electra
Turn on the Grid of the Future

Future role of DSO with large-scale DERs workshop

Aachen - 19/03/2015

ELECTRA presentation

Mattia Marinelli

European Commission

The research leading to these results has received funding from the European Union Seventh Framework Programme (*FP7/2007-2013*) under *grant agreement* n° 609687

DTU Technical University of Denmark

EERA
European Energy Research Alliance
Smart Grids Joint Programme

www.ElectraIRP.eu

Agenda

- **ELECTRA project overview**
- **Web-of-cell concept**
- **Use cases synopsis**
- **Mapping to the 10 questions…**

The ELECTRA IRP

Proposal full title: "**E**uropean **L**iaison on **E**lectricity grid **C**ommitted **T**owards long-term **R**esearch **A**ctivities"

Proposal acronym: **ELECTRA**

Topic ENERGY.2013.10.1.8 - Integrated Research Programme on Smart Grids

Type of Funding scheme: Combination of Collaborative Project and CSA

Submitted: 10/01/2013 **Starting Date: 01/12/2013** **Ending Date: 30/11/2017**

ELECTRA IRP in figures:

- **21** Partners
- **12** Work Packages
- **48** Months
- **13.1 M€** Total Budget
- **16** EU Countries
- **1 + 1** **AB + ICB**
- **10.0 M€** EU Funds

ELECTRA IRP Participants

European FP7-ENERGY-2013-IRP

no.	Participant Organisation name	Country
1		IT
2		AT
3		BE
4		BE
5		DK
6		FI
7		FR
8		DE
9		GR
10		IT
11		LV
12		NO
13		PL
14		PT
15		ES
16		NL/BE
17		NL
18		TR
19		UK
20		DE
21		DE

The ELECTRA IRP
Goals and Objectives

The **ELECTRA IRP will develop radically new control schemes for the real time operation of the 2030 power system**. This will enable grid operators to ensure dynamic balance and stability in a future power system with a high share of decentralised generation.

The ultimate goal of ELECTRA is to test the developed new control concepts at experimental level and in such a way that industrial stakeholders can implement these innovative solutions in field testing activities in a subsequent phase

The ELECTRA IRP overarching goal is to reinforce the EERA Joint Programme on Smart Grids with the aim to strengthen coordinated European research building support for realizing the European SET Plan objectives.

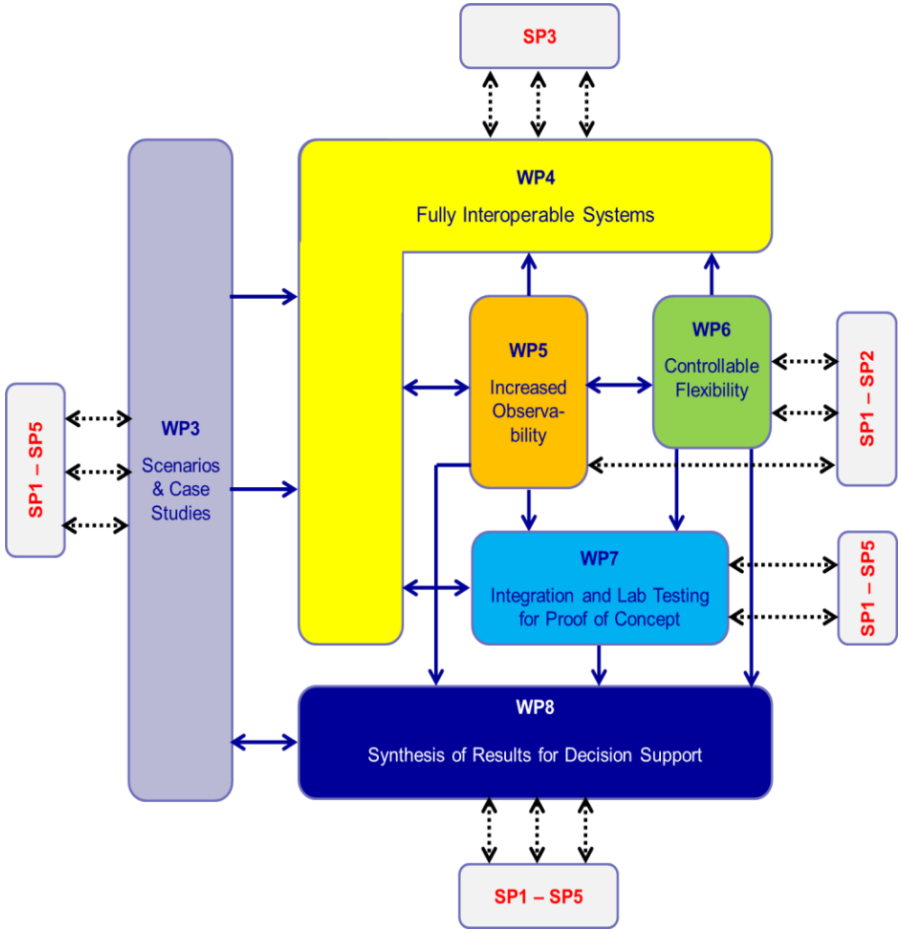
The ELECTRA IRP
Work Packages

Work package No	Work package	Type of activity	Lead participant short name	Person-month	Start Month	End Month
	CSA					
	RTD Activity					
	CSA					
	MGT					
	OTH					
			TOTAL	**~1000**		

The ELECTRA IRP
Work Packages

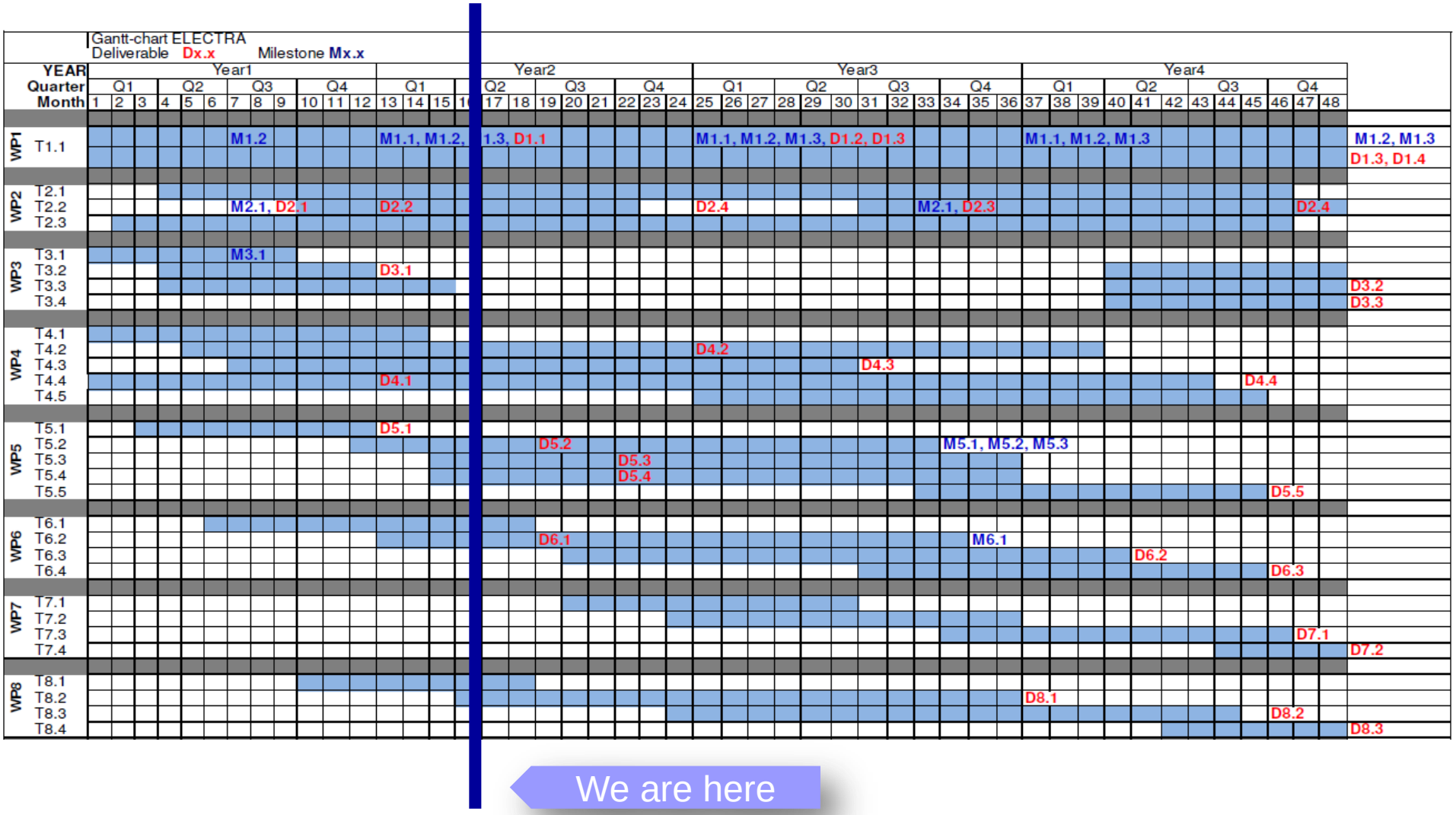
Work package No	Work package	Type of activity	Lead participant short name	Person-month	Start Month	End Month
WP1	Coordination and Networking	COORD	RSE		**M01**	M48
WP2	Development of Joint Research Facilities	COORD	DERlab		**M02**	M48
WP3	Scenario & Case Studies for Future Power System Operation	RTD	TEC		**M01**	M48
WP4	Fully Interoperable Systems	RTD	VITO		**M01**	M45
WP5	Increased Observability	RTD	SINTEF		**M03**	M45
WP6	Controllable Flexibility	RTD	VTT		**M06**	M45
WP7	Integration and Lab Testing for Proof of Concept	RTD	AIT		M20	M48
WP8	Future control room functionality	RTD	DTU		**M10**	M48
WP9	Researchers Exchange	COORD	USTRATH		**M06**	M45
WP10	Actions on International Cooperation	COORD	RSE		**M03**	M46
WP11	Program Management and Reporting	MGT	RSE		**M01**	M48
WP12	Dissemination, Knowledge Transfer and Exploitation	OTHER	RSE		**M01**	M48
		TOTAL		**~1000**		

R&D Work Programme



- **WP3**: How will the future power system look like?
- **WP4**: How can different concepts be translated in technical specifications?
- **WP5**: The uncertainty increases – What need to be observed?
- **WP6**: Need for flexibility from all available resources - What kind of flexibility will be available?
- **WP7**: How can new control concepts be evaluated at laboratory scale level?
- **WP8**: How can decision for future control rooms be supported?

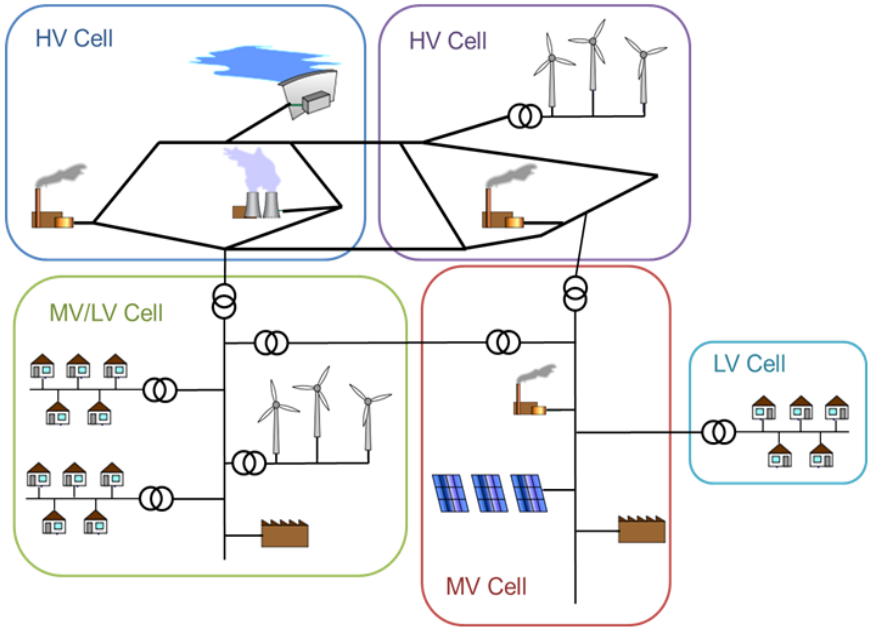
Gantt


Gantt-chart ELECTRA
Deliverable Dx.x
Milestone Mx.x
YEAR
Year1
Year2
Year3
Year4
Quarter
Q1
Q2
Q3
Q4
Month
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48
WP1
T1.1
M1.2
M1.1, M1.2,
1.3, D1.1
M1.1, M1.2, M1.3, D1.2, D1.3
M1.1, M1.2, M1.3
M1.2, M1.3
D1.3, D1.4
WP2
T2.1
T2.2
T2.3
M2.1, D2.1
D2.2
D2.4
M2.1, D2.3
D2.4
WP3
T3.1
T3.2
T3.3
T3.4
M3.1
D3.1
D3.2
D3.3
WP4
T4.1
T4.2
T4.3
T4.4
T4.5
D4.2
D4.3
D4.1
D4.4
WP5
T5.1
T5.2
T5.3
T5.4
T5.5
D5.1
D5.2
D5.3
D5.4
M5.1, M5.2, M5.3
D5.5
WP6
T6.1
T6.2
T6.3
T6.4
D6.1
M6.1
D6.2
D6.3
WP7
T7.1
T7.2
T7.3
T7.4
D7.1
D7.2
WP8
T8.1
T8.2
T8.3
T8.4
D8.1
D8.2
D8.3
We are here

Achieved results
T3.2 Web-of-Cells Concept

Control Cell concept: a "cell" is…

- …a group of interconnected loads, distributed generation resources and storage units, with well-defined electrical and geographical boundaries.



- …is connected to neighboring cells via tie-lines (one or multiple). By opening or closing the inter-cells connections, the global system is configurable.
- Has adequate monitoring infrastructure installed as well as local reserves capacity.
- Uses the inter-cell coordination in order to support system-wide optimized reserves activation.
- Can contain multiple voltage levels (MV/LV).
- Is managed by a ***Control Cell Operator* (CCO)**.

Achieved results
T3.2 Use Cases

Summary of Use Cases:

	PRESENT GRID	FUTURE 2030+ GRID
BALANCE / FREQUENCY CONTROL	-	Inertia control
	Frequency containment control (FCC)	Frequency containment control (FCC)
	Frequency restoration control (FRC)	Balance restoration control (BRC)
	Replacement reserve (RR)	Balance steering control (BSC)

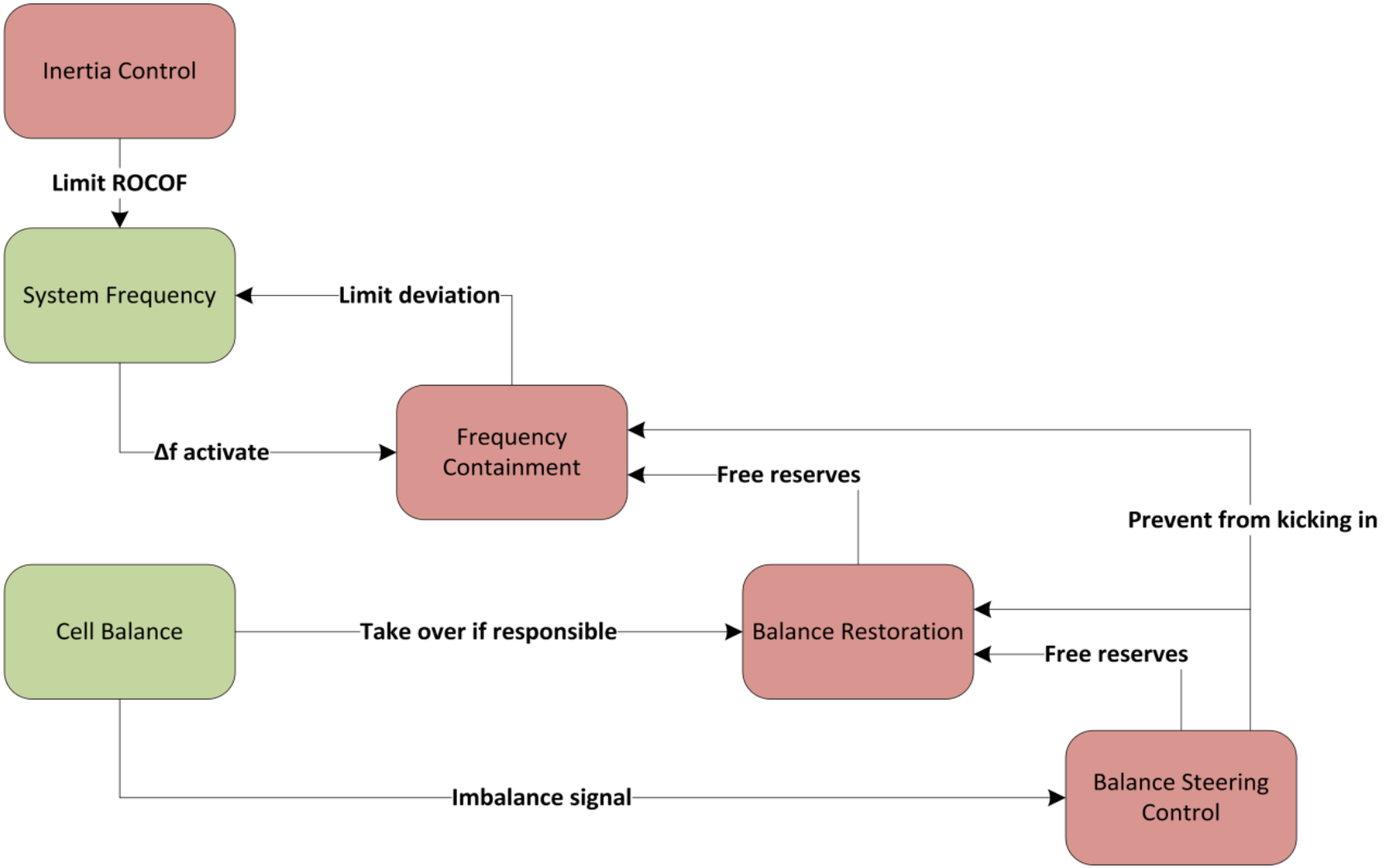
	PRESENT GRID	FUTURE 2030+ GRID
TRANSMISSION / VOLTAGE CONTROL	Primary voltage control (PVC)	Primary voltage control (PVC)
	Secondary voltage control (SVC)	Post-primary voltage control (PPVC)
	Tertiary voltage control (TVC)	

Balance/frequency control

- **Frequency stability is a global system wide issue**. In the proposed cell-based architecture, **the main principles of Load-Frequency Control still apply**. These principles are however applied at **cell level instead of at Control Area level**, requiring novel observables and a novel control architecture

1. **Inertia control:** limitation of rate of change of frequency (df/dt) to a maximum allowed value dfmax/dt
2. **Frequency containment control**: stabilization of the frequency deviation to a set safe band (as already done today, but including also the participation of loads)
3. **Balance restoration control**: restoring cell active power balance (inter-cell load flows to their scheduled secure values).
4. **Balance steering control:** freeing up balance restoration and preventing activation of frequency containment (via short term forecast). Global optimization.

Balance/frequency control



Transmission/voltage control

Voltage stability is a local issue, therefore it is appropriate to solve these issues **using resources located as close as possible** to the occurring problem (using as many resource as possible within each cell). Furthermore, since it is expected that more generating units will be connected at distribution level, **fewer big power plants will be available for voltage control services at transmission level**. As a consequence, there will be a displacement of responsibilities from transmission to distribution levels.

1. **Primary voltage control:** automatic control accomplished by fast-acting devices (it may include also active power provision in LV grids).
2. **Post primary voltage control**: bring the voltage levels in the nodes of the power system back to nominal values while optimizing the reactive power flows in order to reduce the losses in the network.

Workshop questions 1-5

1. Expected outcome of the solutions?
   - 2030+
2. EU distribution automation trends?
   - Local problems solved locally
3. Observability needs?
   - WP5 is devoted to this. 20+ control triples identified (both classical and innovative)
4. Requirement for supply reliability?
   - TBD
5. DSO Resources for congestions management?
   - WP6 activities are devoted to this evaluation

Workshop questions 6-10

6. Flexibility availability at DSO level (when)?
   - WP6 activities are devoted to this evaluation (R6.1)
7. Trading of flexibility services at DSO level?
   - 2030+
8. Coordination of resources among players?
   - TBD in WP6 (controller conflicts)
9. Standardization needed for information exchange?
   - TBD in WP4 (interoperability)
10. Regulation framework evolution?
   - Increased delegation of responsibilities to DSOs

CONTACT INFORMATION

Mattia Marinelli

matm@elektro.dtu.dk

ELECTRA IRP website link:
www.ElectraIRP.eu