

APPENDIX A PROJECTS WITHIN NEW ENERGY AND CLIMATE TECHNOLOGY 2012-2015

CONTRACT YEAR	PROJECT OWNER	PROJECT DESCRIPTION	TECHNOLOGY SUPPLIERS	SUPPORT AWARDED (NOK)	PROJECT'S ENERGY RESULT (kWh/year)
Renewable heating					
2012	Nord-Trøndelag county authority	Dynamic thermal energy storage (DTES) in low-temperature local heating system at Mære Landbruksskole in Steinkjer	<ul style="list-style-type: none"> • Technology developer: Gether AS • Energy circulation system: Kværner Piping Technology AS • Management systems/cybernetics: Enoco AS • Energy tanks: Vangstad AS 	6 756 755	1 400 000 Conversion from electricity, oil and natural gas
2013	Oslo Lufthavn AS	Snow cooling plant at Oslo Airport Gardermoen	<ul style="list-style-type: none"> • Technology developer: Oslo Airport and Team-T AS (e.g. Norconsult and Cowi are partners) • Contractor: Veidekke AS 	4 260 306	940 000 Production of free cooling, alternatively for electricity
2013	Agder Energi Varme AS	New solutions for heating from hydronic systems for low energy buildings in Kristiansand	<ul style="list-style-type: none"> • Developer of solution: Agder Energi Varme 	3 813 750	810 000 New application of district heating (from waste), alternatively for electricity
2015	Asker municipality	Drilling of two approx. 800-metre deep geothermal energy wells in Asker municipality	<ul style="list-style-type: none"> • Project developer: Asplan Viak AS • Drilling energy wells: Båsum Boring AS • Collectors: Protan AS and Abbakonda AS 	2 564 500	232 000 Production of heating
Renewable power					
2012	Tjeldbergodden Kraft AS	Tjeldbergodden Gjenvinningskraftverk, low-pressure turbine for power recovery from waste water (seawater) from the methanol plant at Tjeldbergodden in Aure	<ul style="list-style-type: none"> • Turbine, generator: CleanPower AS • Runner: Oshaug Metall AS • Expertise runner: Evald Holmén Consulting AB • Generator configuration: InPower AS 	4 774 792	2 500 000 Production of electricity
2013	Returkraft AS	Combined heat and power production from low-temperature waste heat from Returkraft's waste combustion facility in Kristiansand using CraftEngine piston engine	<ul style="list-style-type: none"> • Technology developer: Viking Heat Engines AS • Partners development piston engine: Institutt for Produktutvikling (IPU), AVL Schrick GmbH 	3 361 526	150 000 Production of electricity
2013	Asker municipality	Combined heat and power production from landfill gas from Yggeset waste park in Asker using stirling engines	<ul style="list-style-type: none"> • Stirling engine: Cleanergy AB • Partner: Wärmeprozess-technik GmbH • Gas plant: MGE Teknikk 	1 468 120	336 955 Production of electricity and heating
2013	Nordre Follo Renseanlegg IKS	Combined heat and power production from biogas using micro gas turbine at Nordre Follo's plant in Ås	<ul style="list-style-type: none"> • Technology developer: Adigo AS • Gas turbines: Capstone Turbine Corporation 	1 310 000	600 000 Production of electricity
2013	Vardar Varme AS	Power production from utilizing available excess heat from low-pressure vapour from bio-boilers at Follum in Hønefoss by using a Tocircle expander	<ul style="list-style-type: none"> • Technology developer: Tocircle Industries AS 	6 571 344	4 698 268 Production of electricity
2014	Gjøvik, Land og Toten Interkommunale Avfallsselskap IKS	Energy utilization of landfill gas with installation of five stirling engines at Dalborgmarka Miljøpark at Gjøvik	<ul style="list-style-type: none"> • Technology supplier: Cleanergy AB, MGE-Teknik AB 	1 400 300	486 000 Production of electricity and heating, as well as conversion
2015	Agder Energi Vannkraft AS	Integrated small-scale power turbine ("turbinator") for production of electricity from releasing minimum water flow from the Gåseflå dam	<ul style="list-style-type: none"> • Turbine, generator: CleanPower AS 	3 412 553	1 750 000 Production of electricity

PROJECT'S CLIMATE RESULT IN NORWAY (kg CO ₂ equiv/year)	PROJECT STATUS	INNOVATION	EXPERTISE DEVELOPMENT
379 000 Conversion from oil and natural gas	Under development, partially operational	<ul style="list-style-type: none"> Dynamic thermal energy storage Patenting technology New combination of technology with low-temperature local heating systems Multiple innovations in system, individual technologies, storage and management for optimization of performance and utilization of low-temperature surplus energy 	<ul style="list-style-type: none"> Cooperation with the Norwegian University of Science and Technology (NTNU), University of Oslo (UiO) and Bioforsk, as well as Nord-Trøndelag county authority, which is in turn building operative experience in relation to other market players Research arena at Mære landbruksskole Horizon 2020 application submitted with SINTEF as the coordinator, NTFK and Gether as partners, and the DTES system facility at Mære as the main case Publication in the media and interest in public agencies Master and doctorate degrees at NTNU
0	Ready for commissioning	<ul style="list-style-type: none"> Utilization of snow as source of free cooling 	<ul style="list-style-type: none"> Demonstration facility Knowledge about system development, functionality and suitability of the technology Information dissemination with associations, e.g. Norsk VVS Energi- og Miljøteknisk Forening and Fjernvarmeforeningen Presentations at various conferences Project tasks associated with the project, master's thesis or doctoral assignments relevant when the facility becomes operational
0	Two building projects in operation, one project under development	<ul style="list-style-type: none"> Innovative composition of technology, introduced in new market segment Simplified and more efficient hydronic system inside the building, suitable for industrialization Utilization of structure for distribution of hot water for consumption for floor heating Try new consumption points, e.g. washing machine and dishwasher for hot water from renewable sources Prøve nye forbrukspunkt, f.eks. vaskemaskin og oppvaskmaskin på varmtvann fra fornybarkilder 	<ul style="list-style-type: none"> Demonstration facility for the district heating industry, architects and property developers Cooperation with other expertise environments (major contractors, the HVAC sector, Bellona) Objective measurement of consumption for verification and analysis Tailored measurement programme offered to end user for customer follow-up and increased awareness Presentations in meeting arenas and at conferences Various articles in technical press
54 056 Reduced propane consumption	Under establishment	<ul style="list-style-type: none"> Demonstration of deep drilling under Norwegian conditions and in typically Norwegian bedrock Drill bit developed to handle crystalline bedrock Continuous casting in critical zones to reduce the risk of landslides and leaks New type of coaxial collectors enables high energy withdrawal 	<ul style="list-style-type: none"> Demonstration facility Experience transfer, e.g. via involvement in FutureBuilt Expertise development among all involved players Information dissemination via technical press, seminars, conferences, etc.
0	Not operational in 2015 (due to deficient water access)	<ul style="list-style-type: none"> Turbine and generator in the same unit makes gearbox unnecessary Adapted tempered seawater with regard to corrosion Replaceable runner for seasonal variation in water volume Patenting of technology is under consideration 	<ul style="list-style-type: none"> Reference facility for the industry Facilitated for monitoring, measurement and learning Relevant for connection to research projects and education Information dissemination through presentations and conferences, nationally and internationally Granted EU funds for further development of the technology in cooperation with Spanish Gas Natural Fenosa 260 kW turbine under development for utilization of minimum water flow at Gåseflå dam with support from Enova (see project under owner Agder Energi Vannkraft) Important lessons learned in the design (corrosion protection, fastening of composite component, etc.) Exhibited at Hydro 2014 (Italy) and Hydro 2015 (France)
0	Under commissioning	<ul style="list-style-type: none"> Known motor technology (piston engine) adapted to new area of application Simple design, very effective Several patents, e.g. on heat recovery unit and valve system (injection system) 	<ul style="list-style-type: none"> Demonstration facility (Returkraft has about 3 000 visitors each year) Several cooperation projects with research and educational institutions, e.g. Sintef, Teknova, Denmark Technical University (DTU) Doctorate at DTU
0	Operational	<ul style="list-style-type: none"> Verification of stirling engines' suitability for power production from low-quality landfill gas with low methane content. Can tolerate impurities in gas Several patents, e.g. for the burner, gas cooler and piston 	<ul style="list-style-type: none"> Demonstration facility, open for tours Continued major interest in the facility New knowledge about solving the challenge with significant variation of the gas production against the fact that the stirling engines need constant gas pressure
0	Operational	<ul style="list-style-type: none"> Newsworthiness as this is first-time implementation of micro-turbine cleaning facility for production of power and heat (co-gen) Development of complete control system 	<ul style="list-style-type: none"> Demonstration facility. Available for visitors from industry and academia Web-based monitoring of the facility enables easy data acquisition and sharing
0	Under development	<ul style="list-style-type: none"> Enables power production from steam with low pressure and temperature Flexibility in using multiple machines adapted to seasonal fluctuations Patented technology 	<ul style="list-style-type: none"> Demonstration facility Included in Viken Skog's efforts in "Treklyngen" at Follum, a business cluster for comprehensive and coordinated utilization of forestry, including sharing of expertise
56 358 Conversion from oil	Under establishment	<ul style="list-style-type: none"> Stirling engine can withstand polluted landfill gas Can be run with landfill gas with a methane content down to 18% 	<ul style="list-style-type: none"> Learning arena for dissemination of experience and knowledge is established when needed or based on demand Facility can be used for tours upon request
0	Under development	<ul style="list-style-type: none"> Simplified method for verification for the general public for the regulatory requirement relating to release of minimum water level Semi-regulated axial kaplan turbine with integrated generator Standardization of total solution for turbinating small water volumes Cost-optimized valve solution for controlling the minimum water flow release 	<ul style="list-style-type: none"> Reference facility for the industry Facilitated for measurement, monitoring and learning Potentially opened for tours for students from the University of Agder Development of several new key suppliers

REALIZED DISSEMINATION OF TECHNOLOGY	FURTHER DEVELOPMENT AND DISSEMINATION
<ul style="list-style-type: none"> • First implementation of full-scale facility in Norway and globally • Development cooperation with the University of Oslo with regard to further cooperation at the Natural History Museum in Tøyen. Two minor special contracts at the UiO Natural History Museum related to management system 	<ul style="list-style-type: none"> • Particularly suited for buildings with glass/atriums, historical buildings, energy efficiency for buildings on small lots, cooling in supermarkets • Technology supplier estimates potential spread to several thousand plants in Norway. • National potential for reduced greenhouse gas emissions • International potential for spread that can result in conversion to renewable energy and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • First snow-cooling plant in Norway • Implemented in one hospital in Sweden 	<ul style="list-style-type: none"> • Suitable for meeting cooling needs in buildings and facilities in areas with snow and frost in the winter and large areas available for snow harvesting and storage. • International potential for dissemination in areas with similar climatic conditions, which can yield greater use of renewable energy for cooling and reduced greenhouse gas emissions.
<ul style="list-style-type: none"> • Parallel development courses underway through Enova's competition for simplified heating solutions. • A building with only a tap water structure, where floor heating is taken from the tap water, planned construction start-up: Spring 2015 • A new building with 70 apartments under construction with new solution • Industrialized production at LK system's plant in Sweden 	<ul style="list-style-type: none"> • Suitable in buildings with very low energy consumption, cf. TEK15 • Industrialization makes the solution suitable for water-borne facilities throughout Norway. • Relevant for major contractors, associations and the industry • Several equipment producers want to participate, planning multiple prototypes of integrated cabinet solutions in the near future • In negotiations with developer to test and further develop the solution with hot tap water as the energy carrier
<ul style="list-style-type: none"> • First full-scale implementation of the technology in Norway • There are energy wells of a corresponding depth abroad, but with different subsurface conditions. 	<ul style="list-style-type: none"> • Suitable in city neighbourhoods where area usage and energy price are decisive • Asker municipality is considering energy wells for a specific development area (Føyka/Elvely) • Technology supplier estimates that the spread potential is for geothermal drilling projects in city neighbourhoods, where multiple shallow wells can be replaced with one deeper well. The potential in Norway is expected to be about 1000 wells a year. • National potential for spread that could contribute to increased renewable energy production and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • Pilot in the Nea watercourse is operational every summer (Statkraft) • Sales agent agreement with company in Puerto Rico (covers the Caribbean, Central America, and northern South America) • Sales agreement with company in Turkey (covers Turkey) 	<ul style="list-style-type: none"> • Transferable to utilization of mandatory minimum release in watercourse. Increasing focus in Europe with implementation of the EU's Water Directive • Transferable to water canals and dams connected to irrigation/water supply • Technology supplier estimates spread potential at around 20 industry plants in Norway, with comparable water consumption • Approved two SkatteFunn (Tax Deduction Scheme) applications for further development of the technology • Gas Natural Fenosa indicates a potential for 100 additional facilities following successful pilot installation in Spain • International potential for spread that can yield improved utilization of waste water for power production and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation globally • Developer signed agreement with BE Aerospace, the first test machines have been delivered • Two test machines delivered to Caterpillar in the US/Germany (exhaust heat) • One test machine delivered to Mitsui in Japan (geothermal) 	<ul style="list-style-type: none"> • Suitable for other energy sources: solar thermal, biomass and geothermal energy • Technology supplier estimates own spread potential to 2000 units globally by 2016, increasing to 4000 units total by 2017 • International potential for spread that can yield increased production of electricity from renewable energy and energy recovery, and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • Norway: Two orders for corresponding facilities • Internationally: There are currently facilities in the UK, Germany, Poland, Slovenia 	<ul style="list-style-type: none"> • Suitable for landfill facilities and methane gas plants. In Norway: 62 landfills in operation and 85 methane gas facilities • International potential for dissemination that can yield increased production of electricity and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation in Norway • Implemented in several facilities internationally, e.g. in the US and Europe 	<ul style="list-style-type: none"> • Suitable for biogas plants, landfill facilities and facilities for handling food and other waste. • In Norway there are 20 biogas facilities which treat drain mud from cleaning plants in Norway, 62 waste disposal sites in operation and 85 methane gas plants. • Primarily relevant for medium-sized facilities. • Suitable for large greenhouse facilities which need power, heating and CO₂. • Project owner is experiencing major interest from the market • International potential for spread that can yield increased production of electricity from renewable energy and energy recovery, and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • The project is a second-time implementation of a full-scale facility • Turbine previously implemented at Senja Avfall IK 	<ul style="list-style-type: none"> • The project creates a platform for further dissemination of steam expanders in the Nordic countries, and then internationally. • Repetition of expander production and run-time enables roll-out of other energy solutions with similar technology, e.g. ORC systems • Technology supplier estimates spread potential at about 20 district heating plants in Norway, and 90 plants in the rest of the Nordic countries • International potential for dissemination that can yield increased production of electricity from waste heat, and reduced greenhouse gas emissions.
<ul style="list-style-type: none"> • Second-time implementation of technology in this application area in Norway 	<ul style="list-style-type: none"> • Suitable for biogas, natural gas and a mix of natural and biogas • Further spread of the technology could take place through information on the project's owners website and tours of the facility • National and international potential for dissemination that can yield increased production of electricity and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • First full-scale turbinator installed at Tjeldbergodden Gjenvinningskraftverk, with support from Enova • Pilot in the Nea watercourse is operational every summer (Statkraft) 	<ul style="list-style-type: none"> • Suitable for utilization of minimum water flow in watercourses • Suitable for industry with sizable water flows • Transferable to water channels and dams connected to irrigation/water supply • Technology support estimates spread potential at about 50 plants in Norway in a 10-year perspective • Increasing focus on turbinating minimum water flow release in Europe • International potential for dissemination that can yield increased use of water resources for power production and reduced greenhouse gas emissions



102 projects in 2012-2015

New energy and climate technology is essential for adaptation to a low emission society. Enova's work within new energy and climate technology will help reduce greenhouse gas emissions and support the development of restructuring of energy end-use and energy production in the long term through developing and utilizing technologies and new solutions that can contribute towards this.

In the 2012-2015 period, Enova supported a total of 102 new energy and climate technology projects with a total of NOK 3.3 billion.

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CONTRACT YEAR	PROJECT OWNER	PROJECT DESCRIPTION	TECHNOLOGY SUPPLIERS	SUPPORT AWARDED (NOK)	PROJECT'S ENERGY RESULT (kWh/year)
2015	Kildal Kraft AS	340 kW micro power plant in Meløy municipality with a new turbine concept and standardized and prefabricated mini power plant installed in a container solution	Concept developer: Standard Hydro Power AS Turbine: Tocircle AS Container principle: Minipower AS	2 774 671	1 200 000 Production of electricity
2015	Waves4Power AS	Full-scale demonstration of 100 kW wave power buoy near Runde Miljøsenster in Herøy municipality	Technology supplier: Waves4Power AS Others: Siemens, OPD Hydraulic system: Petronas, Parker Bottom colour/rust treatment: Jotun Cables: Nkt cables Simulations, etc.: Chalmers, SP Buoy transport: Olympic Shipping	12 005 100	250 000 Production of electricity
2015	Hans Arild Grøndahl	Solar cell roof using new technology. Norway's first CIGS solar cell system with a new installation system adapted to Norwegian weather conditions. Automatic fire switch installed.	CIGS solar cells: SolarFrontier Fire switches: Santon Installation system: Mul10metal	942 760	65 561 Production of electricity
2015	Statkraft AS	Test turbine - Smøla	Project developer: Statkraft AS	30 734 876	31 000 000 Production of electricity
Non-industrial plants and facilities					
2013	Digiplex Fet AS	Construction of cost-efficient, safe and environmentally friendly data centre in Heia Næringspark in Fet municipality	• Overall contractor and construction contractor: Miljøbygg • M&E contractor: Gunnar Karlsen	30 300 000	7 358 400 Energy efficiency
2014	Norwegian Public Roads Administration Region South	Installation of intelligent lighting system in the tunnel between Gvammen (Hjartdal municipality) and Århus (Seljord municipality). Traffic is registered using a camera, and light zones are activated and follow the car through the tunnel	• Technology supplier: not determined	499 920	114 006 Energy efficiency
2015	Lyse Elnett AS	Demonstration of smart grid technology in an area in downtown Stavanger with 25 power grid stations and approx. 1 300 customers	• Concept: Lyse Elnett and ABB Norway AS • Measurement and management system in customer point, etc.: Lyse Elnett • Power grid stations, switchgear, management system: ABB Norway AS	14 687 000	500 000 Reduction of grid loss (electricity)
Transport					
2015	Eidesvik Offshore ASA	Installation of energy storage system (battery) in the Viking Energy supply vessel	Multiple suppliers will be used, but a final decision has not yet been made	7 440 000	4 541 547 Reduced fuel consumption (LNG and MGP and energy efficiency)
2015	Grieg Star AS	Hybrid operation of electric cranes on cargo ship	• Battery solution: Grenland Energy • Management system: Kongsberg Maritim • Cranes: MacGregor	1 150 000	1 014 361 Reduced fuel consumption
2015	Lindum AS	Introduction of a hyperthermophilic biological pre-processing stage in the production of biogas at Lindum in Drammen. Active degradation of biomass with bacteria culture that replaces the passive heating stage and increases the capacity without added energy supply	Technology developer: Hyperthermics Energy AS	7 200 000	4 010 000 Production of biogas, and energy efficiency
2015	Asko Norge AS	Commercial operation of three electric lorries in Norway	• Service: Norsk Scanla AS • Supplier and contractual party: HyTruck • Constructor: Emiss BV • Addition: SpesialKarosser AS • Cooling unit: ThermoKing AS	2 250 000	349 500 Reduced diesel consumption, and conversion from diesel to electricity
2015	Nel Fuel Norway AS	Energy-efficient hydrogen filling station with a new hydrogen production concept based on electrolysis of water. The station will be located in Akershus county authority, adapted for taxis and passenger cars	• Technology developer: Nel Fuel AS • Electrolysis provider: NEL Hydrogen AS • Hydrogen filling station: H2 Logic	7 760 000	2 600 000 Energy-efficient production and filling of hydrogen
2015	Halstensen Granit AS	Grain mill on board the shipping company's new trawler "Granit", with production steps not yet tested at sea	Not chosen yet	5 700 000	12 622 500 Reduced oil consumption and utilization of waste heat
2015	Halstensen Granit AS	Installation of electric winch motor based on PM (Permanent Magnetic)	• Technology: Rolls Royce	2 347 500	7 200 000 Reduced fuel consumption and electricity consumption
2015	Hordaland county authority	Hordaland county authority will build an onshore facility that will facilitate zero and low emission ferries for up to eight ferry routes in Hordaland	• Consultant: DNV GL	133 600 000	62 133 000 Reduced marine diesel consumption and conversion to electricity

PROJECT'S CLIMATE RESULT IN NORWAY (kg CO ₂ equiv/year)	PROJECT STATUS	INNOVATION	EXPERTISE DEVELOPMENT
0	Under development	<ul style="list-style-type: none"> Turbine with permanent generator maintains high performance over varying rotational speeds, and thus optimally exploits variations in water level Standardized container solution for micro power plant 	<ul style="list-style-type: none"> Cooperate with Østfold University College for engineering of the container solution – completed bachelor's thesis with related scientific theory and method Cooperation with various cutting-edge environments for development of system solution and standardization solutions
0	Under development	<ul style="list-style-type: none"> 25-year rust and anti-fouling protection, developed by Jotun and SP New generation of dynamic cables for marine energy Connection hub for connecting marine energy to the grid Relief system for dynamic cables 	<ul style="list-style-type: none"> Coordinated cooperation and exchange of experience between involved players and expert environments through the development of the wave power plant's technology elements. Extensive verification of technologies Development of simulation models and testing of cable strain in cooperation with Chalmers Tekniska Högskola, Technical Research Institute of Sweden Media coverage Sharing technical solutions with the marine energy industry
0	Near completion and operational	<ul style="list-style-type: none"> CIGS technology is new in Norway New installation system 	<ul style="list-style-type: none"> Empirical data from the project determines spread, particularly assessment of new CIGS technology with new installation system in relation to normal crystalline solar cells IFE Kjeller will use the facility for research Information meeting with Øvre Romerike fire and rescue
0			
0	Commissioning	<ul style="list-style-type: none"> Use of evaporation/adiabatic cooling units Use of the building as a local route for ventilation air 	<ul style="list-style-type: none"> Company network established Participating contractor is building expertise Execution of tests at the University of Leeds to optimise the rack design to reduce PUE
0	Under establishment	<ul style="list-style-type: none"> Connection of two familiar technologies; AID cameras and dimming system for LED lighting systems Light level in the tunnel controlled based on need using AID cameras, where lighting zones are activated when there is traffic and follow the car through the tunnel The lighting level will be reduced to 10% when there is no traffic 	<ul style="list-style-type: none"> Prestigious project where a future-oriented and energy conservation profile is selected Project owner assumes expertise development and spread both internally and externally
0	Under establishment	<ul style="list-style-type: none"> Smart grid technology for electric power systems that use bidirectional communication, distributed measurement and management systems, new sensor technologies and management of equipment (load, prod.) with grid customers Test new solutions, concepts and technologies Verify useful values of reducing grid losses Lay foundation for future development and efficiency 	<ul style="list-style-type: none"> Demonstration project Goal to establish industry standard Project under Demo Norge via the Smart Grid Centre in Norway Communication via industry network Continuous measurement and documentation Made available to research institutions upon completion, including Sintef and others
969 441 Reduced fuel consumption (LNG and MGO)	Under establishment	<ul style="list-style-type: none"> Installation of batteries in existing vessels with dual fuel propulsion (LNG and MGO) Batteries function as storage and additional energy source Stable load for generators where the batteries will handle the high peaks (peak-shaving) Alternating use of generator and battery ("charge/discharge") reduces use of generators with low output (where both consumption and emission are disproportionately high) 	<ul style="list-style-type: none"> Contribute to use of battery technology achieving broader market introduction The first such facilities will create a reference for cost and gains for other corresponding projects Participating sub-suppliers are developing knowledge (Kongsberg Maritime, Westcon Power & Automation, ZEM, Electro Automation Austevoll, etc.)
270 145 Reduced diesel consumption/LSMGO (Low Sulfur Maritime Gas Oil)	Under establishment	<ul style="list-style-type: none"> Installation of battery system for operation of electric cranes on cargo ships The cranes produce electricity when the load is lowered More optimised crane operation and reduced energy and fuel consumption 	<ul style="list-style-type: none"> Development and lab testing for verification of associated control system Verification of the solution under real operating conditions Quantify emission reductions and fuel savings
1 054 627 Production replaces diesel	Under establishment	<ul style="list-style-type: none"> Patented hyperthermophilic bacteria break down biomass very quickly in phase 1 in a biogas plant Biological generation of heat during the process reduces the energy need for pre-processing Biological hydrogen generation as added effect 	<ul style="list-style-type: none"> Expertise development surrounding multiphase biogas process internally at Lindum's two plants in Norway and in the company's R&D department Experience from the project is shared in several research and development projects Expertise transfer to other players in the waste industry through a biological work group in Avfall Norge
141 016 Reduced diesel consumption, and conversion from diesel to electricity	Under establishment	<ul style="list-style-type: none"> Electric lorries will replace traditional diesel lorries 1-1 New combination of lorry and cooling unit 	<ul style="list-style-type: none"> Better experience basis Knowledge sharing with other players Expertise development for electric vehicles among service and maintenance suppliers Test reach and battery capacity in a winter climate
0	Under establishment	<ul style="list-style-type: none"> Compact and more energy-efficient hydrogen production adapted to hydrogen stations Higher capacity than previously demonstrated Modular station for flexibility when scaling up 	<ul style="list-style-type: none"> Demonstration facility Internal expertise development, as well as expertise development with associated partners Information dissemination through conferences, seminars and inspections
3 824 618 Reduced oil consumption	Under establishment	<ul style="list-style-type: none"> Integration of new production stages that exploit waste heat and waste for production of new products Considerable improvement in specific energy per produced good Exploitation of everything from the fish that is collected from the ocean, including valuable fish oils 	<ul style="list-style-type: none"> Increased expertise and experience regarding the equipment's functionality on board during movement
2 181 600 Reduced fuel consumption	Under establishment	<ul style="list-style-type: none"> The new winch will yield higher fishing capacity (reduced trawling operation) The winch is operated by a motor with no gears Better performance and regenerative effect Energy consumption reduced by about 25 per cent 	<ul style="list-style-type: none"> Employees who operate the equipment will gain new experience Learning about the winch motor's interaction with existing deck machinery
16 547 261 Reduced marine diesel consumption	Under establishment	<ul style="list-style-type: none"> Norwegian maritime cluster is at the global forefront and the probability of technological innovations in tenders is significant Contribute to testing and gaining experience with more new technology elements (charging solutions and battery technology) 	<ul style="list-style-type: none"> Involved partners will considerably increase their expertise regarding battery solutions in ferries, which will provide an important head start in further development and sale of such solutions

REALIZED DISSEMINATION OF TECHNOLOGY	FURTHER DEVELOPMENT AND DISSEMINATION
<ul style="list-style-type: none"> • First-time global implementation of the turbine technology for hydropower production • The turbine technology is a further development of turbine technology based on gas and vapour, implemented at Senja Avfall IK in Lenvik and Vardar Varme in Hønefoss, with support from Enova • The system solution is a composition of existing technology in a new application 	<ul style="list-style-type: none"> • The technology is primarily suited for micro power plants of < 1 MW – multiple containers can be installed and operated in parallel and thus increase capacity • Technology supplier estimates that spread potential is 50-100 facilities in Norway under 1 MW. Furthermore, the supplier estimates a major international spread potential – several hundred over a few years • International potential for spread that can yield increased production of renewable power and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation in Norway and globally 	<ul style="list-style-type: none"> • The technology is suited for input to the grid, or for remote areas or installations far from the grid, e.g. electrification of aquaculture facilities, offshore installations, etc. • Technology supplier estimates a significant spread potential along the Norwegian coastline up to 2020, as well as about a hundred buoys outside the UK within 2017/2018 • International potential for spread that could yield increased production of renewable power and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • First national installation of new CIGS technology 	<ul style="list-style-type: none"> • Already national interest (TV2) in the solar cell industry and among potential buyers • International potential for areas with a Nordic climate
<ul style="list-style-type: none"> • First-time implementation in Norwegian data centres • Implemented in Sweden • Corresponding technology will be used in ongoing development of Digiplex data centre in Sweden 	<ul style="list-style-type: none"> • Several construction steps are under consideration • Potential unclarified, but growing Norwegian industry and several establishments are expected • Transferable to Nordic data centres • International potential for spread that can yield improved energy efficiency and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • First-time implementation of the combination of AID cameras and lighting management in Norway and globally 	<ul style="list-style-type: none"> • Project owner estimates a future national potential for improved energy efficiency of 3 GWh/year, based on the Norwegian Public Roads Administration's manual (N500) • International potential for spread that can yield improved energy efficiency
<ul style="list-style-type: none"> • First-time implementation of the total concept globally • Certain parts of the technology have previously been demonstrated internationally, but this is the first time in Norway 	<ul style="list-style-type: none"> • Transferable to Lyse Elnett's other grids and facilities • Significant international potential for the smart grid concept, including switchgear, power grid stations, measurement and management systems, etc. with smart grid functionality • Technology supplier estimates a substantial spread potential; 20-50% of the 130 000 power grid stations in Norway are expected to have a form of smart grid technology over the next ten years. The potential for export of the solutions is expected to cover all the 60 countries to which they currently deliver switchgears and power grid stations • National and international potential for spread that results in reduced grid losses and increased possibility for handling local power production and power-intensive equipment
<ul style="list-style-type: none"> • Second-time implementation in Norway in a ship with dual fuel operation (LNG and MGO) 	<ul style="list-style-type: none"> • Eidesvik wants to use corresponding technology on as many of their supply vessels as possible (own and operate 26 ships) • The technology is also transferable to other companies' supply vessels, as well as to vessels within related vessel groups such as anchor handling vessels, construction vessels, etc. – both nationally and internationally • International potential for spread that could result in reduced use of fossil fuels and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • First installation of such a system on board a ship in a global scale 	<ul style="list-style-type: none"> • Could potentially be installed in all of Grieg Star's newer ships • The technology is transferable to corresponding ships with electric cranes, which are starting to become a standard • International potential for spread that could yield reduced consumption of fossil fuel and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • First full-scale implementation of the technology in Norway and globally 	<ul style="list-style-type: none"> • Suitable for implementation when producing biogas from waste and other biological material • Technology supplier sees a possibility for implementation in the company's other focus areas, such as fish sludge from aquaculture and fertilizer from agriculture • Technology supplier estimates that spread potential is approx. 30 plants in Norway, 250 plants in Scandinavia and 7500 plants in Germany • International potential for spread that could result in increased biogas production with reduced energy consumption, conversion to renewable energy and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • First electric lorries in commercial operation in Norway • Electric lorries are already operational in other European countries, but only in a pilot scale 	<ul style="list-style-type: none"> • Potential for larger scale phase-in of electric lorries in ASKO's fleet • National and international potential for phase-in of electric lorries for city distribution in other transportation enterprises
<ul style="list-style-type: none"> • First implementation of the technology solutions (pressure electrolysis in filling station) globally • First hydrogen station in Norway aimed at the passenger car segment with robustness and capacity for commercial operations 	<ul style="list-style-type: none"> • National and international potential for energy-efficient hydrogen production and simple, modular hydrogen solutions that could result in increased use of hydrogen as fuel
<ul style="list-style-type: none"> • First-time implementation of the technology in Norway and globally 	<ul style="list-style-type: none"> • Potential for spread to other trawlers with rights for production processes on board, nationally and globally • There is currently a high demand for the products that are produced on board the vessel due to the high degree of freshness • Large volumes of available residual raw material that can be used in the new technology
<ul style="list-style-type: none"> • First-time implementation of complete outfitting in Norway and globally 	<ul style="list-style-type: none"> • The winches are designed for both trawlers and anchor handling vessels. Large markets may open up that could lead to more energy-efficient vessels in various sectors
<ul style="list-style-type: none"> • Norway only has one fully electric car ferry, this project will result in more fully electric ferries and plug-in hybrids • The project will provide an important experience basis for further implementation of battery technology in ferries and other vessel types 	<ul style="list-style-type: none"> • The project will help lower prices of several key components • Large market for ferry operations in Norway and significant potential for transition to more electrical operations • The project will stimulate new technology and advance the industry • The project will lead to more tenders with more stringent requirements for reduced energy consumption and reduced greenhouse



Enova's support programmes for new technology

New energy and climate technology will be a crucial contribution towards solving the energy challenges of the future. However, introduction of new technologies is demanding, in part due to the increased risk compared with conventional technology and reduced profitability.

Enova's support programmes in this area will contribute to the introduction of new energy and climate technology in the market, by reducing risk and increasing profitability for those who are the first to use a new technology.

We have five support programmes for new technology:

- Pre-project support – new energy and climate technology in industry
- Support for new energy and climate technology in industry
- Support for new technology for the buildings of the future
- Support for new energy and climate technology in transport
- Support for introduction of new technology

APPENDIX A PROJECTS WITHIN NEW ENERGY AND CLIMATE TECHNOLOGY 2012-2015

CONTRACT YEAR	PROJECT OWNER	PROJECT DESCRIPTION	TECHNOLOGY SUPPLIERS	SUPPORT AWARDED (NOK)	PROJECT'S ENERGY RESULT (kWh/year)
Industry					
2012	Hydro Aluminium AS	HAL4e Amperage Increase Project – Reduced specific energy use in aluminium production through increase of the amperage on the HAL4e cells at the test centre in Årdal	• Technology developer: Hydro Aluminium	6 159 496	835 000 Energy efficiency
2013	Vulkan Infrastruktur og Drift	Heat recovery plant for using steam from bakery ovens in a new production site for Mesterbakeren AS in Oslo	• Technology developer: Foodtech Bakeri og Industry AS • HVAC engineering: Erichsen & Horgen AS	467 003	58 897 Heating production
2013	Mostad Mekaniske AS	Energy cap on existing building in Oppdal, for insulation and capture and storage of solar heating, with energy storage in well for utilization of varying seasonal production and consumption in building	• Technology supplier: Mostad Mekaniske	42 580	30 000 Production of heating, alternatively for electricity
2013	Resitec AS	Improved energy utilization through recovery of silicone from the waste flows from silicone production at Elkem Solar's facility in Kristiansand	• Technology supplier: Resitec	4 766 500	8 665 200 Improved energy efficiency through recovery
2013	Nøsted Kjetting AS	New continuous process for production of high-strength chain at Nøstad Kjetting's facility in Mandal	• Technology developer: Nøsted Kjetting • Welding technology: ESAB • Robotics: ABB • Heat treatment and automation: SINTEF Raufoss Manufacturing AS • Project development: Engk Total AS • Adiabatic cutting: Schubert, EFT Induction technology	12 000 000	5 000 000 Energy efficiency
2013	Metallco Aluminium AS	Use of induction for drying aluminium shavings for aluminium recycling at Metallco Aluminium's facility in Toten	• Technology developer: Metallco Aluminium AS and Plasma Kraft AS	283 463	0 (not operational)
2013	Hydro Aluminium AS	HAL4e Pilot Plant – Further development and prototype testing of the next generation HAL4e cells at Hydro's reference centre in Årdal	• Technology developer: Hydro Aluminium	39 181 500	5 100 000 Energy efficiency
2013	Scanbio Ingredients AS	New energy-efficient drying process of fish peptides at Scanbio Ingredients in Bjugn	• Technology developer: Scanbio Ingredients • Management system: VisionTech AS • Engineering: Multiconsult AS	11 350 000	19 018 000 Reduced use of heating from fuel oil
2013	Andersen Gartneri AS	Installation of AGAM dehumidifier in greenhouses in Råde municipality. Uses low-temperature regeneration of hygroscopic salt	• Technology developer: Agam FlexTechnic Aps	174 295	180 000 Energy efficiency, and reduced propane consumption
2014	Enpro AS	Technology to reduce energy consumption and greenhouse gas emissions through use of CO ₂ from impure exhaust in production of industrial mineral products. The pilot will be installed at	• Technology development: Enpro in cooperation with ENGSL Minerals	40 000 000	6 800 000 Energy efficiency
2014	Moelven Mjøsbruket AS	Rehabilitation and isolation of drying plant for timber at Moelven Mjøsbruket in Gjøvik	• Technology developer: Drytec Sverige AB	443 121	529 400 Energy efficiency
2014	Hydro Aluminium AS	Construction of an industrial pilot on Karmøy for next generation energy-efficient primary aluminium production based on a new technological platform, called HAL4e	• Technology developer: Hydro Aluminium	1 555 000 000	96 000 000 Energy efficiency
2014	Elkem AS Bremanger	Pilot facility for dry classification in silicone production at Elkem in Bremanger	• Technology developer: three suppliers are under evaluation	3 825 025	13 555 100 Energy efficiency
2014	Nutrimar AS	Energy optimization of production process for processing offal from salmon at Nutrimar on Frøya	• Technology developer: Nutrimar AS	18 500 000	7 500 000 Energy efficiency and conversion from oil
2014	Rørosmeieriet AS	CADIO energy system with CO ₂ as the cooling medium will be installed at Rørosmeieriet at Røros	• Technology supplier: CADIO • Ventilation system: Omicron Automasjon AS	1 557 500	471 000 Energy efficiency
2014	Norsk Titanium AS	Demonstration plant with two machines for 3D printing of titanium at Norsk Titanium in Ringerike	• Technology developer: Norsk Titanium • Supplier of main components: Tronrud Engineering • Welding solution: SBI	7 715 700	747 00 Energy efficiency
2015	Klavenes gård og gartneri DA	Installation of a new type of dehumidifier in greenhouse in Holmestrand with air-to-water heat pump, which also enables regulation of dehumidification between multiple departments	• Technology supplier: SmartTekEnergi AS	282 127	108 000 Energy efficiency, and reduced propane consumption
2015	Tizir Titanium og Iron AS	Verification of new furnace technology in titanium oxide production at TTI's smelting plant in Tysseidal	• Technology supplier: Tizir	122 734 320	22 000 000 Energy efficiency, and reduced consumption of coal/coke

PROJECT'S CLIMATE RESULT IN NORWAY (kg CO ₂ equiv/year)	PROJECT STATUS	INNOVATION	EXPERTISE DEVELOPMENT
39 000 Reduced process emissions	Commissioning	<ul style="list-style-type: none"> Improved anode production technology Next level process management and operating procedures 	<ul style="list-style-type: none"> Included in Hydro's reference centre in Årdal Increasing expertise in Hydro's technological environment and with external partners such as the Norwegian University of Science and Technology (NTNU) and SINTEF Related projects have several doctorates in subjects highly relevant to the project Experience with improved production technology and use of next level procedures Expecting to publish important operating results after a verification period
0	Operational	<ul style="list-style-type: none"> Verification of possible achievable energy recovery and energy utilization 	<ul style="list-style-type: none"> Demonstration facility Case study for the industry must be prepared to communicate and highlight the possibilities Relevant to provide experience data to SINTEF's project INTERACT (supported by NFR) Meetings with the bakery industry and technology supplier to present operating results that will arise over time
0	Under commissioning	<ul style="list-style-type: none"> Embedding hydronic heating pipes for solar heating on roofs. The heating system is connected to energy storage in existing well It is being investigated whether the method can be patented 	<ul style="list-style-type: none"> Tailored measurement and follow-up forms the basis for further development and optimization Planned publication of results in professional journal Company is open to student theses, and other connections from expertise environments
3 320 000 Reduced process emissions	Under development, partially operational	<ul style="list-style-type: none"> Use of known separation methods applied in a new way to clean waste flows from silicone production and upgrading it to silicone powder with a high value and more applications Added substance to prevent oxidation for cuttings Separation and cleaning of very fine-grained powder in several stages Safe drying of fine-grained powder 	<ul style="list-style-type: none"> Close cooperation with the Eyde network, e.g. in the "zero waste" project Cooperation with Sintef and others, where results from this project will be shared and used further Implemented publication at EuroPM2015 in Reims, France Technology and results are shared through work in Cabriss, which is a Horizon 2020 project with 15 European partners
30 000 Reduced use of fuel oil	Under commissioning	<ul style="list-style-type: none"> Reducing number of production steps from 19 to 10 steps, of which the number of heating steps is reduced from five to two Transition from production machines to integrated process. There is no commercial equipment for this 	<ul style="list-style-type: none"> Important lessons are energy management, new processes with reduced resource consumption, energy and raw material utilization Collaboration with the University of Agder (UiA) and Umoe: Establishment of centre for innovative design for smart production Expertise sharing between the involved expertise suppliers through an extensive test programme Two Master's degrees completed (UiA)
0 (not operational)	Completed, not operational	<ul style="list-style-type: none"> Verification of suitability for use of induction for drying metal Increased material and energy utilization Combustion of undesirable organic elements on ingoing materials 	<ul style="list-style-type: none"> Building expertise through experience with testing and operation Planned development of contract network with various expertise and certification environments in the industry Experience from the pilot project will be used towards a full-scale installation When the facility is operational, it will be published and attempts will be made to sell the facility to other users Have verified the technology
510 000 Reduced process emissions	Under development	<ul style="list-style-type: none"> Innovative cathode and anode solutions Next level procedures for process management and operation 	<ul style="list-style-type: none"> Included in Hydro's reference centre in Årdal Increasing expertise in Hydro's technological environment and with external partners such as the Norwegian University of Science and Technology (NTNU) and SINTEF Related to technology programme supported by Innovation Norway, where Sintef is among the participants Related projects have several doctorates in subjects highly relevant to the project
5 762 000 Reduced use of fuel oil (diesel)	Under commissioning	<ul style="list-style-type: none"> New specially designed evaporator New system for washing with extraction substance Regeneration of electricity in one of the process systems Patenting of process is under evaluation 	<ul style="list-style-type: none"> Possibility to licence the technology to others in the same sector in Norway and abroad, alternatively enter into a joint venture with the partners that want to use the technology
19 000 Reduced use of propane	Operational	<ul style="list-style-type: none"> Reduces energy consumption for dehumidification by 25% due to energy-efficient low-temperature regeneration of hygroscopic salt 	<ul style="list-style-type: none"> Company network established Continuous measurement and documentation ongoing Publication in a scientific periodical is under assessment
14 400 000 Reduced emissions compared with best available technology	Under establishment	<ul style="list-style-type: none"> Use of CO₂ from industrial exhaust with a concentration of 4-5% No other impurities than CO₂ are collected during the process Production of superior mineral products Known elements individually, composed in a new way 	<ul style="list-style-type: none"> Expertise development related to process efficiency, CO₂ utilization in value chain, production of "green" minerals and chemicals Verification of the technology in an industrial scale Detailed results from the facility will be given to the ISO 14000 series (lifecycle analysis) and thus contribute to the best practice database globally
0	Operational	<ul style="list-style-type: none"> New method for maintenance of timber dryer with concrete structures New type of insulation (polyurethane) is sprayed on all external walls/roof of the dryer followed by flexible sealing layer 	<ul style="list-style-type: none"> Cooperation with the Norwegian Institute of Wood Technology with a large contact network within wood processing in Norway, the expertise will be developed and spread in this environment The durability of this technology will be evaluated in 5-10 years
7 000 000 Reduced process emissions	Under establishment	<ul style="list-style-type: none"> New design of technological platform for aluminium production with low energy consumption, high production efficiency and low environmental impact New principles for cathode design Several technology elements have been patented Larger cells and increase in electricity strength and productivity 	<ul style="list-style-type: none"> Demonstration project for verification of technology Expertise development internally in Hydro and external expertise environments in Norway Project is part of Hydro's long-term vision for development of the electrolysis technology Related projects have several doctorates on topics that are highly relevant to the project
0	Under establishment	<ul style="list-style-type: none"> Verification of technology for dry classification of silicone products Energy use is reduced in relation to delivered end product per produced unit Opens for a superior product, and more new products 	<ul style="list-style-type: none"> Suitable for removing barriers in further roll-out of the technology Cooperation with Sintef/NTNU and Comex AS Expertise dissemination internally in the Elkem system
2 272 500 Conversion from oil to LPG gas	Under development	<ul style="list-style-type: none"> Known technologies are put together and used in new ways to optimize the production process Production of more superior end-products 	<ul style="list-style-type: none"> Learning about system development and the suitability of the technology Sharing expertise with Pescatech, Entro, among others NTNU will be contacted regarding project and master's theses connected to the project
142 713 Reduction of oil	Under establishment, partially in commissioning	<ul style="list-style-type: none"> New type of facility with CO₂ as the working medium; in addition to cooling, hot water can also be delivered CO₂ provides the opportunity to achieve a temperature difference on the hot side In combination with propane, the facility will also be efficient at high 	<ul style="list-style-type: none"> Training of employees. Cadio will train employees that will operate the system Project owner is positive to establishment of arena to share knowledge Facility will be open for tours
0	Under development	<ul style="list-style-type: none"> Reduced use of titanium and need for machining Goal for pilot to become the first commercial 3D printer for major, complex titanium components Enables local production with few process steps, as well as lower energy use through less waste Several patents related to the concept 	<ul style="list-style-type: none"> Dissemination of expertise internally in the company One of the goals of the project is to establish an arena to spread experience and knowledge, as well as training for future commercial production units Further develop machines and software for new generation machines and more efficient production
13 090 Reduced propane consumption	Commissioning	<ul style="list-style-type: none"> Testing of new type of dehumidifier for reducing costs related to dehumidification in greenhouses The solution is based on known technology put together in a new way The system benefits from flexible air and heat distribution 	<ul style="list-style-type: none"> Demonstration facility Experience that shows operational stability has been gained Dehumidification capacity, operating conditions and energy consumption are registered Publication in scientific periodicals and conferences Cooperation with Norsk Landbruksrådgiving, Covent, Silicia companies in Forskningsparken Vestfold, etc.
7,106 000 Reduced use of coal/coke	Under development	<ul style="list-style-type: none"> New water-cooled copper ceramic roof System for controlled heating balance in melting furnace New cleaning and degasification handling system 	<ul style="list-style-type: none"> Technology spread in the Eramet system through "Challenge Initiative", the research centre in Trappes and the corporate department Industrial Management Information dissemination in the industry through participation in Ferrolegeringsindustriens Forskningsforening (FFF) PhD study within the Gassmaks research programme

REALIZED DISSEMINATION OF TECHNOLOGY	FURTHER DEVELOPMENT AND DISSEMINATION
<ul style="list-style-type: none"> • First implementation of the technology in Norway and globally • Technology forms the basis for the Karmøy Technology Pilot project 	<ul style="list-style-type: none"> • Part of an internal technology development course, for use in Hydro's future plants in Norway and globally • Some spin-off potential for transfer to Hydro's existing plants • National and international potential for dissemination which could improve energy efficiency and reduce greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation of the technology in Norway • Previously tested in Germany 	<ul style="list-style-type: none"> • Suitable for implementation in all industrial bakeries and restaurants • Technology's profitability increases with the size of the bakery/installation • Expansion of the installation is under way to see if it is possible to increase the energy result with new implementations • Technology supplier estimates dissemination to 30-40 facilities in Norway • International potential for dissemination which could provide increased utilization of waste heat and reduced greenhouse gas emissions • Using the technology in new projects is being considered due to the project results
<ul style="list-style-type: none"> • First implementation in Norway • Not aware of any other corresponding system solutions internationally 	<ul style="list-style-type: none"> • Suitable for large existing and new buildings with a heating demand and energy storage possibilities (e.g. large business buildings, shopping centres, storage buildings, public buildings, industry buildings and agricultural buildings) • National potential for increased utilization of renewable energy
<ul style="list-style-type: none"> • First facility is being installed and commissioned in Norway 	<ul style="list-style-type: none"> • Suitable for implementation in connection with solar cell silicone production and kerf • Work is ongoing at the R&D stage with multiple potential sources where the technology can be used on concrete installations in Europe • There is a larger market for this in Asia • International potential for dissemination which could increase efficiency and increased material utilization and reduce greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation of the technology in Norway and globally 	<ul style="list-style-type: none"> • Project owner estimates a dissemination potential to own production, as well as globally to about 100 installations (of which five are in Scandinavia, 20 in Europe) • National potential for reduced greenhouse gas emissions • International potential for dissemination which can increase efficiency, as well as reduce consumption of raw materials (steel), and reduce greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation of the technology in Norway and globally 	<ul style="list-style-type: none"> • The technology can be transferred to industry that uses drying technology on semi-conductive materials • Suitable for combustion of several types of organic elements (lacquer, hydrocarbons) on inbound material in the same process • Project owner estimates that the technology could be implemented throughout its entire production • Technology supplier estimates an international dissemination potential, focusing on aluminium producers in Russia, the EU and US/CND • National potential for reduced greenhouse gas emissions • International potential for dissemination which can increase energy efficiency and reduce use of propane, and reduce greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation of the technology in Norway and globally • Technology forms the basis for the Karmøy Technology Pilot project 	<ul style="list-style-type: none"> • Included as part of the technology development course in Hydro Aluminium, very significant for future facilities • Spin-off potential for transferring to Hydro's existing facility • National potential for reduced greenhouse gas emissions • International potential for dissemination which can increase energy efficiency and reduce greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation of the technology in Norway and globally 	<ul style="list-style-type: none"> • Suitable for all drying processes where proteins are involved, both marine (for example by-products from aquaculture) and animal (for example slaughterhouse waste), etc. • Project owner/technology developer estimates a dissemination potential to their facilities nationally and internationally • National potential for reduced greenhouse gas emissions • International potential for dissemination which could reduce use of fossil fuels, and reduce greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation in Norway • Implemented abroad (Denmark and Israel) • Installation of eight identical machines due to good results after a short time in operation 	<ul style="list-style-type: none"> • Suitable for implementation in greenhouses • Project owner estimates that technology is relevant for 60% of all Norwegian greenhouses • National potential for reduced greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation on a commercial scale globally • Technology tested in a downscaled size in Abu Dhabi 	<ul style="list-style-type: none"> • Technology is suitable for stationary CO₂ emission sources with access to saltwater • Spread potential is global, but with a primary focus on developing geographical areas, where consumption of end-products is major • Expansion facility, which is three times larger, planned in the same area with the same CO₂ source • National potential for energy efficiency and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation in Norway • Previously tested in Sweden 	<ul style="list-style-type: none"> • Suitable for timber mills that are isolated in the "traditional" manner • National potential for more implementation is considered great (there are many timber dryers consisting of concrete/concrete elements) • International potential for dissemination which could provide increased energy efficiency and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation in Norway and globally • Technology platform has been tested at Hydro's reference centre in Årdal 	<ul style="list-style-type: none"> • Possibility for spread of the technology beyond Hydro's own smelting plants • Installation of test cells with the goal of further developing the technology • National potential for energy efficiency and reduced greenhouse gas emissions • International potential for dissemination which could provide increased energy efficiency and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation in Norway and globally • Small-scale tests and trials have been carried out 	<ul style="list-style-type: none"> • Interesting and relevant for players also outside the process industry • Goal to build an industrial-scale plant based on the pilot • National potential for energy efficiency • International potential for dissemination which could provide increased energy efficiency and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation in Norway and globally 	<ul style="list-style-type: none"> • Transferable to other industries • The technology developer considers the spread potential major, both nationally and internationally • Nutrimar will continue development and investment in the technology in connection with the industry's further development • National and international potential for increased energy efficiency and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation in Norway and globally • Carried out testing for more than two years 	<ul style="list-style-type: none"> • Potential for application in the food industry, other process industry, hotels and housing cooperatives • Technology supplier estimates construction of two facilities per year in a ten-year period • Technology supplier will develop market activities in cooperation with relevant partners • National and international potential for increased energy efficiency and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation in a commercial scale in Norway and globally • Multiple-year test production and development of prototype and pilot machines • Production of (a considerable volume) of components for qualification of the technology vis-à-vis aviation 	<ul style="list-style-type: none"> • This facility will form the basis for construction of more production units • Very relevant for the aviation industry, which is experiencing major growth • Could eventually become relevant for the automobile industry, defence, oil/gas, maritime and other areas • Potential for increased use of titanium in new areas when the cost of production of titanium components is reduced • National and international potential for spread that could increase energy efficiency
<ul style="list-style-type: none"> • First implementation in Norway 	<ul style="list-style-type: none"> • The technology is suitable for dehumidification in greenhouses • The technology is transferable to the industry for dehumidification and drying for a number of purposes • The technology supplier estimates that the technology is relevant for about 40% of the national greenhouse industry, with a considerable international spread potential • National and international potential for spread that could increase energy efficiency, reduce fossil fuel consumption and reduce greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation nationally and internationally 	<ul style="list-style-type: none"> • Considerable spread potential in transfer to Eramet's other facilities • Parts of the technology are transferable to the smelting plant industry in general and Ferro, Ferrosilicone and silicone production in particular. Nationally and internationally • International potential for spread that could increase energy efficiency, reduce fossil fuel consumption and reduce greenhouse gas emissions



Drammen adorns itself with solar smaragd

In the property business, “green buildings” has become an established term for buildings with environmental qualities. Now, Drammen will get its own solar smaragd. In the seven-floor office building currently being erected by Union Eiendomsutvikling AS, green solar cells will become an integrated part of the façade. Enova is supporting the technological innovation with NOK 1.5 million.

However, the solar cells are only one of several energy and climate-friendly solutions chosen for the building, which will be named “EnergiBygget” (the energy building). The dialogue with Enova has caused the property company to increase its energy ambitions for the jewel several times during the project.

APPENDIX A PROJECTS WITHIN NEW ENERGY AND CLIMATE TECHNOLOGY 2012-2015

CONTRACT YEAR	PROJECT OWNER	PROJECT DESCRIPTION	TECHNOLOGY SUPPLIERS	SUPPORT AWARDED (NOK)	PROJECT'S ENERGY RESULT (kWh/year)
2015	Alcoa Norway ANS	Demonstration of advanced technology for production of primary aluminium at Alcoa's plant at Lista in Farsund municipality	Technology developer: Alcoa	280 448 695	9 700 000 Energy efficiency
2015	Glencore Nikkelverk AS	Energy-efficient 1-stage electrowinning process for production of copper at the Glencore Nikkelverk in Kristiansand	Concept developer: Glencore Nikkelverk AS Cathodes: Glencore Technology Pty Ltd DSA anodes: Outotec Oyj Measurement system (HelmTracker): Hatch Ltd Extract system: SAME Ingeniera	380 000 000	35 000 000 Energy efficiency
2015	Arba Follum AS	Demonstration facility for production of a bio-based substitute for fossil coal at Treklyngen's plant area at Follum in Drammen	Process and technology owner: Arbaflame AS	138 000 000	142 500 000 Heat recovery, and production and consumption of biogas
Buildings					
2012	Lerkendal Invest AS	Scandic Lerkendal Hotel in Trondheim, energy-efficient hotel at a passive house level and comprehensive system solution w/ focus on needs based management and regulation, decentralized ventilation, solar collector, LED lighting	<ul style="list-style-type: none"> Principal design: Rambøll Norge AS, HENT AS Management system: GK Norge AS, Bravida Norge AS Cooling: GK Norge AS, K.Lund AS Ventilation: GK Norge AS 	14 000 000	1 979 127 Energy efficiency
2012	Rema Eiendom Nord AS	Use of new energy technology and development of comprehensive energy system for the future's grocery stores, implemented at Rema Kroppanmarka in Trondheim	<ul style="list-style-type: none"> Principal design: SINTEF Energi AS Management system: Danfoss AS Cooling system: Carrier Refrigeration AS Ventilation: Systemair AS Façade: Aerogel Norge AS 	1 000 000	123 750 Energy efficiency
2013	City of Oslo, Kulturbyggene in Bjørvika	The new public library in Oslo. Heating and cooling with TABS (Thermoactive building elements), reduces energy and effect for cooling and heating, in addition to passive house design (needs-based management, decentralized hybrid ventilation, low SFP, free cooling)	<ul style="list-style-type: none"> TABS and façade (advisors and developers): Lund Hagerm Arkitekter, Atelier Oslo, Asplan Viak, Multiconsult AS Façade: Contractor – Roschman Konstruktionen aus Stahl und Glas GmbH TABS: Supplier(s) not yet determined 	10 839 144	325 300 Energy efficiency
2013	Kjørhoparken AS	Rehabilitation of Powerhouse Kjørbo in Bærum into an energy-plus office building. The building will produce more energy over the course of its lifetime than is used for construction and operation. Innovative total concept, with a focus on building structure, technical installations and local production of energy	<ul style="list-style-type: none"> Concept solutions: Skanska Norge AS, Snøhetta AS, SAPA Building System AB, Asplan Viak AS, Multiconsult AS and ZEB. Overall contractor: Skanska Norge AS Suppliers: Hubro, Stokkan lys Systemair, Sunpower, Bærum Byggmontering, KlimaControl, Johnsen Control, Thermocontrol AS, SAPA 	12 960 447	349 364 Energy efficiency, conversion, as well as production of power, heating and cooling
2013	Skanska Norge AS	Skarpsnes Boligfelt in Arendal with a passive house standard for houses and apartment buildings that produce as much energy as they consume over the year, with local storage and deliveries to the grid	Principal design: Skanska Norge AS, ZEB	5 271 853	271 800 Energy efficiency, as well as production of power and heating
2013	Aktivhus Entreprenør AS	Huldra Økogrend in Hurdal, Eco-village consisting of 34 buildings and 44 dwelling units	<ul style="list-style-type: none"> Principal design: Aktivhus AS/Aktivhus Entreprenør AS Management system, ventilation, solar cell, LED lighting, windows w/blinds: Isoreflex Energy Products AS 	12 866 302	497 710 Energy efficiency and electricity production
2014	Orkla Elektronikk Lomundal	Solar roofing on villa rooftops in Orkdal	<ul style="list-style-type: none"> Technology supplier: SED Photovoltaik Partners: Orkdal Energi AS, Jøla Takservice AS 	80 242	1 195 Production of electricity
2014	Kjeldsberg Sluppen ANS	Sluppenveien 17bc in Trondheim will be erected with high ambitions, including several innovative energy solutions	<ul style="list-style-type: none"> Overall contractor: NCC Construction AS Technical sub-contractors: K.Lund AS, Tekniske Ventilasjon and Vintevoll AS and Johnson Controls 	737 000	187 000 Energy efficiency
2014	Fantoft Utvikling AS	A combined retail building and office building in Bergen is being built with high energy ambitions; 50% lower delivered energy compared with energy label A (will be rented to Sweco and Meny)	<ul style="list-style-type: none"> Engineering group: Sweco Architect: Lund&Partners Total contractor: Lars Jønsson Electrical: BI Elektro Ventilation: GK Piping: Vestrheim 	5 400 000	1 099 429 Energy efficiency, as well as production of power and heating
2014	NG Kiwi Oslo Akershus AS	New Kiwi shop in Nes, Akershus, with several technical solutions that will be coordinated to run the shop, and also achieve a passive house standard	<ul style="list-style-type: none"> Contractor: Panelbygg Refrigeration system: Carrier Refrigeration Norway Solar cell system: Sol og Vind AS 	3 328 170	502 658 Energy efficiency, and production of power and heating
2014	Norwegian Defence Estates Agency (OSLO)	Construction of a zero energy office building, "Haakonsvern" in Bergen (according to SINTEF ZEB's requirements) through optimization of technical solutions	<ul style="list-style-type: none"> Total contractor: Veidekke Entreprenør Builder: Norwegian Defence Estates Agency Control function: Multiconsult AS and LINK arkitektur AS Project development: SINTEF/NTNU 	2 350 000	273 396 Energy efficiency, and production of power and heating
2014	Bjørkheim Senter AS	Low energy business building with a grocery shop part and residential block in Samnanger. New solutions for interaction between cooling and heating system in addition to utilization of seawater	<ul style="list-style-type: none"> Builder: Bjørkheim Senter AS through Finn Moen Architect: Architect Helge Christiansen AS Advisers: Energi, Kulde og VVS, Energi og miljøutvikling AS Total contractor: Montasje Kompaniet AS 	3 000 000	352 127 Energy efficiency, and production of heating

PROJECT'S CLIMATE RESULT IN NORWAY (kg CO ₂ equiv/year)	PROJECT STATUS	INNOVATION	EXPERTISE DEVELOPMENT
5 260 000 Reduced process	Under establishment	<ul style="list-style-type: none"> Advanced smelting technology for primary aluminium production with lower energy consumption and lower direct CO₂ emissions 	<ul style="list-style-type: none"> Expertise development at Alcoa Norge for demonstration, operation and verification of advanced smelting technology New technology requires "high-expertise jobs" in Norway
0	Under establishment	<ul style="list-style-type: none"> Permanent cathodes in Duplex steel with microstructure surface Low-energy dimension-stable anodes (DSA) with defined nano structure New measurement principles and monitoring system that results in improved process control and possibility for automatization Set new industry standard with regard to working environment, emissions and safety 	<ul style="list-style-type: none"> Demonstration facility Expertise elevation at Nikkelverket and among the involved technology suppliers Participation in the SUPREME research project with other smelting plant industry and research environments Communication through the Eyde network Presentation of the technology in industry networks and international conferences Cooperation with NTNU, Teknova and international expertise companies
0	Under establishment	<ul style="list-style-type: none"> One-stage energy-efficient production of quality raw material from round timber Thermal integration and heat exchange in pellet production Heat recovery from process condensate with high organic content Integrated process for production and use of biogas Scale-up of production capacity/plant size 	<ul style="list-style-type: none"> Market and customer expertise is developed through marketing and testing activities Lectures and posters at energy and industry conferences Cooperation with NGOs
0	Operational	<ul style="list-style-type: none"> Sum of many measures focusing on needs based management and regulation, goal is 50 kWh/m² Decentralized ventilation systems, two on each floor Solar collectors with accumulation Energy recovery from lift 	<ul style="list-style-type: none"> Demonstration building Reference project for the hotel industry Information dissemination through presentations in industry networks and at conferences
0	Operational	<ul style="list-style-type: none"> Waste heat utilization from cooling to heat floors, ventilation. Stored in accumulator tanks Ventilation solutions with bypass. Reduced fan energy Very advanced integrated SD facility Nanomaterial in translucent façade connected together with light management (façade solution) 	<ul style="list-style-type: none"> Measurements after commissioning show a 30% reduction Spin-off from the CREATIV research project Master and doctorate at the Norwegian University of Science and Technology (NTNU), to continue internationally in EU project Carried out publications nationally and internationally Continuation of the work with Snøhetta and development of the Technical Function Description
0	Under development	<ul style="list-style-type: none"> Newly developed transparent façade with increased exposure to daylight Reduced cooling need due to TABS (concrete core activated cooling) 	<ul style="list-style-type: none"> Groundwork has started Participating parties are building expertise New Oslo Public Library is part of a training programme for young employees in Multiconsult The project is being published on Kultur- og idrettsbygg's website (kulturbyggene.no) and FutureBuilt's website
0	Operational	<ul style="list-style-type: none"> Low energy use for construction, reuse of materials, better insulation and airtightness than passive house level, innovative façade solutions State of the art lighting and management system Energy-efficient hybrid ventilation system Energy production covers energy for operation and construction (solar cells, heat pump and waste heat utilization) 	<ul style="list-style-type: none"> Demonstration building and flagship building Spin-off from the Powerhouse Alliance and ZEB Important expertise development for all players, advisers, producers, suppliers Masters and doctorates at the Norwegian University of Science and Technology (NTNU) associated with the project Several presentations at courses and conferences; the ZEB conference, Enova conference, VVS-dagene, etc. Established extensive network of technology suppliers to develop better solutions for energy-plus buildings
0	Under development	<ul style="list-style-type: none"> 100% renewable energy supply, solar collectors, heat pump, energy well, heat storage, solar cells App for controlling own energy use Development of the Plus customer programme Hot fill dishwasher and washing machine 	<ul style="list-style-type: none"> Demonstration area Connected to R&D EBLE, pilot in ZEB, planned solar irradiation measurement Teknova/Sintef, grid connection cooperation with Agder Energi, sustainable buildings (Agder Wood) Master at the University of Agder (UiA)
0	Commissioning	<ul style="list-style-type: none"> Zensehome advanced management and regulation system for ventilation and heating via a pipeline grid Dwelling units equipped with several technical elements in a unique combination Satisfies passive house energy level without balanced ventilation 	<ul style="list-style-type: none"> Reference project with an entire neighbourhood will make it possible to conduct comparative studies. Zensehome provides the opportunity for collecting detailed knowledge regarding energy use, usage pattern, etc. Master's theses at NTNU and University of Southern Denmark related to the project Master's thesis at NMBU; "fukt og naturlig ventilasjon (Spring 2016) Research project: "Power from the people" Expertise contribution from the Norwegian State Housing Bank; Fukt og naturlig ventilasjon. Measurements in two dwelling units
0	Operational	<ul style="list-style-type: none"> Building-integrated solar cells in roofing with natural cooling of the solar cells Installation of measurement station for solar radiation, to measure efficiency 	<ul style="list-style-type: none"> Demonstration and showcase facility aimed at interested market players Suitable for removing barriers for further implementation in the Norwegian market Learning project to acquire experience and expertise Verification of product properties
0	Completed	<ul style="list-style-type: none"> Thermal covers to improve the indoor climate while also reducing energy use and power draw Covers cast in place provide the possibility of increasing the capacity of energy storage through cast-in water pipes For added energy, a combined heat pump/cooling machine to provide heating and cooling from outdoor air is used 	<ul style="list-style-type: none"> Testing and verification of thermal cover in a large-scale Experience and documentation from the project will be used in future construction projects Carried out lectures on concrete associations at Gløshaugen A course in COWI AS is planned Work on a technical article in several periodicals about the project and concept have started
0	Under development	<ul style="list-style-type: none"> Interaction between all components and building parts, where energy efficiency is an important focus (e.g. needs-based ventilation solution with exchanger, adiabatic cooling for reduced cooling need, utilization of waste heat between the two building parts) 	<ul style="list-style-type: none"> Prototype project across industries with regard to exploiting joint operation of technical facilities Meny will use the project as a reference for the Meny shop of the future Sweco will open the building for showings, and is marketing the building nationally
0	Under commissioning	<ul style="list-style-type: none"> Passive house level supported by Enova Combination and coordination of technical solutions, such as building-integrated solar cells, aerogel panels and light management, LED lighting indoors and outdoors Maximum utilization of waste heat from refrigeration plant and wells/heat pump for heating from hydronic systems. Heat pump/well also used for cooling and for lower energy consumption by the refrigeration plant 	<ul style="list-style-type: none"> Relevant universities/colleges will be contacted in 2016 with an offer to use metering data for analyses The building has a considerable number of measurements that will be used for analyses to gain experience with coordinating the technical solutions
0	Complete, move-in process is ongoing	<ul style="list-style-type: none"> Unique interaction between the best available passive measures in combination with optimized technical solutions and own production of energy (e.g. the orientation of the building, solar screening, solar cell system) ensure a delivered energy figure down to 16 kWh/m² 	<ul style="list-style-type: none"> The building was built according to the planned ambitions. If operation of the building is completed with the stated ambition, information about the project will be provided locally and nationally The building's results will be followed up, published and analysed SINTEF ZEB has contributed to development of the pre-project and will contribute in the continuation with the contractors
0	Engineering	<ul style="list-style-type: none"> LED lighting in grocery shop and rental area Comprehensive solutions in interaction through use of seawater collectors, recovery of waste heat from the grocery shop, as well as use of energy-efficient equipment 	<ul style="list-style-type: none"> The project has a considerable learning and demonstration potential for NorgesGruppen internally Provides learning and expertise to advisers and executors Prototype project for how renters can contribute in the most energy-efficient building possible The project will be open to tours Learning arenas for sharing of information and expertise are planned

REALIZED DISSEMINATION OF TECHNOLOGY	FURTHER DEVELOPMENT AND DISSEMINATION
<ul style="list-style-type: none"> • First implementation of the technology in Norway and globally 	<ul style="list-style-type: none"> • Design and installation of multiple furnaces/cells in Norway for further development and commercialization of the technology • National and international potential for spread which could increase energy efficiency and reduce greenhouse gas emissions
<ul style="list-style-type: none"> • First full-scale implementation of the total concept which results in record-low electricity consumption, in Norway and globally • Some individual elements have been implemented at plants in the US and Chile. None in Norway 	<ul style="list-style-type: none"> • Considerable spread potential in transfer to production of copper through electrolysis • Elements of the technology have a spread potential for general production of copper, as well as zinc and nickel • Technology supplier estimates that spread potential within copper and zinc production is 6-7 TWh • International potential for spread which could increase energy efficiency and reduce greenhouse gas emissions
<ul style="list-style-type: none"> • Arbaflame has installed a pilot plant at Grasmo in Eidskog • First full-scale demonstration of use of the product in Thunder Bay, Canada • Knowledge of technology and product is spread through technical sales and marketing, and through full-scale testing with customers 	<ul style="list-style-type: none"> • Suitable as a co-incineration fuel or complete substitute for fossil coal in power production with very low investment requirements at the customer stage • Suitable as replacement for fossil coal in metallurgical industry; carbon source and reduction agent • Suitable as energy carrier for production of next generation biofuel • Technology supplier estimates that spread potential is 5 million tonnes of Arbapelllets annually over a 5-10 year period • National and international potential for spread through energy-efficient production of a renewable energy carrier, which can contribute to increased renewable energy production and reduced greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation in Norway • Not aware of any other corresponding system solutions internationally 	<ul style="list-style-type: none"> • Comprehensive concept relevant for hotels in Norway • All or parts of concept interesting internationally • International potential for dissemination which could increase energy efficiency and reduce greenhouse gas emissions • Due to reduced construction activity, multiple planned projects where parts of the solutions would be used have been postponed
<ul style="list-style-type: none"> • First implementation in Norway • No identical projects tested internationally, but elements are being tested in Switzerland and Germany • Elements have been utilized in own shops 	<ul style="list-style-type: none"> • Suitable for implementation in other grocery stores, several chains have now started using all or parts of the concept solution • Several of the solutions and technologies are suitable for other types of non-residential buildings • Technology developer indicates that they want to implement the technology and solution in the EU • International potential for dissemination which could increase energy efficiency and reduce greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation of TABS in Norway. Has been implemented abroad • First implementation of façade solution in Norway and globally 	<ul style="list-style-type: none"> • Suitable for implementation in several types of non-residential buildings • Technology indicates an international potential for selling the façade solution • International potential for dissemination which could increase energy efficiency and reduce greenhouse gas emissions
<ul style="list-style-type: none"> • The world's first rehabilitation to an energy-plus house in a lifetime perspective globally, first Norwegian which incl. bound energy 	<ul style="list-style-type: none"> • Relevant for all future Norwegian rehabilitation and new buildings • Particularly interesting for rehabilitation in cold areas • International potential for dissemination which can increase energy efficiency and conversion, and reduce greenhouse gas emissions • Nationally and internationally recognised demonstration project, has completed a substantial number of tours • The solutions are followed up in the operations phase. Relevant technology suppliers are involved
<ul style="list-style-type: none"> • First implementation in Norway • No identical projects tested internationally, but elements have been tested • Reduced scope due to deficient sales 	<ul style="list-style-type: none"> • Testing of various production methods (buildings), as well as technical solutions • Relevant for future residential area development • International potential for dissemination which could increase energy efficiency and conversion and reduce greenhouse gas emissions
<ul style="list-style-type: none"> • First combination of the technologies in Norway and globally 	<ul style="list-style-type: none"> • Relevant for housing development • Project owner and technology developer indicate a potential in further development locally, as well as nationally in Finnmark County • The active house concept combined with eco-society models have a considerable potential as sustainable local communities • Deliveries are planned in other construction projects and stages. Boligtun 2-5 in Hurdal is currently in the engineering phase
<ul style="list-style-type: none"> • First implementation in Norway and Scandinavia (previously implemented in Austria) 	<ul style="list-style-type: none"> • Relevant for the building materials of the future, the market potential here is nearly unlimited (estimated 250 million m2 residential area in Norway) • Solar roofing can replace ordinary roofing on all types of roofs, which makes the project interesting in projects where roofing is being replaced • National potential for increased production from renewable energy • International potential for dissemination which could result in increased production of electricity from renewable energy, as well as reduced greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation of TABS system in Norway, but has been used somewhat on the Continent 	<ul style="list-style-type: none"> • The builder considers such a concept to be the solution of the future • Thermal covers are being used to an increasing extent in Europe • National potential for reduced energy consumption • The concept is under consideration in other places by Uponor • The results of Sluppenvegen 17bc can impact sales/the market's interest in chosen solutions
<ul style="list-style-type: none"> • Interaction between these components has not been previously tested in Norway 	<ul style="list-style-type: none"> • Relevant for the entire construction industry • National potential for increased energy efficiency, and increased utilization of renewable energy • International potential for dissemination which could increase energy efficiency, increased utilization of renewable energy sources and reduce greenhouse gas emissions
<ul style="list-style-type: none"> • Kiwi Auli has been a source of inspiration for new projects in NorgesGruppen (under realization and planning), and has helped elevate the level of ambition for the new projects • Continuing certain technologies with both the same and new suppliers to test various producers and gain experience with other suppliers 	<ul style="list-style-type: none"> • Kiwi has already started constructing a new environmental shop where parts of the technical solutions have been continued/ further developed. Additional shops are under consideration. • Kiwi is considering whether to incorporate several of the technical solutions in Kiwi's technical standard, which could have consequences for both existing shops and new shop projects. In connection with redesign of Kiwi's grocery shop, the environment was also assigned greater significance than before, and one of the concepts will continue some of the technologies from Kiwi Auli • International potential for spread which could increase energy efficiency and production, and reduce greenhouse gas emissions
<ul style="list-style-type: none"> • First implementation of the comprehensive interaction in Norway 	<ul style="list-style-type: none"> • If the energy goals are reached, the solutions could contribute premises for new building regulations • The project could be a template for other projects in the Norwegian Defence Estates Agency and others who are interested • International potential for spread which could increase energy efficiency and production, and reduce greenhouse gas emissions
<ul style="list-style-type: none"> • Known technologies, but the comprehensive solution is very newsworthy • First implementation of such a comprehensive solution in Norway 	<ul style="list-style-type: none"> • Major national grocery retail players are involved, as well as advisers who work nationally • Such a comprehensive concept will be of great value for future solutions • National potential that could improve energy efficiency • International potential for spread which could result in reduced energy use, as well as reduced greenhouse gas emissions



Energy-efficient indoor swimming pool in Asker municipality

Ambitions are high as Asker municipality starts construction of a new indoor swimming pool that will be complete in the summer of 2017. By combining several exciting technological solutions, Asker is building a swimming pool for the future. The facility will not solely be conserving electricity. The roof will have an approx. 500 m² solar cell system, with highly efficient solar cell panels, where the solar cells will ensure that the facility also produces electricity. Heat pumps will collect energy from 15 geothermal wells to heat the facility, while other heat pumps will recover energy from the ventilation system for air, pool and tap water.

The swimming pool will be a prototype project in the FutureBuilt programme for climate-friendly city neighbourhoods and buildings, one of the nation's first passive house level swimming pools and will be among the most energy-efficient swimming pools in Norway.

Enova is contributing NOK 9.9 million to the project.

APPENDIX A PROJECTS WITHIN NEW ENERGY AND CLIMATE TECHNOLOGY 2012-2015

CONTRACT YEAR	PROJECT OWNER	PROJECT DESCRIPTION	TECHNOLOGY SUPPLIERS	SUPPORT AWARDED (NOK)	PROJECT'S ENERGY RESULT (kWh/year)
2014	Gardermoen Campus Utvikling AS	Construction of ambitious low energy hospital in Ullensaker, for rent to LHL, with energy rating A	<ul style="list-style-type: none"> • Builder: Aspelin Ramm Eiendom AS, through Gardermoen Campus Utvikling AS • Contractor: HENT AS • Technical subcontractors: Gunnar Karlsen AS 	29 900 000	4 882 200 Energy efficiency
2014	City of Oslo Kulturbyggene i Bjørvika	A new Munch museum with a passive house standard and high environmental ambitions	<ul style="list-style-type: none"> • Advisers and developers: eStudio Herreros, LPO Arkitekter AS, Asplan Viak, Multiconsult AS • Suppliers of lift and escalators are Reber Schnidler AS and Thyssen AS for freight lift • No other contracts have been awarded so far 	13 391 000	2 060 157 Energy efficiency
2014	Våler Distribusjonslager AS	Expansion of storage building with extensive measures on energy supply, advanced technical systems and optimal management of this	<ul style="list-style-type: none"> • Total contractor: Peab AS • Architect: Meter Arkitekter AS • Construction manager: Brick AS 	11 427 800	1 705 639 Energy efficiency, and production of electricity, heating and cooling
2014	Entra Eiendom	Papirbredden 3 in Drammen; new office building of 7 floors with energy demand below "passive house level" and 0% heating supply based on fossil fuels or direct electricity	<ul style="list-style-type: none"> • Builder: Papirbredden Eiendom AS • Total contractor: Strøm Gundersen AS • Architect: LPO Arkitekter AS • Advisers: EvoTek AS, EM Teknikk AS, EM Teknikk Energi AS, Rambøll Norge AS and ECT AS 	3 393 441	869 803 Energy efficiency, and production of cooling
2014	Undervisningsbygg Oslo KF	New primary school (Brynsengfaret skole) in Oslo with ambitious environmental and energy goals. Energy need will be reduced beyond regulatory requirements, as well as production of electricity for own use	<ul style="list-style-type: none"> • Overall contractor: NCC Construction AS 	4 556 000	660 386 Energy efficiency, and production of electricity and heating
2014	Bergen municipality	Rehabilitation of Varden school in Bergen; "State of the art" energy system using multiple renewable energy sources	<ul style="list-style-type: none"> • Technology supplier: Zolas energi 	551 802	60 000 Energy efficiency, and production of electricity and heating
2014	Wergelandsveien 7 ANS	Rehabilitation of Wergelandsveien 7 in Oslo: Reduction of real energy use in commercial buildings through a newly developed, innovative façade (Qbiss)	<ul style="list-style-type: none"> • Technology developer: Trimo 	16 212 000	1 180 000 Energy efficiency
2014	Haram municipality	Construction of a care centre in Haram municipality where both construction and energy use must fulfil the requirements according to NS3701 as a minimum	<ul style="list-style-type: none"> • Overall contractor: Ålesund Bygg 	3 400 000	1 251 741 Energy efficiency, and production of electricity and heating
2014	Grønland 67 AS	Drammen's Solar Smaragd: Façade-integrated solar cell system with new architectural solutions for Norwegian office buildings	<ul style="list-style-type: none"> • ISSOL 	1 553 236	105 900 Energy production
2015	Tromsø municipality	New swimming facility in Tromsø; swimming pool for sporting events, family-friendly pool with connection to an outdoor pool, health and spa pool	<ul style="list-style-type: none"> • Concept development: Asplan Viak AS • Supplier not determined 	3 350 000	1 219 050 Energy efficiency and heat recovery
2015	Directorate of Public Construction and Property	Energy-efficient office building in Brønnøysund	<ul style="list-style-type: none"> • Supplier not determined 	14 970 000	1 848 225 Energy efficiency and heat recovery
2015	Asker municipality	Holmen indoor swimming pool, among Norway's most energy-efficient swimming pool facilities with innovative structural and technical solutions, e.g. underground solar collectors, solar cells and user-friendly energy-optimized operations, passive house standard	<ul style="list-style-type: none"> • Pooltech AS – Steel pools with bottom that can be lowered and raised • Enwa – cleaning technology with membrane filter • Solel AS – solar cells • TS Electro – SD and EOS facilities 	9 944 000	1 227 398 Energy efficiency, heat recovery, and production of electricity and heating
2015	Directorate of Public Construction and Property	New administration building Evenstad. Gasification of chips for production of electricity and heating using CHP		3 000 000	350 198 Production of electricity and heating, and energy efficiency
2015	Rossabø Eiendom AS	24/7 building: An office building with a good environment, where the user can impact the most important environmental factors, individual monitoring and control in each office	<ul style="list-style-type: none"> • Supplier not determined 	2 579 672	586 289 Energy efficiency and production of electricity
2015	Vestaksen Kobbervikdalen 4 AS	Buskerud Storcash environmental building, an energy-efficient wholesaler for food. Passive house standard with optimal energy solutions	<ul style="list-style-type: none"> • Supplier not determined 	1 600 000	730 737 Energy efficiency and production of electricity and heating
2015	Fjeldset Elverum AS	KIWI Fjeldset Miljøbygg, commercial building/grocery shop with comprehensive energy solution	<ul style="list-style-type: none"> • Fusen AS will deliver the solar cell system and battery bank 	1 897 492	279 043 Energy efficiency and production of electricity and heating

PROJECT'S CLIMATE RESULT IN NORWAY (kg CO ₂ equiv/year)	PROJECT STATUS	INNOVATION	EXPERTISE DEVELOPMENT
0	Under establishment	Sum of multiple technical solutions <ul style="list-style-type: none"> Detailed, coordinated room management logic Ventilation system divided by façade, energy-efficient cross flow heat exchangers with separated air flows Low temperature heating and "high temperature" cooling, one-pipe system for heating and cooling Directly cooled, energy-efficient hospital equipment 	<ul style="list-style-type: none"> Prototype project within energy, indoor climate, and universal design Annual results in Aspelin Ramm's projects are published in an environmental report Information dissemination through conferences, seminars and inspections Cooperation with Sintef energy research in the Interact project Consultants discuss the project in their environments
0	Engineering	Meets high requirements for energy efficiency, greenhouse gas emissions, as well as storage of Munch's art <ul style="list-style-type: none"> Division into zones according to the building's function and need, use of low emission materials Airborne heating and cooling with a high level of heat recovery, natural ventilation at times when heating or heat recovery is not needed in dynamic zone Electricity-producing lift, and energy-efficient escalators Innovative solutions for solar screening 	<ul style="list-style-type: none"> The building (12 floors) will become an attractive landmark in Oslo A lot of media attention regarding the innovative solutions is expected Mention in professional journals that will contribute to a focus on the energy and environmental results The building will be made available to visitors who want to see the building's energy solutions Cooperation with FutureBuilt will function as a learning arena
0	Under development	Combination of various measures and a high degree of energy self-sufficiency: <ul style="list-style-type: none"> Considering Norway's largest solar cell system connected to a single building, in combination with large freezer installations Utilization of excess heat from freezer installations 	<ul style="list-style-type: none"> Prototype project within energy use and energy supply Frequent inspections of the building Cooperation with educational institutions is under consideration Storebrand Eiendom is an owner, and there is a possibility of transfer of expertise
0	Partial move-in	Combination of solutions to fulfil requirements beyond the passive house level: <ul style="list-style-type: none"> Heating from heat pump and energy wells Heat recovery unit Measures to satisfy thermal conditions without using mechanical cooling Special measures to reduce internal load Direct use of well water for comfort cooling 	<ul style="list-style-type: none"> Included in Drammen's knowledge park Increase of expertise with involved parties Demonstration effect
0	Under development	Combination of solutions to achieve high energy goals: <ul style="list-style-type: none"> Façade-integrated solar cell panels Liquid-to-water heat pump with energy well for heating production, as well as free cooling Placement of sports centre on the roof with translucent aerogel walls (very low U value and G value) 	<ul style="list-style-type: none"> Could become an important reference for other buildings Experience with new energy requirements Is a prototype project in Future Built Advisers, architects and other enterprises in the City of Oslo will be invited on tours Relevant to link the project with research forums
0	Under development	Energisystem som kombinerer flere fornybare energikilder; <ul style="list-style-type: none"> Hybride solfanger/solcellepanel (PVT) i synergi med varmepumpe med borehull som varmekilde 	<ul style="list-style-type: none"> Demonstrasjonsprosjekt Kompetanseheving for de involverte i prosjektet Bygget stilles disponibelt for visninger og presentasjoner for spredning av kompetanse
0	Under commissioning	<ul style="list-style-type: none"> Façade system with up to seven layers of glass/aluminium in a framework Pressure equalization system that reduces the impact from physical forces, particularly temperature variations Increased insulation effect through reflective insulation Qbiss is a new element façade with very good U values compared to the thickness of the façade elements 	<ul style="list-style-type: none"> The building will be open for tours Developers, contractors and architects will get useful knowledge from the project
0	Under establishment	Comprehensive solution with known technology composed in new ways to achieve ambitious energy goals: <ul style="list-style-type: none"> Water-to-water heat pump connected to discharge air and energy wells Solar heat collector for e.g. heating tap water Solar cell system for production of electricity Measurement of energy items Fans and ventilation with needs based management 	<ul style="list-style-type: none"> A lighthouse will be built locally with a focus on energy efficiency and renewable energy sources Contributes to learning locally, and somewhat nationally The building will be open for tours The contractor chosen will increase its expertise in constructing energy-efficient buildings Marketing in a local and national scale is planned
0	Commissioning	<ul style="list-style-type: none"> Use of façade-integrated solar cell panels in facades and on roof 4mm-thick glass laminated with crystalline solar cells in between Façade panels are "tailored" in relation to format, colour and transparency to achieve desired architectonic expression by printing a picture of grass on the inside of the outermost glass to achieve desired colour/expression 	<ul style="list-style-type: none"> Demonstration facility/reference facility with regard to measurement and follow-up, compared with simulation of annual energy production Dimensioning of electric parameters such as circuits/loops, inverters, measurement, distribution, fuses Photo printing on glass, cost-efficient systems for installing panels Dimensioning of mechanical parameters such as glass finishing, resistance against breaking, wind, etc. Overview of the supplier market for façade-integrated solar cells
0	Under establishment	<ul style="list-style-type: none"> Increased utilization of waste heat from discharge air Use of LED and 80% heat recovery Energy-efficient tap water production 	<ul style="list-style-type: none"> Obtained foundation and experience from foreign swimming pool facilities Detailed engineering in cooperation with suppliers, i.e. proposals for energy conservation measures are challenges with regard to available products and cost Developing national expertise along with NTNU
0	Under establishment	<ul style="list-style-type: none"> Combination of building design and technical solutions Thermal storage Efficient utilization of local energy sources and daylight 	<ul style="list-style-type: none"> Expect expertise development within engineering group and participating contractor
0	Under development	<ul style="list-style-type: none"> Better than passive house standard with innovative standalone measures and comprehensive solutions Needs based operation Recovery of heat from greywater and ventilation system Local production of electricity and heating from geothermal wells, ground solar collectors, solar cells on roof, façade Innovative monitoring and management system 	<ul style="list-style-type: none"> Demonstration project, facilitated for simple and energy-efficient operation, highly relevant for future sports facilities SIAT/NTNU will use readings from the swimming facility for further research and education on energy consumption in swimming pools One master's thesis has been written on Holmen svømmehall by an NTNU student, and another master's thesis will be written in the next semester
0	Engineering	<ul style="list-style-type: none"> ZEB COM objective Cogeneration (CHP) using bio Hybrid ventilation and needs based LED lighting 	<ul style="list-style-type: none"> One of few very Norwegian CHP will provide vital operating experience Reduced greenhouse gas emissions
0	Under establishment	<ul style="list-style-type: none"> ZEB-O-EQ objective Covers half of energy demand through self-production Decentralized needs based management of ventilation and lighting 	<ul style="list-style-type: none"> The building will become a demonstration building where industry and schools will be invited on tours for information about our solutions Stord/Haugesund University College is involved Local contractors are able to increase their expertise
0	Under establishment	<ul style="list-style-type: none"> Passive house standard focussing on energy supply, technical installations and management 100 per cent self-sufficient with heating, improved refrigeration room solution, CO₂ cooling agent, solar power production, LED lighting installation, utilization of daylight and needs based ventilation 	<ul style="list-style-type: none"> Demonstration project, sharing experiences externally, and facilitates inspections, etc. Active sharing of experience through dedicated website and inspection possibilities are planned Experience and new expertise developed through the project shall initially be shared internally and in NorgesGruppen Solutions are implemented in the Aksen Næringspark project
0	Commissioning	<ul style="list-style-type: none"> Comprehensive energy concept Low energy standard, local energy production, solar cells on roof and walls, storage in battery bank Use of wood materials in substructure and utilization of the wood siding's hygrothermal properties Aerogel in roof, utilization of waste heat for heating via ventilation and air heaters Use of insulation in ground with low GWP and steel containing a high percentage of recycled steel 	<ul style="list-style-type: none"> Demonstration project is compared with the chain's other buildings Norwegian Institute of Wood Technology is involved Considering cooperation with universities/colleges to follow up and analyse energy consumption and operation of the facility

REALIZED DISSEMINATION OF TECHNOLOGY	FURTHER DEVELOPMENT AND DISSEMINATION
<ul style="list-style-type: none"> Solutions are unknown in connection with construction of a hospital in Norway and globally 	<ul style="list-style-type: none"> Relevant for the industry, but interest beyond this industry is also assumed The project will have significant media coverage regarding detailed engineering, recruitment of other renters and during the development phase International potential for spread that could increase energy efficiency and production, and reduce greenhouse gases
<ul style="list-style-type: none"> Parts of the solution have previously been tested First implementation of the solutions within the category Kulturbygg 	<ul style="list-style-type: none"> Cooperation with FutureBuilt can function as a dissemination arena nationally and internationally National potential for energy efficiency International potential for spread which could result in energy efficiency and reduced greenhouse gas emissions
<ul style="list-style-type: none"> First implementation of the solution in a warehouse in Norway 	<ul style="list-style-type: none"> Demonstrasjonseffekt gjennom de involverte aktørene Potensiale nasjonalt for energieffektivisering, og økt utnyttelse av fornybar energi
<ul style="list-style-type: none"> First implementation of an office building with this combination of technical solutions in Norway 	<ul style="list-style-type: none"> Experience from the project could be continued as general knowledge in the long term Helps develop the Drammen area as an expertise and innovation area National potential for energy efficiency International potential for spread which could result in energy efficiency and reduced greenhouse gas emissions
<ul style="list-style-type: none"> First implementation of a school with façade-integrated solar cells 	<ul style="list-style-type: none"> Solution is considered to have a major potential for spread/ripple effects National potential for energy efficiency and increased production from renewable energy International potential for spread which could result in energy efficiency, increased utilization of renewable energy and reduced greenhouse gas emissions
<ul style="list-style-type: none"> First implementation of the technology in Norway, there are fully developed products from e.g. Sweden, the Netherlands and Germany 	<ul style="list-style-type: none"> Considered to have major ripple effects Relevant for large buildings where a compromise between the available area and desired energy production is necessary National potential for energy efficiency and increased production from renewable energy International potential for spread which could increase energy efficiency, particularly in southern areas with considerable sunlight
<ul style="list-style-type: none"> First implementation in Norway. The solution with façade-integrated solar cells with printing to achieve the desired impression has not previously been used in Norway or elsewhere before this project Press coverage from multiple media, and the building has been visited by numerous interested parties 	<ul style="list-style-type: none"> National potential Project owner describes potential for using solar cell panels as façade panelling in all new and existing buildings International potential for spread in corresponding climate zones, which could increase energy efficiency and production, and reduce greenhouse gas emissions
<ul style="list-style-type: none"> No care facilities in Norway with corresponding energy ambitions 	<ul style="list-style-type: none"> National potential for spread which could result in energy efficiency International potential for spread which could result in energy efficiency and reduced greenhouse gas emissions Major interest among local contractors
<ul style="list-style-type: none"> First implementation in Norway. The solution with façade-integrated solar cells with printing to achieve the desired impression has not previously been used in Norway or elsewhere before this project Press coverage from multiple media, and the building has been visited by numerous interested parties 	<ul style="list-style-type: none"> National potential Project owner describes potential for using solar cell panels as façade panelling in all new and existing buildings International potential for spread in corresponding climate zones, which could increase energy efficiency and production, and reduce greenhouse gas emissions
<ul style="list-style-type: none"> One of the first facilities in Norway with a comprehensive energy concept 	<ul style="list-style-type: none"> The technology is transferable to corresponding facilities
<ul style="list-style-type: none"> One of few facilities in Northern Norway 	<ul style="list-style-type: none"> The technology is transferable to corresponding building types in the same climate
<ul style="list-style-type: none"> Either the first or second implementation of several of the individual measures in Norway 	<ul style="list-style-type: none"> Major national potential, reference for indoor swimming pools in Norway, innovative structural and technical energy solutions that will yield savings of several million kroner a year Potential for corresponding buildings in corresponding climates
<ul style="list-style-type: none"> One of the first facilities in Norway 	<ul style="list-style-type: none"> National potential Depending on price, this could become interesting technology in locations with substantial forestry
<ul style="list-style-type: none"> One of the first facilities in Norway, the first in Western Norway 	<ul style="list-style-type: none"> Local potential
<ul style="list-style-type: none"> One of the first facilities in Norway 	<ul style="list-style-type: none"> National potential
<ul style="list-style-type: none"> Use of wood building materials and a battery bank have been considered for future projects in KIMI and NorgesGruppen 	<ul style="list-style-type: none"> National potential Too early to determine further spread without gaining operating experience



Millions awarded to the power grid of the future

Lyse Elnett will receive NOK 15 million in investment support from Enova for a project that will build and test the power grid of the future. A total of 30 power grid stations in downtown Stavanger and Sandnes will be made fully automatic through use of new technology.

Smartgrid is the name used for power grids that are more “intelligent” through the use of instrumentation and communication technology. This is the first time the smartgrid technology has been tested on this scale in Norway.

Lyse’s goal and ambition is to achieve energy savings partially directly in the power grid, in part through reduced losses in the grid and indirectly through facilitating increased interaction with customers and application of new technology to manage electricity consumption. Another important goal is further increasing security of supply.

APPENDIX A PROJECTS WITHIN NEW ENERGY AND CLIMATE TECHNOLOGY 2012-2015

CONTRACT YEAR	PROJECT OWNER	PROJECT DESCRIPTION	TECHNOLOGY SUPPLIERS	SUPPORT AWARDED (NOK)	PROJECT'S ENERGY RESULT (kWh/year)
2015	SIT Geovarme AS	District library/activity house in connection with Moholt student village with e.g. local heating production, greywater recycling, heat sharing	• Supplier not determined	8 200 000	1 081 029 Energy efficiency, and production of heating
2015	Fosnes municipality	Combined indoor swimming pool/multipurpose house at Jøa in Fosnes municipality	• Supplier not determined	1 700 000	235 898 Energy efficiency, and production of heating
2015	Entra Eiendom AS	Powerhouse Brattørkaia	• Concept development: Powerhouse alliance	36 500 000	3 652 351 Energy efficiency, and production of electricity and heating
2015	Skanska CDN Oslo 3 AS	Storo Garden, office building with passive cooling and heating of the building via heat exchange with a geo-well, and heating/cooling of ventilation air. Comfort cooling via a self-regulating system without using regulation components	• Supplier not determined	5 815 320	1 186 800 Energy efficiency, and production of heating
2015	St. Olavs Hospital HF	Østmarka – energy-ambitious development Psychiatry	• Supplier not determined	2 900 000	442 577 Energy efficiency
2015	Stiftelsen Glasslåven Granavollen	Net heat-producing, rehabilitated building with comprehensive focus on reusing natural materials, heat recovery from glass furnace, measurement of vapour buffer, output and application of new commercial technology products	• Supplier flue gas cooler – Bioovn (Danish company) • Supplier ventilation windows – Ventilationsvinduet (Danish company) • Partner moisture readings – Treteknisk (research institute) • Partner energy solution – Asplan Viak AS	850 000	108 345 Energy efficiency
2015	R. Gjestad AS	Integrated design with recovery of waste heat and cooling. Innovative CO ₂ -based cooling plant that primarily delivers cooling to the refrigerated cases in the shop and secondary ice water (climate cooling) for connected buildings with very high energy efficiency	• Design: SINTEF Energi AS • Management system: Danfoss • CO ₂ system: enex srl • Installation: Trondheim Kulde AS	600 000	100 000 Energy efficiency
2015	Boligbygg Oslo KF	Façade rehabilitation of preserved building with super-insulating plaster containing Nano particles	Isokalk Norge AS	460 000	19 764 Energy efficiency
2015	Stormberg AS	Solar cell system with battery storage capacity for delivery to warehouse in Kristiansand	• Technology supplier (battery system with storage and management): Eltek AS	1 607 278	68 400 Production of electricity
2015	Vestfold and Telemark KFUK-KFUM	Knattholmen Kystleirskole. Combined (integrated) solution solar collectors along with liquid-to-water heat pumps (HYSS: Hybrid Solar System)	• Technology supplier: Free-Energy	709 000	88 978 Energy efficiency, and production of heating
2015	Directorate of Public Construction and Property	Integration of a so-called Power Optimizer (PO) for optimization of electricity production from a 251 kW highly efficient solar cell system in the Directorate of Public Construction and Property's new office building for the police and the Norwegian Public Roads Administration at Stord	• Builder: Directorate of Public Construction and Property • Technical consultant: Multiconsult ASA • Contractor: Kvinherad elektro AS, supported by Future Solutions AS and Kraftpojkarna AB • Solar cells: ECSOLAR (Wuxi Saijing Solar Co., Ltd) • Power Optimizer: Solar Edge Technologies Inc	2 263 238	206 157 Production of electricity
2015	Posten Norge AS	Low-energy logistics building with an energy-efficient solution for gates (72), and renewable energy production based on wind and solar, storage of energy and sale of excess heat to the area's local heating grid	• Supplier not determined	14 200 000	2 956 847 Energy efficiency, recovery of waste heat, and production of electricity
2015	Overhalla municipality	Skage day-care centre, nearly zero energy level, hybrid collectors (solar) integrated in the building, storage solutions for heating and heat recovery of greywater	Supplier not determined	1 331 000	166 115 Energy efficiency, production of electricity, and heat recovery
Residences					
2014	Geir Mikkelsen	Construction of a small house in Larvik. The house will deliver more power to the grid than it consumes over the course of one year, through electricity production from solar cells	• Electrical system: Sønnico AS • Architect: French Touch • Lighting: SG AS • Building contractor: TS-Elementer AS • Plumber: Rørleggermester Lysebo AS	115 600	16 284 Energy efficiency, and production of electricity and heating
2015	Henriksen, Andreas	House near the passive house requirements with comprehensive smart house solution. Extensive management of lighting, heating and ventilation through advanced KNX smart house solution	• Rambøll, BBT, LOS Elektro, Bergen Varme & Sanitær Ventilasjon – Bygg og Ventilasjon as	80 898	13 048 Energy efficiency, and production of heating

PROJECT'S CLIMATE RESULT IN NORWAY (kg CO ₂ equiv/year)	PROJECT STATUS	INNOVATION	EXPERTISE DEVELOPMENT
0	Under development	<ul style="list-style-type: none"> Comprehensive energy solution Energy-efficient building structure, solar collectors, delivers energy to neighbouring buildings, waste heat from greywater, free cooling, heat storage Façade air aggregates, room management logic for solar screening, air volumes, energy-efficient cross exchangers 85% 	<ul style="list-style-type: none"> Expect expertise development among the engineering group and participating contractor
0	Under establishment	<ul style="list-style-type: none"> Comprehensive energy solution Passive house level, bottom of pool can be raised and lowered, needs based circulation of pool water, LED lighting, needs based ventilation, economy showers and free cooling via wells Local production 109 261 kWh from heat pump with geo-well, solar heating, recovery of heat from ventilation system and bleed water exchanger 	<ul style="list-style-type: none"> Demonstration project Cooperation with NTNU – SIAT The project is followed up in the construction and operating phase to verify performance and function over time. Results will be published as Bachelor's and Master's theses, and articles and presentations at conferences
0	Under establishment	<ul style="list-style-type: none"> Comprehensive energy concept Energy plus building, produces more energy than is consumed for lighting, heating, ventilation and cooling, material use, construction and future rehabilitation Needs based management, hybrid low SFP ventilation, reduced heat loss from distribution of heating and tap water, free cooling, waste heat Production of energy from heat pumps and solar cells 	<ul style="list-style-type: none"> Demonstration project Part of the Powerhouse alliance is in close cooperation with NTNU/SINTEF Expect multiple master and project theses National and international publication
0	Engineering	<ul style="list-style-type: none"> Energy-efficient and environmentally friendly cooling/pre-heating solution for ventilation in office building without cooling compressor Passive cooling solution through underground storage system, seasonal storage of heating Integrated cooling and heating system, increased well diameter (14 cm) 	<ul style="list-style-type: none"> The facility will be facilitated for demonstration The result is verified via detailed measurements Expertise development among suppliers regarding geo-wells (changed dimensioning conditions), aggregate suppliers (changed system solution), and supplier of cooling/air conditioning system internally in the building (changed dimensioning conditions, system solution)
0	Under establishment	<ul style="list-style-type: none"> Passive house solutions and products security building with the requirements that apply for physical load, self-harm, installations cannot be used as "weapons", management of installations (e.g. lighting, sun screening) in relation to people with psychological illnesses 	<ul style="list-style-type: none"> Demonstration building, could spread to e.g. psychiatric buildings, hospitals, prisons Cooperation with St. Olavs Hospital, NTNU, Sykehusbygg HF, engineers, contractors, etc.
0	Under development	<ul style="list-style-type: none"> Demonstration facility (first in Norway with recovery of small-scale heat recovery of glass furnace) 	<ul style="list-style-type: none"> Demonstration facility (first in Norway with recovery of small-scale heat recovery of glass furnace) Build knowledge about system structure, functionality and suitability for technology interaction Presentations at meeting forums and various conferences Measurement of and recovery/consumption for verification and analysis The facility can be opened for tours Cooperation with Tretknisk and Asplan Viak
	Commissioning	<ul style="list-style-type: none"> Comprehensive design Integration of a parallel compression CO₂ cooling unit with three temperature levels (AC-cool-freeze) in a multipurpose building 	<ul style="list-style-type: none"> Demonstration facility with detailed measurement of energy consumption Further development after Rema Kroppanmarka Follow-up of SINTEF/NTNU, several master's degree students involved Reference project for the grocery industry (KPN-INTERACT)
	Under development	<ul style="list-style-type: none"> Lime plaster with super-insulating properties Enables new insulation of preserved buildings, as it can be approved by the preservation authorities Contribute to energy efficiency and improved indoor climate 	<ul style="list-style-type: none"> Demonstration facility with measurements Also builds expertise among
0	Under establishment	<ul style="list-style-type: none"> Sum of multiple technical solutions; New energy storage solution Compact current transducer that is bi-directional between the grid and batteries New technology for management system that predicts and optimizes interaction between power production, energy storage and consumption 	<ul style="list-style-type: none"> Measurement programme for documentation and exchange of experience Development of experience from use of various solar cell technologies (mono and polycrystalline) placed on the roof and south-facing wall of the building Internal and external expertise development Information dissemination through conferences, seminars and inspections Development of experience from use of bi-directional current transducer in zero building as a plus customer
	Under establishment	<ul style="list-style-type: none"> Norwegian-developed combined/integrated solution for solar collectors with liquid-to-water heat pumps Integrated design results in high performance for the heat pump system (SCOP on 6-8) 	<ul style="list-style-type: none"> Demonstration facility with measurement/software for documentation of energy result/energy follow-up Increased expertise within good integration of heat pumps vis-à-vis other energy systems and optimization with regard to heating need in building Communication during engineering/execution phase to installers/contractors Active marketing and publication in technical periodicals (Teknisk Ukeblad, Kulde, VVS)
0	Under establishment	<ul style="list-style-type: none"> Innovative system solution with highly efficient PV panels with integrated Power Optimizer for each panel, connected to two accumulator tanks (hot and cold) for storage of excess production during summer 	<ul style="list-style-type: none"> Demonstration facility Empirical data from solar power production in the south-western region of Norway Expanded measurement programme for documentation and exchange of experience Building experience for alternative system solution for battery bank Internal expertise development Information dissemination through conferences, seminars and inspections
0	Under establishment	<ul style="list-style-type: none"> Comprehensive concept consisting of a solar cell system, wind turbine, buffer battery and autonomous streetlights Local energy production covers 100% of energy for electric fleet of vehicles and for use in the building Excess heat is delivered to the area's joint local heating grid 	<ul style="list-style-type: none"> Demonstration facility is expected to receive major local/national attention Experience from local renewable energy production vs. energy storage of electricity and supply of electric car fleet, energy exchange in the area and partially also the quick gate solution Touring facility for solution with self-production of electricity for a dedicated fleet of electric vehicles
0	Under establishment	<ul style="list-style-type: none"> Comprehensive concept Very well insulated building structure, rotating heat recovery units in series 92-5%, needs based ventilation/lighting, low-temperature heating from hydronic systems Combination of solar cells and thermal solar collector in same module with energy storage in wells Greywater recycling 	<ul style="list-style-type: none"> Local/regional demonstration project Local/regional expertise development
0	Commissioning	<ul style="list-style-type: none"> Familiar technology is put together in new ways Ventilation system with heat pump for heating ventilation air and tap water. Pre-warming of supply air via ventilation duct in the ground. This will also provide "free" cooling in the summer 	<ul style="list-style-type: none"> Touring and reference residence for Sønnico and builder Experience will be shared on the project website Established contact with the electrician study programme at Thor Heyerdal Upper Secondary School Article about the project in local paper, and Teknisk Ukeblad TU
0	Commissioning	<ul style="list-style-type: none"> Comprehensive solution with familiar technology for commercial buildings, infrequently used in a residential connection (management and ventilation) Needs based management, low-temperature heating 19 different zones, thermal mass/storage 	<ul style="list-style-type: none"> Extensive measurement and instrumentation of all energy flow Expertise development among involved local/regional contractors, major national adviser Stipulates requirements for close cooperation between electrician, plumber and ventilation and to optimize the smart house functions

REALIZED DISSEMINATION OF TECHNOLOGY	FURTHER DEVELOPMENT AND DISSEMINATION
<ul style="list-style-type: none"> • One of the first facilities in Norway 	<ul style="list-style-type: none"> • National potential
<ul style="list-style-type: none"> • One of the first facilities in Norway, and first in the region 	<ul style="list-style-type: none"> • Local and national potential
<ul style="list-style-type: none"> • Realization of the first newly built energy plus office building in Norway 	<ul style="list-style-type: none"> • Major national potential for all or parts of the solutions • International potential for spread that could increase energy efficient and production and reduce greenhouse gas emissions
<ul style="list-style-type: none"> • Components in the system are known in Norway today, system solution is not common, challenges involve dimensioning the facility so necessary cooling/heating capacity can be extracted from the system at the correct temperature 	<ul style="list-style-type: none"> • National potential • Skanska CDN intends to use the technology in several of its construction projects, where a cooling need exceeding a certain limit is expected +M92
	<ul style="list-style-type: none"> • National potential • Project owner lists major spread potential for own and other buildings
<ul style="list-style-type: none"> • First building in Norway with heat recovery from small-scale glass furnace • Corresponding heat recovery projects known in Denmark • There are currently some rehabilitated buildings in Norway with net heat delivery • Projects with a total focus on sustainable rehabilitated buildings (energy solutions and use of natural materials) are still considered ground-breaking 	<ul style="list-style-type: none"> • Small-scale heat recovery from glass furnaces can be added to existing and new establishment of small-scale glass production • Experience from using hybrid ventilation solution, particularly in combination with use of natural materials, can be used in buildings with corresponding internal load sizes • Quantification of "indoor climate effect" from buffering of moisture in untreated wood panel with support increased use of wood in buildings
<ul style="list-style-type: none"> • First implementation in Norway • About 20 installations implemented globally +1.83 	<ul style="list-style-type: none"> • Potentially a concept that should be used in multipurpose buildings (with grocery shop) that need climate cooling, heating of tap water and general heating • Transferable to multipurpose buildings with high energy consumption for heating and cooling, also without grocery shops • Project estimates that spread potential is 1000 facilities in Norway, globally, this system could be used in most grocery shops
<ul style="list-style-type: none"> • First implementation in Norway, result will determine future investment in the product 	<ul style="list-style-type: none"> • National potential for new insulation of preserved brick buildings with plaster • Internationally interesting for buildings in corresponding climate zones
<ul style="list-style-type: none"> • First implementation of corresponding facilities in Norway today 	<ul style="list-style-type: none"> • Particular spread potential for commercial buildings that need to store excess production • Technology supplier estimates a spread potential for all new power grid stations in the distribution grid, telecom base stations, energy-plus houses, etc.
<ul style="list-style-type: none"> • First Norwegian installations, apart from three test facilities 	<ul style="list-style-type: none"> • National potential Norwegian-developed solution • Project owner estimates major national potential, relevant in e.g. day-care centres, schools, sports facilities, office buildings, etc. in areas with the possibility for well drilling/ground loops • Less suitable for small houses • Potential for other countries with a Nordic climate
<ul style="list-style-type: none"> • First implementation in Norway 	<ul style="list-style-type: none"> • Particular spread potential for commercial buildings that need heating and cooling at the same time • Project owner is building experience, and will consider the solution's suitability for future new buildings • National potential for spread that could yield increased production of renewable power
<ul style="list-style-type: none"> • First implementation in Norway • No known corresponding projects within this building category with corresponding solutions for energy production and energy exchange with other buildings in the area 	<ul style="list-style-type: none"> • National potential • Applicant is planning more corresponding buildings
<ul style="list-style-type: none"> • Considered on a national level as one of the most ambitious day-c are centres in relation to net energy demand and own renewable energy production 	<ul style="list-style-type: none"> • Local/regional potential
<ul style="list-style-type: none"> • No corresponding buildings in Vestfold, one of the first energy-plus houses in Norway 	<ul style="list-style-type: none"> • Relevant for players that are constructing new buildings or implementing energy measures • Focus on constructing energy-efficient residences without costs being too high, and increased comfort • Want to increase focus on solar power
<ul style="list-style-type: none"> • Few known residences in Bergen/Hordaland with such extensive management and regulation 	<ul style="list-style-type: none"> • National potential



Efficient ship cranes improve air quality

Enova is investing NOK 1.15 million in the Grieg Star shipping company. The cranes on board Grieg Star's ships can now charge batteries when they are lowering cargo, just like electric cars charge their batteries when the car brakes. The battery system is the first high-efficiency optimized battery package for maritime use and was developed and produced in Norway. Apart from emitting less CO₂, it could help improve local air quality in the harbours by reducing emissions of SOx, NOx and soot particles. One bonus effect is that the cranes will become more efficient, reducing the turn-around time.

Another effect of the installation is that the ship will be prepared for using onshore power in the harbours that provide this. This will further reduce local pollution such as sulphur and soot particles. The battery system will save in excess of one gigawatt hour per year for each ship it is installed on. Grieg Star has ten suitable ships in its fleet, and this pilot project comprises one of them.