IREC ®

Shaping Energy for a Sustainable Future

PRODUCTS
SOLUTIONS
SERVICES

TECHNOLOGY CATALOGUE

INDEX

CUSTOMIZED INDUSTRIAL PROCESS MONITORING

USING IN-LINE OPTICAL AND OPTOELECTRONIC INSPECTION

THE CONCEPT

SEMI-CONDUCTORS · TECHNICAL PLASTICS · LIQUIDS

GRAPHENE · GLASS · TEXTILE
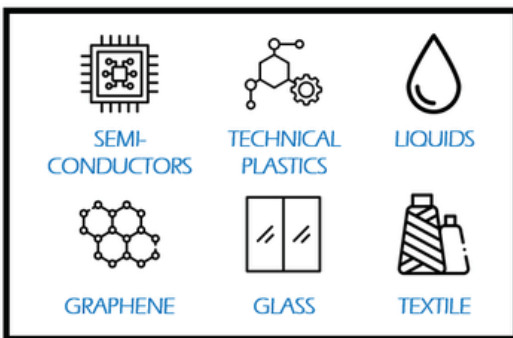
EARLY DEFECT DETECTION

ADDED VALUE

- Non-destructive
- Highly customizable

TRL

7

CONTACT

https://irec.cat

KTT area

ktt@irec.cat

+34 933 562 615

PRODUCT DESCRIPTION

- Modular and adaptable **multi-sensor head** for the **in-line monitoring of industrial processes**
- Uses **advanced AI** and **combinatorial analysis** to deliver clear and direct outcomes
- Can cover the **analysis of many different materials**, from complex semiconductors to glass or plastic
- **Non-destructive** characterization to assess the quality of the final or intermediate products
- Helps to **identify defects and small deviations** of the physico-chemical properties of the materials, allowing early correction and/or prevention of pre-critical production faults
- **Contributes to the digitalization** towards industry 4.0

APPLICATIONS

- Manufacturing industrial processes requiring in-line monitoring for high-value products
- Customized inspection systems for materials' assessment
- Advanced characterization of complex materials

DESIRED PARTNERS

- Fabrication/manufacturing industries
- Metrology companies
- Quality control end-users

EXPECTED BENEFITS

Real-time monitoring · Production optimisation · Saves material · Reduces costs

technical details

TYPE OF ANALYSED MATERIALS

The present solution allows to perform an extensive and non-destructive local characterization of many different materials, in a fast and practical way, with none or minimal sample preparation. The materials under analysis can be: composites, chemical products, liquids, ceramics, graphene, organic materials or even agrifood.

DETAILS OF THE ANALYSIS

Can analyse a variety of **properties**: Quantification of composition (including dopants and additives), chemical structure, crystallinity, intrinsic materials' strain, poli-types, and optical and electrical properties.

Can use a variety of **techniques**: *structural and physicochemical* (IR, Raman, XRF, fluorescence). *optical* (reflectance, transmittance, thermography, UV/VIS/IR inspection) or *optoelectronic/electrical* (I-V, dark I-V, spectral response/quantum efficiency, electroluminescence, resistivity, capacitance, photoluminescence spectroscopy).

Employs automatic Big Data **analysis** using analytical and statistical AI methods.

IMPLEMENTATION

Several pilot plants have been implemented for different industrial processes, together with: ZSW, Sunplugged, Saule, LENZ, Dismeco, Graphenea, Lurederra, Ecopol, checking materials as diverse as silicon in photovoltaic panels, polymers, graphene or classification of glasses for recycling.

Sorting system - Pilot line for recycling plastic in Lurederra (Navarra)

Process monitoring system- pilot line for ClGs PV production in ZSW (Sttugart)
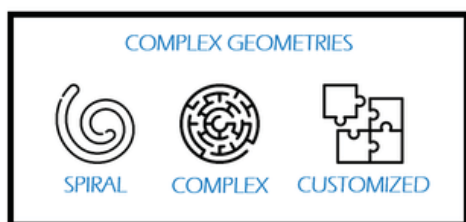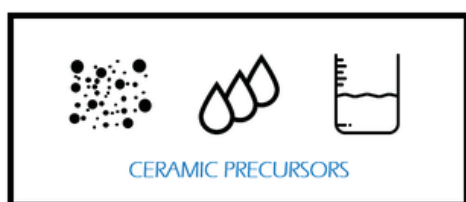
CERAMIC COMPLEX GEOMETRIES BY 3D PRINTING

MAKING MONOLITHIC SOLID OXIDE SHAPES

THE CONCEPT

CERAMIC PRECURSORS

3D PRINTING

COMPLEX GEOMETRIES

SPIRAL   COMPLEX   CUSTOMIZED

ADDED VALUE

- Increased robustness
- Increased thermal shock resistance
- Reutilization of waste heat for reforming processes

TRL

4

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CONTACT

- https://irec.cat
- KTT area
- ktt@irec.cat
- +34 933 562 615

PRODUCT DESCRIPTION

- Original 3D printing process able to fabricate **customized ceramic structures** in a single step
- Allows the fabrication of **monolithic** ceramic **complex geometries**
- **Reduces cost of implementation** and raw materials of the related technologies
- Allows **integration of functionalities** by customizing final product features, such as enhanced active surface area

APPLICATIONS

Focuses on manufacturing of devices made of **ceramic functional materials** for several applications, such as:

- Solid oxide cells fabrication
- High temperature packaging
- Customized testing setups
- Catalytic reactors

DESIRED PARTNERS

- System integrators
- Investors
- Final users

EXPECTED BENEFITS

Feasible complex structures

Minimised gas leakages

Reduces waste

Reduces cost

technical details

INNOVATIVE SOLUTION

This manufacturing solution solves the limitation of the ceramic industrial fabrication technology, limited to tape cast sheets and extruded shapes, which limits the geometries of the SOC devices, and thus their performance. It eliminates the use of seals and interconnect plates (the main points of failure), allows control of porosity gradients and a variety of materials in the same product. The ceramic fuel cell will integrate all the elements of a SOFC in one monolithic structure that requires complex geometries only obtainable via 3D printing. Such geometries do not currently exist in the ceramic 3D printing field. This method overcomes a series of technical problems related to 3D printing machines and ceramic slurries.

COMPETITIVE ADVANTAGE

Complex geometries- can solve traditional problems such as the presence of weak joins and leakages for Solid Oxide Cells, maximize the active area in photocatalysts or improve mass and heat transfer in functional devices (SOC, catalytic reactors)

Hierarchical complexity- allows designing features with shape complexity across multiple size scales to maximize active surface in SOCs or catalytic reactors as well as improve mechanical properties (bioinspired materials) in all the devices under development

Material complexity- allows material differently processed at different points resulting in a variety of properties, including a combination of materials. This allows generating highly interesting porosity graded structures for SOCs or active composites for SOCs

Functional complexity- allows direct fabrication of devices integrating different functionalities

Examples of possible complex geometries for SOC devices or catalytic reactors.
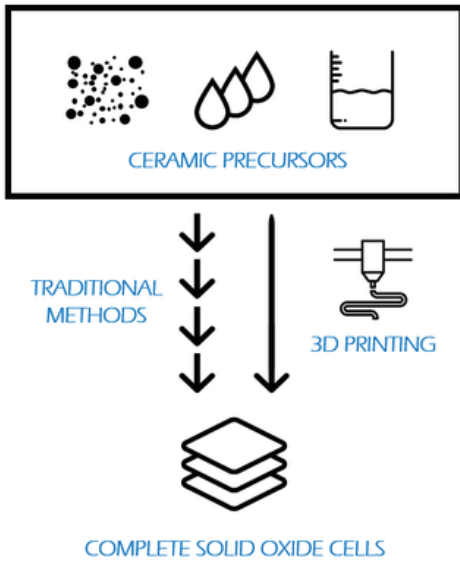
3D printer by Ceramaker

Patent number EP3754768A1

ELECTROCHEMICAL CERAMIC CELLS BY 3D PRINTING

FABRICATION MONOLITHIC SOLID OXIDE CELLS

THE CONCEPT

CERAMIC PRECURSORS

TRADITIONAL METHODS   3D PRINTING

COMPLETE SOLID OXIDE CELLS

ADDED VALUE

- Increased robustness by design
- Simplified manufacturing

TRL

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CONTACT

- https://irec.cat
- KTT area
- ktt@irec.cat
- +34 933 562 615

PRODUCT DESCRIPTION

- Fabrication of an all-ceramic monolithic **solid-oxide cell stack** by **3D printing**
- **Multimaterial devices** done in a **single-step** by merging more than 60 steps
- Final multilayered material body with all the standard stack functionalities
- Allows manufacturing electrochemical ceramic devices without gas leakages **avoiding weak structural points**
- **Easy customization** of size, shape and power: higher flexibility and lower time-to-market

APPLICATIONS

Focuses on manufacturing of **electrochemical devices** made of **functional ceramic materials** for several applications:
- Solid oxide fuel cells
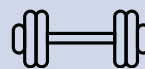- Solid oxide electrolysers

DESIRED PARTNERS

- System integrators
- Investors
- Final users

EXPECTED BENEFITS

Simplified fabrication

Mechanical robustness

Reduces waste

Reduces cost

technical details

INNOVATIVE SOLUTION

The technology proposes an original 3D printing process able to fabricate customized plug and play SOFC stacks in a single step. In turn, It redefines the fabrication paradigm of SOFCs enabling straightforward manufacturing of such devices by merging more than 60 steps into a single one via printing layer-by-layer consecutive active materials to generate fuel cells directly stacked one onto the other. It makes use of additive manufacturing technologies opening the possibilities for SOFC designs to near free-shape, which increases the flexibility of the fabrication process and widens the range of applications due to easy customization of the product even to portable/transportation sector (inaccessible up to now). Additionally, this technology allows the fabrication of joint-less SOFCs, removing the weakest point of the current technology, therefore increasing their durability.

Developing this "tabletop factory" to fabricate SOFC-based devices represents a cost reduction of more than 60% per kW together with a reduction of the initial required investment in up to one order of magnitude. It opens the possibility of manufacturing currently inaccessible complex design solutions: e.g. joint-free stacks.

ADDITIONAL DETAILS

- Facilitates the fabrication of the most efficient zero-emission power generation technology, i.e. Solid Oxide Fuel Cells.
- Enables straightforward fabrication of complex devices such as SOFCs by merging more than 60 industrial steps into a single one, simplifying the design for manufacturing and reducing the time-to-market (20-30%).
- Allows the fabrication of joint-less SOFCs, removing the weakest point of the current technology, therefore increasing their durability and widening their application range.
- SOFC technology integrates embedded functionality (fluidics, cooling, reforming, etc), making printed Plug&Play systems easily connectable to the power plant.
- Opens SOFC designs to near free-shape, which is crucial for the use of this highly efficient and clean power generation technology in portable/transportation applications (inaccessible up to now).
- The solution reduces waste of critical raw materials compared to traditional techniques, prevents the loss of valuable Critical Raw Materials (CRM) with a reduction of up to 80% of advanced ceramics.
- Substantially reduces the capital costs (-72%) and production costs (-59%).
- As a tabletop factory technology, empowers the citizens to become producers of clean energy devices.

Patent number WO2023021217
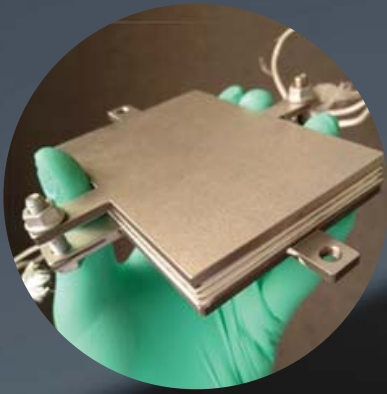
SOFC STACKS FOR AERO-NAUTICAL APPLICATIONS

BREAKTHROUGH TECHNOLOGY FOR COMPACT AND LIGHT-WEIGHT SOFCS

THE CONCEPT

LIGHT & COMPACT SOFC STACKS

↓

SHIPS   DRONES   AIRCRAFTS

ADDED VALUE

- Modular production
- Easy to recycle
- Replaceable spare parts

TRL

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CONTACT

https://irec.cat

KTT area
ktt@irec.cat

+34 933 562 615

PRODUCT DESCRIPTION

- **Highly performing** electrolyte-supported solid oxide fuel cells using a 3D printing technology
- The improved design boosts the capacity compared to conventional cells, offering optimal performance versus stability compromise
- Output power/stack weight & volume: **Highest ratio on the market** (> 600 W/kg, 2 kW/L)
- Easily combined into **stacks**
- **Reduced** amount of **interconnect** material

APPLICATIONS

These 3D-printed SOFCs are specially designed for
- Unmanned Aerial Vehicles (UAV)
- Aircrafts
- Marine segments

DESIRED PARTNERS

Stack manufacturers and power system integrators in maritime transportation, aircraft and UAV industries.

EXPECTED BENEFITS

Highest output/weight   Improved efficiency   Lightweight   Quick refuelling

technical details

INNOVATION SOLUTION

Our design increases the area of the electrolyte, correlating with an increase of performance, achieving higher volumetric and gravimetric densities when compared to standard SOFC.

The design confers mechanical support to the cells, making them more durable and resistant to deformation.

Our 3D printed SOFCs can easily be combined in stacks, which might be further integrated into a complex systems and subsequently integrated into final applications, such as aircrafts, Unmanned Aereal Vehicles or marine applications, among others.

3D printing is a versatile technique allowing to produce different shapes that might fit into a plethora of designs.

COMPETITIVE ADVANTAGE

- *vs* **batteries**: Lower operational costs, shorter refuelling times, improved efficiency, no harmful emissions, scalability, lower weight
- *vs* **PEM**: Higher energy efficiency (attributed to their high operating temperatures), ability to use a variety of fuels, no need for precious metal catalysts
- *vs* **standard SOFC**: Higher power density, modular production process (stack shape customization, easier scalability, lower investment), more resistant

IMPLEMENTATION

We are currently collaborating with H2B2/IPCEI initiative to develop this technology.
Patent number: EP19382509.
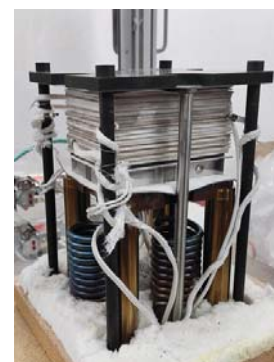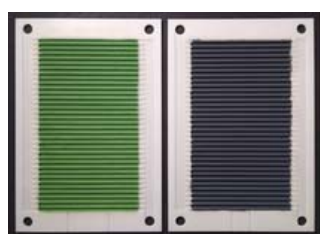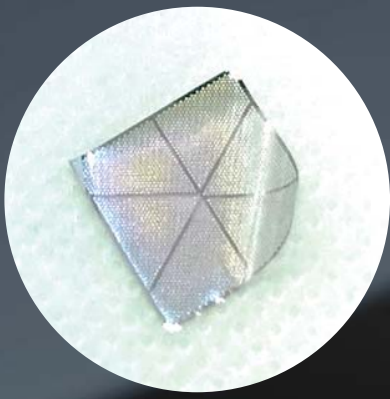
ULTRA-COMPACT REVERSIBLE SOLID OXIDE CELLS

POCKET-SIZED KW-RANGE STACKS

THE CONCEPT

THIN FILM   OXIDE

↓

REVERSIBLE SOC

⇅

HYDROGEN PRODUCTION   ENERGY STORAGE   MOBILITY

ADDED VALUE

- High density current per volume
- High production yield at low cost

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- https://irec.cat
- KTT area
- ktt@irec.cat
- +34 933 562 615

PRODUCT DESCRIPTION

- Revolutionary **ultra-compact** thin film **reversible** solid oxide **electrolyser-fuel cell**
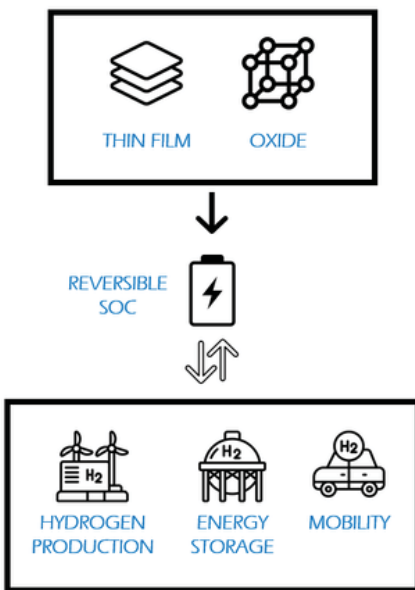- **Pocket-sized** kW-range stacks
- **Negligible content** of critical raw materials (CRM)
- Able to **efficiently store renewable** energy and **generate** it through the use of **green hydrogen**
- Suitable when **small-sized constraints** or long-term applications are required
- Lower working temperature range than current technology

APPLICATIONS

- **Hydrogen production** (chemical + metallurgical industry)
- **Energy storage** (Grid-storage, off-shore generation, decentralised off-grid scenarios, solar energy)
- **Mobility** (Land, naval, air)

DESIRED PARTNERS

- Microelectronics foundry
- System integrators

EXPECTED BENEFITS

Ultra-compact   Low CRMs content   Reversible   Low cost

technical details

INNOVATION SOLUTION

This technology is a thin film reversible Solid Oxide Electrolysis Cell (SOEC) which is able to operate at high current densities (3 A/cm^2) and at lower temperature range (T<500°C). In addition, it requires negligible quantities of Critical Raw Materials (0.05 kg/kW). The use of thin film technology (< 1μm) represents a technological innovation driven by nanoscale phenomena. Furthermore, the solution combines nanoscale advances and materials yet to be explored with pioneering to provide new ultra-compact and fast-response power–to–gas (P2G) and power–to–power (P2P) storage solutions with high performance.

KEY ELEMENTS

- Thin Film Reversible Solid Oxide Cells: < 1μm thick cells
- Pocket-size kW-range stacks: Footprint 27 cm^3/kW
- Ultralow content of CRMs: 0.048 g/kW in our ultracompact cell vs. 19-58 g/KW conventional SOFC
- Exceptional capabilities: SOEC x30 the current hydrogen production per unit volume (>1000 kg/hm^3); SOFC x5 the specific power densities (>2.5 kW/kg)
- Better P2G efficiency (95%) compared to other electrolysers, also P2P efficiency is increased (65%).
- High production yield at low cost: Use conventional microelectronics manufacturing technology
- Cheaper hydrogen production enables a larger uses cases for green hydrogen. The competitive production of green hydrogen using IREC's SOEC contributes to increase the integrate higher shares of renewable energy sources.
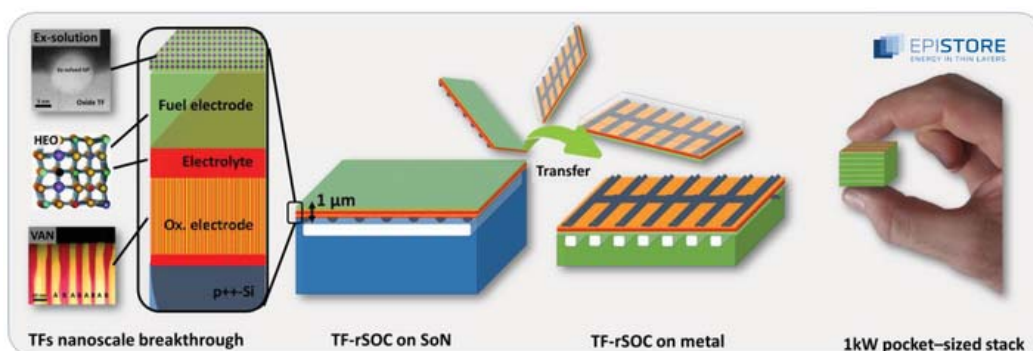
Patent number: WO2024017941+ EP23383322

SOLID-STATE MICRO-OXYGEN BATTERY

SMALL SIZED AND STABLE ENERGY STORAGE DEVICE

THE CONCEPT

THIN FILM   OXIDE

↓

MICRO-BATTERY

↓

IOT   SMART PIPING   HEAT EXCHANGER
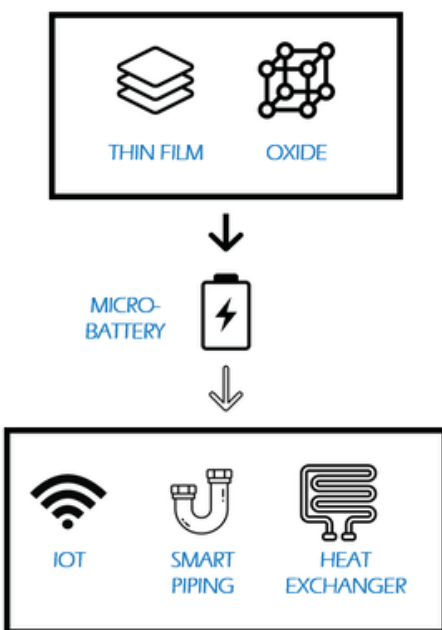
ADDED VALUE

- Battery operation at high temperatures
- Tailored design

TRL

3

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CONTACT

- https://irec.cat
- KTT area
- ktt@irec.cat
- +34 933 562 615

PRODUCT DESCRIPTION

- Solution for **energy storage** having high energy and power density
- **Rechargeable** battery based on oxygen ions
- **Micro device** fabricated by thin film deposition techniques
- Made of **oxide ceramic materials**
- Uses more **abundant chemical elements**, no lithium is used
- Working temperature of the device is 150 to 500 °C.

APPLICATIONS

- High temperature energy storage
- IoT nodes
- Smart piping
- Oil and gas
- Heat exchanger

DESIRED PARTNERS

- System integrators
- End-users.

EXPECTED BENEFITS

Fast charge-discharge   Higher stability and safety   High-temperature operation   Can be miniaturized

technical details

INNOVATION SOLUTION

Lithium-ion (Li-ion) batteries are the most popular battery option available today. Encapsulating more than 90% of the global grid market, they are used on plenty of fields and applications. However, limitations such as current lithium shortages, limited range of operating temperatures, degradation over time and environmental hazards associated to its extraction and end-of-life are drivers that encourage the development of other battery systems based on other materials. For high temperature settings, special Li-ion batteries can operate up to 150°C. Some similar devices such as multilayer ceramic capacitors can be designed to operate at maximum temperatures between 150°C and 230°C. For even higher temperatures other alternatives such as ZEBRA batteries (operation between 270°C and 350°C), Na-S batteries (working temperatures between 400 or 700°C) are used, but their size (in the case of ZEBRA batteries) and associated hazards (in the case of Na-S batteries) can turn them into unsuitable options for some harsher environments. Therefore, the usage of an energy storage system based on oxygen ions, which are small-sized and are stable in a wide range of high temperatures and harsh environments could offer a more suitable solution for different applications on some specific industrial fields.

KEY ELEMENTS

This technology is a rechargeable battery based on oxygen ions. For this, oxygen ions are accumulated and exchanged between two electrode layers which are separated by a solid electrolyte. The two electrode layers and the electrolyte are made of oxide ceramic materials that are stacked on top of each other. Thin film deposition techniques may be used for the fabrication of the battery. The operational temperature range between 150°C and 400°C. Other available properties are a tunable voltage between 100 mV and 1.5 V and high stability in harsh environments.
The fabrication of the device is carried out by thin film technology. Can be (but not limited to) pulsed laser deposition or atomic layer deposition
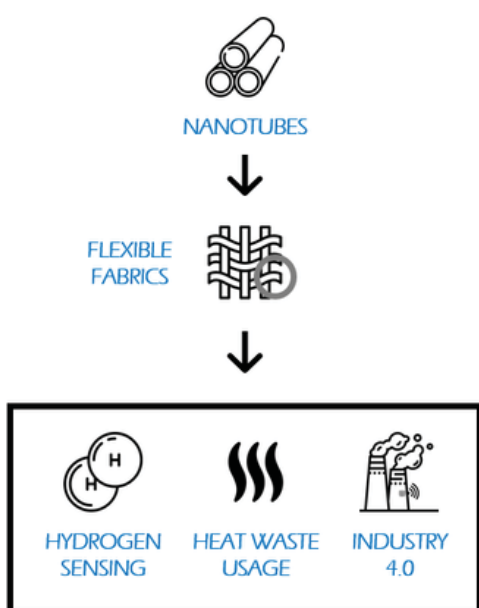
Patent number WO2023213905

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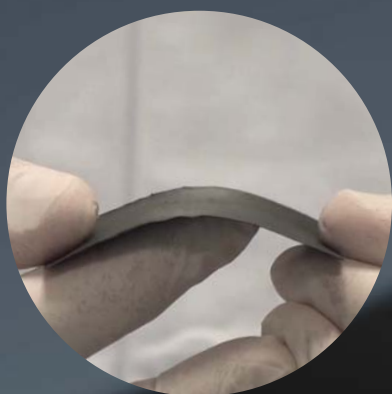
THERMOELECTRIC NANOSTRUCTURED FLEXIBLE FABRICS

FOR HYDROGEN SENSING AND POWER GENERATION FROM HEAT WASTE

THE CONCEPT

NANOTUBES
↓
FLEXIBLE FABRICS
↓

HYDROGEN SENSING | HEAT WASTE USAGE | INDUSTRY 4.0

ADDED VALUE

- Adapts to any hot surface
- High performance and mechanical properties

TRL

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CONTACT

- https://irec.cat
- KTT area
  ktt@irec.cat
- +34 933 562 615

PRODUCT DESCRIPTION

- Non-toxic **thermoelectric flexible fabrics** made of nanotubes which **adapt** to any hot surfaces
- The fabrics are very **light** and **thin**
- Exhibit **high performance** and good mechanical properties
- Application in a sensitive self-powered thermoelectric **hydrogen sensor**
- Can be mass-produced at **low-cost** with already existing manufacturing industrial processes

APPLICATIONS

- Hydrogen sensor
- Energy harvesting from heat waste in domestic settings
- Power IoT nodes in industrial environments
  - Industry 4.0
  - Chemical industry
  - Petrochemicals
  - Automotive sector

DESIRED PARTNERS

Industrial partners and IoT manufacturers.
System integrators.

EXPECTED BENEFITS

Self-powered devices | Low-cost, large area production | Flexible material | Environmentally friendly

technical details →

ADDITIONAL DETAILS

This paper-like fabric is a promising thermoelectric material, with an internal structure based on silicon nanotubes, that maximizes electrical conductivity and limits thermal conductivity, so as to obtain the highest figure of merit possible. It has been tested and fabricated in IREC's laboratories, but the production process employs well established mass manufacturing techniques like electrospinning and CVD.

Other relevant features that arise from the material's architecture are its lightness, the ease with which it adapts to multiple geometries, its flexibility and the stability that it has, even at high temperatures (700°C). A self-powered hydrogen sensor has been fabricated by depositing a catalyst on the fabric which converts hydrogen and oxygen into water. In this case, the material makes use of the heat released from the exothermic reaction that takes place at the surface of the sensor. The produced sensors are capable to detect small amounts of hydrogen.

NEW PROSPECT MARKETS

In addition to the main applications listed above, the ongoing extension of this technology to room temperature could open the door to a large number of new markets. Human and animal wearables, agriculture industry and food packaging are some of the additional interesting sectors that could benefit from these developments.

The flexibility of the fibers, the appropriate fluidics to allow transpiration, and the fact that the materials are biocomatible and disposable could make them excellent harmless everlasting power sources for body wearables, skin patches or implants.
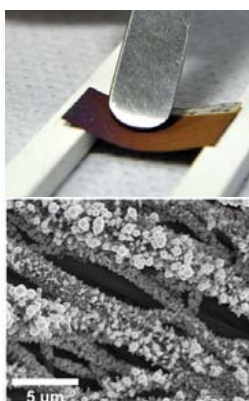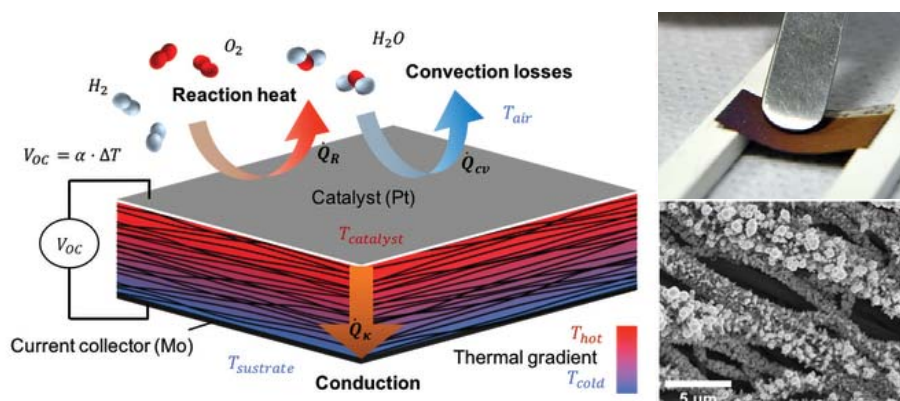
Adaptable to any surface shape

Patent number: EP3306685
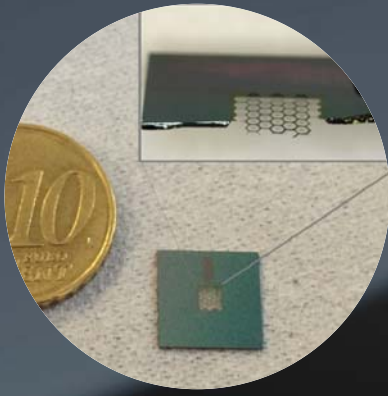
COST EFFECTIVE MICRO-OXYGEN SENSOR

TECHNOLOGY FOR A CLEANER TOMORROW

THE CONCEPT
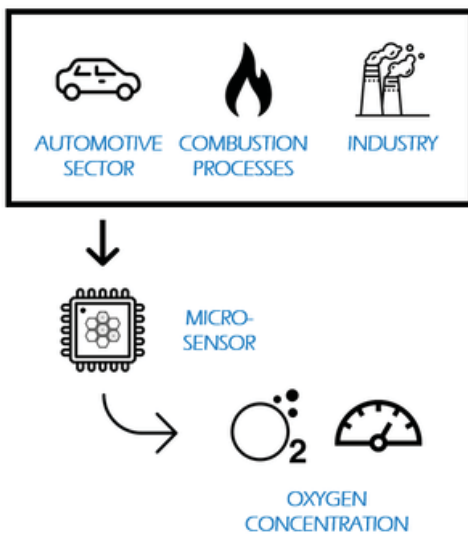
ADDED VALUE

- Improves energy efficiency of burners
- Reduces fuel consumption and environmental impact
- Miniaturized low-cost sensor

TRL

4

CONTACT

https://irec.cat

KTT area
ktt@irec.cat

+34 933 562 615

PRODUCT DESCRIPTION

A **customizable micro-fabricated** zirconia-based **sensor** which provides a fast and stable response to different **oxygen** concentrations. It comprises a nanometric membrane and self-heating elements, everything integrated in less than 1 cm^2.

Microfabrication techniques, added to the know-how of the group, allow to **adapt the design** of the sensor to any space constraint.

APPLICATIONS

- Industrial gas boilers
- Industrial combustion processes
- Automotive sector

DESIRED PARTNERS

- System integrators,
- Boiler manufacturers
- Automotive sector distributors

EXPECTED BENEFITS

Reduction of harmful emissions

Large-scale low-cost production

Small volume

Response time in the range of milliseconds

technical details

SPECIFICATIONS

The sensor incorporates self-supporting membranes of ceramic materials with nanometric dimensions. These membranes are separated by silicon nerves with a double function: on the one hand, they confer stability to the film of active material. On the other, they serve as a support on which heating elements are integrated. The latter will provide a very fast and efficient heating since they are very close to the active element. At the same time, its electricity consumption will be almost negligible due to the small dimensions to be heated. The sensor is fabricated using silicon microtechnology.

The technology allows an almost instantaneous heating (ca. 2s) thanks to the miniaturization and the integration of the heating elements, which will remain active in any condition. Current sensors need longer (30-40s) to reach their optimum operating temperature. Likewise, the small volume it occupies means that the sensor can be placed in a variety of locations. As additional advantages, energy consumption will be small and the manufacturing cost is much lower, thanks to the large-scale manufacture using microfabrication techniques.

The same technology can be used to add functionalities to the sensor, such as multigas or temperature sensing, by replacing certain materials or changing the design somewhat.

MICROFABRICATION

The use of microfabrication technology allows getting possibly the smallest potentiometric oxygen sensor in the market which will allow its location in places of difficult access nowadays. At the same time, these reduced dimensions will enable its fabrication in mass production conditions; therefore, a great decrease in the manufacturing expenses is anticipated. These two facts would allow improving the combustion process control via an optimum location of the sensor and more redundancy (since more sensors could be allocated for the same price and space).

PERFORMANCE

The performance of the sensor has been tested in laboratory environments where the device chemical response, cyclability and stability have been evaluated positively.

Proof of concept devices with integrated heater have demonstrated good operability under very diverse conditions with negligible energy consumption.

Patent number: P201331791
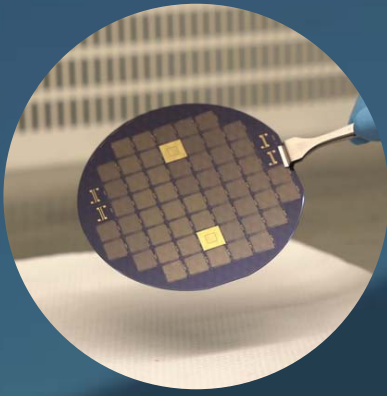
SOLID STATE IONICS-BASED TRANSISTORS

NEW GENERATION SYNAPTIC TRANSISTORS FOR NEUROMORPHIC COMPUTING

IREC R
Shaping Energy for a Sustainable Future

THE CONCEPT

THIN FILM · COMPLEX OXIDES

↓

SYNAPTIC TRANSISTOR

↓

AUTONOMOUS VEHICLES · ARTIFICIAL INTELLIGENCE · SECURITY
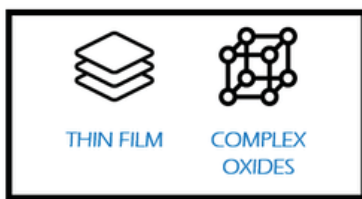
ADDED VALUE

- Able to evolve over time in response to its activity
- Robust and stable

TRL

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CONTACT

🔗 https://irec.cat
✉ KTT area
   ktt@irec.cat
📞 +34 933 562 615

PRODUCT DESCRIPTION

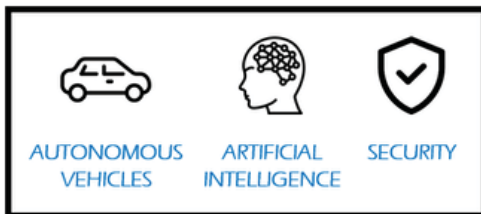- **Synaptic transistor** or **non-volatile memory** based on solid oxide thin films
- Mimics the **efficient operation of our neurons** by synapses
- Electrolyte-gated transistor able to work at **low temperature**
- Conductance of the channel is controlled by an **analogic voltage** giving rise to a non-volatile multistate transistor
- Made of ceramic materials that provide **robustness** and stability to the transistor
- Compatible with **traditional microelectronic industry**

APPLICATIONS

- High demand computing applications: AI, autonomous vehicle, image recognition, language understanding
- Microelectronic sector, i.e. neuromorphic and stochastic computing, non-volatile memories for data storage
- Magneto-ionic switching

DESIRED PARTNERS

Microelectronic integrators
Semiconductor industry
Integrated device manufacturers
SW and HW designers
Silicon intellectual property and design houses

EXPECTED BENEFITS

Multilevel synaptic transistor and memory

Compatible with semiconductor industry

Non-volatile elements

Independent of atmospheric conditions

technical details →

INNOVATION SOLUTION

The technology is a synaptic transistor or a non-volatile memory based on a solid oxide ion gating to be applied to neuromorphic computing.

This new generation transistors overcome Paul-Newmann architecture limitation of conventional CMOS technology and the limitations on stability and integration of current synaptic transistors.

The main disruption of this technology is the solid oxide thin film electrolyte able to work at low temperature. This feature opens the door to a full new range of applications in microelectronic sector, such as autonomous vehicles, diagnosis or security.

MAIN BENEFITS

- Multilevel synaptic transistor and memory all-in-one that overcomes Paul-Newmann architecture limitation.
- Analog switching performance for neuromorphic computing thought non-volatile elements, high data storage and low energy consumption.
- Not dependent of atmospheric conditions (e.g. humidity) because oxide ions migrate via a vacancy mechanism or an interstitial mechanism, both of which are a bulk conduction mechanism needing no surface absorption.
- Low operation temperature (compatible with standard electronic devices).
- Compatible with mainstream microelectronic technology.

WORKING PRINCIPLE
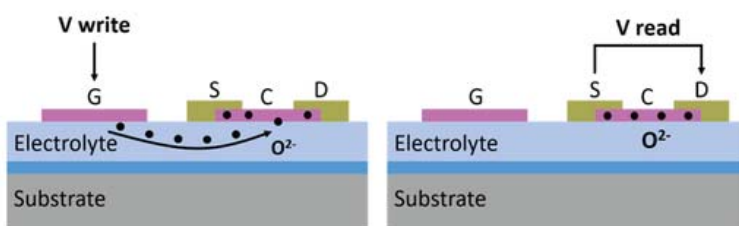
IMPLEMENTATION

A proof of concept demonstrated for multistage process system based on solid oxide ionics.

Patent number WO2022263659

SYNTHETIC NATURAL GAS PRODUCTION

TO CONVERT CARBON DIOXIDE INTO RENEWABLE NATURAL GAS

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Shaping Energy for a Sustainable Future

THE CONCEPT

INITIAL GASES

IREC CATALYSTS

OWN REACTOR

SYNTHETIC METHANE
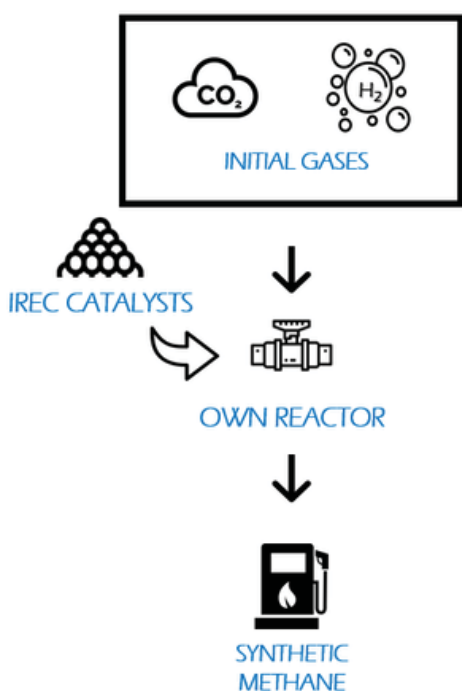
ADDED VALUE

- Improved activity stability and selectivity
- Tolerance to impurities

TRL

6

CONTACT

https://irec.cat

KTT area
ktt@irec.cat

+34 933 562 615

PRODUCT DESCRIPTION

- Designed and constructed an in-house **catalytic chemical reactor** prototype for **methanation**
- Developed own catalysts to convert **carbon dioxide** into **renewable natural gas** to increase the efficiency of the reaction into methane
- These advanced catalysts **meet the standards** of novel methanation compact reactors
- The process produces synthetic natural gas of quality **equivalent to natural gas** from the grid

APPLICATIONS

- Biogas or combustion fumes valorisation
- Gas vehicle mobility
- Injection of synthetic gas into natural gas grid
- Chemical storage of renewable energy
- Valorisation of CO_2- circular economy with GHGs reduction

DESIRED PARTNERS

- Reactor engineering companies
- End-users, such as energy industry/companies/utilities
- Investors or accelerators

EXPECTED BENEFITS

25 % more active than commercial

60 % reduction in CO_2 emissions

4x volume reduction

40 % extended lifespan

technical details

TECHNICAL SPECIFICATIONS OF THE CATALYST

- Ternary system of active metal, promoters and porous support
- Catalysts shaped in relation to (micro) reactor specifications (0.2-3mm)
- Tolerance to sulphur poisioning (H_2S ppb)
- Optimal formulation considering a support porosity (100-200 m^2/g)
- Catalyst metal loading adjusted to biogas applications (10-25%)
- Complete characterization of fresh & spent catalyst (SEM-EDX, TEM, BET, CO-quimi, TGA, TPR, TPO)

KEY ELEMENTS OF THE INNOVATION

- Production of synthetic fuels from carbon of biogenic origin or by reuse of carbon dioxide and water
- Feasible incorporation of hydrogen to the current gas grid by its conversion to methane
- Use these synthetic fuels as a large-scale energy storage that allows to increase the share of non-fossil-source energies
- Development of a circular economy around carbon dioxide emissions contributing to its effective reduction through the use of a closed loop of carbon of biogenic origin
- Energy interconnection between the electricity and gas networks, and promotion of new options and opportunities for the development of new energy models
- Use of biomass and other sources of waste with organic content such as sewage sludge and/or slurry contributing to environmental improvements

IMPLEMENTATION

Catalysts validated in biomethane pilot plants in real conditions, using other infrastructures and own technology: Waste water treatment plant (EDAR, Sabadell), Energy lab 2.0 KIT (Karlsruhe), waste management plant in Mas Barberans (Tarragona).
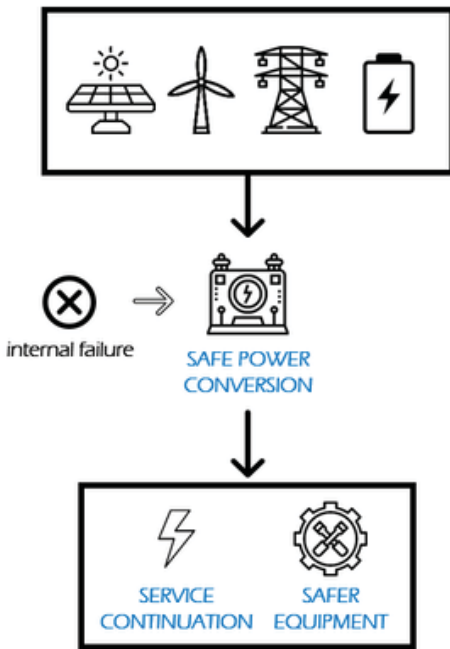

Methanation unit in EDAR (Sabadell)

Biomethane reactor in Mas Barberans (Tarragona)

Some icons used in this catalogue are extracted from
https://www.flaticon.com/

VERSATILE AND RESILIENT POWER CONVERTER

TOWARDS A SYSTEM BASED ON RENEWABLE ENERGY

THE CONCEPT

ADDED VALUE

- Reliable electrical network in remote areas
- Security and quality of the service

TRL

5

CONTACT

- https://irec.cat
- KTT area
- ktt@irec.cat
- +34 933 562 615

PRODUCT DESCRIPTION

- **Power converter** adapted to handle **renewable energy** efficiently: from generation, storage to the electrification and integration of new vehicles
- **Fault-tolerant** converter: Remains in operation after any of its internal component fails, thanks to its redundant internal structure and reconfiguration hardware
- Minimizes redundant components
- It **reduces** considerably the initial **capital investment**, as well as the **costs of implementation and maintenance**

APPLICATIONS

Our power electronic converters:
- Can replace redundant equipment by our fault-tolerant systems
- Can be implemented in remote areas
- Makes implementation of electric vehicles, renewables, management and batteries for storage more feasible

DESIRED PARTNERS

Industrial partners in the field of power electronics and investors.

EXPECTED BENEFITS

40% capital cost reduction

Reliability of the electrical network

>50 % extended lifespan

Implementation of renewables

technical details

COMPETITIVE ADVANTAGE

The technology provides several advantages comparing to current solutions, such as the cost reduction, the reduced energy losses due to system failure, increasing the O&M time to repair of the equipment (allowing continuous operation under such conditions) and an extended lifetime. This technology is based on a new internal configuration of the semiconductor-based switches which compose the power converter, and also the redundant components can be used for both converters DC/DC and DC/AC, unlike other cases.

With the appropriate management system, higher levels of resilience, efficiency and operational capacity can be achieved. The internal reconfiguration of the system in case of failure or change of operation is automated when a series of indicators are detected leading to isolate the faulty component and maximizing the efficiency of the device during its operation.

MAIN BENEFITS

The system is based on a new internal configuration of semiconductor-based switches on the power converter. With the appropriate management, higher resilience, efficiency and operational capacity can be achieved.

Our innovation has the following benefits:

- **Capital cost reduction**: We estimate that our system will save 40% of the cost compared to redundant systems. The proposed fault-tolerant converter is about 5-10% more costly than no-fault tolerant inverters (without redundancy). However, including a redundant converter implies almost double the capital investment.
- **O&M cost reduction**: By including the additional components, the system may continue operating although a failure occurs, reducing maintenance needs.
- **Life Extension**: The lifetime will be increased. In preliminary analysis, the structure without redundancy got 3.53 years at continuous full-load condition operation meanwhile the proposed concept got 7.65 years.
- **Efficiency**: Similar in both technologies.

Patented number: EP4214824A1

LCOE
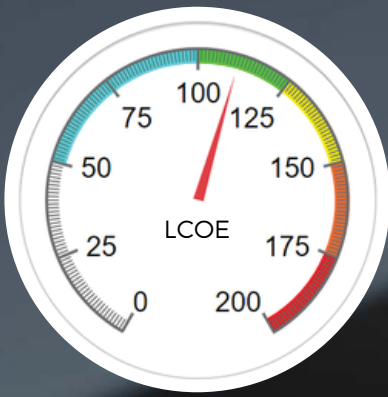
FOWAPP

FLOATING OFFSHORE WIND ASSESSMENT APP

THE CONCEPT

TURBINES   SITE

CONNECTIONS   AUXILIARY MEANS
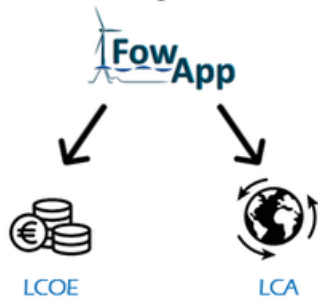
FowApp

LCOE   LCA

PRODUCT DESCRIPTION

- **Desktop application** to compute the **Levelized Cost of Energy** (LCOE) and to perform a detailed **Life Cycle Assessment** (LCA) of **floating offshore wind farms**
- The software calculates all the intermediate results such as wake or grid energy losses
- **Includes a library** for the user inputs, such as site specifications, components or auxiliary means
- Designed to be intuitive and user-friendly

APPLICATIONS

Focus on **floating offshore wind farms**:
- Early project development
- Technology assessment
- Environmental impact evaluation
- Performance analysis

ADDED VALUE

- Transparency of input and output data used for calculations

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5-6

CONTACT

🔑 https://irec.cat
✉ KTT area
   ktt@irec.cat
📞 +34 933 562 615

DESIRED PARTNERS

Project developers, specialised engineering companies, consultancies and data aggregators.

EXPECTED BENEFITS

User-friendly/ Usability

Quick and reliable results

Overall scenario overview

Costumizable by user

technical details

FEATURES

FowApp is:

- built specifically for the floating wind industry
- developed using a well established software
- storing all the information, except the images, in an SQLite database
- capable to import data from MS Excel
- complete, integrating electrical power flow and wake calculations
- detailed from the technical perspective
- offering a full project overview using a relatively easy to use App

INPUT DATA

The app includes a library where generic information is stored, such as site definitions, components (wind turbines, cables, substructures, anchors, etc.) and auxiliary means details (cranes, vessels, helicopters, etc.). On the other hand, any number of projects may be defined, using information of the library plus additional details such as the layout, electrical connections and the life cycle process (design, construction, O&M and decommissioning).

OUTPUT DATA

Three main results are obtained and combined to get the LCOE and LCA:

- the AEP (Annual Energy Production)
- the LCC (Life Cycle Costs)
- the associated environmental impacts of the following categories:
    - Global Warming Potential (GWP)
    - Abiotic Depletion Potential Elements (ADPe)
    - Primary Energy Demand (PED)
    - Acidification Potential (AP)
    - Eutrophication Potential (EP)
    - Aquatic Toxicity Potential (ATP)
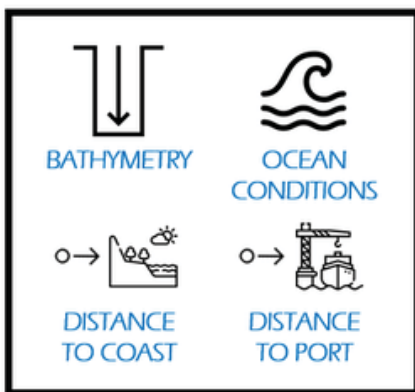   - Human Toxicity Potential (HTP)

LCC = CAPEX + OPEX + DECEX

WORLDWIDE DATA-BASE FOR OFFSHORE WIND LCOE

TO BOOST THE IMPLEMENTATION OF FLOATING OFFSHORE WIND ENERGY

IREC ℝ
Shaping Energy for a Sustainable Future

THE CONCEPT

BATHYMETRY

OCEAN CONDITIONS

DISTANCE TO COAST

DISTANCE TO PORT

BEST LOCATIONS (LCOE)

ADDED VALUE

Demonstrates the viability and areas of interest for potential projects

TRL

4-5

CONTACT

https://irec.cat

KTT area

ktt@irec.cat

+34 933 562 615

PRODUCT DESCRIPTION

- **Global world-wide dataset and map** of the LCOE for the construction of **floating offshore wind parks**
- Based on internal calculations using critical parameters
- Includes the associated **development costs** and highlights the **most suitable areas**
- Uses **publicly available** data
- Can be adapted to include additional datasets; Carbon footprint analysis following the LCA methodology is currently being implemented
- Delivers a very easy to use, very easy to read data
- Power delivery performance calculations have been used as a reference for energy output

APPLICATIONS

Helps to initiate the spatial analysis of potential floating windfarms to have an overview of the best areas.

DESIRED PARTNERS

- Floating offshore wind park developers and constructors
- Public administration
- Strategic infrastructures' decision makers

EXPECTED BENEFITS

Easy to use

Global approach

Cost analysis

Helps implementation

technical details

ADDITIONAL DETAILS

In its development, variable cost factors have been considered based on bathymetry, ocean conditions, distance to the coast, and distance to port. Power delivered to the onshore grid has been used as a reference for energy output, rather than turbine production.

The level of detail is complex, as the tool utilizes databases of all the ports worldwide. The analysis was performed at the Exclusive Economic Zones, 200 nautical miles from the coast, and depths ranging from 60 to 1000 meters of water, with a resolution of one arc minute. The delivered data has fairly good precision.

Regarding Levelized Cost of Energy (LCOE) values, average results for different floating concepts supporting a 15 MW turbine in a 300 MW wind farm are represented, identifying many areas with costs below €100/MWh.
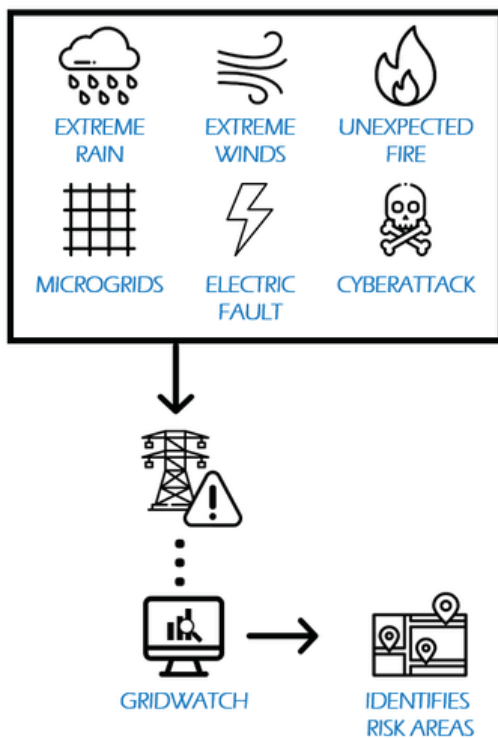

This map is available for consultation under an open license at floatingwindmap.energysmartlab.com. Commercial use is restricted.

GRIDWATCH TOOL

ASSESSES RISKS IN THE ELECTRICAL NETWORK AND IMPROVES ITS RESILIENCE

THE CONCEPT

EXTREME RAIN

EXTREME WINDS

UNEXPECTED FIRE

MICROGRIDS

ELECTRIC FAULT

CYBERATTACK

GRIDWATCH → IDENTIFIES RISK AREAS

ADDED VALUE

- Maintains the energy supply on the grid
- Increases preparedness for future extreme events

TRL

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6-7

CONTACT

- https://irec.cat
- KTT area
  ktt@irec.cat
- +34 933 562 615

PRODUCT DESCRIPTION

- **Visualization tool** of the **power grid** to identify **risk areas of the network** in the case of extreme weather events and external threats
- Can early **detect vulnerabilities** of the system and translate them to risk of network failure
- Predicts certain weather impacts to elements of the grid
- **Improves network resilience** when applying **corrective and mitigating measures** in the risk areas, like reconnection and sectorialization in microgrids
- **Fault location** of the electrical grid using **machine-learning** techniques
- Computes the **optimal electric scheme** of the grid to isolate problems and continue the operation
- Can be integrated with external tools

APPLICATIONS

- Electrical distribution planning
- Risk prevention and awareness
- Reinforcement of the electrical grid
- Application of preventive measures
- Solving electrical faults, cyberattacks to grid elements and other emergencies affecting the grid

DESIRED PARTNERS

Electric utility companies

EXPECTED BENEFITS

Reduction of risks

Low cost of implementation

Versatile tool

Service continuation

technical details

CURRENT FUNCTIONALITIES

- Assessment of electric assets at ground level exposed to flooding risks
- Electric lines assessment for high exposure to extreme wind currents, subjected to high potential breaking hazard
- Zonal assessment for extreme temperatures and dense vegetation, forecasting the fire prone zones. Additionally, the connection of fire sensors is considered
- Electrical system risk statistics
- Weather impact to the elements of the grid such as Dynamic Thermal Line Rating and the calculation of the aerial line elongation
- Fault location of the electrical grid using machine-learning techniques
- Self-healing mechanism: minimizes the negative impact on energy supply and maximize system resilience through grid reconnection and sectorialization in microgrids
- Connection with external tools such as Copernicus, weather online, local meteorological stations, and other, to gather weather forecast data
- Can incorporate new functionalities that could be of interest for users, such as integrations with REST APIs and MQTT connections

FUTURE IMPROVEMENTS

Future work will implement a fire alarm system detecting the areas with major wildfire risk through the installation of fire detectors. It will involve fire assessment, overheat and increase of the algorithm accuracy by including parameters of small relevance.

IMPLEMENTATION

Validated in pilot tests in **Barcelona** and **Bristol** (for the extreme weather events feature), in **IPTO grid**, Greece (healing in a large-scale islanding scenario), in **Estabanell grid**, Spain (healing cyber-attacks), and in **Endesa grid** in Doñana National Park, Spain.

Self-healing and extreme weather events feature being validated in Doñana

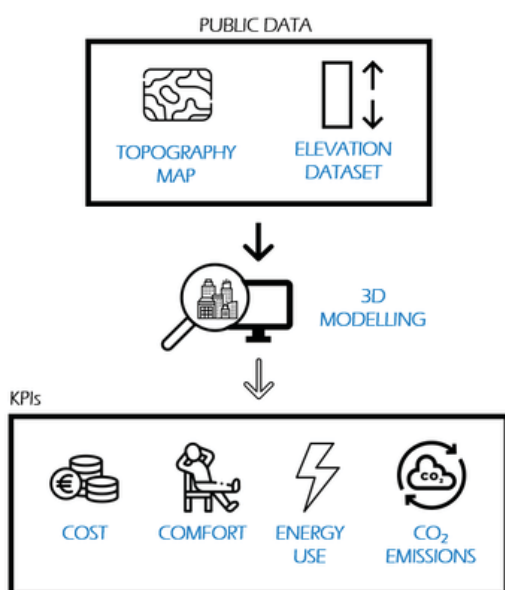Cyber-attack feature validated in Estabanell grid

3D MODELLING OF URBAN AREAS

METHODS AND TOOLS TO PLAN CLIMATE NEUTRAL DISTRICTS

THE CONCEPT

PUBLIC DATA

TOPOGRAPHY MAP — ELEVATION DATASET

3D MODELLING

KPIs

COST   COMFORT   ENERGY USE CO_2 EMISSIONS

ADDED VALUE

- Based on OGC standard CityGML
- Procure for automatic generation of windows
- Potential expansion of calculation modules

TRL

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6-7

CONTACT

- https://irec.cat
- KTT area
  ktt@irec.cat
- +34 933 562 615

PRODUCT DESCRIPTION

- Methods and tools designed to **generate 3D models** of **large urban areas**
- Uses a large amount of **publicly available data**, such as **topographic maps** and **elevation datasets**
- Adapted to the **Spanish cadaster**
- Can predict the **impact of urban actions** taking energy efficiency, environmental, economic and social factors into account
- Capable to deliver and visualize **key performance indicators** to support **decision-making processes**, such as primary energy, CO2 emissions, economic and consumption balance, LCA, energy certificates or comfort

APPLICATIONS

- Help decision-makers in urban regeneration
- Residential retrofits at district scale
- Energy transition planning
- Environmental impact assessment
- Generation of digital twins for urban areas and cities

DESIRED PARTNERS

- Town councils and public companies
- Urban planning companies and promoters
- Environmental and energy consultants

EXPECTED BENEFITS

Personalized outputs   OGC standard format   User friendly   3D visualization

technical details

INNOVATION SOLUTION

A set of methods and specific own produced software tools allows obtaining 3D geometries of neighborhoods in CityGML standard, developed by Open Geospatial Consortium. The CityGML standard defines a conceptual model and exchange format for the representation and exchange of virtual 3D city models. It facilitates the integration of urban geodata for Urban Digital Twin.

The virtual representation of cities is used for various purposes, in the context of planning urban actions. In addition, the 3D models can connect to customizable calculation modules that offer insights on energy and environmental performance, as well of economic costs at district level.

TECHNICAL DETAILS

- Through public data (2D cadastre in .shp format + LIDAR in .las format) the 3D model of the buildings is generated with the open-source software 3dfier in .OBJ format. The own specific code developed in Python stores the geometric data of buildings (walls, roofs and floors) from .OBJ format in PostgreSQL database with postGIS extension in a specific form in order to be exported later through the 3DCityDB in CityGML format
- The generated code works as input with the .OBJ format, which allows flexibility in the definition of the geometry because many 3D generation and modelling software can work with it
- 3D geospatial visualization of data using CesiumJS

IMPLEMENTATION

This technology is being tested and is under refinement in several urban areas, as for example the Districte Innovació Llevant in Palma (Spain).
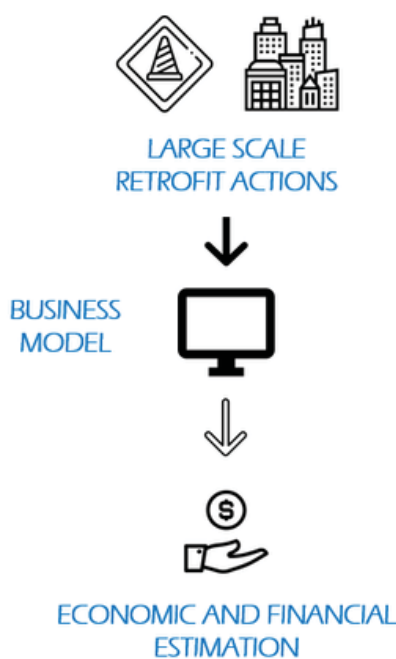
BUSINESS MODEL FOR RESIDENTIAL RETROFITS AT DISTRICT SCALE

ECONOMIC AND FINANTIAL INFORMATION FOR RETROFITTING ACTIONS

THE CONCEPT

LARGE SCALE RETROFIT ACTIONS

↓

BUSINESS MODEL

↓

$

ECONOMIC AND FINANCIAL ESTIMATION

ADDED VALUE

- Unique tool for large-scale retrofitting actions
- Helps decision-makers

TRL

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CONTACT

📍 https://irec.cat
✉ KTT area
   ktt@irec.cat
📞 +34 933 562 615

PRODUCT DESCRIPTION

- **Business model tool** to support reliable predictive **economic and financial large-scale retrofitting actions** under **Private Public Partnership** (PPP) frameworks
- Quantitative evaluation
- Analysis of the **critical elements** of the operation for the different types of end-users
- Tool targets large retroffiting actions ranging from 150 – 500 dwellings in several buildings (10-50) in a district

APPLICATIONS

- Tool for large-scale residential retrofitting
- Financial analysis and implementation support tool for retrofitting agents
- Strategic analysis of retrofitting actions of the building stock for municipalities

DESIRED PARTNERS

Private and SME stakeholders (e.g. investors, real estate agents, retrofitting managers, urban planners, construction companies), public sector (e.g. municipalities, regions, city councils) and end-users.
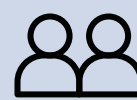
EXPECTED BENEFITS

Large-scale actions

Quantitative evaluation

Customizable by stakeholders

Analysis of critical elements

technical details →

INNOVATION SOLUTION

The new tool is programmed in Python programming language and is useful to evaluate several strategies for the renovation of existing building stock. It moves from a quick list of input according to several Public Private Partnership models, in addition to other potential business models. Furthermore, the design of the model is supported by a step-by-step methodology in order to deal with a financial appraisal that is interactive in each context, customizable for each stakeholder, and user-friendly. This innovative tool has a stronger potential when it runs in a GIS-based software environment and interacts with a PostgreSQL database, as demonstrated in two case studies located in Spain.

KEY ELEMENTS

The most critical parameters can be analysed in a sensitivity analysis around a defined case base. The model computes a set of indicators as results of the analysed area and a set of parameters / variables which can be set depending on the case. The model works in Python with aggregated data for evaluating potential business model scenarios.
Several PPP business models can be considered (e.g. Retrofitting agent, Turnkey, Public) by customizing some of the parameters in the model.
The indicators are economical and financial conditions for the:

- End users: monthly quote, end-user savings
- City council: city operational costs; revolving fund size
- Retrofitting manager: operational costs, benefits, financial costs and financial needs.

IMPLEMENTATION

Applied and validated in two case studies. Under deployment in pilot areas in Palma de Mallorca and other districts in Italy, Austria, Portugal and Spain.
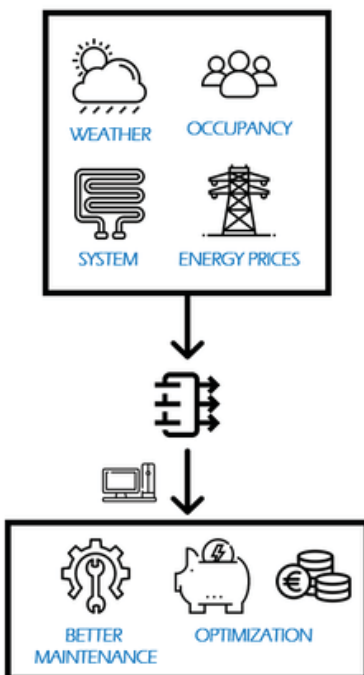

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FLEXIBLE HEATING AND COOLING SOLUTIONS

ALGORITHMS FOR MONITORING AND MANAGEMENT OF HVAC SYSTEMS

THE CONCEPT

ADDED VALUE

- Optimization balancing comfort-cost-environment
- Increased lifetime of equipment

TRL

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CONTACT

🔒 https://irec.cat
✉ KTT area
   ktt@irec.cat
📞 +34 933 562 615

PRODUCT DESCRIPTION

- Two complementary control algorithms improve operation and performance of heating and cooling systems
  - **Fault detection and diagnosis (FDD)** algorithm assesses heat pump performance and identifies anomalies to reduce energy and operational costs
  - **Model predictive control (MPC)** enables to plan and operate heat pumps or other HVAC systems in an optimal way based on external inputs
- Takes into account the specificities of the system, short-term forecasts of weather, occupancy and prices
- Possible to integrate with existing platforms

APPLICATIONS

- Heat pumps
- Flexible heating and cooling loads
- Control and operation of HVAC systems

DESIRED PARTNERS

Heat pump manufacturers, facility managers, aggregators of flexibility, owners or constructors of buildings, developers of energy management systems

EXPECTED BENEFITS

20-30% energy savings

Fault detection

Improved thermal comfort

30% reduction of energy bills

technical details

KEY ELEMENTS OF PREDICTIVE CONTROLS

Predictive and price-driven rule controls reduce energy costs and environmental footprint of heating and cooling. It uses simplified models to predict the behavior of the system and defines the optimal energy management strategy for heating and cooling. The input data is the forecast of weather, energy market prices and occupancy in the building, so that the predicted scenario consider future boundary conditions. The developed solutions manage thermal mass of the buildings to enhance energy flexibility. In addition, the algorithms are able to include solutions of active demand-side management through existing protocols like Smart-Grid ready or OpenADR, to enable direct connection to flexibility aggregators.

KEY ELEMENTS OF FAULT DETECTION

Automated fault detection and diagnosis techniques can prevent the deterioration and identify possible faults, which leads to savings in energy, service and operating costs. Our solution uses machine learning to learn the behavior of the heat pump. A constant monitoring of the heat pump measurements ensures that any deviation from normal operation is detected and diagnosed, using the default sensors that comes with the heat pump.

IMPLEMENTATION

Collaborations with industry: HITACHI/Johnson Controls - BAXI - EPRI, Naturgy- Schneider Electric. Solutions validated through experiments in a real environment.
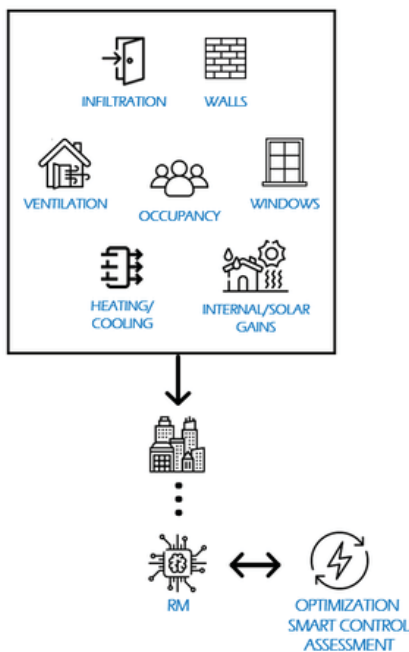

Heat pump in our testing lab

Demo case in the Llevant Innovation District in Palma de Mallorca

BUILDING REDUCED ENERGY MODELS

INTELLIGENT ALGORITHMS FOR NEXT GENERATION POSITIVE BUILDINGS

THE CONCEPT

ADDED VALUE

- Complex phenomena are simplified
- Lower computational time
- Easy to integrate with existing platforms/devices

TRL

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CONTACT

- https://irec.cat
- KTT area
  ktt@irec.cat
- +34 933 562 615

PRODUCT DESCRIPTION

- **Simplified building behavior algorithms** that predict the energy profile using few resources
- The reduced models (RM) define the key parameters able to **explain and forecast** the energy demands and consumption behaviour
- Can be **adapted** to various cases, ready to be implemented in existing technologies or devices
- Can predict the **user behaviour** and **user interaction** with the building
- **Assessment** and **predictive maintenance** of technologies

APPLICATIONS

- New or retrofitted tertiary and commercial buildings
  - Semi-automated energy audits (energy layers of eBIM)
  - Dynamic recommendations to users (edge computing)
  - Model predictive control for optimal management (BEMS 5.0)
  - Manage building flexibility at district level (PEB/PED)

DESIRED PARTNERS

- Monitoring devices producer
- BIM developers
- BEMS developers
- District tools producers
- DSO and utilities.

EXPECTED BENEFITS

20-30% energy savings

30-50% cost reduction

Improved thermal comfort

Optimized maintainance

technical details

MOTIVATION

In a context of change towards the decarbonisation of the economy, the building sector faces gigantic challenges, both in the building stock and in newly constructed buildings. The Green Deal and the renovation wave establish the way forward that requires a new generation of tools and methodologies capable of meeting the planned challenges in the shortest possible time, the least use of resources, and putting the end user in the main focus.

Intelligent design, management and operation of buildings is a capital pillar in the strategy for the reconversion of the building sector, which should allow for optimized renovations in terms of cost and consumption, efficient use of existing buildings, and new flexible buildings as part of positive energy districts. In this context, the use of Resistances and Capacitances (RC) models, integrated into targeted products and services within RM, ensures maximum reliability of results at minimum cost of resources, and offers a set of new market services with broad commercial potential.

KEY ELEMENTS

- RM aims to equip intelligent existing devices and tools which will be able to take profit on the new IT advancements (5G)
- RM evolved from reference ISOs to different precision levels
- Based on up to 17 characteristic parameters of buildings; the models use 6 transitive input variables to obtain the thermal zones behaviour
- RC models could be easily adapted to case, through calibrated white models or monitored data sets
- Easy scripts based on matricial formulation to be adapted to any platform
- Heating, cooling and free-floating modes availability, with temperature RMSE between 0.15 -0.80 °C
- Fit with real data from short-term (minutes), to medium-term (weeks), even for free-floating conditions

IMPLEMENTATION

Validated in real buildings for **tertiary** (office, sport centres) and **residential** uses, taking into account different climate conditions (**continental - Mediterranean**).
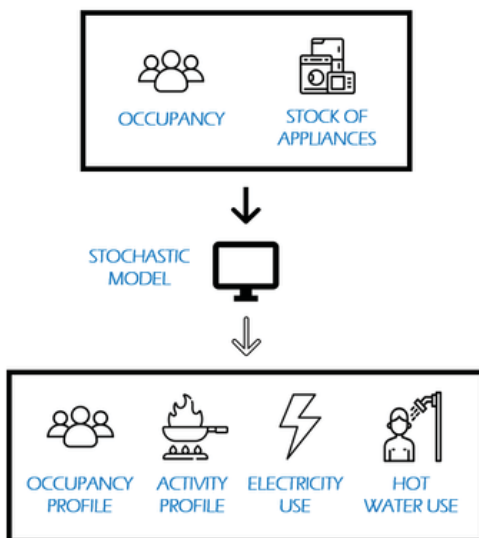

Residential (Terrassa, Spain)

Office buildings (Manresa, Spain)

STOCHASTIC MODEL FOR ENERGY DEMAND

FROM OCCUPANCY BEHAVIOUR, ELECTRIC CONSUMPTION AND DOMESTIC HOT WATER

IREC ^R
Shaping Energy for a Sustainable Future

THE CONCEPT

ADDED VALUE

- Specially adapted to Mediterranean climate
- Easy integration with other simulation tools

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CONTACT

- https://irec.cat
- KTT area
  ktt@irec.cat
- +34 933 562 615

PRODUCT DESCRIPTION

- Stochastic model that generates **occupancy patterns, electric consumption** related to electric devices and **domestic hot water profiles for residential buildings**
- Profiles with a **high time resolution**
- Able to **reproduce realistic households** with different occupancy levels and electric devices.
- Implemented in **TRNSYS**, as a Type/Subroutine coded in Fortran.

APPLICATIONS

Set of profiles/data available on request, for applications in:
- Positive energy districts and neighbourhoods
- Electrical grid optimisation
- Renewable energy systems integration

DESIRED PARTNERS

- Urban planners
- Building designers
- Energy consultants

EXPECTED BENEFITS

Realistic households

Flexible methodology

High resolution

Detailed information

technical details

ADDITIONAL DETAILS

Modelling user behaviour and its interaction with household systems is a challenge to reduce the gap between simulation and reality. The hypotheses of occupancy could have an important effect on energy and peak power estimation, making the validity of simulation limited. In the framework of building performance analysis through simulation, the occupancy behaviour, the electricity consumption caused by appliances, and the operation of the heating and cooling systems have usually been based on daily and/or weekly profiles. This approach has some strong points when the focus is to evaluate the performance of the building envelope and the heating and cooling supply systems. However, it has not shown to be useful when a detailed characterization of the household consumption is needed, as for example when studying the interactions with the grid in a "prosumer" building. From this perspective, a solid modelling approach to evaluate grid interaction, peak power values, demand side management strategies and design of positive energy districts and energy communities should comprise both high-resolution time step models together with stochastic occupancy and electrical devices consumption models.

KEY ELEMENTS

- The model is implemented in TRNSYS, as a Type/Subroutine coded in Fortran
- High-resolution: 3-min
- Occupancy, electricity and domestic hot water profiles as a result of the tool
- A flexible methodology that can be adapted to different scenarios:
  - Different occupancy levels (1, 2, 3 or 4 occupants)
  - Different stock of appliances and energy performance
  - Different occupancy scenarios (for example related to pandemic restrictions)
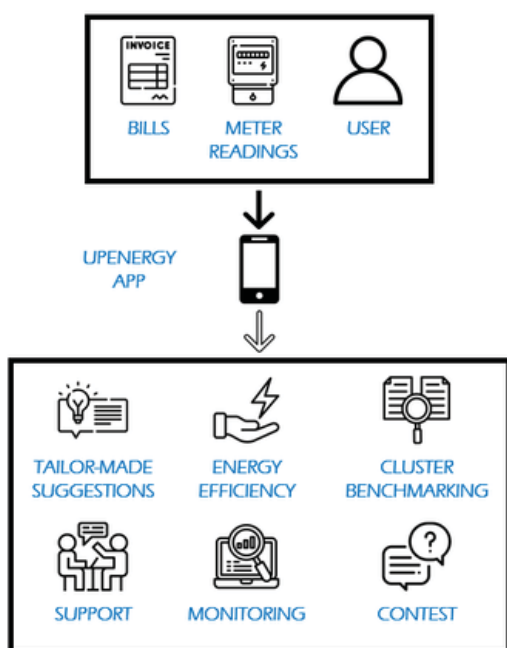- Adapted to Spanish behaviour

Some icons used in this catalogue are extracted from
https://www.flaticon.com/
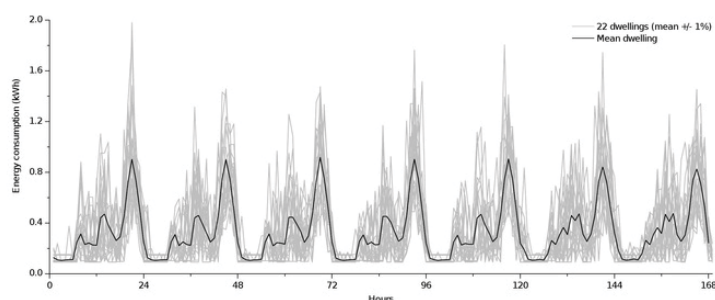
UPENERGY

APP TO CENTRALIZE AND MONITOR YOUR ENERGY USAGE

IREC R
Shaping Energy for a Sustainable Future

THE CONCEPT

ADDED VALUE

- Promotes efficient use of energy in companies and the administration
- Facilitates networking and mutual learning

TRL

6-7

REGISTERED

CONTACT

- https://irec.cat
- KTT area
  ktt@irec.cat
- +34 933 562 615

PRODUCT DESCRIPTION

- **Mobile App** that works as an **energy calculator** for all home energy consumptions
- The engine sorts **all the energetic information**, and easily displays daily, weekly, monthly and yearly consumptions per sources
- Based on bills and meter information (both electrical and thermal sources) and end-user self-characterization
- **Tailor-made suggestions** oriented to **end-user** and **cluster groups**
- Cluster benchmarking & group competitions to save energy

APPLICATIONS

For residential end-users through companies and public bodies, to get:

- Detailed knowledge of the energy consumptions sorted by sources and in a regular time-scale
- Oriented to user energy savings recommendations and tips
- Groupal contents to save energy through gamification scenarios
- Cluster benchmarking for smart comparisons

DESIRED PARTNERS

Local to supramunicipal public bodies, small to large companies, NGO and non-profit organizations.

EXPECTED BENEFITS

Easy to understand

Clustering of users

Creates a network

Reduces CO$_2$ footprint
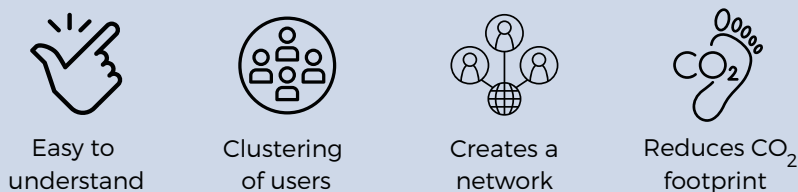
technical details

FUNCTIONALITIES OF THE APP

- Characterization of the user through the definition of energy sources and consuming elements in the home
- Characterization of the user through access to their energy consumption data via billing and/or access allowed to Datadis
- Graphics of consumption according to different metrics and time periods
- Comparison of own consumption
- Comparison of consumption with third parties
- User-oriented energy saving recommendations
- Common and group energy saving challenges

PROGRAMMING DETAILS

- Open code "React native" Framework, in java script
- Backend: Python, bash and SQL
- App downloaded in Android/IOS
- CRM (web): Windows, Mac and GNU/Linux
- Uses Open Source data
- Database: PostgreSQL

IMPLEMENTATION

Energy communities within the Osona region (Catalonia) will be the beta-testers of the App.
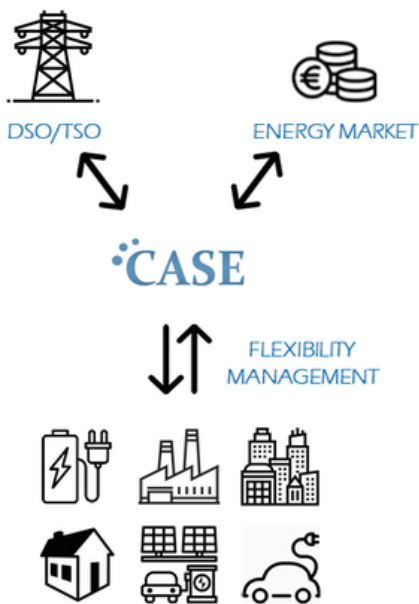
CASE- THE DEMAND AGGREGATOR

MONETIZE THE FLEXIBILITY OF ANY ASSET

THE CONCEPT

DSO/TSO   ENERGY MARKET

CASE

FLEXIBILITY MANAGEMENT

PRODUCT DESCRIPTION

- **Software platform** for demand aggregators
- **Demand aggregators** are the **new market actors** that enable demand side **response** and **flexibility** to participate in energy markets and grid services
- Provides advanced technological **solutions** to **monetise** demand management and **flexibility** of energy assets and allows the **integration** of **renewable** energy sources
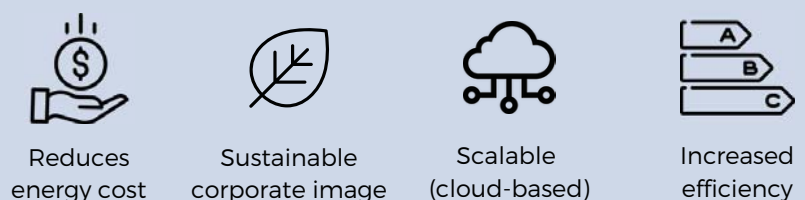
APPLICATIONS

- Distributed energy resources
- Energy markets
- Local energy communities

ADDED VALUE

- Modular architecture
- Consumer in the center of the energy system
- Capacity to manage all distributed resources

DESIRED PARTNERS

Industrial and commercial partnerships to demonstrate CASE technical and economic feasibility: energy retailers, aggregators, ESCO's, EV fleet managers.

TRL

TRANSFERRED

6

EXPECTED BENEFITS

Reduces energy cost

Sustainable corporate image

Scalable (cloud-based)

Increased efficiency

CONTACT

https://irec.cat

KTT area

ktt@irec.cat

+34 933 562 615

technical details

INNOVATION SOLUTION

CASE software platform offers a customized and flexible solution to independent aggregators and retailers to efficiently manage distributed flexibility resources. CASE improves the aggregator operation using artificial intelligence, sophisticated mathematical models and cloud computing. CASE is able to forecast market condition, consumption and flexibility using information gathered from smart buildings and distributed energy sources to make the best decision for the aggregator and the end-user benefit. CASE was born to provide a holistic tool for the operation of demand aggregators, providing optimal flexibility management in a variety of scenarios. At its core, it relies on the combination of advanced machine learning techniques to predict the flexibility of its clients' portfolio and the market conditions, robust mathematical modelling and optimization algorithms for optimal portfolio management and behavior analysis. These characteristics are not present in any other aggregator software solution in the market.

MAIN FUNCTIONALITIES

- **Market forecast:** predicts prices in different electricity markets for the next day
- **Load Forecast:** three different algorithms tested over four different type of consumption (residential, tertiary building, industry and district), validated over real data
- **Flexibility Forecast:** predicts the flexibility of various appliances (PV, HVAC or batteries)
- **Bidding optimization:** optimizes the day-ahead aggregator bidding strategy in different markets, taking into account the load, flexibility and market forecasts
- **Intraday optimization:** schedules in real time the flexibility resources, makes a follow up of the flexibility activations and eventually redispatches flexibility
- **Observability and data analysis:** the consumer can monitor its consumption and its flexibility, providing economic and environmental indicators.

IMPLEMENTATION

Applied in 3 pilot demonstration projects at laboratory scale and 2 pilots working 24/7 under real conditions. Validated in: Tirant lo Blanc library (Montgat) and a pre-commercial program.
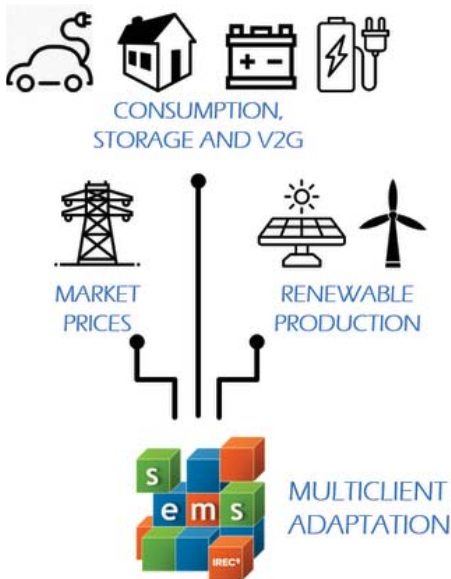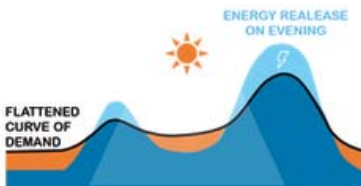
Technology licenced to Bamboo Energy

SEMS- SMART ENERGY MANAGEMENT SOLUTION

A PRODUCT FOR OPTIMIZING ENERGY USAGE

THE CONCEPT

CONSUMPTION, STORAGE AND V2G

MARKET PRICES

RENEWABLE PRODUCTION

MULTICLIENT ADAPTATION

ADDED VALUE

ENERGY RELEASE ON EVENING

FLATTENED CURVE OF DEMAND

TRL

7-8

TRANSFERRED

CONTACT

https://irec.cat

KTT area

ktt@irec.cat

+34 933 562 615

TECHNOLOGY DESCRIPTION

- **Hardware and software solution** for the smart and dynamic energy management of self-consumption solutions
- Able to include **multiple types of consumption** and generation units, energy storage systems, as well as electric vehicle charging infrastructure or vehicle-to-grid systems
- Offers the necessary **intelligence** to find the **optimal operation** of the system, to minimize energy costs, energy consumption peaks and emissions, all autonomously and automatically

APPLICATIONS

- Microgrids
- Buildings with several energy assets (consumption, storage, electric vehicles...) and e-parkings
- Local energy communities

DESIRED PARTNERS

- Entities requiring smart energy management

EXPECTED BENEFITS

20 % increase in energy storage use

10-15 % reduction in energy bills

peak shaving

8-10 % increase in self-consumption of RES

technical details

SOLUTION INTELLIGENCE

- Machine learning for the forecast of energy demand and forecast of use of electric vehicle chargers.
- Mathematical optimization for the energy management of the different resources at 24 hours.
- Download weather and energy price curves.
- Real-time control for adjustments to unforeseen events.
- Open system for Demand Response services activations.

MONITORING SYSTEM VIA SCADA

- Historicization of the information collected from devices.
- Configurable notification system, by SMTP to any desktop or mobile device, that includes alarms and events generated by physical equipment.
- Configurable reporting (web or RTF, XML, PDF, HTML, and CSV...).
- Remote access to the application for real-time viewing, maintenance and retrieval of data.
- Calculation of indicators for operation, economic savings, CO_2 emissions and peak power.
- Management system configuration.
- Management of user profiles and rights within the monitoring screens.

PROTOCOLS / COMMS

- Configurable drivers to communicate with PLCs, remote I/O devices, and other data-acquisition equipment: MQTT, API REST, Modbus TCP, Client and server, SNMP, MODBUS, RTU/ASCII, CAN/CAN Open, IEC 60870-5-104.
- Connect to SQL databases (MS SQL, MySQL).

IMPLEMENTATION

Installed in 3 pilots working 24/7. Interoperability already validated in 9 commercial systems with different communication systems: SMA - SCHNEIDER - FRONIUS - EATON/NISSAN - Circutor WallBox - WallBox ENEL - MAGNUMCAP - FASTO
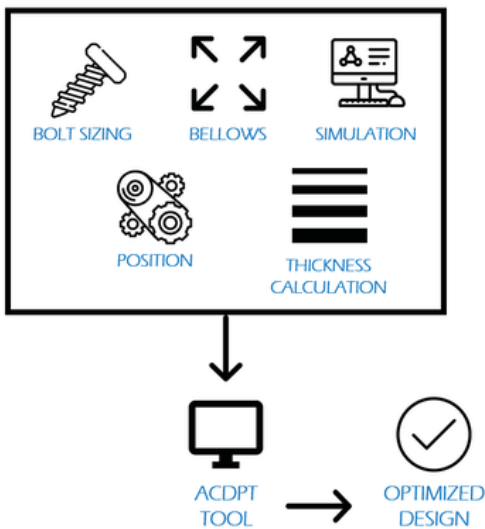
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FUSIONCAT-ACDPT TOOL

ACCELERATOR COMPONENTS DEVELOPMENT AND POSITIONING TOOL

THE CONCEPT

PRODUCT DESCRIPTION

- Tool to perform calculations related to the design of **accelerator** and **fusion-related mechanical components**
- Determines and validates designs of such components using **different industry standards** and **methods**
- Uses widely known codes and standards, brought together for the first time for accelerator components design.

APPLICATIONS

Design of components for:
- Particle accelerators
- Fusion-related components

ADDED VALUE

- Helps the commissioning activities
- Integrated codes and standards validation
- Multi stage design

IMPLEMENTATION

The tool is already being used to design components of IFMIF-DONES's High Energy Beam Transport (HEBT) and Beam Dump (BD) line.

TRL

5-6

REGISTERED

EXPECTED BENEFITS

Validation of designs

For accelerator fusion components

Time saving

Reduces cost

CONTACT

- https://irec.cat
- KTT area
  ktt@irec.cat
- +34 933 562 615
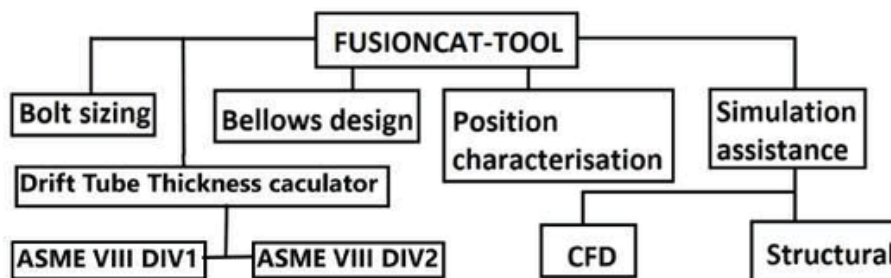
technical details

INNOVATION SOLUTION

The growing need for energy has pushed the necessity of alternate energy sources that can be both sustainable and be enough to cater to the needs of generations to come. Even though fusion has been a fairly old technology, limitations in resources and supporting technologies have resulted in the delay of its adoption. In recent times, significant improvements have been made to cater to these limitations. This tool helps to aid the progress of fusion technologies by developing a platform for designers to be able to perform necessary calculations for designing fusion and accelerator-related components.

TECHNICAL DETAILS

The platform is user friendly. GUI is developed using the open-source programming language PYTHON and its packages, and involves tools for:

- **Bolting Support Design** - validates the design of bolting support as per EN1993 1-8 European standard
- **Expansion Bellows Design** - facilitates designers to as per EJMA standard for various strains (linear, lateral and rotational) related to the expansion bellows
- **Position Characterization** - aids the commissioning activities utilizing linear alignment systems
- **Simulation Assistance** - performs calculations needed by analysis process for both structural and CFD
- **Drift Tube Thickness Calculator** - computes suitable thicknesses for externally pressured vacuum tubes such as accelerator drift tube and others as per ASME BPVC codes

CONTACT

LOCATION

Barcelona headquarters:
Jardins de les Dones de Negre 1, 2nd floor
08930 Sant Adrià del Besòs, Barcelona (Spain)

Tarragona site:
Campus de Sescelades, edifici N5
Marcel·lí Domingo, 2. 43007 Tarragona

E-MAIL

If you have any questions or queries, you may contact the KTT unit at KTT@irec.cat

TELEPHONE

Tel. +34 933 562 615

WEBPAGE

Updated information at https://www.irec.cat/ and https://www.irec.cat/tech-transfer/

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