D6.7 UP-TO DATE INNOVATIVE TECHNOLOGY SCAN

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EXECUTIVE SUMMARY

This deliverable represents a scan of innovative technologies relevant for the residential building sector and so potentially for renovation projects performed within DREEAM.

The document has two parts:

- **PART I** - Market scan of innovations in the residential building sector
  The scan was done beyond Climate-KIC, in order to provide a wider overview of options (page 9-73).
- **PART II** – Innovations developed in EU-funded projects under H2020 scheme (page 74-142).

PART I – INNOVATION MARKET SCAN

BUILDING ELEMENTS COVERED

- Facade Components
- Windows
- Heating System
- Cooling
- Lighting
- Solar Thermal
- Storage Tank
- PV
- Control Systems
- Battery
- Alternative Energy Generation

METHODOLOGY

In order to gather the most innovative technologies within energy efficiency in buildings a thorough online research was done through the most relevant institutions in the field.

- Climate – KIC - http://www.climate-kic.org/
- Fraunhofer - https://www.fraunhofer.de/
- BPA Energy Efficiency- https://www.bpa.gov/EE/Pages/default.aspx
- National Renewable Energy Laboratory - http://www.nrel.gov/
- Northwest Energy Efficiency Alliance - http://neea.org/about-neea
- ARPA-E - https://arpa-e.energy.gov/
- Office of Energy Efficiency and Renewable Energy- http://energy.gov/
- International Energy Agency - https://www.iea.org/

The statements done regarding the different technologies are obtained from the suppliers and not tested by DREEAM

TRL

In order to classify the different innovations the Technology Readiness Level (TRL) is mentioned, estimating the maturity of each technology.

Please note that the TRL estimation refers to the time of the writing and might have changed in the meantime. Also a lot of innovation does not have updated website. So TRL mentioned for those are close approximation.

- TRL 5: Component and/or breadboard validation in laboratory environment
- TRL 6: System model or prototype demonstration in relevant environment
- TRL 7: System prototype demonstration in an operational environment
- TRL 8: Actual System complete and qualified through test and demonstration

http://www.earto.eu/fileadmin/content/03_Publications/The_TRL_Scale_as_a_R_I_Policy_Tool_-_EARTO_Recommendations_-_Final.pdf

FAÇADE COMPONENT

Façade component

ENERPAPER

TRL = 9

The product uses stabilized cellulose that can be turned into a product that meets the need to create a thermo-acoustic barrier

- Key Points
  - 50% less chemical additives
  - 35% saving from energy for heating
  - 70% reduction on transportation cost
- Application – building type
  - New buildings (Residential, Commercial)
- Application process
  - Non-disruptive

Façade component

HEAT REFLECTIVE FAÇADE PAINT

TRL = 9

Near infrared reflection (NIR) technology based paint that effectively reduces heat absorbtion

- Key Points
  - The temperature peaks can be limited to 15-20%
  - can be broken in all colors
- Application – building type
  - New buildings (Residential, Commercial)
  - Refurbishment
- Application process
  - Non-disruptive

http://www.sto.se/sv/produkter_system/innovationer/stocolor_x_black/stocolor_x_black.html

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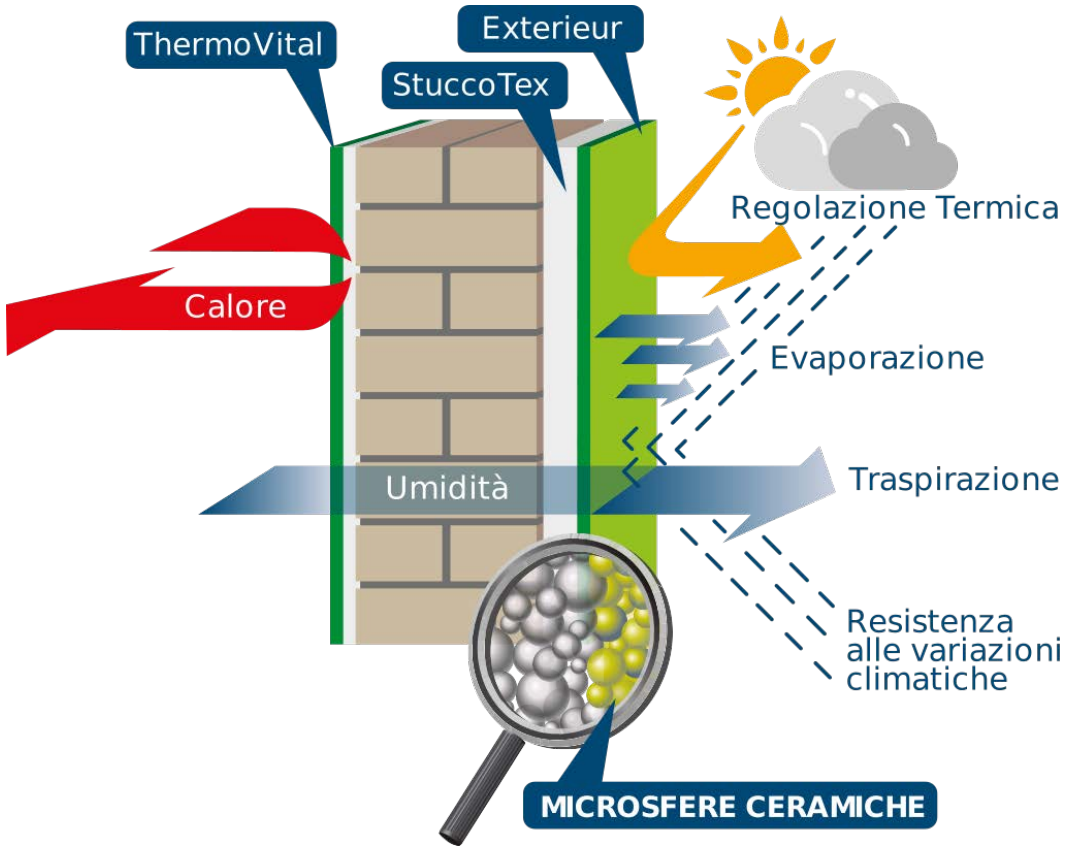
Façade component

THERMO SHIELD

TRL = 9

a multi-purpose coating that can be used for external walls and interior walls of the house

- Key Points
  - prevents the formation of micro-cracks avoiding infiltrations
  - varies its behavior according to external conditions
  - Keeps humidity rate around 55%
- Application – building type
  - New buildings (Residential, Commercial)
  - Refurbishment (Residential, Commercial)
- Application – process
  - Non-Disruptive



https://tecnovagroup.com/thermoshield-isolamento-termico-pareti/

Façade component

AIR QUALITY IMPROVING INDOOR PAINTING

TRL = 9

Self cleaning color that reduces organically harmful substances and indoor smell

- Key Points
  - first active photo catalytic color that works completely without UV light
  - Normal lamp lights are enough to start the cleaning process
- Application – building type
  - New buildings (Residential, Commercial)
  - Refurbishment (Residential, Commercial)
- Application – process
  - Non-Disruptive

http://www.sto.se/sv/produkter_system/innovationer/stocolor_climasan/stocolor_climasan.html

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Façade component

GELCLAD

TRL = 5-6

Aims at creating a novel cost-effective, durable, industrialised and easy to install composite insulation cladding system

- Key Points
  - based on a single structured panel with excellent insulation properties
  - the novel cladding system can be set with passive pre-programed materials
  - 20% lower embodied energy than traditional oil based panels
- Application – building type
  - New buildings (Residential, Commercial)
  - Refurbishment (Residential, Commercial)
- Application – process
  - Disruptive

GELCLAD PANEL CONCEPT

https://www.gelclad.eu/#about

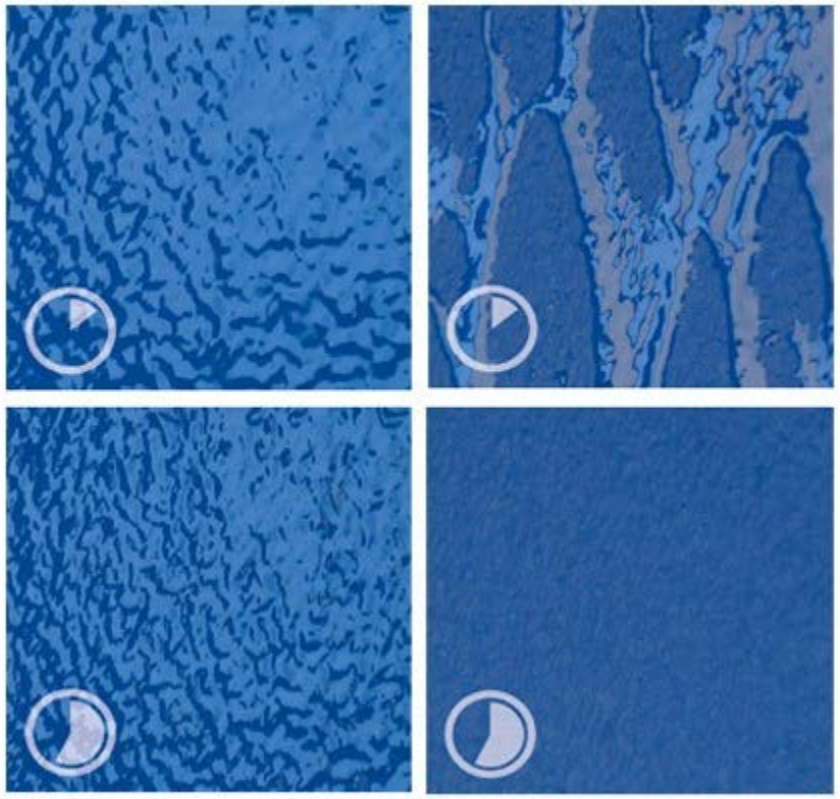
Façade component

QUICK DRYING PAINT

TRL = 9

Exterior paint that allows the façade to dry quickly after rain, fog or dew

- Key Points
  - provides long-term protection against algae and fungal attacks
  - available in many different colors and has a high color tone stability
  - Can withstand high mechanical loading
- Application – building type
  - Refurbishment (Residential)
  - New Buildings (residential)
- Application – process
  - Disruptive



http://www.sto.se/sv/produkter_system/innovationer/stocolordryonic/stocolordryonic.html

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Façade component

LIGHT, RIGID INSULATING FOAM

TRL = 8

Expanded Polystyrene insulating foam for thermal and acoustic insulation

- Key Points
  - Lifetime durability
  - Flexible mechanical properties
  - Easy to install
- Application – building type
  - Refurbishment (Residential)
  - New Buildings (residential)
- Application – process
  - Disruptive

https://www.plasticsportal.net/wa/plasticsEU~en_GB/portal/show/content/products/foams/proEPS_insulating_with_EPS

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Façade component

SELF CLEANING PLASTER AND PAINT

TRL = 9

Exterior paint that washes off the dirt and reduces adhesion

- Key Points
  - special microstructured and water repellent surface
  - significant reduction in the risk of algae or mold spores
  - Extremely water repellent and diffusion open, also protects against weathery façades
- Application – building type
  - Refurbishment (Residential)
  - New Buildings (residential)
- Application – process
  - Disruptive

http://www.sto.se/sv/produkter_system/innovationer/lotusan-/stocolor_lotusan.html

WINDOWS

Windows

SMART SUN PROTECTION

TRL = 7-9

Electrochromic glass darkens automatically when the sun shines and keeps the heat out

- Key Points
  - Applying voltage enables smart glass to darken or brighten accordingly
  - Previously only available in blue and with long switching times
  - A new process facilitates faster electrochromic glass panes in different colors

Application – building type

  - New building (Residential, Commercial)

https://www.fraunhofer.de/en/press/research-news/2017/february/automatically-darkening-windows-in-a-wide-range-of-colors.html

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Windows

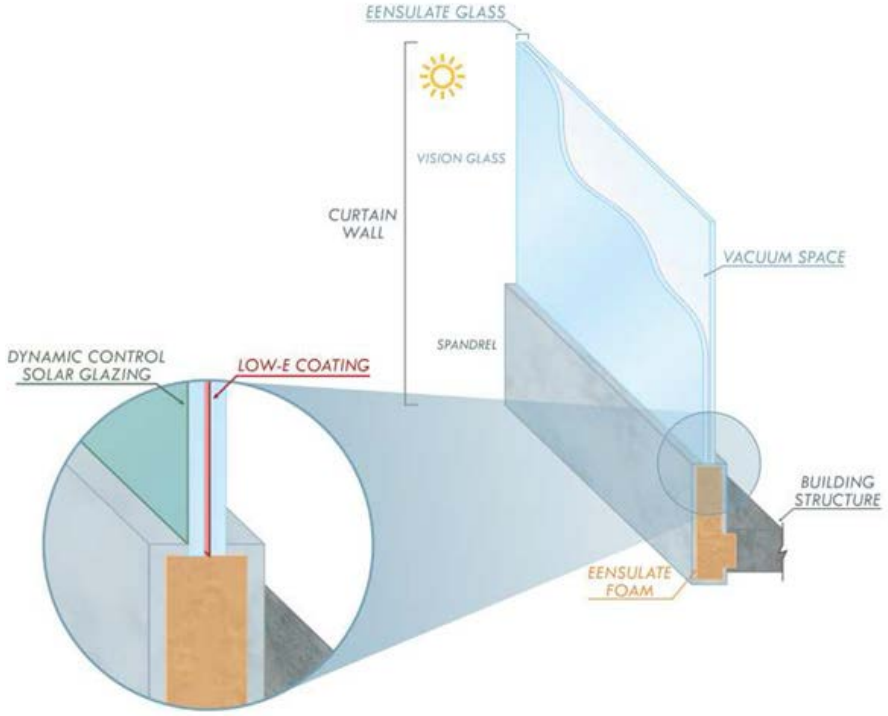
EENSULATE WINDOW

TRL = 5

Affordable advanced architectural glass to address thermal and acoustic insulation

- Key Points
  - cost-effective control of solar radiation
  - cost-effective retrofitting and new construction of curtain wall facades
  - Reduction of energy bills by at least 20%

  Application – building type
  - New building (Residential, Commercial)
  - Refurbishment
- Application – process
  - Disruptive



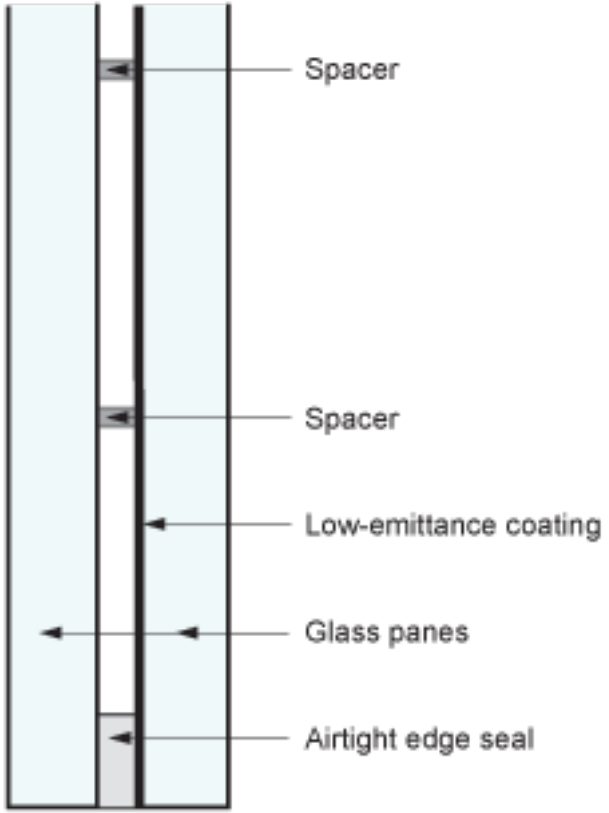
EVACUATED WINDOW

TRL =6

Most thermally efficient window that has the lowest U value

- Key Points
  - U-factor of 0.20 or less
  - Low vaccum pressure eliminates conductive or convective heat exchange between the panes of glass

  Application – building type
  - New building (Residential, Commercial)
  - Refurbishment
- Application – process
  - Disruptive



https://www.efficientwindows.org/adv_glass.php

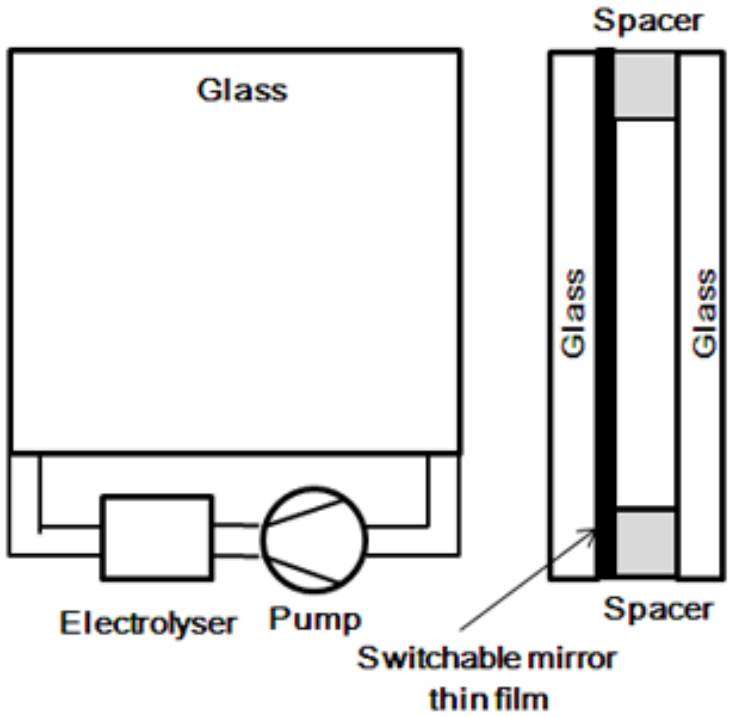
GASOCHROMIC WINDOW

TRL = 6

Dynamic window technology that produces similar effect to electrochromic window but using gas

- Key Points
  - Visible transmittance can vary between 0.10–0.59
  - Transmittance levels of less than 0.01 for privacy or glare control are possible
  - Switching speeds are 20 seconds to color and less than a minute to bleach

  Application – building type
  - New building (Residential, Commercial)
  - Refurbishment
- Application – process
  - Disruptive



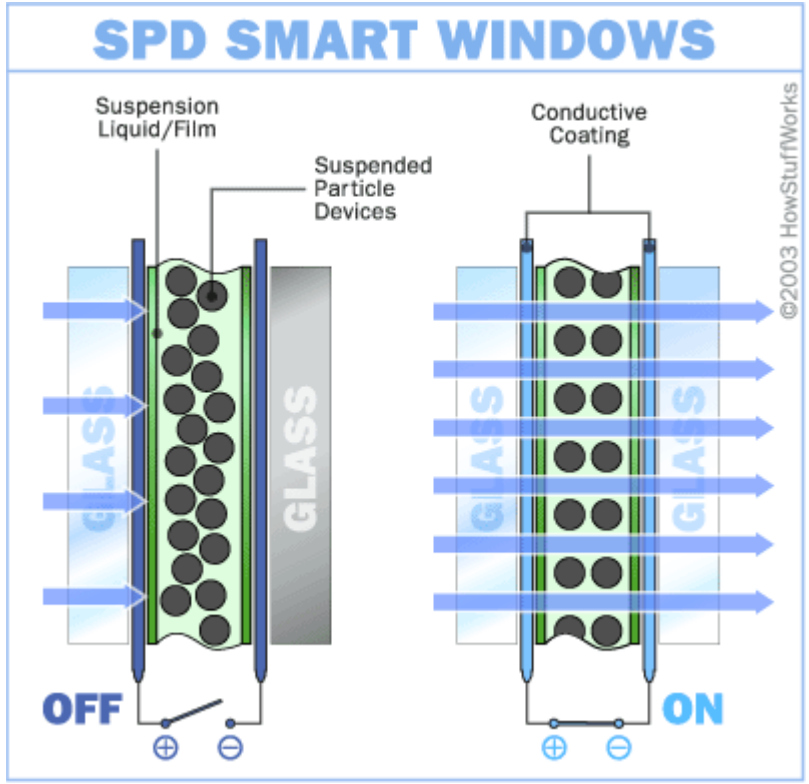
https://www.commercialwindows.org/gasochromic.php

SUSPENDED PARTICLE DEVICE (SPD) WINDOWS TRL = 7

Window that uses electrically controlled film to change transparency

- Key Points
  - near instant switching times (less than one second)
  - Power requirements are 0.5 W/sf for switching and 0.05 W/sf to maintain a constant transmission state

  Application – building type
  - New building (Residential, Commercial)
  - Refurbishment
- Application – process
  - Disruptive



https://www.commercialwindows.org/spd.php

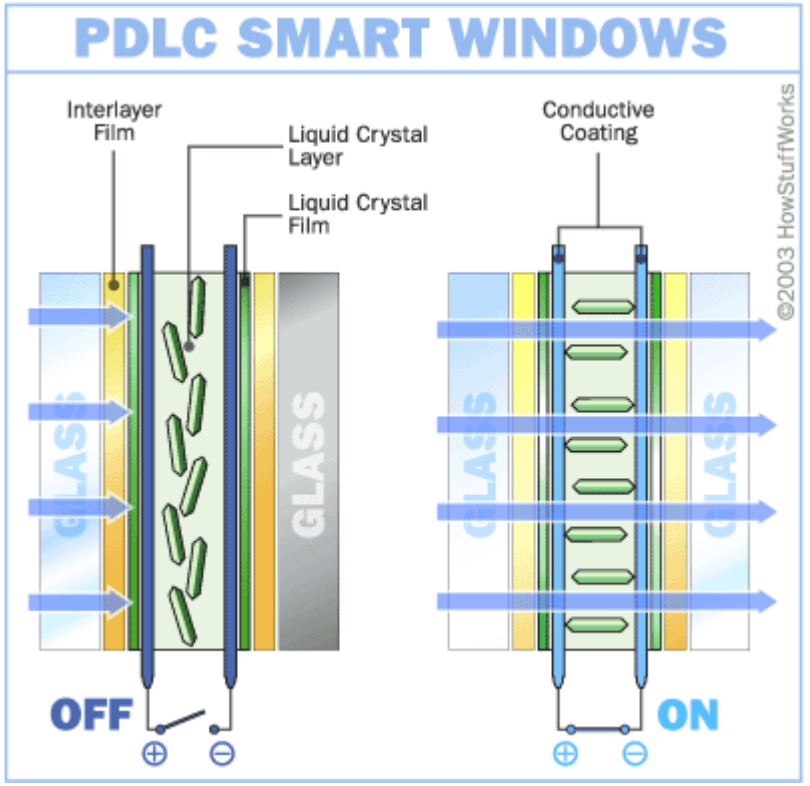
LIQUID CRYSTAL DEVICE WINDOWS

TRL = 7

Window that uses polymer dispersed liquid crystal to change transparency

- Key Points
  - obscures direct view and provides privacy in powerless state
  - Ultraviolet (UV)-stable formulations now permit exterior applications
  - visible transmittance range is typically 50–80%

  Application – building type
  - New building (Residential, Commercial)
  - Refurbishment
- Application – process
  - Disruptive



https://www.commercialwindows.org/liquidcrystal.php

HEATING SYSTEM

Heating System

RADBOT

TRL = 7

a smart thermostatic radiator valve

- Key Points
  - zoning and occupancy sensing to ensure the spaces people occupy are only heated when required
  - low cost and easy to install device
  - heat energy savings estimated at 30% and an ROI of around one year
- Application – building type
  - New buildings (Residential)
  - Refurbishment (Residential)
- Application – process
  - Non-disruptive

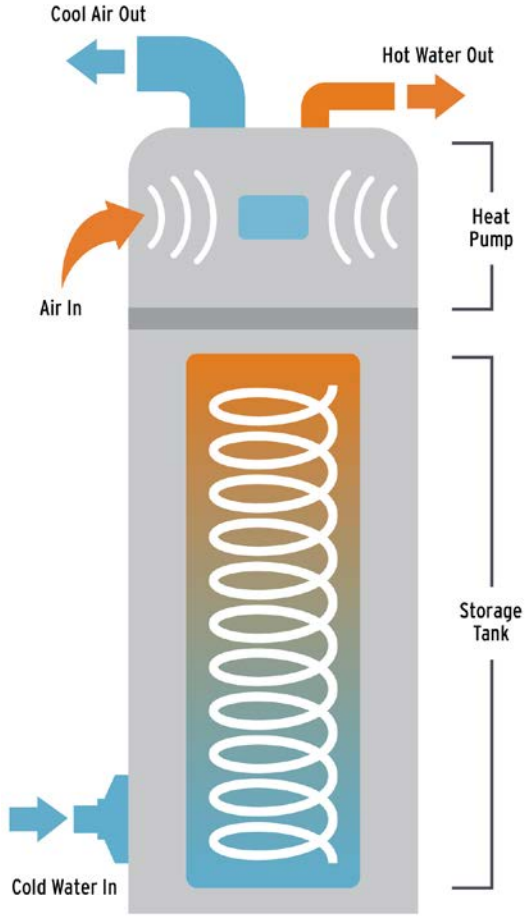
Heating System

HEAT PUMP WATER HEATER

TRL = 9

Smart water heater that uses electricity to produce more heat rather than generating it

- Key Points
  - electricity reduction up to 60%
  - More control
- Application – building type
  - New buildings (Residential)
  - Refurbishment (Residential)
- Application – process
  - Non-disruptive



https://hotwatersolutionsnw.org/

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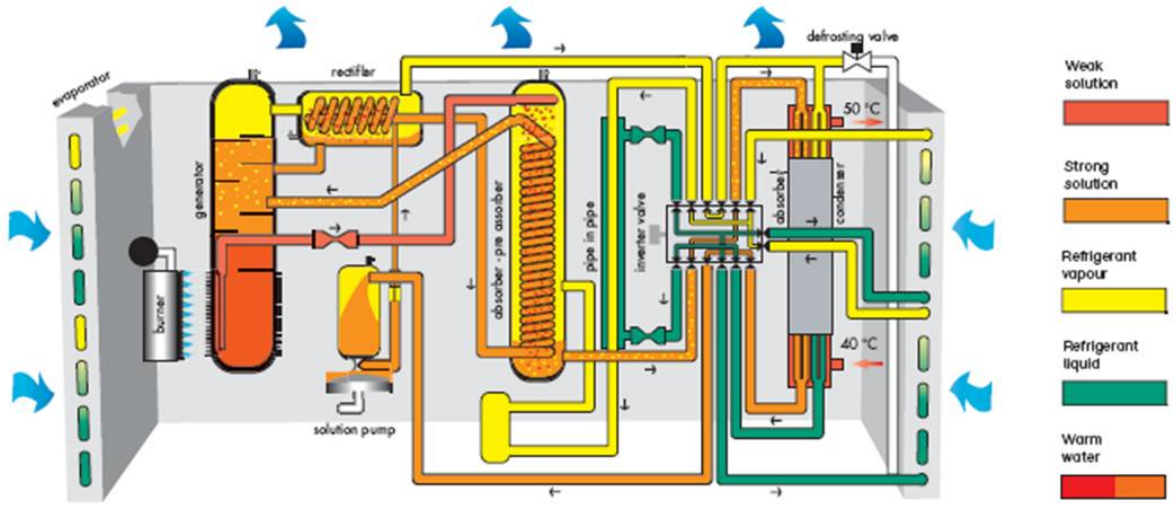
Heating System

ABSORPTION HEAT PUMP

TRL = 9

Air-source heat pumps driven by a heat source such as natural gas, propane, solar-heated water, or geothermal-heated water

- Key Points
  - can make use of any heat source, including solar energy, geothermal hot water, or other heat sources
  - amenable to zoned systems, in which different parts of the house are kept at different temperatures.
- Application – building type
  - New buildings (Residential)
- Application – process
  - Disruptive



https://www.energy.gov/energysaver/heat-pump-systems/absorption-heat-pumps

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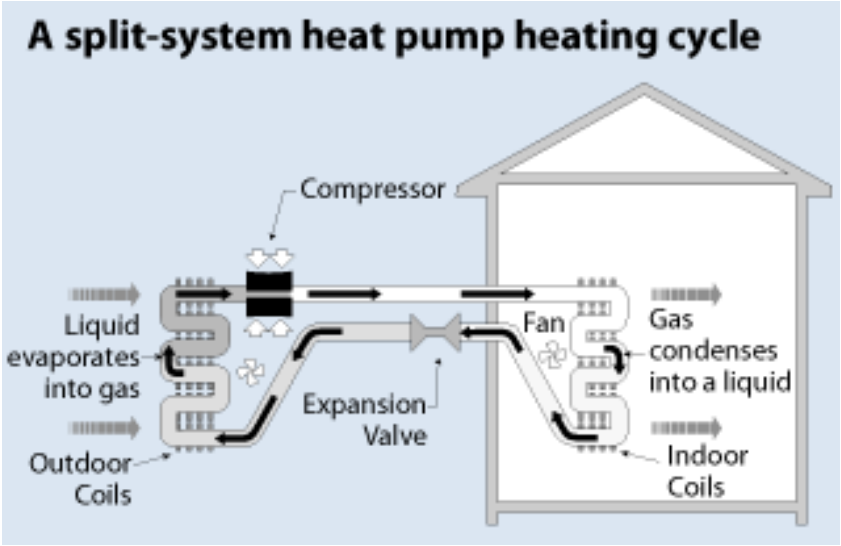
Heating System

DUCTLESS, MINI-SPLIT HEAT PUMPS

TRL = 9

Heat pumps that are ideal for small space and houses where extension is not possible

- Key Points
  - zero energy losses associated with the ductwork of central forced air systems
  - small size and flexible
- Application – building type
  - New buildings (Residential)
  - Refurbishment
- Application – process
  - Disruptive



https://www.energy.gov/energysaver/heat-pump-systems/ductless-mini-split-heat-pumps

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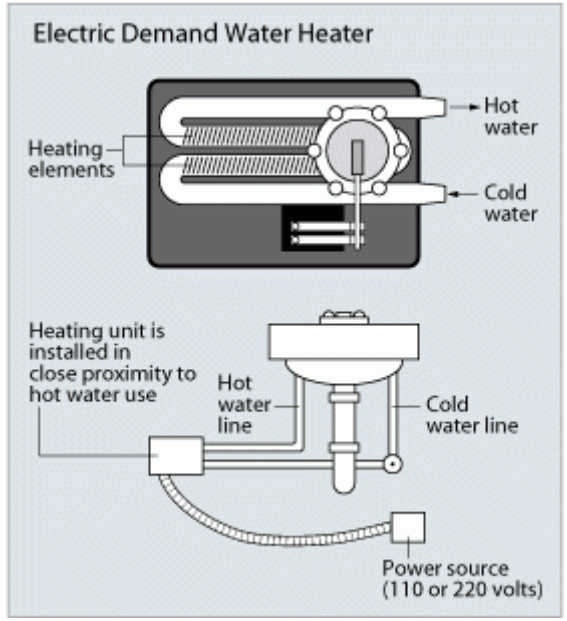
Heating System

TANKLESS WATER HEATERS

TRL = 9

Provides hot water only as it is needed and don't produce the standby energy losses associated with storage water heaters

- Key Points
  - 24%–34% more energy efficient than conventional storage tank water heaters
  - lower operating and energy costs
  - easily replaceable parts
- Application – building type
  - New buildings (Residential)
  - Refurbishment
- Application – process
  - Disruptive



https://www.energy.gov/energysaver/water-heating/tankless-or-demand-type-water-heaters

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VENTILATION

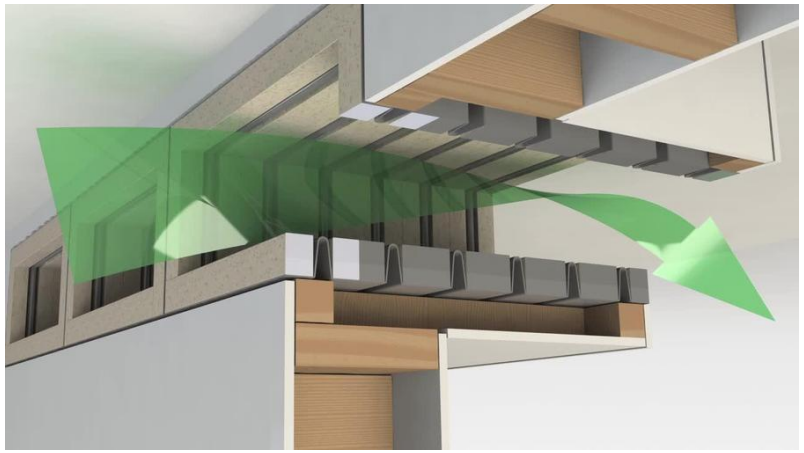
Ventilation

SOUNDSCOOP

TRL = 9

SoundScoop is an air transfer unit that can be used both inside and on the façade of buildings to tackle noise problem with natural ventilation

- Key Points
  - Interior Soundscoop specifically targets sound of a mid-frequency – such as the human voice
  - façade Soundscoop targets lower frequency sounds such as traffic noise
  - more than 10dB of sound attenuation in a given octave band
- Application – building type
  - New building (Commercial, Residential)
  - Refurbishment (Commercial, Residential)
- Application – process
  - Disruptive



https://www.arup.com/projects/soundscoop

COOLING

CEILING PANEL COOLING MODULE

TRL = 8

Offers hygienic cooling even in tropical climates, and uses up to 70 percent less energy

- Key Points
  - Ceiling panels covered in special heat-conducting film function well below the dew point
  - High-density modularity reduces the system's overall size
  - The long-lasting modules can be taken down and re-installed elsewhere
- Application – building type
  - New building (Commercial, Residential)
  - Refurbishment (Commercial, Residential)
- Application – process
  - Disruptive

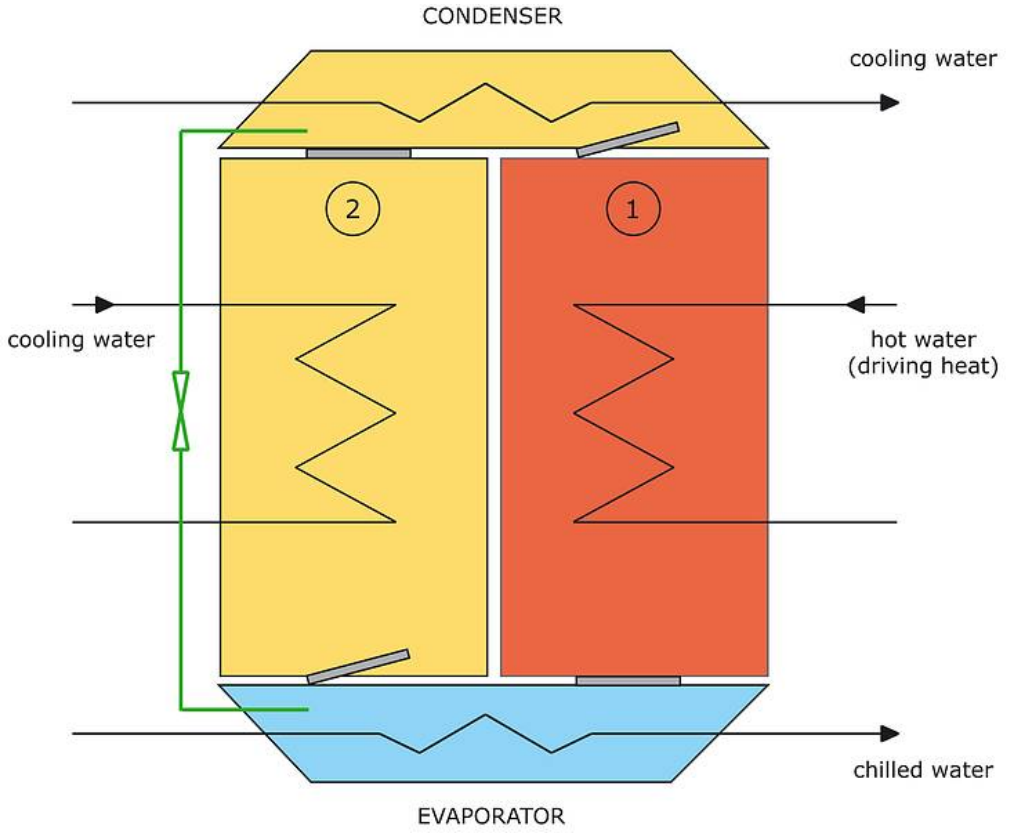
https://www.fraunhofer.de/en/press/research-news/2016/dezember/ceiling-panel-cools-regardless-of-climate.html

ADSORPTION CHILLERS

TRL = 8

Uses solid sorption materials instead of liquid solutions to produce low temparature

- Key Points
  - simple mechanical construction
  - a coefficient of performance (COP) of about 0.6 with a driving temperature of 80 °C
- Application – building type
  - New building (Commercial, Residential)
  - Refurbishment (Commercial, Residential)
- Application – process
  - Disruptive



http://www.solair-project.eu/142.0.html

LOW ENERGY FAN COOLING UNIT

TRL = 8

Innovative new hybrid, low energy Fan Coil Unit

- Key Points
  - water-based air-conditioning system
  - low noise and optimal air swirl effect for efficient cooling
- Application – building type
  - New building (Commercial, Residential)
- Application – process
  - Disruptive

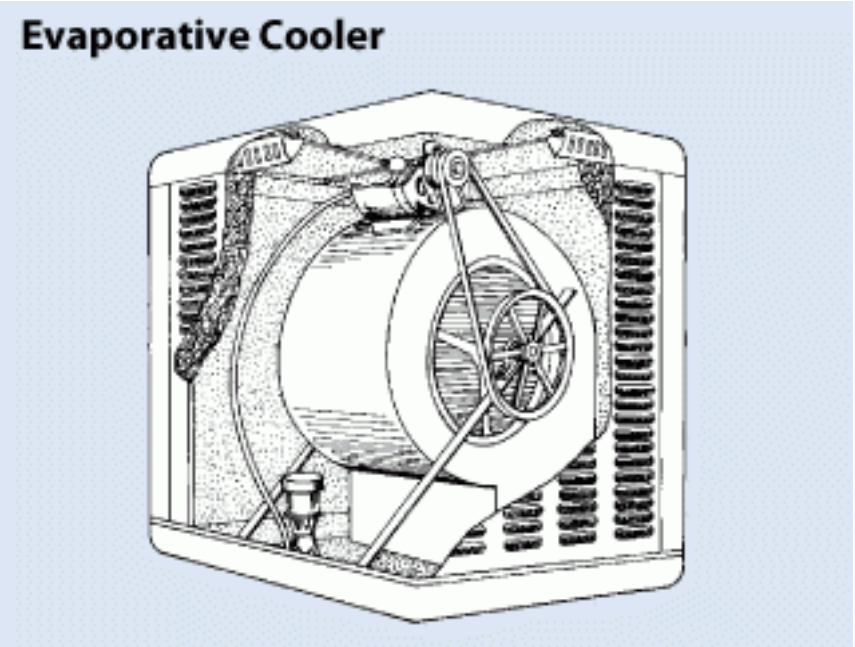
http://www.airedale.com/web/Products/Comfort-Cooling/Artus-Fan-Coil-Unit.htm

EVAPORATIVE COOLERS

TRL = 8

Cools outdoor air by passing it over water-saturated pads, causing the water to evaporate into it

- Key Points
  - costs about one-half as much to install as central air conditioners
  - Uses about one-quarter as much energy
  - Requires more frequent maintenance than refrigerated air conditioners
  - They arere suitable only for areas with low humidity.
- Application – building type
  - New building (Commercial, Residential)
  - Refurbishment (Commercial, Residential)
- Application – process
  - Disruptive



https://www.energy.gov/energysaver/home-cooling-systems/evaporative-coolers

LIGHTING

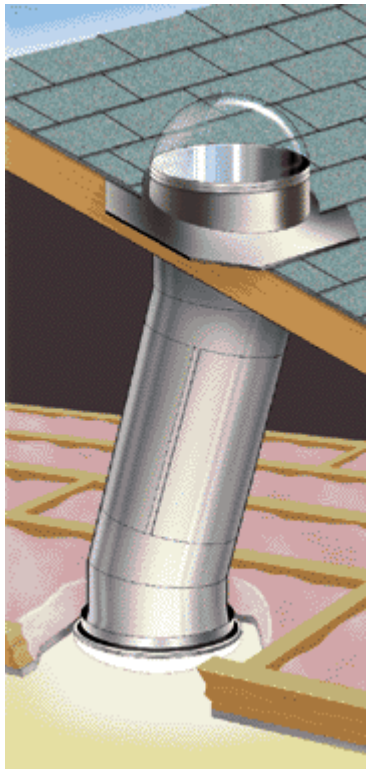
Lighting

TUBULAR SKYLIGHTS

TRL = 9

Introduces Daylight to Dark Homes

- Key Points
  - **less expensive than standard skylights**
  - Can be used in cold climates with additional diffuser to reduce heat loss
  - Easy installation and can be used in tough spaces
- Application – building type
  - New building (Residential)
  - Refurbishment (Residential)
- Application – process
  - Disruptive



https://www.greenbuildingadvisor.com/article/tubular-skylights-introduce-daylight-to-dark-homes

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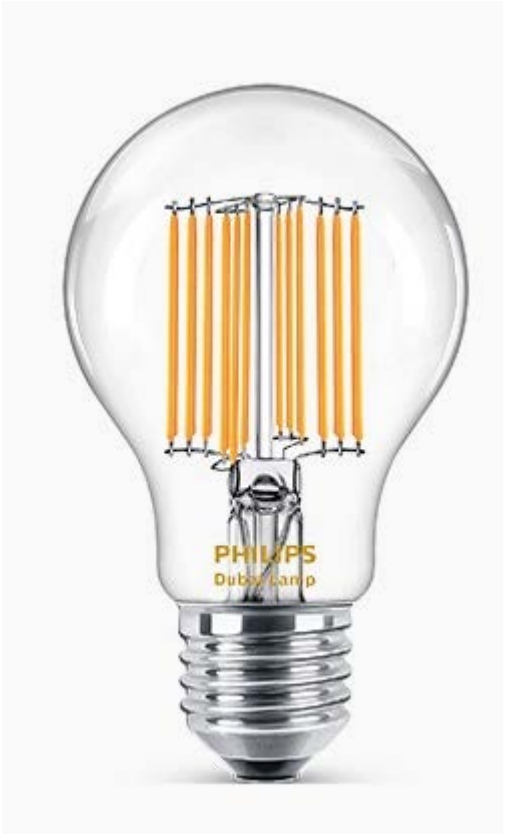
Lighting

SUPER EFFICIENT LED

TRL = 9

An LED filament light bulb marketed only in Dubai but highly efficient

- Key Points
  - strings of LEDs housed in a thermally conductive gas
  - capable of producing 200 lumens per watt
  - consumes just 3 watts of electricity
- Application – building type
  - New building (Residential)
  - Refurbishment (Residential)
- Application – process
  - Non-Disruptive



https://www.greenbuildingadvisor.com/article/philips-produces-a-super-efficient-led

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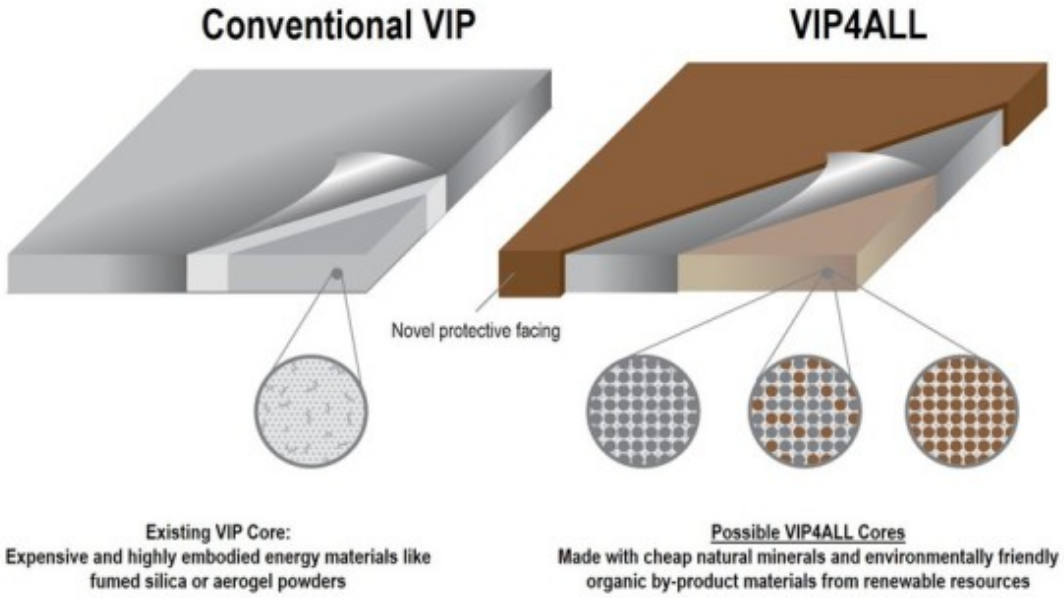
INSULATION

VACUUM INSULATION PANEL

TRL = 5

A true technical and cost-effective VIP solution by using natural minerals and/or renewable organic by-products

- Key Points
  - excellent thermal insulation properties at thickness smaller than one third of conventional air-filled insulation for the same R-Value
  - a new thin exterior encapsulating face layer made with cork, making it much more user-friendly
- Application – building type
  - Refurbishment (Residential, Commercial)
- Application – process
  - Disruptive



WOOD-DERIVED FOAM MATERIALS

TRL = 7

A novel foam material produced entirely from wood which is environment friendly and recyclable

- Key Points
  - can be used in exactly the same way as conventional plastic foams
  - lightweight base material that can be formed into rigid boards or flexible sheets
  - easily sawed or cut to the desired dimensions
- Application – building type
  - New building (Residential)
  - Refurbishment (Residential)
- Application – process
  - Disruptive

https://www.fraunhofer.de/en/press/research-news/2015/april/wood-derived-foam-materials.html

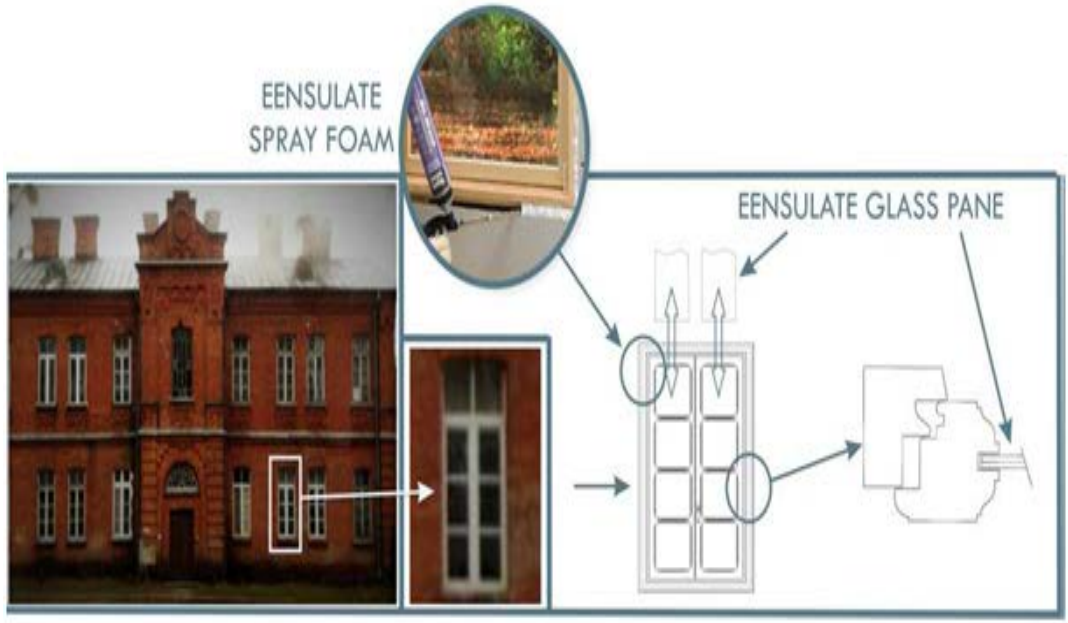
Insulation

EENSULATE FOAM

TRL = 5

Highly insulating mono-component and environmentally friendly spray foam

- Key Points
  - significant reduction of thermal bridges during installation
  - Improvement by at least 25% of the insulation properties
  - Easier implementation
- Application – building type
  - Refurbishment (Residential)
  - New Buildings (residential)
- Application – process
  - Disruptive



http://www.eensulate.eu/project-description#targets

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PCM BASED INSULATOR

TRL = 5-6

Combination of insulation and thermal mass that changes proeperty depending on climate

- Key Points
  - PCM in building materials absorb and give off heat
  - They regulate heat, to secure a pleasant indoor climate
  - researchers have combined the thermic and insulating characteristics of PCM and foams
- Application – building type
  - New building (Residential)
  - Refurbishment (Residential)
- Application – process
  - Disruptive

https://www.fraunhofer.de/en/press/research-news/2016/dezember/combination-of-insulation-and-thermal-mass.html

SOLAR THERMAL

PV

SOLAR CELL INTEGRATED FACADE

TRL = 6

Ventilated light weight façade that uses solar energy to produce electricity

- Key Points
  - possibilities of combining different surface materials
  - reduced consumption of 55 to 80 kWh per square meter
  - 20 millimeter thin plates weigh only 10 kg / m^2
- Application – building type
  - New building (Residential, Commercial)
  - Refurbishment (Residential, Commercial)
- Application – process
  - Disruptive

http://www.sto.se/sv/produkter_system/innovationer/stoventec_artline/stoventec_artline.html

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STORAGE TANK (ENERGY STORAGE)

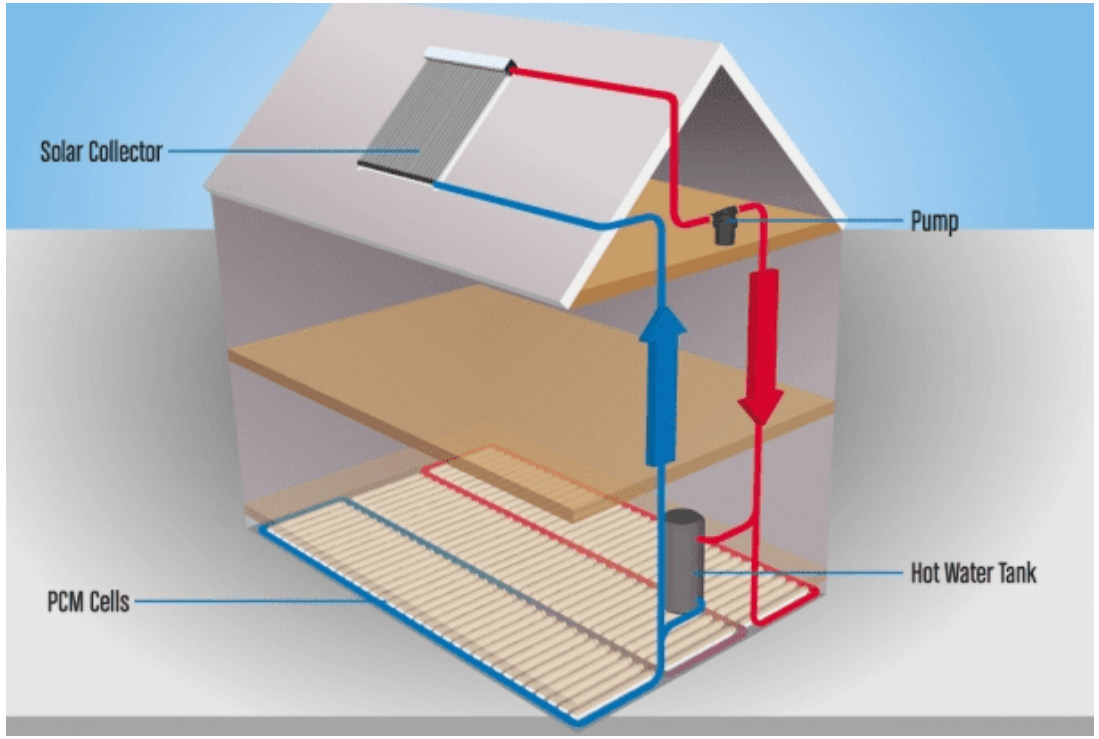
Storage Tank

HEATTANK

TRL = 8

Unique heat storage system for solar system individual owners (0.5-2 m^3)

- Key Points
  - possible to increase the efficiency of energy systems operating between -100 and +600 °C
  - 90% space saving (1/8 smaller the regular storage systems)
  - 1/2 - 2 years ROI
- Application – building type
  - New building (Commercial, Residential)
- Application – process
  - Disruptive



PV

ENERGY ROOF PV

TRL = 8

A polyurethane-encased PV laminate which incorporates a novel cableless and screwless mounting and wiring technology

- Key Points
  - allows the individual modules to be connected electrically and mechanically in just one step
  - can be adapted to any individual roof
  - Self cleaning
- Application – building type
  - New building (Residential, Commercial)
  - Refurbishment (Residential, Commercial)
- Application – process
  - Non-Disruptive

http://pvdatabase.org/products_view_detailsmore.php?ID=8

PV

EPISHINE

TRL = 6

World's first metal free organic printable photo voltaic cell

- Key Points
  - Can be used in places where traditional solar is inadequate
  - most scalable, resource efficient and affordable solar module in the world
  - Optimal for integrating with small things
  - Flexibility
- Application – building type
  - New building (Residential, Commercial)
  - Refurbishment (Residential, Commercial)
- Application – process
  - Non-Disruptive

https://epishine.se/#innovation

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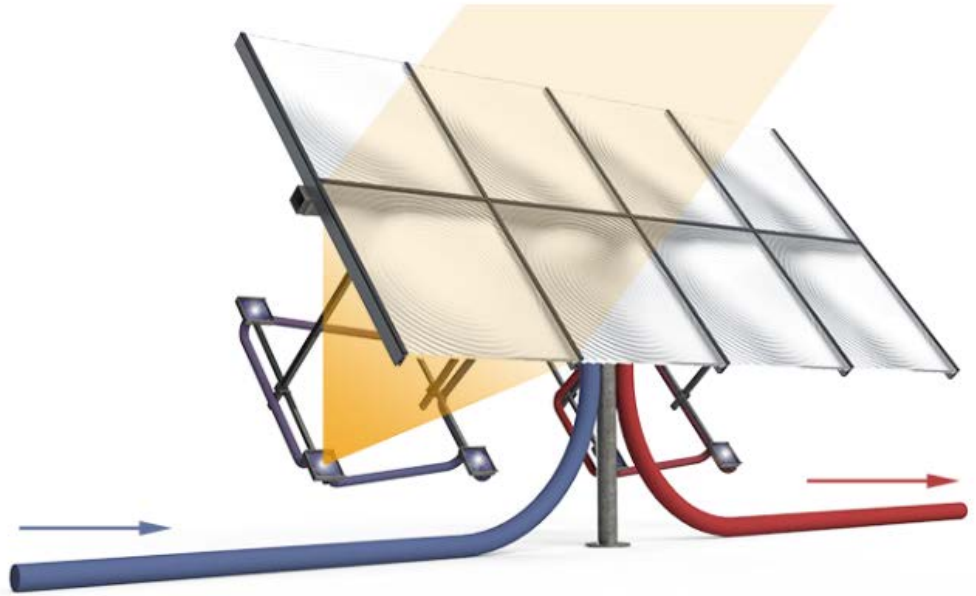
PV

HELIAC

TRL = 8

solar fields based on low-cost, high-efficiency lenses

- Key Points
  - lenses that generate heat instead of the more costly, curved mirrors
  - no maximum limit to how many panels may be connected.
  - competitive to fossil alternatives in systems down 200 kW
  - also allows for cooling when combined with absorption heat pumps
- Application – building type
  - New building (Residential, Commercial)
  - Refurbishment (Residential, Commercial)
- Application – process
  - Non-Disruptive



https://www.heliac.dk/utility-scale/applications.html

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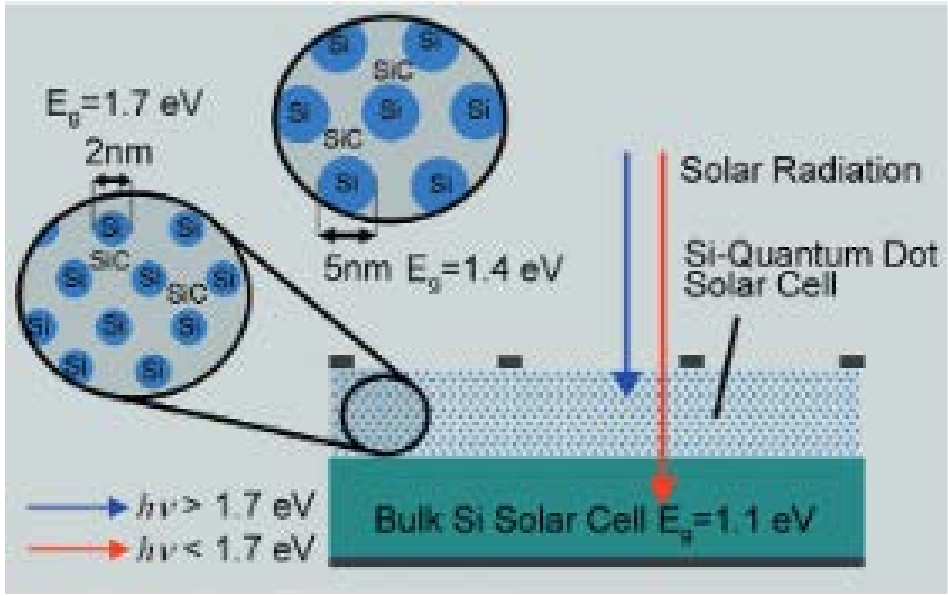
CRYSTALLINE SILICON BASED TANDEM SOLAR CELLS

A promising way to circumvent the conversion efficiency limits of conventional single-junction photovoltaic cells

- Key Points
  - increased efficiency by the multi-junction approach
  - additional pn-junctions on top of a Si cell
- Application – building type
  - New building (Residential, Commercial)
  - Refurbishment (Residential , Commercial)
- Application – process
  - Non-Disruptive



https://www.ise.fraunhofer.de/content/dam/ise/de/documents/infomaterial/brochures/photovoltaik/11e_ISE Flyer silicon%20tandem%20cells.pdf

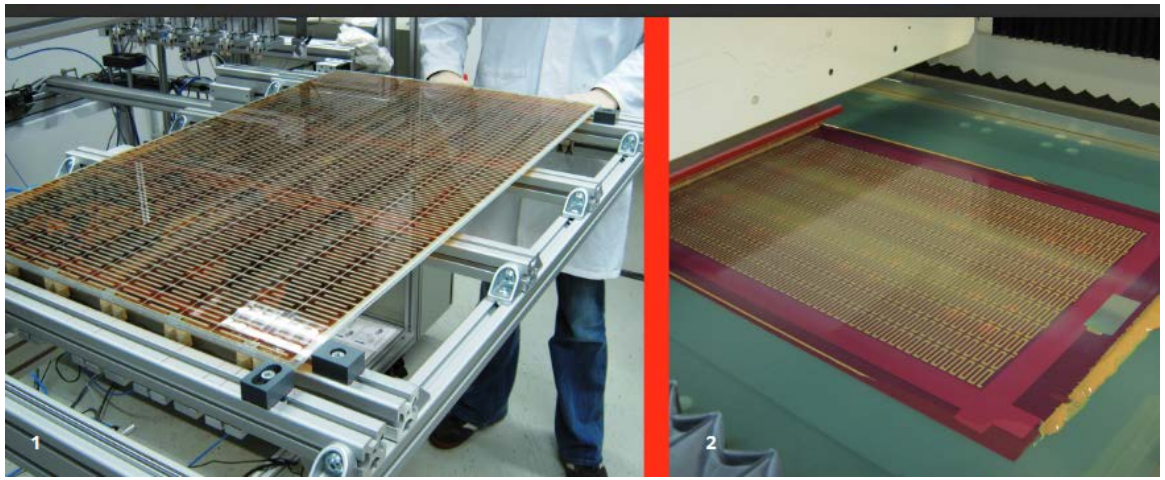
PV

DYE SOLAR CELLS AND MODULES

TRL = 5-6

photo electrochemical solar cells that convert light into electrical energy using organic dye

- Key Points
  - simple to manufacture
  - nanocrystalline carrier layer made of titanium dioxide TiO2 whose surface is chemically bonded with a mono-layer of dye molecules
  - low-Cost Production
- Application – building type
  - New building (Residential, Commercial)
  - Refurbishment (Residential, Commercial)
- Application – process
  - Non-Disruptive



https://www.ise.fraunhofer.de/content/dam/ise/en/documents/information-material/Photovoltaics/11e_ISE_Flyer_DyeSolarCells.pdf

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BI FACIAL PV

TRL = 6

New PV that can absorb solar ray from both side

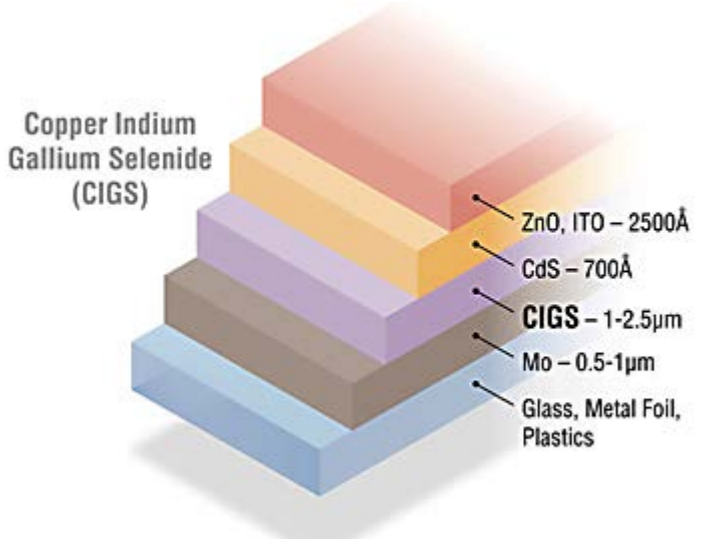
- Key Points
  - increased efficiency and lowered cost of solar energy systems
- Application – building type
  - New building (Residential, Commercial)
  - Refurbishment (Residential, Commercial)
- Application – process
  - Non-Disruptive

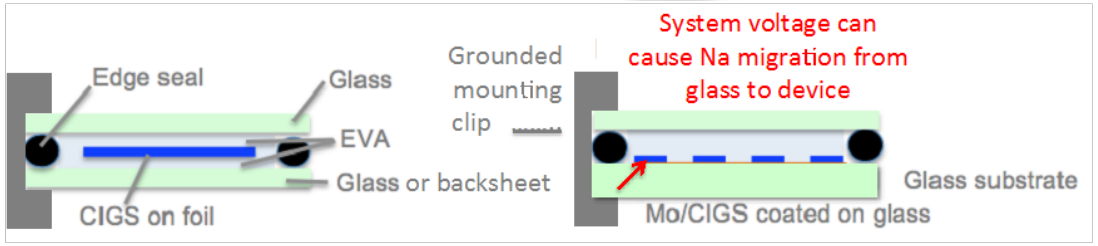
https://pvpmc.sandia.gov/pv-research/bifacial-pv-project/bifacial-pv-characterization-and-rating-standards/

COPPER INDIUM GALLIUM DISELENIDE SOLAR CELLS

CIGS-based thin-film solar cell modules represent the highest-efficiency alternative for large-scale, commercial thin-film solar cells

- Key Points
  - Record small-area single-junction efficiency now tops 22%
  - several companies have confirmed module efficiencies exceeding 16%
- Application – building type
  - New building (Residential, Commercial)
  - Refurbishment (Residential, Commercial)
- Application – process
  - Non-Disruptive





https://www.nrel.gov/pv/copper-indium-gallium-diselenide-solar-cells.html

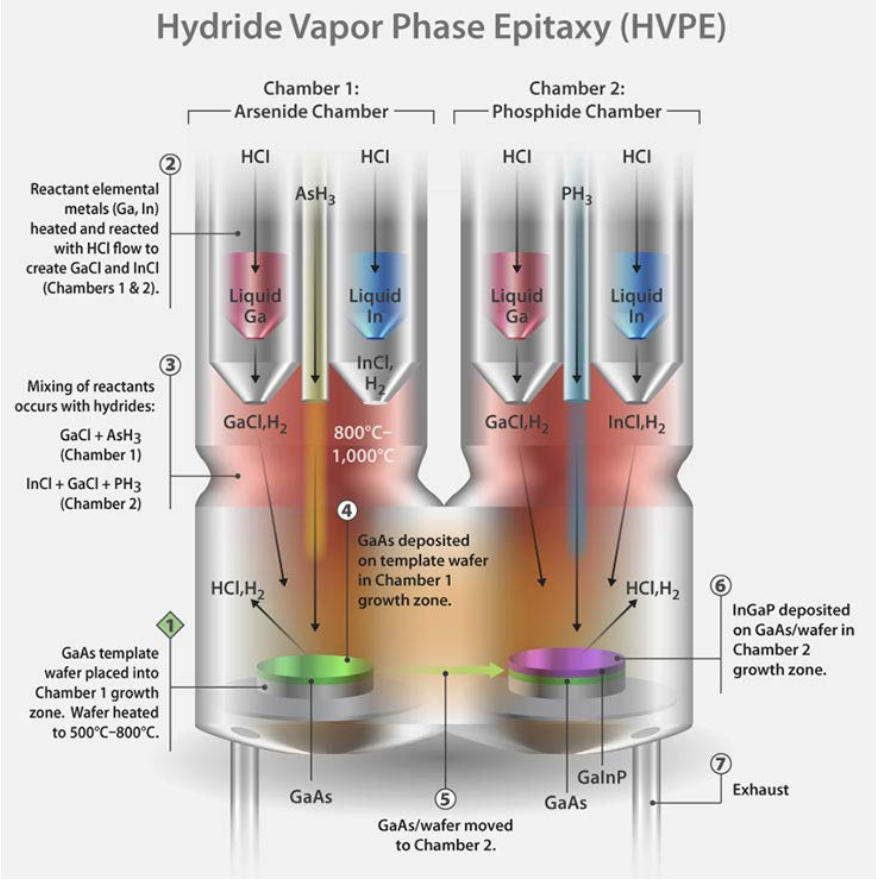
PV

LOW-COST III-V SOLAR CELLS

TRL = 6

Advance III-V solar cells with effective conversion efficiency

- Key Points
  - advanced hydride vapor-phase epitaxy
- Application – building type
  - New building (Residential, Commercial)
  - Refurbishment (Residential, Commercial)
- Application – process
  - Non-Disruptive



https://www.nrel.gov/pv/low-cost-iii-v-solar-cells.html

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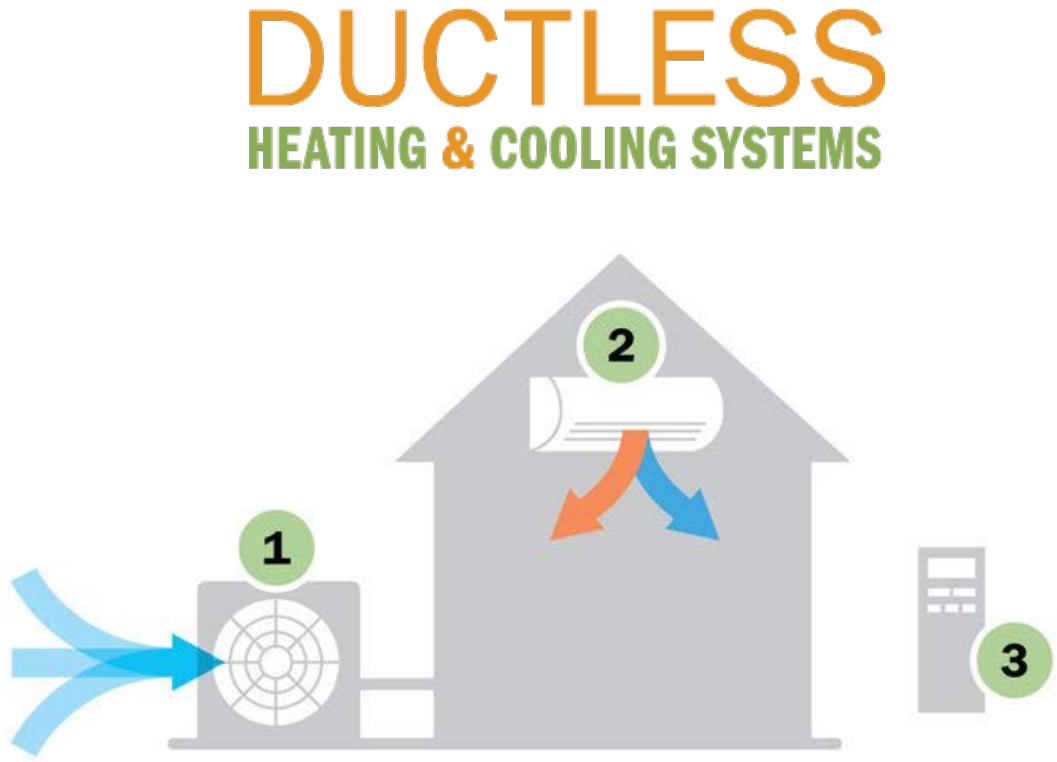
DISTRICT HEATING AND COOLING

DUCTLESS

TRL = 9

Simple, efficient alternative to traditional electric heaters and furnaces

- Key Points
  - ideal primary heating and cooling solution for those with electric baseboards, wall heaters or electric furnaces
  - ultra-quiet
  - electric heating costs reduction by up to 50%
- Application – building type
  - New building (Residential, Commercial)
  - Refurbishment (Residential, Commercial)
- Application – process
  - Disruptive



https://goingductless.com/what-is-a-ductless-heat-pump

CONTROL SYSTEMS

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TEMPIRO

TRL = 7

Lets user control any electrical heating or cooling device remotely

- Key Points
  - Requires a 5 minute DIY installation
  - Smart fuse system that allows to control device through an app
  - Easy to install and saves energy and money
- Application – building type
  - New Building (Residential, Commercial)
  - Refurbishment (Residential, Commercial)
- Application – process
  - Non-Disruptive

Plug the smart fuse into the fuse box

Download the app

Connect to the internet

https://tempiro.com/en/

SCREEDBUTLER

TRL = 8

Monitors the performance of buildings in real-time from the construction phase through to the maintenance phase

- Key Points
  - Easy set-up
  - Low work and machine time
  - Precise forecasts
- Application – building type
  - New building (Residential, Commercial)
- Application – building type
  - Non-Disruptive

BATTERY

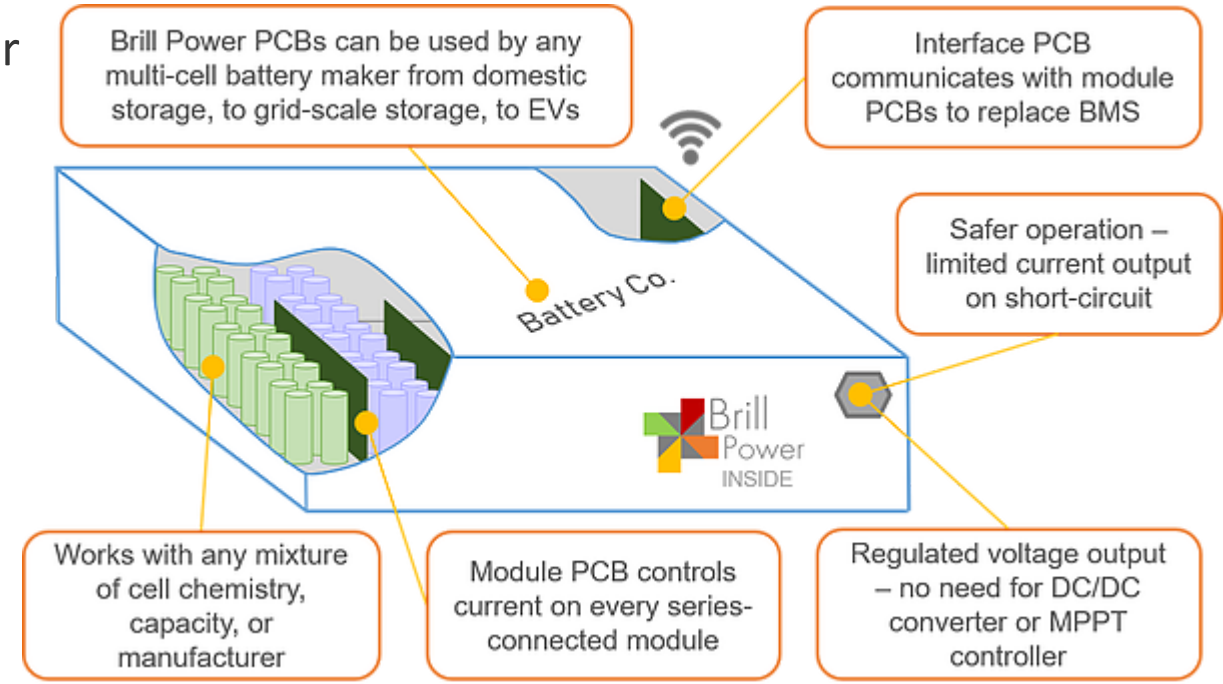
Battery

BRILL POWER

TRL = 5

Improved battery system performance with intelligent control technology

- Key Points
  - Can be used by any multi-cell battery maker
  - No need for DC/DC converter or MPPT controller
  - Extended life time of up to 60%
- Application – building type
  - New building (Residential, Commercial)
  - Refurbishment (Residential, Commercial)



https://www.brillpower.com/

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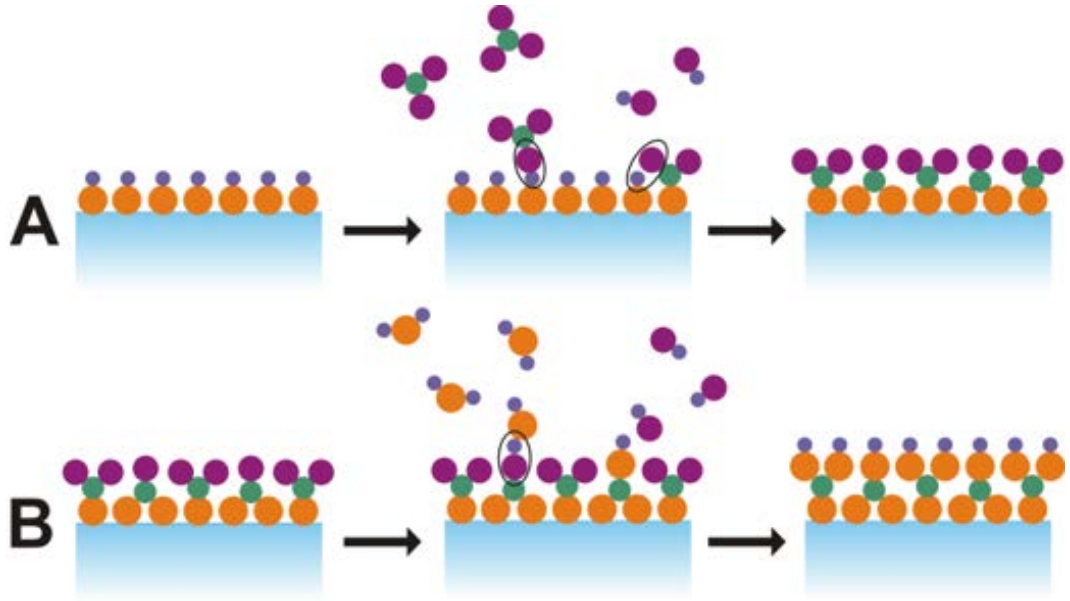
Battery

DELFT-IMP

TRL = 5

Metal-air battery that uses oxidation of lithium at the anode and reduction of oxygen at the cathode.

- Key Points
  - Long life span
  - High energy density (up to 12 kWh/kg)
  - Light weight (compared to standard)
- Application – building type
  - New Building (Residential, Commercial)
  - Refurbishment (Residential, Commercial)



Battery

LARGE AND POWERFUL REDOX FLOW BATTERY

TRL = 6-7

Eight times larger than the previous A4-sized systems but generates nearly ten times more power

- Key Points
  - reaches stack power up to 25 kW, with a cell size of 0.5 square meters
  - balance out fluctuations in the supply of renewable energy
  - cost-effective, robust, durable, and can be individually customized
- Application – building type
  - New Building (Residential, Commercial)
  - Refurbishment (Residential, Commercial)

https://www.fraunhofer.de/en/press/research-news/2013/march/redox-flow-battery.html

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IT AND SMART SOLUTION

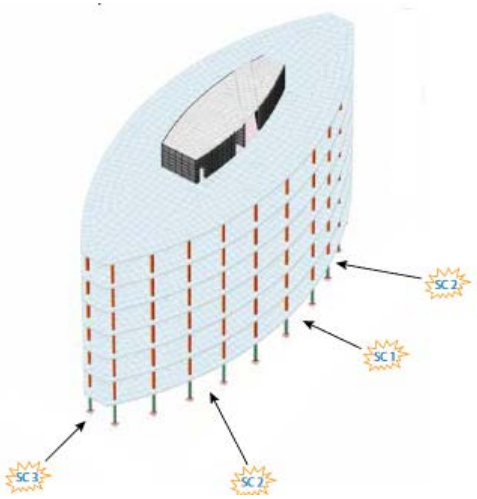
IT and Smart solution

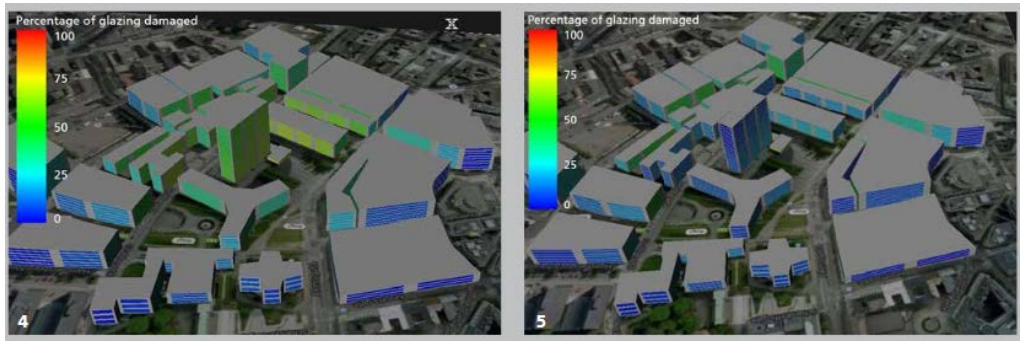
VITRUV

TRL = 8

supports city planners at all stages of their work and helps optimize existing infrastructures

- Key Points
  - rapid assessment of the safety-related topic
  - insights into vulnerability, weaknesses and specific areas of risk
  - concrete solutions to minimize risks
- Application – building type
  - New building (Residential)
  - Refurbishment (Residential)
- Application – building type
  - Non-disruptive





https://www.fraunhofer.de/en/press/research-news/2016/dezember/security-planning-for-urban-areas-simplified.html

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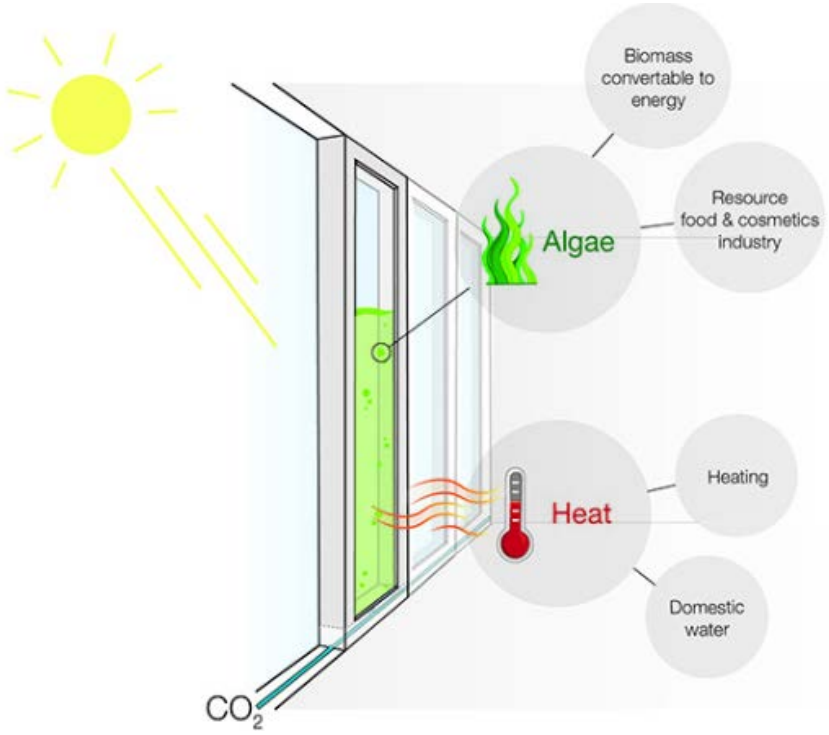
ALTERNATIVE ENERGY GENERATION

FABIG FAÇADE SYSTEM

TRL = 6

A façade with algae photo bioreactors made of glass, a further improvement of SOLARLEAF project

- Key Points
  - bio-algae reactors are optimised both technically and biochemically
  - produces biomass as a raw material and food supplement as well as heat for building operation
- Application – building type
  - New building (Residential, Commercial)
  - Refurbishment (Residential, Commercial)
- Application – building type
  - Disruptive



https://www.arup.com/projects/fabig-facade-system-with-algae-photo-bioreactors

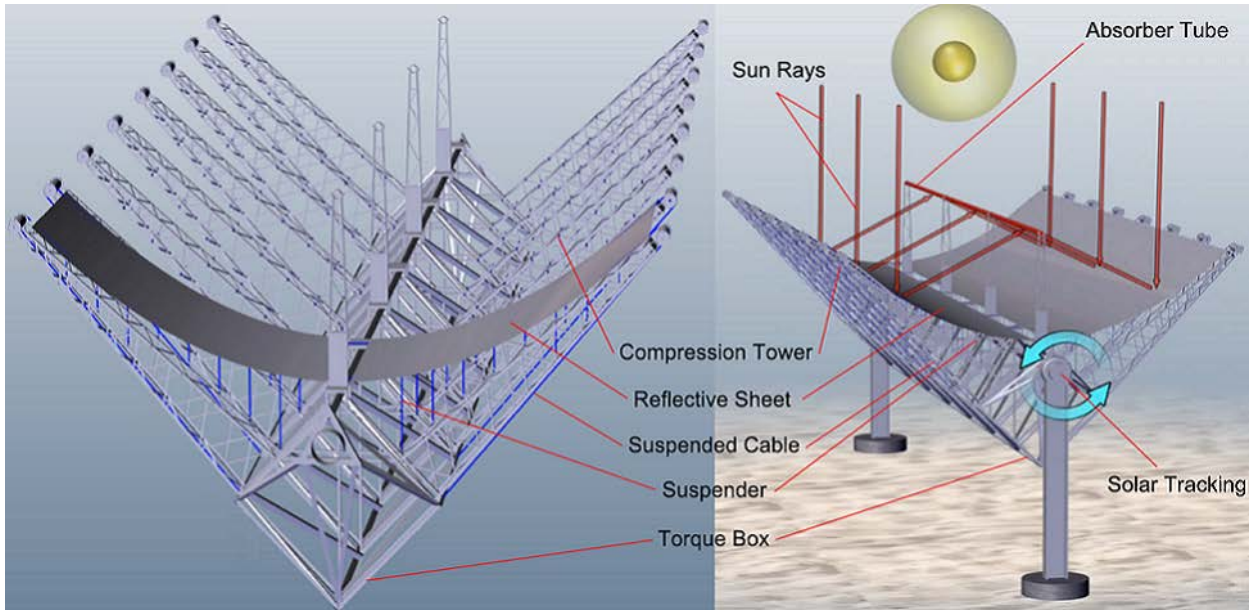
Alternative Energy Generation

SOLABOLIC

TRL = 5-6

Parabolic shaped solar collector that can reduce the cost of solar thermal energy

- Key Points
  - 40% fewer components
  - Flexible mirrors
  - Increased local content
  - Simpler assembly
- Application – building type
  - New building (Residential, Commercial)
  - Refurbishment (Residential, Commercial)
- Application – building type
  - Disruptive



http://www.solabolic.com/technology

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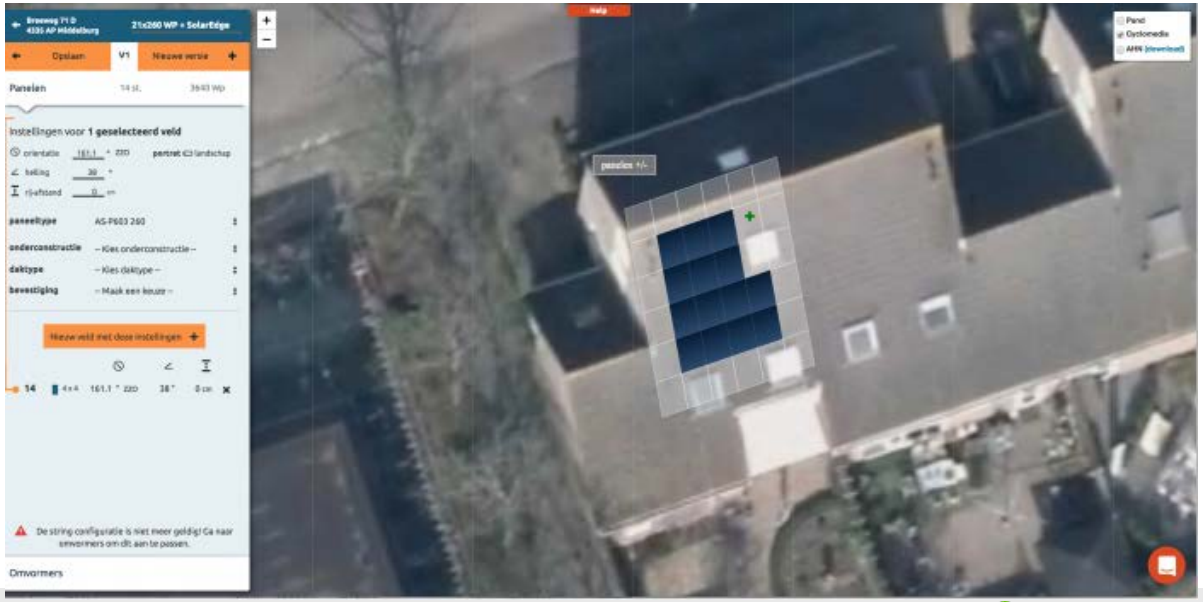
Alternative Energy Generation

SOLAR MONKEY

TRL = 9

Helps installers to distinguish themselves with solar panels software

- Key Points
  - acquisitions costs reduction up to 25%
  - Unique shading analysis based on environmental recognition
  - Fast, simple and reliable
- Application – building type
  - New building (Residential)
  - Refurbishment (Residential)
- Application – process
  - Non-Disruptive



https://solarmonkey.nl/

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PART II – INNOVATIONS DEVELOPED IN OTHER EU-FUNDED PROJECTS

OVERVIEW OF THEMATIC AREAS COVERED BY OTHER EU-FUNDED PROJECTS

- High performance insulation systems
- Materials with reduced embodied energy
- Nanotechnologies for multifunctional lightweight construction materials
- ICT and new business models
- Design, decision and support tools for energy efficient buildings, districts and cities
- Energy performance monitoring and management of energy efficient buildings
- Energy performance monitoring and management at district and city levels
- Low carbon and efficient energy generation systems for buildings and districts
- New high performance energy-efficient buildings
- Deep energy renovation of existing buildings
- Deep energy renovation of districts and smart energy efficient solutions for cities

OVERVIEW OF EU-FUNDED PROJECTS SCANNED

WALL-ACE
Inno-VIP

Amanac
Innova microsolar
Indewag
Scores
VEEP

Re
Impress

Innowee

Briskee
Conseed
Ibroad
RECO2ST
Sim4Block

Entropy
Greensoul
Energaware
Newtrend
Pocketwatt
Opteemal
E2district
Quantum
Stunning
Accept

Holsider
Hit2GAP
Envision
Rezbuild
Zero plus
Heart
Moeebius
Topas

Plug n Harvest
Respond
Moder
Rennovates
Renozeb
Thermoss
Energy Matching

Flexynets
Indigo
Indeal

AZEB
Chess
Setup

4REINU
Hybuild
Bertim
Pro-Get-one

P2endure
Refurb

Enerfund
DR-BOB

TRL

In order to classify the different innovations the Technology Readiness Level (TRL) is mentioned, estimating the maturity of each technology.

Please note that the TRL estimation refers to the time of the writing and might have changed in the meantime.

- TRL 5: Component and/or breadboard validation in laboratory environment
- TRL 6: System model or prototype demonstration in relevant environment
- TRL 7: System prototype demonstration in an operational environment
- TRL 8: Actual System complete and qualified through test and demonstration

http://www.earto.eu/fileadmin/content/03_Publications/The_TRL_Scale_as_a_R_I_Policy_Tool_-_EARTO_Recommendations_-_Final.pdf

HIGH PERFORMANCE INSULATION SYSTEMS

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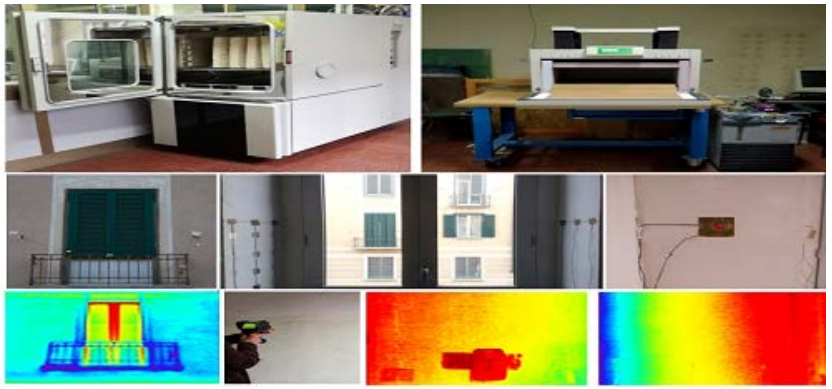
High Performance insulation systems

WALL-ACE

TRL = 6-7

Develops a consistent package of new advanced sustainable insulation products and systems

- Key Points
  - insulating thermal coating-finishing with low emissivity
  - internal high performance insulating plaster
  - insulating interior patching filler
  - external high performance insulating render
  - insulation clay bricks
- Application – building type
  - Refurbishment
  - New Buildings
- Application – process
  - Disruptive and Non-disruptive



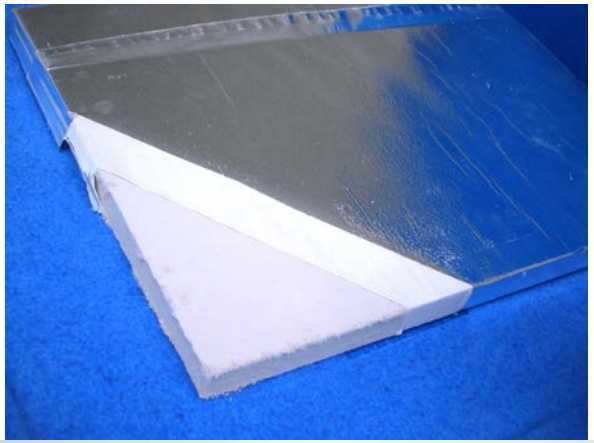
High Performance insulation systems

INNOVIP

TRL = 4-6

Develops innovative multi-functional vacuum-insulation-panels (VIPs) for use in the building sectors

- Key Points
  - extremely effective and space-saving solution
  - VIPs comprise a porous core material encased in an airtight envelope
  - thermal performance improved by at least 25%
- Application – building type
  - Refurbishment
  - New buildings
- Application – process
  - Disruptive



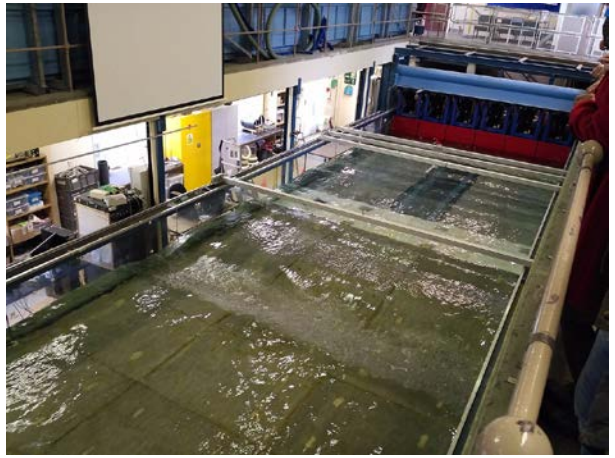
MATERIALS WITH REDUCED EMBODIED ENERGY

RE

TRL = 3-5

To develop a RE^4 prefabricated energy-efficient building concept that can be easily assembled and disassembled for future reuse

- Key Points
  - REuse and REcycling of CDW materials
  - Prefabricated elements made of recycled materials
  - CDW derived materials and structures value will be increased
- Application – building type
  - Refurbishment
  - New Buildings
- Application – process
  - Disruptive



IMPRESS

TRL = 6

will leverage on the potential of prefabrication by developing a new range of easy to install panels

- Key Points
  - An iterative design methodology
  - Integrated with a cloud based BIM database
- Application – building type
  - Refurbishment
- Application – process
  - Disruptive

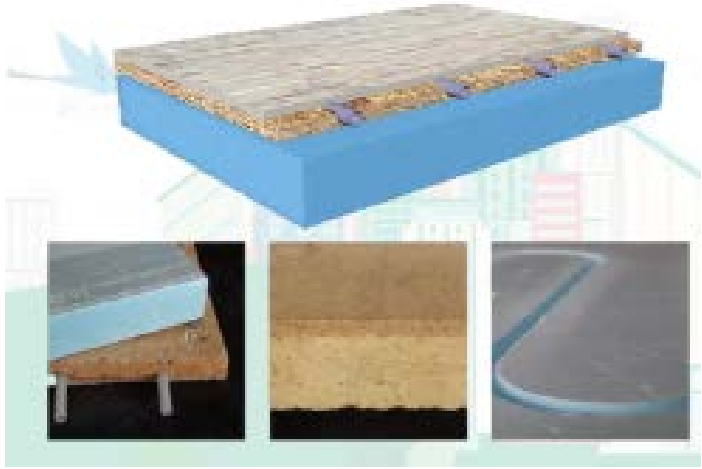
NANOTECHNOLOGIES FOR MULTIFUNCTIONAL LIGHTWEIGHT CONSTRUCTION MATERIALS AND COMPONENTS

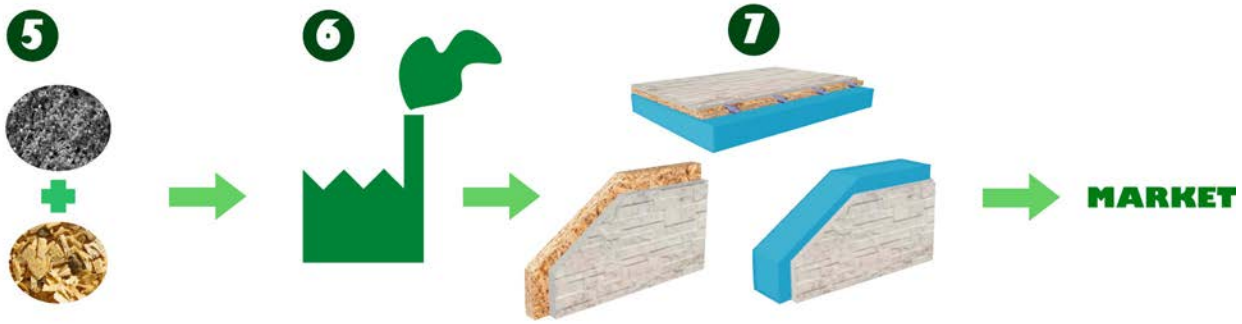
INNOWEE

TRL = 4-5

Focuses on building innovative pre-fabricated components including different waste construction materials

- Key Points
  - Particular construction waste is separated, crushed and sieved
  - Depending on size, materials are used to produce different geopolymer based panels
- Application – building type
  - Refurbishment
  - New buildings
- Application – process
  - Disruptive





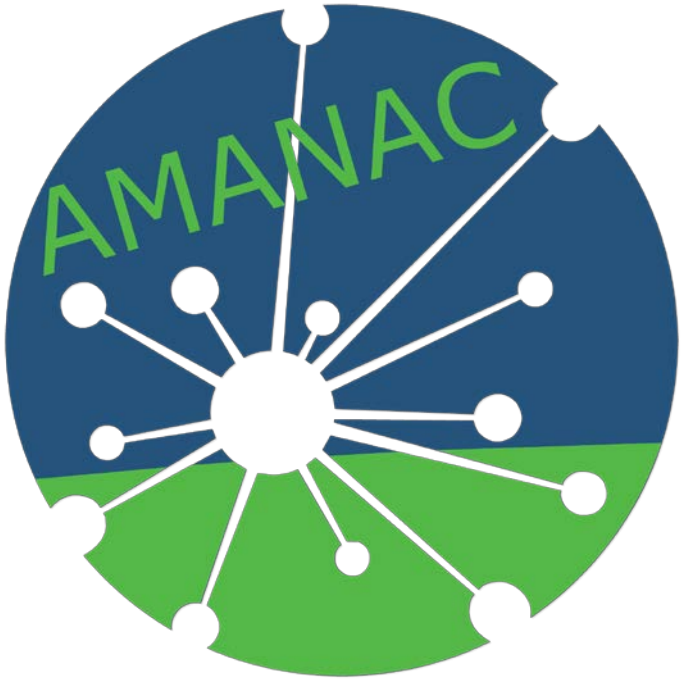
ADVANCE TECHNOLOGIES AND MATERIALS

AMANAC

TRL =

developed an effective collaboration platform between the FP7 & H2020 advanced materials and nanotechnology projects in EeB PPP

- Key Points
  - create an effective and long lasting collaboration and coordination platform within all the Advanced Materials and Nanotechnology projects (AMANAC)
- Application – building type
  - Existing and new buildings
  - Refurbishment

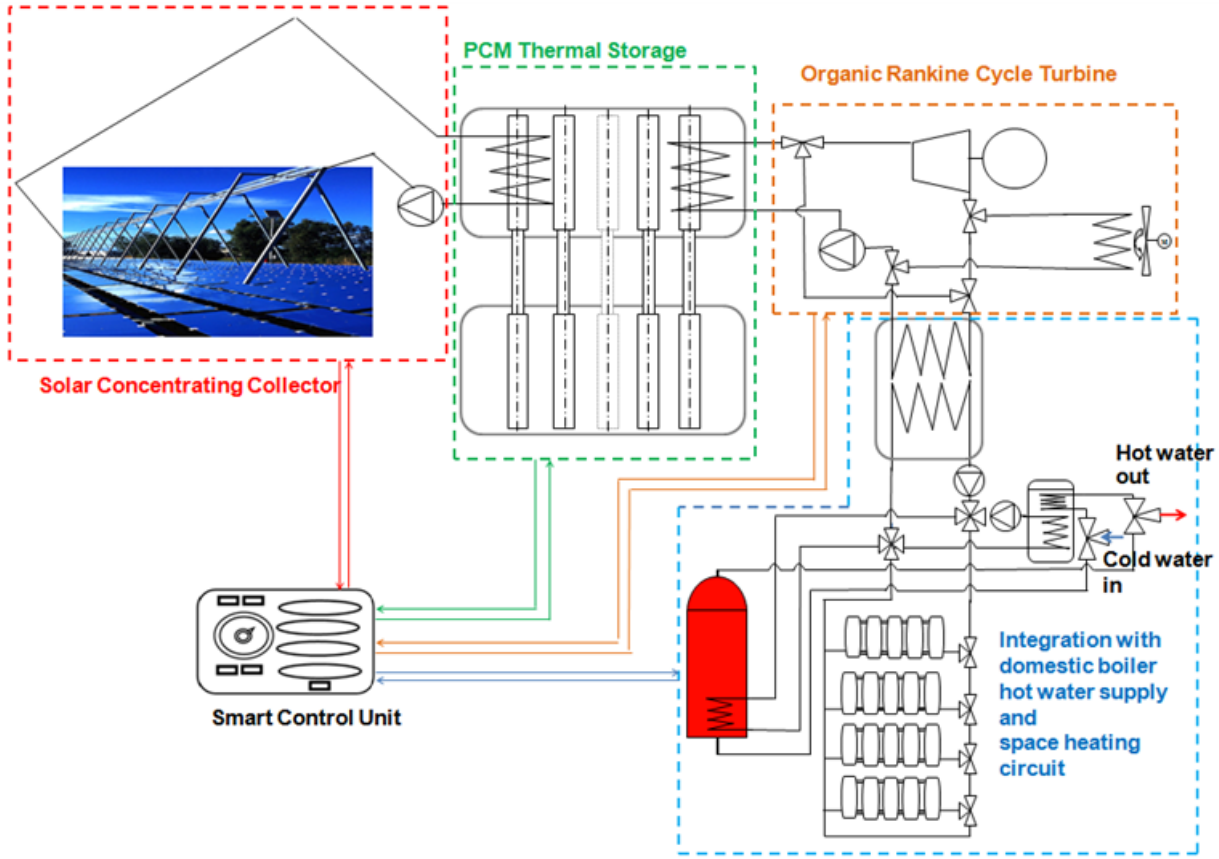


INNOVA MICROSOLAR

TRL =5-6

Aims to develop an innovative high performance solar heat and power system for individual dwellings and small business residential buildings

- Key Points
  - cost-effective 2-kWel/18-kWth solar heat and power system
  - The whole system will be integrated with domestic boiler hot water and space heating system
- Application – building type
  - Existing and new buildings
- Application – process
  - Non-disruptive

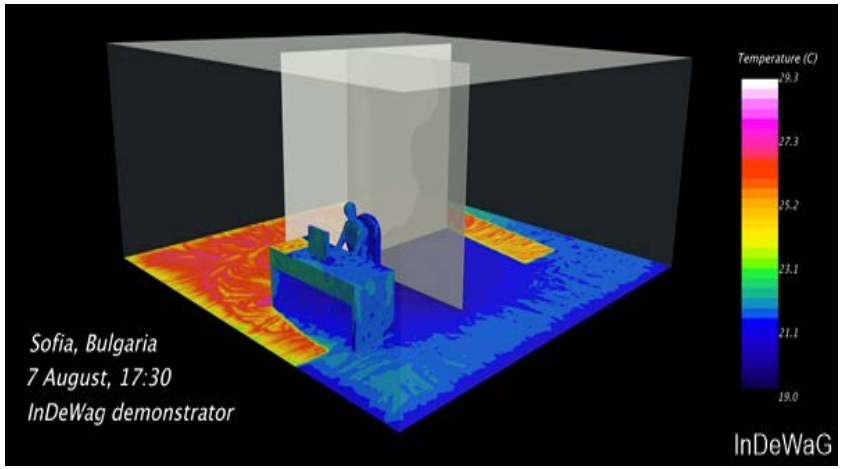


INDEWAG

TRL = 7

Develops glazing units using water flow glazing technology

- Key Points
  - New technologies
  - Captures solar radiation
  - Generated heat can be transferred through a pipe system
  - Façade may act as either a heating or cooling device
- Application – building type
  - New buildings
- Application – process
  - Non-disruptive



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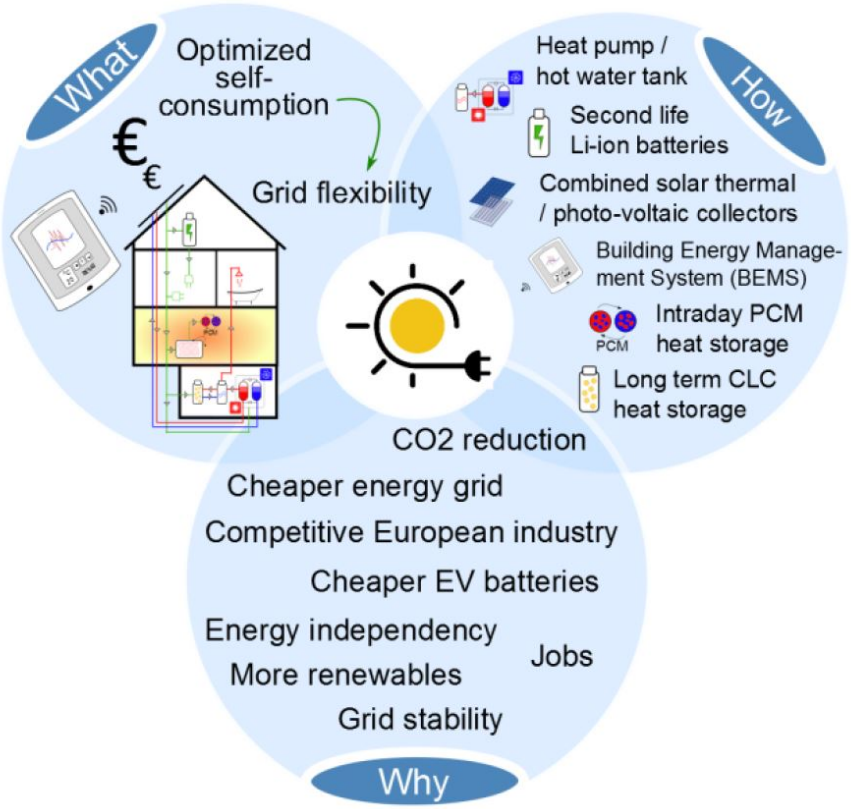
SCORES

TRL = 3-4

Will combine and optimize the multi-energy generation, storage and consumption of local renewable energy and grid supply

- Key Points
  - storing energy at the lowest cost by using hybrid storage
  - optimal integration of the key technologies for storage and conversion
  - New sources of flexibility for the grids
- Application – building type
  - Refurbishment
  - New buildings
- Application – process
  - Disruptive or Non-disruptive

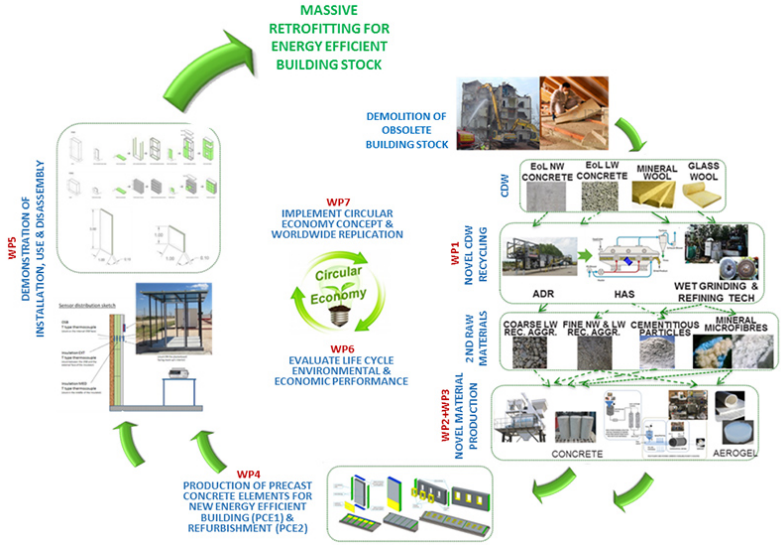


VEEP

TRL = 4-6

Cost-effective recycling of CDW in high added value energy efficient prefabricated concrete components for massive retrofitting of our built environment

- Key Points
  - novel multilayer precast concrete elements
  - new concretes as well as superinsulation material produced by using at least 75% (by weight) of C&DW recycled materials.
  - Advanced Drying Recovery (ADR) redesigned for modular construction
- Application – building type
  - Refurbishment
  - New Buildings
- Application – process
  - Disruptive



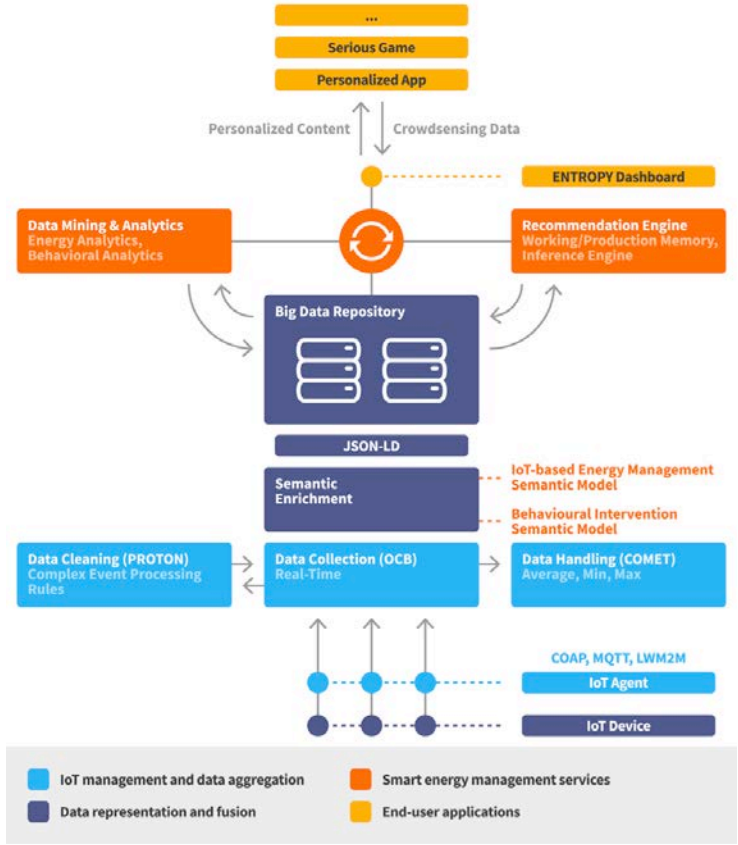
ICT AND NEW BUSINESS MODELS

ENTROPY

TRL = 8

aims to design and deploy an innovative IT ecosystem targeting at improving energy efficiency through consumers understanding, engagement and behavioural changes

- Key Points
  - exploits the advantages provided by a set of novel ICT technologies for enabling the design, development and provision of personalized energy management and awareness services in smart buildings
- Application – building type
  - New and Existing buildings
- Application – process
  - Non disruptive

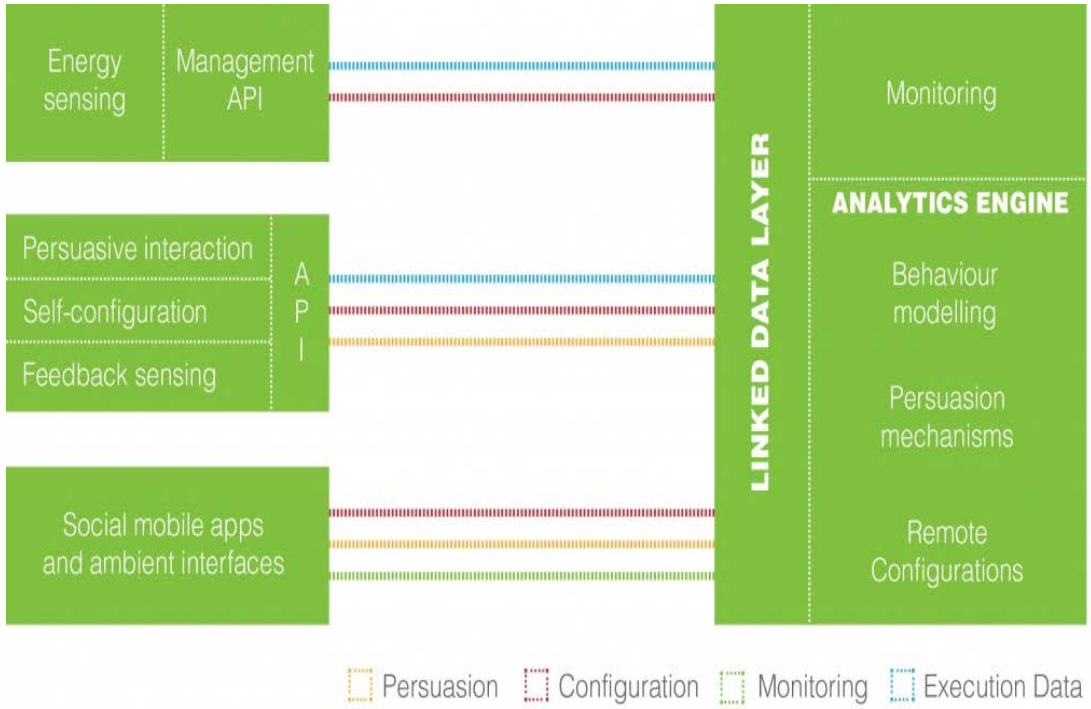


GREENSOUL

TRL = 6-7

Eco-aware Persuasive Networked Data Devices for User Engagement in Energy Efficiency

- Key Points
  - Smart Analyzers that not only monitor and react, but also incentivise and persuade users to save energy
  - Green-Souled Things with a Smart Adaptor that turn everyday appliances into user-friendly internet connected energy-aware things
- Application – building type
  - New and Existing buildings
- Application – process
  - Non disruptive



ENERGAWARE

TRL = 8

Energy Game for Awareness of energy efficiency in social housing communities

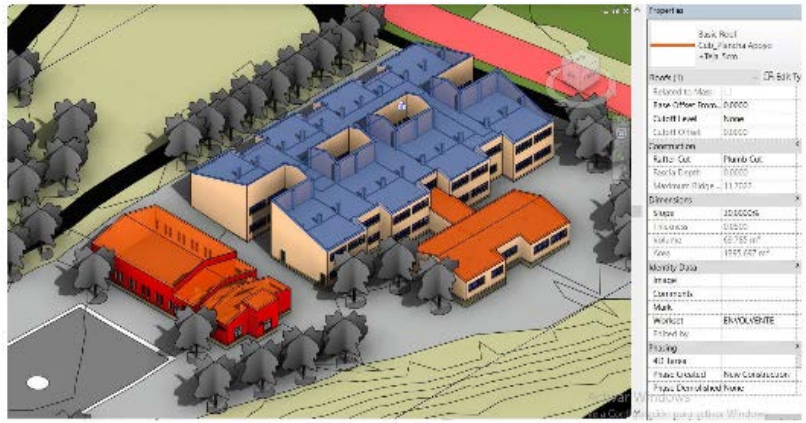
- Key Points
  - users can play to learn about the potential energy savings from installing energy-efficiency measures
  - The social media features will provide users a platform to share data of their achievements, compete with each other, give energy advice, as well as, join together to form virtual energy communities
- Application – building type
  - New and Existing buildings
- Application – process
  - Non disruptive

NEWTREND

TRL = 6-7

Seeks to improve the energy efficiency and current renovation rate of the existing European building stock

- Key Points
  - Integrated Design Methodology including a guided process through all steps of refurbishment
  - Collaborative Design Platform
  - District Information Model
  - Simulation and Design Hub
- Application – building type
  - Refurbishment
- Application – process
  - Non disruptive

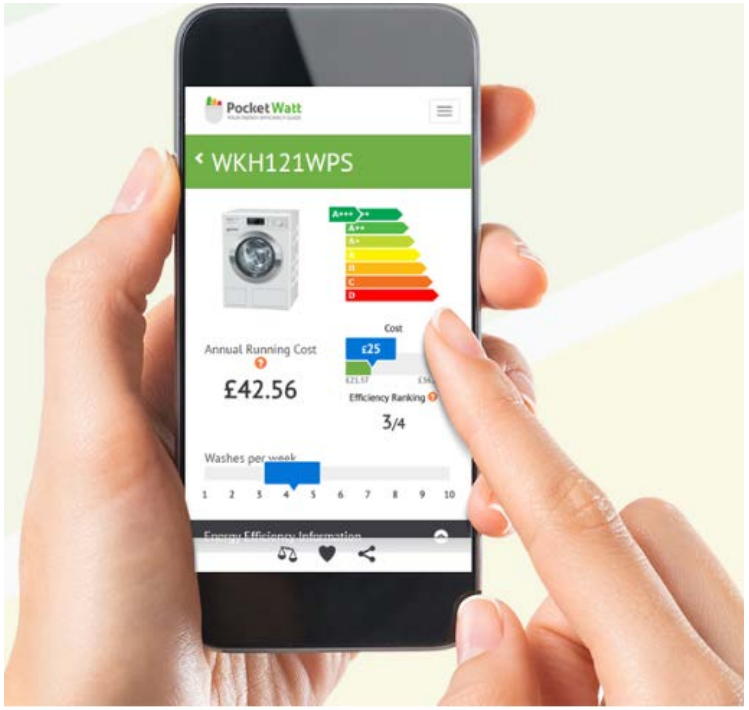


POCKETWATT

TRL = 7

New Smartphone or PC based web tool that makes learning about and comparing energy efficiency, performance and consumer benefits of a product simple

- Key Points
  - Latest information on how energy efficient a product is in store
  - Compares efficiency of different products
  - Shows how much money an appliance costs to run
- Application – process
  - Non disruptive



https://pocketwatt.eu/PocketWatt.aspx

OPTEEMAL

TRL = 7

Developing an optimized energy efficient design platform for refurbishment at district level

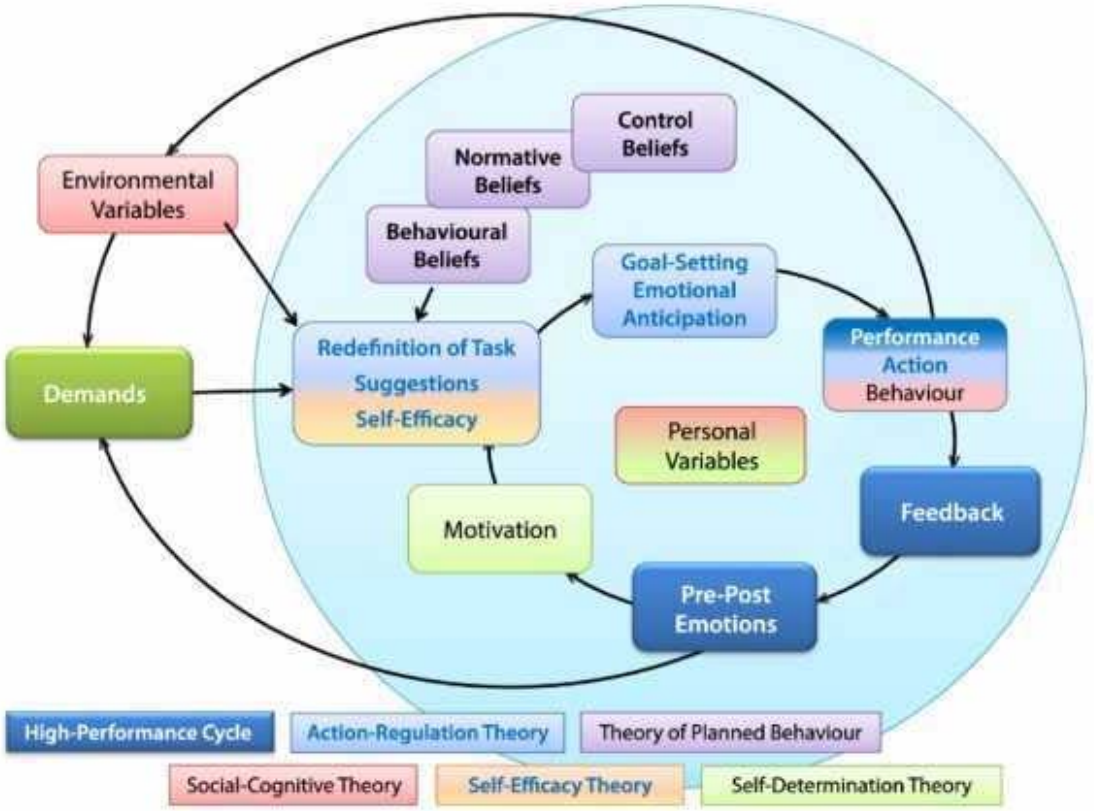
- Key Points
  - reduced time delivery and uncertainties
  - improved solutions when compared to business-as-usual practices
  - an integrated ontology-based District Data Model
- Application – building type
  - Refurbishment
- Application – process
  - Non disruptive

E2DISTRICT

TRL = 7

Aims to develop, deploy, validate, and demonstrate a novel cloud enabled District Management and Decision Support framework for DHC systems

- Key Points
  - Innovative district simulation capabilities
  - Advanced supervisory control
  - Novel business models for exploiting the dynamic nature of the domain
- Application – building type
  - New and Existing buildings
- Application – process
  - Non disruptive



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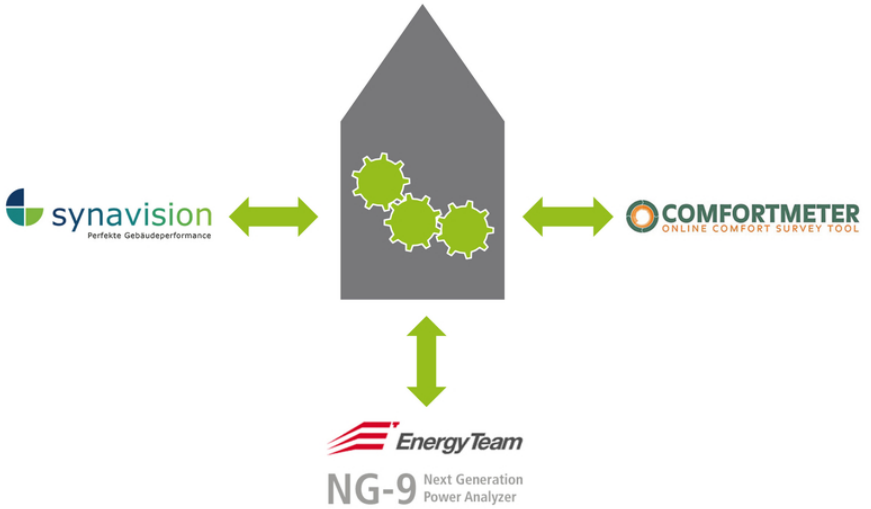
QUANTUM

TRL = 3-5

Quality management for building performance - improving energy performance by life cycle quality management

- Key Points
  - focuses on ICT tools to allow for fast and robust scalability of quality management services
  - Tool for functional specifications of Building Services
  - Web based survey tool
  - Tool for low cost sub-metering and real-time local analysis
- Application – building type
  - Refurbishment
  - New Buildings
- Application – process
  - Non disruptive

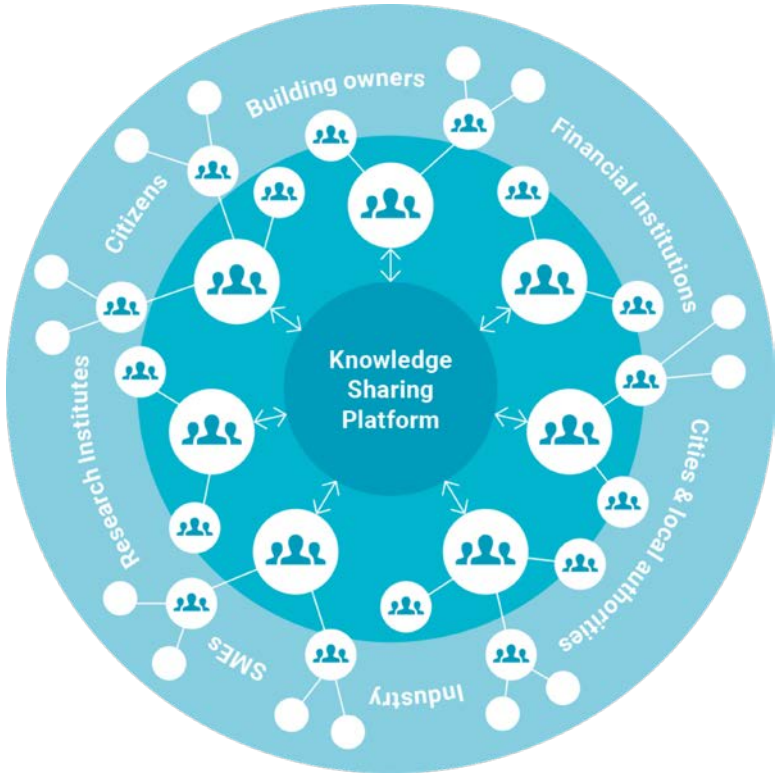


STUNNING

TRL = 5-7

To identify and promote innovative packages for renovation to accelerate their acceptance by the market players and consumers

- Key Points
  - Support the growth of a diverse stakeholder community around a web-based knowledge sharing platform
  - Identify and cluster innovative refurbishment packages
  - Identify the barriers which prevent innovative refurbishment packages from being replicated by the involved players of the value chain
- Application – building type
  - Refurbishment
- Application – process
  - Non-disruptive



ACCEPT

TRL = 7-9

consists of 3 software apps to support the construction industry in knowledge transfer and quality assurance to improve energy efficiency of buildings.

- Key Points
  - CoOpApp runs on smart glass, using AR to access knowledge transfer
  - SiMaApp helps site managers to increase efficiency of construction process
  - Web based app DashBoard ensures quality assurance
- Application – building type
  - New buildings
- Application – process
  - Disruptive

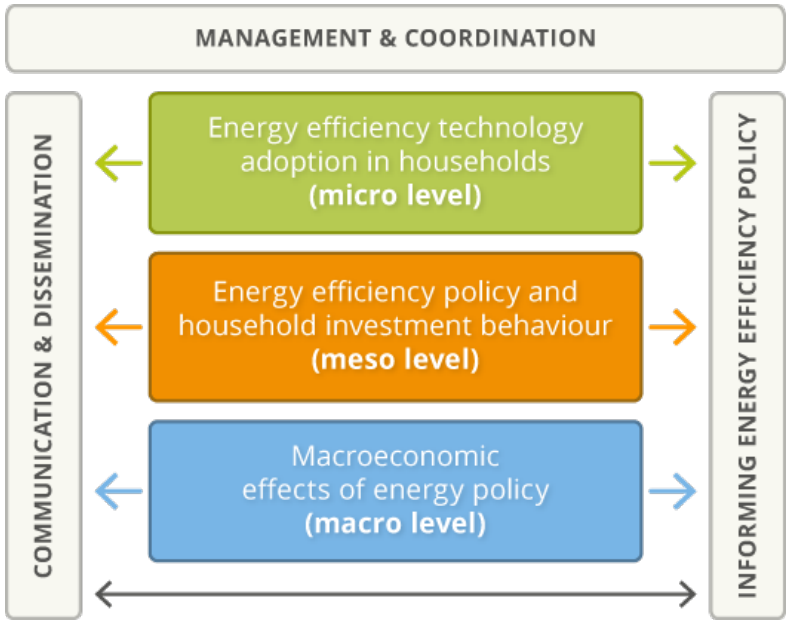
DESIGN, DECISION AND SUPPORT TOOLS FOR ENERGY EFFICIENT BUILDINGS, DISTRICTS AND CITIES

BRISKEE

TRL = 8

Provides evidence-based input to energy efficiency policy design and evaluation

- Key Points
  - addresses the interrelations between microeconomic factors, sectoral energy demand and macroeconomic effects
  - consistent methodological framework implemented in 5 work packages
  - Provide empirical evidence for the magnitudes of discount rates accounting for differences across households, technologies and countries
- Application – building type
  - Refurbishment
  - New buildings
- Application – process
  - Non disruptive



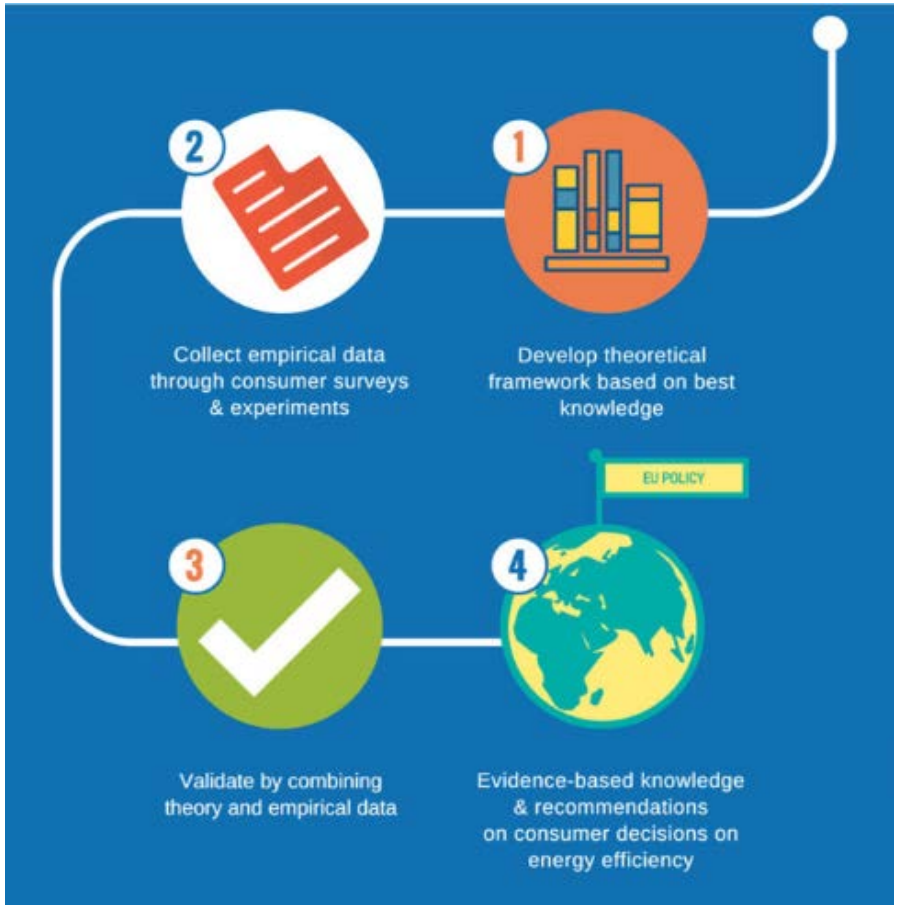
Design, decision and support tools for energy efficient buildings, districts and cities

CONSEED

TRL = 6

Studies how consumers make decisions which involve an energy component, and to make (energy) operating costs more salient to consumers

- Key Points
  - Develops a theoretical framework
  - Collects empirical data on consumer behaviour through a range of different methods
  - validates the theoretical models using our empirical data
- Application – process
  - Non disruptive



IBROAD

TRL = 3-5

Aims to design, develop and demonstrate individual building renovation roadmaps and building logbooks

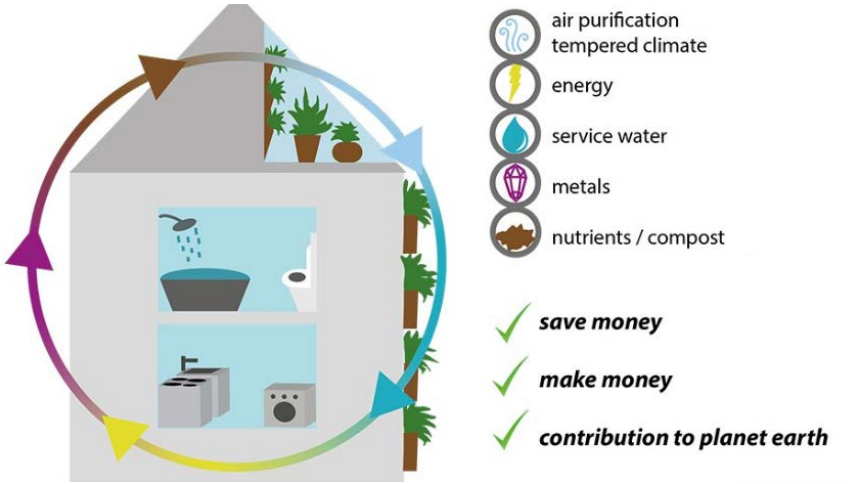
- Key Points
  - Simplified standardised calculation procedures for techno-economic assessment
  - Flexible database structure and generic database on techno-economic data, building specific data, etc
  - User interface and graphical presentation of results
- Application – building type
  - Refurbishment
- Application – process
  - Non disruptive

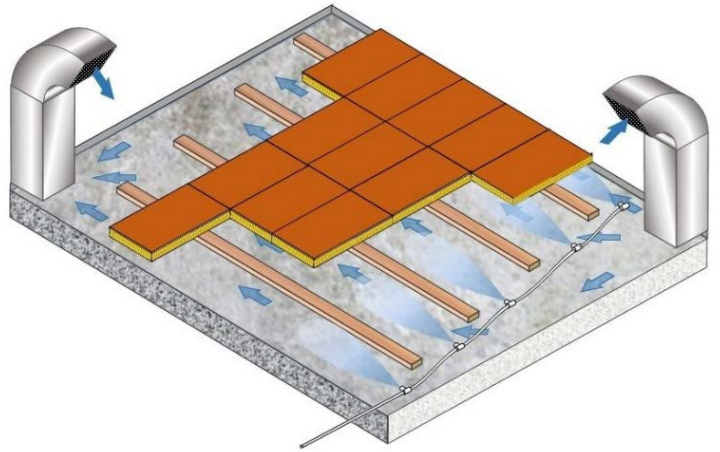
RECO2ST

TRL = 4-5

Residential Retrofit assessment platform and demonstrations for near zero energy and CO2 emissions

- Key Points
  - easy 3-step approach to building renovations
  - user-driven refurbishment tool
  - optimized installation tool
  - customizable Retrofit-Kit
- Application – building type
  - Refurbishment
- Application – process
  - Disruptive





SIM4BLOCKS

TRL = 5

Aims to maximize the use of renewable energy at the block of buildings scale through demand response

- Key Points
  - innovative demand response (DR) services for smaller residential customer
  - optimal use of the DR capability in the context of mark tariffs and RES supply fluctuations
- Application – process
  - Disruptive

ENERGY PERFORMANCE MONITORING AND MANAGEMENT OF ENERGY EFFICIENT BUILDINGS

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HOLISDER

TRL = 4-5

Introduces a Holistic Demand Response optimization Framework that enables significant energy costs reduction.

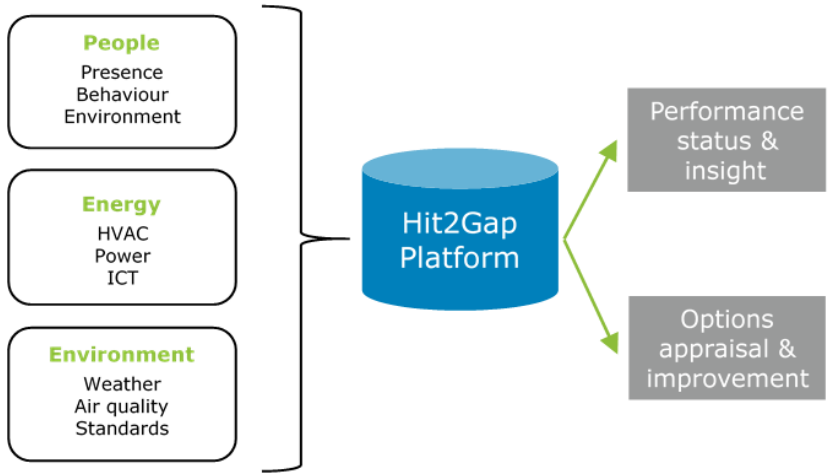
- Key Points
  - Integrating Real-Intelligence in Energy Management Systems
  - Proper tackling of consumers' reluctance to participate in Demand Response
  - High replicability across different building types and systems
- Application – building type
  - Existing buildings
- Application – process
  - Disruptive & non disruptive

HIT2GAP

TRL = 6-7

Highly Innovative building control Tools Tackling the energy performance GAP

- Key Points
  - reduce the gap between the theoretical energy performance of buildings and the actual consumption in use
  - Can identify construction defect
  - To propose a new paradigm for the development of energy management platforms in buildings
- Application – building type
  - New buildings
- Application – process
  - non-disruptive

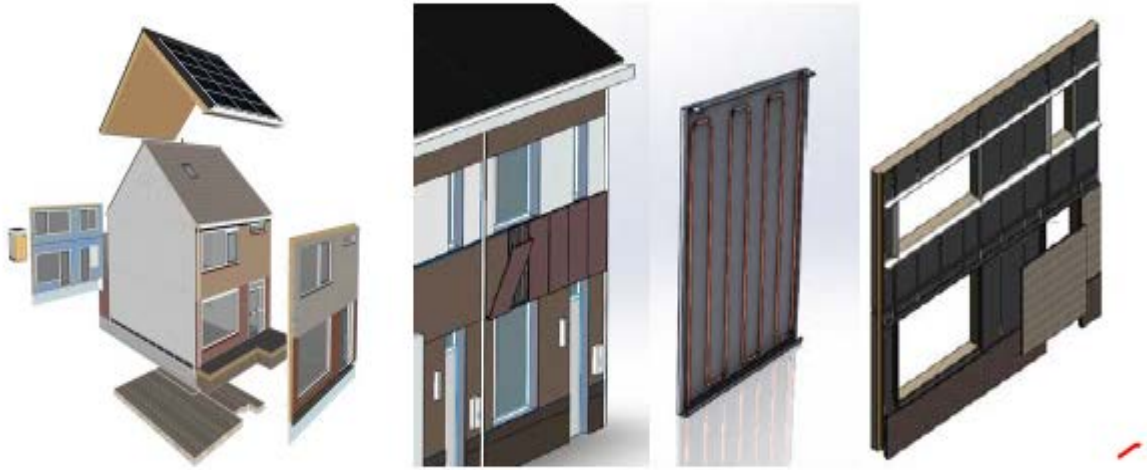


ENVISION

TRL = 5

Aims at developing an integrated renovation concept using solar radiation absorbing façade element on all the available building surfaces

- Key Points
  - Solar heat collectors based on the usage of NIR absorbing coloured coatings
  - Covered solar heat collectors using colored NIR transparent glasses
  - Smart ventilated heat harvesting window
  - PV harvesting glasses
- Application – building type
  - Refurbishment
- Application – process
  - Disruptive



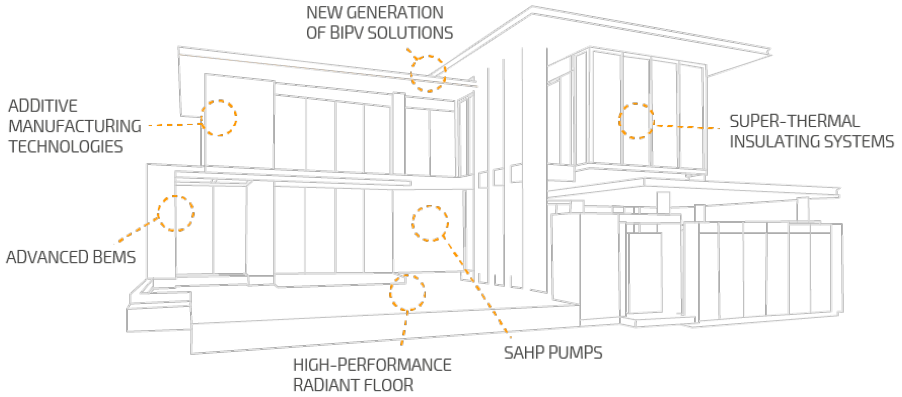
Energy performance monitoring and management

REZBUILD

TRL = 3-5

Aimed at defining a collaborative refurbishment ecosystem focused on the existing residential building stock.

- Key Points
  - annual renovation rate of 2,5% instead of the current rates lower than 1%.
  - common decision making platform
  - tailored retrofitting plan
- Application – building type
  - Refurbishment
- Application – process
  - Non-disruptive

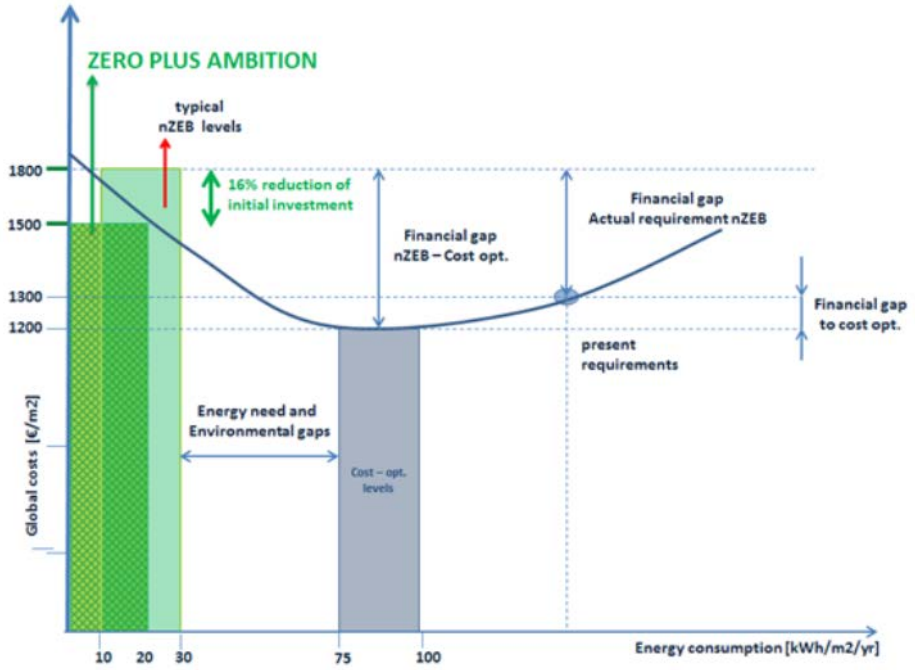


ZERO-PLUS

TRL = 6-7

Aims to search for efficient buildings design for new highly energy performing buildings

- Key Points
  - comprehensive, cost-effective system for Net Zero Energy (NZE) settlements
  - to develop a system whose investment costs will be at least 16% lower than current costs
  - reduction of the operational energy usage in residential buildings to an average of 0-20 kWh/m² per year
- Application – building type
  - New Buildings
- Application – process
  - Non-disruptive



http://www.zeroplus.org/

HEART

TRL = 5

Aims at developing a multifunctional retrofit toolkit

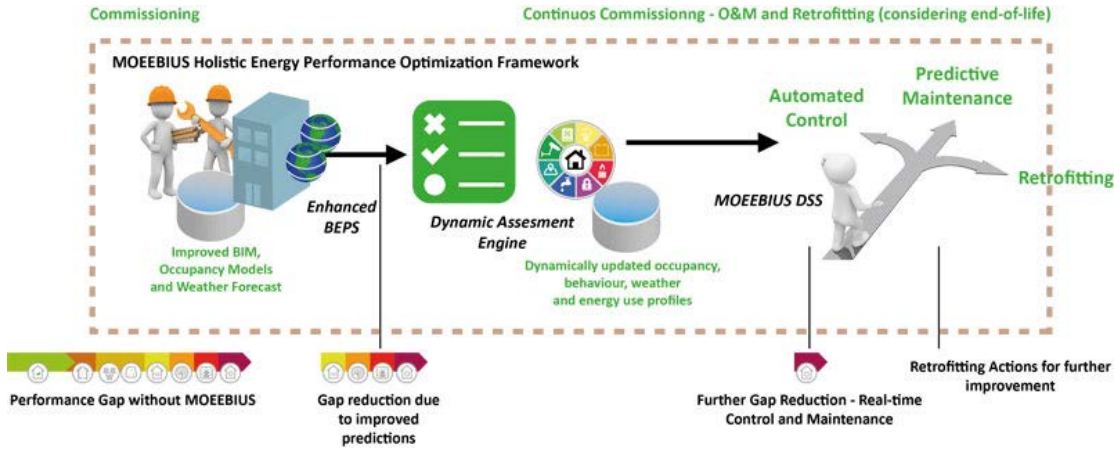
- Key Points
  - Will provide high level of energy efficiency through renovation
  - Concept can be extended to new residential and commercial buildings
  - Simplifies and optimizes all relevant process
- Application – building type
  - Existing buildings
- Application – process
  - Disruptive

MOEEBIUS

TRL = 5-6

Modeling Optimization of Energy Efficiency in Buildings for Urban Sustainability

- Key Points
  - Advanced capabilities of current Building and District Energy Performance Simulation Tools
  - Enabling the efficient Integration of distributed and intermittent energy resources
  - Facilitating Energy Performance Contracting penetration in EU Energy Services Markets
- Application – building type
  - New Buildings
- Application – process
  - Non-disruptive



Energy performance monitoring and management

TOPAS

TRL =6-8

Developing an open, cloud based platform of analytic tools to minimise the gap between the predicted and the actual energy usage building block

- Key Points
  - to reduce the existing gap to 10% and approach additional energy savings in the pilot regions of up to 20%
  - continuous performance auditing
- Application – building type
  - Existing and new buildings
- Application – process
  - Non-disruptive

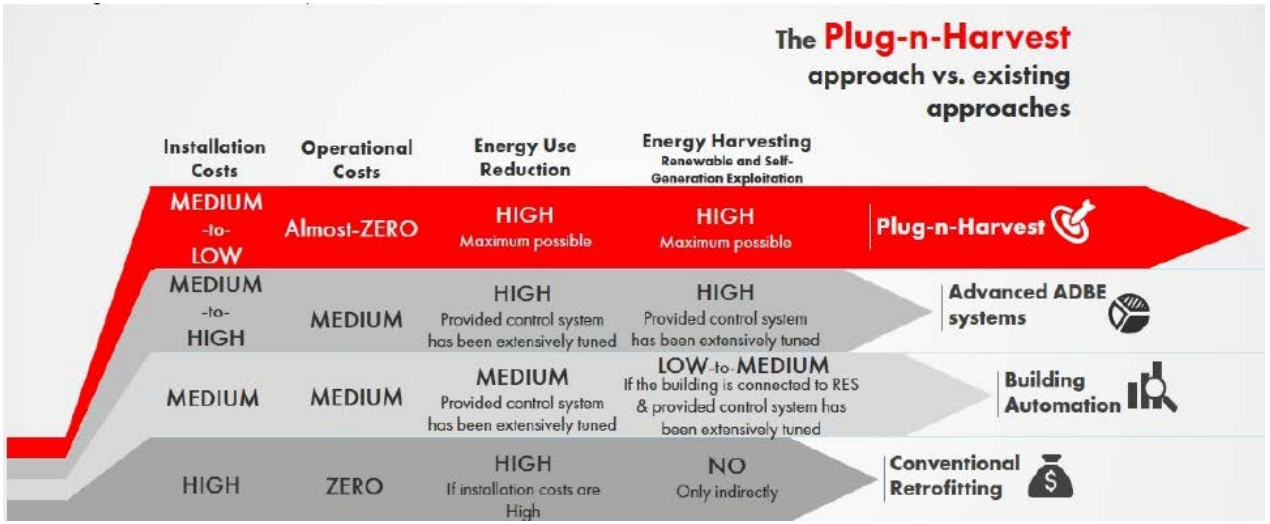
ENERGY PERFORMANCE MONITORING AND MANAGEMENT AT DISTRICT AND CITY LEVELS

PLUG-N-HARVEST

TRL = 3-5

Plans to design, develop, demonstrate & exploit a new modular, PnP concept/product for adaptable/dynamic building envelopes

- Key Points
  - deployable to both residential and non-residential buildings
  - able to provide high energy use reductions and high energy harvesting from RES
  - almost-zero operational costs
- Application – building type
  - Existing buildings
- Application – process
  - Disruptive



Energy performance monitoring and management at district and city levels

RESPOND

TRL = 3-4

Plans to implement a cooperative energy demand management solution so that residential users can better match energy supply with demand

- Key Points
  - interoperable energy automation, monitoring and control solution
  - integrated approach to optimise energy dispatching in real time
- Application – building type
  - Refurbishment
- Application – process
  - Non-disruptive

Energy performance monitoring and management at district and city levels

MODER

TRL = 6

Develops processes and practices that enable building owners to activate refurbishment at district level

- Key Points
  - Visualization tool for large scale project
  - Tools to compare different alternatives of RES system
  - Holistic energy system design at district level
- Application – building type
  - Refurbishment
- Application – process
  - Non disruptive

https://www.vtt.fi/sites/moder/project

RENNOVATES

TRL = 6-8

A holistic systemic deep renovation concept using smart services and developing smart energy-based communities

- Key Points
  - equips residential buildings with a made-to-measure prefabricated new envelope based on state-of-the-art insulation materials
  - Buildings will be made ready for 50 more years to act sustainable
- Application – building type
  - Existing Buildings
- Application – process
  - Disruptive

RENOZEB

TRL = 3-5

Aims to accelerate Energy renovation solutions for Zero Energy buildings and neighborhoods

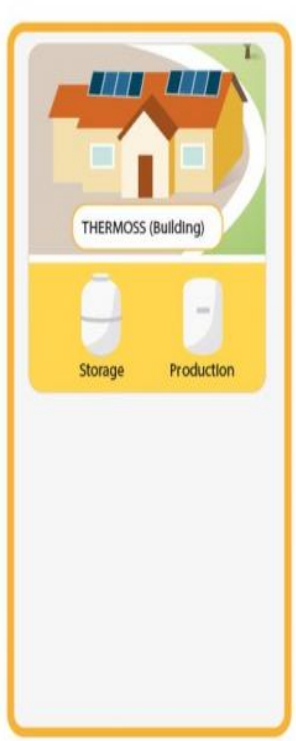
- Key Points
  - nearly Zero Energy Building (nZEB) renovation market
  - transformation of buildings into Active Energy
  - ICT tools to support the methodology
- Application – building type
  - Refurbishment
- Application – process
  - Non-disruptive

THERMOSS

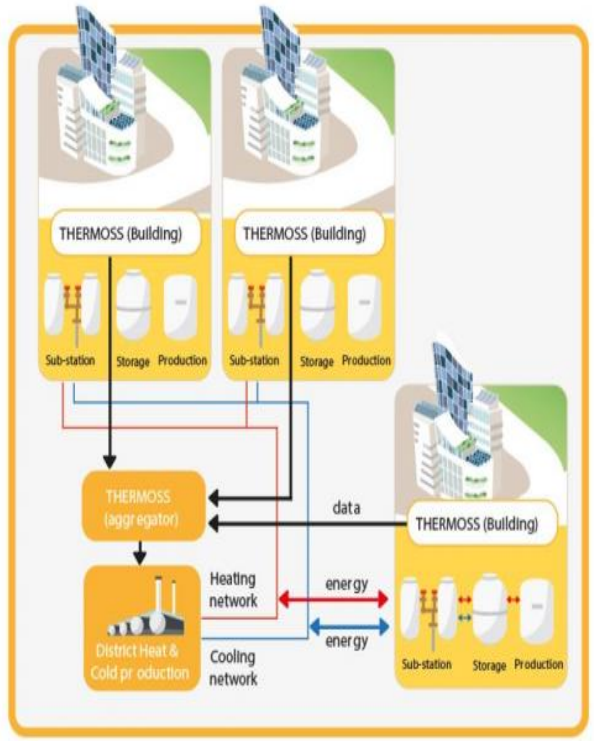
TRL = 5-6

To study, develop and demonstrate innovative technologies and tools to optimise the economic and energetic performance

- Key Points
  - Will address the challenge of 30% energy consumption reduction in buildings and 20% in districts
  - 4 sets of technology package retrofit solutions
  - increased efficiency of non-connected residential building
- Application – building type
  - Refurbishment
- Application – process
  - Disruptive



THERMOSS and independent building



THERMOSS and District Heating Cooling connected buildings

ENERGY MATCHING

TRL = 5-6

Aims at developing adaptive and adaptable envelope and building solutions for maximizing RES (Renewable Energy Sources)

- Key Points
  - versatile click&go substructure
  - solutions are integrated into energy efficient building concepts for self-consumers connected in local energy network
- Application – building type
  - New building
  - Refurbishment
- Application – process
  - Non disruptive

INNOVATIVE TECHNOLOGY FOR DISTRICT LEVEL HEATING AND COOLING

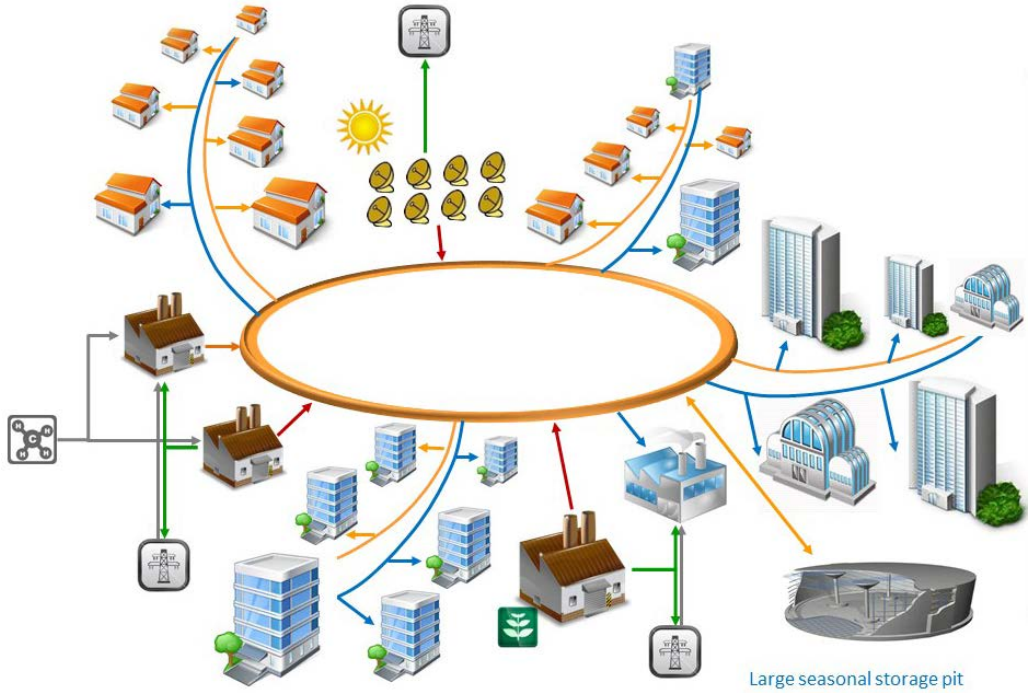
Innovative technology for District level heating and Cooling

FLEXYNETS

TRL = 7

Fifth generation, Low temperature, high energy district heating and cooling networks

- Key Points
  - intelligent district heating and cooling networks that reduce energy transportation losses
  - integrates effectively multiple generation sources
- Application – building type
  - New building
  - Refurbishment
- Application – process
  - Disruptive



Innovative technology for District level heating and Cooling

INDIGO

TRL = 5-7

New generation of Intelligent Efficient District Cooling systems

- Key Points
  - development of a more efficient, intelligent, and cheaper generation of District Cooling
  - an innovative and optimized management strategy (algorithms) focused mainly on energy efficiency maximization
- Application – building type
  - New building
  - Refurbishment
- Application – process
  - Disruptive

Innovative technology for District level heating and Cooling

INDEAL

TRL = 6

Targets to turn the current DHCS into a new next-level automated DHCS that will guarantee the increase of the overall energy efficiency

- Key Points
  - Efficiency of DHCS by up to 60%
  - Access to heating for low income
  - Heat and power losses by 20%
  - Reduction in consumption of households by 50%
- Application – building type
  - New building
  - Refurbishment
- Application – process
  - Disruptive

NEW HIGH PERFORMANCE ENERGY-EFFICIENT BUILDINGS

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AZEB

TRL = 5

Aims to achieve significant construction and lifecycle cost reductions of new NZEB's through integral process optimization in all construction phases

- Key Points
  - quantifiable indicators for the buildings performance
  - common methodology for cost effective NZEB
- Application – building type
  - New and Existing Buildings
- Application – process
  - Disruptive

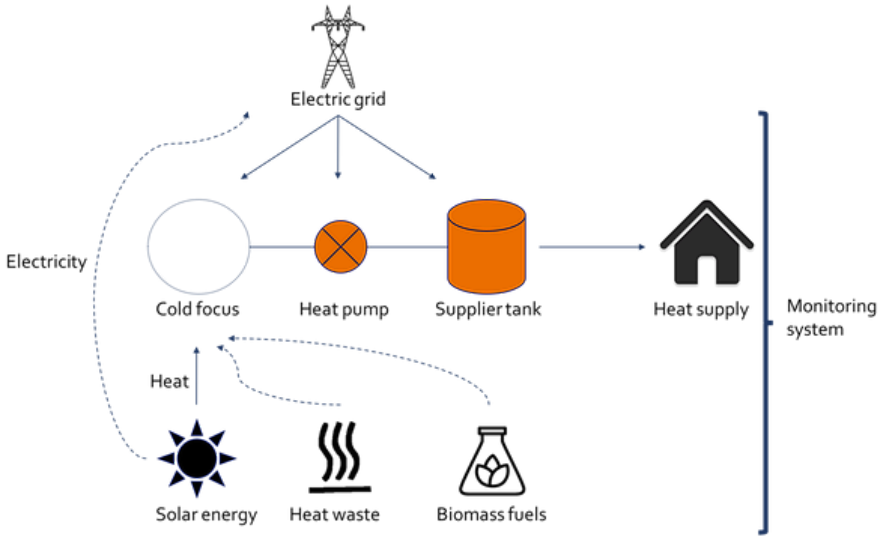
Affordable Zero Energy Buildings

CHESS-SETUP

TRL = 6

Design, implement and promote a reliable, efficient and profitable system able to supply heating and hot water in buildings mainly from renewable sources

- Key Points
  - used solar panels will be hybrid photovoltaic and solar thermal (PV-ST) panels
  - the integration of other energy sources as biomass or heat waste
  - system operation will be optimized according to some external factors
- Application – building type
  - New and Existing Buildings
- Application – process
  - Disruptive



DEEP ENERGY RENOVATION OF EXISTING BUILDINGS

Deep energy renovation of existing buildings

4RINEU

TRL = 3-5

Will help to choose the right decision in deep renovation of residential buildings in EU using robust and reliable technology concepts and business models

- Key Points
  - Will minimize failures in design and implementation
  - manage different stages of the deep renovation process
  - provide information on energy, comfort, users' impact, and investment performance.
- Application – building type
  - Existing buildings
- Application – process
  - Disruptive

HYBUILD

TRL = 5

Develops two innovative compact hybrid storage systems for buildings in two different climate system

- Key Points
  - To develop cost effective, environment friendly solution
  - To efficiently contribute to the decarbonisation of buildings
  - To enhance energy savings, leading to reduced greenhouse gas emissions and fossil fuel utilization
- Application – building type
  - Refurbishment
- Application – process
  - Disruptive

BERTIM

TRL = 5

Building energy renovation through timber prefabricated modules

- Key Points
  - High energy performance prefabricated modules
  - Innovative holistic renovation process methodology
  - Affordable business opportunity
- Application – building type
  - Existing Buildings
- Application – process
  - Disruptive

Deep energy renovation of existing buildings

PRO-GET-ONE

TRL = 4-5

Proactive synergy of integrated efficient technologies on buildings' envelopes

- Key Points
  - will add (or substituting the existing with) new prefab and plug and play high energy performing envelopes.
  - Will use appropriate steel structures to reduce horizontal loads and implementing the structural safety while supporting the new envelopes
  - Will ensure tailored and customized solutions for users an increase the desirability of retrofit options.
- Application – building type
  - Refurbishment
- Application – process
  - Disruptive

Figure 17. Façade, plan and detailed section of a typical application of the GET system on the Peristeri building.

https://www.progetone.eu/

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P2ENDURE

TRL = 5-7

Aims to provide scalable, adaptable and ready-to-implement innovative PnP prefab solutions for deep renovation of building envelopes and technical systems.

- Key Points
  - key innovation comprises the upscaling and EU-wide implementation of prefab Plug-and-Play (PnP) systems combined with 3D-printed components, 3D laser and thermal scanning integrated with BIM for deep renovation implemented through “4M modular processes” for rapid and low-disturbance on-site assembly
- Application – building type
  - Refurbishment
- Application – process
  - Disruptive and Non disruptive

REFURB

TRL = 8

Seeks to approach energy renovations from the buyer's point of view and provide all kind of house owners with a compelling offer

- Key Points
  - a holistic approach to the renovation process in which technology combinations trigger step-by-step deep energy renovation of existing, private residential buildings
  - Reduced gap between the supply side and demand side
- Application – building type
  - Refurbishment
- Application – process
  - Non disruptive

DEEP ENERGY RENOVATION OF DISTRICTS AND SMART ENERGY EFFICIENT SOLUTIONS FOR CITIES

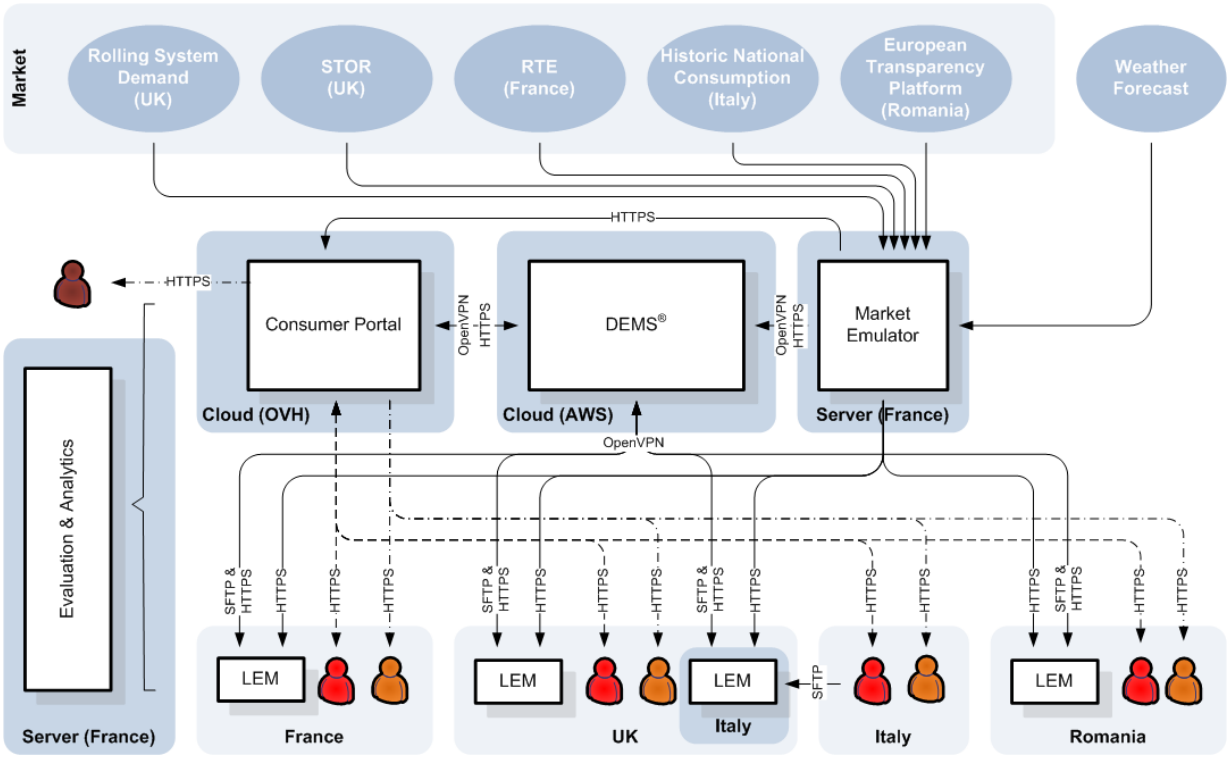
smart energy efficient solutions for cities

DR-BOB

TRL = 7

provides an innovative scalable cloud based central management system with a local real-time energy management

- Key Points
  - can maximise economic profit or to minimise CO2 emissions according to user requirements
  - can automatically adapt to current energy demand/ supply, dynamic price tariffs and weather conditions
- Application – building type
  - New and Existing buildings
- Application – process
  - Non disruptive



https://www.dr-bob.eu/

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ENERFUND

TRL = 8

a tool that rates and scores deep renovation opportunities.

- Key Points
  - enhances public awareness in building retrofit potential
  - Track, filter and compares buildings based on their energy efficiency ratings
- Application – building type
  - Existing buildings
- Application – process
  - Non disruptive