Battery Flagship and Related Battery Calls Advisory Group Meeting

Ankara, 25 April, 2019

Battery R&D Activities in Rina Consulting

Donato Zangani, R&D Manager

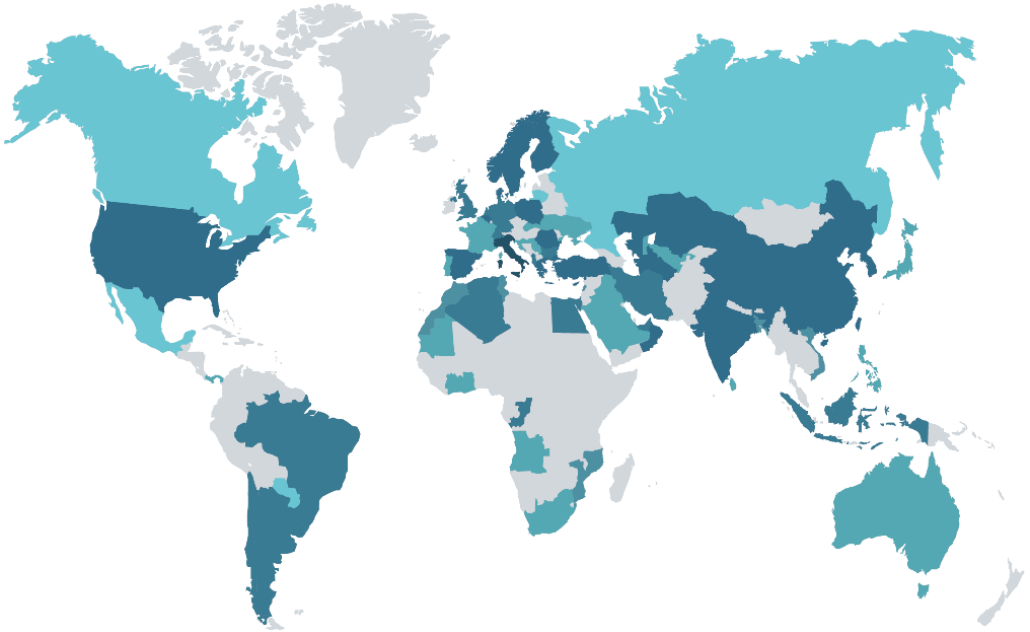
Competence and Experience

OVER 150 YEARS OF EXPERIENCE

RINA provides a wide range of services across the Energy, Marine, Certification, Transport & Infrastructure and Industry sectors through a global network of 170 offices in 65 countries.

RINA is a member of key international organisations and an important contributor to the development of new legislative standards.

What is RINA today



3700
Colleagues

170+
Offices

65+
Countries

LEVEL OF RINA PRESENCE

RINA TÜRKİYE

birlikte mükemmele...

HABERLER VE ETKİNLİKLER

- Haberler
- Basın Bültenleri
- Etkinlikler
- Basın Duyuruları

TÜM HİZMETLERİMİZ

Tüm hizmetlerimizi görmek için tıklayınız

BİZE ULAŞIN

İstanbul Merkez Ofis
Değirmen Sk. Nida Kule İş Merk.
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Kadıköy Istanbul TÜRKİYE
Telefon : +90.216.571 54 00
Faks : +90.216.571 54 99
info.tr@rina.org

HABERLER

19.09.2017 NACE CIP Seviye 2 Boya Enspektörlüğü Eğitimi (6 Kasım - 11 Kasım 2017)
Oku »

19.09.2017 NACE CIP Seviye 1 Boya Enspektörlüğü Eğitimi (30 Ekim - 4 Kasım 2017)
Oku »

28.09.2015 ISO 9001:2015 yayınlandı
Oku »

15.09.2015 ISO 14001:2015 yayınlandı
Oku »

EVENTS

19.06.2017 2017- 2. Yarı Yıl " İklim Değişikliği ve Sürdürülebilirlik Eğitimleri"
Oku »

İLETİŞİM

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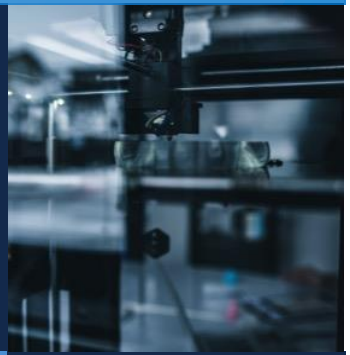
Our markets

SERVICES FOR:

Marine

Industry



Energy

Transport & Infrastructure

Certification

RINA
A spotlight on Innovation

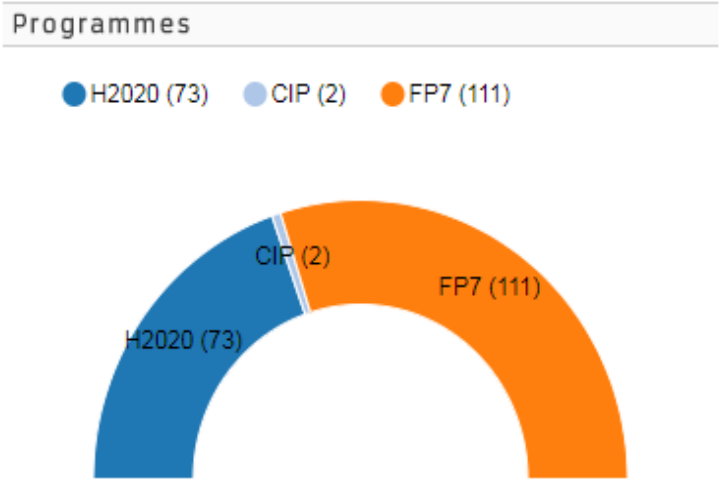
- **210+** Industrial innovation Regional, National and EU **funded projects**, delivered in the past 10 years
- **300+ M€ Global value** of industrial innovation EU **funded projects**, delivered in the past 10 years
- **4th top** industrial participant in **FP7** across EU*
- **4th top** industrial participant in **H2020*** across EU**
- **Around 25% success rate in H2020**
- 5000+ partners in Innovation funded projects ***

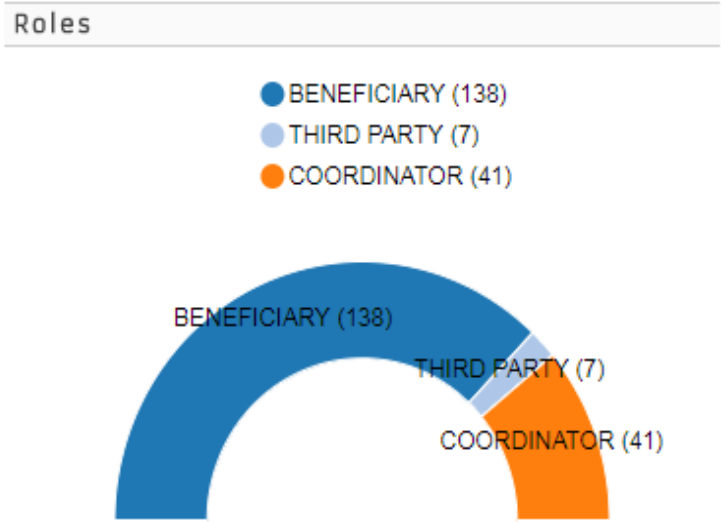
* Final FP7 Monitoring Report
** INTERIM EVALUATION of HORIZON 2020
*** www.researchranking.org

Corporate R&D
Who we are

- Corporate Reseach and Development (R&D)
- About 30 people (Genoa, Milan, Rome, Viareggio, Bruxelles)
- Opportunity identification and management
- Coordinating the participation of the company in R&D calls
- Project Management and supervision of technical activities
- Financial and administrative management
- Actively involved in various Work-Programmes, due to our multi-disciplinary skills

Corporate R&D
Achievements – Overall from FP7 to H2020





https://ec.europa.eu/research/participants/portal/desktop/en/organisations/org_profile.html?pic=999951467

SEVENTH FRAMEWORK PROGRAMME

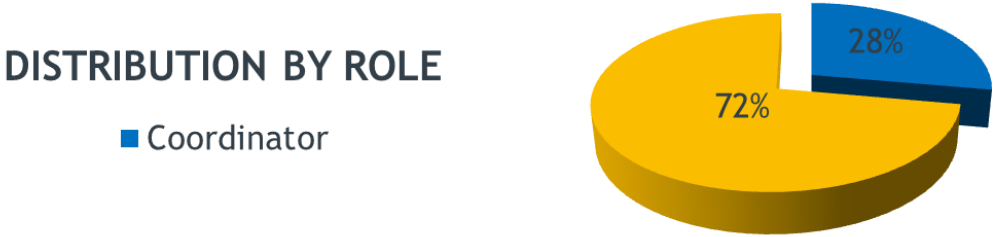
European Commission
HORIZON 2020

Corporate R&D
Achievements – FP7

WINNER
PROPOSAL

Table 7: Ranking of top 10 PRC organisations in FP7 signed grant agreements in terms of counts of participations for the period 2007-2013

PRC Rank	Overall rank	Organisation	Country	Partici-pations	EU Financial Contribution
1	118	ATOS SPAIN SA	ES	141	51.948.726,85
2	127	SIEMENS AKTIENGESELLSCHAFT	DE	132	56.889.078,96
3	149	THALES COMMUNICATIONS & SECURITY SAS	FR	117	60.362.385,21
4	159	D'APPOLONIA SPA	IT	111	31.175.942,48
5	162	TELEFONICA INVESTIGACION Y DESARROLLO SA	ES	109	52.620.460,39
6	164	STMICROELECTRONICS SRL	IT	109	42.701.588,98
7	165	AIRBUS DEFENCE AND SPACE GMBH	DE	109	39.809.035,94
8	173	ACCIONA INFRAESTRUCTURAS S.A.	ES	107	30.563.210,26
9	180	PHILIPS ELECTRONICS NEDERLAND B.V.	NL	103	51.724.950,41
10	191	SELEX ES SPA	IT	98	30.492.717,32



Corporate R&D
Achievements – H2020

Table 30 Top-50 private for profit companies in terms of EU funding

Rank	Participant legal name	Country	EU contribution (EUR million)	Number of participations
1	SIEMENS AKTIENGESELLSCHAFT	Germany	48.7	43
2	ATOS SPAIN SA	Spain	31.9	74
3	BORREGAARD AS	Norway	26.7	3
4	ROBERT BOSCH GMBH	Germany	23.6	39
5	AVL LIST GMBH	Austria	22.4	34
6	ENGINEERING - INGEGNERIA INFORMATICA SPA	Italy	18.9	35
7	ACCIONA INFRAESTRUCTURAS S.A.	Spain	18.7	37
8	ASML NETHERLANDS B.V.	Netherlands	18.0	3
9	IBM ISRAEL - SCIENCE AND TECHNOLOGY LTD	Israel	15.5	19
10	INDRA SISTEMAS SA	Spain	14.4	37
11	DAIMLER AG	Germany	14.4	12
12	GlaxoSmithKline Biologicals	Belgium	14.1	2
13	ENERGOCHEMICA TRADING AS	Slovakia	13.4	1
14	ALSTOM TRANSPORT S.A.	France	12.7	9
15	SOLIDPOWER SPA	Italy	12.7	5
16	ITM POWER (TRADING) LIMITED	United Kingdom	12.6	8
17	D'APPOLONIA SPA	Italy	11.8	39
18	RENAULT SAS	France	11.7	18
19	TELEFONICA INVESTIGACION Y DESARROLLO SA	Spain	11.3	33
20	THALES COMMUNICATIONS & SECURITY SAS	France	11.2	20
21	IBM IRELAND LIMITED	Ireland	10.9	18
22	IBM RESEARCH GMBH	Switzerland	10.2	38
23	PHILIPS ELECTRONICS NEDERLAND B.V.	Netherlands	9.9	20
24	INFINEON TECHNOLOGIES AG	Germany	9.7	10
25	THALES ALENIA SPACE FRANCE	France	9.5	24

RANKING OF MOST SUCCESFULL PRIVATE COMPANY IN EU

1) Atos (74) - Spain
2) Siemens (43) – Germany
3) Bosch (39) - Germany
   Rina Consulting (39) - Italy
5) IBM Research (38) - Switzerland
6) Acciona (37) - Spain
   Indra (37) - Spain
8) Engineering (35) - Italy
9) Avl List (34) - Austria
10) Telefonica (33) - Spain
11) Leonardo (30) - Italy

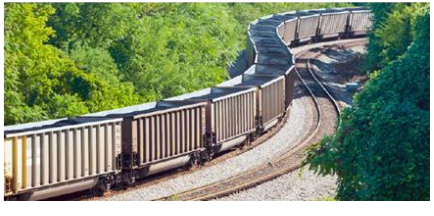
Source:
INTERIM EVALUATION of HORIZON 2020

Corporate R&D
Where we work







CRITICAL INFRASTRUCTURE PROTECTION & SECURITY

DISASTER RESILIENCE AND CLIMATE CHANGE ADAPTATION

EARTH OBSERVATION AND SATELLITES TECHNOLOGIES

SUSTAINABLE TRANSPORT, MOBILITY AND LOGISTICS

MARITIME AND BLUE ECONOMY

SMART CITIES AND COMMUNITIES

CIRCULAR ECONOMY AND BIO-BASED INDUSTRY

SUSTAINABLE INDUSTRIAL PRODUCTION

LOW-CARBON ENERGY

SUSTAINABLE AND ENERGY-EFFICIENT BUILDINGS

NANOTECHNOLOGIES, MATERIALS & PROCESSES

FACTORY OF THE FUTURE & INDUSTRY 4.0

ICT & INTERNET OF THINGS

HEALTH AND WELLBEING

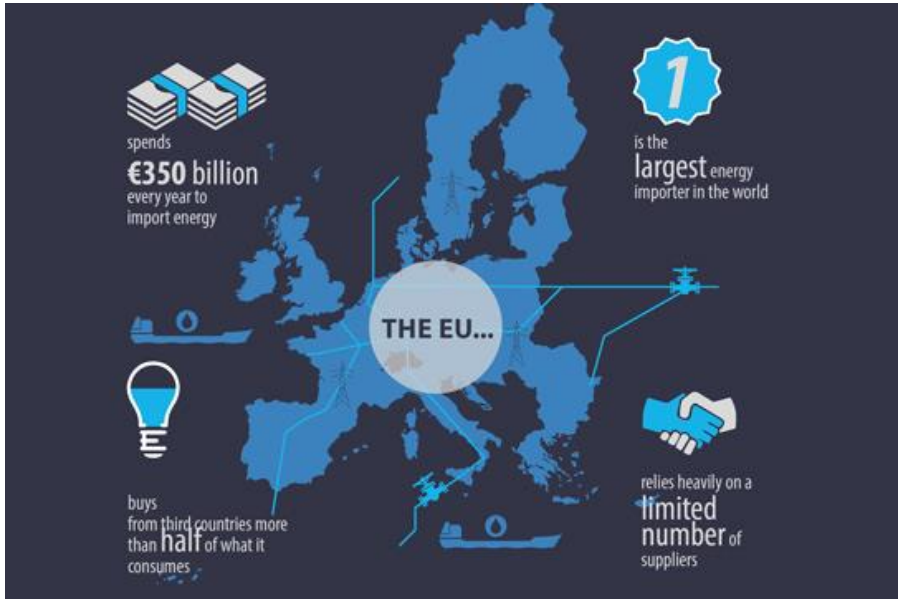
AGRICULTURE, FOOD AND WATER RESOURCES

EU Energy

We’re now living the energy transition (and EU is leading it!)

- EU-28 Renewable share is around 17%
- PV and Wind new plants competitive with newly built fossil fuel Power plant at MW scale
- Almost 2 million people working on RES and EE
- Around 25 B€ are invested in Energy R&D
- 20-20-20 targets almost achieved everywhere
- 0 €/kWh price is more and more usual on energy stock exchange
- Energy Efficiency in Buildings and some RES are topic of «common audience»
- Huge unlocked EE and RES potential in vehicles, industry, thermal energy etc.

Secure, clean and efficient energy



To make the transition to a competitive energy system, we need to overcome a number of challenges, such as increasingly scarce resources, growing energy needs and climate change.

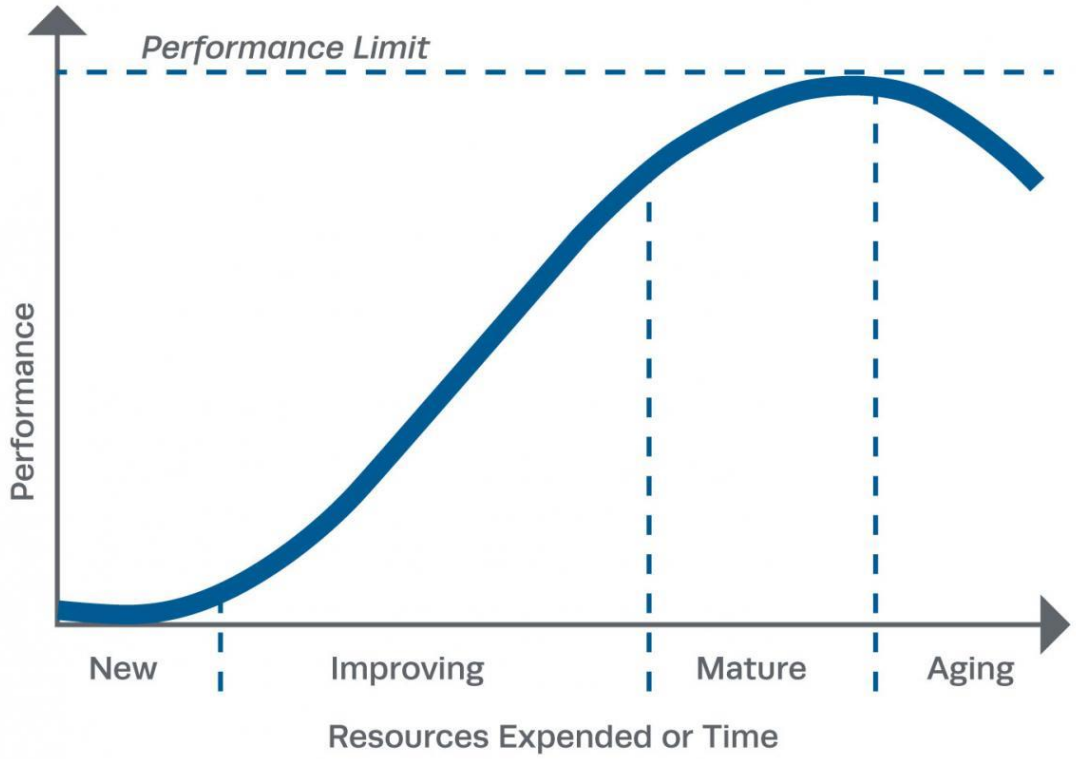
The Energy Challenge is structured around seven specific objectives and research areas:

- Reducing energy consumption and carbon footprint
- Low-cost, low-carbon electricity supply
- Alternative fuels and mobile energy sources
- A single, smart European electricity grid
- New knowledge and technologies
- Robust decision making and public engagement
- Market uptake of energy and ICT innovation.

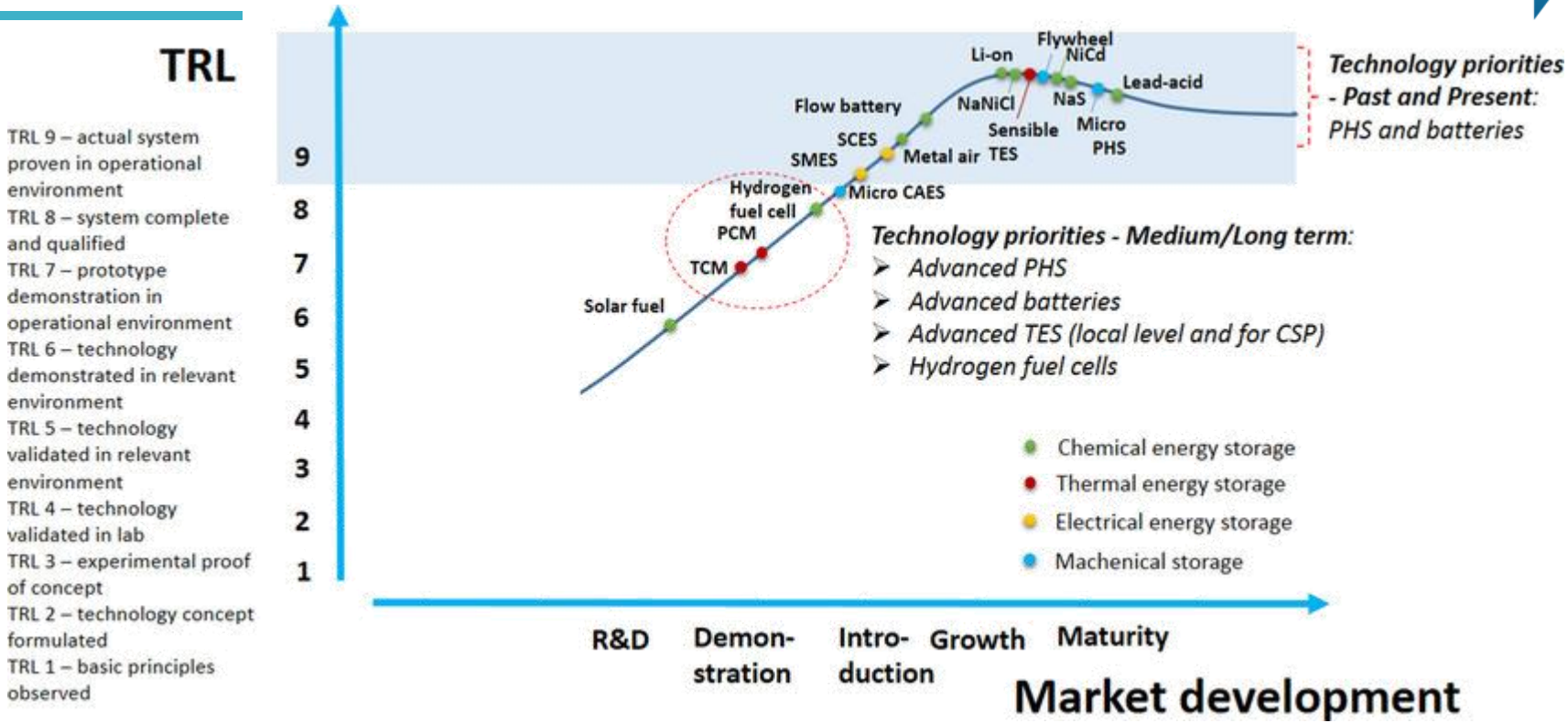
EU Vision

Energy Union	•Free flow of energy through the EU through adequate infrastructure and without technical or regulatory barriers •Improved energy efficiency will reduce dependence on energy imports, lower emissions, and drive jobs and growth
2030 Energy strategy	•a 40% cut in GHG emissions compared to 1990 levels •at least a 27% share of renewable energy consumption •at least 27% increase of energy efficiency (compared to projections) •electricity interconnection target of 15% by 2030
2050 Energy strategy	•a 90% cut in GHG emissions compared to 1990 levels •at least a 40% share of renewable energy consumption •Long term planning and investments (new transmission lines etc.)
Energy Security strategy	•Analysis based on Energy security stress tests in 2014 •Promote EU independency from Russia Gas and MENA crude oils •Attention to Cyber attacks
Clean Energy for EU Islands	•Islands as test bench for sustainable energy technologies (bills up to 400%) •better energy security for islands, which will be less reliant on imports

Maturity curve for energy storage technologies

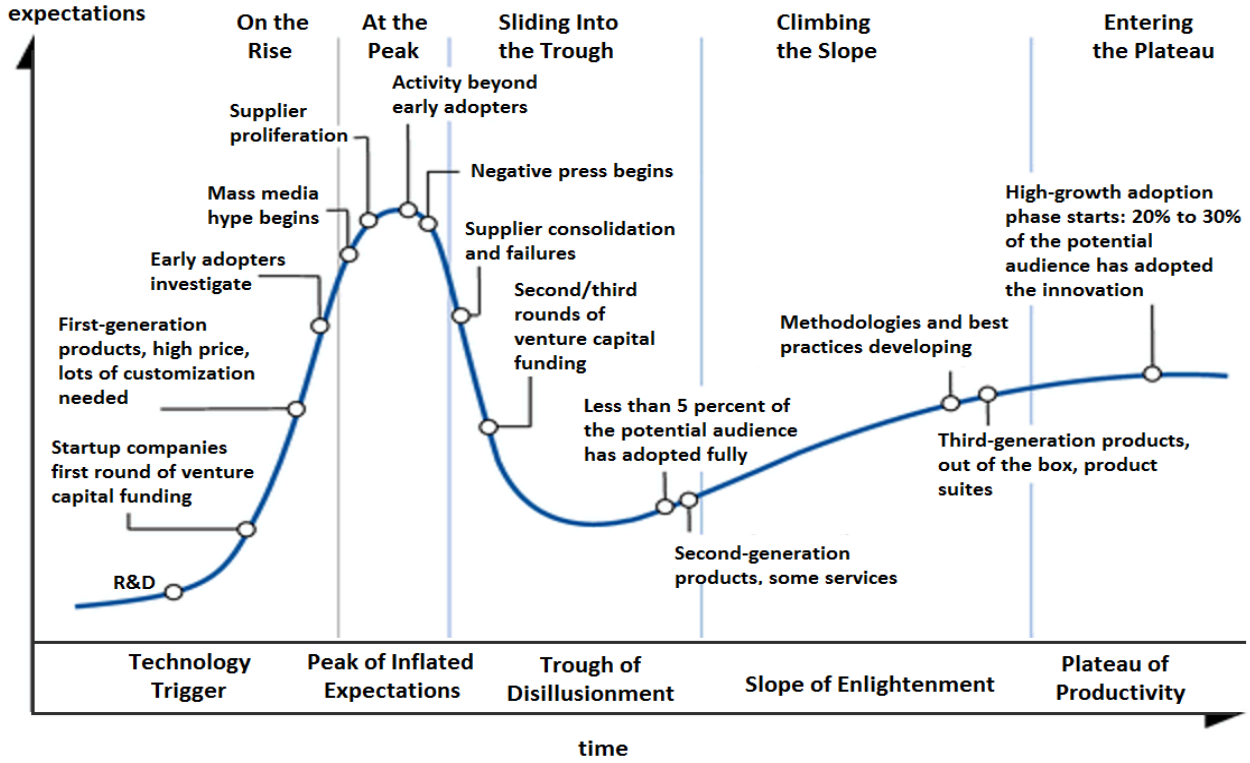


Maturity curve for energy storage technologies

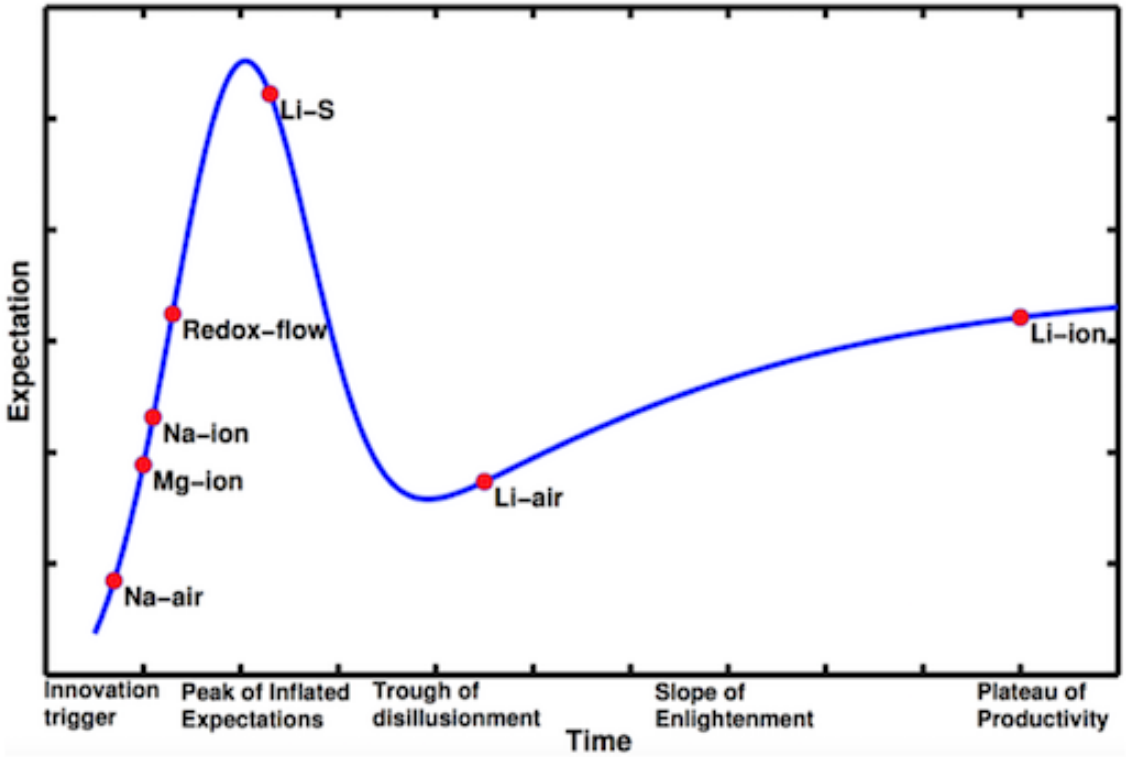


After: T.-T. Nguyen et al., *A review on technology maturity of small scale energy storage technologies*, Renew. Energy Environ. Sustain., 36 (2017)

Maturity curve for battery technologies



Maturity curve for battery technologies



After: Beyond the Hype: What's the Future of Batteries?, Scientific American, 2016

EU Challenges

A RES based energy scenario, which aims to be Independent and reliable

- **MORE FLEXIBLE POWER PLANTS** (both fossil fuel and RES based)
- **COST EFFECTIVE ENERGY STORAGE**
- **POWER – TO – X** (heat, gas, chemicals, fuel etc.)
- **RENOVATION and SMART MONITORING OF ENERGY INFRASTRUCTURES** (electric and gas grids, DHNs etc.)
- **INTEROPERABILITY OF ENERGY GRIDS** (transnational, urban and polygeneration)
- **ENERGY SUSTAINABILITY IN ISLANDS AND REMOTE AREAS**
- **URBAN ENERGY METABOLISM** (waste heat, virtuous waste valorization, 4th generation DH, EVs etc.)
- **ROLE AND REGULATION OF PROSUMERS**
- **COST EFFECTIVE ALTERNATIVE FUELS** (hydrogen, biomethane, syngas…)
- **LARGE UNLOCKED EE POTENTIAL IN INDUSTRY** (also in terms of flexible loads)
- **INNOVATIVE ENERGY ECONOMICS** (financing schemes, new energy stock criteria, sustainable feed-in etc.)

Which opportunities for RINA?

Not just RES and EE engineering services but also…

Transfer of knowledge from «fossil» to RES sector
Off-shore engineering (wind farms, buoying systems, study of off shore storage solution, renovation of platforms etc.), O&G engineering (biomethane, hydrogen, HSE for storage etc.)

Energy Grids interaction

Control and Management of Energy Systems
Smart Grids, sustainable energy in islands and isolated areas, more flexible fossil fuel power plant, RES+Storage flexible plants, virtual aggregation of energy loads/producers for flexibility services etc.

Market proposition for energy utilities
Innovation in energy investment analysis leveraging local feed-in schemes (biomethane, alternative fuels, EE in industries…), joint purchasing of energy storage to operate on the grid, new kind of ESCO models for industries (waste heat, aggregation etc.), new EVs+Home contracts etc.,

Performance Certification and test methodology development
Needs of procedures to qualify beneficial impact of some RES/EE measures

Our Research Projects related to Battery Technologies

RINA Research Projects related to Battery Technologies

SMILE in a nutshell

Title: SMILE – Smart Islands Energy Systems
Funded: by the EU in H2020 Grant Agreement N. 731249
Budget > 14M€
Duration: 2017-2021
Partners: 19 from 6 EU countries

SMILE in a nutshell

SMILE overall objective

The SMILE project aims **to demonstrate**, system-wide in real-life operational conditions, a set of **both technological and non-technological solutions adapted to local circumstances** targeting the distribution grid to enable:

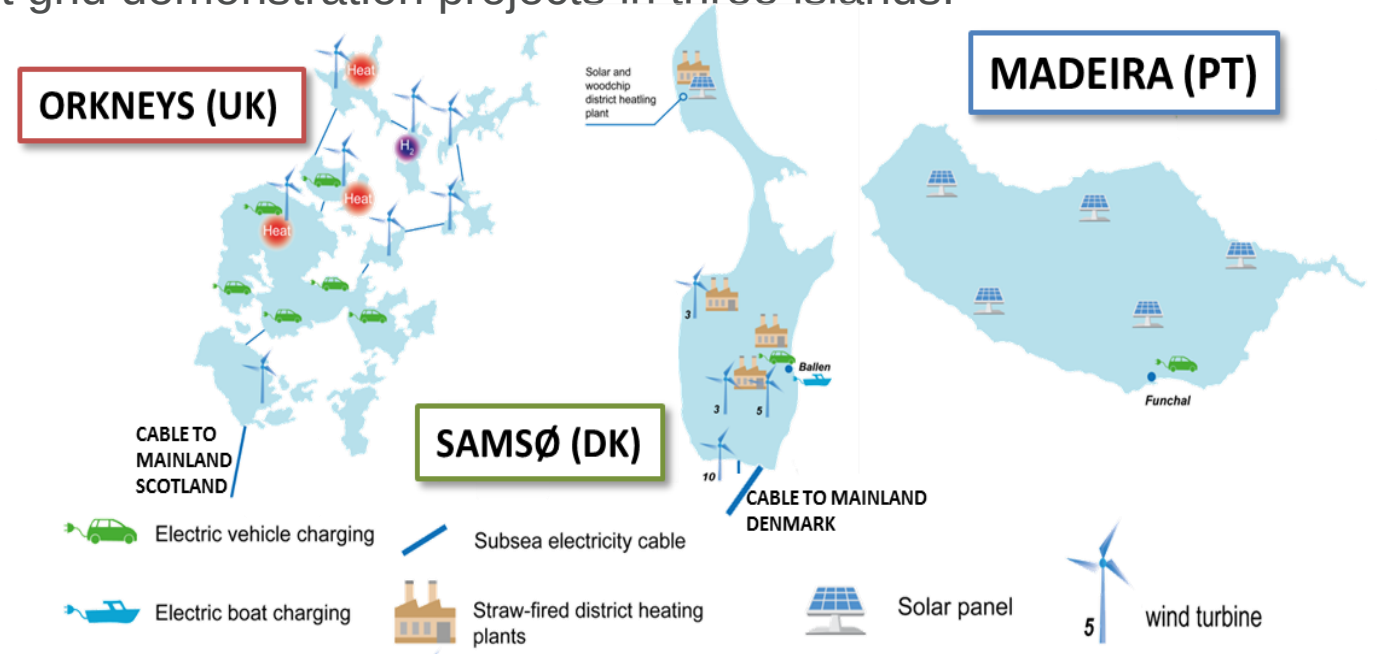
- **demand response**
- **smart grid functionalities**
- **storage and energy system integration**

3 large-scale pilot projects will be implemented **in 3 different regions of Europe with similar topographic characteristics but different policies, regulations and energy markets**

SMILE overall objective

The project's main objective is to demonstrate 9 innovative technological solutions in large-scale smart grid demonstration projects in three islands:

- Orkneys (UK)
- Samsø (DK)
- Madeira (PT).



Why island locations?

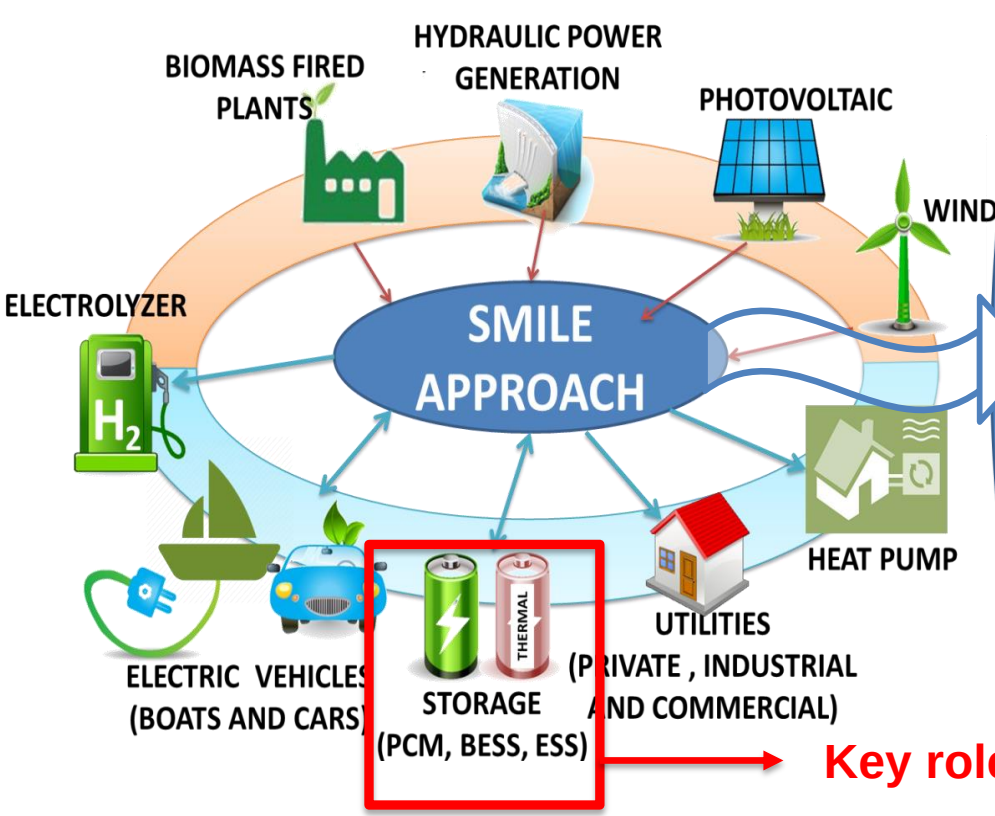
- Island communities can be more easily engaged in the real-life testing of solutions aimed at solving important challenges impacting life on the island
- Constitute ideal candidates for demo activities requiring societal engagement & active residents' commitment.

Why island locations?

The 3 selected case studies:

- characterised by high shares of RES
- intend to demonstrate **stable grid operation** in the context of the adoption of **energy storage solutions** and/or the connection between the electricity network and other energy networks
- intend to demonstrate **smart integration of grid users** from transport and mobility
- Specific set of challenges & Technology options
- Energy market conditions
- Mutual learning & Replication

Overall concept



SMILE APPROACH

Cross-functional control and automation framework

- Plug&Play scalable software solutions
- Cyber security measures
- Fault identification mechanisms and reconfiguration

DEMAND SIDE MANAGEMENT

- Predictive algorithms for demand-response
- Predictive algorithms for integration of grid users from transport
- Energy management algorithms and aggregation tools

Key role of the battery technologies

ORKNEY

The overall goal associated to this demonstrator is to maximise the productivity of the existing generation assets, mostly owned locally, and to support the rollout of electric vehicles. Within this framework, the main objective of the Orkney pilot project is to transform a **semi-smart grid system** (management of generation only) into a **fully smart system** (management of generation and demand), by using existing grid infrastructure and integrating new communications and control systems as well as **storage systems** and new controllable energy demand for heat and transport.

ORKNEY

The demonstrator is focused on installing controllable demand in a specific zone of the island:

In particular 3 types of demand are controlled:

- Domestic heat
- Electric Vehicles
- Industrial load

ORKNEY

Battery technologies play a key role in particular in the installation related to domestic heating where in particular **Phase Change Material** based **heat batteries developed by the partner Sunamp** and Battery Energy Storage System (**BESS**) developed **by partner Lithium Balance** are used and combined with Heat Pump and hot water thermal store in order to implement efficient and controllable solutions

In the framework of the overall architecture, also the storage in Electric Vehicles plays a relevant role.

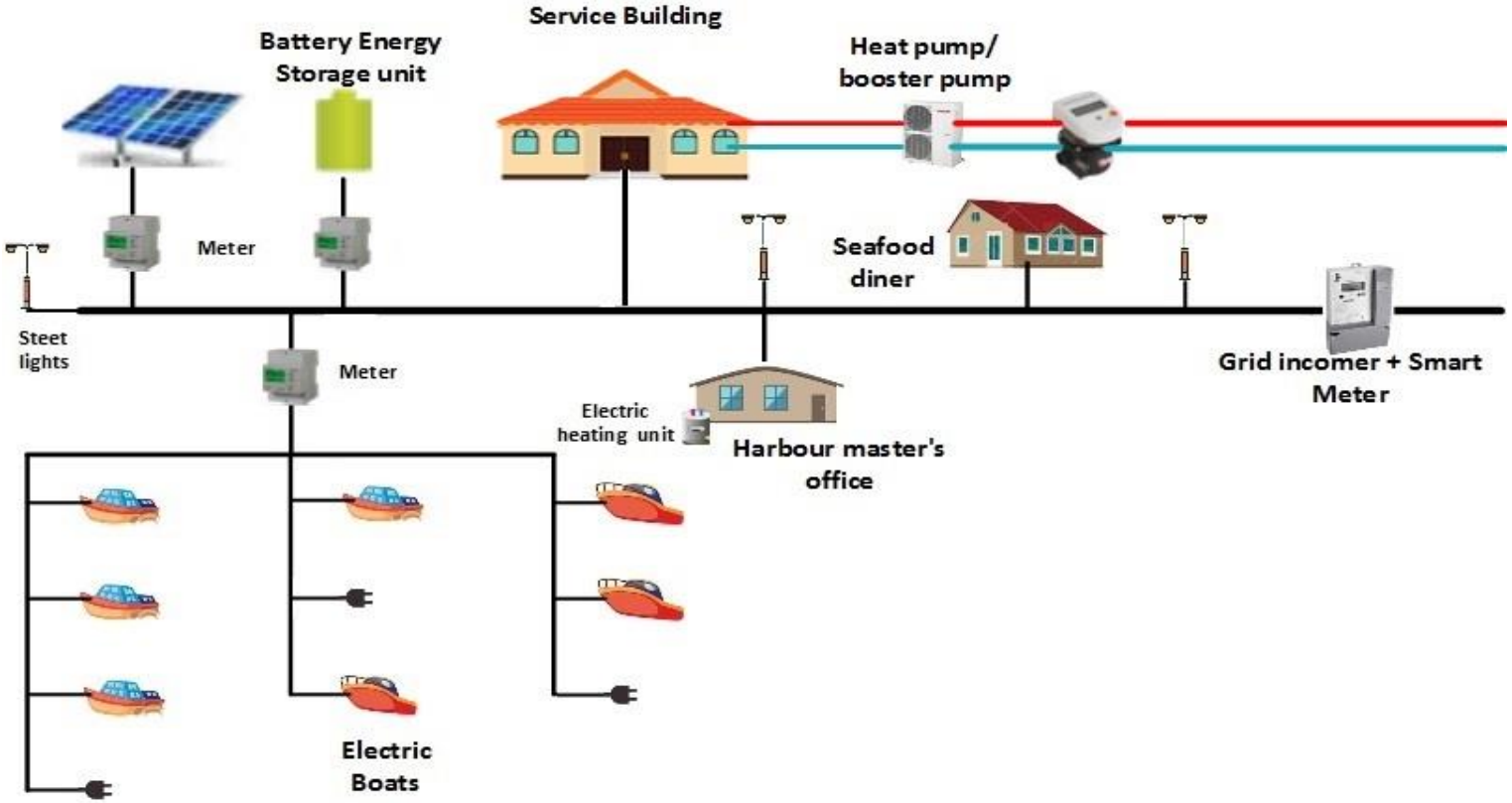
The developed batteries are currently under installation in **45 domestic houses**

SAMSØ

The core of the Samsø Regional Demonstrator is **a battery energy storage system (BESS)**. The idea is to create a real-condition smart grid system with renewable energy sources and electric loads. The smart grid system is extended to a smart energy system by including heat pumps, which combine the electricity sector with the heating sector. The flagship case concerns the boats in the marina of Ballen, Samsø. The boats are to be charged with electricity by renewable energy sources (RES) by an intelligent charging system. **A BESS system (240 kWh)** in the Ballen marina has been installed to maximise the use of renewables.

Reference: Report D3.1 Specifications and Data Report for the Samsø Demonstrator

SAMSØ



Reference: Report D3.1 Specifications and Data Report for the Samsø Demonstrator

MADEIRA

BESS Systems have been installed in the island for achieving the following objectives:

- Maximization of renewables production consumption at domestic and commercial level
- Voltage and Frequency control

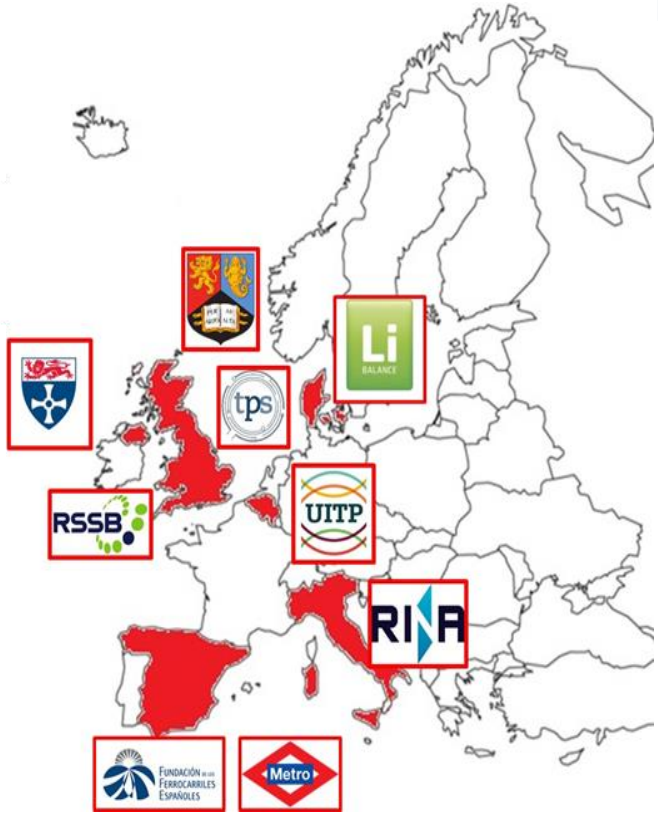
Reference: Report D3.1 Specifications and Data Report for the Samsø Demonstrator

E-LOBSTER

Title: E-LOBSTER – Electric LOsses Balancing through integrated STorage and power Electronics towards increased synergy between Railways and electricity distribution networks
Funded by the EU under the Grant Agreement N. 774392
Budget > 4M€
Duration: 2018-2021
Partners: 9 from 5 EU countries

CONSORTIUM

- RINA (RINA-C)
- TURBO POWER SYSTEMS LTD (TPS)
- RAIL SAFETY AND STANDARDS BOARD LIMITED (RSSB)
- THE UNIVERSITY OF BIRMINGHAM UOB)
- LITHIUM BALANCE A/S (LIBAL)
- METRO DE MADRID SA (MDM)
- UNIVERSITY OF NEWCASTLE UPON TYNE (UNEW)
- FUNDACIÓN FERROCARRILES ESPAÑOLES (FFE)
- UNION INTERNATIONALE DES TRANSPORTS PUBLICS (UITP)



E-LOBSTER overall goal

To develop an Electric Transport-Grid Inter-Connection System able to establish mutual synergies between:

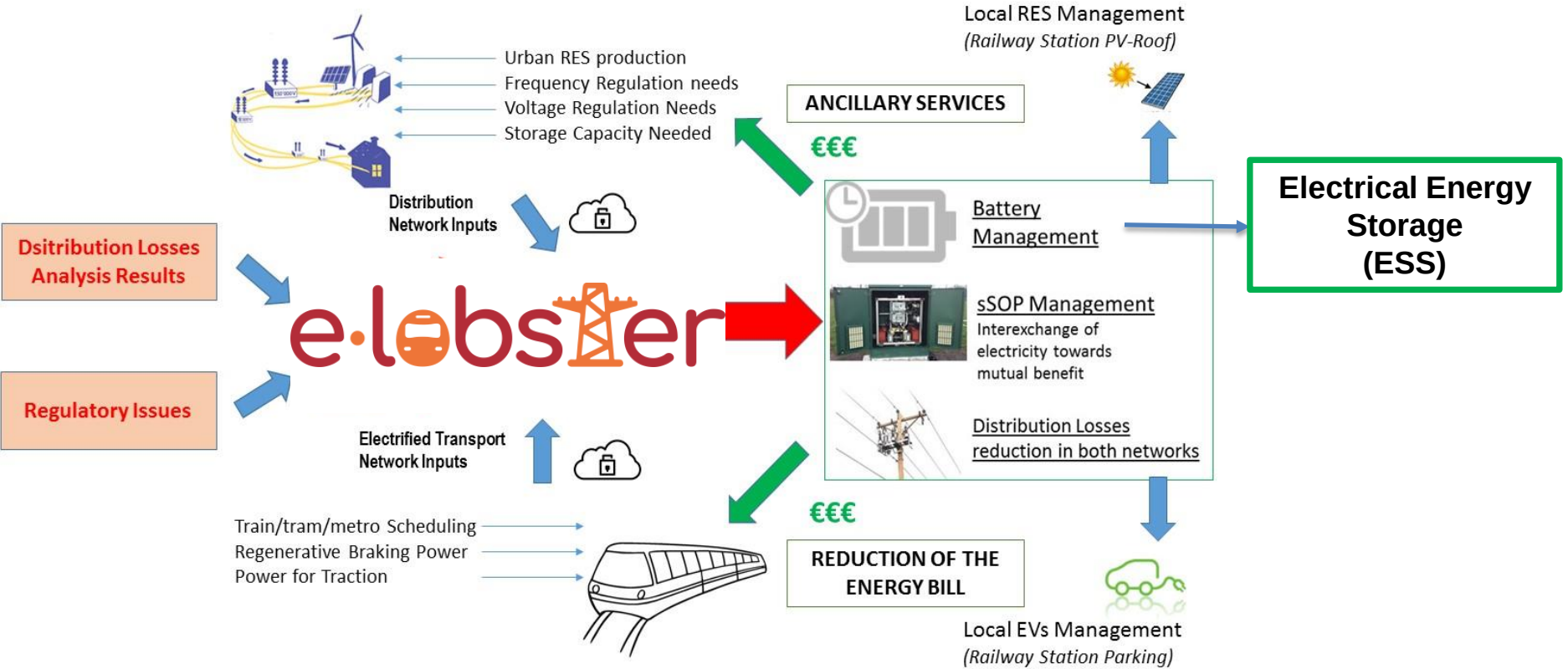
- power distribution networks
- electrified urban transport networks
- charging stations for electric vehicles.

To demonstrate tools and technologies, software and hardware to monitor in real time the source of losses of both the networks prioritising techniques for their minimisation via a coordinated control of the power supply for electrified transport and recharge stations for electric cars and towards the maximisation of the local consumption of RES production thanks to the use **of Electrical Energy Storage (EES).**

R2G Management system

E-LOBSTER is proposing an advanced R+G (Railway to Grid) Management system which will be able to reduce electricity losses in both the networks, maximizing the use of local RES generators through **devoted storage technologies** for both applications and making them interacting one each other in a mutual synergy strategy.

CONCEPT AND OVERALL APPROACH

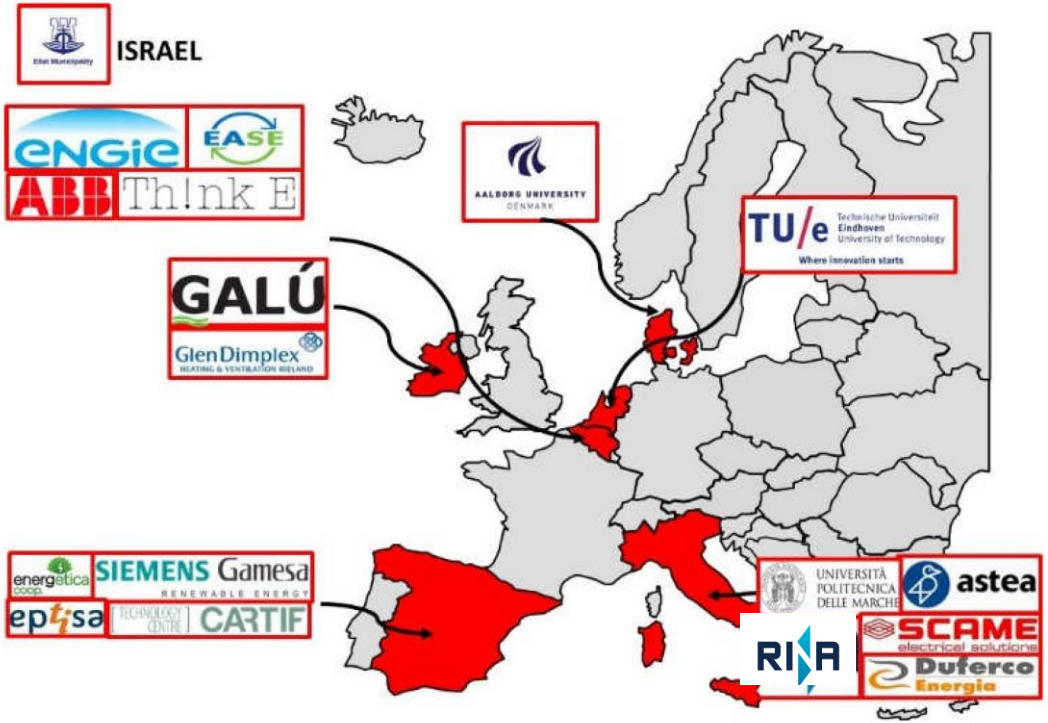


Video

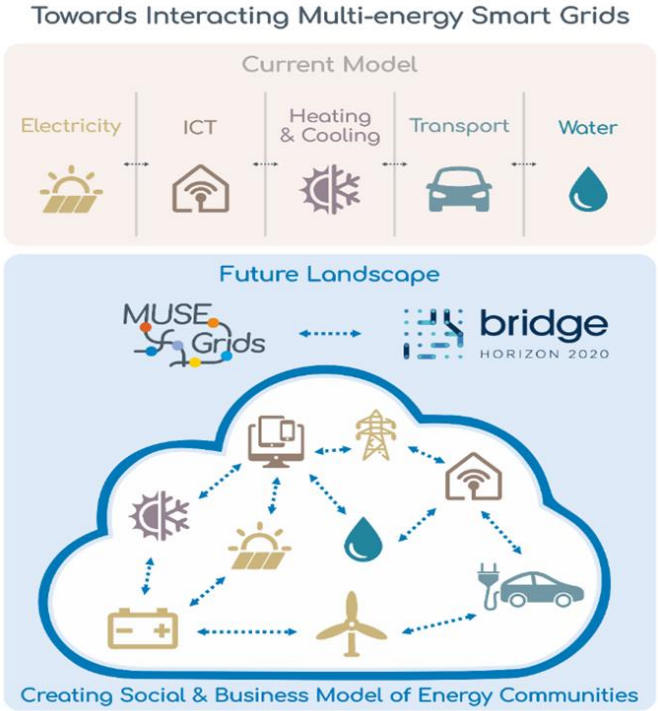
MUSE GRIDS in a nutshell

Title: MUSE GRIDS – Multi Utilities Smart Energy GRIDS
Funded: by the EU in H2020 Grant Agreement N. 824441
Budget > 7 M€
Duration: 2018-2022
Partners: 18 partners from EU 7 countries

MUSE GRIDS in a nutshell



MUSE Grids aims to demonstrate, in two weakly connected areas, a set of both technological and non-technological solutions targeting the interaction of local energy grids



Two different technologies related to batteries will be implemented:

- Smart Electrical Energy Systems (P2H – Power to heat) as a flexible load for the grid
- Neighborhood batteries for power quality improvement and phases balancing

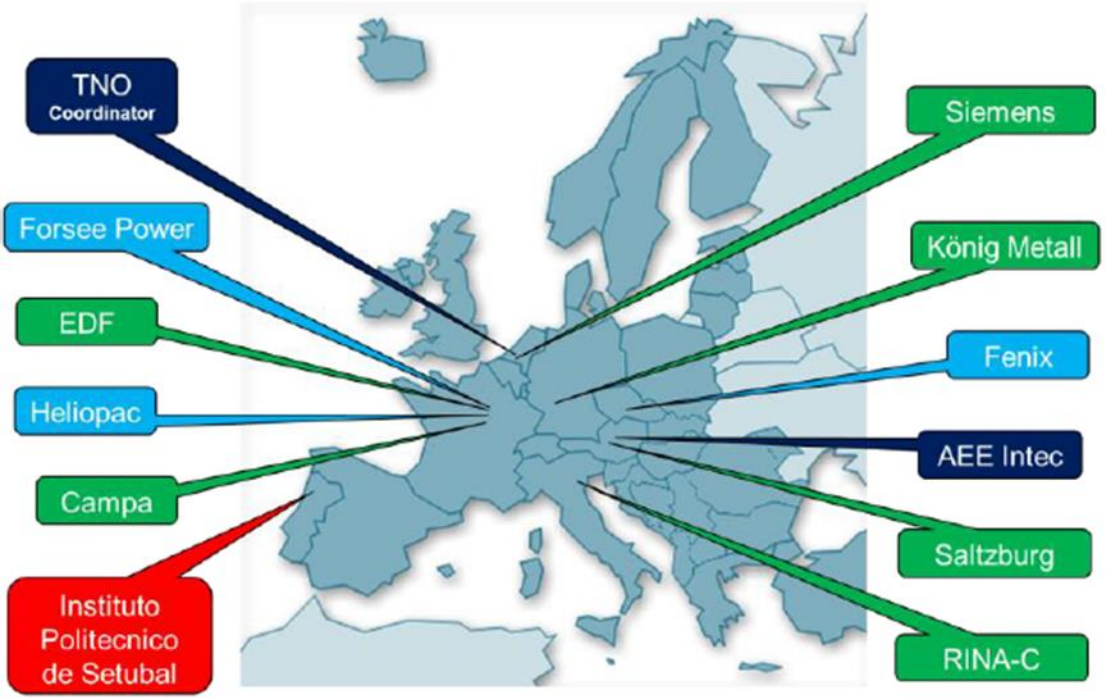
- Two large-scale pilot projects will be implemented in two different EU regions, in urban (Osimo - Italy) and rural (Oud-Heverlee - Belgium) contexts with weak connections with national grids.
- These pilots will test and promote the main project concepts:
  - Smart energy system
  - Local Energy Community.
- A Smart Energy System is defined as an approach in which smart electricity, thermal, water, gas grids etc are **combined with storage technologies** and coordinated to identify synergies between them towards maximization of energy independency and reduction of operation costs.

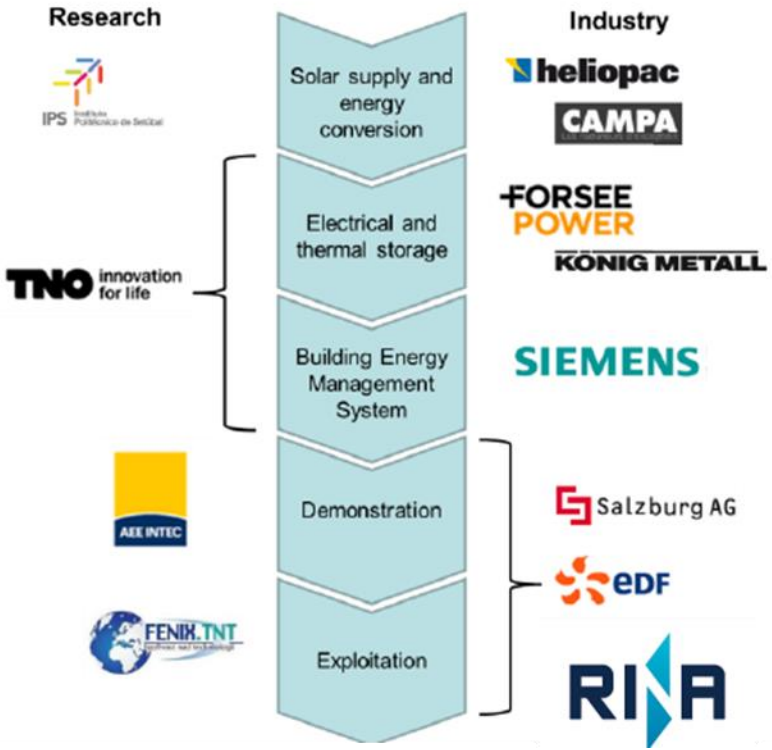
- The purpose is to reduce energy carbon footprint while meeting energy demands and creating real and sustainable **energy islands**.
- To achieve this both physical networks (electricity, natural gas, district heating and cooling, water) and non-physical networks (mobility and citizens/communities) have to interact in order to become a Local Energy Community where inhabitants can act and exchange energy to provide reliable and cheap energy in collaboration.
- The project started at the end of 2018

SCORES in a nutshell

Title: SCORES – Self Consumption Of Renewable Energy by hybrid Storage systems
Funded: by the EU in H2020 Grant Agreement N. 766464
Budget: 6 M€
Duration: 2017-2021
Partners: 12 partners from EU 7 countries

SCORES in a nutshell





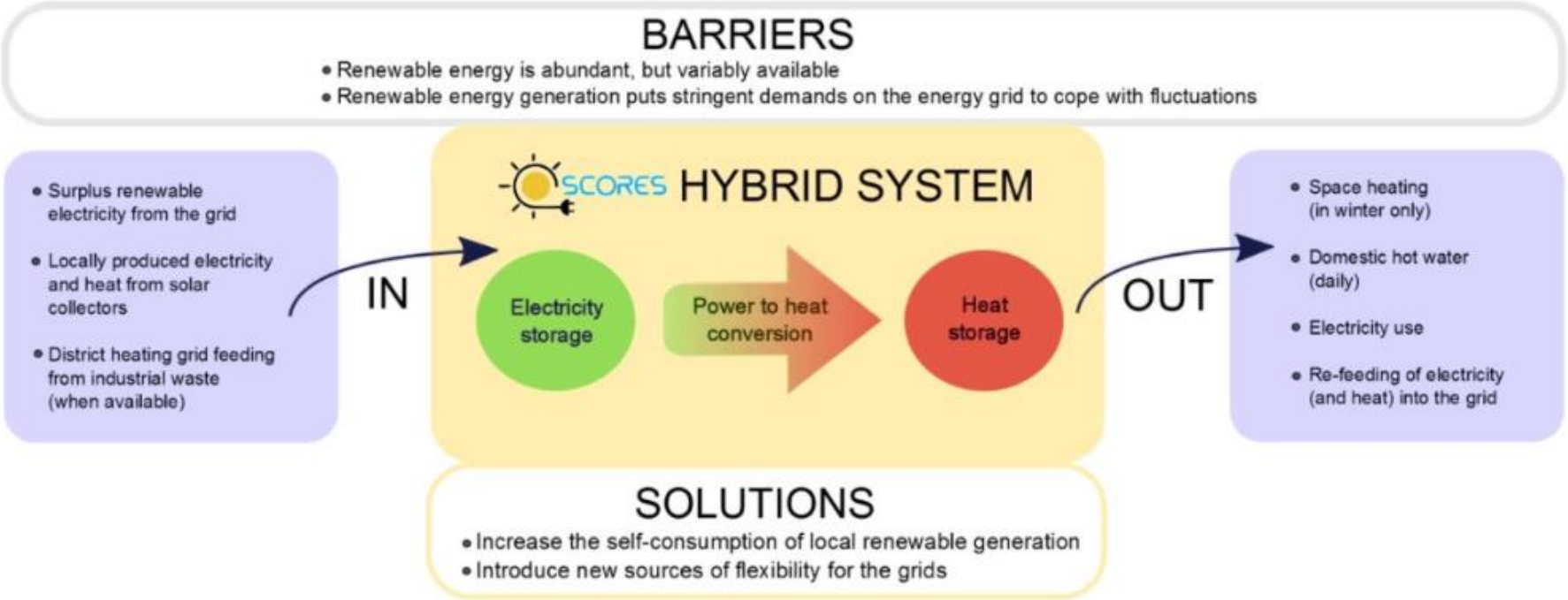
SCORES – Self Consumption Of Renewable Energy by hybrid Storage systems

SCORES combines and optimizes the **multi-energy generation**, **storage** and **consumption** of **local renewable energy** (electricity and heat) and **grid supply**. Via the development of compact hybrid storage technologies, integrated through a smart Building Energy Management System, the project will optimize the self-consumption in residential buildings, bring new sources of flexibility to the grid, and enable **reliable operation** with a **positive business case** in Europe's building stock.

SCORES – Self Consumption Of Renewable Energy by hybrid Storage systems

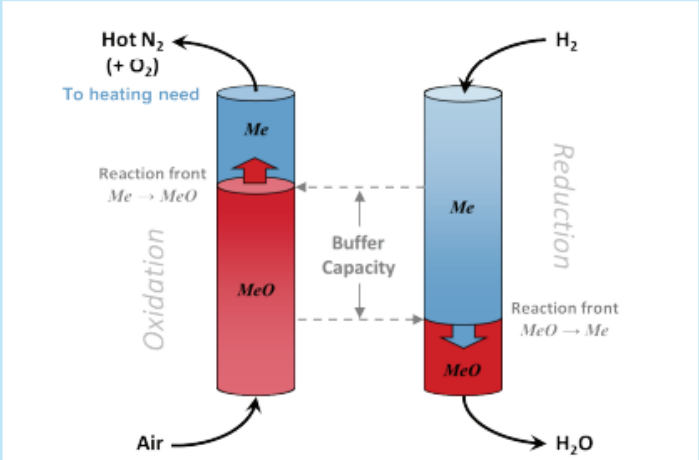
The purpose of the SCORES system is to provide part of the electricity and heating demands of a building from renewable sources. Part of the system will be a **Redox-heat storage system** that will serve as a long-term heat storage. The system will be able to store excess electric energy from the grid or PV(T) in a form of heat that could be recovered later for the use in the building thus potentially reducing the loads on the grid itself. **Second life Li-ion batteries** and **hot water heat storages** will complete the storage system in the residential environment.

SCORES – Self Consumption Of Renewable Energy by hybrid Storage systems



SCORES – REDOX-HEAT battery

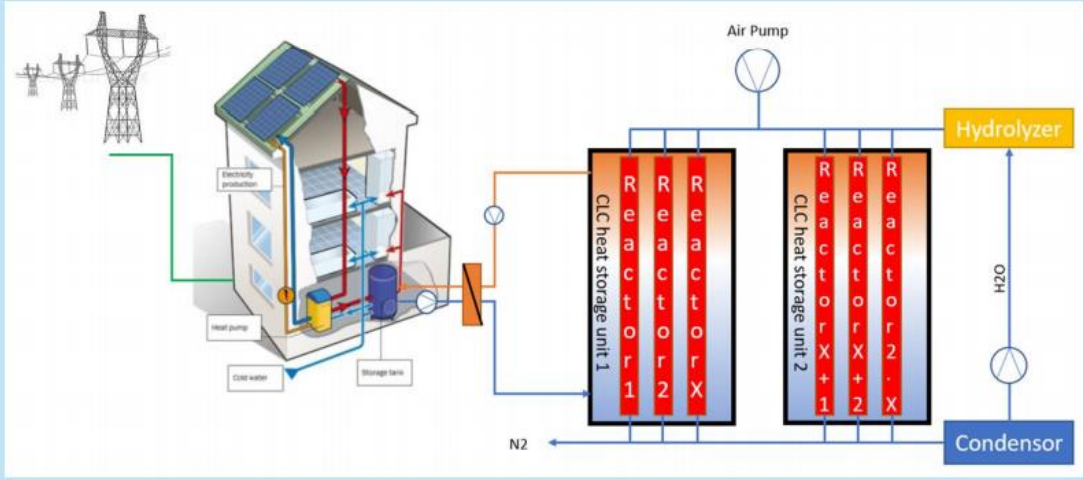
Principle behind REDOX-HEAT battery



$CuO + H_2 \rightarrow Cu + H_2O$ -2 MJ/kg (Cu) (17.9GJ/m³ Cu) – material level

$Cu + ½O_2 \rightarrow CuO$ -2.45MJ/kg (Cu) (22GJ/m³ Cu) – material level

REDOX-HEAT system integrated in the building



The REDOX-HEAT battery exploit the thermal energy released in both the oxidation (air as reagent) and reduction (hydrogen produced via the excess electric generation of PVs as reagent) of a copper cylinder.

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Many thanks for your attention!

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