Politecnico di Torino

PROCEDURA DI GARA N° 01/2023 – Partenariato pubblico-privato istituzionalizzato ex art. 17 del decreto legislativo 19 agosto 2016 n. 175 per la realizzazione, gestione ed utilizzo di una infrastruttura tecnologica di innovazione nazionale in rete per la simulazione e il monitoraggio del sistema energetico nell'ambito del Progetto IRSME
CODICE IDENTIFICATIVO GARA: CIG 95641423A8 – CUP E17G22000590001 – CUI F00518460019202300012 1

PROGETTO APPROVATO DAL MUR

Ministero dell'Università e della Ricerca
Direzione generale dell'internazionalizzazione e della comunicazione

Avviso per la *"Concessione di finanziamenti destinati alla realizzazione o ammodernamento di Infrastrutture Tecnologiche di Innovazione"* da finanziare nell'ambito del PNRR

Piano Nazionale di Ripresa e Resilienza, Missione 4, *"Istruzione e Ricerca"* - Componente 2, *"Dalla ricerca all'impresa"* - Linea di investimento 3.1, *"Fondo per la realizzazione di un sistema integrato di infrastrutture di ricerca e innovazione"*, finanziato dall'Unione europea - NextGenerationEU

Proposta definitiva

Intervention field 6: Investment in digital capacities and deployment of advanced technologies
DESI dimension 4: Integration of digital technologies + ad hoc data collections
055 - Other types of ICT infrastructure(including large - scale computer resources / equipment, data centres, sensors and other wireless equipment)

Finanziato dall'Unione europea
NextGenerationEU

MUR
Ministero dell'Università e della Ricerca

Spett.le
Ministero dell'università e della ricerca
Direzione Generale dell'internazionalizzazione e della comunicazione
Via Michele Carcani, 61 – 00153 ROMA

OGGETTO: Proposta definitiva in esito alla fase negoziale per l'accesso alle agevolazioni previste dall'Avviso per la concessione di finanziamenti destinati alla realizzazione o ammodernamento di Infrastrutture Tecnologiche di Innovazione, da finanziare nell'ambito del PNRR – Progetto identificato con il codice B2473605 – IRSME

Il sottoscritto Guido Saracco, nato a TORINO il 24/11/1965, nella sua qualità di legale rappresentante (ovvero, procuratore speciale, in forza di idonea e adeguata procura speciale) del Soggetto Proponente Politecnico di Torino, con sede legale in TORINO, alla via CORSO DUCA DEGLI ABRUZZI , 24,

DICHIARA

- che la proposta definitiva è coerente con gli esiti della fase negoziale espletata a norma dell'art. 11 dell'Avviso in parola;

DICHIARA, altresì

- di confermare tutto quanto già dichiarato in sede di presentazione della Domanda recante Codice B2473605
- di essere consapevole che, in caso di dichiarazioni mendaci, ovunque rilasciate nel contesto della presente proposta e nei documenti ad essa allegati, potrà incorrere nelle sanzioni penali richiamate dall'art. 76 del D.P.R. 445/2000, oltre alla decadenza dai benefici, come previsto dall'art. 75 del D.P.R. in parola, conseguenti il provvedimento emanato in base alle dichiarazioni non veritiere;
- di consentire al trattamento dei dati personali per le finalità e con le modalità di cui al decreto legislativo 30 giugno 2003, n. 196, e successive modifiche ed integrazioni.

PRESENTA

la proposta progettuale identificata nella piattaforma GEA con il codice ITEC0000021, di cui alla presente. Costituiscono parte integrante e sostanziale della proposta tutti gli allegati indicati nella Sezione Allegati, che si intendono sottoscritti in uno alla presente, nonché gli Allegati trasmessi in sede di presentazione della domanda, come modificati in questa sede.

Firmato digitalmente

Proposta definitiva

Avviso per la "Concessione di finanziamenti destinati alla realizzazione o ammodernamento di Infrastrutture Tecnologiche di Innovazione" da finanziare nell'ambito del PNRR – Proposta progettuale definitiva in esito alla fase negoziale – Codice B2473605

Soggetto proponente

- **Anagrafica Soggetto Proponente**
    - Denominazione: Politecnico di Torino
    - Codice CAR: 000182_UNIV
    - CF: 00518460019
    - Pec: politecnicoditorino@pec.polito.it
    - Tipologia soggetto: Università e Scuole Superiori a Ordinamento Speciale
    - Sede legale:
        - CAP: 10129
        - Via/Piazza: CORSO DUCA DEGLI ABRUZZI
        - Civico: 24
        - Comune: TORINO
        - Provincia: TORINO
        - Regione: Piemonte
- **Anagrafica Rappresentante Legale**
    - Nome: Guido
    - Cognome: Saracco
    - Codice fiscale: SRCGDU65S24L219S
    - E-mail: rettore@polito.it
    - Data di nascita: 24/11/1965
    - Comune di nascita: TORINO
    - Sesso: Maschio
- **Anagrafica Referente del progetto**
    - Nome: ROMANO
    - Cognome: BORCHIELLINI
    - Telefono: 0110908507
    - Cellulare: 00393386094049
    - E-mail: itec.energia@polito.it

Finanziato dall'Unione europea
NextGenerationEU

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Dati di sintesi della proposta progettuale

Titolo del Progetto: NATIONAL INNOVATION INFRASTRUCTURE NETWORK FOR THE SIMULATION AND MONITORING OF THE ENERGY SYSTEM

Acronimo del Progetto: IRSME

Settori e ambiti prevalenti dell'iniziativa:

- Clima, energia, mobilità sostenibile:

- Mobilità sostenibile
- Energetica industriale
- Transizione energetica totale
- Energetica ambientale
- Transizione energetica ambientale

Keywords:

hardware in the loop; digital twin; energy networks; energy scenario; real time simulation; interconnected lab; Hypergrids; energy transition; sector-coupling;

Livelli di maturità tecnologica prevalente (TLR): 6; 7; 8;

Data di avvio del progetto: 01/01/2023

Durata del progetto (in mesi): 36

Costo complessivo del progetto: 34.708.000,00 €

Tipologia intervento: Realizzazione/Creazione

Localizzazione

Infrastruttura distribuita: Si

Numero sedi: 13

Sede 1

- CAP: 10138
- Via/Piazza: Via Paolo Borsellino
- Civico: 36 int 16
- Comune: TORINO
- Provincia: TORINO
- Regione: Piemonte

Sede 2

- CAP: 80138
- Via/Piazza: Corso Umberto I
- Civico: 40
- Comune: NAPOLI
- Provincia: NAPOLI
- Regione: Campania

Sede 3

- CAP: 70126
- Via/Piazza: Via Edoardo Orabona
- Civico: 4
- Comune: BARI
- Provincia: BARI
- Regione: Puglia

Sede 4

- CAP: 20133
- Via/Piazza: Piazza Leonardo da Vinci
- Civico: 32
- Comune: MILANO
- Provincia: MILANO
- Regione: Lombardia

Sede 5

- CAP: 09124
- Via/Piazza: Via Università
- Civico: 40
- Comune: CAGLIARI
- Provincia: CAGLIARI
- Regione: Sardegna

Sede 6

- CAP: 87036
- Via/Piazza: Via Pietro Bucci
- Civico: s.n.
- Comune: RENDE
- Provincia: COSENZA
- Regione: Calabria

Sede 7

- CAP: 16128
- Via/Piazza: via del molo
- Civico: 65
- Comune: GENOVA
- Provincia: GENOVA
- Regione: Liguria

Sede 8

- CAP: 40126
- Via/Piazza: Via Zamboni
- Civico: 33
- Comune: BOLOGNA
- Provincia: BOLOGNA
- Regione: Emilia Romagna

Sede 9

- CAP: 35122
- Via/Piazza: Via VIII Febbraio
- Civico: 2
- Comune: PADOVA
- Provincia: PADOVA
- Regione: Veneto

Sede 10

- CAP: 90133
- Via/Piazza: Piazza Marina
- Civico: 61
- Comune: PALERMO
- Provincia: PALERMO
- Regione: Sicilia

Sede 11

- CAP: 56126
- Via/Piazza: Lungarno Antonio Pacinotti
- Civico: 43
- Comune: PISA
- Provincia: PISA
- Regione: Toscana

Sede 12

- CAP: 34127
- Via/Piazza: Piazzale Europa
- Civico: 1
- Comune: TRIESTE
- Provincia: TRIESTE
- Regione: Friuli Venezia Giulia

Sede 13

- CAP: 00185
- Via/Piazza: Piazzale Aldo Moro
- Civico: 5
- Comune: ROMA
- Provincia: ROMA
- Regione: Lazio

Piano economico

Costi complessivi di progetto

Spese ammissibili	Costi (€) (1)	IVA (€) (2)	Totale (€) (1+2)
a) Spese Manager Infrastruttura ed altre figure manageriali	1.000.000,00	0,00	1.000.000,00
b) Strumentazione scientifica, apparecchiature e macchinari	15.867.540,00	4.475.460,00	20.343.000,00
c) Impianti tecnici generici	3.771.300,00	1.063.700,00	4.835.000,00
d) Licenze software e brevetti	1.060.800,00	299.200,00	1.360.000,00
e) Fabbricati e terreni	0,00	0,00	0,00
f) Recupero, ristrutturazione, riqualificazione e ampliamento immobili	1.326.000,00	374.000,00	1.700.000,00
g) Spese per progettazione e altre spese tecniche	2.652.000,00	748.000,00	3.400.000,00
h) Costi indiretti	2.070.000,00	0,00	2.070.000,00
Totale (€)	27.747.640,00	6.960.360,00	34.708.000,00

Articolazione costi di progetto per localizzazione

Sede/Sito 1			
Spese ammissibili	**Costi (€) (1)**	**IVA (€) (2)**	**Totale (€) (1+2)**
a) Spese Manager Infrastruttura ed altre figure manageriali	600.000,00	0,00	600.000,00
b) Strumentazione scientifica, apparecchiature e macchinari	1.323.660,00	373.340,00	1.697.000,00
c) Impianti tecnici generici	397.800,00	112.200,00	510.000,00
d) Licenze software e brevetti	106.080,00	29.920,00	136.000,00
e) Fabbricati e terreni	0,00	0,00	0,00
f) Recupero, ristrutturazione, riqualificazione e ampliamento immobili	132.600,00	37.400,00	170.000,00
g) Spese per progettazione e altre spese tecniche	265.200,00	74.800,00	340.000,00
h) Costi indiretti	241.000,00	0,00	241.000,00
Totale (€)	3.066.340,00	627.660,00	3.694.000,00

Sede/Sito 2			
Spese ammissibili	**Costi (€) (1)**	**IVA (€) (2)**	**Totale (€) (1+2)**
a) Spese Manager Infrastruttura ed altre figure manageriali	400.000,00	0,00	400.000,00
b) Strumentazione scientifica, apparecchiature e macchinari	2.730.000,00	770.000,00	3.500.000,00
c) Impianti tecnici generici	390.000,00	110.000,00	500.000,00
d) Licenze software e brevetti	159.120,00	44.880,00	204.000,00
e) Fabbricati e terreni	0,00	0,00	0,00
f) Recupero, ristrutturazione, riqualificazione e ampliamento immobili	198.900,00	56.100,00	255.000,00
g) Spese per progettazione e altre spese tecniche	397.800,00	112.200,00	510.000,00
h) Costi indiretti	300.000,00	0,00	300.000,00
Totale (€)	4.575.820,00	1.093.180,00	5.669.000,00

Sede/Sito 3			
Spese ammissibili	**Costi (€) (1)**	**IVA (€) (2)**	**Totale (€) (1+2)**
a) Spese Manager Infrastruttura ed altre figure manageriali	0,00	0,00	0,00
b) Strumentazione scientifica, apparecchiature e macchinari	677.820,00	191.180,00	869.000,00
c) Impianti tecnici generici	198.900,00	56.100,00	255.000,00
d) Licenze software e brevetti	53.040,00	14.960,00	68.000,00
e) Fabbricati e terreni	0,00	0,00	0,00
f) Recupero, ristrutturazione, riqualificazione e ampliamento immobili	66.300,00	18.700,00	85.000,00
g) Spese per progettazione e altre spese tecniche	132.600,00	37.400,00	170.000,00
h) Costi indiretti	100.000,00	0,00	100.000,00
Totale (€)	1.228.660,00	318.340,00	1.547.000,00

Sede/Sito 4			
Spese ammissibili	**Costi (€) (1)**	**IVA (€) (2)**	**Totale (€) (1+2)**
a) Spese Manager Infrastruttura ed altre figure manageriali	0,00	0,00	0,00
b) Strumentazione scientifica, apparecchiature e macchinari	2.730.000,00	770.000,00	3.500.000,00
c) Impianti tecnici generici	318.240,00	89.760,00	408.000,00
d) Licenze software e brevetti	84.864,00	23.936,00	108.800,00
e) Fabbricati e terreni	0,00	0,00	0,00
f) Recupero, ristrutturazione, riqualificazione e ampliamento immobili	106.080,00	29.920,00	136.000,00
g) Spese per progettazione e altre spese tecniche	212.160,00	59.840,00	272.000,00
h) Costi indiretti	190.400,00	0,00	190.400,00
Totale (€)	3.641.744,00	973.456,00	4.615.200,00

Sede/Sito 5			
Spese ammissibili	**Costi (€) (1)**	**IVA (€) (2)**	**Totale (€) (1+2)**
a) Spese Manager Infrastruttura ed altre figure manageriali	0,00	0,00	0,00
b) Strumentazione scientifica, apparecchiature e macchinari	1.219.920,00	344.080,00	1.564.000,00
c) Impianti tecnici generici	358.020,00	100.980,00	459.000,00
d) Licenze software e brevetti	95.472,00	26.928,00	122.400,00
e) Fabbricati e terreni	0,00	0,00	0,00
f) Recupero, ristrutturazione, riqualificazione e ampliamento immobili	119.340,00	33.660,00	153.000,00
g) Spese per progettazione e altre spese tecniche	238.680,00	67.320,00	306.000,00
h) Costi indiretti	180.200,00	0,00	180.200,00
Totale (€)	2.211.632,00	572.968,00	2.784.600,00

Sede/Sito 6			
Spese ammissibili	**Costi (€) (1)**	**IVA (€) (2)**	**Totale (€) (1+2)**
a) Spese Manager Infrastruttura ed altre figure manageriali	0,00	0,00	0,00
b) Strumentazione scientifica, apparecchiature e macchinari	677.820,00	191.180,00	869.000,00
c) Impianti tecnici generici	198.900,00	56.100,00	255.000,00
d) Licenze software e brevetti	53.040,00	14.960,00	68.000,00
e) Fabbricati e terreni	0,00	0,00	0,00
f) Recupero, ristrutturazione, riqualificazione e ampliamento immobili	66.300,00	18.700,00	85.000,00
g) Spese per progettazione e altre spese tecniche	132.600,00	37.400,00	170.000,00
h) Costi indiretti	100.000,00	0,00	100.000,00
Totale (€)	1.228.660,00	318.340,00	1.547.000,00

Sede/Sito 7			
Spese ammissibili	**Costi (€) (1)**	**IVA (€) (2)**	**Totale (€) (1+2)**
a) Spese Manager Infrastruttura ed altre figure manageriali	0,00	0,00	0,00
b) Strumentazione scientifica, apparecchiature e macchinari	677.820,00	191.180,00	869.000,00
c) Impianti tecnici generici	198.900,00	56.100,00	255.000,00
d) Licenze software e brevetti	53.040,00	14.960,00	68.000,00
e) Fabbricati e terreni	0,00	0,00	0,00
f) Recupero, ristrutturazione, riqualificazione e ampliamento immobili	66.300,00	18.700,00	85.000,00
g) Spese per progettazione e altre spese tecniche	132.600,00	37.400,00	170.000,00
h) Costi indiretti	100.000,00	0,00	100.000,00
Totale (€)	1.228.660,00	318.340,00	1.547.000,00

Sede/Sito 8			
Spese ammissibili	**Costi (€) (1)**	**IVA (€) (2)**	**Totale (€) (1+2)**
a) Spese Manager Infrastruttura ed altre figure manageriali	0,00	0,00	0,00
b) Strumentazione scientifica, apparecchiature e macchinari	1.084.980,00	306.020,00	1.391.000,00
c) Impianti tecnici generici	318.240,00	89.760,00	408.000,00
d) Licenze software e brevetti	84.864,00	23.936,00	108.800,00
e) Fabbricati e terreni	0,00	0,00	0,00
f) Recupero, ristrutturazione, riqualificazione e ampliamento immobili	106.080,00	29.920,00	136.000,00
g) Spese per progettazione e altre spese tecniche	212.160,00	59.840,00	272.000,00
h) Costi indiretti	159.400,00	0,00	159.400,00
Totale (€)	1.965.724,00	509.476,00	2.475.200,00

Sede/Sito 9			
Spese ammissibili	**Costi (€) (1)**	**IVA (€) (2)**	**Totale (€) (1+2)**
a) Spese Manager Infrastruttura ed altre figure manageriali	0,00	0,00	0,00
b) Strumentazione scientifica, apparecchiature e macchinari	1.084.980,00	306.020,00	1.391.000,00
c) Impianti tecnici generici	318.240,00	89.760,00	408.000,00
d) Licenze software e brevetti	84.864,00	23.936,00	108.800,00
e) Fabbricati e terreni	0,00	0,00	0,00
f) Recupero, ristrutturazione, riqualificazione e ampliamento immobili	106.080,00	29.920,00	136.000,00
g) Spese per progettazione e altre spese tecniche	212.160,00	59.840,00	272.000,00
h) Costi indiretti	159.400,00	0,00	159.400,00
Totale (€)	1.965.724,00	509.476,00	2.475.200,00

Sede/Sito 10			
Spese ammissibili	**Costi (€) (1)**	**IVA (€) (2)**	**Totale (€) (1+2)**
a) Spese Manager Infrastruttura ed altre figure manageriali	0,00	0,00	0,00
b) Strumentazione scientifica, apparecchiature e macchinari	1.219.920,00	344.080,00	1.564.000,00
c) Impianti tecnici generici	358.020,00	100.980,00	459.000,00
d) Licenze software e brevetti	95.472,00	26.928,00	122.400,00
e) Fabbricati e terreni	0,00	0,00	0,00
f) Recupero, ristrutturazione, riqualificazione e ampliamento immobili	119.340,00	33.660,00	153.000,00
g) Spese per progettazione e altre spese tecniche	238.680,00	67.320,00	306.000,00
h) Costi indiretti	180.200,00	0,00	180.200,00
Totale (€)	2.211.632,00	572.968,00	2.784.600,00

Sede/Sito 11			
Spese ammissibili	**Costi (€) (1)**	**IVA (€) (2)**	**Totale (€) (1+2)**
a) Spese Manager Infrastruttura ed altre figure manageriali	0,00	0,00	0,00
b) Strumentazione scientifica, apparecchiature e macchinari	745.680,00	210.320,00	956.000,00
c) Impianti tecnici generici	218.790,00	61.710,00	280.500,00
d) Licenze software e brevetti	58.344,00	16.456,00	74.800,00
e) Fabbricati e terreni	0,00	0,00	0,00
f) Recupero, ristrutturazione, riqualificazione e ampliamento immobili	72.930,00	20.570,00	93.500,00
g) Spese per progettazione e altre spese tecniche	145.860,00	41.140,00	187.000,00
h) Costi indiretti	109.900,00	0,00	109.900,00
Totale (€)	1.351.504,00	350.196,00	1.701.700,00

Sede/Sito 12			
Spese ammissibili	**Costi (€) (1)**	**IVA (€) (2)**	**Totale (€) (1+2)**
a) Spese Manager Infrastruttura ed altre figure manageriali	0,00	0,00	0,00
b) Strumentazione scientifica, apparecchiature e macchinari	745.680,00	210.320,00	956.000,00
c) Impianti tecnici generici	218.790,00	61.710,00	280.500,00
d) Licenze software e brevetti	58.344,00	16.456,00	74.800,00
e) Fabbricati e terreni	0,00	0,00	0,00
f) Recupero, ristrutturazione, riqualificazione e ampliamento immobili	72.930,00	20.570,00	93.500,00
g) Spese per progettazione e altre spese tecniche	145.860,00	41.140,00	187.000,00
h) Costi indiretti	109.900,00	0,00	109.900,00
Totale (€)	1.351.504,00	350.196,00	1.701.700,00

Sede/Sito 13			
Spese ammissibili	**Costi (€) (1)**	**IVA (€) (2)**	**Totale (€) (1+2)**
a) Spese Manager Infrastruttura ed altre figure manageriali	0,00	0,00	0,00
b) Strumentazione scientifica, apparecchiature e macchinari	949.260,00	267.740,00	1.217.000,00
c) Impianti tecnici generici	278.460,00	78.540,00	357.000,00
d) Licenze software e brevetti	74.256,00	20.944,00	95.200,00
e) Fabbricati e terreni	0,00	0,00	0,00
f) Recupero, ristrutturazione, riqualificazione e ampliamento immobili	92.820,00	26.180,00	119.000,00
g) Spese per progettazione e altre spese tecniche	185.640,00	52.360,00	238.000,00
h) Costi indiretti	139.600,00	0,00	139.600,00
Totale (€)	1.720.036,00	445.764,00	2.165.800,00

Cronoprogramma di attuazione

Obiettivi intermedi: una sintesi

Codice identificativo	Mese di avvio (dalla data di avvio progetto)	Durata (in mesi)	Stima dei costi (€)
1	01/01/2023	4	3.470.800,00
2	01/05/2023	11	22.030.919,00
3	01/04/2024	10	3.613.748,00
4	01/02/2025	7	2.121.733,00
5	01/09/2025	4	3.470.800,00
		Totale (€)	34.708.000,00

Obiettivo intermedo: 1

- Descrizione

IO1-Start up activities (e.g., IM Recruitment, Staff profiles Management Plan; Risk Management Plan) The main objective is to establish an effective management of the IRSME project. The first step will be to recruit the personnel, including the Infrastructure Manager (IM), local infrastructure coordinators and research managers. The second step of the IO1 will define the continuous monitoring procedures, the risk analysis and contingency plan and foster its long-term sustainability according to the strategies and roadmap defined. The following Actions and timespan are foreseen (See Annex1 b.4):
Task 1.1 – Recruitment (M1-M4) -Task 1.2 - Definition of the continuous monitoring procedures (M2-M4)- Task 1.3 – Definition of the risk analysis and contingency plan (M2-M4) -Task 1.4 – Definition of the models for long-term sustainability (M2-M4)

- Mese di Avvio

1

- Durata in Mesi

4

- Deliverables

Deliverable 1 – Report with profiles for the IM and other staff
Deliverable 2 – Report including the procedures for:
• Continuous monitoring and risk analysis;
• Contingency plan.
• Long-term sustainability
Recruited personnel -1 research manager (M2)

Obiettivo intermedo: 2

- Descrizione

IO2 -Design of the infrastructure: consists in completing the design phase, defining the technical specifications for all the laboratories making up IRSME. Detailed definition of the infrastructure requirements and the following aspects are expected: • Detailed requirement gathering for infrastructure labs; design of specifications for tools and equipment (input for purchasing) design of new facilities.• Technical Tools and equipment procurement: supplier inquiry, selection, agreement set up and procurement of all hardware and sourcing of all external services.• Physical space and infrastructure renovation: detailed project: Layout design for spaces, facilities and installations (input for building tenders); Technical projects for spaces facilities and installations.
Task 2.1: Design of the Infrastructural Territorial Nodes and main infrastructure (M5-M15); Task 2.2: Design of the Satellite Nodes (M5-M15); Task 2.3: Design of the operation of SNs and ITNs (M5-M15).
(See Annex1 b.4)

- Mese di Avvio

5

- Durata in Mesi

11

- Deliverables

Task 2.1 -Deliverable 1: Midterm review report (M10)
Deliverable 2: Design and executive project of the IRSME infrastructure (M15)
Task 2.2 -Deliverable 1: Midterm review report(M10)
Deliverable 2: Executive project of all Satellite Nodes (M15)
Task 2.3 - Deliverable 1: Midterm review report(M10) Deliverable 2: Final detailed report (M15)

Obiettivo intermedo: 3

- Descrizione

IO3 Renovation, refurbishment and extension of buildings. Technical installation.
After the conclusion of design phase (IO2), the renovation phase of all the laboratories part of IRSME will take place. The expected goals for this IO, within 25 months since the project start is the completion of the technical installations, along with renovation, refurbishment and extension of buildings where necessary. Task 3.1: Renovation, refurbishment and extension of buildings (M16-M25).Task 3.2: Technical installation of technology modules (M16-M25). Task 3.3: Technical installation of interface, communication and computational modules (M16-M25). (See Annex1 b.4)

- Mese di Avvio

16

- Durata in Mesi

10

- Deliverables

Task 3.1 Deliverable: As-built laboratory documentation (M20)
Task 3.2 Deliverable 1: Midterm review report Deliverable
2: Realization of the technical plants (e.g., electric power supply) in the defined area in CVIT and documentation as build of the infrastructure. (M25)
Task 3.3 Deliverable 1: Midterm review report Deliverable (M20)
2: Final detailed report (M25)

Obiettivo intermedo: 4

• Descrizione

IO4 – Installations and commissioning. After the conclusion of construction phase (IO3), the installation and commissioning phase of all the laboratories part of IRSME will take place. The expected goals for this IO, within 32 months since the project start are:
-Functional performance verification and validation tests of the infrastructure will be performed so to take the ongoing rate of activation of the facilities up to 100%. Thus, the infrastructure commissioning will be realized, and the experimental facilities activated ·
-Functional tests of all parts and software, as standalone system and in network co-operation
-Installation and commissioning of each laboratory is represented as a stand-alone task as follows.
Task 4.1: Main infrastructure commissioning (M26 – M32)
Task 4.2: Validation of the territorial infrastructural and satellites nodes (M26 – M32)
Task 4.3: Documentation and operating rules (M26 – M32)
(See Annex1 b.4)

• Mese di Avvio

26

• Durata in Mesi

7

• Deliverables

Task 4.1 Deliverable: Commissioning report for the main infrastructure (M32)
Task 4.2 Deliverable: Successful testing of the equipment of territorial and satellites nodes (M32)
Task 4.3
Deliverable 1: Intermediate test report (M29)
Deliverable 2: Final test report (M32)

Obiettivo intermedo: 5

• Descrizione

IO5 – Outreach and opening to the market. After the conclusion of commissioning phase (IO4), the outreach and opening to market phase of all the laboratories part of IRSME will take place.
The expected goals for this IO, within 36 months since the project start are:
· Opening to market
· Dissemination
Each of them is detailed as a task with its own specific timeframe as follows.
Task 5.1 – Opening to the market (M33-M36)
Task 5.2 – Dissemination (M33-M36)
(See Annex1 b.4)

• Mese di Avvio

33

• Durata in Mesi

4

• Deliverables

D1: Catalogue of services (M34)
D2: Web site creation, LinkedIn and other social media profile creation;Outreach and opening to the market (report) (M36)

Allegati

Allegato 1 - Proposal template

Allegato 1: Proposal template

Ministero dell'Università e della Ricerca
Direzione generale dell'internazionalizzazione e della comunicazione

Avviso per la *"Concessione di finanziamenti destinati alla realizzazione o ammodernamento di Infrastrutture Tecnologiche di Innovazione"* da finanziare nell'ambito del PNRR

Missione 4, "*Istruzione e Ricerca*" - Componente 2, "*Dalla ricerca all'impresa*" -
Linea di investimento 3.1, "*Fondo per la realizzazione di un sistema integrato di infrastrutture di ricerca e innovazione",* finanziato dall'Unione europea - NextGenerationEU

REFORMS AND INVESTMENTS UNDER THE RECOVERY AND RESILIENCE PLAN

NextGenerationEU

Call for proposals

Intervention field 6: Investment in digital capacities and deployment of advanced technologies
DESI dimension 4: Integration of digital technologies + ad hoc data collections
055 - Other types of ICT infrastructure (including large-scale computer resources/equipment, data centres, sensors and other wireless equipment)

Mission 4 – "Education and Research"
Component 2: from research to business
Investment 3.1: "Fund for the realisation of an integrated system of research and innovation infrastructures

Annex 1 (technical annex)

Proposal template, pursuant to Article 8 of the call for proposals

(To be provided in English only)

DISCLAIMER: This document is aimed at informing potential applicants for call-PNRR funding. It serves only as an example. The actual Web forms and templates, provided in the online proposal submission system under the online proposal submission system, might differ from this example. Proposals must be prepared and submitted only via the online proposal submission system.

Part A – Strategic framework of the initiative

(max. 12,000 characters)

A.1. Objectives of the initiative

The energy transition and its contribution to the ecological transition are played out on three levels: exploitation of primary sources, transmission and distribution infrastructures, and end-use technologies. The correct definition of the contributions of the various energy chains and their integration (**sector-coupling**) is fundamental to address the ecological transition challenges and must be included within a three-level framework: **conceptual/planning**, at the service of the political decision-maker; **industrial/technological**, at the service of the business world; **communicative/social** for the active involvement of citizens.
From this need arises the proposal of the **IRSME** (Infrastruttura di innovazione nazionale in Rete per la Simulazione e il Monitoraggio del sistema Energetico) **National Multidisciplinary Laboratory** based on an **innovative multi-site IT platform** that connects, on the GARR national research network (or other complementary solutions), National laboratories (both existing and new) **for the simulation, prototyping and testing energy systems**. The infrastructure aims to respond to the challenges posed by the energy transition by allowing **in silico** analysis and experimentation by modelling of energy infrastructures, technologies, real components, and their mutual interactions, both physical and cyber. The proposed innovative approach involves the use of **software, hardware, and power hardware-in-the-loop techniques**, including also geographically extensive systems and networks, and a multidisciplinary simulation in terms of cyber-physical-social-economic **"multi-layer"** systems, integrating real systems and components with virtual energy systems environments. The ambitious vision of the project is to create the prerequisites for the **digital-twin** of the National energy system, also in relation to its insertion in the global energy context, through the progressive implementation of **multiscale simulation** tools that integrate the representation of components and subsystems, protocols for the **experimental validation** of models, tools for **data-sharing**, the implementation of **benchmarking** methodologies based on the principles of industrial ecology.
For the purposes of the lab's activities, the intention is to create an innovative infrastructure that implement the concept of distributed simulation through the adoption of a multi-site architecture, whose nodes are Italian (but may be open also to foreign partners once established by exploiting the GEANT network) connected through infrastructures and communication protocols suitable for simulation purposes and enabling the sharing of resources.
The National innovation infrastructure is based on the innovative principle of the "cost-effective" National modular laboratory to do research. This avoids replication of investments and infrastructures, and any National university or research structure may contribute at National level by participating to the initiative and sharing knowledge and experiences. Moreover, the proposal aims to match the demand for innovation from regional and National industrial sectors, including their allied industries, thanks to the innovation and experimentation offered by the Country's highly qualified research facilities. The primary objective is to encourage participation, coordination and launch of public-private research and competitive development initiatives on emerging energy issues, activating a structured and stable network of technical-scientific relations and cooperation between the research world and the business system. ENSIEL's ENET-RTLab national laboratory has already tested a national research infrastructure. This could be expanded in size and functionality and form the basis of the proposed infrastructure.

The project results are expected to contribute to the following outcomes:

- Reference testing and experimentation facilities which will offer a combination of physical and virtual facilities, in which technology providers can get support to test their advanced technologies. The impact of this objective will be benchmarked in terms of:
    - number of total accesses to the lab by technology providers
    - share of time dedicated to testing facility over the total activity time
    - total revenues
- Support to full integration, testing, and experimentation to solve issue or improve solutions in the energy sector, including validation and demonstration/experimentation. The impact of this objective will be benchmarked in terms of:
    - Number of research lines (even self-financed) using of the lab facilities
    - Number of used energy modules
- Number of analysed scenarios and cases studies
- Become a common resource open to all the players, with focus to end users who should closely be involved. The impact of this objective will be benchmarked in terms of:
    - Number of involved national stakeholders
    - Number of involved international stakeholders
    - Number of public workshop and events
- Bridge the gap between labs and market due to lack of in-depth testing in the real environment to fully validate them before the deployment. The impact of this objective will be benchmarked in terms of:
    - Number of prototypes investigated
    - Number of energy services investigated
    - Number of patents applications developed/supported using the infrastructure
- Test and pilot the applications of science and innovation in the energy sector to foster the rapid development of Digital Twins and new services based on them, as an example, real time and interactive computing. The impact of this objective will be benchmarked in terms of:
    - Number of developed technological digital twin models
    - Hours of simulation
    - Hours of real-time computational effort
- The infrastructure will seek to support technology providers, but it is also expected to include end-users of the technologies to ensure co-creation defining testing scenarios, protocols, and metrics, relevant to each sector. The impact of this objective will be benchmarked in terms of:
    - Number of involved technology providers
    - Number of end-users involved in the scenario simulation
    - Number of co-creation workshops

A.2. Geographical area of interest

The main geographical area of interest is Italy, with on-going and past experiments of the proposing group have shown the feasibility at least on the European geographical scale.
From the technological viewpoint, it has been shown by first tests on the proposed technology in the electricity sector that it can be implemented countrywide through a network of labs among some of the partners of the consortium ENSIEL which created the pilot ENET network of dispersed laboratories (Politecnico di Torino, Politecnico di Bari, Università di Genova e Savona, Università di Napoli "Federico II", JRC). Measured latencies on the Italian Peninsula showed that the technology supports most of the cyber-physical simulations in the energy sector.

A.3. Sectors/domains

Development, validation and testing of models, methods, and technologies to support the energy and ecological transition, with emphasis to "Sector Coupling" (or "Smart System Integration", or "System of Systems"), i.e., for the integration among the energy sectors and underlying transmission/distribution networks. On the technology side, all the following are relevant to promote the integration of renewable/decarbonized energy sources into the energy system: Power-to-Heat, Power-to-Gas, Power-to-Fuel; energy storage systems (electrical, thermal, mechanical, chemical energy); Combined Heat and Power (CHP) and Combined Cooling Heat and Power (CCHP) systems, bioenergy, and production of sustainable energy carriers (hydrogen, methane, biofuels), CCUS.

About the power system sector, Renewable Energy Sources (RES) introduce new challenges in the planning in the operation of the electricity system. This requires new methods (e.g., to guarantee the critical infrastructure security through innovative defense systems), and technologies (e.g., HVDC, new automation systems, network components like STATCOM and compensators), which must be tested in a real-like environment. The creation of models exactly replicating the real-time operation of the system (i.e., Digital Twin) allows to make several tests in a safe and controlled environment, without affecting the operation of the real system and may accelerate the technology transfer from labs to market.
The proposed research infrastructure will be characterized by an advanced software/hardware technology, a multi-disciplinary approach, and a distributed and dispersed architecture countrywide. The dispersed laboratory will also provide services to main operators in the energy sector such as Transmission and Distribution System Operators (TSOs, DSOs), Energy companies and ESCO, Public Bodies, Regulatory Agencies, etc.

A.4. Keywords

- Energy transition
- Energy systems
- Power Hardware in the loop
- Digital twin
- Energy networks
- Energy scenarios
- Real time simulation
- Interconnected lab
- Sector-coupling
- Hypergrids

A.5. Prevailing levels of TRLs

Reference TRL: 6, 7, 8

Due to the nature of the labs and the consolidated experience of the partners it is expected a prevailing TRL ranging from 6 to 8 for the domain poles (technology nodes). The infrastructural nodes to connect the distributed laboratory has a TRL 7 at the beginning of this project.

A.6. Coherence with the priorities set in the European, National and Regional strategic agendas

The Energy sector has been at the center of the national and international agenda and nowadays war in Ukraine stressed more the subject about issues such as system adequacy, geopolitical dependencies protection and security of critical infrastructures, cyber-attacks etc.

Planning and efforts necessary to implement the Energy transition and a full decarbonization are issued in the PNIEC Piano Nazionale Integrato Energia e Clima (Strategic integrated national plan for the Energy and Climate). In this plan, very challenging objectives are addressed, such as: the reach, by 2030, of 30% quota of RES (Renewable Energy resources) in the overall gross final consumption of energy and of the 55,4 % quota of electricity by RES or the phase-out of coal fueled power station by 2025. Terna, the Italian TSO, forecast in its Triennal Plan 2020 -2023 the necessity to install more than 40 GW new RES capacity. This profound transformation will imply the creation of new technologies for the production, transport, storage and use of the electricity and among them it is relevant to note the participation of new flexibility resources (demand, distributed generation, and storage) in the market of the ancillary services (mercato dei Servizi di Dispacciamento). In this context, the national regulating Agency (ARERA) gave rise to new pilot projects and a new regulation in the field through Delibera 300/2017/R/eel di ARERA.
In this context, the proposal is coherent with this vision. Furthermore, the project is also oriented to provide services and research results to the operators involved in the Energy Communities. In fact, Directive EU 2018/2001, introduced the possibility of consumers and prosumers to aggregate their consumptions and manage collectively the energy they need in the so-called Energy communities.

At European Level it is important to note that this project is coherent with the SET Plan Action 4: 'Increase the resilience and security of the energy system'. Action 4 is based on a set of common targets agreed in November 2016. It is supported by the ETIP smart networks for energy transition (SNET) and European Research Area Network for Smart Energy Systems (ERA-NET SES).
In November 2018, the working group produced an implementation plan (IP) for energy systems including activities that will contribute substantially to the EU Green Deal. The implementation plan was updated in 2020.

The project we propose here is coherent with these themes abut also with an overall existing strategic European target which is to establish innovation and co-creation environments to develop smart services and flexible energy systems.
From the viewpoint of the technology at the basis of the proposed infrastructure, we observe different European institutions focused on the need to share knowledge and research infrastructures, by implementing the "laboratories in the network" framework.

A.7. Synergies with other initiatives envisaged within Mission 4 ("Education and research"), Component 2 ("From research to enterprise"), with particular, but not exclusive, reference to Investment 3.1 ("Fund for the creation of an integrated system of research and innovation infrastructures")

IRSME project is consistent with the recommendations (2020) addressed to Italy by the European Commission on the need to "promote private investment to encourage economic recovery" and to "focus investment on the green and digital transition, in particular research and innovation". According with this national objective, **IRSME** is conceived and structured to favour a close integration between companies and the research world, giving characteristics of resilience and sustainability to Italy's development processes. The interest and the participation in **IRSME's** project of the largest national stakeholder operating in energy fields, support and prove this statement. (See, par. B.2.2.)
In this perspective, **IRSME's** project aims to strengthen and complete the supply chain of the research and innovation process, aiming at the systemic use of research results by the productive fabric and supporting the diffusion of innovation, including through the activation of private skills and capital, as well as the introduction of innovative management models.

IRSME also contributes to completing the package of actions that the Italian Government approved to enhance research and technology transfer within the framework of PnRR-MUR, Mission 4 ("Education and research"), Component 2 ("From research to enterprise").
This package of actions includes investments in Research Infrastructure - RI ("Fund for the creation of an integrated system of research infrastructures - RI" - investment 3.1), the strengthening of the "National R&D Standards" (Investment 1.4) and the creation of the "Innovation Ecosystems" (Investment 1.5).
Importance is given to the synergies that **IRSME** is able to establish with the current European and National Research Infrastructures in the energy field, whose strengthening is the subject of Investment 3.1, listed in the PNIR National Research Infrastructure Plan, attached to the National Research Programme 2021-2027. The National and European RI in which Italy participates in the energy field included in the PNIR (2021-2027) are "facilities, resources and related services, used by the scientific community to conduct high-quality research in their respective fields, without constraint of institutional or national affiliation", as defined by the European Strategic Forum for Research Infrastructures (European Strategy Forum on Research Infrastructures - ESFRI), an advisory body of the Council of the European Union for the RI.
Italy considers the RI to be relevant for the country, allocating investments, through the Ordinary Fund of Public Research Bodies (FOE), for more than a billion euros, from 2010 to today.
IRSME has all the features to integrate and be complementary to the existing National and European RI to which Italy participates in the energy field. In particular, **IRSME** is highly attractive for researchers around the world, representing the physical or virtual place open to all, to be able to conduct cutting-edge research, experiment, grow and innovate.
IRSME offers a wide range of data, equipment, services and expertise to conduct studies and research with scientific experiments and contributes decisively in the development of knowledge in the various sectors of Energy, with the creation of knowledge oriented to global social challenges that never before require innovative approaches and methods.
The access offered by **IRSME** is also a unique opportunity for the "Private Sector" to use the best existing technologies and skills, create and test new products and services for the market, solving technical problems that may slow down the development of innovative and highly competitive business activities. It is therefore appropriate to promote increasingly open and sustainable access, favouring the different types and modes of access that exist.

The National and European RI in the energy field participated by Italy (coded according to the ESFRI domain and according to their dimension of European, national, and global impact) with which **IRSME** will interface are summarized below.
All the RIs refer to the National Agency for New Technologies, Energy and Sustainable Economic Development - ENEA, which is the founding partner of **IRSME**. This facilitates and strengthens the integration of **IRSME** with the RIs described below. For this purpose, as described in paragraph B.1., **IRSME** provides specific structural nodes of its national infrastructure at the ENEA's RIs.

European and National RIs participated by ENEA

- **ECCSEL - European Carbon Dioxide Capture and Storage Laboratory Infrastructure**
- **GRID-LAB**
- **MONSTER: MOlteN Salts Technologies for solar Energy and Reforming**
- **PIBE: Integrated Platform for the use of biomass and waste of plant origin**
- **SOL-IN - SOLar thermal technology experimental INfastructures**
- **PRORETE Low temperature thermal networks testing plant**
- **ZECOMIX - (Zero Emission of Carbon with mixed technologies)**

IRSME also integrates with other initiatives envisaged within Mission 4 ("Education and research"), Component 2 ("From research to enterprise"), with particular reference to investments:

- 1.3 " Extended partnerships to universities, research centres, companies and basic research projects", for the theme "Energy Scenarios of the Future";
- 1.4 "Strengthening of research facilities and creation of national R&D" for the technological fields "Sustainable mobility" and "Agriculture Technologies Agritech";
- 1.5 " Creation and strengthening of innovation ecosystems, building of territorial R&D leaders for energy issues.

In these projects **IRSME** will integrate and contribute, through its infrastructure present in all the universities and companies involved, with studies and simulations aimed at defining the technological, economic and environmental impacts related to the energy aspects involved.

The Energy Center of Politecnico di Torino has a leading role in establishing innovation and research infrastructure. Within the Energy Center, the Global Real-time Simulation lab (G-RTS Lab) has carried out the following activities together with national and international partners:

- Testing of smart charging systems for vehicle-to-grid applications using the RTS technique, in cooperation with EDISON
- Testing of control strategies of distributed storage and V2G in distribution networks, in cooperation with with RWTH Aachen University and IREN energia.
- Optimization and experimental validation of the protection settings for the tram network in Turin, in cooperation with INFRA.TO and GTT.
- Fault location algorithms validation through SIL, in cooperation with IREN energia.
- RTS test of a low voltage system state estimation, in cooperation with Aachen RWTH University.
- A PV simulator integrated to a distribution system in Real-Time.

- Testing control strategy for battery storage management in smart grids.

Politecnico is founding member of 3 **National Centers** proposals (Investment 1.4) dedicated to Sustainable Mobility, HPC-Big Data and Quantum Computing and Agritech.
Politecnico is also the Coordinator of the proposal "Digital and Sustainable North-Western Italy (NODES)", an **Innovation Ecosystem** (Investment 1.5) involving territories in Piemonte, Valle D'Aosta and the bordering provinces of Lombardia with many innovation actors (universities, innovation clusters, research centers, competence centers, incubators and accelerators).
In the Innovation **Ecosystems for the South** call (financed through the National Supplementary Fund to the Italian NRRP) Politecnico participates in several proposals concerning different thematic areas. Moreover, it's working as coordinator on the second phase of the proposals "Electrical Green Transition for Molise Region (IEco green Molise)", Mediterranean Innovation Centre for the Contrast of Climate Change (Med4C)" and "Innovation hub TERRA - Ecological Transition, Regeneration and Re-functionalization of a Marginalized Area of the Siracusa Petrochemical Industry".

Politecnico is also working on its future participation in several **Partnerships extended** to universities, research Centers, companies and funding of basic research projects (Investment 1.3, a forthcoming call). In particular, Politecnico will participate to one Partnership concerning specific areas of interest for this Technological Infrastructure, Future Energy Scenario, and also to the Partnerships dealing with transversal themes of Cybersecurity and Artificial Intelligence.
Finally, Politecnico di Torino is applicant entity of 3 other **Technological Innovation Infrastructures** concerning respectively aerospace, terrestrial mobility and sustainable mobility that work with a complimentary and synergic approach both in the proposal phase and in the future implementation phase.
As it is evident from the above description, Politecnico di Torino will be involved as coordinator or partner of initiatives submitted to MUR covering the whole spread of the research and innovation chain, from low TRL with Partnerships and Research Infrastructures, to intermediate-high TRL with National Centers and Innovation Ecosystems.

A.8. International profile and reach of potential users (with particular reference to SMEs)

Politecnico di Torino strongly committed to collaboration with research institutions, industry, government authorities and other types of associations at the international level.
With more than 460 bilateral international agreements and 120 double degree agreements, Politecnico has links with the most prestigious Universities in Europe. Politecnico is part of some of the major European interuniversity networks, such as CESAER, CLUSTER, EUA, T.I.M.E, SEFI, ISCN and Magalhaes; it is member of Unite! University network for innovation, technology, and engineering, one of the first "University Alliances" in Europe and coordinator of the connected H2020 project, addressing the 2030 vision on the future of universities towards a European Research Area.
IRSME international profile and reach of potential users builds also on the strong network of Politecnico di Torino that in the last five years has been involved in 328 research projects, in particular 196 European and international projects (68,5 M€ contribution, coordinator role in 25% of projects) and 132 national and regional projects. Among the EU and international projects, 27 are dedicated to terrestrial and air mobility, 15 to aerospace and 49 to energy.

The implementation of a Digital Twin in the energy sectors to improve management and operations of the Electricity System and increase the share of renewables in an efficient way can benefit of the following expected outcomes:

- new ways for energy companies, TSOs and DSOs, to share data and break the data-repository.
- Investigate how the critical infrastructures may responds to large disturbances or shocks or malicious and cyber-attacks.
- Pilot the applications of science and innovation to foster the rapid development of Digital Twins and new services based on them.

Digitalization of energy renewable resources and flexibility services can be tested through the proposed infrastructure. Clean Electrification, a basic pillar of the Energy Transition as focused in the IEA 2021 Outlook, is a very important sector which can take advantage of fast-prototyping and cross-fertilization due to proposed research infrastructure.

- Results are expected in: the uptake of innovative data-driven cross-sector integrated services, solutions and products using cross-sectorial data resulted from other sectors than energy that empower prosumers and facilitate consumer investment in the energy transition (e.g., renewables, energy efficiency, renovation, demand response, storage, electric transportation and automotive);
- the development and fast market-uptake of digital twin models of household energy consumers to help consumers, citizens, energy suppliers, aggregators, and energy communities;
- access for prosumers to a wider range of emerging services and application;
- improvement of quality of new and current energy services and new digital platforms, smart meters and tools.

In terms of the direct effects on SMEs, the interested enterprises can become users of the platform to test the impact that a given technology they develop could have on sub-systems of the national energy system. On the other side, they could receive from simulated scenarios on the platform quantitative assessments in support of their strategic plans and the definition of corporate R&D plans or the establishment of collaborations with other SMEs in key strategic sectors. The final aim is to have more competitive SME as they more aligned with nation-wide and even EU-wide development goals about the energy transition.

To the best of our knowledge, there are no simulation projects at international level. Top consulting companies in support of national energy agencies and ministries have been developing strategies and quantitative scenarios to generate national energy and climate plans for the single nations. Sovra-governmental institutions like the International Energy Agency (IEA) constantly produces energy transition pathways quantifying from a techno-economic perspective the different possible scenarios.
On the hand, distributed lab infrastructures have been already proved even though they are more confined to research projects and with a focus on just the electric power systems and its systems/sub-systems/components. With IRSME, the goal is to establish a new nation-wide distributed infrastructure that will include all relevant technology needed for the energy transition, with a focus on all relevant energy vectors and related distribution/transmission infrastructure. The infrastructure will be then used simulate different energy transition scenarios with unprecedented resolution in terms of technology richness and time-resolution to cope with up to real-time dynamics.

A.9. Start date of the initiative

1st January 2023

A.10. Please choose one of the following options below:

Single-Site Infrastructure ☐

Multi-Site Infrastructure ■

Part B – Initiative features (max 40,000 characters)

B.1. Activities

The proposed laboratory is a national research and innovation infrastructure based on knowledge, competencies, models (seen as software implementation) and hardware facilities that currently exist in existing research laboratory.

The laboratory implements the concept of distributed real-time simulation. The architecture used is multisite, able to involve Italian and foreign laboratories (network nodes) by networking them according to defined and specific paradigms and protocols. The size, computational capacity and facility richness of each node can be increased and shared through the interconnection of different nodes by "tunnelling it" on the GARR (national) and GÉANT (international) networks.

The infrastructure supporting the laboratory activities (hereinafter referred to as the "platform") is a system composed of several causally connected layers: the physical domain layer composed of electrical-multi-carrier infrastructures for the delivery of energy in its main marketed forms (electrical, thermal, chemical energy), the physical ICT virtualization and control layer composed of IoT acquisition and implementation devices integrated with the infrastructure domain and interconnected data-center for large-scale processing and storage, the virtualization layer for the flexible and shared management of ICT resources, the software layer, in Edge/Cloud configuration, for the interaction with the devices and for the processing of the huge amount of acquired data, a logical layer for the modelling of the physical infrastructures to build digital twin and on which to run the simulation software with paradigms able to adequately exploit the underlying ICT resources and provide innovative services to SMEs and sector bodies.

The platform will enable different classes of services ranging from the monitoring of electrical distribution networks and, generally on the energy infrastructures, for the forecasting of consumption and load on the grid, for the identification of anomalies and for the support of maintenance activities, the optimisation of electricity distribution infrastructure and the dynamic redistribution of energy produced, new models of electronic brokering and contracting of energy services in the context of the relevant exchanges, and services for the energy efficiency of buildings.

An innovative infrastructure requires the integrated involvement of various high-profile system engineering competences, ranging from domain technology (e.g. energy sector) to ICT competences of cyber-physical systems for the digitisation of domain infrastructures, to those for the construction of modern hardware and software infrastructures for the acquisition and processing, also with time constraints, of massive data, up to domain technical competences for simulation and software engineering competences for the development, testing and deployment of services. In addition to these skills, there are computer science and data engineering skills for the construction of algorithms and for the treatment and processing of different data types that characterise the domain of interest.

Co-simulation involves the exchange of data between simulators placed in different laboratories.

Communication can be carried out by:

- Direct connection of two simulators. The main limitation of this approach is the need for the simulator to use the same information encoding. With different output encodings, translator codes are required, which can increase the computational load of the simulators.
- Through a common interface. For example, the VILLAS Framework, developed by RWTH Aachen, represents a suitable platform that can operate as a gateway, allowing information sent/received from each laboratory to be pipetted correctly.

Communication within a co-simulation, geographically distributed, requires the use of a common protocol, so that information can be clearly defined and understood by all simulators involved.

The most commonly used protocols are:

- TCP protocol: this is a connection-oriented protocol that ensures the proper delivery of information. Devices establish a connection before transmitting data and close the connection after data transmission. In addition, lost packets are retransmitted.
- UDP protocols: is a connectionless protocol. This means that the protocol cannot guarantee the correct delivery of data. Valid data are the last ones sent and delivered to the destination.

The characteristics of the UDP protocol make it faster than the TCP protocol and therefore particularly suitable in time-sensitive applications (such as real-time simulation). In addition, this protocol is the one at the core of the VILLAS framework, opening up the use of this gateway as the basis for the lab's communication structure in the early stages, leaving the possibility for further enhancements depending on the different applications that will be implemented.

In the following, the organisation of each layer will be described, identifying the competences necessary for the definition and design of the entire distributed infrastructure, and finally highlighting the possible services that will be enable and their impact on socio-economic models in the current context of ecological and digital transition.

Platform architecture

The laboratory platform has a multi-layer architecture, and it is the first example of a multi-site infrastructure realised with innovative paradigms and technologies for the simulation and analysis of innovative energy systems. The innovation is therefore both in its entirety, as an infrastructure enabling cooperation between scientific communities belonging to the areas of integrated multi energy systems, and in the technologies adopted for the realisation of each of its layers.

The different layers are described below, highlighting the innovation contribution that they make to the whole platform.

Layer 0 - Infrastructure the electricity supply chain: traditional power plants or those based on renewable energy sources, transmission grid (including from a super-grid perspective) and electricity distribution grid (including from the perspective of microgrids and energy communities), innovative control methods based on field measurement for the management of non-programmable resources (smart grid), primary (high/medium voltage) and secondary (medium/low voltage) transformer substations, electrical utility plants (domestic, industrial, commercial, hospitals), electrical infrastructure for electrification of electrical consumption (one- and two-way charging stations for electric vehicles, low- and medium-high-enthalpy heat production for different uses). The possibility of obtaining information on the real-time behaviour of the system will make it possible to verify whether the actual implementation of new systems and their consequent connection to the electrical system presents critical elements in instantaneous terms (e.g., management of power peaks, power quality problems).

Layer 1 - IoT infrastructures for cyber-physical systems: IoT (embedded or general-purpose) acquisition and control devices (e.g., SCADA and related sensors/actuators), large-scale wired and wireless communication networks, interconnection infrastructures at node level, data centres and GPU-based HPC systems with related power and cooling infrastructures.

Layer 2 - Virtualisation infrastructures of the cyber-physical system: operating systems and real-time operating systems for acquisition and control devices, software agents for the implementation of the control plane of acquisition and control devices, virtualisation infrastructures of acquisition and control system resources, virtualisation infrastructures at different levels of granularity for data centres; software for the implementation of the control plane and security levels.

Layer 3 - software infrastructure for the implementation of the data-plane: data acquisition and control software, pre-processing agents in Edge according to the characteristics of the data to be acquired and QoS constraints, secure and efficient communication infrastructures, scalable data-ingestion and data/delta-lake infrastructures, stream brokering and stream processing infrastructures, data mining and machine-learning libraries and services, synthesis, and model data storage systems.

Layer 4 - Digital models of the physical infrastructure: digital-twin of acquisition and control devices, graphbased models for network analysis, building information models, simulators of parts of the infrastructure for electricity supply, socio-economic simulators for demand analysis.

Layer 5 - Deliverable services These are detailed in the description of the Laboratory nodes.

Laboratory nodes

The infrastructure is composed of two different types of nodes:

1) Infrastructural Territorial Nodes (ITNs), representing the the physical nodes composing the national research and innovation infrastructure. Each of them includes the set of hardware, software, protocols, and interfaces which allow the real-time information exchange within the infrastructure. Each university partner must locate one ITN, which must be equipped for this purpose with the suitable IT hardware and the related software.
2) Satellite Nodes (SNs), representing the nodes that collect the domain's knowledge, the competencies, the simulation tools, and the hardware facilities to study the technology and/or the domain they refer. They are connected to the National infrastructure through the ITN that is the reference in the territory where the SNs are located.

Hence, conceptually the ITNs are *interface nodes*, which are used to collect the know-how and the facilities of the satellite nodes and make them available at National Infrastructure level.

The different ITNs may be connected through the GARR network (in case of the ITN is host by a university partner) or with dedicated networks made available by industry partners (e.g., fiber optic network).

The satellite nodes are connected to one of the ITN and will provide knowledge, ideas, models, software and hardware to the infrastructure. The industrial partners can host its own SN, if they have skilled personnel to be devoted to the activity. In case of Small and Medium Enterprises (SMES), the node of the closest partner can bring them in the loop, through remote-inclusion methods and equipment.

The ITNs will facilitate the collection of the territory competencies and their systematization within a unique National framework. The analysis and research on a particular topic could involve only a part of the SNs connected to different ITNs, leading to a strong modularity in answering to the instances coming from both the academia and the industry.

Domains:

- D.1 Renewable energy generation
- D.2 Sector/Grid Coupling (Power-to-X)
- D.3 Synthetic fuels and chemicals
- D.4 Energy storage
- D.5 Energy networks
- D.6 Energy market
- D.7 Final uses
- D.8 Grid Security & Safety
- D.9 CO2 Storage

Services:

- S.1 Prototype testing
- S.2 Infrastructure digital twin
- S.3 Curiosity-driven academic research
- S.4 Policy-making support
- S.5 Industrial instance-based research

The nodes of the IRSME infrastructure are listed and described below.

Infrastructural Territorial Node			
Name	Main characteristics		
TORINO	It represents the physical nodes composing the national research and innovation infrastructure and includes the set of hardware, software, protocols and interfaces to exchange information in real-time within the infrastructure.		
Satellite Nodes of the Infrastructural Territorial Node			
Name	**Università/Ente di Ricerca/ Azienda**	**Domain(s)**	**Brief description**
G-RTS Lab	Energy Center Lab - Politecnico di Torino (POLITO)	D.1, D.5, D.7	G-RTS studies the role of electricity in energy transition, with a focus on emerging smart grids (and super grids by Real Time Simulation approach.

Thermal Energy Storage lab (TESL)	EC-L - POLITO	D.1, D.2, D.4, D.5, D.7	Optimization, dynamic fluid simulation, modelling of final uses, data collection, optimization design.
Data-driven Approaches to Power System (DA2PS)	POLITO	D.1, D.5, D.6, D.7	Optimization and analysis methods to power system economics, planning, operation and control.
Electrical Safety Lab (ELSA-Lab)	POLITO	D.8	Focus on electricity system safety (lightning, LED system)
Energy Conversion Lab	EC-L - POLITO	D.2, D.3, D.7, D.9	Conversion technologies, energy carrier final uses, experimental and analytical test, synthesis, circular economy.
Energy Scenario	EC-L - POLITO	D.1, D.2, D.3, D.4, D.5, D.6, D.7, D.8, D.9	Scenario analysis, optimization, operational modelling, long-term modelling, planning, GIS, HIL
Services offered by satellite nodes			
S.1, S.2, S.3, S.4, S.5			
Partner companies identified by public announcement			
AMET S.r.l, Col Giovanni Paolo SpA, CVA spa, RSE, ACEA Pinerolese Industriale S.p.A., PUNCH HYDROCELLES, PUNCH TORINO, ITALGAS			
Companies identified as users by public announcement			
ASBECO SRL, Consorzio Un.I.Ver, CVA spa, EGEA SPA, GREENENERGY HOLDING S.p.A, MARAZZATO, ACEA Pinerolese Industriale S.p.A., AZIENDA CONSORZIALE SERVIZI MUNICIPALIZZATI (ACSM) S.P.A.			
Companies having active partnership with ITN or SN			
IREN, SONATRACH, SASOL, CASALE, HYSTECH, ENI, LAVAZZA, ACEA PINEROLESE, SOLVAY, ASJA AMBIENTE, CORNAGLIA group			

Infrastructural Territorial Node	
Name	Main characteristics
NAPOLI	It represents the physical nodes composing the national research and innovation infrastructure and includes the set of hardware, software, protocols and interfaces to exchange information in real-time within the infrastructure.
Satellite Nodes of the Infrastructural Territorial Node	

Name	Università/Ente di Ricerca/Azienda	Domain(s)	Brief description
TERNA S.P.A. SALERNO	TERNA S.P.A.	D.1, D.2, D.4, D.5, D.6, D.8	Real Time Digital Simulation Laboratory

UNINA DII	UNIVERSITA' DI NAPOLI "FEDERICO II"	D.1, D.2, D.4, D.5, D.6, D.7, D.8, D9.	Electrical Power Systems & RES Laboratories
UNINA DIETI		D.1, D.2, D.4, D.5, D.7, D.8.	Electrical Power Systems Laboratories
UNINA DICMaPI DICEA		D.1, D.2, D.3, D.4, D.5, D.7, D.9	Low-Carbon Energy Carriers and Decarbonization Laboratories
UNISA -1	UNIVERSITA' DI SALERNO ENSIEL	D.1, D.2, D.4, D.5, D.6, D.7, D.8	DER Management Laboratory for Grid Security
UNISA - 2		D1, D3, D4	Organic RES and Cold Enegy Storage Laboratory
UNISA - 3		D8	Grid Security Laboratory
UNISANNIO	UNIVERSITA' DEL SANNIO - ENSIEL	D.1 D.2 D.3 D.5 D.7 D.8	Energy Engineering and Information Technology Laboratories
UNICAMPANIA	UNIVERSITA' DELLA CAMPANIA"L.VANVITELLI" - ENSIEL	D.1, D.2, D.5, D.6, D.7	Simulation and Monitoring Laboratories
PARTHENOPE	UNIVERSITA' DI NAPOLI "PARTHENOPE"- ENSIEL	D.1 D.2 D.3 D.5 D.7 D.8	Energy Laboratories
TRISAIA	ENEA	D.1	SOL-IN SOLar thermal technology experimental INfastructures
PORTICI		D.1, D.5, D.4	GRId - LAB & PRORETE Low temperature thermal networks testing plant.
Services offered by satellite nodes			
S.1, S.2, S.3, S.4, S.5			
Partner companies identified by public announcement			
TERNA, AZ CONSULTING, ENGINEERING, GRADED S.p.A, SIPPIC SpA, TELENIA, Ten Project srl, ZP, AVALEN			

Companies identified as users by public announcement
TERNA, ENEL, GRADED, TELENIA, Città Metropolitana di Napoli
Companies having active partnership with ITN or SN
TERNA, ENEL, GRADED, Autorità del Sistema Portuale del Mar Tirreno Centrale, Stellantis, RIVOIRA, MARGHERITA S.p.A., CIRA, Leonardo, Engineering, Edison, MISE, Thales Alenia Space, ERG, Idnamic, RSE, ENEA. ATENA, Ariespace, Wavenergy, P.I.G.I., Città Metropolitana di Napoli, Magaldi, ENI.

Infrastructural Territorial Node			
Name	Main characteristics		
BARI	It represents the physical nodes composing the national research and innovation infrastructure and includes the set of hardware, software, protocols and interfaces to exchange information in real-time within the infrastructure.		
Satellite Nodes of the Infrastructural Territorial Node			
Name	**Università/Ente di Ricerca/Azienda**	**Domain(s)**	**Brief description**
LabZERO	POLIBA	D.1, D.5, D.8	LabZERO is a node of the "Networks of Public Research Laboratories" in Apulia. The Laboratory has two sites at Poliba and ENEA CR Brindisi. ZERO is a main node equipped with RTDS and PHIL. Power systems analysis & control is the main expertise.
Smart Grids test- facilities	POLIBA	D.2, D.5, D.7	External entities can have access to two fully-equipped smart grids available at ZERO and PRINCE labs.
Laboratory CEMES at PRINCE	POLIBA	D.1, D.5	Development of multi-level converter for HVDC and MVDC. MV STATCOMs are developed for large Photovoltaic plants.
Urban energy lab	POLIBA	D.1, D.7	Simulation of the urban energy demand, RES penetration, thermo-chemical storage and PCMs.
Centre on Critical Infrastructures	UNISALENTO	D.3, D.5, D.8	Knowledge development in the field of security and resilience for critical infrastructures.
Services offered by satellite nodes			

S.1, S.2, S.5
Partner companies identified by public announcement
Terna, ENEA, ESTRA, Engineering SpA, Typhoon HIL, Nuova Pignone SpA
Companies identified as users by public announcement
ENEL Global Infrastructure & Networks
Companies having active partnership with ITN or SN
RSE SpA, SNAM, AVIO SpA, Isotta Fraschini SpA, Enel X Italia Srl, Siemens SpA, Bosch SpA

Infrastructural Territorial Node			
Name	Main characteristics		
BOLOGNA	It represents the physical nodes composing the national research and innovation infrastructure and includes the set of hardware, software, protocols and interfaces to exchange information in real-time within the infrastructure.		
Satellite Nodes of the Infrastructural Territorial Node			
Name	**Università/Ente di Ricerca/Azienda**	**Domain(s)**	**Brief description**
UniBO	Università di Bologna	D1, D.2, D.3, D.4, D.5, D.7, D.8, D.9	Dynamic numerical simulation, stochastic optimization, real time cosimulation, HIL, plant performance, data collection and validation.
UniMO	Università di Modena e Reggio Emilia	D.1, D.3, D.5, D.7	Modelling, optimization, in depth analysis, optimization design, implementation of demonstrators, monitoring from sensor networks and satellite imaging.
UniPR	Università di Parma	D.2, D.5	Mathematical modelling, fluid dynamics, complex process, networks monitoring, performance optimization.
Services offered by satellite nodes			
S.1, S.2, S.3, S.4, S.5			
Companies identified as users by public announcement			
IREN, Panaria Group Industrie Ceramiche			
Companies having active partnership with ITN or SN			
Galletti SpA, RBM, Pacetti Srl, Fores Srl, Comune di Carpi ed Unione delle Terre d'Argine, Aimag S.pA.a., Agenzia per l'Energia e lo Sviluppo Sostenibile (AESS), Zanotti Energy Group s.r.l., Amati s.p.a., CPL CONCORDIA SOC. COOP., EnergyNet s.r.l., SIRAM SpA, MBS Srl			

Infrastructural Territorial Node

Name	Main characteristics		
GENOVA	It represents the physical nodes composing the national research and innovation infrastructure and includes the set of hardware, software, protocols and interfaces to exchange information in real-time within the infrastructure.		
Satellite Nodes of the Infrastructural Territorial Node			
Name	**Università/Ente di Ricerca/Azienda**	**Domain(s)**	**Brief description**
UniGE 1	Università degli Studi di Genova	D1, D.4, D.5, D.7, D.8	Experimental activity in the Savona Campus, HIL of microgrids and components, operational management and real time control, demand response
UniGE 2	Università degli Studi di Genova	D.1, D.5, D.8,	Co-simulation, control algorithms validation, microgrid controller testing, prototyping, data driven modelling, optimization.
UniGE 3	Università degli Studi di Genova	D.1, D.2, D.3, D.4, D.5, D.6	Conversion technology management and monitoring, simulation and control of gas networks, long term scenario analysis, environmental impact of energy
			policies.
Services offered by satellite nodes			
S.1, S.2, S.3, S.4, S.5			
Companies having active partnership with ITN or SN			
Enel, Algowatt, Maps, Stam, Leonardo, Polo Energia, Ambiente e Sviluppo Sostenibile, We build, Duferco, Controlli, Iren, Amiu, Ansaldo Nucleare, Ecospray Technologies			

Infrastructural Territorial Node			
Name	Main characteristics		
TRIESTE	It represents the physical nodes composing the national research and innovation infrastructure and includes the set of hardware, software, protocols and interfaces to exchange information in real-time within the infrastructure.		
Satellite Nodes of the Infrastructural Territorial Node			
Name	**Università/Ente di Ricerca/ Azienda**	**Domain(s)**	**Brief description**
UniTS	Università degli Studi di Trieste	D.5, D.8	Simulation of control devices, interface test, device tests.
Services offered by satellite nodes			
S.1, S.2, S.5			

Partner companies identified by public announcement
Tajfun HIL DOO, ZUDECK, CIVIESCO

Infrastructural Territorial Node			
Name	Main characteristics		
MILANO	It represents the physical nodes composing the national research and innovation infrastructure and includes the set of hardware, software, protocols and interfaces to exchange information in real-time within the infrastructure.		
Satellite Nodes of the Infrastructural Territorial Node			
Name	**Università/Ente di Ricerca/ Azienda**	**Domain(s)**	**Brief description**
PoliMI 1	Politecnico di Milano	D.1, D.4, D.5, D.6, D.7, D.8	Real time estimation algorithms, test of network protocols, reliability and safety.Modelling, distributed computing, simulation, optimization and control of multi-energy systems. Control and supervision algorithms. Simulation of the electricity market. Validation of protection devices. Forecast of network infrastructure usage and optimization, simulation of controllers.
PoliMI 2	PoliMI	D.2, D.3	Test of catalytic processes, development and validation of
			simulation models.
PoliMI 3	PoliMI	D.1, D.2, D.5	Testing of electrical and thermal machines. Development and experimental validation of optimization logics.
UniPV 1	Università di Pavia	D.1, D.2, D.4, D.5, D.6, D.8	Simulation and monitoring of real operating microgrid. Optimization dimensioning, GIS, increasing resilience, testing of configurations and EMS, implementation of management and analysis platform, business model development, scenario analysis.

UniPV 2	Università di Pavia	D.2, D.3, D.5, D.8	Two full scale pilot plan, real condition testing, mechanical test of pipelines and components, in depth analysis. Analysis of instability conditions connected to hydrogeological risk. Sensor monitoring, control algorithms, predictive maintenance.
Services offered by satellite nodes			
S.1, S.2, S.3, S.4			
Partner companies identified by public announcement			
A2A Calore, AGRINOVAC srl, Enertech SRL, RSE			
Companies identified as users by public announcement			
A2A Calore			
Companies having active partnership with ITN or SN			
Unareti, ABB, A2A Calore e Servizi, EON, EURAC,			

Infrastructural Territorial Node			
Name	Main characteristics		
PADOVA	It represents the physical nodes composing the national research and innovation infrastructure and includes the set of hardware, software, protocols and interfaces to exchange information in real-time within the infrastructure.		
Satellite Nodes of the Infrastructural Territorial Node			
Name	**Università/Ente di Ricerca/Azienda**	**Domain(s)**	**Brief description**
UniPD 1	Università degli Studi di Padova	D.1, D.2, D.4, D.5, D.8	Real-time simulation of power electronic systems, modelling of power converters, development and testing of energy management systems, multi vector energy network models
UniPD 2	UniPD	D.1, D.5, D.6, D.7	Modelling, energy and information exchanges, security constraints compliance, data collection and validation.
UniPD 3	UniPD	D.2, D.3, D.5, D.9	Stationary and dynamic process simulation, dynamic optimization, operational research.
UniPD 4	UniPD	D.2, D.4, D.9	Synthesis and characterization of functionalized materials, conversion technologies, methods to

			control operating and failure properties of storage devices, analytical tests.
UniPD 5	UniPD	D.1, D.2, D.4, D.7	Dynamic simulation of thermal storage systems, optimization algorithms of interfaces devices, intelligent management, full scale testing laboratories in real conditions coupled with digital building model.
UniPD 6	UniPD	D.1, D.2, D.5, D.7	Analysis of the potentials of traditional and new generation district heating networks, verify the potential of synergies in the management of traditional electrical and thermal networks. Dynamic urban planning models on a GIS basis.
UniPD 7	UniPD	D.4, D.5	Optimization of hydraulic machines, optimal management of mechanical energy and hybrid energy storage systems. Experimental tests, dynamic performance, modelling of plants and machines.
Services offered by satellite nodes			
S.1, S.2, S.3, S.4, S.5			
Partner companies identified by public announcement			
AGSM AIM Spa, ANDRITZ Hydro S.r.l., HIREF SPA, INNOVA, J4 srls, STE Energy S.r.l, Clivet Spa, Kaymacor, GREEN PUROS			
Companies identified as users by public announcement			
ANDRITZ Hydro S.r.l., GIORDANO CONTROLS SPA, Provincia Autonoma di Trento, HIREF SPA			
Companies having active partnership with ITN or SN			
APRIE, ACSM, Pietro Fiorentini, Giammarco Vetrocoke Engineering, FIAMM, Glass to Power, Green Energy, Civiesco, Veritas, Engie, CVA S.pA., Enel GreenPower, Edison.			

Infrastructural Territorial Node			
Name	Main characteristics		
PISA	It represents the physical nodes composing the national research and innovation infrastructure and includes the set of hardware, software, protocols and interfaces to exchange information in real-time within the infrastructure.		
Satellite Nodes of the Infrastructural Territorial Node			
Name	**Università/Ente di Ricerca/ Azienda**	**Domain(s)**	**Brief description**

UniPI 1	Università degli Studi di Pisa	D.1, D.5, D.7	Methodologies development algorithms and algorithms for the optimization of energy production and use. Forecasting, diagnostics and monitoring of integrated energy systems. Simulation of energy systems of civil and industrial interest. Energy analysis and diagnosis
UniPI 2	UniPI	D.1, D.2, D.4	HIL technology demonstrator; laboratory tests for simulating the operation of heat pump systems, thermal storage and photovoltaic production plants. Operational test of innovative technologies for energy conversion.
UniPI 3	UniPI	D.1, D.2	Technological demonstrators of energy conversion processes. Energy systems project simulation. Experimental tests on pilot plant
UniPI 4	UniPI	D.1, D.2, D.3, D.7	Experimental systems for the conversion of agri-food and plastic waste products from industrial activities and MSW for the production of compounds with high added value. Integrated simulation systems (CFDProcess - LCA) in hard to abate sectors.
UniPI 5	UniPI	D.1, D.2, D.3	Test laboratory for electrical storage systems, technological demonstrator for thermal storage systems. Simulation and analysis of energy conversion processes, chemicals, materials. Impact of conversion processes on energy systems.
UniPI 6	UniPI	D.1, D.4, D.5, D.7	Management, forecasting, diagnostics and monitoring of integrated energy systems. Development of electric vehicle charging algorithms. Testing laboratory.
UniFI 1	Università degli Studi di Firenze	D.1, D.5, D.7	Modelling, design and prototyping, component development, development of integrated systems, component testing and certification, numerical modelling of components and systems. Dynamic modelling of energy scenarios.
Services offered by satellite nodes			
S.1, S.2, S.3, S.4, S.5			
Partner companies identified by public announcement			
DIDDI DINO & FIGLI S.R.L, Estra, Nuovo Pignone Tecnologie srl, Officine Mario Dorin S.p.A., KW Apparecchi, NEWTON			
Companies identified as users by public announcement			
Estra, Nuovo Pignone Tecnologie srl			
Companies having active partnership with ITN or SN			
McPhy, Baker & Hughes, Enapter, Hera, Archa, GF Biochemicals, Lucart, FIAMM Energy Technology, Montecchio Maggiore (VI), Terna, ENEL, Mahindra, ENI, i-EM, M.A.I.O.R. S.r.l, Immergas S.p.A, Drinkstation Inc.			

Infrastructural Territorial Node			
Name	Main characteristics		
CAGLIARI	*It represents the physical nodes composing the national research and innovation infrastructure and includes the set of hardware, software, protocols and interfaces to exchange information in realtime within the infrastructure.*		
Satellite Nodes of the Infrastructural Territorial Node			
Name	Università/Ente di Ricerca/Azienda	Domain(s)	Brief description
TERNA S.P.A. CAGLIARI	**TERNA S.P.A.**	D.1, D.2, D.4, D.5, D.6, D.8	Real Time Digital Simulation Laboratory
UNICA - 1	**UNIVERSITA' DI CAGLIARI**	D.1, D.2, D.4, D.5, D.7	Smart Grid and Storage Laboratory
UNICA - 2		D.7, D.9	Energy Efficiency
			and RES
Services offered by satellite nodes			
S.1, S.2, S.4, S.5			
Partner companies identified by public announcement: TERNA			
Companies identified as users by public announcement: ABINSULA SRL, Consorzio C.I.S.A, Consorzio industriale Sardegna.			
Companies having active partnership with ITN or SN:			
TERNA, ENEL, RSE, ENEA, Abisnsula, CIPNES, GAXA, IMI REMOSA, SARAS.			

Infrastructural Territorial Node			
Name	Main characteristics		
COSENZA	*It represents the physical nodes composing the national research and innovation infrastructure and includes the set of hardware, software, protocols and interfaces to exchange information in realtime within the infrastructure.*		
Satellite Nodes of the Infrastructural Territorial Node			
Name	Università/Ente di Ricerca/Azienda	Domain(s)	Brief description
UNICAL	**UNIVERSITA' DELLA CALABRIA - ENSIEL**	D.1, D.2, D.3, D.4, D.5, D.6, D.7, D.9	Electrical Power System & RES
Services offered by satellite nodes			

S.1, S.2, S.3, S.4, S.5
Partner companies identified by public announcement: CRETA ENERGIE SPECIALI, BDI, TEN PROJET
Companies having active partnership with ITN or SN:
ENEL, RSE, ENEA, CRETA ENERGIE SPECIALI, BUSINESS DEVELOPMENT ITALIA

Infrastructural Territorial Node			
Name		Main characteristics	
PALERMO	*It represents the physical nodes composing the national research and innovation infrastructure and includes the set of hardware, software, protocols and interfaces to exchange information in realtime within the infrastructure.*		
Satellite Nodes of the Infrastructural Territorial Node			
Name	Università/Ente di Ricerca/Azienda	Domain(s)	Brief description
TERNA S.P.A. PALERMO	**TERNA S.P.A.**	D.1, D.2, D.4, D.5, D.6, D.8	Real Time Digital Simulation Laboratory
UNIPA -1	**UNIVERSITA' DI PALERMO**	D.3, D.4, D.9	Chemical engineering laboratories
UNIPA - 2		D.1, D.2, D.4, D.5, D.6, D.7	Thermal physics Laboratories
UNIPA - 3		D.1, D.2, D.4, D.5, D.6,	Electrical power
		D.7, D.8	engineering Laboratories
UNICT	**UNIVERSITA' DI CATANIA - ENSIEL**	D.1, D.2, D.5, D.6, D.7, D.9	Electrical Power System Laboratories
UNIME	**UNIVERSITA' DI MESSINA - ENSIEL**	D.1, D.4, D.7	Power Electronics & Electrical Drives Laboratory
Services offered by satellite nodes			
S.1, S.2, S.3, S.4, S.5			
Partner companies identified by public announcement: TERNA, Caronte e tourist, Free mind, Wisnam, Col Giovanni Paolo, Prysmian Electronics			
Companies identified as users by public announcement: Caronte e tourist, Prysmian Electronics, Col Giovanni Paolo, Città Metropolitana Palermo			
Companies having active partnership with ITN or SN:			

TERNA, ENEL, RSE, ENEA, Prysmian Electronics, COL Giovanni Paolo, ENI, ENGINEERING, ARCHIMEDE, Città Metropolitana Palermo

Infrastructural Territorial Node			
Name	Main characteristics		
ROMA	*It represents the physical nodes composing the national research and innovation infrastructure and includes the set of hardware, software, protocols and interfaces to exchange information in real-time within the infrastructure.*		
Satellite Nodes of the Infrastructural Territorial Node			
Name	Università/Ente di Ricerca/Azienda	Domain(s)	Brief description
UNIROMA - 1	SAPIENZA UNIVERSITA' DI ROMA	D.1, D.2, D.4, D.5, D.6, D.7, D.8, D9.	Electrical Power Systems & RES Laboratories
UNIROMA - 2		D.1, D.4, D.5, D.7, D.9	Energy Systems Laboratories
UNICAS -1	UNIVERSITA' DI CASSINO E DEL LAZIO MERIDIONALE - ENSIEL	D.1, D.5, D.6, D.7	Electrical Power Systems Laboratory
UNICAS - 2		D2, D4, D.5, D.7	Industrial Measurement Laboratory
UNIPG	UNIVERSITA' DI PERUGIA - ENSIEL	D.1, D.2, D.3,D.4, D.5,D.6, D.7, D.9, D.10	Integrated Center for experimental analysis and realtime.
CASACCIA	ENEA	D.2, D.4, D.10	ZECOMIX - (Zero Emission of Carbon with mixed technologies)
Services offered by satellite nodes			
S.1, S.2, S.3, S.4, S.5			
Partner companies identified by public announcement			
ASM TERNI, Engineering.			
Companies identified as users by public announcement			
ENEL			
Companies having active partnership with ITN or SN			
ATER, TEP Energy Solution, SKF Industrie, algoWatt, TERNA, ENEL, SGI, Repl, e-distribuzione.			

B.2. **Governance model**

B.2.1. Infrastructure and operational management

(Describe the operational management, also highlighting the profile and the role of the "infrastructure manager")

The proposal sets up a research infrastructure made up of laboratories interconnected in a network in an effective and innovative way (networked laboratories and NOT one of the many laboratory networks) which requires HW equipment, know-how and skills and specific IT protocols. The research infrastructure will also be developed in collaboration and at the service of companies, operators (TSO, DSO, ESCO ...), P.A. central and local, regulatory authority.
Each regional cluster of universities and companies will be interconnected to the others through an infrastructural node previously described. Each infrastructure node will enable the networking of 'n'

technological domains, i.e., technologies relevant to the energy and ecological transition whose functioning wants to be analyzed with respect to the entire Italian energy system.

Each infrastructure node will be coordinated by a zonal contact person, i.e., a university or business partner of the initiative. The overall connection infrastructure will be coordinated by the Turin Polytechnic.
Experiments (distributed co-simulations of integrated energy systems) can be conducted within each infrastructure node, as well as multi-site experiments can and will be planned.
The former will be coordinated by the zonal contact person. The latter from the Polytechnic of Turin and a specially constituted steering committee of the partnership to be set up within three months of the start of the project.
The infrastructure manager, in addition to following the progress of the work for the commissioning of the individual nodes, will define an access plan to the laboratories based on the services that can be provided and will produce a service 'booking' interface with allocation of times and associated costs.

Politecnico di Torino (POLITO) is the technical and operational proposer, which has historical and strong worldwide cooperation with industrial and academic partners. The participation in many national and international projects allows POLITO to accrue a great experience in the coordination and management of complex projects funded by public and private bodies, ranging from projects funded by EU to projects funded by National and local governments, to projects funded and in cooperation with companies. Technology transfer is one of Politecnico excellences, with 307 inventions protected by 712 patents filed (2012-2021), of which 441 are active. Since 2017 POLITO has invested about 45M€ in open access research infrastructures enabling technological innovations and new business development. POLITO is founding member of the national competence center CIM4.0-Competence Industry Manufacturing 4.0 SCARL, which is a public-private partnerships that carries out orientation and training activities for companies on Industry 4.0.

The Legal Entity undertaking to implement and manage the Infrastructure (see paragraph B.2.2), through the Manager of the Innovation Infrastructure, will be the point of contact with the MUR.

The special purpose vehicle involves different kinds of members and its Governance is based on:

- **General Assembly:** will be composed by members representing collectively all the interests of IRSME and appointed by the partners. It is the body with full decision-making power, and it will meet at least once a year. Within its functions, it will approve the IRSME's annual reports, accounts, and annual budget, and it will appoint and dismiss Board members.

- **Board of Directors (BoD):** it will be appointed by the General Assembly and has full powers for ordinary and extraordinary management. The BoD will appoint the Manager of the Technological Innovation Infrastructure IRSME. It will take the final decision about strategic and operational elements.
- **Advisory Board:** it will be an external independent Committee composed of internationally renowned experts and other stakeholders that provides non-binding strategic advice on the infrastructure's activities.

The Manager of the Innovation Infrastructure (Infrastructure Manager) named IRSME is expected to control and oversee all management operations, people, and strategy developments of the organization. Very strong leadership skills will be essential since the Manager of the Innovation Infrastructure is the one expected to interact with the staff, the scientists, and the funders. The duties will be to:

- Develop and execute the Infrastructure's strategies
- Coordinate with science professionals in determining technological innovation, service provision, and priorities.
- Prepare and implement comprehensive business plans
- Support the development of new service opportunities
- Communicate and maintain trust relationships with stakeholders, science professionals, business partners, and funders
- Oversee the organization's financial performance
- Coordinate activities ensuring that timelines and expected results are met.

The specific requirements are:

- Proven experience as Manager or other managerial position in science-based organizations; previous experience in managing Technological Innovation Infrastructures and core facilities will be preferred
- Demonstrable experience in developing strategic and business plans
- Thorough knowledge of the Technological Innovation Infrastructure ecosystem
- Strong understanding of financials and performance measures
- Excellent organizational and leadership skills
- Excellent communication, interpersonal and presentation skills
- Outstanding analytical and problem-solving abilities
- MSc/MA in Business Administration or relevant field; MA in the field of technological innovation infrastructure/science management will be preferred.

To support the infrastructure manager, the following roles are planned:

➢ **Local infrastructure coordinator**:

One for each laboratory or geographical area, with the tasks of:

- In the implementation phase: coordinate lab installation and support the IM in onsite reporting and management, interface with suppliers

- At steady state: manage lab access and maintenance, monitor achievement of target goals and infrastructure income statement, customer interface, periodic upgrade

➢ **Infrastructure research manager:**

One for each laboratory or geographical area, with the tasks of:

- Interfacing with universities and research centers to define, implement and monitor the research program progress, in coordination with the other labs.

➢ These staff units will be provided by the public-private company

B.2.2. PPP operation

(Describe the PPP expected modality as to the involvement of private partners: companies, specialized private infrastructure developers, investors, etc. In case of a PPP operation launched as a private initiative, the section should also indicate the private partner)

IRSME will be defined as a Public-Private Partnership which satisfies the principles and the legal form of the "Partenariato Pubblico-Privato Istituzionalizzato" (Institutional Public-Private Partnership). The Public-Private Partnership (PPP) is a form of cooperation between public bodies and private entities that aims to ensure the planning, financing, construction and management of an infrastructure or the provision of a service. In particular, the Institutional PPP will imply the cooperation between the public and private actors within a separate entity, such as a joint enterprise, jointly owned by the public and private partner, whose mission is to ensure the provision of a work or service for the benefit of the public. At European level, PPPs are characterized by the following elements:

- The relatively long duration of the collaboration
- The method of financing the project, guaranteed in whole or in large part by the private partner
- The operational role of the economic operator, who participates in various phases of the project (planning, creation, implementation, financing)
- The role of the public partner, of defining the objectives to be achieved in terms of public interest, quality of the services offered, pricing policy, and monitoring compliance with these objectives
- The sharing of risks between the public partner and the private partner, to whom risks are transferred, which, in traditional contractual forms (contract, loan, etc.) are usually borne by the public sector.

For the implementation of the infrastructure, the Politecnico di Torino will rely on the contribution of private entities to co-finance the initiative through an institutionalized public-private partnership operation, pursuant to art. 17 of the Legislative Decree 175/2016.

The reasons of this choice are linked to the Politecnico intent to assure an adequate scientific involvement in the partnership governance, aiming to a constant equipment upgrade and innovation and to safeguard the open access.

To this end, a joint public-private company will be established, with predominantly private capital (51 percent), where the resources to be contributed by the private party(ies) may be financial and in kind, the latter to a maximum extent of 20 percent of the total eligible investments of the project.

Private contribution to PPP activities consists, apart from the contribution of capital or other assets, in active participation in the execution of the tasks assigned to the joint venture and/or in the management of that entity.

The private partners will be selected **through a public tender process** that will have as its object, at the same time, the subscription or purchase of the company's shareholding by the private partners and, where appropriate, the entrustment of the implementation and /or management of specific sites which are part of the activity of the joint company's activity (so-called "dual-object" tender).

In the case of awarding the tender to multi-subjective competitors, they shall establish a new joint stock company with shareholdings corresponding to their share in the grouping or other form of collective participation.

The private partners, possessing the qualification requirements stipulated by legal and regulatory standards in relation to the services for which the company was established, will manage the infrastructure so that it will deliver services placed on the free market in favor of public and private stakeholders in the national and international territory operating in the infrastructure technology sectors.

The most suitable method to allow public entities, which have expressed interest in relation to the infrastructure when submitting the proposal, to participate in the joint public-private company is being evaluated.

Politecnico di Bari, Politecnico di Milano, Università degli studi di Bologna, Università degli Studi di Cagliari, Università della Calabria, Università degli Studi di Genova, Università degli Studi di Napoli Federico II, Università degli Studi di Padova, Università degli Studi di Palermo, Università di Pisa, Università di Roma Sapienza, Università degli Studi di Trieste, Enea. Moreover, also Consorzio Interuniversitario nazionale per l'informatica (CINI), il Consorzio Interuniversitario per Energia e Sistemi Elettrici (EnSiEL) declared their interest.
POLITO carried out a preliminary market consultation through the publication of a call for expression interest for the design, implementation, management, and co-financing of IRSME addressed to private entities. The following private companies have submitted their expression of interest to participate as partners:

#	Partner companies identified by public announcement	City	Province	Region
1	STE Energy S.r.l	Padova	PD	Veneto
2	J4 srls	Abano Terme	PD	Veneto
3	Free mind	Acireale	CT	Sicilia
4	Wisnam	Acireale	CT	Sicilia
5	ASM TERNI S.P.A	Terni	TR	Umbria
6	AGSM AIM Spa	Verona	VR	Veneto
7	A2A Calore	Brescia	BS	Lombardia

8	Caronte e tourist	Messina	ME	Sicilia
9	CVA	Châtillon	AO	Valle D'Aosta
10	Estra	Prato	PO	Toscana
11	TELENIA	Bucciano	BN	Campania
12	ZP	Napoli	NA	Campania
13	Engineering Ingegneria Informatica S.p.A	Roma	RO	Lazio
14	Nuovo Pignone Tecnologie srl	Firenze	FI	Toscana
15	GRADED S.p.A	Napoli	NA	Campania
16	RSE	Milano	MI	Lombardia
17	INNOVA	Storo	TN	Trentino-Alto Adige
18	Tajfun HIL DOO Novi Sad	Novi Sad	EE	Serbia
19	DIDDI DINO & FIGLI S.R.L	Pistoia	PT	Toscana
20	BUSINESS DEVELOPMENT ITALIA SRL	Cosenza	CS	Calabria
21	Creta Energie Speciali S.r.l	Rende	CS	Calabria
22	SIPPIC SpA	Napoli	NA	Campania
23	HIREF SPA	Tribano	PD	Veneto
24	RSE	Milano	MI	Lombardia
25	TERNA	Roma	RO	Lazio
26	ANDRITZ Hydro S.r.l. Unipersonale	Schio	VI	Veneto
27	Ten Project srl	San Martino Sannita	BN	Campania
28	Col Giovanni Paolo SpA	Troffarello	TO	Piemonte
29	AMET S.r.l	Torino	TO	Piemonte
30	Clivet Spa	FELTRE	BL	Veneto
31	Enertech SRL	Milano	MI	Lombardia
32	AGRINOVAC srl	Milano	MI	Lombardia

33	ACEA Pinerolese Industriale S.p.A.	Pinerolo	TO	Piemonte
34	Officine Mario Dorin S.p.A.	Firenze	FI	Toscana
35	Clivet Spa	Feltre	BL	Veneto
36	PUNCH HYDROCELLES	Torino	TO	Piemonte
37	PUNCH TORINO	Torino	TO	Piemonte
38	Soc. Officine Dorin	Firenze	FI	Toscana
39	ZUDECK	Muggia	TS	Friuli Venezia Giulia
40	CIVIESCO	Udine	UD	Friuli Venezia Giulia
41	KW Apparecchi	Monteriggioni	SI	Toscana
42	AVALEN	Vallo della Lucania	SA	Campania
43	NEWTON	Poggibonsi	SI	Toscana
44	Kaymacor	Legnago	VR	Veneto
45	GREEN PUROS	Treviso	TV	Veneto
46	Prysmian Electronics Srl	Milano	MI	Lombardia
47	Italgas	Torino	TO	Piemonte
48	E.ON Business Solutions Srl	Milano	MI	Lombardia
49	ENGIE	Roma	RO	Lazio

Moreover, the following private companies have submitted their expression of interest to use the IRSME infrastructure service's:

#	Companies identified as users by public announcement	City	Province	Region
1	GIORDANO CONTROLS SPA	Villa Bartolomea	VR	Veneto
2	Consorzio Un.I.Ver	Vercelli	VC	Piemonte
3	Consorzio C.I.S.A	Serramanna	SU	Sardegna
4	MARAZZATO	Pollein	AO	Valle D'Aosta
5	IREN	Reggio Emilia	RE	Emilia Romagna

6	Consorzio industriale Sardegna	Olbia	SS	Sardegna
7	ENEL	Roma	RO	Lazio
8	Caronte e tourist	Messina	ME	Sicilia
9	CVA	Châtillon	AO	Valle D'Aosta
10	Estra	Prato	PO	Toscana
11	TELENIA	Bucciano	BN	Campania
12	Nuovo Pignone Tecnologie srl	Firenze	FI	Toscana
13	ABINSULA SRL	Sassari	SS	Sardegna
14	GRADED S.p.A	Napoli	NA	Campania
15	EGEA SPA	Alba	CN	Piemonte
16	Panaria Group Industrie Ceramiche SpA	Fiorano Modenese	MO	Emilia Romagna
17	Provincia Autonoma di Trento	Trento	TN	Trentino-Alto Adige
18	GREENENERGY HOLDING S.p.A	Torino	TO	Piemonte
19	ANDRITZ Hydro S.r.l. Uniperso	Schio	VI	Veneto
20	ASBECO SRL	Alba	CN	Piemonte
21	A2A Calore	Brescia	BS	Lombardia
22	HIREF SPA	Tribano	PD	Veneto
23	ACEA Pinerolese Industriale S.p.A.	Pinerolo	TO	Piemonte
24	AZIENDA CONSORZIALE SERVIZI MUNICIPALIZZATI (ACSM) S.P.A.	Primiero S. Martino di Castrozza	TN	Trentino-Alto Adige
25	ITALGAS	Torino	TO	Piemonte
26	Prysmian Electronics Srl	Milano	MI	Lombardia
27	E.ON Business Solutions Srl	Milano	MI	Lombardia

Politecnico di Torino will oversee the creation and implementation of the Innovative Infrastructure. Indeed, Politecnico di Torino will have the coordinator role until the establishment of the corporate vehicle, and it has a complete operational independence.

B.3. Budget plan

Eligible cost (Art. 7 of the call for proposal)	Costs (€)		
	Not to be located in Mezzogiorno Regions	To be located in Mezzogiorno Regions	Total
a. Expenses, even if not accounted for as tangible and intangible investments, related to one highly qualified infrastructure manager andother executive personnel (managers) in charge of the services offered by the Infrastructure	600.000 €	400.000 €	1.000.000 €
b. Scientific instrumentation, research equipment and machinery and relative accessories, turnkey	11.976.000 €	8.366.000 €	20.342.000 €
c. Technical installations strictly connected to the functionality of equipment and machinery	2.907.000 €	1.928.000 €	4.835.000 €
d. Software licences and patents	775.200 €	584.800 €	1.360.000 €
e. Buildings and land (including built land) not exceeding 10% of the total cost of the project. For sites in a state of decay and for those previously used for industrial purposes that include buildings, this limit is increased to 15%	- €	- €	- €
f. Rehabilitation, renovation, redevelopment and expansion of buildings if strictly necessary as to the functionality of the Infrastructure	969.000 €	731.000 €	1.700.000 €
g. Design cost and other related technical expenses	1.938.000 €	1.462.000 €	3.400.000 €
h. Indirect costs, forfeit (up to a maximum of 7% of the other project costs)	1.210.600 €	860.400 €	2.071.000 €
Total	20.375.800 €	14.332.200 €	34.708.000 €

The goal of the innovation infrastructure is to produce digital twin of the national energy system. To this end, the main required items are:

- physical laboratories for testing key technologies for energy commodities (electricity and hydrogen) and non-energy commodities (e.g., CO_2) distribution, conversion and storage;
- High-speed computing computational capacity for real-time co-simulation of the energy system layers;
- a digital infrastructure for replication (twinning) of the national energy system.

For each technology domain, a digital twin will be produced by means of technology testing. Hence, test-rigs will be needed to perform tests on the key technologies that will be part of our future energy systems. Focus will be given especially to energy storage technologies. Hence, a test-rig of hydrogen-based energy storage systems, one for testing closed- and open electrochemical batteries and novel concepts for thermal energy storage (e.g., latent heat and thermochemical energy storage) will be constructed and operated across the territorial nodes. We expect that around 10 M€ will be used for the above-described activities.

Besides populating the technological domains, computational capacity is needed to simulate the operational behaviors of the various technology and distribution infrastructure. To this end, a digital real-time simulation infrastructure will be built. This infrastructure will connect the distributed lab network. This another major equipment that will be complemented with real time communication devices, high-speed computing servers, actuators, power controllers, data acquisition and processing servers, a data lake, measuring and acquisition devices, etc. We estimate an overall investment cost of another 10 M€.

All the above activities will be finalized to produce a digital twin of the national energy systems that will enable scenario-making activities to support national energy policy in support of the energy and ecological transition.

Personnel costs: 1 general manager (FTE for three years) overseeing the overall project management and two territorial managers (FTE for three years) overseeing the everyday infrastructure activity for the pool of nodes under their supervision.

B.4. Project time schedule

(In addiction to sections B.4.1 and B.4.2, please provide a general description as to the execution of the interventions)

The project time schedule of IRSME is structured in multiple intermediate objectives that lead to the full functionality of the different laboratories which will constitute the final Innovation Infrastructure of IRSME.
The first intermediate objective is dedicated to the recruitment of infrastructure management and in general to the setup of operations and to guaranteeing the continuation of infrastructure monitoring and sustainability activities.
Intermediate objectives number 2, 3 and 4 correspond respectively to the phases of design, construction, installation and commissioning of the laboratories that make up the infrastructure. Each phase is declined in separate tasks, each of which is expected to take place within a determined timeframe.
Then, in order to monitor the actual achievement of the final objectives, specific deliverables and KPIs have been outlined for each task and have to be checked in a specific timeframe.
As last, an intermediate objective on infrastructure outreach and opening to the market has been defined.

B.4.1. Intermediate objectives

<table>
<tr><td colspan="4">Intermediate Objective title: IO1 – Start up activities (e.g., IM Recruitment, Staff profiles Management Plan; Risk Management Plan)</td></tr>
<tr><td>Start month</td><td>1</td><td>Duration (min 4 months)</td><td>4</td></tr>
<tr><td colspan="4">Summary of the activities:

The main objective is to establish an effective management of the IRSME project, implement the governance structure, ensure effective monitoring of the project development and foster its long-term sustainability.

The first step will be to recruit the personnel, including the Infrastructure Manager (IM), local infrastructure coordinators and research managers.

The IM will be hired with a fixed-term position, he will be in charge of: (i) developing and executing the II's strategies, (ii) preparing and implementing the business plans, (iii) managing the interactions with academic and industrial partners and stakeholders, (iv) monitoring and supervising the financial development of the project, (v) supporting the development of new opportunities and (vi) establishing and coordinating the priorities of the II.</td></tr>
</table>

The IM will put a significant effort into promoting and facilitating digitalization of the services provided, referring to best practices available worldwide, in ensuring the principles of FAIR data and Open Science and to this end, a Data Management Plan will be defined. Moreover, the IM will also be in charge of the implementation of the Guidelines for gender equality and inclusion practices.

IM, with the collaboration of the research managers, will provide coordination with National centers and private/public Italian and European Research Institutions and clusters (addressing also the joint participation to funded research calls).

IM will define a proper Communication Plan, also organizing specific workshops and dissemination events.

The IM, with the collaboration of Local Infrastructure coordinators, will also deal with the risk management and contingency plans. Indeed, a careful risk analysis will be conducted, for possible political, financial, technical, technological scientific, legal, and human resources related issues, and suitable contingency plans will be discussed, proposed, and implemented.

The second step of the IO1 will define the governance structure of the Infrastructure, the continuous monitoring procedures, the risk analysis and contingency plan and foster its long-term sustainability according to the strategies and roadmap defined by the Board.

The following Actions and timespan are foreseen:

Task 1.1 – Recruitment (M1-M4)

The IM will be recruited. The profiles and requirements of Local infrastructure coordinators and research managers will be defined and recruitment started. Definition of the II management plan.

Task 1.2 - Definition of the continuous monitoring procedures (M2-M4)

Continuous monitoring will be a fundamental aspect of the IRSME project. The main aim will be to define the procedures for an effective management and implementation of the infrastructure, along the Design, Construction, Installation, and outreach phases.

Continuous monitoring will be implemented through periodic meetings among the governance bodies of IRSME. Moreover, the IM together with the local infrastructure coordinators will monitor and supervise the financial development of the project, and will ensure the submission to the MUR of the period reports on the performance indicators associated with the project and on the expenses effectively incurred.

Task 1.3 – Definition of the risk analysis and contingency plan (M2-M4)

The methodology for the risk analysis and contingency plan will be set according to the Open PM v0.9, built on the following four-step approach: Risk Identification, Risk Assessment, Risk Response Development, Risk Control.

Task 1.4 – Definition of the models for long-term sustainability (M2-M4)

IRSME will operate for at least 15 years after the completion. A scheme of a long-lasting functionality of the project will be elaborated, with the aim to establish a robust government and management structure ensuring the continuous and smooth functionality of the infrastructure. Sustainability will be carefully addressed, in terms of operational costs (e.g., running costs, maintenance, user support) as well as the necessary continuous upgrade of the instrumentations as a consequence of the scientific advances that may arise. Furthermore, within the duration of the project, the following implementation documents will be produced: Regulation governing Intellectual property generated by the research and innovation activities Regulation of Access Mechanism, Tariffs, updated version of Data Management Plan, Communication Plan.

Activity KPI/Deliverable	**Target Value (KPI) / Completion Month (milestone and deliverable)**
Deliverable 1 – Report with profiles for the IM and other staff	KPI: 1 report / M1
Recruited personnel	KPIs: IM recruited / M2
Deliverable 2 – Report including the procedures for: • Continuous monitoring and risk analysis; • Contingency plan. • Long-term sustainability	1 report / M4

Intermediate Objective title: IO2 – Design of the infrastructure up to supplier selection and purchase of equipment. Construction work plan and agreement set up

Start month	5	**Duration (min 4 months)**	11

Summary of the activities:

The main goal of this IO consists in completing the design phase, defining the technical specifications for all the laboratories making up the infrastructure IRSME.
Detailed definition of the infrastructure requirements and the following aspects are expected:

- Detailed requirement gathering for infrastructure labs; design of specifications for tools and equipment (input for purchasing) design of new facilities.
- Technical Tools and equipment procurement: supplier inquiry, selection, agreement set up and procurement of all hardware and sourcing of all external services
- Physical space and infrastructure renovation: detailed project: Layout design for spaces, facilities and installations (input for building tenders); Technical projects for spaces facilities and installations

Task 2.1: Design of the Infrastructural Territorial Nodes and main infrastructure (M5-M15)

This task aims to design the main infrastructure connecting all the IRSME poles, the Infrastructural Territorial Nodes (ITN), thorough GARR (national) and GÉANT (international) networks.
Identification of the technical requirements, layout design for spaces, facilities and installations and executive project. Procurement of all hardware and sourcing of all external services.

Task 2.2: Design of the Satellite Nodes (M5-M15)

This task aims to design of all Satellite Nodes (SN) within each ITNs. The SN will be connected to the main infrastructure thorough the ITNs.
Identification of the technical requirements, layout design for spaces, facilities and installations and executive project. Procurement of all hardware and sourcing of all external services.

Task 2.3: Design of the operation of SNs and ITNs (M5-M15)

Identification and definition of the operating rules, technical performance, and safety and management guidelines of Satellite Node, Infrastructural Territorial Node, and main IRSME infrastructure. Identification of the technical requirements, design and executive project. Procurement of all the hardware equipment and sourcing of all external services.

Activity KPI/Deliverable	**Target Value (KPI) / Completion Month (milestone and deliverable)**
Task 2.1 Deliverable 1: Midterm review report Deliverable 2: Design and executive project of the IRSME infrastructure KPI: intermediate check (M10) on the % of the progress	**M10** **M15** **>40-60%**
Task 2.2 Deliverable 1: Midterm review report Deliverable 2: Executive project of all Satellite Nodes KPI: intermediate check (M10) on the % of the progress	**M10** **M15** **>40-60%**
Task 2.3 Deliverable 1: Midterm review report Deliverable 2: Final detailed report KPI: intermediate check (M10) on the % of the progress	**M10** **M15** **>40-60%**

Intermediate Objective title: IO3 – Renovation, refurbishment and extension of buildings. Technical installation.			
Start month	16	**Duration (min 4 months)**	10

Summary of the activities:

After the conclusion of design phase (IO2), the renovation phase of all the laboratories part of IRSME will take place. The expected goals for this IO, within 25 months since the project start is the completion of the technical installations, along with renovation, refurbishment and extension of buildings where necessary.

Task 3.1: Renovation, refurbishment and extension of buildings (M16-M25)

All the identified and selected buildings for hosting the required technology and infrastructure hardware (communication and computational servers) will be re-qualified to comply with the technical specifications of the new items to be installed.

Task 3.2: Technical installation of technology modules (M16-M25)

In this task the IRSME infrastructure, ITNs and SNs experimental areas will be fully equipped. The infrastructure designed in Task 2.1, 2.2 and 2.3 will be installed in the renovated areas in Task 3.1. This task encompasses from starting from the procurements of the components up to the realization of the technical plants. All experimental facilities will be set up and tested for functional validation.

The various hardware equipment concerning technology modules will be installed and interconnected with the required building and infrastructure communication interfaces.

Task 3.3: Technical installation of interface, communication and computational modules (M16-M25)

A preliminary use for industrial purposes, also open to other partners, customers and users, will be tested. The industrial staff will install (supported by suppliers) all the required technical rigs and simulators.

The backbone of the IRSME distributed infrastructure will be installed including the related physical and digital equipment.	
Activity KPI/Deliverable	**Target Value (KPI) / Completion Month (milestone and deliverable)**
Task 3.1 Deliverable: As-built laboratory documentation	**M25**
Task 3.2 Deliverable 1: Midterm review report Deliverable 2: Realization of the technical plants (e.g., electric power supply) in the defined area in CVIT and documentation as build of the infrastructure. KPI: % work progress (30% at M18 – 60% at M21 – 100% at M25)	**M20** **M25**
Task 3.3 Deliverable 1: Midterm review report Deliverable 2: Final detailed report KPI: intermediate check (M20) on the % of the progress	**M20** **M25** **>40-60%**

Intermediate Objective title: IO4 – Installations and commissioning			
Start month	26	**Duration (min 4 months)**	7

Summary of the activities:

After the conclusion of construction phase (IO3), the installation and commissioning phase of all the laboratories part of IRSME will take place.
The expected goals for this IO, within 32 months since the project start are:

· Functional performance verification and validation tests of the infrastructure will be performed so to take the ongoing rate of activation of the facilities up to 100%. Thus, the infrastructure commissioning will be realized, and the experimental facilities activated
· Functional tests of all parts and software, as standalone system and in network co-operation

Installation and commissioning of each laboratory is represented as a stand-alone task as follows.

Task 4.1: Main infrastructure commissioning (M26 – M32)
The main infrastructure that will interconnect the distributed lab network will be commissioned after validation tests to prove its capability of management and communication of the overall designed system architecture.

Task 4.2: Validation of the territorial infrastructural and satellites nodes (M26 – M32)
Each node of the infrastructure will be tested and validated against pre-defined testing protocols.

Task 4.3: Documentation and operating rules (M26 – M32)
The start-up of the infrastructure will be tested not only in terms of functionality expected but also from the documentation point of view and operating rules for infrastructure managers and users.

Activity KPI/Deliverable	**Target Value (KPI) / Completion Month (milestone and deliverable)**
Task 4.1 Deliverable: Commissioning report for the main infrastructure	**M32**
Task 4.2 Deliverable: Successful testing of the equipment of territorial and satellites nodes	**M32**
Task 4.3 Deliverable 1: Intermediate test report Deliverable 2: Final test report KPI: intermediate check (M29) on the % of functional performance KPI: final check (M32) on the % of functional performance	**M29** **M32** **>60-80%** **>90%**

Intermediate Objective title: IO5 – Outreach and opening to the market			
Start month	33	**Duration (min 4 months)**	4

Summary of the activities:

After the conclusion of commissioning phase (IO4), the outreach and opening to market phase of all the laboratories part of IRSME will take place.
The expected goals for this IO, within 36 months since the project start are:

- Opening to market
- Dissemination

Each of them is detailed as a task with its own specific timeframe as follows.

Task 5.1 – Opening to the market (M33-M36)
Final versions of the following implementation documents will be produced: Regulation governing Intellectual property generated by the research and innovation activities, Regulation of Access Mechanism, Service Catalogue, Tariffs, updated version of Data Management Plan, Communication Plan.

Task 5.2 – Dissemination (M33-M36)
The activity will be devoted to the dissemination of the availability of IRSME to the potential market through dedicated seminars, interviews to specialized magazines, participation to B2B events, organization of dedicated events on the infrastructure, definition of dedicated webpage and social media.

Activity KPI/Deliverable	**Target Value (KPI) / Completion Month (milestone and deliverable)**
Deliverable: D1: Catalogue of services D2: Web site creation, LinkedIn and other social media profile creation Outreach and opening to the market (report)	 **M34** **M36**
KPI:	

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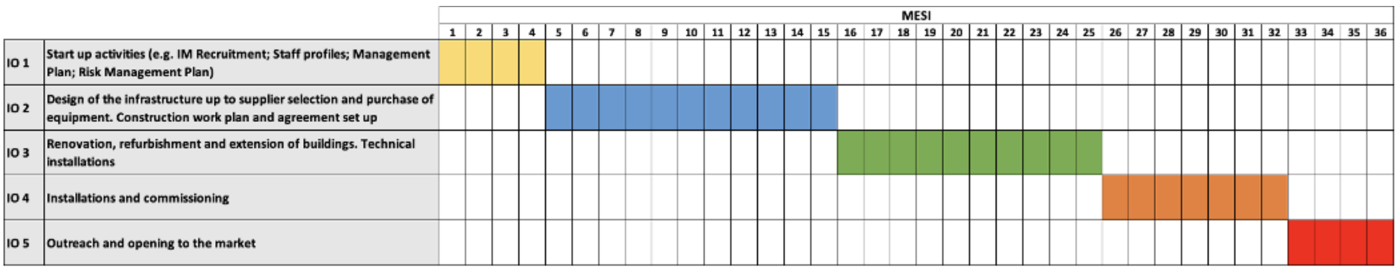
Checks on % of expected customers/users from business model (M36)	**(>80%)**

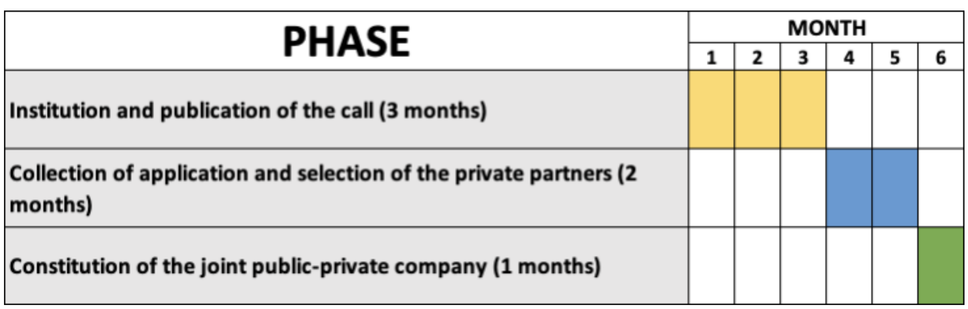
Figure B.1. – Gantt Chart of Intermediate Objectives



B.4.2. Timeframe envisaged for the implementation of the procedure aimed at setting up a PPP

The setting up of the PPP is intended as a preliminary activity to the start of the project, which will last 6 months, from July to December 2022.
The project start date will therefore be 1st January 2023.

For the establishment of the PPP, the following activities will be completed by 1 January 2023:
1. Institution and publication of the call (3 months)
2. Collection of application and selection of the private partners (2 months)
3. Constitution of the joint public-private company (1 months)



B.5. Promotion of knowledge transfer and business creation activities.
(Describe the activities envisaged or the expected impact of the Infrastructure in terms of knowledge transfer and setting-up new businesses)

The proposed innovation infrastructure will enable:
- A real national innovation infrastructure with the innovative principle of the national modular laboratory
- An efficient and cost-effective method for doing national research avoiding the replication of investments and infrastructures
- An inclusive approach that can lead any national university research facility to make its contribution at national level by participating in a single laboratory and shared experiments with a very different impact from common research networks

- The possibility of supporting the national industry both at the level of large companies (through their direct participation in the network which can be "tailored" to their needs and become an important part of their research & development) and at the level of small and medium-sized

enterprises companies (through their possibility for testing and development to exploit any of the domain / technology nodes by integrating with the nearest infrastructural node
- a business model capable of meeting large and small companies according to the scheme of the previous point.

ENSIEL's national laboratory ENET-RTLab has already experimented with a national research infrastructure of this kind, which, expanded in size and functionality, can form the basis of the proposed infrastructure.
The distributed and interconnected nature of the infrastructure will enhance knowledge transfer among partners and users of the infrastructure. The strong commitment from several Universities and private companies will ensure a wide dissemination of the results.
In terms of business creation, advanced digital tools for integrated networks of physical asses will be created that could find interest also beyond the energy sector.

Part C – Expected impact (max. 8,000 characters)

C.1. Expected outcomes of the intervention

(Describe the impact in terms of a) employment and research spin-off, b) synergy with other productive and research domains)

The goal of this laboratory is to pool together expertise from the national research community (both from universities, R&D industrial, public, and private research centers). Sharing knowledge, expertise, HW and SW devices and tools from different research groups and stakeholders will provide a unique opportunity to work together at the national level, leading to strengthen the impact of the research products and results. The philosophy of the multi-site multi-layer and multi-commodity node lab creates a research-friendly environment where instance-based research (driven by industrial needs) and curiosity-drives research (purely academic, with long-term application perspectives) will coexist and feed each other.
This strong collaboration will lead to create synergies in terms of industrial doctorate figures, that can be employed by the industries, or opening spin-off.

The importance of the laboratory lies in the topics is putting together, that are including all the commodities that will be employed for the energy transition and beyond. Hence, the facility will be open to guide the industry/stakeholders along the energy transition issues and challenging, also by supporting them in decision making process, development and deployment.

From the international relations, the existence of such laboratory at national level will foster the international cooperation with similar infrastructures, by creating a unique opportunity to

be a partner offering a complete set of service covering all the aspects of the future energy system.

The presence of this research environment will be hopefully of interest also for multinational companies, that can find the laboratory as valid support in the implementation of their strategy for adequate their business at the current energy transition.
Also, SMES will benefit by the presence of the multi-site laboratory: in fact, any SMES will be able to ask at the geographically close laboratory support for its business, and even in absence of the specific HW/SW or competence at local level, the infrastructure will be able to cover in any case the request by asking to the other Infrastructure Nodes. This is a great advantage: the local NI will be the intermediate with respect to the rest of the infrastructure, by guiding and supporting the SMES to recognize how to correctly respond their needs.
As final remark, the presence of the infrastructure will be helpful also for local and high-level government bodies: in fact, the competencies within the laboratory will be able to support the development, testing and validation of technologies, models and methodologies, useful to practical implement the energy transition in terms of law acts. This will be helpful to decarbonise all the energy sectors by starting by the green electricity, to reach the 2030 and 2050 decarbonisation goals.

The following sectors / industrial players, on the national scale, can benefit from the proposed infrastructure:

- Enabling technologies for the enhancement of primary renewable sources, energy saving, decarbonisation:
- Emerging technologies for electricity generation from renewable sources: solar, offshore wind and micro wind, mini-hydro, geothermal;
- Low-carbon chemical carriers: Hydrogen, Methane and derivatives. Biofuels and waste-toX. Production (electrolysis, reforming, methanation, gasification and pyrolysis, anaerobic digestion). Transport and storage. Use (combustion, fuel cells);
- Polygenerative systems: CHP, CCHP
- Advanced heat pumps;
- Technologies, methods and models for energy efficiency and sustainability in industry, buildings and transport: waste heat recovery in industrial processes; 5th generation District Heating and Cooling systems; Smart Multi-Energy Systems;
- Carbon Capture, Utilization and Storage (CCUS);
- Enabling technologies for Sector Coupling and energy storage:
- Storage systems: electrical, thermal, mechanical, thermochemical
- Power-to-X technologies: power-to-heat; power-to-gas; power-to-fuel;
- Vehicle-to-X technologies: V2B, V2H, V2G and related applications;
- Enabling technologies for the management of electrical networks and systems

Positive impact will be brought by the:

- Development of resilient and efficient networks in the presence of a high fraction of nonprogrammable RES: frequency stability, voltage regulation.
- Development of electrical systems between microgrids and supergrids, interaction and management of the grid at different voltage levels and with a significant presence of distributed generation.
- Development of analytics to support network management: data mining, load predicting, peak shaving, demand side management.
- Analysis of the electricity markets for energy and ancillary services in the presence of sources with marginal cost close to zero. Breakdown of costs and impacts on market prices and on "affordability"
- IT technologies for the implementation of distributed generation and prosumer communities (electronic ledger, blockchain, ...)
- IT technologies for the implementation of distributed generation and prosumer communities (electronic ledger, blockchain, ...)
- Demand side management with participation of the load in the efficient management of the electricity system
- Microgrid with power balance
- Tools to support the Energy policy and regulation
- Elaboration of evolved scenarios, at various possible levels of aggregation: from local energy districts (including energy communities) to the national and European energy system;
- Study and optimization of development policies for renewable sources and energy efficiency;
- Studies and tools to support the definition of tariff policies and regulation of energy and environmental markets;
- Support tools for local, regional, national and community energy planning and management with reference to legal, economic, social and environmental aspects.

C.2. Long-term sustainability profile

(Provide a detailed description of the profitability of the intervention, including and adequately motivating the expected revenues per year over a period of at least 15 years)

Together with environmental and social aspects, financial sustainability, as mentioned in the previous section, a key pillar for the IRSME budget will be the financial sustainability in the long term that will be ensured also by the contribution of private clients, exploiting of intellectual properties and the attraction of additional funding from Italian and EU public and private calls where the unparalleled depth of IRSME research infrastructure skills and private companies (co-founders) network will play a crucial role. The infrastructure operating revenues and costs over a period of 15 years (2026-2040) after the "*in itinere*" phase have been assessed to highlight the overall sustainability.

As can be seen from the consolidated table reported below, project's financial sustainability is mainly supported by 3 different kind of revenue streams: 1) revenues from infrastructure access 2) revenues from research including EU and Italian Grants and exploiting of intellectual property 3) revenues from offering to the market the infrastructure "as a service" (IaaS) in a "pay per use" route to market.

Consolidated Gross Revenues	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Revenues from utilization (accesses)	4.100	4.100	4.100	4.100	4.100	4.100	4.100	5.818	5.818	5.818	5.818	5.818	5.818	5.818	5.818
Revenues from research (grants)	1.383	1.400	1.417	1.434	1.451	1.468	1.486	1.504	1.522	1.540	1.558	1.577	1.596	1.615	1.635
Revenues from IaaS	540	540	540	540	1.080	1.800	1.800	1.800	1.800	3.600	3.600	3.600	3.600	3.600	3.600
Gross Revenues	**6.024**	**6.040**	**6.057**	**6.074**	**6.631**	**7.369**	**7.386**	**9.122**	**9.140**	**10.958**	**10.977**	**10.995**	**11.014**	**11.033**	**11.053**

Figure C.1. – Infrastructure expected revenues over 15 years period after commissioning (data in thousands of euros)

For the kind of laboratories – very focused on the various player in the market of the integrated multi energy system - the first revenue stream, which represents the most important one, accounting for about 58% of the income, comes from the fees per access paid by users that utilize the infrastructure. Since the IRSME living labs will offer services for testing innovative solution toward low carbon integrated multi energy systems that will interest player in different sectors for industrial applications and research project purposes. Three main clusters of users are expected to pay 3 different levels of fees: a) consortium member that are involved in the PPP pay a reduced fee; b) users from universities and other kind of research and educational institutions are allowed to access at a subsidized price; c) private users that pay a market price in order to access and utilize the infrastructure. The second revenue stream is related to research activities, like the participation to international calls (jointly with the university consortium) and to the infrastructures of European or national research programs. This flow is expected to amount for about 17% of the total income. The third expected source of income (about 25% of the total) can be summarized into "IaaS" (Infrastructure as a Service) which means, for example, the pay per use of each laboratory for training activities or simulations. The 3 levels of fees mentioned above remain valid for this revenue stream.

In order to evaluate the sustainability, we decided to use as indicators the NPV (Net Present Value) of each laboratory and of the overall infrastructure. In order to evaluate the NPV we used a WACC (Weighted Average Cost of Capital) of 4,6% as an average between 1,642% (Italian BTP % calculated at 9/3/2022) and 7,2% (estimation of average WACC on the reference sustainable mobility infrastructure sector). Taxes has been evaluated at 28,82% (IRES and IRAP).With this assumption the PBT of the whole infrastructure is therefore 14 years while the NPV in 18 years (i.e. 3 years in itinere and 15 years in production from 2023 to 2040) will be 612K€.