PEDBoard (PED Solutions)

DEMAND SIDE SOLUTIONS

Category 1: LOW ENERGY DEMAND
Technologies for reducing the energy demand - passive measures or building insulations
Building/District Level

Solution 0.1 District level strategies according to local environmental conditions
- S0.1a Wind strategies
- S0.1b Solar orientation strategies
- S0.1c Water resources strategies
- S0.1d Ground coupling strategies

Solution 0.2 Climate change adaptation District Strategies
- S0.2a Cooling of surfaces
- S0.2b Evaporative cooling

Solution 0.3 Mobility (eliminate vehicles emissions)
- S0.3a Foster clean mobility

Solution 1 Building Envelope Retrofitting in Residential
- S1a Residential Building (High Rise) retrofitting
- S1b Residential Building (Private House) retrofitting

Solution 2 New High performance residential buildings
- S2a New High Performance Building (residential)

Solution 3 Building Envelope Retrofitting in Tertiary b.
- S3a Retrofitting of the office building

Solution 4 New high performance tertiary buildings
- S4a New High Performance Building (Shopping Mall)
- S4b New High Performance Building (Academy Building)
- S4c New High Performance Building (Sport Complex)

Category 2: ENERGY MANAGEMENT
all interventions related to monitoring, control, smart readiness, (Improve Energy Efficiency), energy flexibility *Building/District Level*

Solution 5 Smart Building / Home energy controllers
- S5a Energy Management Agent for energy optimization and demand response
- S5b Visulation Units to study human behaviour regarding the energy consumption
- S5c Demand Response Smart Grid
- S5d Heat Matcher

Solution 6 IoT Monitoring
- S6a Smart Lighting, power LED
- S6b LoRa (Long Range) wireless network and activity sensors
- S6c Energy data monitoring of PED
- S6d Integration of new services to the data platform
- S6e Installation of IoT infra

Solution 7 ICT Urban Platform
- S7a Open Urban Platform adaptation

Solution 8 High Speed data transfer network
- S8a High Speed data transfer network

Solution 20 e-car Parking & Charging
- S20a E-car charging points
- S20b Connection of the charging stations to the local demand response system
- S20c Electrification of fleets

Solution 28 Virtual Power Plant
- S28a Virtual Power Plant

SYSTEM INTEGRATION

Category 3: INTEGRATED INFRSTRUCTURES
Storage as energy exchange facilitator, pipelines & heat exchangers... etc

Solution 9 Power storage
- S9a Neighbourhood electro storage facility (power storage)
- S9b Individual battery (power storage) at building level

Solution 10 Thermal Storage
- S10a Phase transfer Liquid tank
- S10b Seasonal storage
- S10c Thermal Storage

Solution 11 District Heating & Cooling Facilities
- S11a Low Temp regional transfer pipeline
- S11b Adjust geothermal district heating for using low temperature
- S11c Connection to the low temperature district heat

Solution 12 Building energy connectivity for energy sharing
- S12a Building energy connectivity for energy sharing
- S12b Building energy sharing (P2P)

Solution 13 Heat Pumps
- S13a CO2 based heat pump
- S13b Advanced Heat Pump (high COP)
- S13c Acoustic Air Heat Pump
- S13d Hybrid heat pump
- S13e Water-water (or geothermal-water) heat pump

Solution 27 Gas Storage
- S27a Biogas Storage
- S27b H2 Storage

Other

SUPPLY SIDE SOLUTIONS

Category 4: RENEWABLE ENERGY SYSTEMS ALTERNATIVE URBAN ENERGY SOURCES
Building/District Level

Solution 14 Solar PV Panels
- S14a PV in roofs
- S14b Building Integrated PV (on the façade)
- S14c Floating Solar pontoons
- S14d Solaroad
- S14e Parking Lot Solar Canopy
- S14f Bifacial PV or PV with agriculture

Solution 15 Solar Thermal Panels
- S15a Hybrid Heat collector (high preassurised CO2)
- S15b PVT Panels
- S15c FPC
- S15d ETC

Solution 16 Geothermal energy
- S16a Geothermal energy

Solution 17 Waste Heat Recovery
- S17a Heat recovery system from AC and sewage water
- S17b Heat recovery system from return pipeline to DHW
- S17c Waste heat sources

Solution 19 Wind turbine
- S19a Wind turbines on-site
- S19b Wind turbines Off-site
- S19c Wind turbines Off-shore

Solution 21 Waste-to-energy
- S21a Residential waste to biogas

Solution 22 Hydro
- S22a RES from mini Hydro

Solution 23 Biomass
- S23a Biomass boiler
- S23b Biogas generation

Solution 24 Combined Heat and Power
- S24a Co-generation (CHP)
- S24b Tri-generation
- S24c Polygeneration

NON-TECHNICAL SOLUTIONS

Category 5: POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS

Solution 18 Policy Innovation
- S18a Integrated Sustainable Energy Planning
- S18b Land use planning fostering energy actions
- S18c Soft-mobility actions

Solution 25 Social structure
- S25a Creation of an energy community
- S25b Energy Poverty mitigation

Solution 26 Services provision
- S26a Ancillary services
- S26b Participation on the markets
- S26c Hydrogen services

SPEC CARD

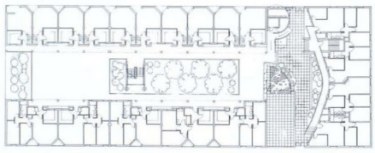
DEMAND SIDE SOLUTIONS

Category 1
LOW ENERGY DEMAND

Solution 0.1
Climate change adaptation - District Strategies

Title	Graphical Detail

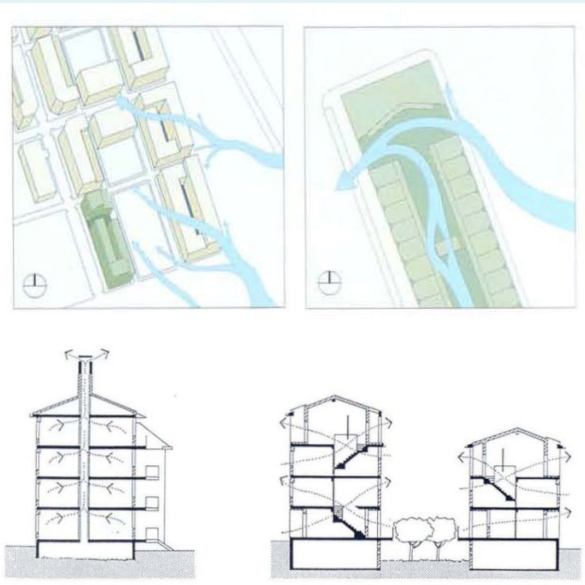
S0.1a Wind strategies



49 dwellings complex with natural ventilation and other bioclimatic strategies
- Location: San Pedro de Alcántara, Málaga, Andalusia, Spain
- Area: 2500 m^2
- Year of commitment: 1993
- Funding Type: Public

City / Country	Making_City	Technical Partner Name & contact Details	
San Pedro de Alcántara (Spain)	No	Margarita de Luxán (ETSAM, Universidad Politécnica de Madrid) Subsequent studies of energy monitoring and analysis of the building in use: CIEMAT (Center for Energy, Environmental and Technological Research) www.ciemat.es	
Implementation Time	3 years	**Initial Investment**	1.653.600 €

What is Solution?	How does it work?
Wind studies and layout and shape strategies for building volumes and housing distribution, to achieve the best natural ventilation.	Climate studies indicated the need for different seasonal uses, and mainly for cooling in summer. The overall volumetry of the set has been designed, therefore, to take advantage of the seasonal wind and breeze regime. The



dominant ones in the area are the following:
• Terral: it comes from the Northwest, from the interior, of a dry and gusty character, it alternates with the levante in a breeze and wind regime.
• Poniente (west): it comes from the Atlantic, with a humid and temperate character.
• Levante: comes from the Southeast; Of humid and fresh character it is alternated with the terral in breeze regime, dominating in the daytime hours.
• South of the Strait: it comes from Tarifa, produces storms.
On the plot, the mountains that cover the north front obstruct the passage of the terral, raising it and preventing the wind and breeze regime from being so clear, and there are buildings that cut the poniente, so the winds that act on the building are the south in summer and the levante throughout the year. It is the action of this last wind, dominant in summer, that has been sought for cooling, adapting the volumetry of the building for its use.
All dwellings are developed with at least two opposite orientations on the facades, facilitating cross ventilation due to temperature differences between them. In duplex dwellings, the effect is increased with the ventilation established between the two levels.
Specific, new elements have been designed for this project, such as solar cooling chimneys, which suck up the hot air accumulated in the upper part of the rooms and which are statically self-regulated by their shape and orientation, for a suction action in the hottest months.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	Regional Government of Andalusia
Operator Who is operating this solution?	Office of Public Works and Transportation of the Regional Government of Andalusia
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	Architects: Margarita de Luxán G. de Diego, Flavio de Celis D'Amico, Ernesto Echevarría

Business model patterns
Public investment (Resilient strategy)

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
The houses are designed trying to make the best use of the capacities of the environment in the aspects of solar collection, natural cooling, seasonal variations, as well as the specificity in the choice of materials and construction details, and in the creation and plant treatment of outdoor use spaces.	**Political:** **Economic:** **Social:** **Technical:** **Environmental:** **Legal:**
Potential for Replication	**Expected Impacts - Benefits**
The research has been conducted so that it could be carried out with extremely economic and simple means, so that the solutions that it provides can be incorporated into the promotions of publicly promoted housing without higher costs than usual.	The premise to carry out this project has been the consideration that bioclimatic or energy conscious buildings are not so much the result of an application of specific techniques, as of the maintenance of a logic, directed towards the adaptation and use of environmental conditions, maintained during the planning and design process of the architectural form; without losing the rest of the implications: constructive, functional, aesthetic, economic, etc.

Relevant Publications / Presentations / Services / Products to this Solution
(1) Luxán García de Diego, M. de, Celis D'Amico, F., Casa Martín, F. da, Echeverría Valiente, E., Villota Rocha, I. de. (1997). 49 viviendas en San Pedro de Alcántara, Málaga. In Dirección General de Arquitectura y Vivienda (Junta de Andalucía) (Ed.), Arquitectura y clima en Andalucía. Manual de diseño (pp. 213-220). Sevilla: Consejería de Obras Públicas y Transportes de la Junta de Andalucía. (ISBN 84-8095-095-1)
(2) Article about the project in the book 'Arquitectura y clima en Andalucía. Manual de diseño' (Spanish)
(3) The project was presented at the Third European Conference on Architecture "Solar Energy in Architecture and Urban Planning" (Florence, 1993) and published by the Commission of the European Community

Reference Applications of this Solution	
(1) Microclimate is a major part of urban living and is experienced by people in public spaces.The main elements affected by microclimate on a city level are: the temperature, humidity ,wind and solar radiation	http://www.iaacblog.com/programs/urban-microclimate/
(2) WINEUR projects EU:	https://ec.europa.eu/energy/intelligent/projects/en/projects/wineur
(3) WINEUR projects EU - Wind Turbines Guide :	http://www.urban-wind.org/pdf/SMALL_WIND_TURBINES_GUIDE_final.pdf
(4) WINEUR projects EU - Report:	https://ec.europa.eu/energy/intelligent/projects/sites/iee-projects/files/projects/documents/wineur_publishable_result_oriented_report.pdf
(5) Rheologic: Basic Urban Wind Effects - Video :	https://rheologic.net/en/urban-wind-assessment
(6) Wind based urban design in dense urban context. Prefacing wind nuisance and optimizing the human wind	https://repository.tudelft.nl/islandora/object/uuid:71f03228-175e-40b0-9fd2-5be4480dcfec/datastream/OBJ1/download
(7) Air flow:	https://salientedge.com/blog/2018cleaning-up-the-big-smoke

SPEC CARD

DEMAND SIDE SOLUTIONS

Category 1
LOW ENERGY DEMAND

Solution 0.1
District level strategies according to local environmental conditions

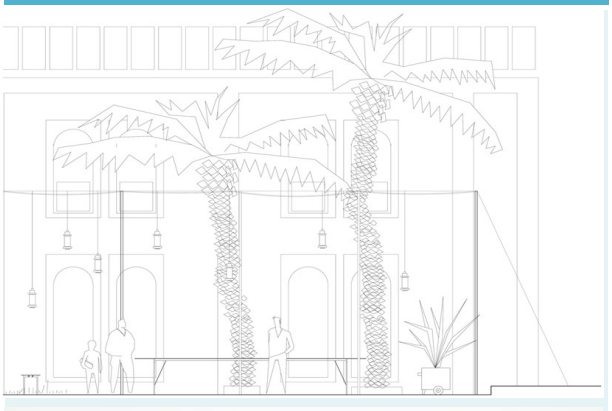
Title	Graphical Detail

S0.1b Solar orientation strategies

The Bab al Bahrain pavilion is a temporary public space that had been transformed into a comfortable area with several activities for the public, by using only the perks of the site, a minimal light structure and a low tech element to protect from the sun.

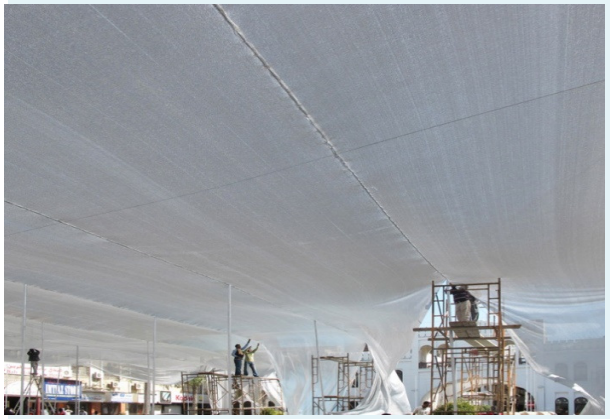
City / Country	Making_City	Technical Partner Name & contact Details	
Bab Al-Bahrain, Manama (Bahrain)	No	Noura Al Sayeh & Leopold Banchini	
Implementation Time	2012	**Initial Investment**	N/A

What is Solution?



How does it work?

The Bab al Bahrain pavilion is a temporary public space. It had an extraordinary success during its permanence and it was constantly used and visited, it held events and even workshops. Its success can be attributed to a good mix of factors, the first one surely being the special value of the place and the second one the it's good bioclimatic design based mainly on shadowing.
The first good virtue of this project is the creation of the public space itself, closing the crossing to the traffic and giving back this historical place to the



citizens, although it was only for a limited time this demonstrated the power of this kind of intervention and the need for quality public space that this city has. The second important virtue was the design of a comfortable public space using only the perks of the site, a minimal light structure and a low tech element to protect from the sun.
Based on a regular grid of thin steel columns the project is basically made by its “canopy”, a light sun-reflecting fabric (generally used in greenhouses) that reflects most of the energy of the sun giving to the place a nice diffused illumination. To make this design really effective the architects took advantage of a large fountain already existing in the site, the fountain with its fresh water favors evapotranspiration and contributes to lower the temperature of the air, favoring a light breeze that crosses the pavilion. Lowering the square's temperature with this intervention favors the reduction of energy demand (air conditioning...) of the sourrounding buildings.
Material Used :
1. Reflective shade mesh fort he cover
2. Metalic painted pillars
3. Glass and steel showcases

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	Ministry of Culture, Kingdom of Bahrain
Operator Who is operating this solution?	Office of Public Works and Transportation of the Regional Government of Andalusia
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	Syed M. Ahmed, Masy Int. Creative wrought iron factory. Bu Hussain aluminium and mirrors.
Financer How / By whom has the implementation of this solution been financed?	Manama Capital of Arab Culture 2012, Ministry of Culture, Kingdom of Bahrain
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	Architects: Noura Al Sayeh & Leopold Banchini

Business model patterns
Space rental Leasing

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Shadowing elements combined with vegetation and water bodies (fountains, lakes,…) favor evapotranspiration and contribute to lower the temperature of the air. This favors the reduction of energy demand (air conditioning,...) of the sourrounding buildings.	**Political:** **Economic:** **Social:** **Technical:** **Environmental:** **Legal:**
Potential for Replication	**Expected Impacts - Benefits**

The choice of a light structure and easy assembly dry materials allows easy repair and maintenance. Likewise, this is an economic solution.	Lowering the square's temperature with this intervention favors the reduction of energy demand (air conditioning...) of the sourrounding buildings. The creation of quality public space, closing the crossing to the traffic and giving back this historical place to the citizens. In addition, a thermally comfortable public space contributes to achieve citizens comfort and allows that several activities take place.

Relevant Publications / Presentations / Services / Products to this Solution	
(1) Bar Al Bahrain Pavillion - Archdaily	https://www.archdaily.com/222125/bar-al-bahrain-pavillion-noura-al-sayeh-leopold-banchini
(2) Bar Al Bahrain Pavillion - Metalocus	https://www.metalocus.es/es/noticias/bab-al-bahrain-pavillion-por-noura-al-sayeh-leopold-banchini
(3) Bar Al Bahrain Pavillion - Designboom	https://www.designboom.com/architecture/noura-al-sayeh-leopold-banchini-bab-al-bahrain-pavilion/
(4) Bar Al Bahrain Pavillion - Archello	https://archello.com/project/bab-al-bahrain-pavillion
(5) Video	https://vimeo.com/manama

Reference Applications of this Solution	
(1) Microclimate is a major part of urban living and is experienced by people in public spaces. The main elements affected by microclimate on a city level are: the temperature, humidity ,wind and solar radiation:	http://www.iaacblog.com/programs/urban-microclimate/
(2) Tejiendo la calle:	https://submarina.info/tejiendo-la-calle/
(3) Palette 2030 Solar Shading:	http://www.2030palette.org/solar-shading/

SPEC CARD

DEMAND SIDE SOLUTIONS

Category 1
LOW ENERGY DEMAND

Solution 0.1
District level strategies according to local environmental conditions

Title	Graphical Detail

S0.1c Water resources strategies

Permeable concrete parking in the Atlético de Madrid Stadium

City / Country	Making_City	Technical Partner Name & contact Details	
Madrid (Spain)	No	Cruz y Ortiz Arquitectos +34 910 052 675 / info@cruzyortiz.com	
Implementation Time	2011 - 2017 (Whole project of the stadium)	**Initial Investment**	20 - 35 €/m^2

What is Solution?	How does it work?

The permeable pavements are a supporting structure, which allows the passage of both pedestrians and vehicles, as well as the filtering of the runoff towards a lower layer of temporary storage (sub-base), composed of gravels, cells and/or reticular boxes. After storage, water is evacuated by infiltration or through drains. The surface layer may be of continuous pavement, such as porous concrete or asphalt, or modular. The latter type includes porous pavers, permeable joint pavers or reinforced grass.

It is not recommended in places with heavy vehicle traffic (e.g. trucks), places with high sediment loads or areas where there are many trees.

The urbanization project on the Atlético de Madrid Stadium has implemented SUDS techniques using permeable pavements and buried detention tanks. On the parking beaches, the deposit is constituted by the granular sub-base itself on which the permeable concrete of the parking spaces sits. The application of SUDS allowed to reduce, in a global way, approximately the 69% of the peak flows for the design storm (return period 10 years and peak intensity of 60.2 mm / h) compared to a conventional scheme (waterproof pavement + drain to collector).

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	FCC
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Atlético de Madrid Club
Implementer Who is implementing this solution?	Cruz y Ortiz Arquitectos
Financer How / By whom has the implementation of this solution been financed?	Atlético de Madrid Club
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	Service Provider: Ecobloc system - GRAF

Business model patterns
Municipal utility Rising block tariff

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
	Political: **Economic:**

	Economic: **Social:** **Technical:** **Environmental:** **Legal:**
Potential for Replication	**Expected Impacts - Benefits**
	· Reduction of the flow and volume of stormwater runoff. · Improvement of water quality by retaining sediments, oils, fats, heavy metals and some nutrients. · Reduces the area dedicated only to runoff management, as it allows the transit of both pedestrians and vehicles. · Possible aquifer recharge and rainwater use. · Wide variety of designs and flexibility to adapt to different urban environments. · It needs to be integrated into a treatment chain, as it has no inherent capacity to eliminate contaminants.
Relevant Publications / Presentations / Services / Products to this Solution	
(1) Videos	https://www.youtube.com/watch?time_continue=21&v=EPRguq1WC34 https://www.motor16.com/videos/alfalto-topmix-permeable-el-suelo-del-futuro/
(2) GRAF - SuDS system	https://www.grafiberica.com/suds-drenaje-sostenible.html
Reference Applications of this Solution	
(1) SuDS: Sustainable drainage systems guide:	https://www.madrid.es/UnidadesDescentralizadas/Agua/TODOSOBREAGUA(Informaci%C3%B3nSobreAgua)/SistemaUrbanosDrenajeSostenible/Gu%C3%ADa%20b%C3%A1sica%20de%20dise%C3%B1o%20sistemas%20de%20gesti%C3%B3n%20sostenible%20de%20aguas%20pluviales.pdf
(2) SuDS: Sustainable drainage systems excel calculation:	https://www.madrid.es/portales/munimadrid/es/Inicio/Medio-ambiente/Agua/SUDS-sistemas-urbanos-de-drenaje-sostenible/?vgnextfmt=default&vgnextoid=05ae02fc13557610VgnVCM2000001f4a900aRCRD&vgnextchannel=63d0e0f6fdc4f510VgnVCM2000001f4a900aRCRD
(3) SUD - Atlantis:	https://donosticity.org/la-empresa-suds-del-donostiarra-peio-lasa-entre-los-premios-europeos-de-medio-ambiente/
(4) CONAMA - Water and city SuDS: Sustainable drainage systems:	http://www.conama.org/conama/download/files/conama2018//STs%202018/10_preliminar.pdf
(5) Nature-based solutions for local climate adaptation in the Basque Country:	http://growgreenproject.eu/wp-content/uploads/2018/05/NBS-Climate-Adaptation-Basque-Country.pdf
(6) Ecopolis - Ecosistema Urbano	https://ecosistemaurbano.com/plaza-ecopolis/
(7) GrowGreen Project - Managing flooding with nature-based solutions in Brest:	
(8) Técnicas de Drenaje Urbano Sostenible	

SPEC CARD

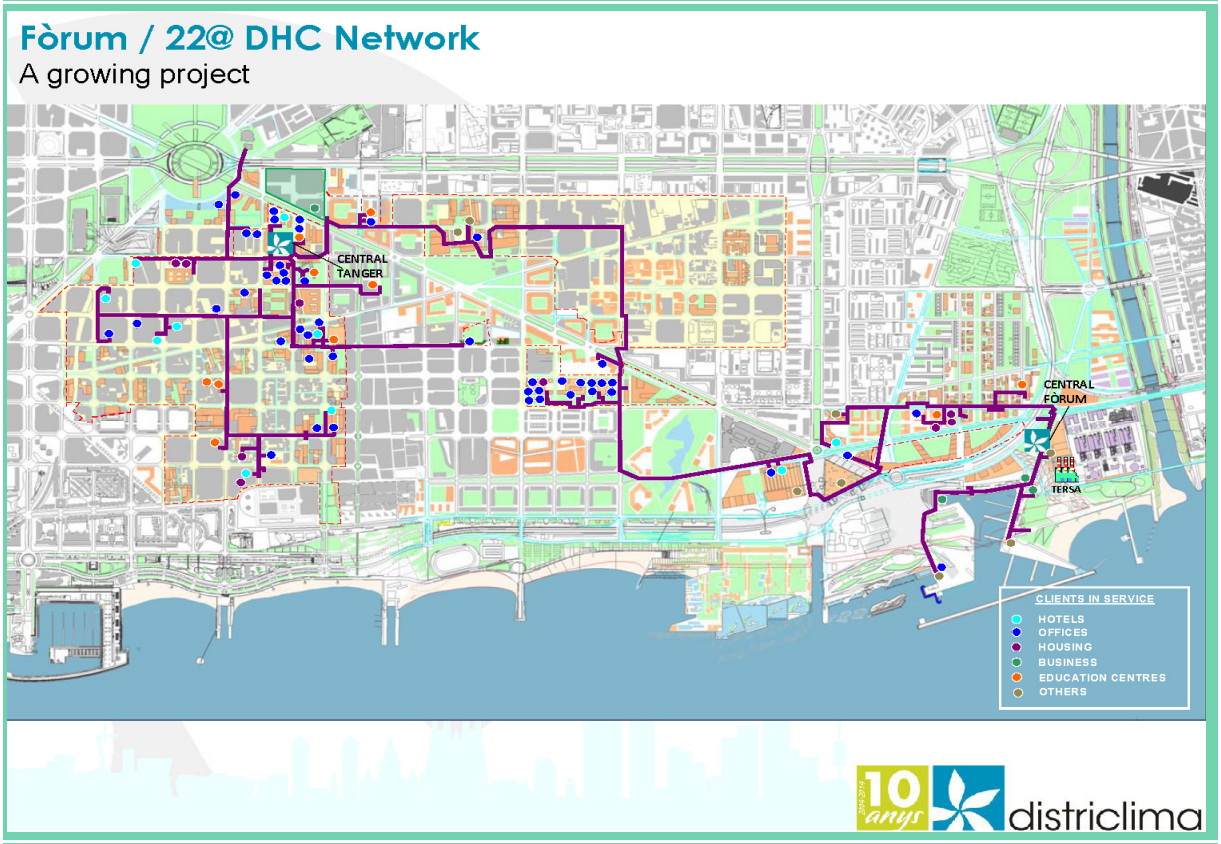
DEMAND SIDE SOLUTIONS

Category 1
LOW ENERGY DEMAND

Solution 0.1
District level strategies according to local environmental conditions

Title	Graphical Detail

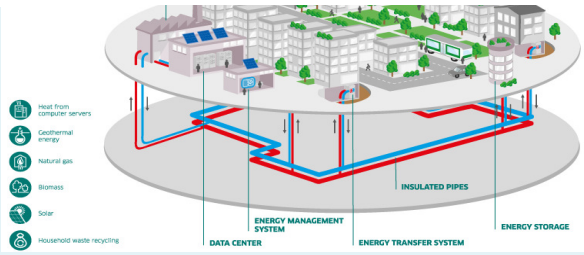
S0.1d Ground coupling strategies

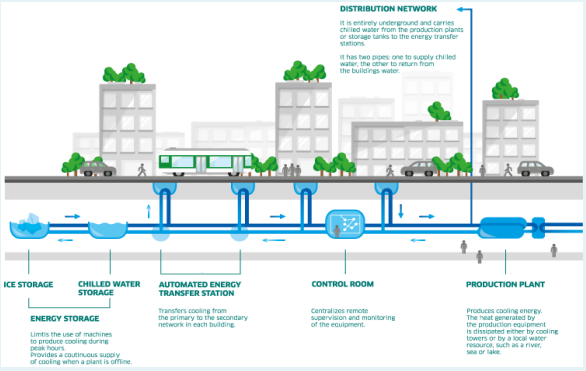


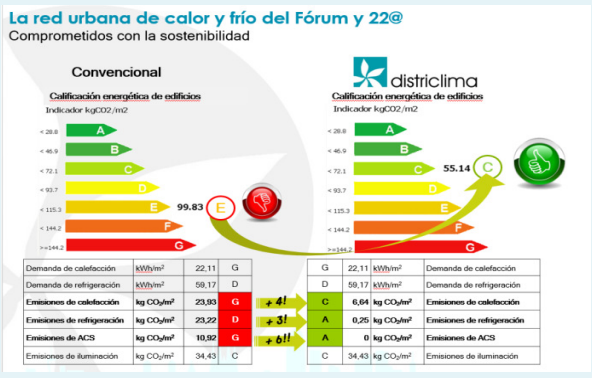
In Spain, ENGIE operates the country's first heating and cooling network: Districlima in Barcelona, which recover the heat generated by household waste processing for re-use as heat for a heating network and to produce chilled water. The network supplies 94 buildings.

City / Country	Making_City	Technical Partner Name & contact Details	
Barcelona (Spain)	No	Districlima, S.A.: Engie: 50,8% Tersa: 20% Agbar: 19,2% ICAEN: 5% IDAE: 5% info@districlima.es	
Implementation Time	2002-2004	**Initial Investment**	55.000.000 €

What is Solution?	How does it work?
	







Central Fórum:
Heat and cold are produced taking advantage of the steam generated in the combustion of urban solid waste of the neighboring TERSA treatment plant.

The production equipment is cooled by seawater, obtaining high yields, without the use of cooling towers.

Energy management is optimized using an accumulator tank of ice water of 5,000 m^3.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	Districlima, S.A.
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Barcelona City Council
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
Municipal utility

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
This solution might be complemented with other energy efficiency solutions.	**Political:** **Economic:** **Social:** **Technical:** **Environmental:** **Legal:**
Potential for Replication	**Expected Impacts - Benefits**

Similar projects focused on heating and cooling: · In Marseille, three ENGIE subsidiaries (ENGIE Cofely Climespace, ENGIE Ineo and ENGIE Axima) have developed a new solution that uses a very local source of renewable energy: the heat energy content of the Mediterranean Sea. Located at the Grand Port Maritime de Marseille, the Thassalia marine geothermal plant is the first in France and the wider Europe to use marine thermal energy to provide heating and cooling for all the buildings connected to its network - a combined footprint of 500,000 m2 ultimately - at the same time as reducing greenhouse gas emissions by 70 %. · In Lisbon, the heating and cooling network operated by Climaespaço is famous for being the first city-scale centralized thermal energy distribution network. It has reduced the capital's annual CO_2 emissions by 40 %, and serves 130 buildings.	The Districlima solution helps to improve the quality of life of the neighborhoods: · The reduction of CO_2 emissions and the reduction of fossil fuels. In 2015, Districlima avoided the emissions into the atmosphere of 17,678 ton of CO_2, with a reduction in the use of fossil fuels of 59%. · The lack of machinery for air conditioning in buildings connected to Districlima translates, among others, in the absence of noise and vibration in the buildings and thus improving the acoustic quality of the city. · Improvement in the air temperature of the neighborhood, by drastically reducing the equipment that refreshes the interior of the buildings, at the cost of emitting heat to the outside. · Reduction of the global consumption of water and chemical products: elimination of cooling towers and other equipment that consume water and chemical additives (biocides, water treatment, etc.). In addition to these global benefits for the city, users of the buildings connected to the network enjoy the following advantages: · Energy supply guarantee: the heat and cold network has excess supply, both in production plants and in thermal production equipment. · Outsourcing of the thermal production service and associated risks (regulatory, service quality commitment ...). · Elimination of machinery replacement costs, no breakdowns, and reduction of maintenance costs. · Reduction of costs of supply of conventional energy (gas and electricity). · Flexibility and adaptability. Ease to have more power, simply expanding the energy exchangers, with hardly any need for more space.

Relevant Publications / Presentations / Services / Products to this Solution	
(1) Districlima web	https://www.districlima.com
(2) Districlima downloads	http://www.districlima.com/es/descargas
(3) Districlima Barcelona	https://www.construction21.org/espana/city/es/la-red-urbana-de-calor-y-frio-de-districlima-en-barcelona-y-sant-adria-de-besos.html
(4) User Guide	http://www.districlima.com/districlima/uploads/descargas/guias-tecnicas/Gu%C3%ADa%20del%20usuario%20Districlima%20Rev2016.pdf

Reference Applications of this Solution	
(1) ENGIE's worldwide operating presence - several projects	https://www.engie.com/en/businesses/district-heating-cooling-systems/
(2) Training course on Geothermal District Heating	http://geodh.eu/wp-content/uploads/2014/11/Manual_corrected.pdf
(3) Sustainable cities with urban geothermal energy	http://www.conama11.vsf.es/conama10/download/files/conama2014/CT%202014/1896711817.pdf
(4) CHEAP-GSHPS PROJECT	https://cheap-gshp.eu/about-cheap-gshps-project/
(5) Canadian Wells	https://www.ecopassivehouses.com/canadian-wells/ https://sgarq.com/en/canadian-or-provencal-well/

SPEC CARD

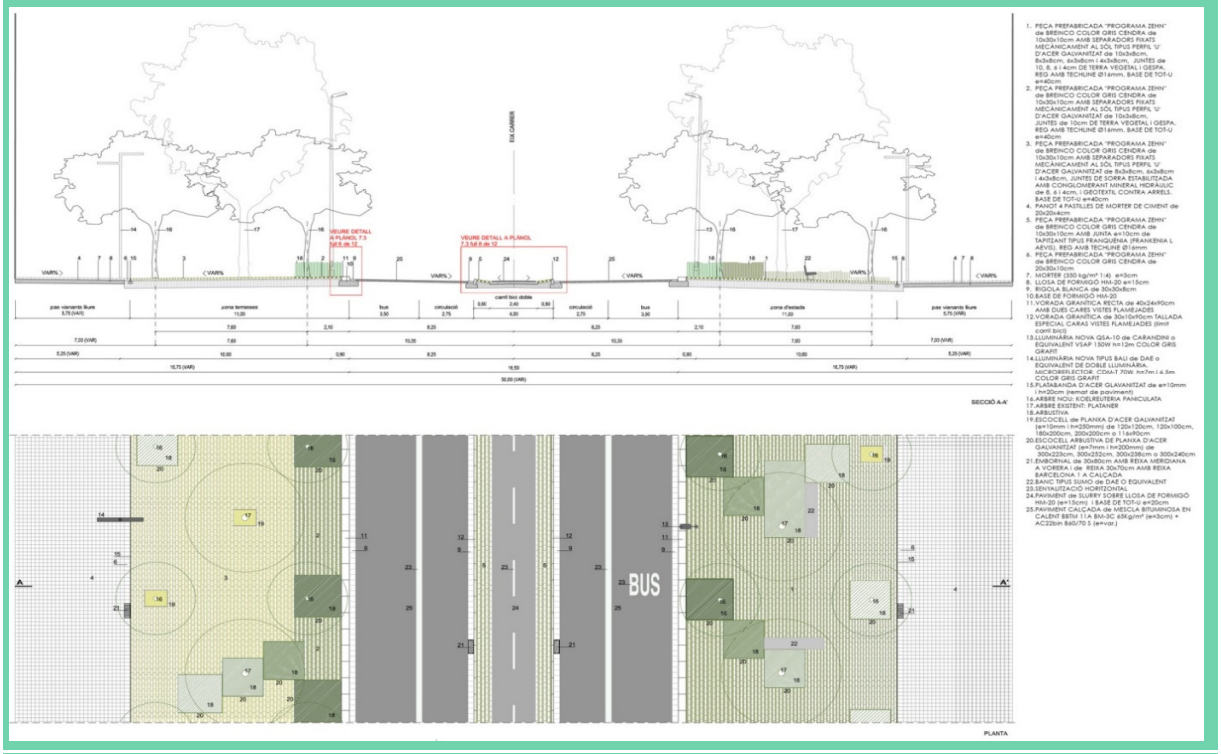
DEMAND SIDE SOLUTIONS

Category 1
LOW ENERGY DEMAND

Solution 0.2
Climate change adaptation - District Strategies

Title | **Graphical Detail**

S0.2a Cooling of surfaces



· The ‘Passeig Sant Joan’ (ENABLE project) is a promenade which connects the district of Gràcia with the Ciutadella Park. Part of it was redeveloped into one of the first Green Corridors in Barcelona, aiming at increasing ecological and social connectivity within the city.
· The total length of the renovated part is 1.2 km and it was completed in 2015.
· This design distributes the use of the space between: wide sidewalks, two car lanes, and a segregated bidirectional lane for bicycles.
· Eixample is one the districts with the lowest availability of green space per inhabitant.

City / Country	Making_City	Technical Partner Name & contact Details	
Barcelona, Spain	No	· Lola Domènech (+34 932 683 277) ld@loladomenech.com · Barcelona City Council · BIMSA	
Implementation Time	May 2009 - May 2015	**Initial Investment**	4.127.161,73 €

What is Solution?	How does it work?
	Objectives To improve public space functionality and use, to increase access to green spaces for district residents (Eixample), to contribute to higher biodiversity in the city, and to promote more and different retail activity at the ground floor of buildings, so to rejuvenate/boost the local economy. Actions Urban regeneration was enabled through the introduction of green infrastructure that: 1) is more welcoming, provides high quality cultural and regulating ecosystem services —thus increases direct use values, attracts more people and more local businesses, 2) through its design favors ground floor service-based retailers (bars and restaurants), which are attractive both to locals and tourists. New green space and amenities promote children's play, relaxation, improved micro-cimate (shading) and less car circulation (pacification, better air quality), hence improving the quality of life in the area. Carbon sequestration is increased via an enlarged area for street trees and other vegetation comparing to traditional sideways in the city. The semi-permeable pavement and irrigation system installed in most part of Passeig Sant Joan allows for water collection and mitigates run-off while also promoting sustainable water use.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	Barcelona City Council
Operator Who is operating this solution?	FCC (fomento de construcciones y contratas)
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Barcelona City Council
Implementer Who is implementing this solution?	BIMSA
Financer How / By whom has the implementation of this solution been financed?	Proeixample S.A. (Ajuntament de Barcelona)
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	Designer: Lola Domènech (+34 932 683 277) ld@loladomenech.com, Cicsa-engineer

Business model patterns
Public investment (Resilient strategy)

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES

Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** **Economic:** **Social:** **Technical:** **Environmental:** **Legal:**
Potential for Replication	**Expected Impacts - Benefits**
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	General aspects about the solution.Could be technical, economical, environmental, social
Relevant Publications / Presentations / Services / Products to this Solution	
(1) Article - Archdaily	https://www.plataformaarquitectura.cl/cl/625586/paisaje-y-arquitectura-remodelacion-del-paseo-de-st-joan-un-nuevo-corredor-verde-urbano-por-lola-
(2) Article - think nature	https://platform.think-nature.eu/nbs-case-study/18419
Reference Applications of this Solution	
(1) Green Pavements	https://www.vitoria-gasteiz.org/wb021/was/contenidoAction.do?idioma=es&uid=u3fb0f976_168551e92d9__7f62
(2) Cooling Paint - Coolseal Los Angeles	https://www.youtube.com/watch?v=Y3qc7Hm3D7A https://www.sciencealert.com/la-s-new-grey-streets-are-one-way-to-fight-back-against-climate-change https://guardtop.com/coolseal/
(3) Solar reflectance of materials	https://www.cement.org/docs/default-source/fc_concrete_technology/sn2982-solar-reflectance-of-concretes-for-leed-sustainable-sites-credit-heat-island-effect.pdf
(4) Cool Pavements - Reducing Urban Heat Islands: Compendium of Strategies	https://www.epa.gov/sites/production/files/2014-06/documents/coolpavescompendium.pdf
(5) Green Pavements - Urban GreenUp Project	https://www.urbangreenup.eu/solutions/green-pavements--green-parking-pavements.kl
(6) Palette 2030 Solar Shading	http://www.2030palette.org/solar-shading/
(7) Nature-based solutions for local climate adaptation in the Basque Country	http://growgreenproject.eu/wp-content/uploads/2018/05/NBS-Climate-Adaptation-Basque-Country.pdf

SPEC CARD

DEMAND SIDE SOLUTIONS

Category 1
LOW ENERGY DEMAND

Solution 0.2
Climate change adaptation - District Strategies

Title	Graphical Detail

S0.2b Evaporative cooling

Smart pavers to refresh from rainwater
- Location: Place du Forum, Montaudran, Toulouse
- Area: 130 m^2
- Year of commitment: 2018
- Progress Status: Delivered
- Funding Type: Public/Private Partnership

City / Country	Making_City	Technical Partner Name & contact Details	
Toulouse (France)	No	2EI Veolia https://www.2ei.veolia.com/en contact@2ei.com	
Implementation Time		**Initial Investment**	250.000 €

What is Solution?	How does it work?
Urban cooling system that uses evaporative pavers fed by depolluting drains. This innovative device, tested for the first time in Europe, is a solution to cool pedestrian spaces during	This solution allows rainwater to be reused for non-potable use: urban cooling. The innovation also lies in rainwater treatment: runoff water is collected and treated through depolluting drains (developed by Veolia) before being stored.

periods of high temperatures, which reduces the effects of urban heat island.

Rainwater collected on the roadway and pretreated by depolluting drains is injected together with potable water as a back-up, under a layer of paving stones capable of filtering these waters to the surface, where they evaporate. This evaporation allows to lower the temperature of the pavement locally and thus improve the comfort felt by pedestrians.

Rainwater is collected and stored. Under the paving stones, a system of drip pipes is installed and the mortar to fix the pavers allows the water to rise by capillary action during its evaporation. In case of drought, drinking water can take over, but the storage area is sized to cover 80 to 90% of needs, remaining neutral in terms of ecological balance.

The system is triggered when the weather sensor installed on the surface registers a certain level of heat. In the test phase, in summer, the ground cooling device has allowed a temperature reduction of more than 5°C and an improvement of the comfort index of 5°C.

It is an autonomous, fully automated solution: the cooling demand is controlled by meteorological sensors. The materials and equipment used are available on the market. The innovation lies in the management and monitoring of the system's performance through these UTCI measures.

The system can be remotely controlled by the user (to change the setpoints or parameters) and requires very little maintenance.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	Toulouse Métropole
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Toulouse Métropole / Oppidea
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	Caisse des Dépôts et Consignations
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	Designer: 2EI Veolia Innove

Business model patterns
Public investment (Resilient strategy)

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
This solution is intended to be combined with other types of cooling solutions (vegetation,...) to create outdoor spaces. It can be integrated into a new space of conviviality at the service of resilience.	**Political:** **Economic:** **Social:** **Technical:** **Environmental:** **Legal:**

Potential for Replication	Expected Impacts - Benefits
2EI has developed innovative devices for humidifying pavements from recovered rainwater, raw water, etc	Innovation to fight urban heat island, that combines water recovery, decontamination and reuse through evaporation

pavements from recovered rainwater, raw water, etc. in Lyon, Toulouse and Nice (France). In a similar system of evaporative pavers installed in Nice, the pavers come from the recycling of scallops, while those of Toulouse come from stone from Japan.	decontamination and reuse through evaporation. The solution could also be useful in winter to fight against snowfall since the water retained in the paving stones remains at a temperature of 10 to 15°C, which prevents the flakes from settling.

Relevant Publications / Presentations / Services / Products to this Solution	
(1) Case study description on Construction21 website	https://www.construction21.org/infrastructure/fr/smart-pavers-to-refresh-from-rainwater.html
(2) The project on Toulouse Métropole website	https://www.toulouse-metropole.fr/-/quand-la-fraicheur-vient-de-la-terre-
(3) 2EI Veolia website	https://www.2ei.veolia.com/en/news/2ei-solution-adapt-heat-waves-and-cool-city
(4) The project on the news (20 minutes)	https://www.20minutes.fr/toulouse/2533087-20190606-toulouse-lutter-contre-chaleur-voici-premiers-paves-rafraichissantes-testes-europe
(5) The project on the news (La Dépêche)	https://www.ladepeche.fr/amp/2019/05/29/a-toulouse-on-teste-les-premiers-paves-rafraichissants-deurope-en-cas-de-canicule,8228303.php

Reference Applications of this Solution	
(1) Evaporative towers in Eco-boulevard project, Madrid (Spain)	https://ecosistemaurbano.com/eco-boulevard/
(2) Ecoquartier Cœur de ville - La Possession - vegetation for evaporative cooling / climate mitigation	https://www.construction21.org/france/city/fr/ecoquartier-c%C5%93ur-de-ville-la-possession.html
(3) Green Roofs	https://www.apabcn.cat/documentacio/areatecnica/PDFS_SHAREPOINT/Presentacions/FA%C3%87ANES-VERDES-07-10-2016/RAMON-MARTINEZ.PDF
(4) Vertical Gardens - Ecoquartier fluvial de l'île Saint Denis	http://www.philippon-kalt.fr/wp-content/uploads/2017/12/PK_E2R_15-1440x1080.jpg
(5) Palette 2030 - Vegetative cooling	http://www.2030palette.org/vegetative-cooling/
(6) Palette 2030 - Constructed wetland	http://www.2030palette.org/constructed-wetland/
(7) Nature-based solutions for local climate adaptation in the Basque Country	http://growgreenproject.eu/wp-content/uploads/2018/05/NBS-Climate-Adaptation-Basque-Country.pdf
(8) Madrid Río - urban cooling	https://urbandesignprize.gsd.harvard.edu/madrid-rio/
(9) Article: public space for the extreme: evaporation	https://ecosistemaurbano.org/english/public-space-for-the-extreme-evaporation/

SPEC CARD

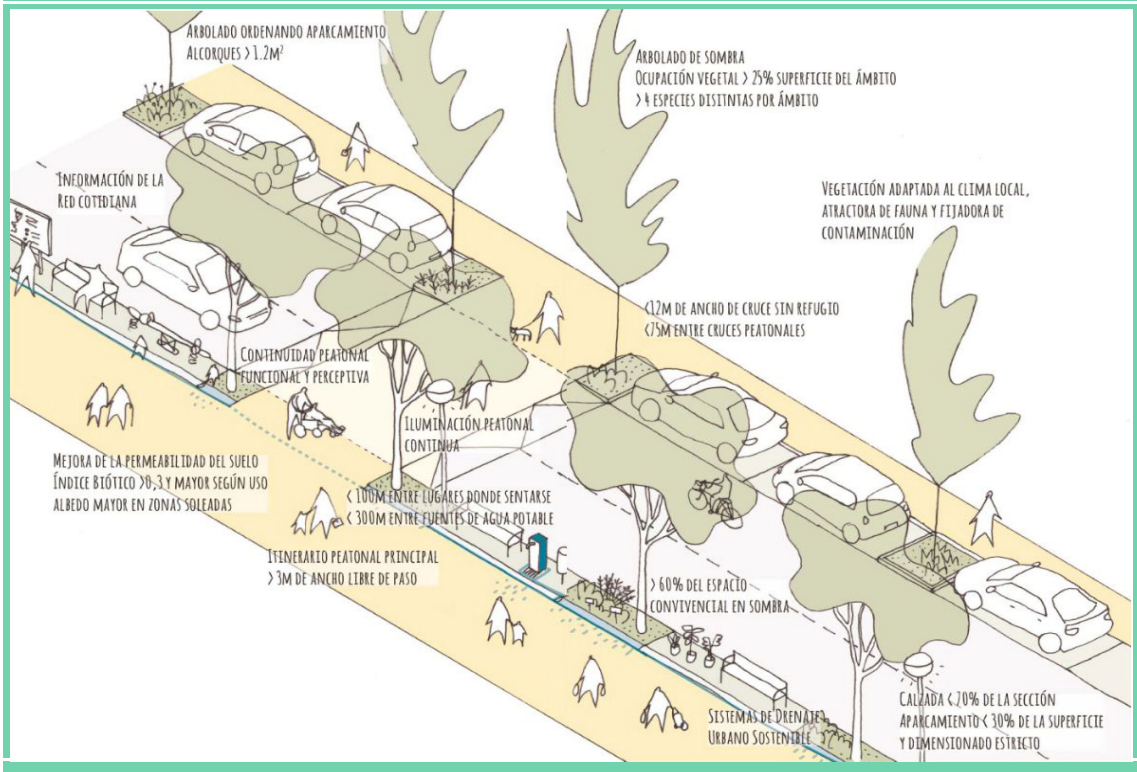
DEMAND SIDE SOLUTIONS

Category 1
LOW ENERGY DEMAND

Solution 0.3
Mobility (eliminate vehicles emissions)

Title	Graphical Detail

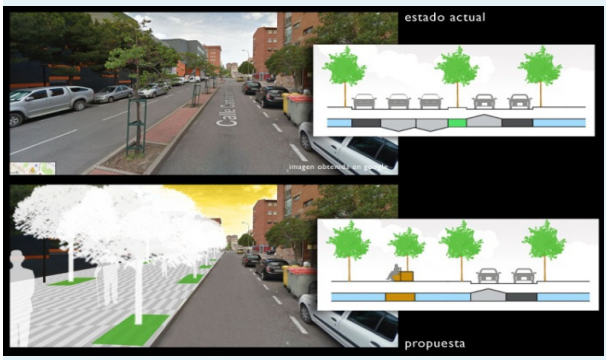
S0.3a Foster clean mobility



Pedestrian strategy for walkable districts:
· At least 1,000 more active travels per day
· High-quality pedestrian corridor improving accessibility

City / Country	Making_City	Technical Partner Name & contact Details	
Madrid (Spain)	No	· Carmen Hernanz - Madrid City Council - hernanzcmc@madrid.es · Grupo de Estudios y Alternativas 21 (GEA21)	
Implementation Time	The measure is expected to be fully operational by October 2019	**Initial Investment**	The total budget 236.875 € This does not include the various construction works required, which will be financed through the Madrid City Council's regular budget

What is Solution?	How does it work?
	Two pilot actions will be implemented in the living lab. The first one will implement a highquality pedestrian corridor, connecting the major green areas in Puente de Vallecas, while improving north-south connectivity for pedestrians in the area. As action plan for a walkable district will improve



access to key facilities (a hospital, cultural centre and a sports facility), and will connect them through a high-quality pedestrian axis, using physical design measures and new technology tools (e.g. smart signage). In particular, the plan will provide, more convenient access to the hospital to residents, crossing the current barrier created by a motorway. The high-quality pedestrian corridor will address both pedestrians and cyclists (also linking to Madrid's other CIVITAS ECCENTRIC measure 'Enabling cycling outside the city centre'). Several sections of this corridor are expected to be completed during 2018.

The second pilot action will transform a disconnected and car-dominated area into a high-quality public space devoted to pedestrian and social life. This will be addressed through the creation of an e-mobility centre (following the experience of similar CIVITAS ECCENTRIC measures in the cities of Munich and Turku, and also linked to Madrid's measure 'Enabling cycling outside the city centre') and will be coupled with a number of improvements in the pedestrian network in the vicinity of the e-mobility centre and in other streets within the city lab.

Both actions will be done in cooperation with residents and local stakeholders, following a participatory approach.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	Madrid City Council
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Madrid City Council
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 690699.
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	Designer: Grupo de Estudios y Alternativas 21 (GEA21)

Business model patterns	
	Public investment (Resilient strategy)

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Pedestrian strategy for walkable districts is complemented with other 10 strategies (tech and non tech) included in the Booklet: https://civitas.eu/sites/default/files/civitas_eccentric_booklet_madrid_web.pdf	**Political:** **Economic:** **Social:** **Technical:** **Environmental:** **Legal:**

Potential for Replication	Expected Impacts - Benefits
	In Madrid, ECCENTRIC will drive the CO_2 reduction foreseen in the Air Quality Plan, targeting 51,100 tonnes/year in the laboratory area, with an upscaling potential of 134,500 tonnes in the whole suburban area. Other benefits: · 6% reduction of car travel in Madrid, related to those using the new HOV parking management scheme

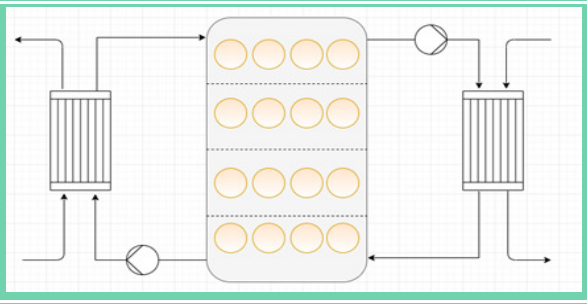
The project ECCENTRIC (H2020 CIVITAS), focuses on sustainable mobility in suburban districts and innovative urban freight logistics, two important areas that have previously received less attention in urban mobility policies. It is being implemented in 5 cities: Torku, Stockholm, Munich, Ruse and Madrid. For more info visit: https://civitas.eu/eccentric/	· Achieve a modal share of 2% for bicycle trips in the lab area · Increasing the modal share for walking by 6% in the lab area · 10-30% decrease of average speed in living lab after safety plans implementation · 50% of reduction in accidents with injuries in the lab area · 10% increase in commercial speed and 9% increase in regularity levels in the new high level bus corridor · 6 new hybrid buses providing 30% energy consumption savings, and noise reduction · 3 pedestrian interventions and 3 traffic safety plans at the neighbourhood level based on a participatory design process · 8% decrease in the number of children travelling to the school by car in the city lab · 20 electric vehicles introduced in Madrid's municipal fleet · 5 urban delivery companies testing e-vehicles in their fleets · 30% reduction of km-goods, thanks to the implementation of a consolidation centre linked to the use of electric vehicles in Madrid · Ultra low emission electric-natural gas distribution vehicle developed and tested in Madrid
Relevant Publications / Presentations / Services / Products to this Solution	
(1) 2020 CIVITAS: Cleaner and better transport in cities ECCENTRIC Sustainable mobility solutions in Madrid (page 17)	https://civitas.eu/sites/default/files/civitas_eccentric_booklet_madrid_web.pdf
(2) Itinerario Miradores (Puente de Vallecas) - Urban regeneration strategies	https://www.arcgis.com/apps/MapJournal/index.html?appid=faaa60fa83364618b7238aafd1d78145
(3) Itinerario Miradores (Puente de Vallecas) - Public Space Strategic Project	http://www-2.munimadrid.es/urbanismo_inter/visualizador/getPDF.do?id=47&nombrePDF=IT.13.02
(4) Street Mix: design making tool to achieve "Complete Streets", ensuring that all streets are accessible to all people	https://streetmix.net/
(5) Living lab area in Madrid	http://civitas.eu/eccentric/madrid
Reference Applications of this Solution	
(1) 2020 CIVITAS: Cleaner and better transport in cities ECCENTRIC	https://civitas.eu/eccentric
(2) Lyon Confluence - Mobility project	https://www.construction21.org/france/city/fr/lyon-confluence.html
(3) Palette 2030 - Transit Oriented Development	http://www.2030palette.org/transit-oriented-development/

SPEC CARD

SYSTEM INTEGRATION SOLUTIONS

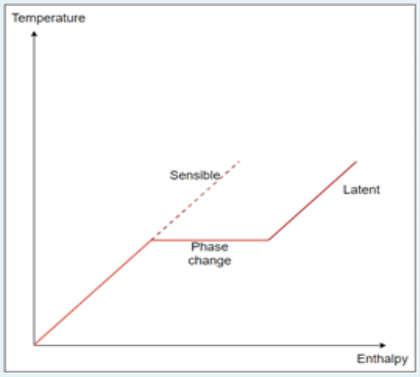
Category 3
INTEGRATED INFRSTRUCTURES

Solution 10
Thermal storage

Title	Graphical Detail
S10a Phase transfer Liquid tank	

- Match hot water supply and demand
- Prolong the heat pump life time
- Increase thermal energy storage intensivity compared to conventional water thermal storage
- With increase of energy content it could be possible to have smaller thermal storage units

City / Country	Making_City	Technical Partner Name & contact Details	
Finland / Oulu	Yes	VTT Technical Research Centre of Finland Ltd	
Implementation Time		**Initial Investment**	

What is Solution?	How does it work?
To increase the energy content of the conventional water based thermal storage we can utilise phase change materials to increase the energy content of the tank. These phase change materials are commercial and they are made of either salt-based material or organic materials. As the temperature rises, material changes it's form from solid to liquid. This transformation absorbs and releases energy which is called latent heat. This allows for greater energy capacity compared to conventional thermal storage.	Latent heat thermal storage is placed in the heating network with a heat pump for example and it can be charged during the night time or times when heat is not required. Heat is released during the peak hours to increase the life time of the heat pump by reducing it's start times. Latent heat storage can also be placed for storing heat from CO2 cold cycle in markets and release it to DH network. Water acts as a heat transfer fluid between PCM and heat exchangers. PCM is encapsulated to ensure better heat transfer rate. 

Stakeholder Analysis

Developer (if relevant) Who has developed this solution?	Several developers, here VTT
Operator Who is operating this solution?	VTT for trials, later energy company and building owner

Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Energy company and building owner
Implementer Who is implementing this solution?	VTT for trials, later energy company and building owner
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
Depends on the price volatility of electricity and heat. The higher, the better for this. One-time investment Leasing

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Using heat pumps will increase temperature of Distric heating low temperature return water and store it in to latent heat thermal storage tank.	**Political:** No major barriers. As a part of sustainable energy systems may have some positive attraction, which is also probably increased by the novelty of the solution. **Economic:** Price compared to conventional tank is higher. This must be judged against smaller size and better properties for especially HP use. **Social:** Novelty may be an advantage, but also on the contrary **Technical:** Additional changes to heating installation may be necessary, since the output temp from PCM storage is quite constant. The changes are however quite ordinary technical adjustments and thus easy. **Environmental:** Phase change material used is not toxic. Potentially increases HP system COP and thus decreases the electricity consumption. Legal: No major barriers, if and when non-toxic PC materials are used.
Potential for Replication	**Expected Impacts - Benefits**
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	If the size of the thermal storage can be reduced compared to conventional storage tanks, interest towards it will increase. additionally if the energy capacity of it can be utilised fully it can solve some problems relating to drilling boreholes for energy storage. Since ground is used as a heat dump during the summer this could be possibly replace by using proper phase change materials. Problems regarding the thermal storage tanks usually are related to their size.

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

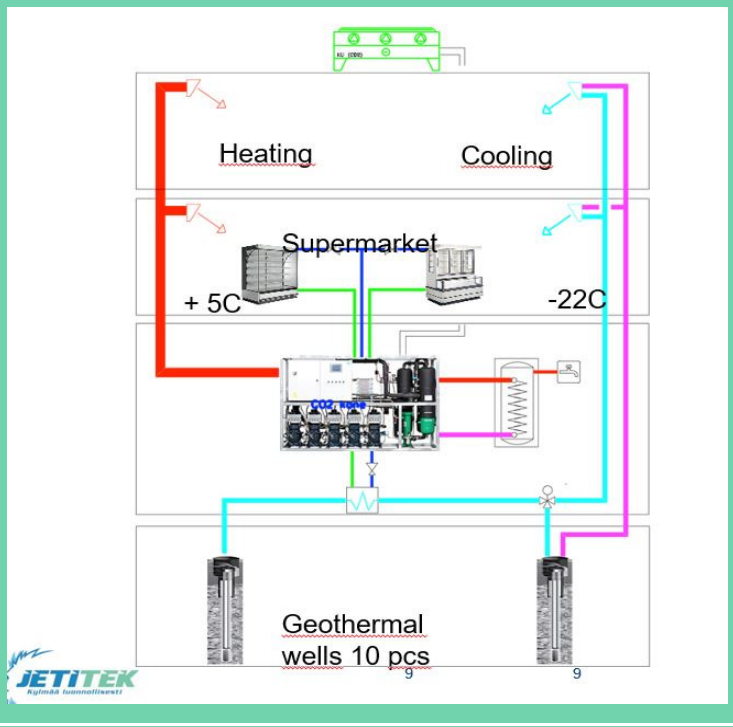
SYSTEM INTEGRATION SOLUTIONS

Category 3
INTEGRATED INFRSTRUCTURES

Solution 10
Thermal storage

Title	Graphical Detail

S10b Seasonal storage



Heat dwells are used to storage heat on sumer period
10 heat dwells are under the buiding, total lengt of the storage is 2,5 km

City / Country	Making_City	Technical Partner Name & contact Details	
	Yes / No	Jetitek (later Caverion)	
Implementation Time	2018-2019	Initial Investment	

What is Solution?	How does it work?
	The cooling of cold storages used temperatures from +10 to -22 C

Under the summer period the cooling of cold strorages in the shop creates lots of heat Normally this heat is evaporated to air with heat exchangers so all the enrgy is lost In this application the heat is stored to the ground IN the winter when extra heat is needed for the building and hot domestic water the heat will be recovered	These temperatures are created woth heat pumps using high pressurised CO2 (100 bars) The hot gas is condensed with compressor and then transferred to the heat dwells into the gound. Each dwell has got a pipe looping down from the surface, these pipes are connected together with a collector pipeline and htis pipeline has got heat exhcanger. This heat exchanger separated the heat collecting liquid from the highly pressurised CO2.

Stakeholder Analysis	
Developer (if relevant) Jetitek has deceloped the solution	Arina
System is operated by Jetitek	Arina
Customer(s) or user(s) Who is this solution targeting ? ARINA is using this system in the shopping centers and markets	Arina
Implementer New ipmlementations are developed for ice rinks, swimming pools and public biuldings	Arina
Financer How / By whom has the implementation of this solution been financed?	Arina is the financer
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
Municipal utility Cooperative utility Shared savings One-time investment Power purchase agreement

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
This solution is used together with heat pumps, please refer to SPEC_S4a	Political: Electricity storages have more hype for politics, but substance-wise thermal storages are in most of the cases far more profitable, since they are much cheaper per energy unit. Economic: To have the full advantage, electricity taxation and transmission pricing principle should be changed towards more effective than energy based and in addition to dynamic one, i.e. dependent on the system balance. This kind of development is in fact ongoing. Social: No significant impacts Technical: The technology has been known for decades and there are some well-working examples. The key issue is probably to have the suitable bedrock quality, to prevent the loss of heat with ground water. However, even in this case the system works, but then just as usual ground heat source, without recharging with waste heat. Environmental: Beneficial, since gives timely flexibility and thus helps in integrating variable renewables in the system. Legal: No significant impacts

Potential for Replication	Expected Impacts - Benefits
The system can be applied in Europe if the soils and regulation allows to make heat dwells	

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

SYSTEM INTEGRATION SOLUTIONS

Category 3
INTEGRATED INFRSTRUCTURES

Solution 10
Thermal storage

Title	Graphical Detail		
S10c Thermal Storage			
	General Data for the solution in bullets		
City / Country	**Making_City**	**Technical Partner Name & contact Details**	
	Yes	**SIV, JET,** VTT, OEN, ARI, OUK	
Implementation Time		**Initial Investment**	€ 64.000 (EU)

What is Solution?	How does it work?
The heat storage tank will be used to reduce the peak capacity for heat and also serves as a short term storage in 24 hours operating cycle	**A3: Thermal energy storage in building one** **A11: Thermal energy storage in building two** In building 1 and 2's heat tanks are planned to have a capacity each of 200 kWh (delta T 50ºC). The volume of this kind of heat tank with water is typically 3500 L. Conventional water will be replaced by a fluid with a phase transfer temperature of 60ºC, so the whole capacity of the heat tanks will be available on a narrow temperature range (from 55ºC to 65ºC). This makes the components an ideal solution to be used together with heat pumps and low temperature heat distribution networks. **A22: Thermal energy storage in Arina** In Arina, a phase transfer liquid heat tank will have a capacity up to 300 kWh (5000 L). The operating temperature is between 50ºC - 60ºC. This tank is used together with the heat pump and high pressure heat collector on the roof. It will also reduce the duty cycles of heat pumps in the winter time when they are used for heat generation

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	

Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
Municipal utility Cooperative utility Shared savings One-time investment Power purchase agreement

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** **Economic:** High initial cost, no financial sources **Social:** **Technical:** known technology, difficult to find space **Environmental:** **Legal:**

Potential for Replication	Expected Impacts - Benefits
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	General aspects about the solution.Could be technical, economical, environmental, social

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD	SYSTEM INTEGRATION SOLUTIONS
	Category 3 INTEGRATED INFRSTRUCTURES
	Solution 11 District Heating & Cooling Facilities
Title	Graphical Detail
S11a Low Temp regional transfer pipeline	
	General Data for the solution in bullets

City / Country	Making_City	Technical Partner Name & contact Details	
	Yes	OEN	
Implementation Time		Initial Investment	€ 46,000 (€14,000 EU)

What is Solution?	How does it work?
Low temperature heating pipes allows the heat transferred for heating to be in lower temperatures	The system uses lower temperatures (<60ºC) compared to regional heating (<110ºC) in heating and hot water production. Lower temperature means better economy in production, less losses in distribution and lower cost in building the distribution pipelines (plastic instead of steel piping). Using the lower temperature will also improve the COP of heat pumps. The extra investment in supplies (more powerful heat exchangers – Actions 4, 12 and 14), heating system) is paid back by the savings in energy cost. In the new solution this consists of internal heating water networks in the buildings and their connections via heat exchangers to larger district heating network

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
Energy cost reduction Municipal utility Cooperative utility Shared savings One-time investment Power purchase agreement

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** **Economic:** **Social:** **Technical:** **Environmental:** **Legal:**
Potential for Replication	**Expected Impacts - Benefits**
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	General aspects about the solution.Could be technical, economical, environmental, social

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

SYSTEM INTEGRATION SOLUTIONS

Category 3
INTEGRATED INFRSTRUCTURES

Solution 11
District Heating & Cooling Facilities

Title **Graphical Detail**

S11b Adjust geothermal district heating for using low temperature

General Data for the solution in bullets

City / Country	Making_City	Technical Partner Name & contact Details	
	Yes	**WAR**, NIJ	
Implementation Time		**Initial Investment**	€ 354,000 (€74,000 EU)

What is Solution?	How does it work?
The geothermal district heating network in Groningen NORTH is initially designed as a high temperature network. However the heating source has been changed to waste heat of datacenters instead of geothermal energy. The district heating network has been adjusted to an high to medium temperature district heating network. This means that the temperature would be approximately 75 °C in summer and up to 90 °C during cold days in the winter	To connect the retrofitted buildings of Nijestee to a high temperature heating network instead of gas, the existing local heating system has to be adjusted by installing a mix heat transformer. This innovated mix injection will be used to control the supply temperature to the apartments of Nijestee buildings independently from the supply temperature of the heat grid. The connection between the heat grid and the retrofitted buildings of Nijestee has been made last month. The last adjustments on the local heating system are currently made. WarmteStad will provide heat for the retrofitted buildings of Nijestee from the beginning of2021.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Municipal utility Cooperative utility Shared savings One-time investment Power purchase agreement

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Geothermal District Heating	**Political:** In this project the local government and the local politics are involved. Social unrest can lead to political questions. In this project questions from politicians are answered adequately. At the moment there is no open question/ barrier. **Economic:** The energy transition involves high costs. This requires investments from building owners, external financiers and from the heat company itself. **Social:** The population is increasingly aware of the fact that something needs to change and we need to combat the climat change. A positive trend is gradually emerging. Our customers understand why this project is needed. **Technical:** In general there can be more innovative techniques we don't know yet, which are better than the technique we will use. **Environmental:** With this project we will reduce the CO2 footprint. The switch from geothermal to residual heat has also increased the reduction of CO2. **Legal:** In the exploitation of our project we have to operate under the national heat law. In general this law is for protecting consumers for monopoly on heat. The coming years the law will change. The challenge is to be compliant to this law. For now we do comply

Potential for Replication	Expected Impacts - Benefits
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	General aspects about the solution.Could be technical, economical, environmental, social

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD	SYSTEM INTEGRATION SOLUTIONS Category 3 INTEGRATED INFRSTRUCTURES Solution 11 District Heating & Cooling Facilities		
Title	**Graphical Detail**		
S11c Connection to the low temperature district heat			
	General Data for the solution in bullets		
City / Country	**Making_City**	**Technical Partner Name & contact Details**	
	Yes / No		
Implementation Time		**Initial Investment**	€548.000 (€23.550 EU)

What is Solution?	**How does it work?**
In the PED South a collective aquifer thermal energy system (ATES) will be connected to a ground source heat pump of the Powerhouse and the Sportscomplex. **Technical data Sportscomplex** Heat pump central heating Brand: Simaka Type: Simatron WP 201/2 WW- R407C Heating power: 200 kW COP W10/W35: 6,02 COP W10/W45: 4,61 Heat pump domestic hot water production Brand: Simaka Type: Simatron WP 50/2 WW- R134a Heating power: 50 kW COP W10/W65: 4,0 Central heating: Expected energy consumption using a heat pump: 61.043 kWh Expected energy consumption using a traditional gas boiler: 36.932 m3 natural gas Avoided CO¬¬2 emissions in comparison with a traditional gas boiler: 37.323 kg CO¬2 Domestic hot water production: Expected energy consumption using a heat pump: 32.847 kWh Expected energy consumption using a traditional gas boiler: 16.826 m3 natural gas Avoided CO¬¬2 emissions in comparison with a traditional gas boiler: 14.354 kg CO¬2 Cooling	WarmteStad made for both the Sportscomplex and Powerhouse WarmteStad a connection with the ATES. In order to switch between groundwater for heating and groundwater for cooling a wheatstone bridge is installed. The groundwater is subsequently used as a source for the heat pumps or directly for passive cooling. WarmteStad has installed for both projects a high efficiency high-temperature heat pump. In the Sportscomplex are two heat pumps installed. One heat pump for central heating (weather-dependent controlled temperature between 35 °C and 45 °C) and one for domestic hot water production (65 °C). In the Powerhouse project is one heat pump installed for both central heating and domestic hot water production (65 °C)

Figure 17: Heat pump and heat exchanger Sportscomplex (October 2018).


Figure 18: Heat pumps and heat exchanger Powerhouse before installation (October 2019).

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	

Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
Municipal utility Cooperative utility Shared savings One-time investment Power purchase agreement

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** In this project the local government and the local politics are involved. Social unrest can lead to political questions. In this project questions from politicians are answered adequately. At the moment there is no open question/ barrier). **Economic:** The energy transition involves high costs. This requires investments from building owners, external financiers and from the heat company itself. **Social:** The population is increasingly aware of the fact that something needs to change and we need to combat the climate change. A positive trend is gradually emerging. Our customers understand why this project is needed. That helps us a lot. **Technical:** In general there can be more innovative techniques we don't know yet, which are better than the technique we will use. But this is for now no issue. **Environmental:** With this project we will reduce the CO2 footprint. **Legal:** In the exploitation of our project we have to operate under the national heat law. In general this law is for protecting consumers for monopoly on heat. The coming years the law will change. The challenge is to be compliant to this law. For now we do comply.

Potential for Replication	Expected Impacts - Benefits
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	General aspects about the solution.Could be technical, economical, environmental, social

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

SYSTEM INTEGRATION SOLUTIONS

Category 3
INTEGRATED INFRSTRUCTURES

Solution 12
Building energy connectivity for energy sharing

Title	Graphical Detail

S12a Building energy connectivity for energy sharing




CHP plant, biomass fuel + heat pumps -> DH network -> heat exchanger for consumer

- District heating (DH) network
- Also feeding heat from buildings to DH network is possible
- Both supply and return sides can be utilised for space heating and domestic hot water heating

City / Country	Making_City	Technical Partner Name & contact Details	
Oulu, FInland	Yes	Oulu Energy	
Implementation Time	Year 2020. DH network building is in place, connecting to it takes one day when the essential other construction works around the DH exchangers are in place.	**Initial Investment**	Ordinary DH exchanger round 3000-10000 euros, DH pipe construction underground > 100 e/m. Heat pump very roughly round 500 euros/heat-kW.

What is Solution?	How does it work?
Connection to district heating network. Apartment buildings use return pipe as a heat source with heat pump, in addition to the normal connection to the supply side. The grocery store feeds excess heat from refrigeration to supply.	District heating connects is usually used so that the heat only-boiler or combined heat only-boiler feeds heat into the network and consumers are connected by heat exchangers between heating water circuit in the building and primary circuit, i.e. the one which consists of underground DH pipes between heat production and buildings. The heat in common solution is taken from supply side and the cooled flow is fed on the return pipe. In this case also return pipe heat is used, mainly by heat pump that increases the temp so that it is suitable for heatinf and domestic hot water. In addition, in milder weather excess heat is fed from the building (grocery store) to the DH network. The prequisite is that supply temp is below about 85 C, which may take in about 0 degrees outside.

Stakeholder Analysis

Developer (if relevant) Who has developed this solution?	DH in general many developers e.g. in Finland from 60's on. Return pipe and excess heat supply e.g. Oulu Energy, Jetitek, GST and Arina.

Operator Who is operating this solution?	Oulu Energy
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Heat customer, i.e. the owner of the building. Also the energy company and with that all the customers can benefit from the solution.
Implementer Who is implementing this solution?	Oulu Energy
Financer How / By whom has the implementation of this solution been financed?	Oulu Energy
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	Jetitek and GST (heat pump suppliers), Arina (grocet store chain), Sivakka (rental housing company), YIT (construction company), inhabitants.

Business model patterns
Municipal utility Cooperative utility Shared savings One-time investment Power purchase agreement

Integration with other smart solutions	**BARRIERS / ENABLERS _ PESTEL STUDIES**
Good with especially those heat production methods, which benefit from economics of scale, like CHP, industrial excess heat, waste combustion, even small nuclear reactors. In more general, always when somebody has excess heat and the other need for it.	**Political:** May be seen as old-fashioned or vice versa, depending on the country and observer. Requires some central planning. **Economic:** Expensive to implement. High capital cost and risk of getting customers and keeping them. However, cheap energy sources can be used, i.e. low operating cost. **Social:** Price setting, its variability, depends on the markets. If the system has different kind of production methods (e.g. CHP and heat pumps with high capacity), the price may be quite stable. **Technical:** Well-known pratices, but also some new solutions exist. **Environmental:** Varies a lot. If properly set with a multiple set of energy sources, a flexible and environmentally sound system, potentially the best one. But can be also the opposite, in extreme when burning coal directly to heat (which is however nearly non-existent in Finland currently). **Legal:** Techno-economically it is of advantage to have obligatory joining to the network, but this of course is a reason for complaints and dissatisfaction. Generally legal issues are well arranged, with a lot of experience, in Nordic countries.

Potential for Replication	**Expected Impacts - Benefits**
Exists in practically all larger towns and cities in e.g. Finland, Sweden and Denmark. Replicability from scratch may involve quite high economical risk, but is technically generally possible especially when the heating need is large enough (peak load hours e.g. >2000/a) and heat consumption over round 2 MWh/a/pipe-m.	General aspects about the solution.Could be technical, economical, environmental, social

Relevant Publications / Presentations / Services / Products to this Solution

Reference Applications of this Solution

SPEC CARD

SYSTEM INTEGRATION SOLUTIONS

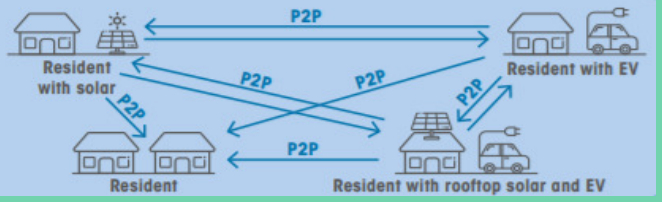
Category 3
INTEGRATED INFRSTRUCTURES

Solution 12
Building energy connectivity for energy sharing

Title	Graphical Detail

S12a Building energy sharing (P2P)

The P2P model creates an online marketplace where prosumers and consumers can trade electricity, without an intermediary, at their agreed price.



Peer-to-peer energy sharing
Source: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Jul/IRENA_Peer-to-peer_trading_2020.pdf?la=en&hash=D3E25A5BBA6FAC15B9C193F64CA3C8CBFE3F6F41

RES production and RES sharing

City / Country	Making_City	Technical Partner Name & contact Details	
	No	IRENA	
Implementation Time		**Initial Investment**	

What is Solution?	How does it work?
Peer-to-peer electricity trading is the business model associated with prosumers and consumers that allows them to share energy among theirselves, normally through a P2P platform, without the need of an intermediary. It can also aid in balancing and congestion management and providing anciallary services.	The common practice with traditional power supply is that consumers purchase electricity from utilities or retailers through fixed tariffs or time-of-use tariffs. In contrast, prosumers sell excessive electricty back to the grid at a "buy-back rate", which is usually at a lower price than that of from consuming energy. mote further deployment of these resources. In P2P electricity trading, prosumers are allowed to switch their roles between buyers and sellers to either purchase or sell electricity. In addition, they are able to directly trade electricity with other consumers to achieve a win-win by seeking a better outcome compared to the relatively high tariffs and the relatively low buy-back rates. It needs: smart meters to help monitor real-time power production and consumption, a Virtual layer for communication between participants, a software platform for P2P trading (can be a website or an app), algorithms to execute P2P transactions (can be done with blockchain), etc.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	it can be an energy community, a cooperative, etc.
Operator Who is operating this solution?	Someone that represents the community or the P2P platform/market operator
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	It is a win-win situation: prosumer benefits from a higher price than the "buy-back rate" and the consumer benefits from a price of consuming electricity lower than the electricity-tariff of the grid.

Implementer Who is implementing this solution?	SonnenCommunity in Germany, Vandebron in Netherlands. etc.
Financer How / By whom has the implementation of this solution been financed?	It can be financed by public entities OR by the prosumers within an energy community, a cooperative, etc.
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
Aggregators Peer-to-peer electricity trading Energy-as-a-service Community-ownership models Pay-as-you-go models

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Can be integrated in a PED, in a NZED; with demand response programmes, to offer ancialliary services (but it might need more technical knowledge). It could be integrated with thermal production as well, if the platform is prepared for that, and the district heating network allows the community to be a prosumer	**Political: S**upportive policies encouraging decentralisation of power systems and better utilisation of existing grid infrastructure; Encourage pilot programmes to work as a test bed, in regulatory sandboxes; and dissemination of results; Improve the access to capital for platform develope **Economic:** It needs capital for the RES installation, and the maintenance of the P2P platform **Social:** Price setting can be decided by the community, or by the prosumer **Technical:** Needs a platform **Environmental:** **Legal:** •Enable trade of power among prosumers and consumers without renewable generation capacities Establish regulations on data collection and access, as well as cybersecurity and privacy for platform owners/developers and platform members, i.e., peers Define clear roles and responsibilities of stakeholders involved in P2P Ensure that consumer rights are respected by stakeholders in P2P schemes Define market operation rules for the P2P schemes **More in: IRENA, PEER-TO-PEER ELECTRICITY TRADING INNOVATION LANDSCAPE BRIEF (2020)**

Potential for Replication	Expected Impacts - Benefits

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution

SPEC CARD

SYSTEM INTEGRATION SOLUTIONS

Category 3
INTEGRATED INFRSTRUCTURES

Solution 13
Heat Pumps

Title	**Graphical Detail**

S13a CO2 based heat pump

General Data for the solution in bullets

City / Country	**Making_City**	**Technical Partner Name & contact Details**	
Oulu, FInland	Yes	Jetitek, Arina	
Implementation Time	2019	**Initial Investment**	

What is Solution?	**How does it work?**
Refrigeration machines of the grocery store, which can also supply heat to district heating network.	Carbon dioxide is used as refrigerant, instead of F-gases. The advantage of CO2 as a refrigeant is that it allows high temperature difference between source and sink, with moderate coefficient of performance, i.e. the ratio beween output heat and input electricity. The hot gas coming from compressor is cooled down gradually (due to its transcritical state), which allows different temperatures taken out of the flow. Even if the carbon dioxide is a greenhouse gas, the warming effect of per mass unit is significantly lower than that of F-gases. This has importance, if there are leakages in the cooling system.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	Jetitek, among the others
Operator Who is operating this solution?	Arina

Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	The store owner, Arina in this case
Implementer Who is implementing this solution?	Jetitek
Financer How / By whom has the implementation of this solution been financed?	Arina
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	When excess heat is fed into the district heating network, the energy company and its customers

Business model patterns
Municipal utility Cooperative utility Shared savings One-time investment Power purchase agreement

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Distict heating network required to deliver the heat	**Political:** As an energy-saving concept supported by common policy **Economic:** A bit more expensive than system based on F-gases, but pays off rather quickly **Social:** No significant impacts **Technical:** CO2-refrigeration is an old system in principle, but only recently it has been developed to reliable level. E.g. high pressures must be taken into account. **Environmental:** Many benefits, no major barriers **Legal:** Legislation favours CO2 refrigeration, as F-gases get more and more restrictions

Potential for Replication	Expected Impacts - Benefits
Very high potential, can be applied in princinple to all stores, which need refrigeration equipment	Lower electricity consumption for cooling, possibility to feed the excess heat to DH network

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

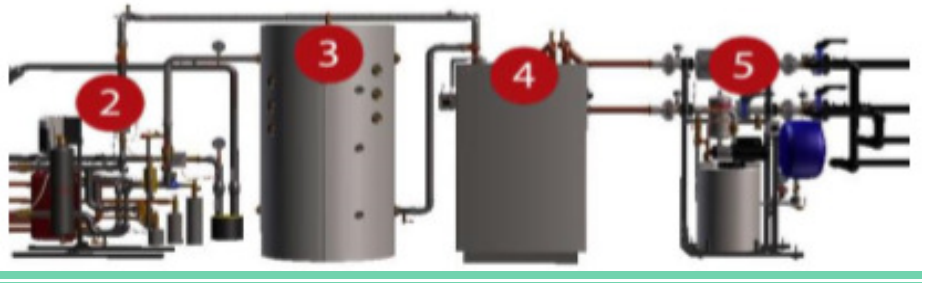
SYSTEM INTEGRATION SOLUTIONS

Category 3
INTEGRATED INFRSTRUCTURES

Solution 13
Heat Pumps

Title	Graphical Detail

S13b Advanced Heat Pump (high COP)



- Exhaust air heat pump
-The system has also heat exchanger from DH network
- Heat factor (output/input) is about 4

City / Country	Making_City	Technical Partner Name & contact Details	
Oulu, FInland	Yes	Oulu Energy / Sivakka	
Implementation Time	2019-2020	**Initial Investment**	About 2000 euros / heat-kW

What is Solution?	How does it work?
Exhaust air (multi-source) heat pump	Heat is gained from exhaust air, which is extracted mechanically, using fans, from bathrooms, toilets and kitchens. This is a commonplace solution in Finland. In new buildings the heat in exhaust air is recovered by air-to-air heat exchanger to incoming fresh air, but if that system lacks in existing buildings, it is expansive to install afterwards. Therefore it may make sense to take the heat out of the exhaust air with heat pump (HP) and increase the temperature so that it can be used for heating and domestic water (min. 55 C for DHW). Here this kind of HP is implemented. The system is modular, i.e. built using modules, which are easy to install and replace when needed. The whole installation includes also the heat exchanger from DH network together with HP. The system optimizes the parallel use of these sources. Coefficient of performance (COP) is around 4, when heating water from 10 to 60 C and air source has a temperature of 20 C.

Stakeholder Analysis

Developer (if relevant) Who has developed this solution?	Many developers
Operator Who is operating this solution?	Oulu Energy / Sivakka
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Owners of all the buildings, which do not have exhaust air heat recovery already
Implementer Who is implementing this solution?	Oulu Energy / Sivakka
Financer How / By whom has the implementation of this solution been financed?	Oulu Energy / Sivakka

Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	The tenants, even if they will probably notice at all that this has been installed. If the solution is feasible, the rents can be kept moderate and stable.

Business model patterns
Municipal utility Cooperative utility Shared savings One-time investment Power purchase agreement

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
No obligatory other solutions in connection with this, but in this case HP is used together with DH	**Political:** Politically favourable, as potentially decrease the energy consumption and emissions **Economic:** Pay-back time may be quite long, especially in system level. However, if properly implemented and used, feasible investment in long term. **Social:** No significant impact. May help to keep the living cost tolerable. **Technical:** Readily available technology, even if there are still details which can be still improved. In this case the target is a turn-key delivery. **Environmental:** Depends on the ratio of emissions from electricity (for HP) and the alternative heating method. Especially when used as a "smart", i.e. timely flexibly used component, potentially decreases the emissions. **Legal:** No major barriers. Building legislation gives benefit for the well-designed systems of this type.

Potential for Replication	Expected Impacts - Benefits
Very high potential for replication. Suitable for all buildings, which have no heat recovery from exhaust air and more or less centralized exhaust air outtake.	Decreases the net energy consumption by e.g. 40%. But, heat is partly replaced by electricity use, so the total benefit depends on the ratio of values of heat and electricity.

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

SYSTEM INTEGRATION SOLUTIONS

Category 3
INTEGRATED INFRSTRUCTURES

Solution 13
Heat Pumps

Title	**Graphical Detail**		
S13c Acoustic Air Heat Pump			
	- Heat pump with less noise		
City / Country	**Making_City**	**Technical Partner Name & contact Details**	
Groningen	Yes	**GPO**, GRO	
Implementation Time		**Initial Investment**	€ 13,000 (€ 7.000 EU)

What is Solution?	**How does it work?**
	The sound effects are significantly lower compared to regular heat pumps.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Municipal utility Cooperative utility Shared savings One-time investment Power purchase agreement

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** Enabler **Economic:** Currently too expensive, but technique has not yet fully penetrated the market. **Social:** Reduction of noise **Technical:** **Environmental:** Reduces CO2 emissions **Legal:** Can become an enabler
Potential for Replication	**Expected Impacts - Benefits**
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	General aspects about the solution.Could be technical, economical, environmental, social

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

SUPPLY SIDE SOLUTIONS

Category 3
INTEGRATED INFRSTRUCTURES

Solution 13
Heat Pumps

Title	Graphical Detail

S13d Hybrid heat pump

gas-driven co2 efficient heat pump

City / Country	Making_City	Technical Partner Name & contact Details	
	NO	BOOSTHEAT, https://www.boostheat-group.com/en/about-us/boostheat-20/the-most-energy-efficient-boiler-in-the-world	
Implementation Time		Initial Investment	

What is Solution?	How does it work?
The BOOSTHEAT.20 is designed to heat individual households and is fueled by gas combustion and the temperature of the surrounding air. It has a capacity of 20kW	The BOOSTHEAT.20 is a two-in-one product that combines the eco-friendliness of a heat pump with the proven efficiency of a condensing boiler. The hybrid design gives you nothing but the best of both worlds. The refrigerant is CO_2,has allowed us to design extremely robust technologies where the fluid is securely confined, making it more sustainable. The unit guarantees maximum efficiency down to an outside temperature of -22C. This performance is achieved through two innovations: Thermal compressor allows renewable energy to be captured at temperatures down to -10C. BOOSTHEAT hybrid design uses a condensing boiler to gradually compensate for the heat pump's loss of efficiency, providing a much better performance than an electrical heating element. *Company estimate based on external laboratory test reports (CETIAT and Gas.be): 188% in aerothermal application (A7) | 229% in geothermal application (W10)

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	BOOSTHEAT

Operator Who is operating this solution?	BOOSTHEAT
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	individual households
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Can be coupeld with district heating substations to become a prosumer; or to supply the network	**Political:** As an energy-saving concept supported by common policy **Economic:** A bit more expensive than system based on F-gases, but pays off rather quickly **Social:** No significant impacts **Technical:** CO2-refrigeration is an old system in principle, but only recently it has been developed to reliable level. E.g. high pressures must be taken into account. **Environmental:** Many benefits, no major barriers **Legal:** Legislation favours CO2 refrigeration, as F-gases get more and more restrictions

Potential for Replication	Expected Impacts - Benefits
Medium (the disadvantage is that it consumes natural gas)	Very low electricity consumption compared to traditional heat pumps. Only used in heating and dhw mode

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD	SUPPLY SIDE SOLUTIONS
	Category 3 INTEGRATED INFRSTRUCTURES
	Solution 13 Heat Pumps
Title	Graphical Detail

S13d Water-water (or geothermal-water) heat pump

water-water/ ground-water / brine-water heat pump

City / Country	Making_City	Technical Partner Name & contact Details	
	NO	ECOFOREST https://ecoforest.com/es/bombas-calor/geotermica/geotermia/133-ecogeo-hp-alta-potencia	
Implementation Time		Initial Investment	

What is Solution?	How does it work?
It is a standard heat pump, with advanced control strategies, that is capable of achieving the best performance. It can be coupled with ground, air or water Power ranges: 12-40 kW / 15-70 kW / 25-100 kW	The ecoGEO HP heat pump is capable of meeting demands for domestic hot water, heating and cooling simultaneously, working in waterfalls of up to 600kW (6 units) and using **various capture sources (geothermal, aerothermal, wastewater ...)** with advanced control strategies and therefore, saving energy (COP of up to 4.6 for heating with B0/W35, and EER of up to 5.2 with B35/W7) Can be connected with an app, photovoltaic installatiosn, etc.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	ECOFOREST

Operator Who is operating this solution?	ECOFOREST
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	households, apartment buildings, offices, etc.
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Can be coupeld with district heating substations to become a prosumer; or to supply the network	**Political:** As an energy-saving concept supported by common policy **Economic:** A bit more expensive than system based on F-gases, but pays off rather quickly **Social:** No significant impacts **Technical:** CO2-refrigeration is an old system in principle, but only recently it has been developed to reliable level. E.g. high pressures must be taken into account. **Environmental:** Many benefits, no major barriers **Legal:** Legislation favours CO2 refrigeration, as F-gases get more and more restrictions

Potential for Replication	Expected Impacts - Benefits
High	Low electricity consumption compared to traditional heat pumps. Can be used in heating, dhw and cooling mode

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

SUPPLY SIDE SOLUTIONS

Category 4
RENEWABLE ENERGY SYSTEMS

Solution 14
Solar PV Panels

Title	Graphical Detail

S14a PV in roofs

Part of the PV on Nijestee flat 1 (left) and Nijestee flat 2 (right).

- PV implementation on roofs
- PV implementation on parking lot

City / Country	Making_City	Technical Partner Name & contact Details	
Groningen	Yes	**NIJ,** GPO, WAM, GRO	
Implementation Time		**Initial Investment**	

What is Solution?	How does it work?
PV in roofs and parking lot (600 kWp) ***Terraced Houses, (3.14 kWp), GPO** After the selection of the three terraced houses completed, the number of PV panels and the capacity will be decided. ***Nijestee flats, (50 kWp), NIJ** 33 kWp has been implemented. Space has been left open on the roof for 20 extra PV panels or around 10 PVT panels per building	Application description, figures if needed

*Mediacentrale, Building, (77.6 kWp), parking lot (131.1 kWp), WAM GRO is investigating the possibility of realizing innovative PV on a parking lot within the PED boundaries *Sport Complex, (335.3 kWp), GRO The building contains 1040 PV panels, each 280 Wp	

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
With the generation of electricity the energy bills will reduce significantly Space rental Municipal utility Cooperative utility Shared savings One-time investment Power purchase agreement

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** PV is generally accepted as standard solution to increase energy balance. **Economic:** The BC is valid for regular PV. **Social:** Positive **Technical:** PV keeps improving its performance, but there are no constraints **Environmental:** **Legal:**

Potential for Replication	Expected Impacts - Benefits
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	General aspects about the solution.Could be technical, economical, environmental, social

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

SUPPLY SIDE SOLUTIONS

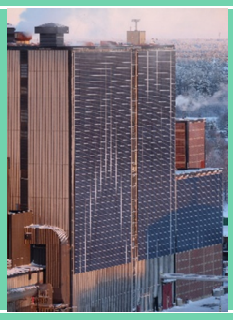
Category 4
RENEWABLE ENERGY SYSTEMS

Solution 14
Solar PV Panels

Title	Graphical Detail

S14b Building Integrated PV (on the façade)

On the left PV panel placement on Sivakka building, on the right other examples from Northern



Southern facade covered by vertical solar panels

City / Country	Making_City	Technical Partner Name & contact Details	
Oulu	Yes	Sivakka	
Implementation Time		Initial Investment	€ 53,000 (€18,200 EU)

What is Solution?	How does it work?
An apartment house from 70's has its southern facade covered with PV panels.	When maximising the production of solar, also vertical planes should be used. This gives not only more area, but also a favourable monthly gain of solar power. In Nordic climate enrgy is needed most in the wintertime or, with in this case better definition, outside summertime. Vertical panels may have e.g. 10% lower annual total gain than the "usual ones" with 45...60 degrees angle, but especially in springtime the production of vertical planes may be even manifold compared to angled ones.

Stakeholder Analysis

Developer (if relevant) Who has developed this solution?	Many developers
Operator Who is operating this solution?	Sivakka
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Sivakka or building owner in general
Implementer Who is implementing this solution?	Oulu Energy and Sivakka
Financer How / By whom has the implementation of this solution been financed?	Oulu Energy /Sivakka
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	If the solution is feasible, finally the tenants benefit from this.

Business model patterns

Energy consumption decrease due to the use of heat pumps leads to bill decrease
Power purchase agreement
White label retailing
Leasing

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
If own consumption can be directed towards solar production, especially so that the peak loads are cut, it gives additional advantage	**Political:** Subsidies available in many countries, i.e. PV has political support **Economic:** Long pay-back time **Social:** Positive and visible image from panels **Technical:** Fastening the panels to the vertical plane requires some special attention, but if skilfully done, no special barriers **Environmental:** Vertical installation is advantageous in terms of system impact and emission reduction (more production in cold seasons) **Legal:** No major issues
Potential for Replication	**Expected Impacts - Benefits**
Medium replicability. Shading, which is common in especially urban areas, limits the applicability. The panels are also not suitable for all kind of architectural styles.	Environmental benefits and a bit smaller and more predictable electricity bill
Relevant Publications / Presentations / Services / Products to this Solution	
Reference Applications of this Solution	

SPEC CARD	SUPPLY SIDE SOLUTIONS
	Category 4 RENEWABLE ENERGY SYSTEMS
	Solution 14 Solar PV Panels
Title	Graphical Detail
S14c Floating Solar pontoons	
	General Data for the solution in bullets

City / Country	Making_City	Technical Partner Name & contact Details	
Groningen	Yes	GRO	
Implementation Time		Initial Investment	€217,000 (€105,000 EU)

What is Solution?	How does it work?
In the surrounding area of the Sport Complex building [A6] floating solar pontoons are planned. 180 panels (156 kWp) are allocated. These very innovative doubled-sized floating panels will make full use of the reflecting properties of the water allowing the usage of two-sided solar panels increasing the yield of solar power. The intention is to implement more panels than was originally considered in order to maximize the solar energy production and to make a more solid business caseç	Application description, figures if needed

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	Groningen
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

The energy bill savings achieved by the PVs will be used in other investments Power purchase agreement Municipal utility With label retailing Leasing

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** Competition between building, energy and environmental department. **Economic:** **Social:** It is preferred that the profits are reinvested in district energy measures. **Technical:** Building on water can be done, but is also a challenge **Environmental:** Can be both an enabler and barrier. The goal is building with nature (Groningen, A15, p.40).
Potential for Replication	**Expected Impacts - Benefits**
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	The city of Groningen is investigating the possibilities of exploiting RES in public area's and reinvesting the profits in the district energy planning measures.

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

SUPPLY SIDE SOLUTIONS

Category 4
RENEWABLE ENERGY SYSTEMS

Solution 14
Solar PV Panels

Title	Graphical Detail

S14d Solaroad

City / Country	Delft	SolaRoad BV, www.solaroad.nl	
	Yes / No		
Implementation Time	months.	Initial Investment	

What is Solution?	How does it work?
SolaRoad's products are based on a simple concept. Robust solar panels with a skid resistant, translucent coating are mounted on a concrete slab. The concrete provides support and loading capacity, the solar panel generates electricity from the sunlight, the coating protects the solar panel, and offers skid resistance for the traffic. The combination is a robust road surface, offering safety and comfort to bikes or vehicles, while harvesting electricity from the sun.	through the integration of photovoltaic material in a road element, covered with a friction providing transparent coating renewable energy is produced. The PV modules are connected to micro inverters which ensure safety, shading tolerance and optimal yield. The electricity is transported to connection boxes where it is either fed back into the grid or can be used locally. This depends on the application.

A16: SolaRoad (70 kWp) GRO

The implementation of the SolaRoad is planned to be in parallel with the construction of a new bicycle lane that is also planned in the area. New to this is the desire that also small motorised vehicles should be able to pass the lane (Groningen, A16, p.40).	

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	Road authority
Operator Who is operating this solution?	N/A
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Road authority
Implementer Who is implementing this solution?	road construction company
Financer How / By whom has the implementation of this solution been financed?	road authority
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
the renewable energy generated can either be sold on the energy market, or used to reduce the energy costs of the owner. Power purchase agreement Municipal utility White label retailing

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
the combination with the electrification of transport is highly appealing. (the combination with smart charging for instance).	Political: What is the value of integration? (this solution is non0-invasive). The market is a governmental market. A steady market growth is crucial for investors to further develop this concept. Economic: investment cost must, and will decrease when volume grows. Social: the fact that is is perfectly integrated (instead of other renewables) makes that there is a high social acceptance. Technical: durability is still under research. the concept itself is proven. Interesting research potential Environmental: The product is under development, amongst others to increase the EOL scenario of the solution. Double use of space, no need for asphalt Legal: for (very) large scale applications the energy production by road authorities might become an issue. Possible need for more heavy vehicles

Potential for Replication	Expected Impacts - Benefits
system is installed in 2014 in Krommenie, since then multiple projects in the Netherlands and France are realized.	

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

SUPPLY SIDE SOLUTIONS

Category 4
RENEWABLE ENERGY SYSTEMS

Solution 14
Solar PV Panels

Title	Graphical Detail

S14e Parking Lot Solar Canopy

@SOLARWATT https://www.pveurope.eu/solar-generator/self-sufficient-solar-parking-lot-dresden

PV implementation on parking lot. Can be combined with e-charging points

City / Country	Making_City	Technical Partner Name & contact Details	
Dresden	No	**SolarWatt**	
Implementation Time		**Initial Investment**	

What is Solution?	How does it work?
It has six parking spaces shelves under a solar carport with charging options and 42 additional parking lots.	The internet of things platform of the Dresden-based company Kiwigrid, in conjunction with a Solarwatt photovoltaic system, ensures that solar modules, electricity storage, charging stations and the public grid communicate with each other. The charging stations and the LED lighting

	communicate with each other. The charging stations and the LED lighting system are supplied solely with solar energy.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
With the generation of electricity the energy bills will reduce significantly Space rental Municipal utility Cooperative utility Shared savings One-time investment Power purchase agreement

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** PV is generally accepted as standard solution to increase energy balance. **Economic:** If it is a private/public parking, it can provide incomes from the e-charging point use and also the access to the parking. If it is residential, it provides shadows and can decrease costs of bills (net metering) **Social:** Positive. It provides shadows to the cars **Technical:** PV keeps improving its performance, but there are no constraints. **Environmental:** One space for multiple uses (parking, generation and possible e-charging point)
Potential for Replication	**Expected Impacts - Benefits**
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	General aspects about the solution.Could be technical, economical, environmental, social

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

SUPPLY SIDE SOLUTIONS

Category 4
RENEWABLE ENERGY SYSTEMS

Solution 14
Solar PV Panels

Title	Graphical Detail

S14f Bifacial PV or PV with agriculture

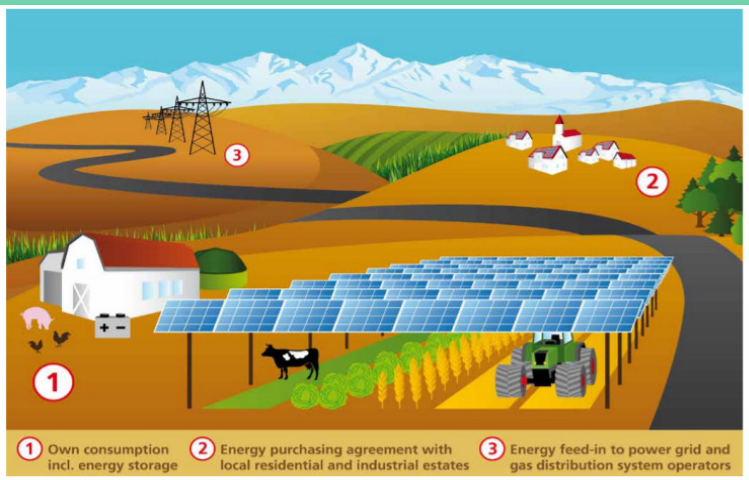


Figure 1: Illustration of an agrivoltaic system. © Fraunhofer ISE

https://www.ise.fraunhofer.de/content/dam/ise/en/documents/publications/studies/APV-Guideline.pdf

PV implementation on parking lot. Can be combined with e-charging points

City / Country	Making_City	Technical Partner Name & contact Details	
Heggelbach/Germany	No	Franhofer ISE	
Implementation Time		**Initial Investment**	

What is Solution?	How does it work?
Winter wheat, potatoes, celery, and a grass/clover mixture were grown as test crops under the agrivoltaic system in Heggelbach. A larger row distance between the bifacial glass-glass solar modules at a height of more than seven meters and the south-west alignment ensure that the crop plants receive a sunlight distribution as even as possible. The 5m	Fruit and special crops that are increasingly affected by hail, frost, and drought damage may benefit from the protection provided by the partial roofing with PV modules. Agrivoltaics enables the dual use of arable land: Photovoltaic modules, which are mounted on a structure, generate renewable electricity and underneath

clearance height and distance between the supports also permits cultivation with large agricultural machines such as combine harvesters with no major restrictions. On average, the installed capacity of the research plant is sufficient to supply 62 four-person households annually	agricultural crops grow. The approach increases land efficiency and could mitigate conflicts over the use of arable land in the future.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	ESCO/Farmers/Cooperative, etc.
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Farmers
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

With the generation of electricity the energy bills will reduce significantly. Also farmers can benefit from the shadows to grow specific crops that do no need so much direct radiation.
Space rental/Farmers
Cooperative utility
Shared savings
One-time investment
Power purchase agreement

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** PV is generally accepted as standard solution to increase energy balance. **Economic:** it can provide incomes from the crops and PV **Social:** **Technical:** PV keeps improving its performance, but there are no constraints. **Environmental:** One space for multiple uses: increase in land use efficiency between 60 and 84 percent as well as improved adaptability during dry periods **Legal:**

Potential for Replication	Expected Impacts - Benefits

Relevant Publications / Presentations / Services / Products to this Solution

Reference Applications of this Solution

SPEC CARD

SUPPLY SIDE SOLUTIONS

Category 4
RENEWABLE ENERGY SYSTEMS

Solution 15
Solar Thermal Panels

Title	Graphical Detail
S15a Hybrid Heat collector (high preassurised CO2)	
	General Data for the solution in bullets

City / Country	Making_City	Technical Partner Name & contact Details	
Oulu	Yes	**JET;** VTT	
Implementation Time		**Initial Investment**	€28,000 (all EU)

What is Solution?	How does it work?
Low temperature heat collectors will be used in Arina to collect heat even from very low temperatures (-20ºC). The normal vacuum tube type of heat collector is able to harvest energy only when the sun is shining. A new type of heat collector is using high pressurized CO2 to collect heat also in the night time. The new collector is made by open end technology and can collect heat from radiation and from surrounding air. This type of heat collector is efficient because it collects energy 24 hours a day.	Application description, figures if needed

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Power purchase agreement
White label retailing

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Used as a heat source of a heat pump. Well suited to be used with HP for grocery store refriregration, feeding the heat to district heating network.	**Political:** No major barriers **Economic:** To be seen. Low temperature differences and air speeds in the surface increase the needed surface area and thus the size of the collector, but on the other hand the device is possible to build robust and simple. **Social:** No major barriers **Technical:** To have defrosting performing properly is essential **Environmental:** No major barriers **Legal:** No major barriers
Potential for Replication	**Expected Impacts - Benefits**
High potential for replicaton. In the countries with milder climate, the use range is even higher than in Finland and COP better.	Widening of the potential heat sources for heat pumps, also in places, where geothermal heat is not available or too expensive.

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

SUPPLY SIDE SOLUTIONS

Category 4
RENEWABLE ENERGY SYSTEMS

Solution 15
Solar Thermal Panels

Title	Graphical Detail
S15b PVT Panels	
	- Photovoltaic Thermal panels to be implemented in different parts of the city

City / Country	Making_City	Technical Partner Name & contact Details	
Groningen	Yes	NIJ for Nijestee, GRO for Sport Complex	
Implementation Time		**Initial Investment**	

What is Solution?	How does it work?
The 88 (200 m2) PVT panels in Sport Complex (type: PowerCollectors) have been placed on top of the sport complex building by Solaris. Heat: 114 kWp, Electricity: 22.8 kWp with 88 panels	Both heat and electricity is generated. These types of innovative solar collectors generate 3 times as much energy compared to regular PV. The heat production is mainly used for the balance of the geothermal district heating system and thereby contributes to the RES of the district heating system. The generated electricity is used for the energy balance of the building.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Power purchase agreement White label retailing

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** Enabler **Economic:** Positive BC **Social:** **Technical:** Very interesting connection with geothermal heat pump system. Optimal use of space. **Environmental:** Avoids CO2 emissions **Legal:**
Potential for Replication	**Expected Impacts - Benefits**
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	General aspects about the solution.Could be technical, economical, environmental, social

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

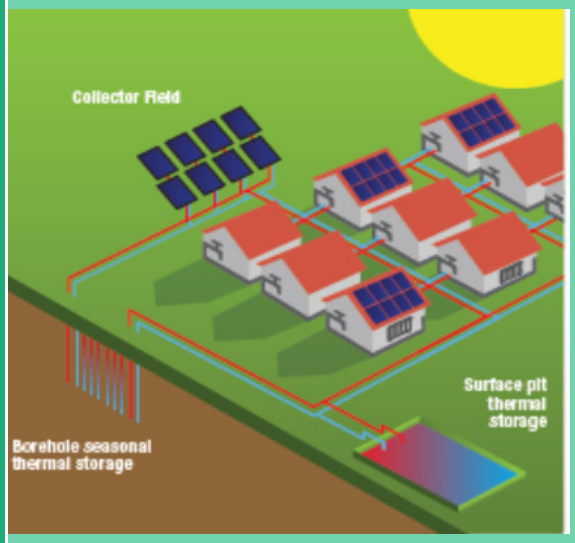
SUPPLY SIDE SOLUTIONS

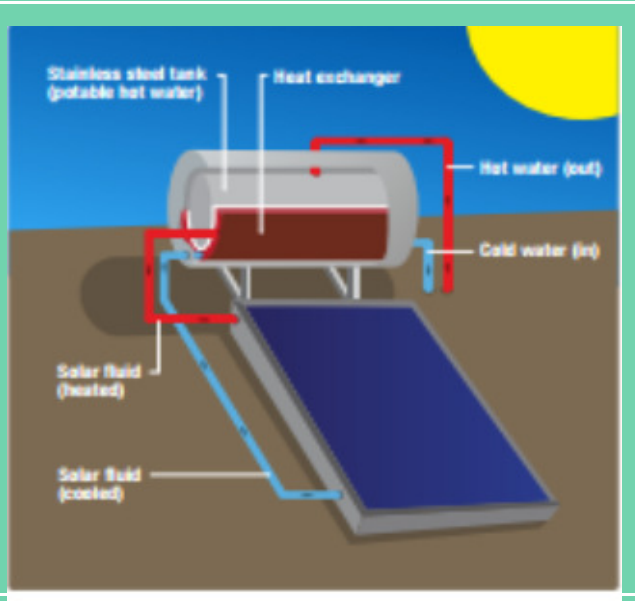
Category 4
RENEWABLE ENERGY SYSTEMS

Solution 15
Solar Thermal Panels

Title	Graphical Detail

S15c Flat plate collectors





http://solarheateurope.eu/about-solar-heat/solar-heat-what-is-it/

City / Country	Making_City	Technical Partner Name & contact Details	
	NO		
Implementation Time		Initial Investment	

What is Solution?	How does it work?
a Flat Plate Collector (FPC) is a solar thermal panel, that collects the solar radiation (thanks to the transparent cover and the absorber plate with good solar characteristics) and transfer it to a fluid (in FPC the fluid is a mixture of water and glycol to avoid freezing). There are different types of panels, with different configurations. The usual temperature range is from 60 to 90ºC. In case of High Vacuum Solar Thermal Flat Plates, which don't use mirrors: there might be some that can reach from 80 to 180ºC (such as TVP Solar Thermal panels).	The basic principle common to all solar heat systems is simple: solar radiation is collected and the resulting heat conveyed to a heat transfer medium – usually a fluid but also air in the case of air collectors. The heated medium is used either directly (to heat tap water for example) or indirectly by means of a heat exchanger which transfers the heat to its final destination (for instance in space heating or industrial process heat). It can be applied individually per buildings, or in a district heating system. In Silkeborg (Denmark) there is a plant of 110 MWth covering 20% of the annual heating demand of the municipality, through the integration of solar thermal panels in the district heating system Usually if solar thermal is used for district heating, seasonal heat storage is recommended (borehole storage in the ground or a surface pit, etc.) In the solar heat europe association there are different factsheets, that you can check to know more about different application of solar thermal panels http://solarheateurope.eu/publications/factsheets/

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Residential houses, any tertiary building with space heating or domestic hot water demands, etc.
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Can be coupled with short thermal storage (such as water or mixture of water-glycol tanks), Phase Change materials, geothermal (for storage) or seasonal storages.	**Political:** Enabler **Economic:** Positive **Social:** **Technical:** Very interesting connection with solar district heating or cooling networks. **Environmental:** Avoids CO2 emissions **Legal:**
Potential for Replication	**Expected Impacts - Benefits**

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

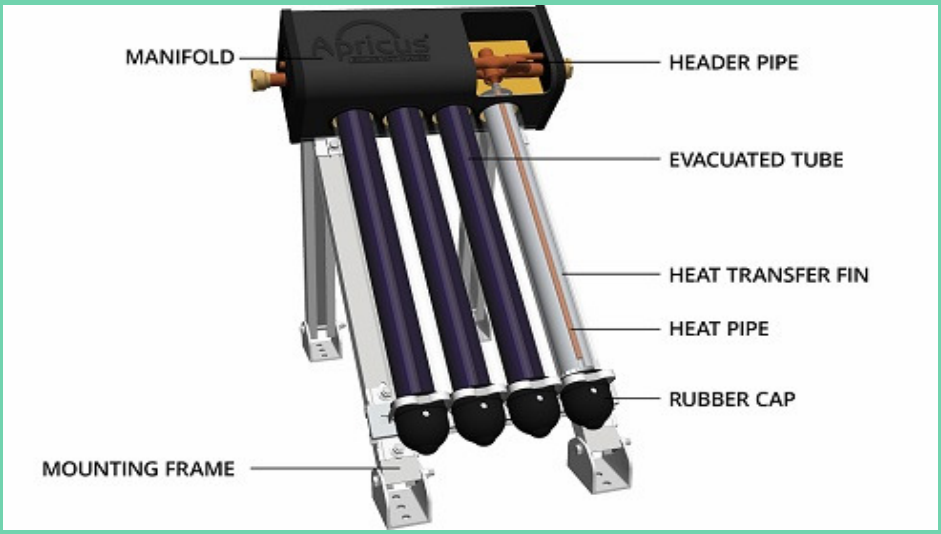
SUPPLY SIDE SOLUTIONS

Category 4
RENEWABLE ENERGY SYSTEMS

Solution 15
Solar Thermal Panels

Title	Graphical Detail

S15d Evacuated tube collectors



https://apricus.com.au/evacuated-tube-solar-hot-water-systems/

City / Country	Making_City	Technical Partner Name & contact Details	
	NO		
Implementation Time		Initial Investment	

What is Solution?	How does it work?
a Evacuated tube collector is a solar thermal panel, that collects the solar radiation and transfer it to a fluid. vacuum between the two glass layers insulates against heat loss. At the manifold, the fluid inside the tubes exchanges heat with the water going to supply the demand. The usual temperature range is : 80 to 150ºC up to 180 ºC	The basic principle common to all solar heat systems is simple: solar radiation is collected and the resulting heat conveyed to a heat transfer medium – usually a fluid but also air in the case of air collectors. The heated medium is used either directly (to heat tap water for example) or indirectly by means of a heat exchanger which transfers the heat to its final destination (for instance in space heating or industrial process heat). It can be applied individually per buildings, or in a district heating system. In the solar heat europe association there are different factsheets, that you can check to know more about different application of solar thermal panels http://solarheateurope.eu/publications/factsheets/

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Residential houses, any tertiary building with space heating or domestic hot water demands, etc.
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Can be coupled with short thermal storage (such as water or mixture of water-glycol tanks), Phase Change materials, geothermal (for storage) or seasonal storages.	**Political:** Enabler **Economic:** Positive **Social:** **Technical:** Very interesting connection with solar district heating or cooling networks. **Environmental:** Avoids CO2 emissions **Legal:**
Potential for Replication	**Expected Impacts - Benefits**

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

SUPPLY SIDE SOLUTIONS

Category 4
RENEWABLE ENERGY SYSTEMS

Solution 16
Geothermal energy

Title	Graphical Detail

S16a Geothermal energy

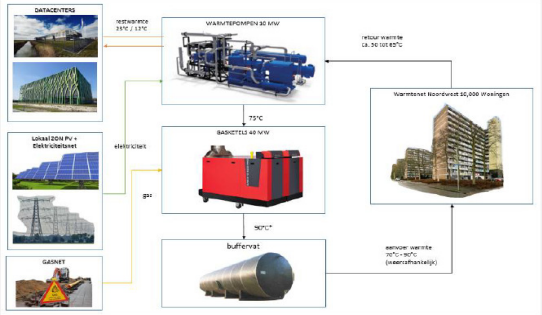


Figure 13: Schematic overview district heating network North PED.

General Data for the solution in bullets

City / Country	Making_City	Technical Partner Name & contact Details	
Groningen	Yes / No		
Implementation Time		**Initial Investment**	

What is Solution?	How does it work?
Geothermal District Heating WAR Two District Heating systems based on RES are located in PED North and PED South and will be the main responsible to supply thermal energy to the buildings located in both PEDs. Within Warmtenet Noordwest some 10,000 – 12,000 households equivalents will be supplied with sustainable heat via an alternative heating district network. The waste heat from two datacenters (Bytesnet and QTS) will be used for the heating.	WarmteStad receives according to forecasts 1,5 MW waste heat from with a temperature of 23°C. WarmteStad extracts 5°C of the waste heat which is used to raise the return water of the district heating from 50 °C up to 75 °C by using Heat pumps. If necessary during the winter we can raise the temperature up to 90 °C by using a CHP and/or gas boilers.

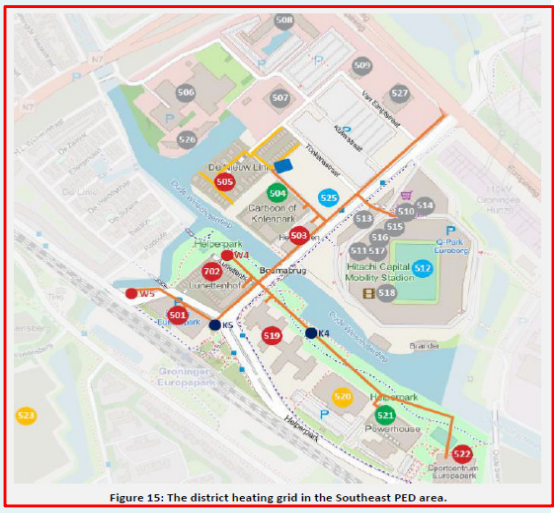


Figure 15: The district heating grid in the Southeast PED area.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
Power purchase agreement Municipal utility Coperative utility White label retailing

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** In this project the local government and the local politics are involved. Social unrest can lead to political questions. In this project questions from politicians are answered adequately (at the moment there is no open question/ barrier). **Economic:** The energy transition involves high costs. This requires investments from building owners, external financiers and from the heat company itself. **Social:** The population is increasingly aware of the fact that something needs to change and we need to combat the climate change. A positive trend is gradually emerging. Our customers understand why this project is needed. **Technical:** In general there can be more innovative techniques we don't know yet, which are better than the technique we will use. But this is for now no issue. **Environmental:** With this project we will reduce the CO2 footprint. **Legal:** In the exploitation of our project we have to operate under the national heat law. In general this law is for protecting consumers for monopoly on heat. The coming years the law will change. The challenge is to be compliant to this law. For now we do comply(Groningen, A27, p.53-54).
Potential for Replication	**Expected Impacts - Benefits**
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	General aspects about the solution.Could be technical, economical, environmental, social

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

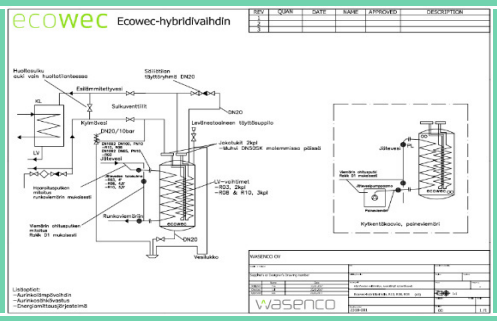
SUPPLY SIDE SOLUTIONS

Category 4
RENEWABLE ENERGY SYSTEMS

Solution 17
Waste Heat Recovery

Title	Graphical Detail

S17a Heat recovery system from sewage water



- Heat recovery from wastewater in apartment buildings
- Passive system without heat pump
- Intermediate, protective water layer between sewage and fresh water

City / Country	Making_City	Technical Partner Name & contact Details	
Oulu, Finland	Yes	Sivakka	
Implementation Time	2019-2020	**Initial Investment**	

What is Solution?	How does it work?
Heat recovery from wastewater to pre-heat cold water for hot tap water	Sewage water from apartments is led through a large-diameter pipe spiral, which is in the water tank. In the tank there is another heat exchanger, from the tank water to fresh, incoming water, for hot tap water pre-heating. The whole installation is made of stainless steel. The tank with exchanger inside is located in the lowest point of the sewage system in the building, to avoid pumping. The efficiency of the recovery is about 20%. In other words, the incoming water is heated by about 10 degrees.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	Wasenco
Operator Who is operating this solution?	Sivakka
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Building owner

Implementer Who is implementing this solution?	Building owner
Financer How / By whom has the implementation of this solution been financed?	Building owner
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	"Invisible" solution but if it works propersly, finally the tenants get an advantage, in addition to environmental gains

Business model patterns
Power purchase agreement Municipal utility Coperative utility With label retailing

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Not necessarily need to have other solutions in place	**Political:** Promotes energy efficiency and is thus politically supported **Economic:** Long pay-back time, about 20 years, but also a long lifetime **Social:** No major barriers/enablers **Technical:** Simple and robust design, movable parts minimised **Environmental:** Saves about 20% of hot tap water heating energy **Legal:** No major barriers. Tight energy regulation gives benefit to also this kind of solutions.

Potential for Replication	Expected Impacts - Benefits
Moderate potential. Requires space under the building (height about 2 m). Sewage system must be arranged so that as many as possible sewage branches are collected to one point, in which the heat recovery device can be installed.	About 20% energy savings in domestic hot water heating.

Relevant Publications / Presentations / Services / Products to this Solution	
Wasenco Oy	http://wasenco.com/ecowec-hybridivaihdin_ottaa_lammon_talteen_jatevedesta/

Reference Applications of this Solution	

SPEC CARD

SUPPLY SIDE SOLUTIONS

Category 4
RENEWABLE ENERGY SYSTEMS

Solution 17
Waste Heat Recovery

Title	Graphical Detail

S17b Heat recovery system from DH return pipeline to space heating and DHW

A32: Waste heat recovery from return pipeline

Figure 35: CHP plants in Oulu, Toppila. 185 MW electricity, 320 MW district heat. Fuels peat and wood.

Figure 36: DH pipe, a "district level" size. Supply and return inside the same polyurethane insulation. Steel pipes.

Figure 37: DH exchangers for space heating and DHW

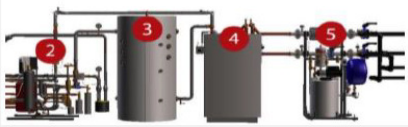


Figure 38: A heat pump system, an example.
2=DH exchanger, 3=buffer storage, 4=HP, 5=connection to heat collector.

- District heating return water is cooled down with a heat pump and the heat used for space and domestic hot water heating
- Advantage depends on the overall DH system. May be feasible, if there is CHP, solar heat, heat pumps and/or flue gas scrubber in the system. All these benefit from lower return temperature.

City / Country	Making_City	Technical Partner Name & contact Details	
	Yes	Oulu Energy	
Implementation Time	Year 2020. DH network building is in place, connecting to it takes one day when the essential other construction works around the DH exchangers are in place.	**Initial Investment**	Ordinary DH exchanger round 3000-10000 euros, DH pipe construction underground > 100 e/m. Heat pump very roughly round 500 euros/heat-kW.

What is Solution?	How does it work?
Apartment buildings use district heating return pipe as a heat source with heat pump, in addition to the normal connection to the supply side.	Heat pump in the DH return side increases the water temperature to suitable level for space and hot tap water heating. Temperature lift is low (under 20 degrees), which may give COP of e.g. 6, i. e. very high. The connection can be done either by cooling the return flow in the secondary circuit inside the building or district heating water in the primary circuit, which connects heat production and buildings together. Primary circuit connection (so-called three-pipe installation) gives the most advantage, but requires more work in especially existing buildings.

Stakeholder Analysis

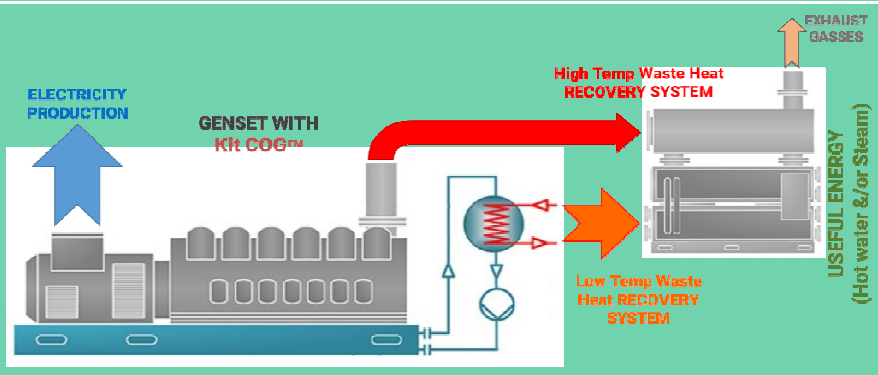
Developer (if relevant) Who has developed this solution?	Many developers
Operator Who is operating this solution?	Oulu Energy
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Building owner and the whole system
Implementer Who is implementing this solution?	Oulu Energy
Financer How / By whom has the implementation of this solution been financed?	Oulu Energy
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	"Invisible" for inhabitants, but if works well, the whole system gets benefit.

Business model patterns
Power purchase agreement With label retailing

Integration with other smart solutions	**BARRIERS / ENABLERS _ PESTEL STUDIES**
Requires DH system and certain elements in the production side to be at its best. See "Expected impacts".	**Political:** If well desrcibed, may be have positive value in politics (energy saving and CO2 emission reduction) **Economic:** Depends very much on the DH system configuration **Social:** No major barriers or special enablers **Technical:** Some technical question marks, like the possible changes in DH water flows after implementing this. Separate components are well known and commercial technology, but the whole solution is not common. **Environmental:** Depends very much on the DH system configuration **Legal:** No major barriers or special enablers, as far as we know
Potential for Replication	**Expected Impacts - Benefits**
Applicable in many DH heated buildings, but suitability to system-specific properties must first be studied.	The solution is the more feasible, the more there are the following in the DH system: - CHP plant. Increases the electricity production due to the lower condensing temperature (which partly compensates the electricity used by heat pump) - Heat pump. Coefficient of performance increases, i.e. electricity consumption decreases, when the incoming water is cooler. - Flue gas scrubber. Cooler return water cools the flue gas to lower temperature, which means that extra heat is gained to DH water. - Solar heat. Lower incoming water temperature to solar collector means more solar gain per m2. - Industrial waste heat. The lower is the incoming water temperature, the higher is usually the waste heat potential. - Bottlenecks in the DH network. Decreasing the return water temperature increase the temp difference between supply and return and thus increases the pipe heat transfer capacity.

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD	SUPPLY SIDE SOLUTIONS
	Category 4 RENEWABLE ENERGY SYSTEMS
	Solution 17 Waste Heat Recovery
Title	Graphical Detail
S17c Waste Heat Sources	 Data Centres Underground Transport Systems Waste Water Management Tertiary Buildings

City / Country	Making_City	Technical Partner Name & contact Details	
General	No		
Implementation Time		Initial Investment	

What is Solution?	How does it work?
Please visit : https://www.reuseheat.eu/category/waste-heat-recovery/	High Temprature and Low Temprature Waste Heat Recovery Systems. Please refer: Data Centers: https://www.reuseheat.eu/data-centres/ Underground Transport Systems: https://www.reuseheat.eu/underground-transport-systems/ Waste Water Management: https://www.reuseheat.eu/waste-water-management/ Tertiary Buildings: https://www.reuseheat.eu/tertiary-buildings/

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES

Potential for Replication	Expected Impacts - Benefits

Relevant Publications / Presentations / Services / Products to this Solution
https://www.reuseheat.eu/category/waste-heat-recovery/
https://www.termogamma.net/fr/industrial-energy-solutions-fr/waste-heat-recovery-for-improved-efficiency-and-environmental-

Reference Applications of this Solution	

SPEC CARD

NON-TECHNICAL SOLUTIONS

Category 5
POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS

Solution 18
Policy Innovation

Title	**Graphical Detail**
S18a Integrated Sustainable Energy Planning	INTENSSS PA Integrated Sustainable Energy Planning > Holistic thinking: sustainable energy provision with pursuit of alternative regional ambitions and developments > Integration: improved integration of spatial planning and energy planning to overcome sectorial divided planning > Area-based: sensitive to regional and local conditions (e.g. local resources, institutional conditions, demand etc.) > Societal engagement: bottom-up approach engaging key regional stakeholders and community driven > Knowledge driven: locally appropriate technologies for production and efficiency while matching supply and demand

City / Country	**Making_City**	**Technical Partner Name & contact Details**	
EU (the Netherlands)	Yes	11 RUG - c.zuidema@rug.nl	
Implementation Time	2 years	**Initial Investment**	depents

What is Solution?	**How does it work?**
Integrated sustainable energy planning, presented as a holistic approach to combining spatial planning with the pursuit of a more sustainable (i.e. renewables based and efficient) energy system. ISEP is a plan developed based on a distinct approach to decicion making including an area-based approach to identify local synergies betwene alternative societal challanges and ambitions, and explicitly means to be based on awide inclusion of a variety of public and private staleholders.	Integrated sustainable energy planning requires cross-sectoral working and network governance due to the variety of social and economic stakeholders involved. It is supported by a specific protocol for making decisions, which is accesible as appendix.

Stakeholder Analysis

Developer (if relevant) Who has developed this solution?	INTENSSS-PA project; (Dr. C. Zuidema)
Operator Who is operating this solution?	

Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Seven EU regions
Implementer Who is implementing this solution?	Seven EU Regions
Financer How / By whom has the implementation of this solution been financed?	EU Horizon 2020
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	Designer: INTENSSS-PA project; (Dr. C. Zuidema)

Business model patterns
Public investment (Resilient strategy)

Integration with other smart solutions	**BARRIERS / ENABLERS _ PESTEL STUDIES**
Can be combined and depends on a variety of technical solutions and explicit forms of stakeholder and citizen engagement.	**Political:** **Economic:** **Social:** **Technical:** **Environmental:** **Legal:**
Potential for Replication	**Expected Impacts - Benefits**
Easy to replicate as a conceptual approach, but will vary in its detailed manifestation within each different locality.	The approach allows for identifying synergies and trade-offs betwene varous energy and non-energy related objectives. In doing so, it can make smart use ofr a variety of governmental (scetoral) budgets, attractc private investments and create societal benefits beyond the mere pursued of renewable energy targets.

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

NON-TECHNICAL SOLUTIONS

Category 5
POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS

Solution 18
Policy Innovation

Title | **Graphical Detail**

S18b Land use planning fostering energy actions

Picture source: City of Oulu/Department of Urban Planning/Hiukkavaara Center

> Land use planning is portrayed as a tool to foster energy actions
> Integration: land use planning is considered as a capacity to integrate the aims of the city, energy network operators, private developers and citizens
> Knowledge driven: assessments and surveys produced during land use planning process can be utilized to generate knowledge about energy opportunities
> Societal engagement: participatory planning process can be utilized for energy-related participation
> Implementability: bridges energy targets and implementation

City / Country	Making_City	Technical Partner Name & contact Details	
EU (Finland)	No	14/UOU/Sari Hirvonen-Kantola (sari.hirvonen-kantola@oulu.fi)	
Implementation Time	1-10 years	Initial Investment	Public land

What is Solution?	How does it work?
Cities can utilize land use planning as a tool to foster energy actions, by adopting the integrative urban development approach. The integrative approach takes the development aspirations of all the PED stakeholders as a starting point of land use planning, and creatively develops them further to discover mutual gains. In strategic land use planning	City of Oulu utilized a district-level structural scheme for Hiukkavaara area and iterative planning process to facilitate discussions and explore opportunities for energy actions with the energy company and construction companies. To establish advantages, Hiukkavaara area was profiled as a sustainable winter city with innovative energy solutions. In Hiukkavaara center area, the city of

discover mutual gains. In strategic land use planning opportunities can be explored together with energy companies, enterprises, citizens and other relevant stakeholders. The cities then can build advantage by profiling areas suitable for implementing energy actions. For exploiting these opportunities for implementation, the cities can utilize detailed land use planning.	city with innovative energy solutions. In Hiukkavaara center area, the city of Oulu utilized innovative plot lease and conveyance for innovation procurement of energy solutions from construction and development companies. Opportunities have been exploited in detailed plans that juridically enable implementation of building projects, including energy actions.

Stakeholder Analysis

Developer (if relevant) Who has developed this solution?	INURDECO-project (University Oulu, City of Oulu)
Operator Who is operating this solution?	The City
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Property owners, residents
Implementer Who is implementing this solution?	Energy companies, energy solution providers, construction and development companies
Financer How / By whom has the implementation of this solution been financed?	The City, construction and development companies, energy companies, property owners, residents
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Energy savings
Public investment
(Resilient strategy)

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Land use planning can be used as a tool to integrate solutions and implement them in specific locations and in collaboration with digital platforms utilizing location intelligence.	**Political:** B: possible resistance due to e.g. commercial interests, E: well in line national and EU-level targets for climate, energy and land use. **Economic:** Private interests may be a barrier in some cases. Possible savings in the overall system on the other hand **Social:** See above. **Technical:** No major barrriers. **Environmental:** Fosters climate, energy and land use targets. **Legal:** Well supported by the Finnish Legislation and also EU principles.
Potential for Replication	**Expected Impacts - Benefits**
Replicability depends on the spatial planning system in each country.	Capacity to guide energy actions to specific locations. Capacity to implement energy targets.

Relevant Publications / Presentations / Services / Products to this Solution

Hirvonen-Kantola, S., Ahokangas, P., Iivari, M., Heikkilä, M., & Hentilä, H-L. (2015). Urban development practices as anticipatory action learning: Case Arctic Smart City Living Laboratory. *Procedia Economics and Finance* , 21, 337–345. Available at: https://www.sciencedirect.com/science/article/pii/S2212567115001859

Reference Applications of this Solution

Hiukkavaara area, Oulu, Finland	

SPEC CARD

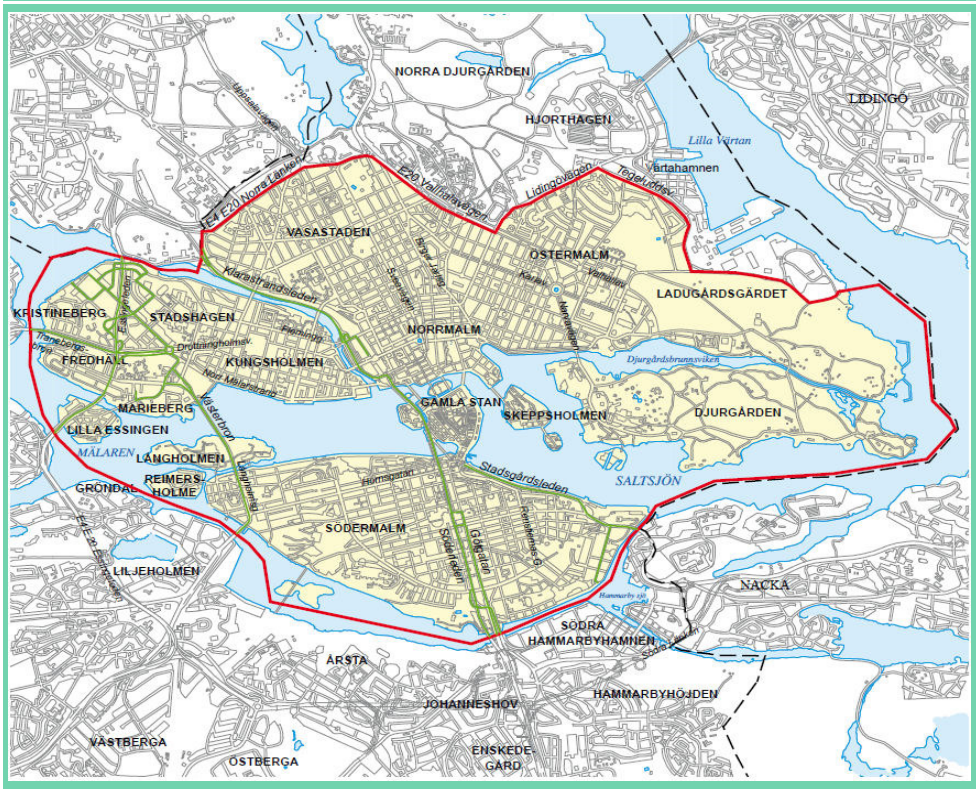
SUPPLY SIDE SOLUTIONS

Category 5
POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS

Solution 18
Policy Innovation

Title	Graphical Detail

S18c Soft Mobility Applications



LOW EMISSION ZONE IN STOCKHOLM: https://urbanaccessregulations.eu/countries-mainmenu-147/sweden-mainmenu-248/stockholm

City / Country	Making_City	Technical Partner Name & contact Details	
	NO		
Implementation Time		Initial Investment	

What is Solution?	How does it work?
	There are two low emission zones (LEZ) in Stockholm:

The Low Emission Zone has been applied in the city of Stockholm since 1996, and the cars that do not meet the requieremnts need to pay a fee of 1000 SEK	There are two low emission zones (LEZ) in Stockholm. 1) Stockholm has a low emission zone in place in Hornsgatan (street) covering passenger cars, mini buses and vans since 15 January 2020. 15 January 2020 minimum standard: Euro 5 1 July 2022 minimum standard: Euro 6 2) The existing central city area lorry and bus low emission zone allows lorries and buses that are less than 6 years from the date of first registration. Euro 6 or better has no time limit until when they can drive in the LEZ.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	The City
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Property owners, residents
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
Energy savings Improvement of air quality Public investment (Resilient strategy)

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
	Political: B: possible resistance due to e.g. commercial interests, E: well in line national and EU-level targets for climate, energy and land use. **Economic:** Private interests may be a barrier in some cases. Possible savings in the overall system on the other hand **Social:** See above. **Technical:** No major barrriers. **Environmental:** Fosters climate, energy and land use targets. **Legal:** Well supported by the Finnish Legislation and also EU principles.

Potential for Replication	Expected Impacts - Benefits
	concentrations of PM0.2 were reduced by between 0.5 and 9% with the LEZ.

	If all vehicles had been fully compliant, then the concentrations would have been reduced by between 0.5 and 12%. Furthermore: • Traffic flows have remained fairly constant. • Few negative business impacts have been reported. https://urbanaccessregulations.eu/low-emission-zones-main/impact-of-low-emission-zones#Stockholm

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

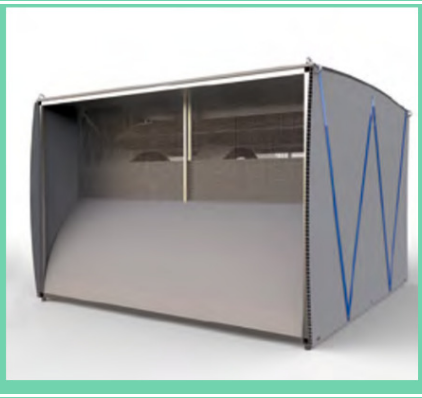
SUPPLY SIDE SOLUTIONS

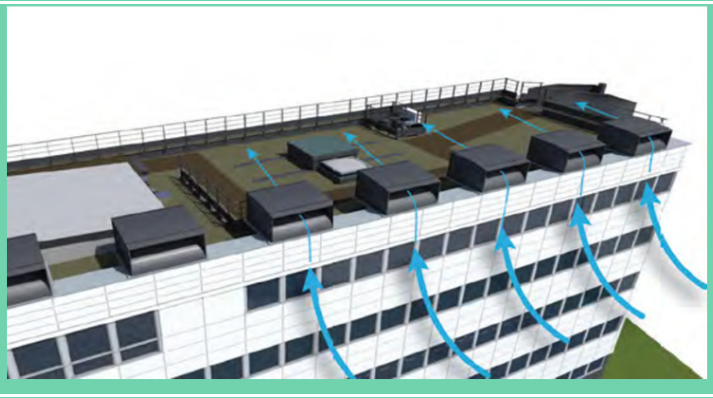
Category 4
RENEWABLE ENERGY SYSTEMS

Solution 19
Wind Turbine

Title	Graphical Detail

S19a Wind Turbines on-site





A discrete, roof-mounted small wind turbine for large buildings

City / Country	Making_City	Technical Partner Name & contact Details	
Luzarches / France	No	Wind my Roof · France, antoine.brichot@windmyroof.com	
Implementation Time		**Initial Investment**	

What is Solution?	How does it work?
Energy price and regulations are pushing building owners to install renewable energy productions. Solar panels consume space on roofs and weigh too much for commercial and logistics buildings. Wind can produce more energy than solar in a number of countries.	The WindBox is a new solution to generate clean electricity on buildings. It is a 1.5 kw wind turbine, horizontal axis, weighing 130kg, designed to be installed on the buildings' acroterion. In this position, the turbine can benefit from higher winds that follow the building's façade, freeing space on the roof for other applications. The turbine is silent and does not vibrate, enabling its installation on any type of building.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** Generally well accepted, but some resistance **Economic:** Good situation. New mills are installed without subsidies. **Social:** Minor restrictions due to the perceived visual harm and that from noise **Technical:** No serious technical issues in onshore wind. For offshore, the techniques for the basement etc are still under development. **Environmental:** Disregarding landscape and noise issues, an enivronmentally sound solution **Legal:** Land use planning is crucial also for wind power. In general the Finnish legislation supports wind energy investments. The permission restrictions guide the build windmills in the areas, where they cause the minimum disturbance.
Potential for Replication	**Expected Impacts - Benefits**
High, when suitable areas are found	• Able to produce clean power on commercial and logistics buildings with roofs too fragile for solar panels. • Can complete an existing solar panels installation to maximise the return on investment and bring energy generation at night. • Exceptional carbon reduction: electricity produced through the Windbox has a lower carbon intensity than solar panels. • Allows for clean electricity production on buildings in areas with little sunshine. • A 5k€ winds study delivered by the company proves the profitability of a project using WindBox.
Relevant Publications / Presentations / Services / Products to this Solution	
www.windmyroof.com	
Reference Applications of this Solution	

SPEC CARD

SUPPLY SIDE SOLUTIONS

Category 4
RENEWABLE ENERGY SYSTEMS

Solution 19
Wind Turbine

Title	Graphical Detail

S19b Wind Turbines off-site

- In Finland the wind power share of electricity production is to be increased from current 7% to about 15% in a couple of years. - the currenty full load hours for wind power in average in Finland is about 3000/year, but will be increased due to longer blades in new turbines
- Much more is to come. There are plans for about 18 000 MW, which would cover over half of the Finnish electricity consumption. All of these plans will not be realized, but in every case the future share of wind power will be very high.
- The investment cost of the land-based wind power is about 1300 e/kW and the maintenance cost about 7 e/MWh. These mean that wind is the cheapest method to produce electricity, concerning new electiricty only-plants.
- A lot of the existing and new plants are situated close to Oulu. Especially in the coastal area of up to 100 km north from Oulu there are a lot of windmills.

City / Country	Making_City	Technical Partner Name & contact Details	
Oulu / Finland	No	Samuli Rinne, City of Oulu	
Implementation Time		**Initial Investment**	

What is Solution?	How does it work?

Stakeholder Analysis

Developer (if relevant) Who has developed this solution?	

Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns			

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** Generally, well accepted, but some resistance **Economic:** Good situation. New mills are installed without subsidies. **Social:** Minor restrictions due to the perceived visual harm and that from noise **Technical:** No serious technical issues in onshore wind. **Environmental:** Disregarding landscape and noise issues, an environmentally sound solution **Legal:** Land use planning is crucial also for wind power. In general the Finnish legislation supports wind energy investments. The permission restrictions guide the build windmills in the areas, where they cause the minimum disturbance.
Potential for Replication	**Expected Impacts - Benefits**
High, when suitable areas are found	

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

SUPPLY SIDE SOLUTIONS

Category 4
RENEWABLE ENERGY SYSTEMS

Solution 19
Wind Turbine

Title	Graphical Detail

S19c Wind Turbines off-shore

WindFloat is a floating foundation for offshore wind turbines with a simple, economic and patented design

City / Country	Making_City	Technical Partner Name & contact Details	
Luzarches / France	No	info@principlepowerinc.com, www.principlepowerinc.com	
Implementation Time		**Initial Investment**	

What is Solution?	How does it work?
The offshore wind market is restricted to locations with low water depths. Offshore wind players aspire to develop deeper water sites that offer advantages such as high quality wind resource, and reduced visual and environmental impact.	A patented floating platform for wind turbines that offers: shallow draft, enabling commissioning of the system at port; a simple, easily disconnected mooring system; simplified logistics with low cost, widely available vessels; standard tubular components for simple fabrication and a structural design to minimise weight.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns			

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** **Economic:** **Social:** **Technical:** the techniques for the basement etc are still under development. **Environmental:** **Legal:**
Potential for Replication	**Expected Impacts - Benefits**
High, when suitable areas are found	• Flexible access to deepwater offshore wind sites. • No crane vessels for installation or maintenance. • Reduced risk throughout project lifecycle. • Stable platform for high performance. • Turbine agnostic and suitable for any commercial offshore wind turbine.
Relevant Publications / Presentations / Services / Products to this Solution	
www.windmyroof.com	
Reference Applications of this Solution	

SPEC CARD

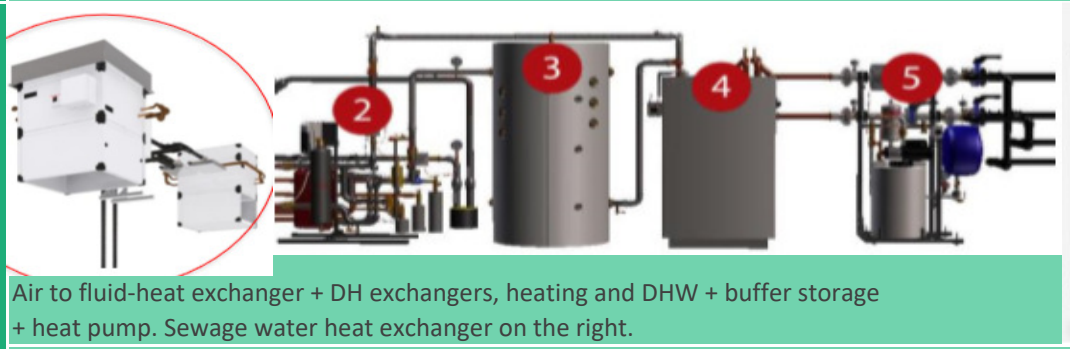
DEMAND SIDE SOLUTIONS

Category 1
LOW ENERGY CONSUMPTION

Solution 1
Building Envelope Retrofitting in Residential buildings

Title	Graphical Detail

S1a Residential Building (High Rise) retrofitting



Air to fluid-heat exchanger + DH exchangers, heating and DHW + buffer storage + heat pump. Sewage water heat exchanger on the right.

General Data for the solution in bullets

City / Country	Making_City	Technical Partner Name & contact Details	
Oulu, Finland	Yes	Sivakka (rental housing)	
Implementation Time	Autumn 2019	**Initial Investment**	Exhaust air heat pump about 2000 e/kW. Sewage water heat recovery about 20 000 e.

What is Solution?	How does it work?
Improvement of energy efficiency in the block of flats, built in 1972. Solutions are: -exhaust air heat pump, combined with district heating -PV -heat recovery from sewage water -heating system balancing -replacement of room thermostats -ventilation air flow rate adjustment -apartment-wise tap water metering -continuous measurements (temp, humidity and pressure difference) -new windows (installed already earlier)	The larger applications here are described in more detail in their specific SPEC-cards.

Stakeholder Analysis

Developer (if relevant) Who has developed this solution?	Several suppliers: e.g. GST Högfors, Ecowec.
Operator Who is operating this solution?	Sivakka
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	In the first hand building owner, i.e. Sivakka. Finally the tenants, who pay the rent.
Implementer Who is implementing this solution?	Several suppliers
Financer How / By whom has the implementation of this solution been financed?	Own funding + EU (by Making-City)

Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	Oulu Energy

Business model patterns
Shared savings Power purchase agreement White label retailing

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Not necessarily dependent on other solutions, but the feasibility is the better the more expensive and "dirty" is the heating energy to be replaced by HP. And vice versa, the cleaner the electricity, the better is HP from environmental point of view. In more detail, HP use timing impacts the effect on the whole system: the more the HP use is weighted towards cheap electricity moments (in Nordic el. market system), the better is also the environmental performance.	**Political:** Climate targets support this. No major barriers. **Economic:** HP investment may have pay-back time of e.g. 10 years, sewage heat recovery 20. Window improvements are generally feasible in Finnish context mostly only if the windows must be renewed in every case. **Social:** If the starting level is weak, then living comfortability is increased (not in this case due to tolerable starting point). However, nearly in every case the change of windows help to decrease the draught from cold window surfaces. HP installation with pre-fabricated modules does not harm the residents. **Technical:** The building should have hydronic space and DHW heating system. Sewage water collection centralized bottom plumbing is needed. **Environmental:** In right places and usage patterns HP may decrease the emissions. Adding HP to CHP DH system is however not always environmentally feasible. HP uses electricity and replaces CHP heat and in further CHP power production. Saved energy must also be compared with that of embodied energy in materials and indirect emissions. The renewal generally decrease emissions, but not always. **Legal:** No significant barriers.

Potential for Replication	Expected Impacts - Benefits
High. There are a lot of buildings, for which this is applicable. The feasibility of the different solutions depends however on the specific building properties. In general, HPs like these here are the more feasible the larger is the building. E.g. water saving devices in turn are very scalable.	Savings in the energy cost, from the building owner point of view, can be calculated quite easily. They depend on the starting level and on the actions done. The system impact is more complicated and depends on the context.

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

DEMAND SIDE SOLUTIONS

Category 1
LOW ENERGY CONSUMPTION

Solution 1
Building Envelope Retrofitting in Residential buildings

Title	Graphical Detail

S1b Residential Building (Private House) retrofitting

General Data for the solution in bullets

City / Country	Making_City	Technical Partner Name & contact Details	
	Yes	Sivakka (rental housing)	
Implementation Time		Initial Investment	

What is Solution?	How does it work?
Windows have been changed already earlier. Roof insulation is increased. Heat recovery (HR) from exhaust air, district heating (DH) return water and sewage water have been added to the building. 10 kWp PV to the façade (see the figure) and on the roof will be installed in the end of 2020.	The energy consumption before the renovation is 414 MWh/year (357 MWh for heating and 57 MWh in electricity). The annually estimated energy consumption after this renovation is 241 MWh (heat+electricity), which means 83 kWh/m2yr, below the Finnish goal of 140 kWh/m2yr for renovation buildings." The impact is due to also other renovation measures than only the window renovation. Windows have been changed already earlier. Roof insulation is increased. Heat recovery (HR) from exhaust air, district heating (DH) return water and sewage water have been added to the building. COP of exhaust air HR is about 3 and that of DH about 5, according to the experiences this far. HR from sewage water saves DHW heating energy by about 25%. These are in line with the expectations. As a new action concerning the building envelope, the roof insulation is increased. 10 kWp PV to the façade (see the figure) and on the roof will be installed in the end of 2020.

Stakeholder Analysis

Developer (if relevant) Who has developed this solution?	SIV
Operator Who is operating this solution?	SIV
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	OE, OUK
Financer How / By whom has the implementation of this solution been financed?	SIV; OE, Making City
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
Shared savings Power purchase agreement White label retailing

Integration with other smart solutions	**BARRIERS / ENABLERS _ PESTEL STUDIES**
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** Largely supported by politics **Economic:** Long pay-back time, but low risk **Social: E**specially in this case the rents must be kept low. Long-sight investments help in this. **Technical:** No major barriers, partly new technology however. Components, materials and solutions have a good availability in general **Environmental: A**t some point the increase in e.g. insulation or building new buildings may override the savings. I.e. embodied energy may be larger than net energy consumed during use. **Legal:** No remarkable barriers. “The spirit of the laws” concerning building support this.

Potential for Replication	**Expected Impacts - Benefits**
After showing the benefits there is a potential for replication by private owners.	The investments would decrease the total cost of living in the apartments. The long-term nature of the investments has been emphasized in public discussions.

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

DEMAND SIDE SOLUTIONS

Category 2
ENERGY MANAGEMENT

Solution 20
E-car Parking and Charging

Title	**Graphical Detail**		
S20a E-car Parking and Charging Points			
	E-car charging stations		
City / Country	**Making_City**	**Technical Partner Name & contact Details**	
Oulu / Finland	Yes	SIV, OEN	
Implementation Time		**Initial Investment**	

What is Solution?	**How does it work?**
Electric car charging points for SIV and YIT buildings and Arina mall. The facility will be part of the local energy system. Local electricity will be used to charge when possible	In building 1, the eCar parking area would have 10 charging stations for eCars. The facility will be located in the close walking distance from SIV and YIT buildings. Half of these are reserved for public use (car sharing and eCar charging) others can be rented for eCar private owners who need a parking facility. SIV will be responsible to build the parking facility and OEN to build the charging stations and taking care of the facility and management. There is now to be charging stations in the parking lot of the shopping mall. Electric cars are currently so expensive, that people in rental houses (Sivakka buildings) are not purchasing them. In smaller scale the chargers are however in place. There are normal Schuko-type sockets outside, one for each parking lot, for most of the places. The fuses are 10 or 16 amperes, so the maximum output is 2300 or 3680 watts. This is less than that for special EV chargers, but can be used for plug-in hybrids. For combustion engine cars, the idea of these sockets is to give power for engine and car interior pre-heating in wintertime.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	SIV and OEN
Operator Who is operating this solution?	SIV, OEN
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Car renters, public, Arina mall users
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns			

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
	Political: **Economic:** **Social:** **Technical:** **Environmental:** **Legal:**

Potential for Replication	Expected Impacts - Benefits
The e-cars are increasing especially in Northern Europe, there is a huge potential especially after the deadlines of forbidding the use of diesel vehicles in major city centers	E-cars are expected to be more efficient than conventional vehicles and with the support of renewable energy the CO2 emissions will decrease

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

DEMAND SIDE SOLUTIONS

Category 2
ENERGY MANAGEMENT

Solution 20
E-car Parking and Charging

Title	**Graphical Detail**		
S20b Connection of the charging stations to the local demand response system			
	General Data for the solution in bullets		
City / Country	**Making_City**	**Technical Partner Name & contact Details**	
	Yes / No		
Implementation Time		**Initial Investment**	

What is Solution?	**How does it work?**
Technical details explaining the solution, figures if needed	Application description, figures if needed

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Revenue Streams/ Monetized Value ??
Public investment (Resilient strategy)

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** **Economic:** **Social:** **Technical:** **Environmental:** **Legal:**
Potential for Replication	**Expected Impacts - Benefits**
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	General aspects about the solution.Could be technical, economical, environmental, social
Relevant Publications / Presentations / Services / Products to this Solution	
Reference Applications of this Solution	

SPEC CARD

DEMAND SIDE SOLUTIONS

Category 2
ENERGY MANAGEMENT

Solution 20
E-car Parking and Charging

Title	Graphical Detail

S20c Electrification of fleets

The City of Madrid aimed to foster the use of electric vehicles (EVs) by local companies, through expanding charging network and testing electric vehicles with Madrid's Municipal Transport Enterprise.

City / Country	Making_City	Technical Partner Name & contact Details	
Madrid / Spain	No		
Implementation Time	2016	**Initial Investment**	

What is Solution?	How does it work?
Electric mobility is starting to grow in Madrid. Although several companies are starting to introduce electric vehicles (EVs) into their own fleets (e.g. taxi companies, private transport companies, car sharing companies) the electric mobility market is still in need of significant support, as is the case in most cities. The City of Madrid aimed to foster the use of electric vehicles (EVs) by local companies, working with key agents in pilot projects.	The municipality of Madrid liaises with at least five key agents and companies (such as supermarket chains, shopping centres) in order to develop pilot projects on EVs, namely the launch of a 'test fleet scheme', including the potential implementation of electric charging facilities installed at their own premises. In addition, strategies to promote the wider uptake of clean vehicles for freight delivery companies and the general public were designed and put in place. Finally, aiming to showcase their benefits, as well as to play an exemplary role, Madrid's municipal departments and public companies have introduced 20 electric vehicles to their municipal fleet. The development of this measure were done in cooperation with Madrid's Municipal Transport Enterprise (EMT), the public transport operator, whose fleet is expected to be an ideal showcase for this kind of technology. EMT helped the city council address various companies and stakeholders to involve them in the broader uptake of e-mobility, cooperating with the city council and easing their access to its charging infrastructure, located at its public underground parking facilities. Car sharing service providers, taxi fleets and freight operators were given special attention. EMT also aimed to increase its electric services and auxiliary vehicles fleets.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	Madrid City Council, Madrid's Municipal Transport Enterprise (EMT)
Operator Who is operating this solution?	Madrid's Municipal Transport Enterprise (EMT)
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	taxi companies, private transport companies, car sharing companies
Implementer Who is implementing this solution?	Madrid City Council, Madrid's Municipal Transport Enterprise (EMT)
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Revenue Streams/ Monetized Value ??

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Vehicle Sharing System, Smart Parking, Bke Sharing System, Mobility HUBs	**Political:** Policy Incentives **Economic:** **Social:** **Technical:** **Environmental:** **Legal:**
Potential for Replication	**Expected Impacts - Benefits**
High potential for replicaiton in other cities	Increasing share of renewables Promoting sustainable private transport models Improving energy usage efficiency Reducing GHG emissions Reducing energy bills

Relevant Publications / Presentations / Services / Products to this Solution
https://www.bable-smartcities.eu/explore/use-cases/use-case/useCase/test-fleets-policy-incentives-and-campaigns-for-the-uptake-of-electric-vehicles.html

Reference Applications of this Solution	

SPEC CARD

SUPPLY SIDE SOLUTIONS

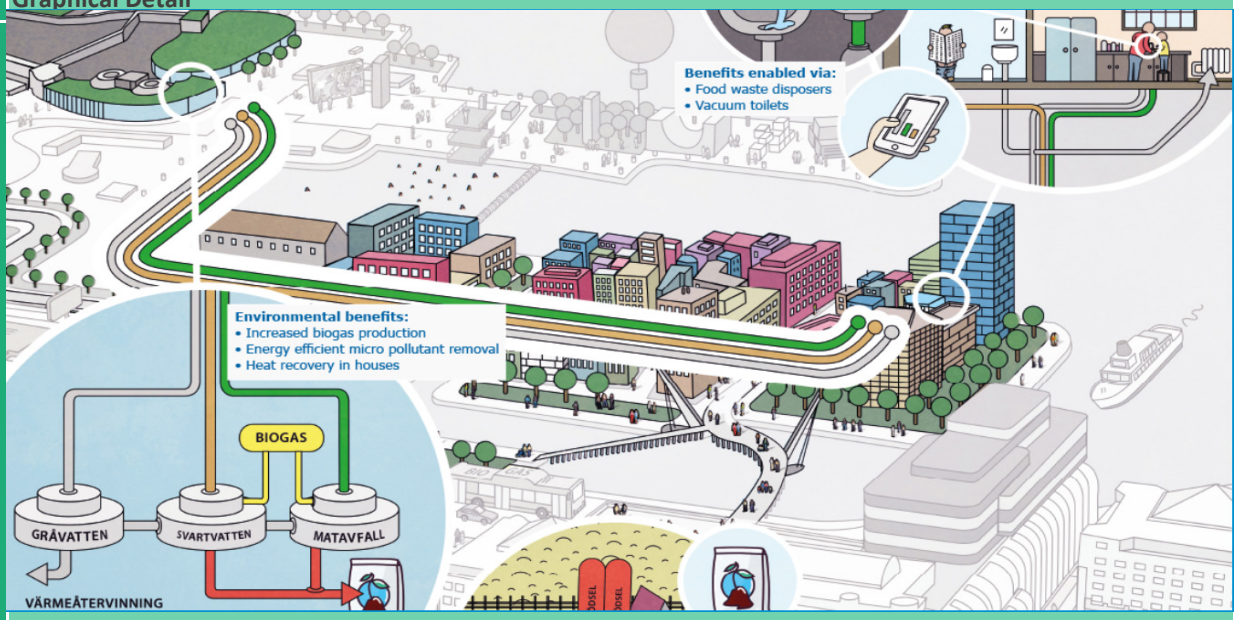
Category 4
RENEWABLE ENERGY SYSTEMS

Solution 15
Waste-To-Energy

Title

S21a Residential waste to biogas

Graphical Detail



https://www.swedenwaterresearch.se/en/projekt/reco-lab-english/news-reco-lab/

City / Country	Making_City	Technical Partner Name & contact Details
Sweden	NO	
Implementation Time		**Initial Investment** More than 4 million, according to https://swedishtestbeds.com/testbed/reco-lab/

What is Solution?	How does it work?
Tre Rör Ut (Three Pipes Out) is a system for collecting food- and toiletwaste in the residential buildings of Oceanpiren in the district of Oceanhamnen in central Helsingborg. Tre Rör Ut consists of a three-pipe	The Reco Lab is a showcase , development plant and test bed for this new sustainable use of water and waste. By connecting the new buildings to three pipelines, grey waste water (bath, shower and washing water) is separated

Helsingborg. The RoPD consists of a three-pipe system which leads toilet waste, food waste and greywater in three separate pipes out from the residential buildings and further on to Reco lab's unit. Reco lab is an abbreviation of Recovery lab, Sweden. Recovery lab is a building, which has three functions; a showroom where education and new value chains for recycled resources are created, a development unit were the treatment plant of the future is tested in practice and a testbed where it will be possible to test new technique and new services in connection to food waste and wastewater treatment.	from black water (toilet waste), and food waste is ground and separated by macerators. This results in a number of environmental benefits: • Less contaminated food waste leads to more biogas production and clean, certified bio-fertilizer for agriculture. • Vacuum toilets decrease water usage and enable recovery of macronutrients such as phosphorus, nitrogen, potassium and sulphur. • The recovered nutrient products (struvite and ammonium sulphate) are turned into tailor-made fertilizer pellets, which is a major step in reducing the need for fossil-based fertilizers. • Efficient heat recovery from source-separated grey water reduces energy consumption. • Up to 80% of grey water can be recovered to drinking water quality.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	water/sewage company NSVA, waste management company NSR and energy company Öresundskraft.
Operator Who is operating this solution?	water/sewage company NSVA, waste management company NSR and energy company Öresundskraft.
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Residential houses benefit from the use of their waste to produce energy, from the sludge some fertilisers can be obtained to be used by farmers, etc.
Implementer Who is implementing this solution?	Sweden Helsinborg city
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	R&D companies in Sweden, among others

Business model patterns

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Can be coupled for production of biofuels, exporting biogas to the gas network, use the biogas for district heating, etc.	**Political:** Enabler **Economic:** Positive **Social:** Positive **Technical:** Very interesting connection with district heating or cooling networks; and gas networks (for biogas exports, etc.) **Environmental: Less landfills.** Avoids related emissions from waste disposal. Circular economy is promoted
Potential for Replication	**Expected Impacts - Benefits**

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

SUPPLY SIDE SOLUTIONS

Category 4
RENEWABLE ENERGY SYSTEMS

Solution 22
Hydro Energy

Title	Graphical Detail

S22a Hydro energy

Very low head [m]

PaT (Pump as a turbine)

More head and flow

Depending on the head and flow range, Kaplan, Francis, Pelton and other most common technologies are applicable.

PaT: https://powerturbines.eu/wp-content/uploads/2020/08/20200108_Redawn_Project_France.pdf
Other: https://www.global-hydro.eu/fileadmin/user_upload/referenzen/kaplan/hausmening/Hausmening_Referenzblatt.pdf

City / Country	Making_City	Technical Partner Name & contact Details	
EU	No		
Implementation Time		**Initial Investment**	

What is Solution?	How does it work?
PaT: The water treatment plants, rural areas and cities can have an upper reservoir that migh produce an excess pressure in the inlet pipe line. This excess of pressure can be used for generating electricity, thanks to the installation of a "Pump as a turbine" technology. When more head (pressure) is available (i.e. there is waterfall, even if it is small), other technologies such as Kaplan, Francis or Pelton turbines can be used.	Use the difference of heigh (head) or pressure, to generate electricity.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	

Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns			

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
	Political: Generally well accepted **Economic:** PaT might be a good techno-economic solution specially when you need to replace pumps. Micro and mini hydro turbines are more expensive **Social:** Minor restrictions if it does not need a big infrastructure or the infraestructure is already there **Technical:** No serious technical issues **Environmental:** if the infraestructure is already there, no environmental restrictions **Legal:** .

Potential for Replication	Expected Impacts - Benefits

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

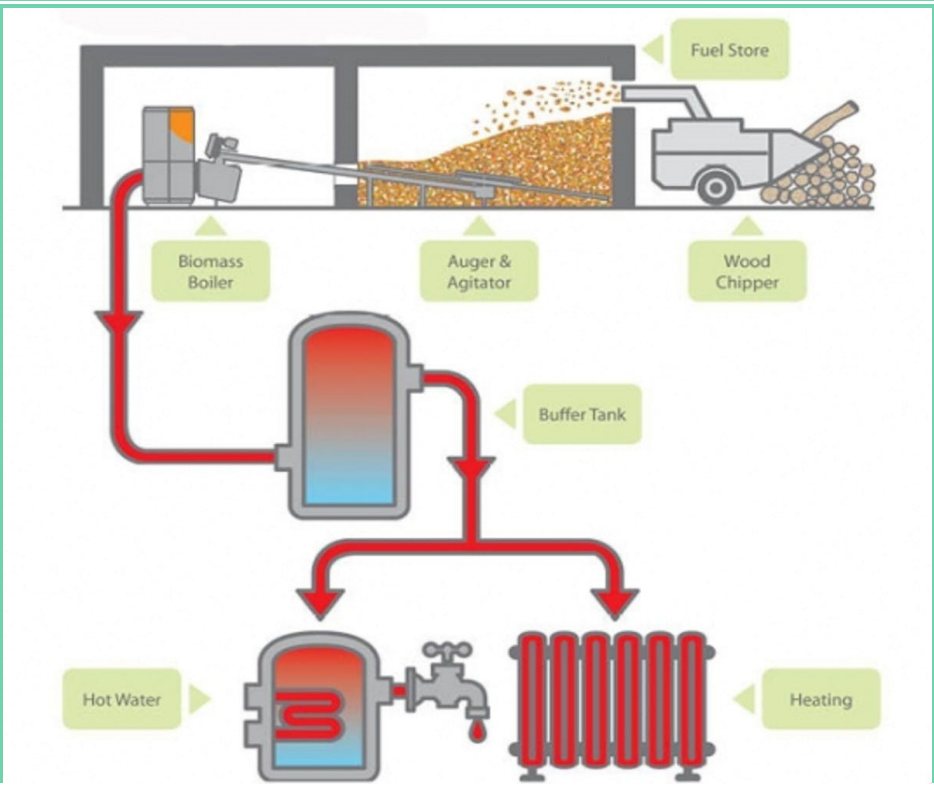
SUPPLY SIDE SOLUTIONS

Category 4
RENEWABLE ENERGY SYSTEMS

Solution 23
Biomass

Title	Graphical Detail

S23a Biomass boilers



https://www.treco.co.uk/news/article/systems-approach-installing-biomass-boiler

City / Country	Making_City	Technical Partner Name & contact Details	
	NO		
Implementation Time		Initial Investment	

What is Solution?	How does it work?
	Biogas and biomass boilers work in a similar manner to conventional boilers, where water is heated up and then circulated to provide the heating requirements for a building. They can therefore easily be retrofitted into an existing system, as well as being installed as part of a brand new heating

We refer here to biomass, to the organic material derived from plants, such as forest waste, wood, or pellets (except peat). Burning them in a biomass boiler provides a renewable and sustainable source of heat. With Biogas we refer to the organic gas derived from the digestion of waste (from residential, agriculture, etc.).	existing system, as well as being installed as part of a brand new heating system. Biomass needs space for storing the wood, pellets or forest waste, and sometimes an automatic screw feeding system for biomass is required (otherwise, it needs someone to feed the system with biomass). Biogas boilers are usually located next to the place where biogas is generated If the heating demand is high, and the capacity required is high, filter systems are recommended to avoid particles to be released to the ambient https://www.treco.co.uk/biomass-boilers

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Residential houses, any tertiary building with space heating or domestic hot water demands, etc.
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Can be coupled with short thermal storage (such as water or mixture of water-glycol tanks),	**Political:** Enabler **Economic:** Positive **Social:** Positive in general. In some countries not so accepted due to the particles that can derived from the combustion of biomass **Technical:** Very interesting connection with district heating networks. **Environmental:** Avoids CO2 emissions from fossil fuels. **Legal:**

Potential for Replication	Expected Impacts - Benefits

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

SUPPLY SIDE SOLUTIONS

Category 4
RENEWABLE ENERGY SYSTEMS

Solution 24
Combined Heat and Power

Title	Graphical Detail

S24a Cogeneration

https://www.danfoss.com/en/about-danfoss/our-businesses/heating/knowledge-center/heating-school/danfoss-and-district-heating-in-denmark/

City / Country	Making_City	Technical Partner Name & contact Details	
	NO	DANFOSS	
Implementation Time		Initial Investment	

What is Solution?	How does it work?
	A traditional power plant only converts approximately 40% of the total energy input to electricity while 60% is wasted to the surroundings as heat. In a

In Denmark most district heating plants are combined heat and power plants that distribute the heat made from the surplus heat generated by the production of electricity. An example is the Sønderborg Kraftvarmeværk (CHP) in Southern Denmark, which burns waste to generate heat and electricity.	combined heat and power plant, 50% of energy input will be converted to heat and distributed to consumers in a district heating network. Thus, energy waste is reduced from 60% to 10%! In Denmark we have CHP plants in many cities that burn straw or wood to generate heat and electricity. Often they are supplemented by co-firing of gas or coal, but in some cases biomass is the sole energy source. Waste is the primary type of biomass used in Denmark, and in many cities waste is used for heat and electricity generation. Furthermore, incinerating the waste reduces the demand for landfills vastly.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	DANFOSS
Operator Who is operating this solution?	DANFOSS
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Residential houses, any tertiary building with space heating or domestic hot water demands, etc.
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Can be coupled with short thermal storage (such as water or mixture of water-glycol tanks),	**Political:** Enabler **Economic:** Positive **Social:** Positive in general. In some countries not so accepted due to the particles that can derived from the combustion of biomass **Technical:** Very interesting connection with SOLAR district heating networks and cooling networks . **Environmental:** Avoids CO2 emissions from fossil fuels. **Legal:**

Potential for Replication	Expected Impacts - Benefits

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

SUPPLY SIDE SOLUTIONS

Category 4
RENEWABLE ENERGY SYSTEMS

Solution 24
Combined Heat and Power

Title	**Graphical Detail**
S24b Trigeneration	 https://www.uv.es/servicio-tecnico-mantenimiento/es/sostenibilidad/produccion-electricidad/produccion-electricidad/central-co-generacion.html

City / Country	**Making_City**	**Technical Partner Name & contact Details**	
	NO		
Implementation Time		**Initial Investment**	

What is Solution?	**How does it work?**
The solution provides heat, power and cooling depending on the demands of the buildings.	On the Tarongers Campus there is a cogeneration plant with two natural gas engines of 1,000 kW each that generate electricity for consumption on the Campus. Cogeneration consists of returning excess energy from our generation system to the grid. In addition, as electricity is generated in a place close to the place where it is consumed, the costs of installing distribution networks are reduced. During their operation, these motors heat up, so the heat energy generated is used to heat the Campus buildings during winter. In summer, as the system has heat exchangers, the heat rejected from the co-generation system is used in an absorption machine to produce cooling. Additionally, ice is produced during the night (when the electricity tariff is low) to reduce cooling peaks during the day. If the absorption machine is not enough, cold water is obtained thanks to chillers to cool the air conditioning system throughout the Campus.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	University Campus
Operator Who is operating this solution?	University Campus
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Students, university campus

Implementer Who is implementing this solution?	University Campus
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Can be coupled with short or seasonal thermal storage (such as water or mixture of water-glycol tanks), The natural gas can be replaced by biomass, biogas, etc.	**Political:** Enabler **Economic:** Positive **Social:** **Technical:** Very interesting connection with district heating networks. **Environmental:** Reduces the demand of cooling, and heating and electricity is produced at the same time. **Legal:**

Potential for Replication	Expected Impacts - Benefits
	The advantages of cogeneration are: savings in electricity bills, having independence, security and reliability in the electricity supply and the sale of surpluses to the grid.

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

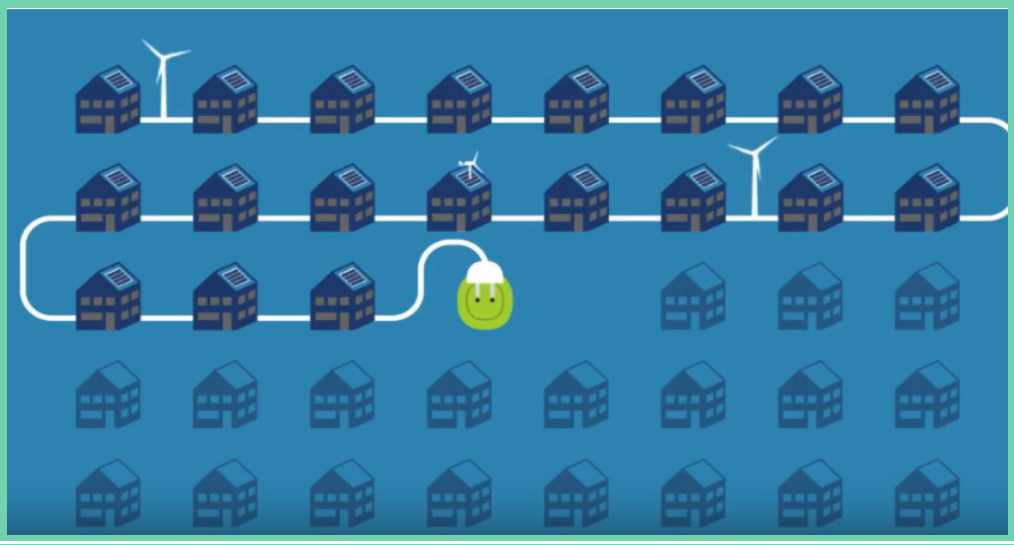
NON-TECHNICAL SOLUTIONS

Category 5
POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS

Solution 25
Social Innovations

Title	Graphical Detail

S25a Creation of an energy community



https://www.rescoop.eu/the-rescoop-model

City / Country	Making_City	Technical Partner Name & contact Details	
	No		
Implementation Time		Initial Investment	

What is Solution?	How does it work?
For REScoop.eu, an energy community is a way to 'organise' citizens that want to cooperate together in an energy-sector related activity based on open and democratic participation and governance, so that the activity can provide services or other benefits to the members or the local community. In this sense, energy communities represent an alternative type of market actor, and a different way/philosophy to do business. The primary purpose of energy communities is to create social innovation - to engage in an economic activity with non-commercial aims.	The primary purpose of energy communities, such as Renewable Energy Communities is to provide community benefits(non-commercial), rather than financial profits. A community can form a REC if they can include natural persons and/or SMEs and/or local authorities (including municipalities). The REC principles are :Open, voluntary and non-discriminatory participation, with an aotonomous operation (possibly democratic), effective control by members located in the proximity to RES projects. They also must be a legal form (such as cooperatives, building community (in Italy and Portugal known as condominios), etc

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	the community
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Property owners, residents
Implementer Who is implementing this solution?	Energy companies, energy solution providers, ESCOs, Cooperatives, municipalities, etc.
Financer How / By whom has the implementation of this solution been financed?	The City, companies, energy companies, property owners, residents
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
Aggregators Peer-to-peer electricity trading Energy-as-a-service Community-ownership models

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
	Political: possible resistance due to e.g. commercial interests **Economic:** Private interests may be a barrier in some cases. Possible savings in the overall system on the other hand **Social:** See above. **Technical:** No major barrriers. **Environmental:** **Legal:** The legal figure of energy communities is not yet transposed in all EU countries.

Potential for Replication	Expected Impacts - Benefits
Replicability depends on the social acceptance and knowledge of citizens about the energy communities concept	Capacity to guide energy actions to specific locations. Capacity to implement energy targets.

Relevant Publications / Presentations / Services / Products to this Solution

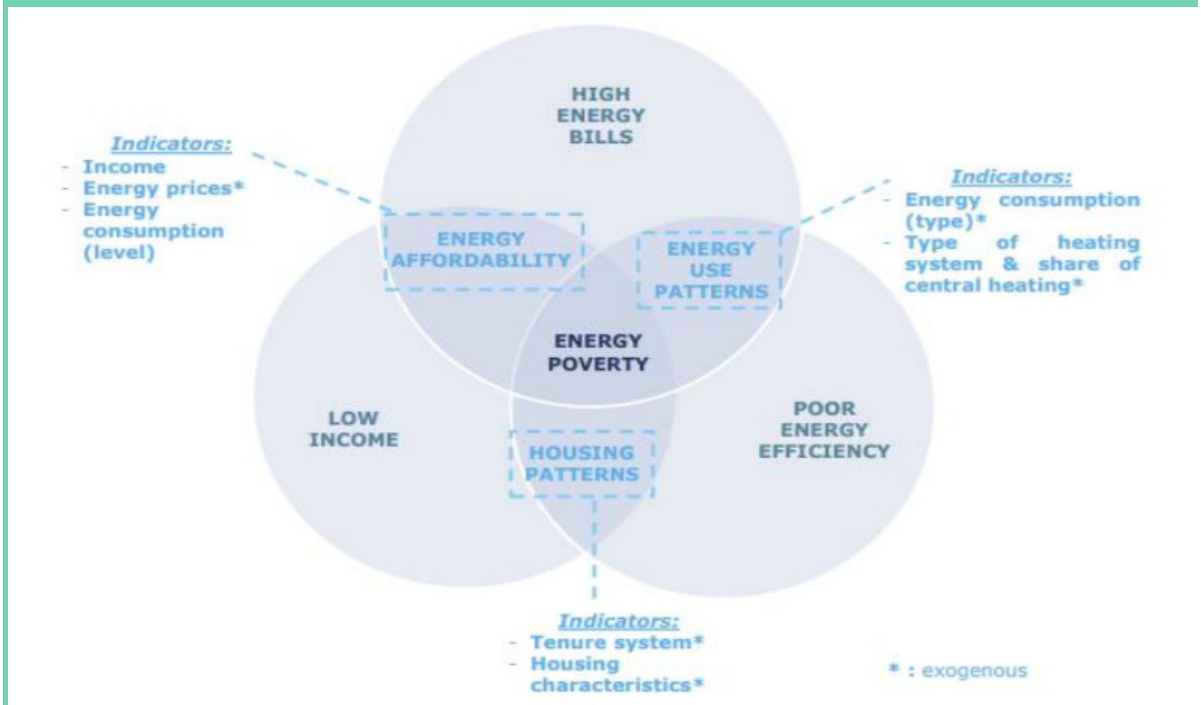
Reference Applications of this Solution	
https://www.rescoopvpp.eu/	
https://come-res.eu/	

SPEC CARD

NON-TECHNICAL SOLUTIONS

Category 5
POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS

Solution 25
Social Innovation

Title	**Graphical Detail**
S25b Energy poverty Mitigation	 **Figure 1: Drivers of energy poverty and key indicators. Source: Insight Report 2015** [7]
	https://comact-project.eu/wp-content/uploads/2021/05/ComAct-D1.1_Overview-report-on-the-energy-poverty-concept_Final-version_UPDATED-1.pdf

City / Country	**Making_City**	**Technical Partner Name & contact Details**	
	No		
Implementation Time		**Initial Investment**	

What is Solution?	**How does it work?**
	The energy poverty issue is addressed differently from country to country. Also the definition is different. The following programmes can be performed:

Provide access to different tools to mitigate energy poverty	- Structural renovation programmes to increase energy efficiency of buildings: The Better Energy Warmer Homes Scheme provides free energy upgrades to building owners who receive specified welfare support from the government - Disconnection prohibition: Disabled, blind and other vulnerable customers cannot be disconnected from the energy or water supply (Hungary Kikapcsolási védelem scheme) - Heating subsidies: The most vulnerable residents in Bulgaria can apply for multiple types of support, including the Bulgarian heating subsidy (Целева помощ за отопление) and the Bulgarian social electricity tariff (Социална тарифа на тока). - Audits and renovation: The government of Barcelona supports low-income households by paying for energy audits, by installing low-cost elements related to energy efficiency, by supporting procedures to change tariffs, and by training residents in efficient consumption habits

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	Municipality/National government
Operator Who is operating this solution?	Municipality/National government
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Property owners, residents with low incomes
Implementer Who is implementing this solution?	Municipality/National government
Financer How / By whom has the implementation of this solution been financed?	Municipality/National government
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
	Political: Needs policy support at national level **Economic:** Private interests may be a barrier in some cases. **Social:** Address the causes, not only the symptoms **Technical:** **Environmental:** **Legal:**

Potential for Replication	Expected Impacts - Benefits

Relevant Publications / Presentations / Services / Products to this Solution

Reference Applications of this Solution	

SPEC CARD

POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS

Category 5
POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS

Solution 26
Services provision

Title	**Graphical Detail**		
S26A Ancillary Services			
	General Data for the solution in bullets		
City / Country	**Making_City**	**Technical Partner Name & contact Details**	
	Yes / No		
Implementation Time		**Initial Investment**	

What is Solution?	**How does it work?**
Technical details explaining the solution, figures if needed	Application description, figures if needed

Stakeholder Analysis

Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Revenue Streams/ Monetized Value ??

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** **Economic:** **Social:** **Technical:** **Environmental:** **Legal:**
Potential for Replication	**Expected Impacts - Benefits**
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	General aspects about the solution.Could be technical, economical, environmental, social
Relevant Publications / Presentations / Services / Products to this Solution	
Reference Applications of this Solution	

SPEC CARD	POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS
	Category 5 POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS
	Solution 26 Services provision
Title	Graphical Detail
S26b Participation on the markets	
	General Data for the solution in bullets

City / Country	Making_City	Technical Partner Name & contact Details	
	Yes / No		
Implementation Time		Initial Investment	

What is Solution?	How does it work?
Technical details explaining the solution, figures if needed	Application description, figures if needed

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Revenue Streams/ Monetized Value ??

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** **Economic:** **Social:** **Technical:** **Environmental:** **Legal:**
Potential for Replication	**Expected Impacts - Benefits**
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	General aspects about the solution.Could be technical, economical, environmental, social
Relevant Publications / Presentations / Services / Products to this Solution	
Reference Applications of this Solution	

SPEC CARD	POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS
	Category 5 POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS
	Solution 26 Services provision
Title	Graphical Detail
S26c Hydrogen Services	
	General Data for the solution in bullets

City / Country	Making_City	Technical Partner Name & contact Details	
	Yes / No		
Implementation Time		Initial Investment	

What is Solution?	How does it work?
Technical details explaining the solution, figures if needed	Application description, figures if needed

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Revenue Streams/ Monetized Value ??
Public investment (Resilient strategy)

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** **Economic:** **Social:** **Technical:** **Environmental:** **Legal:**
Potential for Replication	**Expected Impacts - Benefits**
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	General aspects about the solution.Could be technical, economical, environmental, social
Relevant Publications / Presentations / Services / Products to this Solution	
Reference Applications of this Solution	

SPEC CARD	SUPPLY SIDE SOLUTIONS
	Category 3 INTEGRATED INFRSTRUCTURES
	Solution 27 Gas Storage
Title	Graphical Detail
S27a Biogas Storage	

City / Country	Making_City	Technical Partner Name & contact Details	
Implementation Time		Initial Investment	

What is Solution?	How does it work?

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	

Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES

Potential for Replication	Expected Impacts - Benefits

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

SUPPLY SIDE SOLUTIONS

Category 3
INTEGRATED INFRSTRUCTURES

Solution 27
Gas Storage

Title	**Graphical Detail**
S27b H2 Storage	

City / Country	**Making_City**	**Technical Partner Name & contact Details**	
Implementation Time		**Initial Investment**	

What is Solution?	**How does it work?**

Stakeholder Analysis

Developer (if relevant) Who has developed this solution?	

Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES

Potential for Replication	Expected Impacts - Benefits

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

DEMAND SIDE SOLUTIONS

Category 2
IMPROVE ENERGY EFFICIENCY

Solution 28
Virtual Power Plant

Title	Graphical Detail

S28a Virtual Power Plant

SELLO MULTIPURPOSE CENTER
- Located in Espoo city in Leppävaara area that One of the fastest growing areas in Espoo
- Sello multipurpose center is the local Energy hub of Leppävaara.
- 23 million yearly visitors
- Area if of 102 000 m2 including shops, a library, concert hall, movie theatre.
- 2900 parking lots that includes tens of EV charging station.
-2MW stationary Li-Ion battery
-750kW PV system
-VPP platform

City / Country	MAKING-CITY	Siemens	
Espoo/Finland	No		
Implementation Time	2018->	**Initial Investment**	

What is Solution?	How does it work?
Sello multipurpose center is connected to microgrid that provides through a Virtual Power plant anchillary services. Microgrid consist of battery energy storage, PV production, HVAC and lighting loads, EV chraging sytems and elevators and escalators. Solutions will	Sello multipurpose center's microgrid has been comissioned and is providing anchillary services. During the SPARCS new units will be connected to microgrid. -EV Charing and elscalators will be integrated to microgrid. Standardised way of connecting new loads to microgrid will be developed.

enable standard way of connecting loads to microgrid, AI based predictive algorithm will optimises the flexibility provided by the loads. In macrolevel the solutions reduce the need to use and invest to conventional peak power plants running on fossil fuels.	-Self learning algorithms will be developed to predict and increase flexibility of the assets. -AI based models wll be developed to predict the demand of the flexibility.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	Siemens with Kone and VTT
Operator Who is operating this solution?	Siemens
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	TSO, DSO, Load ans producion asset owners
Implementer Who is implementing this solution?	Siemens
Financer How / By whom has the implementation of this solution been financed?	Siemens finance
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	VPP Operator, Local governments, Prosumers, regulators, engineers and designers

Business model patterns
Hardware and software can be aquired by customer or can be sold as a service including all the hardware, software instalaltion and Operations

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political: Supporting the standardisation of the solution. Enabiling through initiatives and national funding. Promote and support the development of smart grid infrastructure project** **Economic: Anchillary services martket pricing affects the spread of the solution. Investment in energy sectors and renewable rpoduciton.** **Social: Facility sector's poor knowledge of solutions and the risks and possibilities** **Technical: ICT infrastructure, standard communication protocols between shareholders and standardisation of connecting loads** **Environmental: Pandemics can** **Legal: Legal framework that enables access for aggregartors to participate in Requirements in the building codex to have VPP readyness in all new and buildings to be renovated. Data Privacy issues.**
Potential for Replication	**Expected Impacts - Benefits**
	Reducing operation costs Enhances grid stability Optimising investment in power system infrastructure

System has been replicated in multiplse sites in Finland and one site in Sweden.	Enhances new services based on the more data available of the assers Improving energy supply efficiency Reducing energy bill Promoting sustainable behavior Reducing GHG emissions Increasing share of renewables Reducing use of fossils Increasing energy efficiency of appliances Improving energy usage efficiency

Relevant Publications / Presentations / Services / Products to this Solution	
https://cris.vtt.fi/en/publications/positive-energy-district-a-new-puzzle-piece-for-cities-energy-tra	

Reference Applications of this Solution	
virtual power plants to industry with new Sinebrychoff contract	https://press.siemens.com/global/en/pressrelease/siemens-expands-virtual-power-plants-industry-new-sinebrychoff-contract
City of Lappeenranta	https://www.greenreality.fi/en/lprnyt/lappeenranta-become-one-first-cities-world-operate-virtual-power-plant
Väla in Sweden	https://www.mynewsdesk.com/se/vala/pressreleases/vaela-bygger-sveriges-foersta-virtuella-kraftverk-i-samarbete-med-siemens-2977902

SPEC CARD

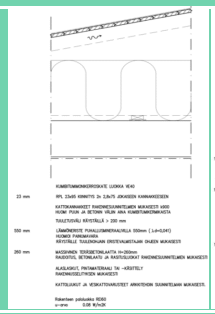
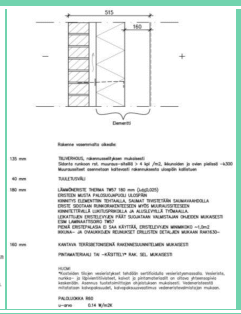
DEMAND SIDE SOLUTIONS

Category 1
LOW ENERGY CONSUMPTION

Solution 2
New High performance residential buildings

Title	Graphical Detail

S2a New High Performance Building (residential)

Apartment block with low space and domestic hot water heating energy consumption

City / Country	Making_City	Technical Partner Name & contact Details	
	Yes	Sivakka & YIT	
Implementation Time	Round 1,5 year	**Initial Investment**	6,1 M€

What is Solution?	How does it work?
Ceiling U=0,08 W/m^{2}K Wall U=0,14 W/m^{2}K, insulation 180 mm PU Windows and doors U=0,6 W/m^{2}K Floor U=0,011 W/m^{2}K Exhaust air heat recovery (air-to-air), pre-heating and -cooling from soil layer under the building Heat recovery with heat pump from district heating return line Heat recovery from sewage water with water-to-water heat exchanger Solar panels Metering (temp, moisture, pressure difference in mech. ventilation) Ventilation rate adjustable by inhabitant Moisture-controlled ventilation in bathrooms	Good insulation and windows and heat recoveries from outcoming streams keep the basic heat consumption small.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	Several suppliers
Operator Who is operating this solution?	Sivakka
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Finally the tenant
Implementer Who is implementing this solution?	Several suppliers
Financer How / By whom has the implementation of this solution been financed?	Own funding

Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	All people, who has something to do with the buuldings

Business model patterns
Pay-back time varies solution by solution, but in general the improvement over the minimum level set by law (which is quite high already) has a pay-back time of e.g. 20 years. However, the risk is generally low, so the investments are feasible in long term. One time payment Loans

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Not necessarily dependent on other solutions, but the feasibility is the better the more expensive and "dirty" is the heating energy the use of which is decreased or be replaced by HP heat.	Political: Largely supported by politics, even if the populistic parties tend to resist may "green" issues Economic: Long pay-back time, but low risk Social: Especially in this case the rents must be kept low. Long-sight investments help in this. Technical: No major barriers, partly new technology however. Components, materials and solutions have a good availability in general. Environmental: At some point the increase in e.g. insulation or building new buildings in general may override the savings. I.e. embodied energy may be larger than net energy consumed during use. Legal: Good support by Finnish legislation ang gets probably even better.

Potential for Replication	Expected Impacts - Benefits
Very largely replicable	See barriers/enablers. This kind of energy performance is probably at least close to the lowest-cost alternative in long term.

Relevant Publications / Presentations / Services / Products to this Solution	
(links to suppliers?)	

Reference Applications of this Solution	

SPEC CARD

DEMAND SIDE SOLUTIONS

Category 1
LOW ENERGY CONSUMPTION

Solution 3
Building Envelope Retrofitting in Tertiary buildings

Title	Graphical Detail

S3a Retrofitting of the office building

Efficient use of multiple energy resources: geothermal heat pump for heating and cooling , solar energy

City / Country	Making_City	Technical Partner Name & contact Details	
	Yes	**WAM,** GRO, ITBB (Geocomfort)	
Implementation Time		**Initial Investment**	1.320.000 € (250,000 €EU)

What is Solution?	How does it work?
The retrofitting is a combination of several measures; from implementing thermal energy storage combined with a geothermal heat pump [A26] to installation of smart thermostats for temperature control [A7]. The 'HeatMatcher' concept that optimizes heating and cooling supply and demand and maximize use of renewable energy sources [A10]. Uncertain actions are implementing new HR+++ glass [A4], PV on roofs and parking lot [A11], PVT [A21] and thermal storage in Mediacentrale [A30].	

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Tenants
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	EU funding for 250 k €, the rest is self financed
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
Energy and operational cost savings Shared savings Power purchase agreement White label retailing

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
It is a combination of different interventions. There are complementary actions like: Advanced energy metering [A7], [A8], HeatMAtcher for MEdiacentrale [A10], S14a - PV in roofs and parking lot [A11], S15b - PVT in Mediacentrale [A21], Geothermal heatpumps [A26], S16a-Geothermal District Heating [A27], Thermal Storage in Nijestee [A29], High pressure waste water digester [A31], Smart Charging Stations [A33]	**Political:** The management structure of WAM consists of shareholders who have to decide on investments. This sometimes hampers the efficiency of implementation. **Economic:** Every measure needs to have a solid BC that is supported by the shareholders. **Social:** **Technical:** Not every technique can be realised considering the old construction of the building. **Environmental:** The current environmental impact is rather bad, but will be improved significantly after the execution of all the measures. **Legal:** Always applies

Potential for Replication	Expected Impacts - Benefits
The geothermal system is already being used by the city.	The building will be disconnected from the gas network and will not use fosil fuels after the project, PV installations will allow to reduce electricty consumption which will reduce fosil fuel energy demand as well as CO2. The energy bills will be lower and have an economic benefit.

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

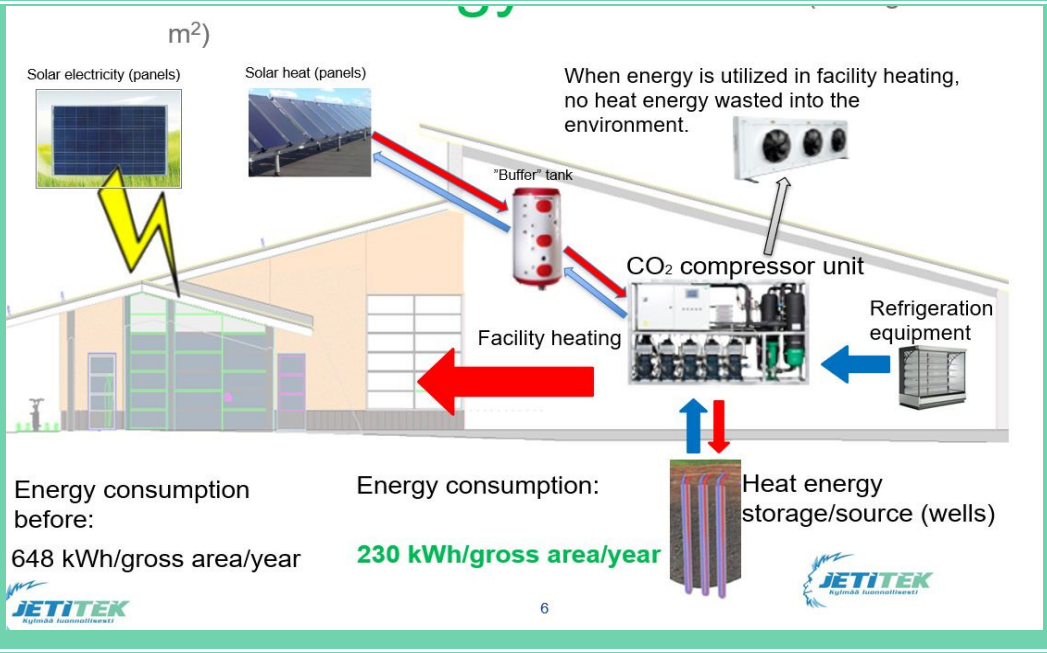
DEMAND SIDE SOLUTIONS

Category 1
LOW ENERGY CONSUMPTION

Solution 4
New high performance tertiary buildings

Title	Graphical Detail

S4a New High Performance Building (Shopping Mall)



Efficient use of multiple energy resources:heat dwells, solar and heat recovery

City / Country	Making_City	Technical Partner Name & contact Details	
	Yes / No		
Implementation Time		Initial Investment	Depending of the scale, payback time less than 2 years

What is Solution?	How does it work?
The system is based on advanced heat pump technolgy using enviromentally friendly CO2 instead of F-gases. When cooling the food, the heat pump produces equal amount of heat, added with electricity consumption. This heat is used in the building for heating, for hot domestic water and surplus can be also distibuted to other surrounding buildinds with regional heating pipeline. The heat surplus can also be stored to heat dwells.	Effient use of heat pump technology with advanced scada system, used to optimise the peaks and balance the use of heat and cold. Heat dwells used to get extra energy or to store surplus to the ground (seasonal storage) Solar panels for operating the system (100% self sustainability on the summer period) for the heat and cold Heat and cold storage by phase change material (improved coefficient of performance) Heat recovery from the AC system 50% smaller electricity consumption, compared to the buildings with the similar size

Stakeholder Analysis

Developer (if relevant) Who has developed this solution?	Jetitek
Operator Who is operating this solution?	Jetititek (since 9/2019 Caverion OY)

Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	This solution is being used in 50 shops in the ARINA grocery store chain in Finland
Implementer Who is implementing this solution?	Arina implements this solution wih the help of Jetitek to every new and refurbished shop
Financer How / By whom has the implementation of this solution been financed?	The financing is coming from Arina the owner
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
Depending the size of implementation, typical reduction in enrgy bill 50%, payback time less that 2 years One time payment Direct financing Loans Access to cross subsidies

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Best when connected with DH network, since then it is possible to utilize the excess heat.	**Political:** Quite techical and invisible solution that do not require anything special from the society, so no poitical barriers. Climate-friendly, so possible support from political groups supporting these targets. **Economic:** very good, payback and references available **Social:**highly appreciated by consumers **Technical:** a solid tested model **Environmental:** CO2 based, environmentally safe **Legal:** Targets to decrease the use of F-gases makes this even more attractive

Potential for Replication	Expected Impacts - Benefits
The system can be replicated in Europe. In Finland the estimated potential to feed heat to DH network is about 1 TWh/a, i.e. 1/80 of the total space heating and DHW end-user consumption in Finland.	50% savings in the energy consumption of the grocery store. One good, easily usable source of heat for DH network, decreasing the electricity use of the heat pumps and thus that of the whole heating system.

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution
45 existing systems by ARINA; the most advanced developed for MAKING CITY project with the ablility to share the resouces with neigbouring buildings

SPEC CARD

DEMAND SIDE SOLUTIONS

Category 1
LOW ENERGY CONSUMPTION

Solution 4
New high performance tertiary buildings

Title	Graphical Detail

S4b New High Performance Building (Academy Building)

- geothermal heat pump (LTH) for heating and cooling ,
- solar energy,
- mechanical ventilation with heat recovery,

City / Country	Making_City	Technical Partner Name & contact Details	
	Yes	**SEV**, RUG, SB	
Implementation Time		**Initial Investment**	

What is Solution?	How does it work?
The Energy Academy Europe is a tertiary building which houses both lecture rooms and offices with a surface of 9,636 m2 and was completed in 2016. It is the most sustainable teaching building in the Netherlands due to a BREEAM Rating Outstanding score of 89.62%. The building is using a heatpump system based upon a district gothermal heat pump. The system is a low temperature heating system which is also used for cooling. - Technical information HP: …. Expected e**nergy consumption per year for heating is:** and for **cooling it is**: Solar boilers are installed for hot water use. There is mechanical ventilation system with heat recovery. For lighting there is movement detection sensors There are also **1600** panels with a **xx MW** capacity. Expected electricty generation is **xx Mwh** per year.	This building contains a geothermal heat pump and has 1,600 solar panels on the roof. The panels are arranged in various angles to allow more panels on the roof and thus increase energy performance.

Stakeholder Analysis

Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Academics, students
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
Energy savings, maintenance cost savings One time payment Loans

Integration with other smart solutions	**BARRIERS / ENABLERS _ PESTEL STUDIES**
	Political: Part of national and regional policies and strategies **Economic:** high investment costs, lack of financial resources **Social:** **Technical:** time constraints, inadequacy of knowledge of new implements and technologies **Environmental:** reduction of CO2 emissions **Legal:** Lack of incentives

Potential for Replication	**Expected Impacts - Benefits**
The system can be replicated in Europe with similar climatic conditions	High. There are a lot of buildings, for which this is applicable. Savings in the energy cost, from the building owner point of view, can be calculated quite easily by comparing consumptions of a similar building with conservative systems. The CO2 reduction can also be calculated for environmental performance.

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

DEMAND SIDE SOLUTIONS

Category 1
LOW ENERGY CONSUMPTION

Solution 4
New high performance tertiary buildings

Title	Graphical Detail

S4c New High Performance Building (Sport Complex)

Efficient use of multiple energy resources: geothermal heat pump (LTH) for heating and cooling, solar energy, flooting solar pontoons,

City / Country	Making_City	Technical Partner Name & contact Details	
	Yes	**GRO,** WAR	
Implementation Time	Finalised	**Initial Investment**	15.500.000 €

What is Solution?	How does it work?
The sports complex building combines sports-, educational-, office- and meeting room facilities. The sports facilities have a total surface area of 4208 m2, while the remaining occupies 1107 m2 of space. The construction of this energy positive building was finished by the end of 2018. - The building is using a heatpump system based upon a district gothermal heat pump. The system is a low temperature heating system which is also used for cooling. A 800 lt buffer tank will also be installed. The energy consumption is expected to be 61 MWh for heating and 7 MWh for cooliing with 67 ton CO2 avoidance.	WarmteStad provided heating and cooling to the building (Action 27). The PVT panels (Action 20) provide hot water for the sportscomplex and are also used for the balance of the hot and cold wells of the geothermal heatpump system. The PV panels on the roof provide enough electricity for the building to become energy positive (Action 11). In the surrounding area Floating solar pontoons are planned (Action 15). Apart from the building 180 Floating Solar pontoons (156.6 kWp) will be installed in the channel behind the building (Action 15) as well as an innovative SolaRoad (Action 16), consisting on a

- Solar boilers are installed for hot water use with an expected energy consumption of 32 MWh and CO2 reduction of 14.4 tons - There is mechanical ventilation system with heat recovery. - For lighting there is movement detection sensors - There are also 1040 panels with an expected generation of 247 MWh/y capacity.	dedicated bike lane with solar panels integrated (70 kWp). For the purpose of energy monitoring and demand/response smart controls will be installed (Actions 7- 8).

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Academics, sports people, students
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
Energy savings, maintenance cost savings One time payment Loans Power purchase agreement White label retailing

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
[A7], [A8], [A11], [A16], [A17], [A27], [A31]	**Political:** Such an ambitious building has a strong political support. **Economic:** Because of the political and social benefits it was allowed to invest more than usual. **Social:** The facilities of the building strongly promotes sports activities and a healthy life style. **Technical:** The building is energy positive and also has a great deal of extra smart functionalities. **Environmental:** Very positive. Carbon neutral. **Legal:** Very positive. Carbon neutral.
Potential for Replication	**Expected Impacts - Benefits**
	Savings in the energy cost, from the building owner point of view, can be calculated quite easily by comparing consumptions of a similar building with conservative systems. The CO2 reduction can also be calculated for environmental performance. Electricity: 265 MWh/y Heat/hot water: 71 MWh/y Expected CO2 reduction: 78 ton Pontoons: 133 MWh/y Solar road: 60 MWh/y Solar parks share: 22 MWh/y

Relevant Publications / Presentations / Services / Products to this Solution

Reference Applications of this Solution

SPEC CARD

DEMAND SIDE SOLUTIONS

Category 2

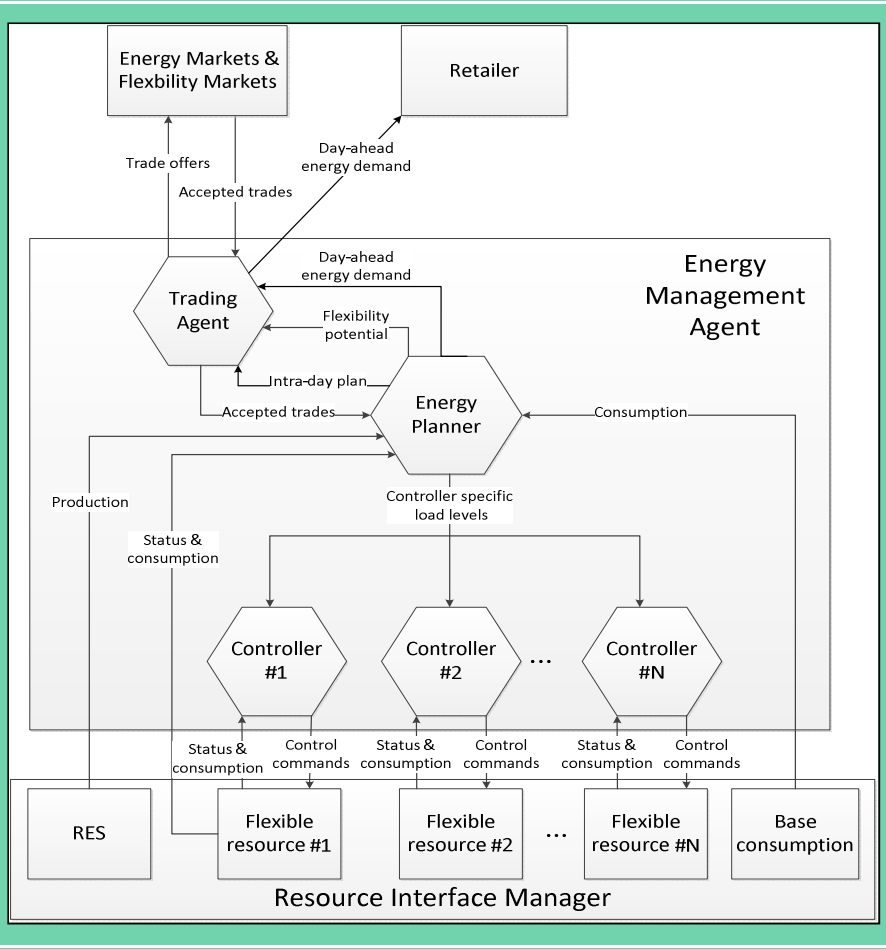
IMPROVE ENERGY EFFICIENCY

Solution 5

Smart Building / Home energy controllers

Title	Graphical Detail

S5a Energy Management Agent for energy optimization and demand response



'- Novel solution for energy optimization and bottom-up based demand response,
- Energy Management Agent (EMA) automates flexibility management on building-level,
- EMA provides a load plan and flexibilities for each site,
- Supports peer-to-peer and aggregation based flexibility management,
- Deep learning technologies utilized for learning building dynamics and optimal control policies

City / Country	Making_City	Technical Partner Name & contact Details	
	Yes	VTT	
Implementation Time		Initial Investment	
What is Solution?		How does it work?	

EMA optimizes the energy usage within a site by controlling flexible resources and trading energy via local markets in order to maximize the reward function (i.e., objective) defined by the end-user. Typically, the reward function is money, but it can also include environmental aspects such as CO2 emissions. The money part of the reward function can in turn include various aspects such as the energy price, power tariffs, local power generation and cross-commodity energy trade.
Energy Management Agent is designed to interact with the outside world (i.e., other Energy Management Agents and/or Aggregators) via local markets.

A5: Smart control building in 1
The building will be fitted with a wireless sensor network which monitors indoor air quality (Temperature, humidity, CO2, pressure) and operates heating, ventilation and lighting. It also monitors the energy consumption (heat and electricity), and operates as a demand response control unit. The data from the consumption will be collected to a common database with the local high-speed network (Oulu, A5, p.20).

EMA can be divided into three logical parts as: Trading Agent, Energy Planner and Controller(s). The Trading Agent is the Energy Management Agent's Interface to energy markets. It is responsible for maximizing the flexibility potential of the site in the markets by trading energy with other market participants.
The Energy Planner is a central component of the EMA. It is responsible for planning and optimizing the energy usage within the site at all times. The basic functionality of the Energy Planner can be roughly divided into four parts:
1. Once a day, before the day-ahead market closes, the Energy Planner provides the Trading Agent with a forecast of the next day's energy demand.
2. Continuously during the day, the Energy Planner provides forecasts of the load for a configurable time window. Again, the Energy Planner can utilize information on the generation, demand and flexibility forecast, as well as, various incentives for making the plan.
3. The Energy Planner provides the Trading Agent with information about the flexibility potential of the site. This information contains the maximum up and down flexibility as well as the minimum price for adjusting the load in a given direction.
4. The Energy Planner monitors and plans the site overall load profile and assigns individual load profiles for each flexible resource. This is done continuously to be able to adapt to trades and other changes in the day-ahead demand plan.
Logically there is a Controller component for each flexible resource type within a site. Each Controller component is responsible for controlling a flexible resource according to the plan provided by the Energy Planner. Implementation of the Controller logic depends on the type of the resource. For example, with on/off device the Controller needs to manipulate the on/off pulse ratio so that the average load within the market resolution (i.e., 15 minutes) matches the load plan. With more complex devices such as heat pumps the control is executed by manipulating temperature set points.

A13: Smart control and metering in building two
The building will be fitted with a wireless sensor network which monitors indoor air quality (Temperature, humidity, CO2, pressure) and operates heating, ventilation and lighting. It also monitors the energy consumption

A18: Smart control in buildings three and four The buildings will be fitted with a wireless sensor network which monitors indoor air quality (T, humidity, CO2, pressure). The control system will optimize the energy consumption (heat and electricity) and also collect necessary data for verification and performance analysis with the local high speed network (Oulu, A18, p.37).	(heat and electricity), and operates as a demand response control unit. The data from the consumption will be collected to a common database with the local high-speed network. In heat pumps and district heating substations there are their own control systems in every case. The idea is to have all the subsystems operating so that the whole system works optimally and is controllable. For example, the heat production distribution between heat pump and district heating should be controllable or in fact automatically controlled in an optimal way in different situations, related to outside temperature, electricity and DH prices etc (Oulu, A13, p.29). **A18: Smart control in buildings three and four** Concerning all smart controls, first there are trials to find out the response of the system. These trials are also to be continued during the whole project. In heat pumps and district heating substations there are their own control systems in every case. The idea is to have all the subsystems operating so that the whole system works optimally and is controllable. For example, the heat production and distribution between heat pump and district heating should be controllable or in fact automatically controlled in an optimal way in different situations (Oulu, A18, p. 37).

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	Several organizations. Here VTT as a main technical partner.
Operator Who is operating this solution?	Perhaps the best would be the energy company, together with the building owner. However, the will of the residents is the basis of everything.
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Building owner. Finally the residents pay everything, however.
Implementer Who is implementing this solution?	See above.
Financer How / By whom has the implementation of this solution been financed?	See above.
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	All the supplying companies at least in investment phase.

Business model patterns
Depends on the volatility of the energy prices. The higher, the higher streams. This can be studied separately with specific case years and equipment, if needed. Municipal utility Cooperative utility

Integration with other smart solutions	**BARRIERS / ENABLERS _ PESTEL STUDIES**
	Political: B: Inadequacy of sustainable and integrated policies, concerning the flexibility issue as a whole. E: Climate targets, emerging discussion about flexibility. **Economic:** B: high investment costs, lack of incentives, financial savings of

Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	customers in long-term is unsure, possibly small savings compared to the required attention. E: Potential savings with certain preconditions. **Social:** E: Increase of the customer's awareness about energy, B: doubt of self control, does not usually increase social status **Technical:** B: difficulties of implementations, E: when a suitable model is created, the replication is in principle easy. No difficult technical problems to solve. **Environmental:** Improving environmental quality through reduced greenhouse gas emissionCO2 **Legal:** B: electricity taxes are fixed c/kWh, but they should be %-based for this. E: General "spirit of the law" is in favour of these in many senses.
Potential for Replication	**Expected Impacts - Benefits**
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	-Enables end-users to take more active role in the energy markets -Makes energy systems more predictable by providing incentive for end-users to plan and optimize energy usage -Supports local flexibility management - Supports RES integration - Reduces CO2 footprint
Relevant Publications / Presentations / Services / Products to this Solution	
Reference Applications of this Solution	

SPEC CARD

DEMAND SIDE SOLUTIONS

Category 2
IMPROVE ENERGY EFFICIENCY

Solution 5
Smart Building / Home energy controllers

Title	**Graphical Detail**
S5b Visulation Units to study human behaviour regarding the energy consumption	
	Display units for visualization the energy consumption and comfort levels

City / Country	**Making_City**	**Technical Partner Name & contact Details**	
	Yes	UOU, SIV, OEN, OUK	
Implementation Time		**Initial Investment**	EUR 8.480

What is Solution?	**How does it work?**
Making-City project has developed an interface in which participants to the Making-City project can access their energy consumption, water consumption, evaluate their climate comfort and provide feedbacks on it, as well as information on their environmental impacts. The application shall also provide alternative and advice on how to act on the different topics, such as carbon emissions compensations, energy reduction and so on	56 display modules (PDA) will be installed in building 1 and 50 display modules to building 2 to assess how human behaviour is affected by different information from the system. People living in the SIV buildings will have very comprehensive information of the local resources and energy balance. The assessment of human behaviour in terms of energy usage from both groups of people will be carried out. The digital application is to be available on in-home displays as well as on mobile devices. On top of the web interface accessible publicly, the interface of the digital mobile application allows following the status of the PED even if you are not a participant of the project nor have login information. Furthermore, the solar production, energy and environmental status of the electricity network are made available

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	UOU
Operator Who is operating this solution?	End-users are the tenants
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Home owners, tenants
Implementer Who is implementing this solution?	UOU, Sivakka

Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	Energy producer

Business model patterns
Bill reduction through energy savings Municipal utility Cooperative utility

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
	Political: Inadequacy of sustainable and integrated policies (part-optimization). This concerns many of PESTEL issues. From political side, in Finland there is quite good consensus that CO2 reductions are to be cut. **Economic:f**inancial savings of customers may occur in mid or long-term, which is a barrier for many **Social:** raising of wondering to new and smart technologies. Considering the supposed time use of the residents, the energy issues must not take much time per day, but be rather automatic. **Technical: In some cases** incompatibility of infrastructure, i.e. the control systems do not have the required properties. **Environmental:** increased awareness and people's desire to learn consumption data **Legal:** depends on individual preferences

Potential for Replication	Expected Impacts - Benefits
	Increasing awareness of the tenants about their energy consumption is expected to lead to a decrease in consumptions.

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

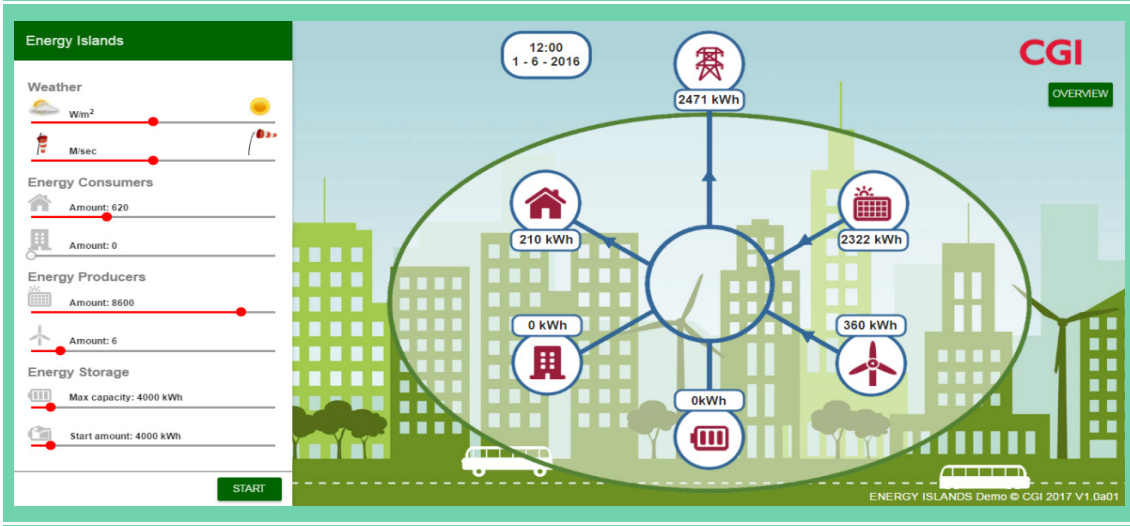
DEMAND SIDE SOLUTIONS

Category 2
IMPROVE ENERGY EFFICIENCY

Solution 5
Smart Building / Home energy controllers

Title	Graphical Detail

S5c Demand Response Smart Grid



Providing energy demand supply balance through smart grid

City / Country	Making_City	Technical Partner Name & contact Details	
	Yes	CGI, RUG, TNO, SB	
Implementation Time		Initial Investment	25.000 €

What is Solution?	How does it work?
Using the available energy flexibility within the PEDs (e.g. Storage, time, shifting, etc.) the solution will optimise the energy productions and consumption within the PEDs The flexibility of the buildings and houses is communicated through the advanced energy metering from advanced energy metering.	Energy flexibility information is collected by Sustainable Buildings, TNO and the EV charging operator. The combined monitoring information is analyzed in the Energy Islands platform. It includes for example, electricity consumption and production, EV charging information from connected charging poles, heat flexibility information from the TNO Heat Matchers. Instead of controlling the flexibility centrally, the demand/response decisions are taken locally (within the buildings or in charging poles), but with input from the central Urban Data Platform enabling optimization of the available flexibility in the whole district.

Stakeholder Analysis

Developer (if relevant) Who has developed this solution?	

Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
Bill reduction through energy savings Municipal utility Cooperative utility

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
S5d - The HeatMatcher for the optimisation of heating resources is Connection of the charging stations to the local demand response system S6c - Energy data monitoring of PED S6d - Integration of new services to the data platform	**Political:** Less energy consumption straightforward to communicate. **Economic:** More locally produced, renewable energy is used, which is cheaper that "grey" energy. **Social:** It's creating greater awareness that renewable energy is cheaper (and cleaner) so citizens will consume energy on in other timeframes. **Technical:** Integration with several different platforms working together to use the available flexibility. **Environmental:** Consume or store when it's produced, so no loss of renewable energy. **Legal:** GDPR compliance is necessary
Potential for Replication	**Expected Impacts - Benefits**
The HeatMatcher algorithm has shown to decrease energy expenses by up to 30%. In an office building like the Mediacentrale with sufficiently large energy requirements this quickly makes the investment profitable.	

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

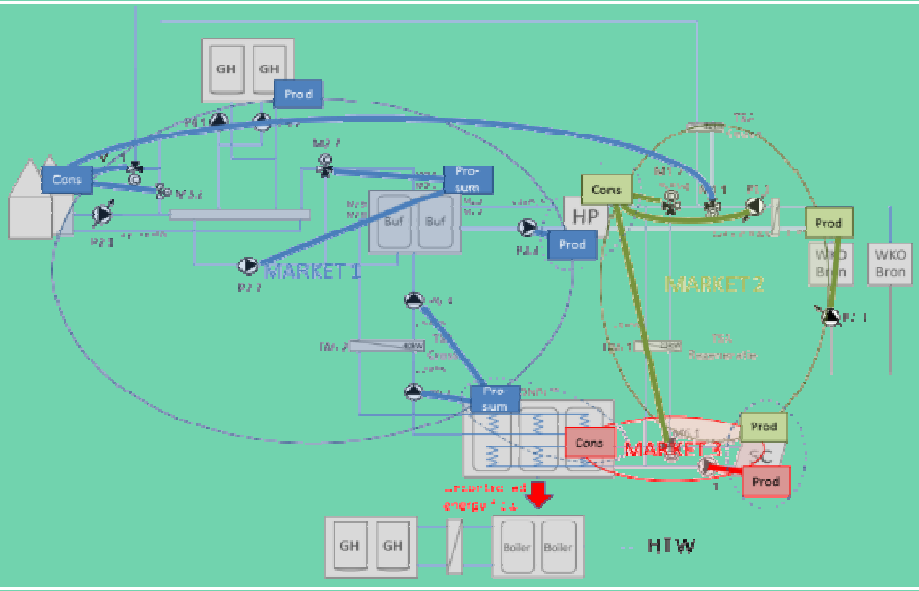
DEMAND SIDE SOLUTIONS

Category 2
IMPROVE ENERGY EFFICIENCY

Solution 5
Smart Building / Home energy controllers

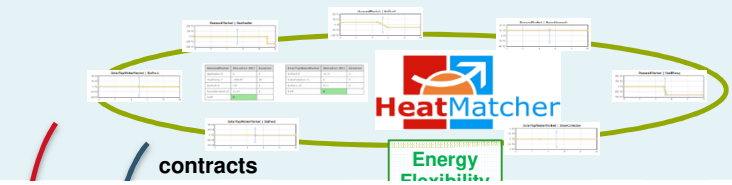
Title	Graphical Detail

S5d Heat Matcher



- Match heating and cooling supply and demand
- Maximize use of renewable energy sources
- Virtual market mechanism: agents sell and buy their energy on the markets
- Exploit the flexibility of all components and uses this flexibility in the optimization algorithm
- Higher abstraction: Controls the energy flows, instead of temperatures used in traditional systems

City / Country	Making_City	Technical Partner Name & contact Details	
Groningen / The Netherlands	Yes	TNO Arun Subramanian (arun.subramanian@tno.nl)	
Implementation Time	3 months	**Initial Investment**	€35.000,00

What is Solution?	How does it work?
HeatMatcher is an innovative real-time matching solution for heating and cooling systems. It determines the optimal balance between producers (supply) and	

consumers (demand) of heat and cold. One of HeatMatcher's unique features is its ability to handle many energy consumers and producers at the same time, which is expected to be a prerequisite for heating and cooling networks in the near future. For instance, by optimising across multiple energy producing components – such as heat pumps with thermal storage, solar collectors and gas heaters – consumers benefit from low costs as the amount of renewable energy in the mix is maximised. With a certain buffer capacity required in the system to enable production of energy when costs are low and consumption occurs later, HeatMatcher is able to exploit the flexibility for each of the components and optimise the match.

"Topology"

In HeatMatcher, each energy producer, consumer and prosumer is represented as an agent capable of expressing its flexibility as a bid curve (as defined in the EFI standard). HeatMatcher combines logically agents into a market and for each discrete time interval requests flexibilities from all participating agents in a market. Upon receiving these flexibility functions, it combines them to determine a market equillibrium, where supply and demand are in balance. Contracts are prepared on the basis of this equillibrium and device constraints and passed down to the agents who translate it to an actuation that the producer/consumer/prosumer device can understand.

Stakeholder Analysis

Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

~20% financial savings in OPEX per year in energy costs
Licensing
Pay as you go

Integration with other smart solutions

Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.

BARRIERS / ENABLERS _ PESTEL STUDIES

Political: N/A
Economic: Split between investor and benefeciary of technology
Social: N/A
Technical: Additional changes to heating installation may be necessary
Environmental: N/A
Legal: N/A

Potential for Replication

Solution was tested across 5 field trials in 4 locations in the Netherlands over multiple years. Definite potential for replication.

Expected Impacts - Benefits

Reduction in gas consumption observed to be ~28% less in last field trial.

Relevant Publications / Presentations / Services / Products to this Solution

Reference Applications of this Solution

SPEC CARD	DEMAND SIDE SOLUTIONS Category 2 IMPROVE ENERGY EFFICIENCY Solution 6 IoT Monitoring		
Title	**Graphical Detail**		
S6a Smart Lighting, power LED			
	LED lighting with dimming		
City / Country	**Making_City**	**Technical Partner Name & contact Details**	
	Yes	OUK, VTT	
Implementation Time		**Initial Investment**	The LED lights were installed already earlier. City of Oulu paid the costs , which was estimated to be 260,000 euros. 40,000(Power management, 11,250 EU Funding)

What is Solution?	**How does it work?**
A new lighting system of the area will be installed in order to reduce the energy consumption. The technology deployed will be high power LED	The lighting control will be smart, so it will dim the lighting scene when no activity is detected on the area. Power supply may cut down to 50% of the maximum. Ambient lighting sensors are also used to keep track on the daylight so the lighting will adapt to the daylight as well

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	Lighting suppliers
Operator Who is operating this solution?	City of Oulu
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	City of Oulu will save energy
Implementer Who is implementing this solution?	City of Oulu
Financer How / By whom has the implementation of this solution been financed?	City of Oulu
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	The inhabitants, Oulu Energy

Business model patterns

Savings through energy reduction Municipal utility Cooperative utility Virtual power plant Active customers Local aggregator Microgrid Power based tariff

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
S6b Wireless Network and acitivity sensors	**Political:** No significant barriers **Economic:** In some cases investment budgets may be a short-time barrier, but generally the change for LEDs have been quick. However, for the smart dimming the payback time may be too long and possible technical/social shortcoming may be a question. **Social:** No major barriers. Generally it is supposed that people find the colour rendering of LEDs more pleasant than previously used sodium bulbs. **Technical:** No major barriers. **Environmental:** CO2 decrease, longer lifetime, less waste . **Legal: Energy efficiency requirements guidew towards these.**
Potential for Replication	**Expected Impacts - Benefits**
The payback period of such solutions are relatively low compared to other energy efficiecny measures and the replication potential is high.	Reduction of energy consumption and thus CO2

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

DEMAND SIDE SOLUTIONS

Category 2
IMPROVE ENERGY EFFICIENCY

Solution 6
IoT Monitoring

Title	Graphical Detail		
S6b LoRa (Long Range) wireless network and activity sensors			
	Smart lightin controller using wireless network		
City / Country	**Making_City**	**Technical Partner Name & contact Details**	
	Yes	**OUK**, VTT	
Implementation Time		**Initial Investment**	35.000,00 €

What is Solution?	How does it work?
Power LED will be combined with smart lighting controller using LoRa (Long Range) wireless network (50 controllers) and activity sensors (50 units) to optimize the lighting level in evening and night time	LoRa based sensor network is used to have seamless control over the "private" and city owned lighting systems. The idea is to send control signals over the area to ensure safe travel and adequate level of lighting in all circumstances. Wireless activity sensors will also be used to provide intelligent control for the lighting

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	City of Oulu
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
Municipal utility Cooperative utility One-time investment Leasing

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES

S6a Smart Lighting	**Political:** Inadequacy of sustainable and integrated policies, low awareness among policy makers **Economic:** Very cost effective but high initial cost **Social:** it will make life in urban areas smarter, safer and more sustainable **Technical:** easy to implement technology **Environmental:** reduction of CO2 emissions **Legal:** no restrcitions
Potential for Replication	**Expected Impacts - Benefits**
	Reduction of energy consumption and thus CO2
Relevant Publications / Presentations / Services / Products to this Solution	
Reference Applications of this Solution	

SPEC CARD

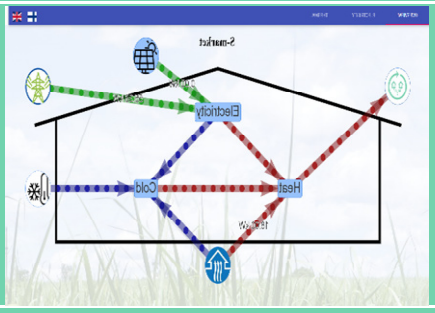
DEMAND SIDE SOLUTIONS

Category 2
IMPROVE ENERGY EFFICIENCY

Solution 6
IoT Monitoring

Title	Graphical Detail

S6c Energy data monitoring of PED



- Measures energy data and the state of the environment from the site
- Sends the energy data and environment state to the centralized data base
- Provides both technical and non-technical visualization user interfaces for monitoring the data
- data pipeline for intelligent control

City / Country	Making_City	Technical Partner Name & contact Details	
	Yes / No	VTT	
Implementation Time		Initial Investment	

What is Solution?	How does it work?
Energy data monitoring is a key component for enabling intelligent ICT services. It coves the data collection, data storing and data quality monitoring. In addition the solution provides both technical and non technical views for both real time and historical data.	Data is measured from the sites. Then the data is transmitted to the ICT server who stores the data in database. Automatic data quality checks queries the database and validates that data storing is operating as specified. If the check detects any problems in the data stream it sends alerts to developers to correct the data pipeline. To see the data both technical and non technical UIs are developed in top of the database to see both the real time data and historical data.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	VTT, CGI
Operator Who is operating this solution?	VTT, CGI
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Building and apartment owners and tenants
Implementer Who is implementing this solution?	VTT, CGI

Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	Building and apartment owners and tenants, energy companies

Business model patterns
Pay per use Multiu-sided revenue model

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
	Political: Municipality owner of data generated in the city. **Economic:** Investment in urban data platform needed. **Social:** Increase awareness of the impact of the PEDs. **Technical:** Scalable platform needed. **Environmental:** **Legal:** GDPR compliance is necessary
Potential for Replication	**Expected Impacts - Benefits**
	Enables intelligent control and other data intelligent solutions Enables measuring the energy performance of PED

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD	DEMAND SIDE SOLUTIONS Category 2 IMPROVE ENERGY EFFICIENCY Solution 6 IoT Monitoring
Title	**Graphical Detail**
S6d Integration of new services to the data platform	**Integration of new data to the data platform**

City / Country	**Making_City**	**Technical Partner Name & contact Details**	
	Yes	CGI, SB, TNO, GRO	
Implementation Time		**Initial Investment**	€ 25,000 (Mking City budget) Total ?

What is Solution?	**How does it work?**
The existing ICT platforms in Groningen are adapted and integrated to create an Urban Data Platform.	The purpose of the Urban Data Platform is to collect relevant data about the city and make it available to stakeholders in the city via standardized interfaces. It enables services built on these standards to be used within the city. Expected services would be; Sustainable Buildings data collection and analysis, TNO EDSL and ESSIM simulations, Groningen Open Data Portal, CGI Energy Islands Insights. (Groningen, A37, p.64).

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
Multi-sided revenue model Freemium Pay with data

Integration with other smart solutions	**BARRIERS / ENABLERS _ PESTEL STUDIES**

S5c Demand response smart grid S6c Energy data monitoring S7a Ope Data Platform Adaptation	**Political:** Enables new services in the city for citizens. **Economic:** Created services can be monetized. **Social:** Services generate awareness about PEDs. **Technical:** Adhering standards ensure the collected data is easily accessible. **Environmental:** **Legal:** Data ownership with the municipality
Potential for Replication	**Expected Impacts - Benefits**
Relevant Publications / Presentations / Services / Products to this Solution	
Reference Applications of this Solution	

SPEC CARD	DEMAND SIDE SOLUTIONS
	Category 2 IMPROVE ENERGY EFFICIENCY
	Solution 6 IoT Monitoring
Title	Graphical Detail
S6e Installation of IoT infra	
	General Data for the solution in bullets

City / Country	Making_City	Technical Partner Name & contact Details	
	Yes / No		
Implementation Time		Initial Investment	

What is Solution?	How does it work?
A38: Installation of IoT infra TNO This action has not been worked on in the first year (Groningen, A38, p.65).	Application description, figures if needed

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Multi-sided revenue model
Freemium
Pay with data

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** **Economic:** **Social:** **Technical:** **Environmental:** **Legal:**
Potential for Replication	**Expected Impacts - Benefits**
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	General aspects about the solution.Could be technical, economical, environmental, social

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

DEMAND SIDE SOLUTIONS

Category 2
IMPROVE ENERGY EFFICIENCY

Solution 7
ICT Urban Platform

Title	Graphical Detail

S7a Open Urban Platform adaptation

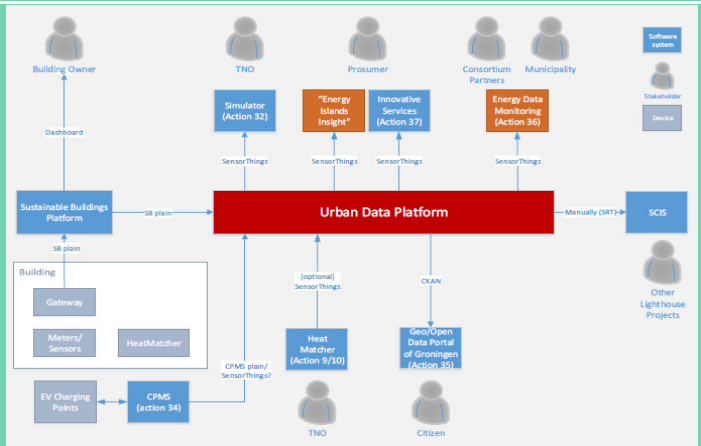


Figure 16: Schematic overview of Urban data platform.

Open Data Platfom

City / Country	Making_City	Technical Partner Name & contact Details	
	Yes	GRO, CGI	
Implementation Time		Initial Investment	

What is Solution?	How does it work?
The existing data platform will be integrated with other platforms as part of the MAKING-CITY project to create an Urban Data Platform storing and publishing any Open Data created as part of the project	Application description, figures if needed

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Open data	
Integration with other smart solutions	**BARRIERS / ENABLERS _ PESTEL STUDIES**
Retrofitting of old buildings and energy systems of new buildings (energy actions) S6c - Energy data monitoring of PED S6d - Integration of new services to the data platform **Solution XX**: Open data Business Models	**Political:** Municipality owner of data generated in the city. **Economic:** The urban data platform can be expanded for other data. **Social:** Increase awareness data available in the city. **Technical:** Data standardization. **Environmental:** **Legal:** GDPR compliance is necessary
Potential for Replication	**Expected Impacts - Benefits**
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	General aspects about the solution.Could be technical, economical, environmental, social
Relevant Publications / Presentations / Services / Products to this Solution	
Reference Applications of this Solution	

SPEC CARD

DEMAND SIDE SOLUTIONS

Category 2
IMPROVE ENERGY EFFICIENCY

Solution 8
High Speed data transfer network

Title	**Graphical Detail**		
S8a High Speed data transfer network			
	High speed wireless data network		
City / Country	**Making_City**	**Technical Partner Name & contact Details**	
	Yes	VTT	
Implementation Time		**Initial Investment**	€20,000 (€ 10,000 EU)

What is Solution?	**How does it work?**
Wireless data transfer network that will cover the whole area for control and data aggregation. (This is already existing as a standard solution in Finland, using common mobile network, so this is realized as a internal network fo practical purposes).	The data network will be used in order to control both electricity and heat management. It also serves the people by delivering online data of the energy balance thus improving the energy awareness of the inhabitants. Third function of this network is to store data for learning, verification and documentation purposes.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

Pay per use
Freemium
Multi-sided revenue model

Integration with other smart solutions	**BARRIERS / ENABLERS _ PESTEL STUDIES**

Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** **Economic:** **Social:** **Technical:** **Environmental:** **Legal:**
Potential for Replication	**Expected Impacts - Benefits**
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	General aspects about the solution.Could be technical, economical, environmental, social
Relevant Publications / Presentations / Services / Products to this Solution	
Reference Applications of this Solution	

SPEC CARD	SYSTEM INTEGRATION SOLUTIONS
	Category 3 INTEGRATED INFRSTRUCTURES
	Solution 9 Power storage
Title	**Graphical Detail**
S9a Neighbourhood electro storage facility	
	General Data for the solution in bullets

City / Country	**Making_City**	**Technical Partner Name & contact Details**	
	Yes	**NIJ,** GRO	
Implementation Time		**Initial Investment**	€ 140.000 (€97.000 EU)

What is Solution?	**How does it work?**
The decision is not clear, no explanations	Application description, figures if needed

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	NIJ
Operator Who is operating this solution?	
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	
Implementer Who is implementing this solution?	
Financer How / By whom has the implementation of this solution been financed?	
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	Enexis (ditribution system operator)

Business model patterns

No direct profits, might not be implemented Pay per use Shared savings Power purchase agreement Cooperative utiliy Active customer

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.	**Political:** **Economic:** There is no business case, funding is challenging **Social:** Can become an enabler **Technical:** Location is needed. Solution is very beneficial for net balancing. **Environmental:** **Legal:** How to bill and share energy without paying the usual energy taxes (Groningen, A28, p.54).
Potential for Replication	**Expected Impacts - Benefits**
Indicate if the system is already in use in other cities, kind of a valuation is also possible.	Potentially, neighbourhood energy can be stored and shared later.

Relevant Publications / Presentations / Services / Products to this Solution	

Reference Applications of this Solution	

SPEC CARD

SYSTEM INTEGRATION SOLUTIONS

Category 3
INTEGRATED INFRSTRUCTURES

Solution 9
Power storage

Title	Graphical Detail

S9a Individual Battery at Building Level

Energy storage system with Li-Ion batteries which provides bi-directional flexibility.
It is aimed for dynamic cycling

City / Country	Making_City	Technical Partner Name & contact Details	
Manchester	No	Ivan Hewlett, Ivan.hewlett@siemens.com	
Implementation Time	2017	Initial Investment	

What is Solution?	How does it work?
Energy storage systems are used to store energy that is currently available but not needed, for later use. The goal is to create a reliable and environmentally friendly system. As the share of renewables increases, so does the need for storage. With storage, energy can be used when it is needed.	The energy storage system is aimed for dynamic cycling. It is a grid-scale 0.5 MWh Li-Ion battery storage system which provides bi-directional flexibility from the perspective of demand/consumption and generation of energy. It is located on the customer side on a private wired network.It supports local renewable energy system operation. It matches time gaps between generation and demand. Siemens has worked with Manchester Metropolitan University (MMU) on its onsite energy system and have installed a Lithium-ion battery to integrate with current onsite generation. The Birley Campus, opened in 2014, consists of an academic building and halls of residence for 900 students. Primarily charged at night-time from the grid supply (when prices are low), the 400kWh Lithium-ion battery storage works with the 375kWh Combined Heat and Power generation, the 157kWh solar panels to supply to provide the Birley Campus with cheaper, and greener power. The battery is discharged at peak periods when the price of energy from the grid is high. The power is greener as more fossil fuels are used to generate power

	is high. The power is greener as more fossil fuels are used to generate power at times of high demand. This is all controlled by a microgrid controller with a demand side response system that actively manages generation, energy storage and flexible load assets to improve energy consumption on campus, reduces emissions and delivers cost savings. As the UK's number one green university in 2017's People and Planet University League, sustainability is a key topic in the curriculum, with students learning about the energy centre and battery storage.

Stakeholder Analysis	
Developer (if relevant) Who has developed this solution?	Manchester City Council
Operator Who is operating this solution?	Siemens
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Universität Manchester (MMU)
Implementer Who is implementing this solution?	Siemens
Financer How / By whom has the implementation of this solution been financed?	Manchester City Council+ Triangulum
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns
Demonstrates potential of battery storage to manage peak demands

Integration with other smart solutions	BARRIERS / ENABLERS _ PESTEL STUDIES
	Economic: Reducing energy bills **Social:** Passive Participation: end users and stakeholder were actively engaged via negotiations and communication sessions, Contributing to MMU being one of the top sustainable campus' in the UK **Technical:** Shaving peak energy demand, Enhances grid stability,Improving energy supply efficiency **Environmental:** Reducing use of fossils, Contribution to carbon reduction targets for the city **Legal:** Obtaining regulatory approval
Potential for Replication	**Expected Impacts - Benefits**
High Replication Potential since it is funded under Triangulum Project	Savings per annum €34,000 Project funding structure required an asset transfer Including the District Network Operator as a project partner could have addressed the regulatory issues

Relevant Publications / Presentations / Services / Products to this Solution
https://www.bable-smartcities.eu/explore/use-cases/use-case/useCase/energy-storage-assets.html
https://triangulum-project.eu/wp-content/uploads/2020/02/3_Manchester_Energy_Energy-storage-system.pdf

Reference Applications of this Solution	