Submission of similar proposals under the same H2020-MSCA-ITN-2020 call	N/A

Relevant Publications and/or Research / Innovation Product

[1]. "Statistical survey of security of supply in the Danish Power System 2007 – 2016", Technical Report 607, 2017 [in Danish].
[2]. "10-20 kV cable fault rate as a function of year of installation and age", Technical Report 605, 2017 [in Danish].
[3]. "Operating experience, diagnostics and maintenance of 30-60 kV PEX cable terminations", Technical Report 604, 2017 [in Danish].
[4]. "Preventing faults in 10-20 kV heavily loaded cable joins", Technical Report 601, 2016 [in Danish].
[5]. Jens Zoëga Hansen, Hans Jørgen Jørgensen, "Insulation condition of dry-cured XLPE cables measured over a period of 13 years", CIRED 2015 Lyon France, paper 0471, 2015.

Beneficiary Legal Name: AIT Austrian Institute of Technology GmbH (AIT), B9	
General Description	AIT Austrian Institute of Technology is Austria's largest non-university research organization with more than 1.300 employees. It takes a leading position in the Austrian innovation system and a corresponding key role in Europe. In the field of Smart Grids and DER integration AIT's main expertise is in low and medium voltage technology, power quality, safety and reliability analysis. The AIT Center for Energy has long term experience in active integration of distributed generation in power distribution networks and related applications. In the year 2018 213 PhDs were employed at AIT. In close cooperation with several Austrian und international universities, PhDs are an integral part of the research done at AIT.
Role and Commitment of key persons (including supervisors)	Thomas Strasser (up to 5% FTE) – Senior Scientist (Smart Grid Automation and Control) will be the main supervisor for ESR11. He received a master's and a PhD degree from Vienna University of Technology (VUT) and was awarded with the venia docendi (habiliation) in the field of automation from the same university. For several years, he has been a senior scientist in the Center for Energy of the AIT. His main responsibilities involve strategic development of smart grid automation and validation research projects and mentoring/supervising junior scientist and PhD candidates. He is active as a senior lecturer (Privatdozent) at VUT. Johannes Stöckl (up to 10% FTE)– Thematic Coordinator (Power Electronics and System Components) will be co-supervisor for ESR 11, 12. He received a master's and PhD degree in Physics from Vienna University of Technology. After his degree he was developer for power semiconductor technologies (IGBTs). He is with AIT for 7 years as a Senior Research Engineer with a focus on rapid prototyping and hardware-in-the-loop methods. The thematic coordination involves design and development as well as test and validation of grid tied components. He will be the cosupervisor for ESR10&12 and help to organize the training courses. Markus Makoschitz (up to 5% FTE) – Senior Scientist (Power Electronics). He received a master's and PhD degree in Electrical Engineering from Vienna University of Technology. He is active as a lecturer for power electronics at the Vienna University of Technology. His main focus is development of power electronics devices and control strategies as well as research for new materials such as wide-band-gap power semiconductors. He will support the co-supervision task of the ESR10&12.
Key Research Facilities, Infrastructure and Equipment	The AIT SmartEST laboratory infrastructure offers an environment for testing, verification and R&D in the field of large scale distributed energy system integration and Smart Grids applications. The infrastructure accommodates distributed energy resource (DER) components as inverters, storage systems, CHP units, voltage regulators/controllers, and other types of related electrical equipment. Powerful controllable AC and DC sources allow full-power testing capability up to 1 MVA (AC), including a high-performance PV Array (DC) Simulation and bidirectional source/sink for battery emulation. Additional equipment for simulating control and communication interfaces and the possibility of operating the equipment under defined (extreme) temperature/humidity conditions offer extended testing capabilities. Advanced power system experiment and verification methods available at the lab include real-time (RT) P-HIL simulation combining close-to-reality hardware system tests with the advantages of numerical simulation to allow for the integration of battery models into the laboratory analysis. By means of a controllable AC voltage source distribution network models can be coupled to the real components to develop, validate and evaluate control algorithms, system concepts and components for Smart Grid applications. The laboratory setup is supplemented with extensive infrastructure for simulation-based analysis and design of electrical systems. Apart from access to state-of-the-art simulation tools for electrical energy systems (and other related engineering domains) the SmartEST lab provides a high performance computer cluster for advanced simulation studies. This allows the study of integrated energy concepts at the system level, while at the same time giving the possibility to analyse such approaches with a high level of technical detail.
Status of Research Premises	All research premises are owned by AIT.
Previous Involvement in Research and Training Programmes	[1]. ELECTRA - European Liason on Electricity Committed Towards long-term Research Activity (coordinator – FP7-Energy) [2]. SPONGE – Smart Grids Rapid Prototyping for Grid Enhancement – (coordinator – Austrian national project) [3]. FACDS – Flexible AC Distribution Systems (Austrian national project) [4]. OpenNES - Open and Interoperable ICT Solution for Integration of ReNewablES (coordinator – Austrian national project) [5]. SPARKS – Smart Grid Protection Against Cyber Attacks (FP7 GA No. 608224) [6]. ERIGrid - European Research Infrastructure supporting Smart Grid Systems Technology Development, Validation and Roll Out – project (coordinator – H2020 GA No 654113) [7]. SmartNet - Smart TSO-DSO interaction schemes, market architectures and ICT Solutions for the integration of ancillary services from distributed energy resources (H2020 GA No. 691405)
Current Involvement in Research and Training Programmes	[1]. MESSE – Model-based Engineering and Validation Support for Cyber-Physical Energy Systems (Austrian national project) [2]. CLUE - Concepts, Demonstration and replication for Local User-friendly Energy Communities (coordinator ERA-Net SES ResSYS Joint Call 2018) [3]. ERIGrid2.0 - European Research Infrastructure supporting Smart Grid Systems Technology Development, Validation and Roll Out – project (coordinator – H2020)
Submission of similar proposals under the same H2020-MSCA-ITN-2020 call	N/A

Relevant Publications and/or Research / Innovation Product

[1]. T. Strasser, et al."An Integrated Research Infrastructure for Validating Cyber-Physical Energy Systems", 8th International Conference on Industrial Applications of Holonic and Multi-Agent Systems, Lyon, France, 29-30 Aug 2017.

[2]. "AIT Smart Grid Converter platform and digital C-HIL-twin" – open power electronics converter platform for controls development including communication protocols

[3]. M. Makoschitz: "Power Electronics for Renewable Energy Systems"; 7th International Conference on Power Science and Engineering, Vienna; 19.11.2018 - 21.11.2018.

[4]. J. Stöckl et al., "Pre-Evaluation of Grid Code Compliance for Power Electronics Inverter Systems in Low-Voltage Smart Grids," 2018 20th European Conference on Power Electronics and Applications (EPE'18 ECCE Europe), Riga, 2018, pp. P.1-P.9.

[5]. S. Kitzler, J. Stöckl, F. Kupzog and Z. Miletic, "Tracking of Aging Processes in Power Electronic Converters Using the Rainflow Method," IECON 2018 - 44th Annual Conference of the IEEE Industrial Electronics Society, D.C., DC, USA, 2018, pp. 3687-3692.

Beneficiary Legal Name: Siemens Gamesa Renewable Energy (SGRE), B10	
General Description	Siemens Gamesa Renewable Energy (SGRE) is a worldwide active wind turbine manufacturer with an installed capacity of more than 83 GW in 90 countries. Furthermore, SGRE is one of the leading manufacturers for offshore wind turbines with more than 20 years of experience. The Grid Compliance department with Grid Compliance Testing is part of the Technology Development organisation within the Offshore Business Unit. Grid Compliance has an overall responsibility to support grid code compliance aspects of developed wind turbines with regards to grid compliance testing as well as simulation model development and its validation. Wind turbines shall have capabilities to support customers with regards to grid connection of wind power plants. The department is involved in international standardisation, grid code development and is working with relevant offshore and onshore customers on grid compliance aspects.
Role and Commitment of key persons (including supervisors)	Frank Martin (10% FTE) is the main supervisor of ESR12 and cosupervisor of ESR14. He will organize/lecture training courses SC1 and SC2, and host secondment of ESR6&7. He is team lead of Grid Compliance Testing (within Grid Compliance department) responsible for grid code requirements, wind turbine related grid compliance measurement campaigns, parameters and capabilities of wind turbines for onshore and offshore. He was working in the modelling and simulation working group (WG) TR4 of the German FGW (Fördergesellschaft Windenergie und andere Erneuerbare Energien) and the WG 27 of the IEC 61400-27 and is currently working in WindEurope's TF GCR (grid code requirements), is involved in ENTSO-E and national grid code implementation activities and WG21 of the IEC 61400-21-4. Klaus Andersen is the Head of the Grid Compliance Department (within Electrical Drive Train organisation) responsible for the two teams and grid compliance related projects and the grid compliance roadmap. He will support the ESR12 on the internal work coordination. Dr Steffan Hansen is the Head of Technology for Electrical Drive Train (within Technology Development Organisation) responsible for overall R&D activities within the areas of power converter development and life cycle management, Direct Drive generator development. He will support the ESR12 on the internal work coordination.
Key Research Facilities, Infrastructure and Equipment	SGRE is developing wind turbines for onshore as well as offshore WPP's. These WT's are tested at mainly two test sites in Denmark (Østerild and Høvsøre) where SGRE is involved in the facilities. For relevant grid compliance tests measurement equipment is owned by SGRE and used for WT tests such as UVRT test equipment, power quality measurement equipment. SGRE is also working with FRAUNHOFER IWES to perform grid compliance tests for current offshore WT developments. For research and special assessments data obtained by grid compliance tests, grid code information and requirements, test procedures as well as WPP for exemplarily WPP's are available.
Status of Research Premises	SGRE is involved in the two test facilities in Denmark. WT's under test as well as relevant measurement equipment is owned and operated by Siemens Gamesa Renewable Energy. Relevant WT measurement data, grid codes and requirements are owned by SGRE.
Previous Involvement in Research and Training Programmes	SGRE has been involved in many EU research projects such as [1]. INNWIND.EU, Nov 2012- Dec 2017, FP7-Energy [2]. EERA-DTOC (EERA Design Tools for Offshore Wind Farm Cluster), 2012-2015, EU FP7, Energy. [3]. MERMAID (Innovative Multi-purpose offshore platforms: planning, Design and operation)
Current Involvement in Research and Training Programmes	[1]. i4Offshore - Integrated Implementation of Industrial Innovations for Offshore Wind Cost Reduction, Nov 2018 - Oct 2023, H2020-EU.3.3.2;
Submission of similar proposals under the same H2020-MSCA-ITN-2020 call	N/A

Relevant Publications and/or Research / Innovation Product

[1]. Massimiliano Curzi, Ranjan Sharma, Frank Martin, In Fault Ride Through Reactive Current Rise Time Requirements of Various European Grid Codes – Analysis Based on a Full-Converter Wind Turbine, Wiley Wind Energy, 2015

[2]. Massimiliano Curzi, Ranjan Sharma, Frank Martin, European Reactive Current Rise Time Requirements during Fault-Ride-Through from a Full-Converter Wind Turbine Perspective, Wind Integration Workshop, 2014

[3]. Mahat Pukar, Sune W. Rasmussen, Ranjan Sharma, Frank Martin, Tobias Siepker, Joergen N. Nielsen, Fault-Ride-Through Measurements and Model Validation of the Siemens Wind Power D3 Variable-speed Direct-drive Wind Turbine Platform, Wind Integration Workshop, 2016

[4]. Ireneusz Grzegorz Szczesny, Lei Shuai, Rasmus Skov Nielsen, Thomas Dreyer, Frank Martin, Harmonic Requirements of International Grid Codes and Assessment of Harmonics for Wind Power Plants, Wind Integration Workshop, 2017

Beneficiary Legal Name: TAJFUN HIL DRUSTVO SA OGRANICENOM ODGOVORNOSCU ZA ISTRAZIVANJE, PROIZVODNJU, TRGOVINU I USLUGE NOVI SAD; short: Tajfun HIL d.o.o. (THiL), B11	
General Description	Tajfun HIL has in-house mastery of: • Modelling of dynamical physical systems including, but not limited to: electric machines, batteries, converters, filters, fuel cells, mechanical subsystems and more. • Sophisticated, high performance software application (product) to interface with the hardware device and with the user of the system. • Knowledge to develop and implement proprietary, sophisticated, high performance computer architectures that can run in real time, with one microsecond time step and work seamlessly with Typhoon HIL software toolchain and hardware device. • Development process of high performance computer systems including but not limited to: circuit design, layout for high speed, design for manufacturing, memory subsystem, high speed serial communication links, packaging, etc.
Role and Commitment of key persons (including supervisors)	Dr Nikola Čelanović, CEO and co-founder of Tajfun HIL, holds a PhD degree from Virginia Polytechnic Institute and State University, Blacksburg. He will provide management support to the ESRs working in the company Dr Dušan Majstorović (10% FTE) is the Chief Technology Officer in Tajfun HIL. He holds a PhD degree from the University of Novi Sad. He will be the main supervisor of ESR13 and cosupervisor of ESR11. He will organize/lecture training course SC4, SC7, SC9, workshop WS3, and ESR8 secondment. Adrien Genić M.Sc. in Electrical Engineering, PhD student at the University of Novi Sad, Faculty of Technical Sciences, is currently the head of Modeling team at Tajfun HIL. He will help the ESR on developing component models and assist the preparation of training courses. Mladen Dinić M.Sc. in Electrical Engineering is the head of Hardware team at Tajfun HIL. He will train the ESR embedded systems and PCB design and assist the preparation of training courses. Petar Gartner M.Sc. in Electrical Engineering, PhD student at the University of Belgrade, Faculty of Electrical Engineering. He will train the ESR control and simulation and assist the preparation of training courses.
Key Research Facilities, Infrastructure and Equipment	Tajfun HIL d.o.o. owns an R&D center premises located in Novi Sad, Bulevar Oslobodjenja 69/VI, with 720 sqm of office space, including research laboratories and offices and with 40 employees working at these premises. The research laboratories are equipped with relevant computer equipment, as well as with Typhoon HIL state of the art Hardware-in-the-loop equipment for testing and simulation, as well as with appropriate software packages.
Status of Research Premises	All research premises are owned by Tajfun HIL d.o.o, and are in no connection with other research premises owned/rented by partner organizations in the project consortium
Previous Involvement in Research and Training Programmes	[1]. "Smart Rapid Prototyping of New Applications for Grid Enforcement", 2015- October 2017, financed by Austrian Research Promotion Agency, 1.4 MEUR project [2]. "World's first renewable energy laboratory on the web", 2012-2015, financed by the Innovation Fund of the Republic of Serbia, 390 kEUR project.
Current Involvement in Research and Training Programmes	[1]. "Demand Response Integration tEchnologies: unlocking the demand response potential in the distribution grid" DRIvE, H2020 project, #774431, 3.96 MEUR [2]. "Powerfull Advanced N-Level Digitalization Architecture for models of electrified vehicles and their components" PANDA, H2020 project, #824256, 3.49 MEUR
Submission of similar proposals under the same H2020-MSCA-ITN-2020 call	SEP-210646648, MERMAID

Relevant Publications and/or Research / Innovation Product

[1]. A. Genić, P. Gartner, D. Medjo, and M. Dinić, "Multi-layer hardware-in-the-loop testbed for microgrids," in *Proceedings of the International Conference on Smart Systems and Technologies (SST)*, Osijek, Croatia, 2016, pp. 95–102.
[2]. J. Poon, E. Chai, I. Čelanović, A. Genić, and E. Adzic, "High-fidelity real-time hardware-in-the-loop emulation of PMSM inverter drives," in *Proceeding of the Energy Conversion Congress and Exposition (ECCE), 2013 IEEE*, Denver, CO, USA, 2013, pp. 1754–1758.
[3]. N. Yousefpoor, A. Azidehak, S. Bhattacharya, B. Parkhideh, I. Celanovic, and A. Genic, "Real-time hardware-in-the-loop simulation of convertible static transmission controller for transmission grid management," in *Proceedings of the 14th Workshop on Control and Modeling for Power Electronics (COMPEL), 2013 IEEE*, Salt Lake City, UT, USA, 2013, pp. 1–8.
[4]. Suljkanović, D. Majstorović, G. Milosavljević, and I. Dejanović, "MDA approach in designing real-time embedded systems," in *Zooming Innovation in Consumer Electronics International* Conference (ZINC), 2016, 2016, pp. 4–7.
[5]. D. Majstorovic, I. Celanovic, N. D. Teslic, N. Celanovic, and V. A. Katic, "Ultralow-latency hardware-in-the-loop platform for rapid validation of power electronics designs," *IEEE Transactions on Industrial Electronics*, vol. 58, no. 10, pp. 4708–4716, 2011.

Partner Organization Legal Name: Commonwealth Scientific and Industrial Research Organisation (CSIRO), P1	
General Description	CSIRO is the Australian largest research organization – top 10 applied science research organization all over the world. Data61 is one of CSIRO research divisions dedicated to data science and information & communication technologies (ICT). It is Data61's predecessor who invited the Wi-Fi technology, i.e. IEEE 802.11a, 802.11g and 802.11n Wi-Fi standards, which has been widely adopted and applied all over the whole today. In addition to being an institution, CSIRO Data61 has become an Australian ICT hub by networking Governments, industries and universities via collaborative R&D projects and student training/co-supervisions.
Key persons and expertise	A/Prof. Shiping Chen received PhD in computer science from the University of New South Wales (UNSW), Australia in 2001. He is a principal research scientist in CSIRO Data61 and team leader of Architecture and Analytic Platform (AAP). He also holds a conjoint A/Professor title with the University of New South Wales (UNSW) and the University of Sydney. He has been working on distributed systems for 20+ years with focus on performance and security. He has published 180+ research papers and has been actively participating in research communities through publishing papers, journal editorships and conference PC/Chair services. His current research interests include: application security, blockchain and service computing. He is a senior member of the IEEE. His GoogleScholar H-index and Scopus H-index is both 25. In the project he will be co-supervisor for ESR14, by jointly providing research training and host secondment with P8 (UNSW). Dr Sherry (Xiwei) Xu is a research scientist in Architecture & Analytics Platforms (AAP) team at Data61, CSIRO (based in ATP, Sydney). She is also a Conjoint Lecturer at the School of Computer Science and Engineering (CSE) of the University of New South Wales (UNSW). She has a PhD from UNSW. Her main research interest is software architecture. She also does research in the areas of service computing, business process, cloud computing and dependability. In the project, she will assist A/Prof. Chen in providing supervision to ESR14.
Key Research Facilities, Infrastructure and Equipment	N/A
Previous and current Involvement in Research and Training Programmes	• We have been consistently providing training and co-supervision by hosting PhD students and junior researchers for both Australian and international universities for many years. • We also supervise undergraduate/honour/Master students thesis projects.

Relevant Publications and/or Research / Innovation Product

[1]. Xiwei Xu, Cesare Pautasso, Liming Zhu, Vincent Gramoli, Alexander Ponomarev, An Binh Tran, Shiping Chen: The Blockchain as a Software Connector. WICSA 2016: 182-191

[2]. Bin Liu, Xiao Liang Yu, Shiping Chen, Xiwei Xu, Liming Zhu: Blockchain Based Data Integrity Service Framework for IoT Data. ICWS 2017: 468-475

Muyi Yang, Xiwei Xu, Shiping Chen,Liming Zhu:. Blockchain-based Solution for Managing Renewable-based Microgrids, accepted to appear on IEEE BIB 2020

Partner Organization Legal Name: DEPsys SA (DEP), P2	
General Description	DEPsys is a leading Swiss technology company establishing thought leadership in the energy market. It provides evolutive solutions based on GridEye platform enabling traditional power distribution networks to cope with the new constraints of decentralized production from renewable energy sources, such as photovoltaic systems and electromobility technologies. GridEye provides an innovative technology solution for distribution system operators (DSO). Uniquely positioned with its deployment simplicity, it is the only solution that can make a grid smart in ONE day, avoiding all installation hassles with true plug & play functionality. GridEye is deployed and operated by DSOs in eight countries in Europe and Asia.
Key persons and expertise	Omid Alizadeh-Mousavi has received his Ph.D. in electrical power systems engineering from Swiss federal institute of technology (EPFL), Lausanne, in 2014. He was scientist at ABB corporate research center in Baden-Dättwil before joining DEPsys in 2016. Currently, he is R&D director in electrical power systems at DEPsys where he is responsible for: (i) development of technical and technological vision for GridEye, (ii) development of applications for distribution grid analysis, control, and optimization, (iii) management and supervision of collaboration with research institutes, universities, and EU projects. He is also the author or coauthor of more than 30 scientific papers in peer-reviewed journals and international conferences. In the project, he will be industrial co-supervisor of ESR5, host the secondment of ESR5 and ESR10, and also lecture in training course SC10.
Key Research Facilities, Infrastructure and Equipment	DEPsys has access to the GridEye measurement data in different distribution grids which can be used for development and validation of different algorithms. Moreover, DEPsys has a very good knowledge of the situation and needs of distribution grids by working with many DSOs across the world for several years. DEPsys has also several collaborations with academic and non-academic research institutes. Furthermore, R&D and Engineering teams of DEPsys include experts in various fields such as, power systems, power electronics, computer science, embedded software, cyber-security, communication, and electronics.
Previous and current Involvement in Research and Training Programmes	DEPsys has been participating in research projects with DSOs, academia, and governmental organizations. Current projects: • REeL demonstrator (in the context of SCCER-FURIES): providing distribution network operators the essential knowledge and technologies to integrate cleaner power supplies and storage facilities. Among the project partners, there is one of the biggest Swiss DSOs (Romand Energie), 2 companies, 6 laboratories from EPFL, and 3 Universities of applied science. • H2020-MSCA-IF-EF-SE 2017: Hosting Marie-Curie Individual Fellowship in Society and Enterprise panel. • SME Instrument (by EC H2020): Business innovation grants for feasibility assessment purposes. Previous projects: • SMILE FA (by Swiss Federal Office of Energy): further development of algorithms for the LV grid based on the model-less sensitivity approach. • SMILE (by Swiss Federal Office of Energy): studied and developed algorithms for monitoring and control of a low-voltage grid. • GridEye (by Commission for Technology and Innovation): developed a demonstration platform for monitoring and control, including a multi-modal communication infrastructure.

Relevant Publications and/or Research / Innovation Product

[1]. Report for The theoretical and application Study on a Metering and Intelligent tool for Low Voltage grid control Enhancement, SFOE, 2016.
[2]. Method for determining mutual voltage sensitivity coefficients between a plurality of measuring nodes of an electric power network, WO2017182918.
[3]. Presentation of GridEye related activities in REeL Demo project for Swiss Federal Office of Energy, 2018.
[4]. O. Alizadeh Mousavi, R. Cherkaoui, “Maximum Voltage Stability Margin Problem With Complementarity Constraints for Multi-Area Power Systems”, IEEE Transactions on Power Systems, vol. 29, no. 6, pp: 2993-3002, 2014.
[5]. O. Alizadeh Mousavi, R. Cherkaoui, M. Bozorg, “Blackouts Risk Evaluation by Monte Carlo Simulation Regarding Cascading Outages and System Frequency Deviation”, Electric Power Systems Research (EPSR), vol. 89, no. 1, pp: 157-164, 2012.
[6]. M. Nick, O. Alizadeh Mousavi, R. Cherkaoui and M. Paolone, “Security Constrained Unit Commitment with Dynamic Thermal Line Rating”, IEEE Transactions on Power Systems, vol. 31, no. 3, pp:2014-2025, 2015.

Partner Organization Legal Name: Equinor Energy AS (EQN), P3	
General Description	Equinor (Former StatOil) was founded as the Norwegian state's oil company in 1972 with the objective to carry out exploration, production, transport, refining and marketing of petroleum and petroleum-derived products on the Norwegian continental shelf. Total revenues for the Equinor Group in 2016 was USD 45,873 million. Equinor Petroleum AS (The partner) is since 2008 a 100% subsidiary of Equinor ASA. EQUINOR is the leading operator on the Norwegian continental shelf and has international upstream operations in more than 30 countries. Equinor is already an innovator in offshore wind and a world leader in carbon capture and storage.
Key persons and expertise	Dr Børre Tore Børresen (5% FTE) will be co-supervisor for ESR6 representing the industrial side and will host secondment of ESR6 during the project. He will organize/lecture training course SC5 and SC6 and workshop 4. He is a leading researcher and an expert in electrochemical energy conversion and storage. He holds a PhD in electrochemistry from Norwegian University of Science and Technology (NTNU) from 1995. He has participated in more than 10 research projects, including 3 EU project (Advanced metal hydride-air batteries, Advanced high-temperature methanol fuel cell systems, New processes for biofuel production), acting as research task responsible. He has more than 20 publications in top international journals and published over 10 conference proceedings. He has supervised 3 MSc projects and acted as an opponent for 5 PhD candidates. Dr Francesco Marra (5% FTE) will be industrial co-supervisor for ESR7. He will lecture in training course SC4. He is an expert in electric energy systems, electric distribution networks with distributed power generation and qualification of new electrical technologies. He has participated in several EU projects, including EU Promotion, MetaPV, acting as project contributor and task leader. He has 30 publications including international 10 journals and 20 on conferences and 3 books' chapters. He has supervised 5 MSc projects and 1 PhD student. He will contribute 5% of the time for the project. Dr Jan Henrik Borch (5% FTE) . He is an expert in storage systems. He heads the research on energy storage within the Equinor and follows the industrial trend and innovation within this sector. He will provide management support to the secondment of the ESR supervised by Equinor.
Key Research Facilities, Infrastructure and Equipment	Equinor has access to data and information systems of Equinor operated offshore wind farms and oil & gas facilities. Equinor operates the Dudgeon and the Hywind (floating) offshore wind farms, with an installed capacity of 402 MW and 30 MW respectively. Connected to Hywind, Equinor is building Batwind, a 1 MWh onshore battery station incorporated into Hywind to capturing the values of offshore wind integration and storage. Study of InnoCyPES will also link to the upcoming Dogger bank wind farm (4 GW).
Previous and current Involvement in Research and Training Programmes	Equinor is and has been participating in a number of EU projects. Current H2020 projects: PROMOTioN – Progress on Meshed HVDC Offshore Transmission Networks, GeoWell – Innovative materials and design for long-life high-temperature geothermal wells, DeepEGS – Deployment of Deep Enhanced Geothermal Systems for Sustainable Energy Business

Relevant Publications and/or Research / Innovation Product

[1]. Presentation at World Future Energy Summit, 15-18 January 2018, Abu Dhabi.
[2]. Presentation at US Offsore Wind Conference, 7-8 June 2018, Boston.
[3]. Presentation at "The Autumn Conference", 28 November 2017, Oslo. The Autumn Conference 2017 is a joint event hosted by Equinor, the Norwegian Ministry of Petroleum & Energy and the International Energy Agency (IEA).
[4]. Presentation at "Scottish Renewables Storage & Systems Conference", Glasgow, 30 June 2016.
[5]. Innovation product: world's first floating wind turbine farm, https://www.StatOil.com/en/news/worlds-first-floating-wind-farm-started-production.html

Partner Organization Legal Name: Swiss Federal Institute of Technology, ETH Zurich (ETH), P4	
General Description	ETH Zürich is the leading research university in continental Europe. The Department of Information Technology and Electrical Engineering forms one of the 16 departments of ETH Zürich. Within the department 37 professors, around 300 doctoral students, and over 300 additional academic staff ensure the world-class quality of research and teaching. The Automatic Control Laboratory (Institut für Automatik, IfA) is a part of the Department of Information Technology and Electrical Engineering (D-ITET) at the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland. The focus of the laboratory is research and teaching in the field of automatic control systems. The lab has four faculties: John Lygeros (head), Florian Dörfler, Roy Smith and Maryam Kamgarpour and three Emeriti Professors: Adolf Glattfelder, Mohamed Mansour and Manfred Morari. In addition, we have approximately 10 postdoctoral students and over 30 PhD students. The laboratory has an extensive research record in both the theory and application of control technology. Our research interests are loosely divided into five categories: theory, computation; energy; applications; and "team projects." The computational aspects of our work often result in software for control system analysis and design. We are responsible for the teaching of a variety of control systems courses at the bachelors, masters and PhD levels. These courses are typically taken by D-ITET undergraduates as well as Masters students in Electrical Engineering; Mechanical Engineering; and Robotics, Systems and Control.
key persons and expertise	Prof. Dr Florian Dörfler (male, H-index 30); Assistant Professor at ETH Zurich, holds a PhD degree in Mechanical Engineering from the University of California at Santa Barbara. He will contribute 5% of his time to the project. He will be cosupervisor for ESR11 and host the secondment.
Key Research Facilities, Infrastructure and Equipment	ETH Zürich offers a wide range of courses targeting the methods used in the project (control, optimization, games, data-analytics etc.) as well as many courses in Energy (including the Energy Science Master Program). It hosts the Energy Science Center as well as three Swiss Competence Centers for Energy Research (SCCER) for Mobility of the Future, Energy-Efficient Buildings and Districts, and New Forms of Heat and Electricity Storage – all of which provide workshops, seminars, courses, and experimental facilities directly relevant for the proposed project.
Previous and Current Involvement in Research and Training Programmes	H2020 project “Massive InteGRATion of power Electronic devices — MI-GRATE”, SNF Assistant Professor Energy Grant “Plug-and-Play Control & Optimization in Microgrids” ETH Seed Project “Novel control approaches for low-inertia power grids”. ETH Zürich has significant experience in managing European research projects. In FP7 the Institution participated as either the coordinator or partner in 608 projects of which 171 were Marie Curie actions (of which 103 were MCIFs and 46 were ITNs). As of January 2016, ETH Zürich is either the coordinator or partner in 103 H2020 projects of which 1 is MCIF (as outgoing host) and 17 are ITNs.

Relevant Publications and/or Research / Innovation Product

[1]. F. Dörfler, M.R.Jovanovic, M.Chertkov, and F.Bullo. Sparsity-promoting optimal wide-area control of power networks. IEEE Transactions on Power Systems, 29(5):2281–2291, September 2014.

[2]. J. W. Simpson-Porco, F. Dörfler, and F. Bullo. Synchronization and power-sharing for droop-controlled inverters in islanded microgrids. Automatica, 49(9):2603–2611, 2013.

[3]. J. W. Simpson-Porco, Q. Shafiee, F. Dörfler, J. M. Vasquez, J. M. Guerrero, and F. Bullo. Secondary frequency and voltage control of islanded microgrids via distributed averaging. IEEE Transactions on Industrial Electronics, 62(15):7025 – 7038, November 2015.

Partner Organization Legal Name: eSmart Systems AS (eSS), P5	
General Description	eSmart is a software company providing big data solutions for infrastructure owners and operators and service providers based on a universal and flexible platform allowing a more efficient distribution of services and use of infrastructure. eSmart is based on more than two decades of successful and extensive international experience at establishing, growing and operating knowledge-based and world-leading IT- and energy-related companies targeting global markets. eSmart develops next generation software systems for grid companies, large energy consumers, prosumers and retailers. Its solutions focus on helping customers benefit from energy market price fluctuations to reduce energy consumption and greenhouse gas emissions. The company's systems and solutions also have applications in broader perspectives in rapidly growing areas such as smart buildings and smart cities. The company's headquarters are in Halden, Norway, which over the last two decades, has developed into one of the most competent energy IT environments in Norway. eSmart focuses on three core customer segments, all facing new challenges and opportunities as a consequence of market changes and new technology: Utilities, Energy Services Companies and Smart Cities. eSmart is at the forefront of the development within data analytics, and machine learning is a core technology in this development and in customer offerings. eSmart is a SME with app. 75 employees with income from product sales, services sales and R&D projects
Key Persons and Expertise	Dr Davide ROVERSO is Chief Analytics Officer (CAO) at eSmart and holds a PhD in Computing Science from Aberdeen University. He has over 25 years' experience in the field of Machine Learning and Big Data Analytics, with applications in diagnostics, prognostics, condition monitoring, and early fault detection in complex processes, in sectors ranging from energy to medicine and environmental monitoring. He has authored over 90 publications in international journals, conference proceedings and edited books. Before joining eSmart he worked as CTO of First Sensing AS, Head of Departments at the Institute for Energy Technology, and researcher at STØ and CSELT. In InnoCyPES, he will be industrial co-supervisor and host of secondment for ESR10 training him on data analytic and machine learning techniques on creating digital twin for transformer condition monitoring. He will lecture in course SC10. Dr Stig Ødegaard OTTESEN is Head of R&D at eSmart. He holds a Master of Science degree in Electrical Power Engineering from NTNU and a PhD in Industrial Economics and Technology Management. The title of the thesis is "Techno-economic models in Smart Grids – Demand side flexibility optimization for bidding and scheduling problems". Before joining eSmart he worked as Research Director at Smart Innovation Norway/NCE Smart Energy Markets, Department and Project Manager in Tieto, had different roles in OM Technology Energy Systems, HandEl Skandinavia AS, Institute for Energy Technology and Statkraft. His interests include Power systems and power markets, Smart Grid technologies and related business models and market design. He will provide management support to host secondment for ESR10.
Key Research Facilities, Infrastructure and Equipment	eSmart is a software company but has a lot of data relevant for the project stored in our big data MS Azure cloud. The data can be exploited by the ESR in the project.
Previous and Current Involvement in Research and Training Programmes	Recently, eSmart is currently involved in two H2020 projects. INVADE aims to provide a Cloudbased flexibility management system integrated with EVs and batteries empowering energy storage at mobile, distributed and centralized levels to increase renewables share in the smart distribution grid. GreenCharge will empower cities and municipalities with recommendations, guidelines, business models and technologies for cost efficient and successful deployment and operation of charging infrastructure for electric vehicles (EV), supporting cities' transition to zero emission/sustainable mobility. eSmart Systems also participated in H2020 EMPOWER, which was concluded in 2018. In addition, eSmart runs several R&D projects funded by The Research Council of Norway and ERANet.

Relevant Publications and/or Research / Innovation Product

Products: Connected Drone and Connected Prosumer.

Publications:

[1]. Ottesen, S. Ø., Tomasgard, A., & Fleten, S.-E. (2016). Prosumer bidding and scheduling in electricity markets. Energy, 94, 828–843. http://doi.org/10.1016/j.energy.2015.11.047

[2]. Ottesen, S. Ø., Tomasgard, A., & Fleten, S.-E. (2018). Multi market bidding strategies for demand side flexibility aggregators in electricity markets. Energy, 149, 120–134. http://doi.org/10.1016/j.energy.2018.01.187

Partner Organization Legal Name: INESC ID - INSTITUTO DE ENGENHARIADE SISTEMAS E COMPUTADORES, INVESTIGACAO E DESENVOLVIMENTO EM LISBOA (INESC), P6	
General Description	INESC-ID, the Systems and Computers Engineering Institute, R&D, is a not for profit, privately owned institution of public interest, dedicated to advanced research and development in the domains of electronics, telecommunications, and information technologies. INESC-ID is strongly affiliated with Instituto Superior Técnico (IST), the leading technical university in Portugal who is also the major shareholder in INESC-ID. The principal objectives of INESC-ID are to integrate competences from researchers in electrical engineering and computer science to advance the state of the art in computers, telecommunications, information systems, and energy, and to perform technology transfer, also through the support of technology based startups, and to provide technical support either through basic research or applied research and advanced education. INESC-ID was awarded the status of Associated Laboratory by the Portuguese government and currently integrates more than 100 PhDs and 200 post-graduate students working in one of the five main action lines: Information and decision support systems, Computing systems and communication networks, Interactive intelligent systems, Energy systems, Embedded electronic systems, and Computational processing of the Portuguese language.
Key Persons and Expertise	Rui Henriques is an Assistant Professor at Instituto Superior Técnico, Universidade de Lisboa, in the domains of Machine Learning and Artificial Intelligence. Rui is an associate researcher at INESC-ID with research contributions in the analysis of complex data and its statistical foundations. Currently, Rui is the principal investigator of two R&D projects dedicated to the analysis of spatiotemporal, high-dimensional and heterogeneous data. Rui had a wide-exposure to industrial projects as a business analyst at McKinsey (2010) and as the director of the Artificial Intelligence division of Tekever in 2017. Rui conducts research with three major application domains: biomedical, urban and energy data domains. Hugo Morais (IEEE SM18) (200 papers / 4500 citations) received B.E. and M.E. degree from Polytechnic of Porto in 2005 and 2010 respectively, and Ph.D. degree in 2012 from the University of Tras-os-Montes e Alto Douro, all in the field of electric power system. He is senior researcher at INESC-ID and Assistant Professor in University of Lisbon. He researcher interest are in the development and deployment of the smart grids' methods and tools. He participates in the definition of operational planning tools used by the French DSO, the development of hardware agnostic solutions, based on IEC standards, to be used in power substations and to control distributed energy resources and in the test and validation of tools to be used by an aggregator providing multiple services at the same time.
Key Research Facilities, Infrastructure and Equipment	INESC-ID has several research labs equipped with all the conditions to support the secondments in the project. INESC-ID hosts a computing cluster for high-performance computing and web applications available to all researchers, telecommunications test rooms, clean rooms (for hardware development), among others.
Previous and Current Involvement in Research and Training Programmes	The members of the INESC-ID team have been previously involved in the following recent R&D projects related to high-performance distributed and parallel computing: [1]. The Cloud-TM H2020 Project (FP7-ICT-2009-5, June 2010 to May 2013) was coordinated by INESC-ID. It aimed at facilitating development and abating operational and administration costs of parallel and data-intensive cloud applications. Designed from the grounds up to meet the scalability and dynamicity requirements of cloud infrastructures, Cloud-TM provides intuitive, yet powerful abstractions aimed at masking complexity and at allowing ordinary programmers to unleash the potentiality of large-scale cloud platforms. [2]. The Euro-TM COST Action (IC1001), coordinated by INESC-ID, focused on the Transactional Memory paradigm as a high-productivity programming model for high-performance parallel programming, capable of boosting developers' productivity and allowing ordinary programmers to unleash the power of parallel and distributed architectures avoiding the pitfalls of manual, lock based synchronization in shared memory programs.

Relevant Publications and/or Research / Innovation Product

[1]. Hugo Morais, et. al "Agreed models, Use Case list, and Use Case description in UML", TDX-ASSIST European Project Report D1.2, 2018
[2]. Rui Henriques and Sara C. Madeira, 2018, Triclustering Algorithms for Three-Dimensional Data Analysis: A Comprehensive Survey, ACM Computing Surveys (CSUR), Volume 51, Issue 5, No. 95, pp. 1-43, ACM New York, NY, USA [10.1145/3195833]
[3]. Tiago Soares, Ricardo Bessa, Pierre Pinson, Hugo Morais, "Active Distribution Grid Management based on Robust AC Optimal Power Flow", IEEE Transactions on Smart Grid, vol. 10, no. 2, 2017

Beneficiary Legal Name: NARI Technology Co., Ltd (NARI), P7	
General Description	NARI Group Corporation (NARI) is the largest whole set supplier of electric power equipment in China and is an active player in the global power industry. NARI is a world-class industrial group with over 17,000 engineers and technicians; achieving revenue over USD 5.7 billion by the end of 2016. NARI owns 23 branch companies and subsidiaries covering power system security and stability control, power grid automation, relay protection and power electronics, HVDC/FACTS, transmission and transformation equipment, power distribution and consumption management, information and communication technology (ICT), renewable energy, water conservancy and hydropower, industrial control etc. Among them, there are 2 listed companies - NARI Technology and Zhixin Electric. promising a good image in the Capital Market. The subsidiary involved in the project is focused on power system security and stability control, who manufacturer security assessment products to the utilities in China and the world.
Key Persons and Expertise	Professor Yusheng Xue is an academician of the Chinese Academy of Engineering, and now is the Honorary President of State Grid Electric Power Research Institute (SGEPRI or NARI), China. Professor Xue has received various National Prizes on his achievement in power system stability and security assessment. He became a PhD supervisor in 1994. By the end of 2019, 25 Master students, 42 PhD students and 4 post doctors were successfully supervised in the field of power systems or nonlinear dynamics. He has published 8 books and more than 640 technical papers, including 132 international publications. In InnoCyPES, Prof. Xue will provide research training and act as co-supervisor to ESR8 and ESR15, and host the secondment of ESR14 and 15.
Key Research Facilities, Infrastructure and Equipment	NARI holds the world largest installation of real time digital simulator in their lab, which is a National Key Laboratory, and acts as National Certification Body for certifying grid connected equipment in China. The lab will be open to the ESRs in InnoCyPES during their secondment.
Previous and Current Involvement in Research and Training Programmes	• Key technologies and demonstration of power grid with high penetration of renewable energy generation. National 863 Program 2011AA05A105, 2012-2014. • Energy management and operational control for source-grid-load collaboration, NHTRDP 2013CB228204, 2013-2018. • Theory and Technology of Intermittent Renewable Energy Prediction Based on Trajectory Eigenvalue and Pattern Classification, NSFC 51561145011, 2015-2018. • Active distribution network status estimation and Network optimization and coordination control Based on Data and Mechanism Analysis, NSFC 61533010, 2016-2020. • Study on Optimization of China's Energy Structure under Carbon Emission Constraint, CAE, 2016-ZD-07, 2016-2018. • Research on the Optimization Model for Shenhua Group's Clean Development Strategy, SHGF, SHGF-16-68, 2017-2018. • Basic Theories and Methods of Analysis and Control of the Cyber Physical Systems for Power Grid, National Key Research and Development Program of China, 2017YFB0903000, 2017-2021. • The Active Support of Power Grid to Energy Transition of Clean Energy-rich Region：A Case Study of Qinghai Province, the Stat Grid Corporation of China, 2018-2019.

Relevant Publications and/or Research / Innovation Product

[1] Yu Xinghuo, Xue Yusheng. Smart Grids: A Cyber–Physical Systems Perspective. Proceedings of the IEEE, 2016, 5(104).
[2] Xue Yusheng, Yu Xinghuo. Beyond Smart Grid—A Cyber–Physical–Social System in Energy Future. Proceedings of the IEEE, 2017, 105(12).
[3] Shu Yinbiao, Xue Yusheng, Cai Bing, et al. A Review of Energy Transition Analysis. Automation of Electric Power Systems, 2018, 42(9,10).

Partner Organization Legal Name: The University of New South Wales (UNSW), P8	
General Description	**UNSW** is a top-ranked university in Australia, member of the elite Group of Eight of Australian research-intensive universities. UNSW ranks 45th in the 2017 QS World University Rankings. Engineering at UNSW continuously ranked top 50 in most international rankings. UNSW is Australia's most comprehensive research-intensive university with the highest amount of funding in Australia form the Australian Research Council (ARC) since 2015. UNSW has an international reputation in renewable energy and grid connections. The team involved in the program include a team over 40 including academic staff, research fellow and PhD students
Key persons and expertise	**Prof. Joe Dong** received PhD in electrical engineering from the University of Sydney, Australia in 1999. He is currently University of New South Wales SHaRP professor of energy systems looking after the research in microgrid and energy systems with over $8m research and industrial projects. In addition to academic experience, he also served as manager for (transmission) system planning of Transend Networks (now TASNetworks – the power transmission company of Tasmania, Australia). He is a Fellow of the IEEE for contributions to the development of computational methods for power system stability and planning. His GoogleScholar H-index is 73 and Scopus H-index is 59. In the project he will be co-supervisor for ESR14, providing research training and host secondment to ESR3, 14 and 15. **Dr Ke Meng** received PhD in electrical engineering from the University of Queensland, Australia in 2009. Dr Meng is currently a senior lecturer at the University of New South Wales, Sydney, Australia. He is a principal investigator for the $600m Smart Grid, Smart City national demonstration project, for a 100MW offshore windfarm design and studies project for Hongkong Electric Company, the $3m microgrid and SWER project at the UNSW. His research interests include power system stability, new methodologies for system security and planning studies, data mining and big data analytics for system contingency assessment. Renewable as well as conventional generation grid connection studies. Dr Meng has published over 100 referred journal publications. In the project, he will assist Prof. Joe in providing supervision to ESR14 and support the Training School 3.
Key Research Facilities, Infrastructure and Equipment	The **Real Time Digital Simulator (RTDS) Laboratory** of UNSW has an 18-rack RTDS system. The power electronics and inverter lab are equipped with over A$7 million equipment for a comprehensive range of power electronics and renewable energy research including emulators, inverters, grid simulators, intelligent transformers and energy storage facilities. The facilities are open to being used by the ESRs.
Previous and current Involvement in Research and Training Programs	CSIRO national flagship project of Future Grid for its gas and electricity network co-optimisation and planning research ($13m). R&D support for the $600m Australian government's Smart Grid, Smart City national demonstration project.

Relevant Publications and/or Research / Innovation Product

[3]. L Liu, K Meng, Z Dong, "Robustness of networks formed from interdependent correlated networks under intentional attacks", Physica A: Statistical Mechanics and its Applications 491, 329-339, 2017

[4]. W Kong, ZY Dong, Y Jia, DJ Hill, Y Xu, Y Zhang, "Short-Term Residential Load Forecasting based on LSTM Recurrent Neural Network", IEEE Transactions on Smart Grid, 2017

[5]. J.B. Zhao, ZY Dong, et al, "Robust Forecasting Aided Power System State Estimation Considering State Correlations", IEEE Trans Smart Grid, (Accepted Oct 2016) to appear (#TSG-00262-2016.R1)

Partner Organization Legal Name: Siemens Danmark (Siemens), P9	
General Description	Siemens Danmark is a subsidiary of Siemens AG. Siemens have approx. 375.000 employees and a turnover of 84 bn Euro. Siemens is a leading industrial company with a strong focus on R&D, operating worldwide. Siemens is a global powerhouse focusing on the areas of electrification, automation and digitalization. One of the world's largest producers of energy-efficient, resource-saving technologies, Siemens is a leading supplier of systems for power generation and transmission as well as medical diagnosis. In infrastructure and industry solutions, the company plays a pioneering role. Siemens has developed MindSphere which is a cloud-based, open Internet of Things (IoT) operating system, enables industries worldwide to link their machines and physical infrastructure to the digital world.
Key persons and expertise	**Henrik Ruff, Nordic Digital Enterprise Manager**. Henrik holds an MSc from DTU, Denmark, as well as a business degree from Copenhagen Business School. The work area is within digital transformation and Industry 4.0, enabling a larger production company in the Nordics to be more effective, by the use of the latest innovative automation technology, PLM software and IoT solutions. Henrik is responsible for the contact to the Academic sector within the Digital Industries division. **Lars Hansen, Systems Engineering Manager | Standard & Regulation Manager** **Marianne Hjortlund, Technology Specialist, MindSphere, IoT.** Marianne holds a Diploma engineering degree in Information and communication technology. Marianne is a specialist within MindSphere, Siemens Industrial Internet of Things, operating system.
Key Research Facilities, Infrastructure and Equipment	Siemens will participate in the project with MindSphere, training, workshops and equipment. Siemens has over 1000 persons dedicated to research and development of MindSphere, being the leading IoT platform in the world. Siemens is very dedicated to being able to provide the best digital solutions requested.
Previous and current Involvement in Research and Training Programmes	Siemens is very active within R&D in general. Within IoT / MindSphere Siemens provides training and workshops both to the public, private and academic sector.
Relevant Publications and/or Research / Innovation Product MindSphere IoT system. Siemens PLM (product lifecycle management) system.	

Partner Organization Legal Name: ORSTED WIND POWER A/S (Ørsted), P10	
General Description	The Ørsted vision is a world that runs entirely on green energy. Ørsted develops, constructs and operates offshore and onshore wind farms, bioenergy plants and innovative waste-to-energy solutions and provides smart energy products to its customers. Headquartered in Denmark, Ørsted employs 6,080 people. Ørsted's shares are listed on Nasdaq Copenhagen (Orsted). In 2018, the group's revenue was DKK 76.9 billion (EUR 10.7 billion). Ørsted's Offshore R&D organization is well-established and divided into six roadmaps. This project will be nested in Roadmap 3 "Electrical infrastructure" which is running various R&D projects and activities focused on wind farm design and operation. Furthermore, Ørsted have extensive experience in running PhDs and find it as a very effective way to integrate academic achievements into the business.
Key persons and expertise	Dr. Karsten Hvalkof is a PhD in Electrical Engineering and very experienced people, business and technical manager. Heading SCADA Ørsted Offshore he has built the department from scratch, been responsible for in-house competences, staff development, leadership, consultant management and strategy development and implementation. Dr. Łukasz Hubert Kocewiak holds BSc and MSc degrees in electrical engineering from Warsaw University of Technology as well as PhD degree from Aalborg University. Currently he is with Ørsted Offshore and is working as an R&D manager and lead power system engineer on development of electrical infrastructure in large offshore wind power plants. The main direction of his research is related to harmonics and nonlinear dynamics in power electronics and power systems especially focused on wind power generation units. He is the author/co-author of more than 70 publications. He is a member of various working groups / activities within Cigré, IEEE, IEC.
Key Research Facilities, Infrastructure and Equipment	In Ørsted Offshore SCADA Department the PhD students will be able to get support from the team of skilled engineers from SCADA Communication and SCADA Control. Furthermore, the project will establish links to areas of Operations, Operations Technology as well as IT Information Security. The project is characterised by multidomain scope which will require utilizing interfaces between Engineering, Operations and Information Technology.
Previous and current Involvement in Research and Training Programmes	[PhD at Aalborg University] Harmonic Modelling, Propagation and Mitigation for Large Wind Power Plants Connected via Extra Long HVAC Cables [PhD at Technical University of Denmark] Real time dynamic rating condition monitoring of offshore wind farm export systems [R&D collaboration with Aalborg University] Multi-Timescale Stability of Modular Cascaded Power Electronic Systems [R&D collaboration with National Grid] The Enhanced Frequency Control Capability (EFCC) Project [R&D collaboration with Aalborg University] Integrated Battery Energy Storage and STATCOM for the Optimal Operation and Control of WPP in Power System [PhD with Aalborg University] Wind Farm Black Start Service Integration To Assure Resiliency In 100% Renewable Future Power Systems [R&D project within H2020] Progress on meshed HVDC offshore transmission networks (PROMOTioN)

Relevant Publications and/or Research / Innovation Product

[1] Ł. H. Kocewiak, B. Laudal Øhlenschlæger Kramer, O. Holmstrøm, K. Høj Jensen, L. Shuai, "Resonance Damping in Array Cable Systems by Wind Turbine Active Filtering in Large Offshore Wind Power Plants," IET Renewable Power Generation, Institution of Engineering and Technology, 6 July 2017, Volume 11, Issue 7, Page(s) 1069-1077.

[2] M. P. S. Gryning, Q. Wu, Ł. H. Kocewiak, H. H. Niemann, K. P. H. Andersen, M. Blanke, "Stability Boundaries for Offshore Wind Park Distributed Voltage Control," IEEE Transactions on Control Systems Technology, IET, July 2017, Volume 25, Issue 4, Page(s) 1496-1504.

[3] M. Kazem Bakhshizadeh, F. Blaabjerg, C. Leth Bak, J. Hjerrild, Ł. H. Kocewiak, B. Hesselbaek, X. Wang, "Couplings in Phase Domain Impedance Modeling of Grid-Connected Converters," IEEE Transactions on Power Electronics, Vol. 31, Issue 10, Page(s) 6792-6796, 2016

5 Ethics Issues

Ethics evaluation for this project has been taken through the completion of the part A form. We use data on personal energy consumption in the ESR projects (ESR2, ESR3, ESR5, ESR10). The project will ensure the legislation from EU and local countries are fulfilled to access the data. We will follow the EU General Data Protection Regulation (GDPR) 2016/679, the Energy Efficiency Directive 2012/27/EU, the Electricity Directive 2009/72/EC, the Gas Directive 2009/73/EC and country-specific legislation.

The project partner Dansk Energi has developed a procedure for transferring data to research projects in compliance with GDPR. Only by signing a data processor agreement with Dansk Energi can the relevant distribution grid operator transfer the smart meter data to the research project, thereby ensuring that all the regulations are being followed when handling the data in the project. Danske Energi also holds training on personal data usage for the energy retailers and distribution grid companies regarding the legislation and regulations on this issue. The ESRs involved in handling data in the research project will receive a specific training in personal data usage in research projects by Dansk Energi.

The procedure from Dansk Energi as well as DTU will be followed in the project. Particularly, we will define a procedure for personal data sharing within the network, so that the personal data is protected for the data owner. Furthermore, all the partners involved in handling personal data will follow the local regulation through the help from the institution's legal department and regulatory authorities. Detailed procedures regarding data accessing, data processing and results publishing will be documented clearly in the data management plan.

The research objective of InnoCyPES will not be affected should a situation arise where rules regarding data handling among the partners are incompatible or it is not possible to obtain permission from the energy users to use the data. In these cases, we will use simulated data, taking the smart metering specifications into the consideration. Hence, the research methodologies and the impact to the research results are completely mitigated.

In addition to energy consumption data, the research method of ESR15 involves interviews and dialogues with volunteering participants. All their personal information such as the name and affiliation will be kept confidential during and after the project. The information after the project will be subject to deletion depending on the agreement. Participants must sign an informed consent prior to joining the research activities and will be informed of the plan for publication and their right to withdraw that consent at any time during the research. Participants will receive information about the research objective, the handling procedure of the collected data, the research methodology, the benefits and burden of research, as well as the research output. With the help from DTU legal department, proper documentation will be in ensured by InnoCyPES regarding volunteer recruitment, inclusion and exclusion criteria, and the informed consent procedure.

6 Letters of commitment

DATA61
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9 January 2020

To Who it may concern,

Letter of Letters of Commitment

Dear Sir/Madam,

I undersigned, in my quality of Research Director of Software & Computational Systems of CSIRO Data61, commit to set up all necessary provisions to participate as partner organisation in the proposal "Innovative tools for Cyber-Physical Energy Systems", submitted by Dr. Guangya Yang, Technical University of Denmark, within the call H2020-MSCA-ITN-2020, should the proposal be funded.

On behalf of CSIRO Data61, I also confirm that we will participate and contribute to the research, innovation and training activities as planned in this project. In particular, our Software & Analytic Platform (AAP) Team will be involved in co-supervision of the 1~3 early stage researchers as specified in ESR3, lecturing in training school, and/or hosting 1~3 secondments designated for ESR3, ESR14/ESR15 in conjunction with the University of New South Wales (UNSW), Australia.

I hereby declare that I am entitled to commit into this process the entity I represent.

Yours sincerely,

Dr Liming Zhu
Research Director, Software & Computational Systems
CSIRO Data61, Australia
Liming.Zhu@data61.csiro.au

DEPSYS

Prof. Guangya Yang
Technical University of Denmark
Elektrovej
Building 325, room 156
2800 Kgs. Lyngby

Puidoux, 2020-01-06

Topic: letter of commitment for H2020-MSCA-ITN-2020

I undersigned Joël Jaton, in my quality of CTO at DEPsys, commit to set up all necessary provisions to participate as partner organization in the proposal "Innovative tools for Cyber-Physical Energy Systems", submitted by Dr. Guangya Yang, Technical University of Denmark, within the call H2020-MSCA-ITN-2020 should the proposal be funded.

On behalf of DEPsys, I also confirm that we will participate and contribute to the research, innovation and training activities as planned in this project. In particular, our R&D team will be primarily involved in co-supervision of ESR5, lecturing in training school (in particular no. 4), and hosting the secondment of ESR5 and ESR10.

I hereby declare that I am entitled to commit into this process the entity I represent.

Puidoux, 2020-01-06

Joël Jaton, CTO

DEPsys SA
Route du Verney 20B
1070 Puidoux
Tél. 021 546 23 00

Danmarks Tekniske Universitet
Center for Electric Power and Energy
Attn. Guangya Yang
Email: gyy@elektro.dtu.dk

Our reference: Francesco Marra
Your reference: Guangya Yang
18 December 2019

Letter of Commitment (LoC) - Project InnoCyPES

Dear Madam/Sir,

Thank you for your invitation to join the proposed Horizon 2020 INNOvative tools for Cyber-Physical Energy Systems (InnoCyPES) to be submitted to Innovative Training Networks, under the working programme Marie Sklodowska-Curie Actions, H2020, call identifier: H2020-MSCA-ITN-2020.

Associate Professor Guangya Yang, from Technical University of Denmark, Department of Electrical Engineering, is acting as the coordinator for the application.

Equinor Energy AS ("Equinor") hereby has the pleasure of informing DTU (the "Applicant") of its intention to support the project "InnoCyPES" ("the Project") as a Partner Organization as outlined in the proposed program, provided that the project is awarded by EU. Our role and work will be as indicated in the proposal.

Equinor can offer research training activity related to the energy industry by hosting shorter external stays and provide research training and co-supervision to researchers associated with the Project. Equinor will not have any obligation to cover any personnel costs during a hosting period. All personell, travel and accommodation costs should be covered by the project.

Equinor will be happy to join the Supervisory Board of the InnoCyPES and develop the research activity and training of the cohort of working programme Marie Sklodowska-Curie Actions and to help you as coordinator to ensure a successful outcome of the Project.

By signing the letter, we also agree to hold the information connected to the application work confidential.

The Applicant shall not publish information concerning this Letter of Commitment without Equinor's prior approval.

Our participation in the Project is dependent on agreeing and entering into a Contract for the Project.

Until such time as a formal Contract is entered into, we reserve our right to cancel, at our own discretion, this Letter of Commitment by immediate notice. Any costs incurred in connection with the Project are at your own risk,

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4035 Stavanger

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and in case of cancellation of this Letter of Commitment Equinor will not cover any cost related to such cancellation.

This Letter of Commitment shall automatically be cancelled if DTU does not enter into contract with the EU.
This Letter of Commitment shall be governed by the laws of Norway, with Stavanger District Court as legal venue.

Please confirm the receipt of this Letter of Commitment by e-mail to the attention of Sylvi Marilyn Gjertsen, smg@equinor.com (email), within 24 (twenty-four) hours of receipt.

Yours faithfully,
for Equinor Energy AS

Sylvi Marilyn Gjertsen
Digitally signed by Sylvi Marilyn Gjertsen
Date: 2019.12.18 07:19:21 +01'00'

Sylvi Marilyn Gjertsen
Sr. Contract Consultant
Strategic Procurement

Equinor Energy AS
Registered number
NO 990 888 213

Office address
Forusbeen 50
4035 Stavanger

Telephone
+47 55995000

www.equinor.com

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

D-ITET
Department of Information Technology and Electrical Engineering

Automatic Control Laboratory

ETH Zurich
Prof. Florian Dörfler
Assistant Professor
Physikstrasse 3, ETL I 26
8092 Zürich

Tel. +41 44 632 72 88
Fax +41 44 632 12 11
dorfler@control.ee.ethz.ch
www.control.ee.ethz.ch

Zürich, December 19, 2019

Subject: Letter of Commitment (LoC)

To Whom It May Concern:

I undersigned Florian Dörfler, in my quality of Professor of the Automatic Control Laboratory at the Swiss Federal Institute of Technology (ETH) Zürich, commit to set up all necessary provisions to participate as partner organisation in the proposal "*Innovative tools for Cyber-Physical Energy Systems*", submitted by Dr. Guangya Yang, Technical University of Denmark, within the call H2020-MSCA-ITN-2020 should the proposal be funded.

On behalf of ETH Zürich, I also confirm that we will participate and contribute to the research, innovation and training activities as planned in this project. In particular, our Automatic Control Laboratory will be involved in Work Package 4 (Cyber and physical symbiosis) with ESR 11 on digitalized power converter design for fast prototype and control appraisal in conjunction with AIT Austrian Institute of Technology GmbH.

I hereby declare that I am entitled to commit into this process the entity I represent.

Sincerely,

Florian Dörfler

To whom it may concern

Halden 03.01.2020

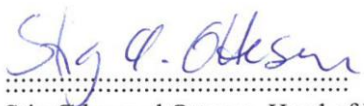
Letter of Commitment (LoC)

I undersigned, Stig Ødegaard Ottesen, in my quality of Head of R&D at eSmart Systems AS, commit to set up all necessary provisions to participate as partner organisation in the proposal "Innovative tools for Cyber-Physical Energy Systems", submitted by Dr. Guangya Yang, Technical University of Denmark, within the call H2020-MSCA-ITN-2020 should the proposal be funded.

On behalf of eSmart Systems I also confirm that we will participate and contribute to the research, innovation and training activities as planned in this project. In particular, we will be involved in co-supervision and secondment of one ESR.

I hereby declare that I am entitled to commit into this process the entity I represent.

Stig Ødegaard Ottesen
Head of R&D eSmart Systems AS
Håkon Melbergs vei 16, NO-1783 Halden



Stig Ødegaard Ottesen, Head of R&D

eSmart Systems AS, Håkon Melbergsvei 16, 1783 Halden, Norway
www.esmartsystems.com, knut.johansen@esmartsystems.com
Tel: + 47 909 81 318, Organisation Number NO. 998927854 MVA

Letter of Commitment

I undersigned, Maria Inês Lynce de Faria, in my quality of President of the Board of Directors, commit to set up all necessary provisions to participate as partner organisation in the proposal "Innovative tools for Cyber-Physical Energy Systems", submitted by Dr. Guangya Yang, Technical University of Denmark, within the call H2020-MSCA-ITN-2020 should the proposal be funded.

On behalf of INESC ID - Instituto de Engenharia de Sistemas e Computadores: Investigação e Desenvolvimento em Lisboa (INESC-ID), I also confirm that we will participate and contribute to the research, innovation and training activities as planned in this project. In particular, INESC-ID will be involved in:

- Co-Supervision of ESR 2 (Information model development for multiple actors' coordination);
- Co-Supervision of ESR 7 (Real-time analytics on high fidelity synchronized measurements);
- Hosting a 3 Months secondment of ESR 7 (Real-time analytics on high fidelity synchronized measurements);
- Hosting a 3 Months secondment of ESR 14 (Economic assessment, CBA analysis, market operation, optimization);
- Lecturing in training school 3 (Theme: Cyber-physical power systems);
- Lecturing in training school 4 (Theme: Data handling).

I hereby declare that I am entitled to commit into this process the entity I represent.

Maria Inês Lynce de Faria

Maria Inês Lynce de Faria

Date: 13/01/2020

INESC-ID - Instituto de Engenharia de Sistemas e Computadores
Investigação e Desenvolvimento em Lisboa
Rua Alves Redol, n.º 9 – 1000-029 LISBOA
Contribuinte N.º 501 547 593 - 5.º D. F. LISBOA (3298) - CAE 72190

NARI 南瑞集团公司
NARI GROUP CORPORATION

Letters of Commitment

To whom it May Concern:

On behalf of NARI, and my capacity of General Manager of Power System Stability Control Branch Company, NARI, I commit to set up all necessary provisions to participate as partner organisation in the proposal "Innovative tools for Cyber-Physical Energy Systems", submitted by Dr. Guangya Yang, Technical University of Denmark, within the call H2020-MSCA-ITN-2020 should the proposal be funded.

On behalf of NARI, I also confirm that we will participate and contribute to the research, innovation and training activities as planned in this project. In particular, our Power System Stability Control Branch Company will be involved in co-supervision of ESR8, ESR15 and secondment of ESR8,14, 15. We will provide in kind support for the project through experience and knowledge of key members of the research group led by Prof Yusheng Xue, and access to the research facilitities including RTDS system, FASTEST(Fast Analysis of Stability using EEAC and Simulation Technologies) , and DSMES (Dynamic Simulation platform for Macro-Energy Systems).

I hereby declare that I am entitled to commit into this process the entity I represent.

Feng Xue
General Manager, Power System Stability Control Branch Company, NARI, China
No.19 Chengxin Avenue, Nanjing, China

T: +86-25-81093737
M: +86-15850791466
E: xue-feng@sgepri.sgcc.com.cn

Tuesday, 31 December 2019

To whom it May Concern:

Re: UNSW Letter of Commitment – Professor Joe Dong

On behalf of UNSW Sydney (UNSW) and in my capacity as Director, UNSW Research Grants and Contracts, I am confirming that we will commit the necessary provisions to facilitate UNSW as a partner organisation in the proposal '*Innovative tools for Cyber-Physical Energy Systems*', submitted by Dr Guangya Yang, Technical University of Denmark, within the call H2020-MSCA-ITN-2020 should the proposal be funded.

On behalf of UNSW, I also confirm that we will participate and contribute to the research, innovation and training activities as planned in this project. In particular, our UNSW Digital Grid Futures Institute will be involved in co-supervision of ESR14 and secondment of ESR14 and 15. We will provide in kind support for the project through experience and knowledge of key members of the institute led by Prof Joe Dong, and access to the research facilities including RTDS system and Digital Wind Power Control and Certification/Verification system facilities.

I hereby declare that I am entitled to commit into this process the entity I represent.

Yours sincerely

Debbie Docherty
Director, Research Grants and Contracts

T: +61 (2) 9385 5249
M: +61 (0) 413 314 841
E: d.docherty@unsw.edu.au

SIEMENS

Siemens A/S, RC-DK SI DS EXE EN, Borupvang 9, 2750 Ballerup

Name Lars Hansen
Department RC-DK SI DS EXE EN

Telephone +45 4477-4366
Mobile +45 6177 2330
E-mail lars.hansen@siemens.com

Your letter of H2020-MSCA-ITN-2020
Our reference LAH
Date January 3, 2020

Dear Sirs,

I undersigned Lars Hansen in my quality of Systems Engineering Manager commit to set up all necessary provisions to participate as partner organisation in the proposal “Innovative tools for Cyber-Physical Energy Systems”, submitted by Dr. Guangya Yang, Technical University of Denmark, within the call H2020-MSCA-ITN-2020 should the proposal be funded.

On behalf of Siemens A/S, I also confirm that we will participate and contribute to the research, innovation and training activities as planned in this project. In particular, our MindSphere Academy will be involved in training school 1 and 3 related to introduction and training of MindSphere, cybersecurity, and product lifecycle management.

I hereby declare that I am entitled to commit into this process the entity I represent.

Sincerely yours,

Siemens A/S

Hansen Lars
Digitalt signeret af Hansen Lars
DN: cn=Hansen Lars, o=Siemens, email=lars.hansen@siemens.com
Dato: 2020.01.03 07:51:36 +01'00'

Lars Hansen

Ruff Henrik
Digitalt signeret af Ruff Henrik
Dato: 2020.01.03 08:36:27 +01'00'

Henrik Ruff

Notice: Compliance with legal and internal regulations is an integral part of all business processes at Siemens. Possible infringements can be reported to our HelpDesk “Tell us” at www.siemens.com/tell-us

Ørsted

Kraftværksvej 53
7000 Fredericia
Denmark

Letter of Commitment

10 January 2020

Our ref. 1-01638-15

To whom it May Concern:

On behalf of Ørsted, and my capacity of Director of R&D in Ørsted Offshore, I commit to set up all necessary provisions to participate as partner organisation in the proposal "Innovative Tools for Cyber-Physical Energy Systems", submitted by Dr. Guangya Yang, Technical University of Denmark, within the call H2020-MSCA-ITN-2020 should the proposal be funded.

On behalf of Ørsted, I also confirm that we will participate and contribute to the research, innovation and training activities as planned in this project. In particular, Ørsted Offshore will be involved in co-supervision of ESR1 and secondment of ESR1 and one more potential ESR, and courses of Training School 1 or other training schools if relevant. We will provide support to the project by sharing knowledge in the offshore renewable sector, insight and experience of the newest SCADA solutions to offshore wind power plants, as well as possibilities of accessing the internal analytics lab exploiting offshore operational experience.

I hereby declare that I am entitled to commit into this process the entity I represent.

Yours sincerely
Ørsted

Christina Aabo, CHRAA
Director of R&D
Tel 9955 7561

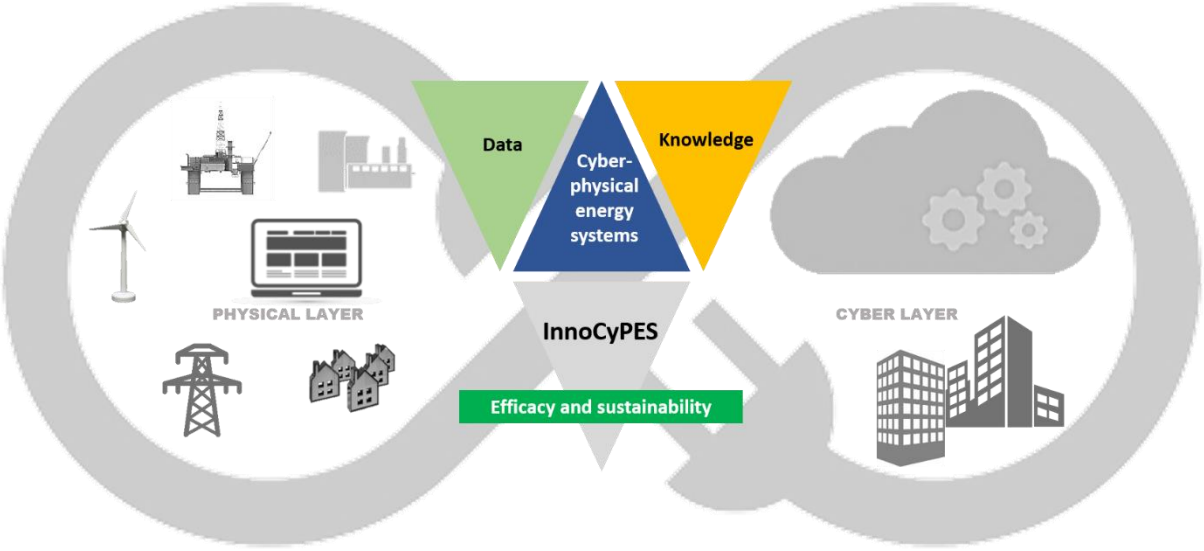
chraa@orsted.dk
orsted.com

End Page

MARIE SKŁODOWSKA-CURIE ACTIONS

Innovative Training Networks (ITN)
Call: H2020-MSCA-ITN-2020

PART B

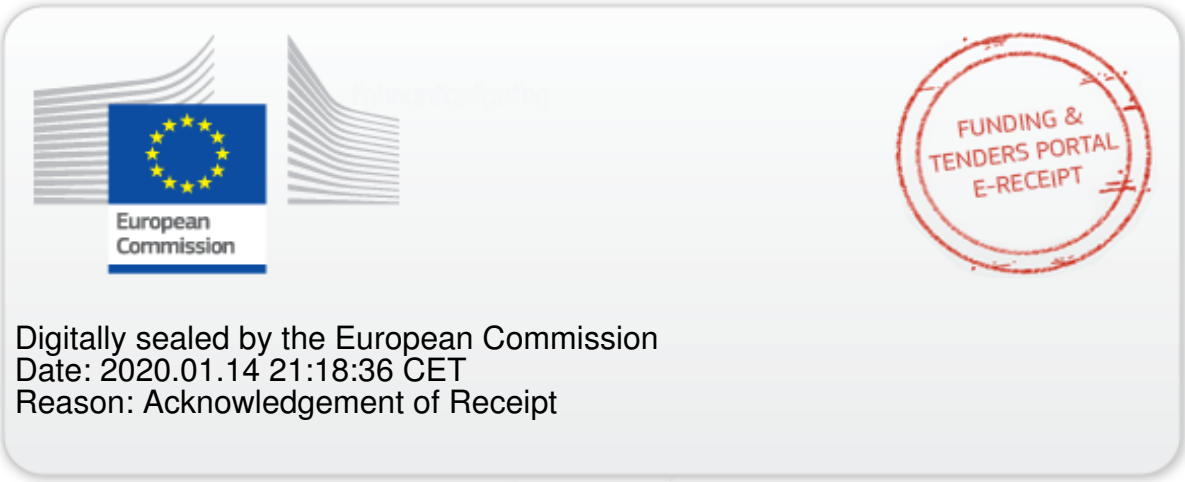


InnoCyPES

Innovative tools for Cyber-Physical Energy Systems

This proposal is to be evaluated as:

[ETN]



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