BB GREEN

Project no: 234124

Project title:

“Battery powered Boats, providing Greening, Resistance reduction, Electric, Efficient and Novelty”

Acronym: BB GREEN

Instrument: Collaborative project

Topic: SST 2008.5.2.1. Innovative product concepts

Call identifier: FP7-SST-2008-RTD-1

D1.7: Final Report

Date: 2015-07-10

Coordinator name: SES Europe AS

BB GREEN

PROJECT FINAL REPORT

Date of latest version of Annex I against which the assessment will be made: Dec 10th 2014.

Period covered: From May 1st 2011 to April 30th 2015

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1. Final publishable summary

1.1. Executive summary

The BB GREEN initiative was established in 2008 with a goal to develop and prove feasibility of a new, innovative and competitive waterborne transport solution, presenting a technological- and environmental step change. The new vessel type should run entirely on renewable electric energy, stored in an onboard battery. The vessel should be able to operate at 30 knots +, and be the "first in the world" of its kind.

Addressed challenge:

In many cities and communities the public transport sector is suffering from heavy congestion and unacceptable emissions (fossil fuels). The project had, in line with EU request, an ambition to reduce the strain on land based transport, introduce a climate friendly waterborne travel choice; and contribute to reduced local- and global emissions.

Insufficient budget:

Unfortunately, the project budget was severely cut to Euro 3,12 mill; down more than Euro 2 mill from the initial. At the end of the project it is clear that the cuts made by the Commission resulted in a considerable overspend for several of the partners to carry out the obligations set in the latest and approved version of the DOW.

Main approach:

Set new SOA through combining innovations, the most efficient and capable technologies, materials, systems and solutions either available or adaptable.

Despite limited resources; amazing achievements have been made:

- Documented a considerable- and emerging market for fast, efficient and emission free ferries across Europe and beyond.
- Developed two new Air Supported Vessel (ASV) hull forms, with significantly reduced hull resistance. A reduction of 40% has been documented in model- and full scale.
- Developed a new air support- and ASV control and automation system.
- Engineered and applied vacuum infused Deveinycell carbon construction techniques for significant weight reduction and improved workforce health. (Fully enclosed process.)
- Built a 20 m BB GREEN prototype for full scale documentation under actual conditions.
- Developed, installed and proved in full scale new permanent magnet battery electric drivelines; and a matching battery Supercharger system.
- Developed a new, lean with low appendix drag, high efficiency, contra rotating pod propulsion system. (System details are confidential; not yet launched on the market).
- Engineered a new Lithium Ion Titanate battery cell module and build a 200 kWh capacity (1/2 commercial size) prototype battery, installed and tested in the prototype; capable of taking very fast recharge (20 minutes); and with a life expectancy of 20.000 + cycles.
- Engineered and built a fully integrated battery/electric control and management system full size.
- The project has done an impressive BB GREEN dissemination job with among other over 110 Dissemination actions (press / WEB - articles, conference papers, National TV and more).

Remaining issues; and the way forward to exploit of the new BB GREEN technology?

- At the end of the project, the feasibility prototype vessel is almost ready for launch, initial testing, debugging and final tests.
- Key project partners continue the work with a plan to meet the project's final goal; to prove a low wake wash, 30 knots fast and efficient (- 40% energy reduction over a conventional vessel) is possible with the BB GREEN initiative.
- Echandia, SES Europe, Aqualiner and the yard BJB have applied for a technological documentation (RTD), dissemination and demonstration project under Horizon 2020 SME Phase 2 with the acronym GFFNOW (green fast ferries NOW!)

Lessons learned:

- It is impossible to fully predict all the challenges related to a very demanding innovation project like the BB GREEN at project application phase / early in the project.
- Unexpected factors occurred; related to technology developments, pricing of new/emerging components /materials / systems, bankruptcy of partners, added requirements from the scientific officer, considerably longer handling time for amendments, and more.
- Unfortunately cost and time for prototyping, testing and documentation ALLWAYS are higher and takes longer than what the project coordinator and the EU negotiation officer predicts.

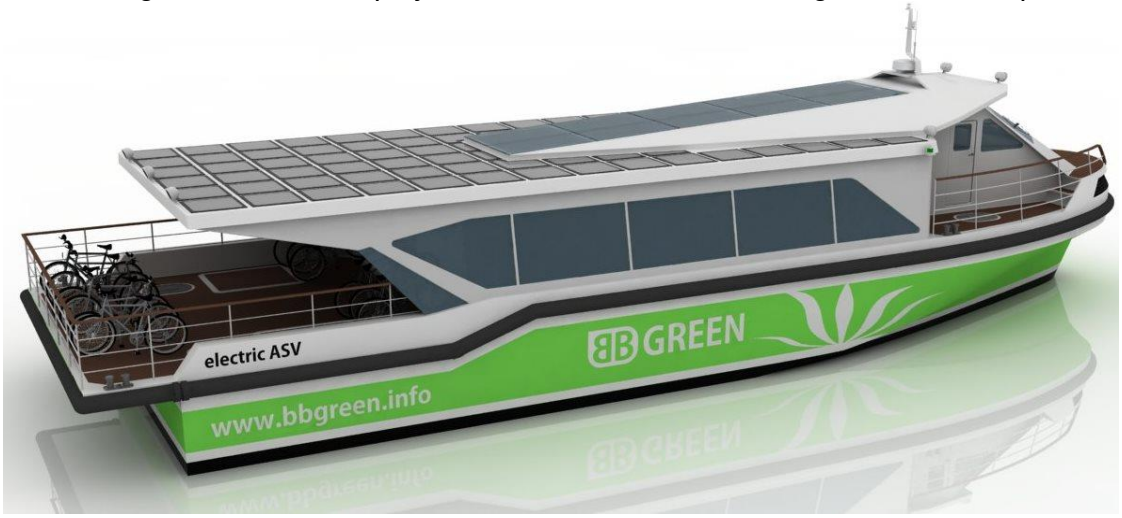


Illustration: The final BB GREEN commercial product – a 20 m 30 knots fast, air supported commuter ferry with up to 80 PAX capacity and space to bring your own bicycle onboard. And the most important – the vessel will have Zero global and local operational emission!

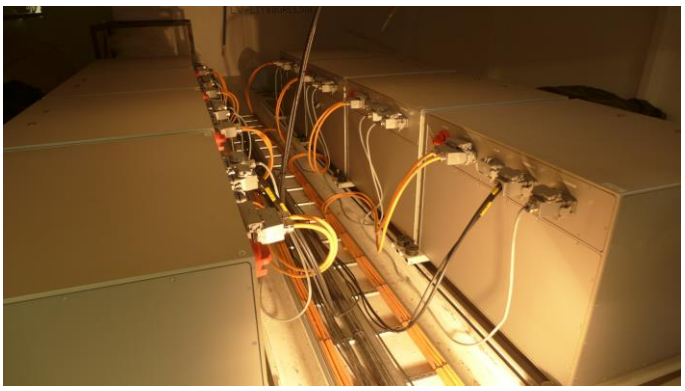


Illustration: Battery bank installed & tested inside the test vessel. From construction.(right).

1.2. Summary description of project context and objectives

Project context:

BB GREEN represents innovation and research with an aim to develop next generation fast and efficient commuter ferries. The new vessel type shall not only cut emissions to water and air by a certain percentage; it should be completely emission free (on the assumption agreed that electric energy for recharging the vessels' battery is sourced from renewable energy sources).

The vessel as presented has primarily been designed for operation in sheltered waters, but the project has also a "spin off" solution available (tank tested in another project) for more demanding sea- and wave conditions.

For a battery electric ferry hull reduced hull resistance is a key issue for success. The BB GREEN will not use a conventional "wet "hull concept. BB GREEN will utilize air supported vessel (ASV) technology. In the project two variants have been extensively tank tested at SSPA Sweden's facilities in Gothenburg; a catamaran version and a mono-hull version. Both delivered significantly better hull resistance values than the conventional counterpart. The mono-hull proved to be the superior and this hull has been used in the continuation of the project and for the construction of the feasibility demonstrator vessel.

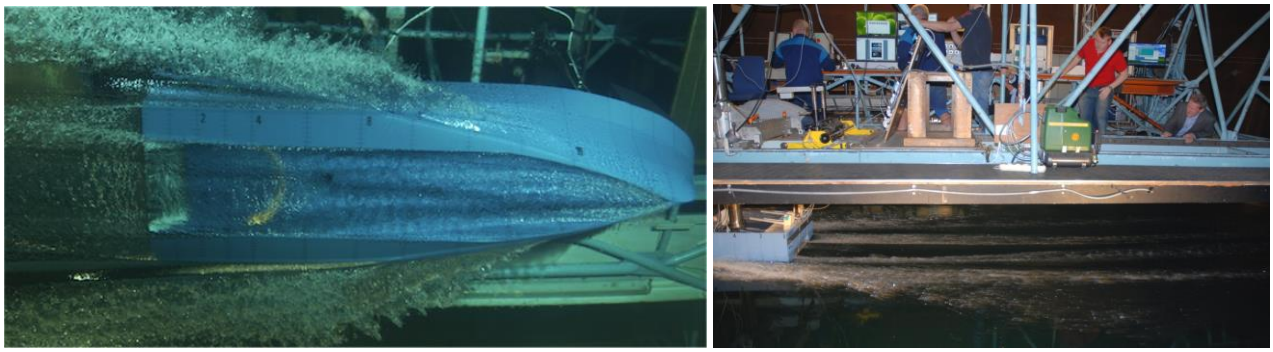


Illustration: Tank testing of the BB GREEN ASV Mono-hull underwater picture at 30 knots speed (left) and wake wash conditions behind the boat at same speed.

With the ASV concept up to 85% of the fully laden vessel displacement is supported on one or more cushions of pressurized air. A lift fan system is contributing to filling of the air cavity underneath the vessel separating most of the normally wetted surface areas from water contact; and reducing overall hull/water resistance significantly.

By means of two battery- electric drivelines BB GREEN can be operated without diesel engines, as used on fast ferries today. On the prototype vessel a smaller diesel engine has been installed, but will only be used as a redundancy system and when the vessel shall be moved from one test site to another. The latter will increasing the vessels range (at slow speed – approx. 5 knots) when required.

In an early phase in the project and on the basis of an risk assessment, the project decided to shift propulsion system; from a set of large diameter surface piercing propulsors to twin, lean shape, low drag contra rotating duo prop systems, designed not only to give market leading efficiency but also excellent manoeuvrability. Investigations were carried out to support the decision.

The project knew exactly what kind of system they would like to use, however no such system for electric operation was commercially available on the market. The solution therefore was to develop such a system adapted to electric drivelines. After a lengthy persuasion process and negotiations with a market leading propulsion- and diesel engine manufacturer the project's coordinator managed to convince this company to support the project, assist in building such a system and lend to the project two prototype units for testing and documentation in the BB GREEN project.

With the kind of power-use- profile of a fast ferry, conventional Lithium Ion battery technology as seen in battery electric and hybrid cars today could not be used. A fast ferry will have a power consumption equal to that of a heavily loaded truck driving steep uphill at all time. The typical power consumption will be close to peak and not fluctuate as is the case for a car. The power density and tough use of a ferry also requires a battery with considerably more (depth) cycle life. A BB GREEN ferry with a 400 kWh battery will require filling up the battery, in a typical use scenario approx. 10 – 12 times a day, for 360 days in a year. With a smaller battery for shorter routes even more frequent recharging will be required.

The project also had its fair share of problems related to the battery and battery cell deliveries. First the battery partner unfortunately went bankrupt; secondly the project coordinator had to source a new replacement partner. Then a prequalification process of the new partner was required. Thirdly the cell supplier faced economic- and delivery problems and could, despite promises, not deliver on agreed time. Therefore, as the correct battery solution was a must for the project, battery partner Emrol had to source and secure an alternative supplier. New negotiations then followed, and the module design had to be completely reworked due to different specification/sizes/voltage etc. Negative effects from this scenario also influenced the electric driveline system provider Echandia, and their system specification and sourcing of components.

To sum up; significantly more man hours and cost as a result of the above went into testing and documentation with the new set up (hardware and soft-ware). The situation also had negative implications on the delivery and installation schedule.

According to the DOW the project partner Aqualiner should be responsible for the construction of the test vessel / feasibility prototype. During the project the EU scientific officer reduced the budget for the construction of the test vessel considerably, to less than Euro 600.000,- and it was agreed to carry out a tender process related to the construction and outfitting of the vessel.

The tender, and information on the tender process were very thoroughly disseminated throughout Europe (and beyond), and the response and request for additional information were overwhelming. More than 30 yards / builders expressed interest in the early stage. However during the initial discussions with the yards that followed it became more and more clear that the budget allocated by EU were far too low compared with the cost expectations of the yards. Despite that; close to 10 yards submitted their tender offers, ranging between more than Euro 2,5 mill (highest) to approx. Euro 850.000 (lowest).

Then a thorough negotiation process with some shortlisted yards, with the lowest tender offers followed. These negotiations were conducted by the project coordinator SE with some assistance from Aqualiner.

BJB from Latvia was the most interesting yard; but when Aqualiner did not manage to secure a contract with BJB and declared that they would not continue with the responsibility for construction of the test vessel, the project coordinator had to find an alternative solution or end the project prior the construction of the vessel. Investigating the possibility of inviting BJB into the project as a partner was suggested and approved by the Commission. Following a lengthy negotiation, and on

the basis that SE should give BJB additional commercial ASV exploitation rights, it was finally agreed that BJB should become a partner.

The work that BJB has carried out has been excellent and as outlined in the DOW composite engineering partner Diab has followed up the yard in a very convincing way, teaching the latest principles of carbon sandwich vacuum infusion techniques and solutions; during the construction of the BB GREEN prototype.

With 5 different scientific officers and replacement of several partners the project's DOW has undergone several changes and deviations from the start until the end of the project. All have been justified and approved by the respective scientific officers. Some reallocation of work and budget between partners and tasks have been carried out.

Project objectives and achievements in the project:

- **Overall project objective (O) and achievements (A) with comments (C):**
    - O: To develop new, robust, highly capable Zero emission maritime transport solutions, designed to fulfil tomorrow's community- and customer's requirement today.
      Prove feasibility of the BB GREEN concept by means of a full size test vessel.
    - A: Final documentation will be available when the prototype is in the water and tested.
    - C: Excellent indications that the objectives will be reached (tank tests, systems evaluations and full scale tests with a similar ASV concept to BB GREEN.)

- **Detailed sub goals / objectives (O), achievements (A) and comments (C):**
    - O: Hull resistance reduction 30% compared with conventional hull at 30 knots speed.

      A: Tank testing shows resistance reduction at 30 knots of close to 40%.

      C: Additional tests with another full size ASV (outside BB GREEN) confirm tank test results at sea. Tests at design load show acceptable hull resistance / load carrying capability to handle the targeted operation. Final validation when test vessel is in the water.
    - O: Reduced wake wash (to acceptable levels for operation).

      A: Towing tank results and observations indicate acceptable levels on wake wash - energy and - wave height. Same positive observations have been made from full scale testing of another ASV of same size.
    - O: Motion dampened ride.

      A: Tank tests and full scale tests confirm positive motion damping with the ASV hull form, and acceptable on-board comfort for the targeted operation type and duration when the BB GREEN vessel is operated at high speed in waves.
    - O: Weight issues; reduced construction weight over GRP and aluminium.

      A: Developed carbon sandwich engineering / construction of the hull and superstructure show approx. 40% reduction in structural weight compared with an aluminium equivalent. According to the weight specifications, operational weight for a weight optimized commercial BB GREEN vessel will meet the targeted weights of 25 tons (design) / 28 tons (max.)
    - O: Secure market leading efficiency over a wide speed range (5 – 35 knots).

A: Selected contra rotating duo prop pod propulsion meets this requirement with a propulsion efficiency of approx. 72% at design speed (30 knots). Full scale tests with an ASV full scale confirm these values.

C: Final validation when test vessel is in the water.
There seems to be further development potential with the developed units; through reducing the appendix drag by making the electrified units even more lean than as tested.

- O: Electric drive line, improve efficiency of total system compared with a conventional diesel, gearbox, propulsion/driveline with 15%.

  A: Final validation when test vessel is in the water.

- O: Eliminate local and global emissions.
- A: Provided electricity comes from renewable energy sources the vessel will be emission free.

- O: Recharging arrangement; secure a simple, safe and reliable on board system (for test vessel).

  A: For test- and demonstration purposes a diesel generator on-board is a back-up / range extender. In a commercial application a land based Supercharger (as developed and proven by partner Echandia) will be used.

- O: Noise and vibration; achieve acceptable noise levels.

  A: Due to budget limitations the test vessel will be “concept feasibility proving test-vessel”, not fully sound dampened as a commercial vessel would be. The electric drivelines are expected to be considerably less noisy than diesel equivalents. The lift fan system is located well away from the passengers and generates modest noise. Final noise measurements / assessments will follow when test vessel is in the water for testing.

- O: Cost issues; competitive or better than conventional diesel fast ferries with similar performance.

  A: Comparison studies show that BB GREEN vessels for a large number of operations/routes can be more cost efficient than diesel conventional counterparts.

  C: For these evaluations a large number of assumptions need to be made; including but not limited to: Pricing of electricity and diesel fuel, subsidies and taxation issues, second hand value and depreciation levels, battery performance and- cost developments. There will be considerable local/regional/national differences.

1.3. Description of main S&T results and foregrounds

A. Resumes on Work Package (WP) level for work performed. Issues and challenges encountered, and main results / achievements during the project:

WP1: Administrative coordination. SE has been in charge.

The work load has been considerably higher than budget mainly due to following issues:

- The project has had to relate to different 5 Scientific Officers all with their individual interpretation of the DOW and respective requests for changes and modifications to project content and budget.
- A voluntarily change (based upon a risk assessment) of the propulsion system required considerable extra work, time and cost. Partly related to secure supporting scientific documentation for the suggested change, - to modifications to the BB GREEN team, - to budget reallocation and DOW changes, and to source, negotiate and agree with a new business unit that could deliver the proposed solution and contribute to fulfilment of the tasks related to the propulsion issues.
- The project has had significant problems related to the unfortunate bankruptcy of partner Amberjac Projects LTD. Amber was responsible for a large number of technical issues related to among other battery development and construction, electric drivelines, power management and electric systems integration, testing and optimization. The bankruptcy had financial implications to the project, but the EU Guarantee Fund proved to be a very good instrument to handle matters of this kind. These issues had to be dealt with by SE and gave extra administrative burdens related to administration, budget and DOW. New partners for each of the previous Amber tasks had to be sourced, participation agreed and budgets renegotiated.
- 3 new partners; Echandia, Emrol and later also BJB had to be enrolled, and registered as new beneficiaries; the process proved to be quite resource demanding.
- Additional requests from the scientific officers related to new documentation on the technological merits, on the new partners and their capabilities, and on the tender specification and -process also gave SE unforeseen extra work load.
- The fact that the negotiation between Aqualiner (supposed to be responsible for the subcontracting of the test vessel construction) and the tender winning yard – BJB - stranded also gave considerable extra administrative work load on SE.
- Above listed issues, mostly outside the control of the coordinator, unfortunately resulted in unforeseeable delays. A considerable amount of time was spent on amendment matters; including getting approvals, shifting budgets, applying for extension etc. This process took unfortunately much longer than expected and the project progress was put on hold as a result of this situation.
- The coordinator has worked hard to secure a follow up of the BB GREEN project, in order to take full advantage of the BB GREEN test vessel. The coordinator has therefore in addition to what has been reported spent considerable time in planning- and securing a proper follow up funding, to the benefit of all the beneficiaries in the project. An application – GFFNOW – was submitted to Horizon 2020 SME Phase 2 (transport) in June 2015.

WP2: Assessment of requirements and critical factors. SE has been in charge.

WP tasks carried out as planned, with main results:

- A thorough understanding of the typical operational requirements has been established
- A large number of suitable routes and operations have been identified.
- Critical factors have been discussed and reported. Changing propulsion system was a result.
- Suitable hull forms were modelled and thoroughly evaluated based upon the above.

WP3: Design development and model testing. SSPA has been in charge**.**

WP tasks carried out however some delay due to awaiting input from other WPS. Main results:

- Concept designs developed fully as planned (WP 2 input) (cat and mono). ASV Mono selected.
- Development of two main BB GREEN designs with several revisions (SE with assistance from Studio Sculli.)
- Two tank testing models developed, instrumented and tested fully as planned.
- Model tests carried out fully as planned with excellent and very encouraging results.
- Data model for scaling of ASV hulls of the BB GREEN type developed.
- Evaluation of BB GREEN concept construction and operation against rules and regulations, done and reported by Lloyds Register.
- Safety aspects related to BB GREEN vessels discussed and reported by Lloyds Register.

WP4: Development of systems. Emrol has been formally in charge, but SE has had the actual WP lead as SE initiated the project and was considered to have the best overall understanding.

Major challenges related to:

- Sourcing components and coordination of all battery/electric driveline related systems when Amber went bankrupt. Handled and rectified by joint efforts from SE, Echandia and Emrol.
- Sourcing a suitable prop system, handled by SE and Echandia with some support from a no named provider of propulsion systems.
- Sourcing of battery input factors, design development, testing and debugging of battery. Considerable extra work and efforts by Emrol.

WP tasks carried out:

- Satisfactory cell testing of Lithium Ion Titanate cell technology.
- Design developed and full size prototype of a new Lithium Ion Titanate battery (200 kWh).
- Development and full size prototype of full electric driveline with small diesel electric generator / range extender.
- Development and full size prototype of low appendix resistance contra rotating duo prop pod propulsion; with joy stick control and vectoring steering/handling.
- Development and full size prototype / electric powering of ASV lift fan system.
- Development and prototype (hardware/software) of ASV automatized control system.

- Design development of Supercharger battery recharging system.
- Development and full size prototype of battery / electric driveline / generator on-board power management system.
- Function testing of all key components.
- Reporting as outlined in the DOW.

Remaining issues:

- In the water final debugging, optimization, monitoring, full power testing and documentation of the systems.

WP5: Test vessel construction, outfitting and testing. SE has been in charge.

Major challenges related to:

- Preparing and carrying out the tender process on the basis of a too low budget made available.
- Failed negotiations between Aqualiner and the tender winner for construction of test vessel.
- However, through negotiation SE succeeded to enrol BJB as a partner in the project.
- Delays in start-up of the vessel construction due to the amendment process, formal acceptance of the new partners and lack of initial funding to the 3 new beneficiaries. (Outside the control of the project.)
- Technical management of the work package has been very demanding for SE and has taken up considerably more time than planned.
- Increased prices of construction materials (Devinycell, carbon mats, vinylester resin, consumables etc.); and insufficient amount of material (margin not included in the budget), resulted in seriously higher cost than initial budget for Diab and BJB. SE also has had higher spending than planned.
- Cost of outfitting / installation materials and time higher than allocated in the budget.
- Cost items not included in the budget and insufficient margins on spares/materials.

WP tasks carried out:

- Composite engineering fully as planned. More detail engineering than planned for Diab and SE.
- Detailed tender specification with tender offer document as planned. Follow up with Non-Disclosure Agreements, information / discussions with a large number of yards required considerably more work for SE than planned.
- Construction of a single use mould with pre-construction teaching of the yard by Diab fully as planned.
- Construction of the test vessel hull (in a mould) and supervised (vacuum table) by Diab fully as planned.
- Construction of the ASV specific hull related systems as planned.
- Battery pack installed in vessel.
- On-board installations and outfitting of the systems, most of the work done as planned.

Remaining issues:

- A minor remaining part of the systems installation and connections remain, will be done within July.
- A minor remaining part of the vessel superstructure mounting remains, will be done within July.
- Testing and debugging, will be done according to plan in August.
- Prototype in the water according to plan in end of August or September.
- Final tests will then take place.

WP6: Demonstration activities. SE has the WP lead.

No demonstrations have yet been carried out with test vessel.

However Echandia, SE, Aqualiner and BJB have applied for support from Horizion 2020 SME Phase 2 to carry out a detailed documentation of the vessel's performance and capabilities (remaining issues in WP5), additional dissemination (with the test vessel), a comprehensive European Road Show (with the vessel) and local feasibility testing on a number of identified routs. Application was handed in for the June 2015 cut off. Project acronym: GFFNOW.

WP7: Validation of project achievements. SSPA has the WP lead.

WP tasks carried out:

- Technical performance has been reported and based upon tank testing results, results from scientific testing of another ASV of similar size, and full size scaling predictions based upon a data model for ASV scaling developed by SSPA under WP3. (D.7.1.)
- Environmental effects have been assessed and reported. (D.7.2)
- Recommendations have been prepared and reported. (D.7.3.)

Remaining issues:

- When the test boat is in the water, the planned tests (WP5) will be carried out.

WP8: Dissemination of project results and achievements. SE has the WP lead.

WP tasks carried out:

- SE has very thoroughly disseminated the BB GREEN concept visions and results from the project through mass media / WEB / press, through conference papers / presentations and TV.
- Aqualiner and the other partners have also carried out a large number of disseminations.
- A total of approx. 120 dissemination activities have been posted on the participant portal.
- At the time of formally ending the project, there is considerable interest for the BB GREN project and a large number of media/WEB/magazines have expressed as they will write more as soon as the boat is in the water and available for demos.
- For the benefit of the project, SE has spent much more man hours on dissemination activities than budget. Due to the importance of preparing the market for BB GREEN, end user partner Aqua has also spent more on dissemination than initially planned.
- The dissemination will not stop with the ending of the project.

B. Main Scientific and technological results from the project:

WP2: Requirements and critical factors:

Achieving a “game change” normally requires a new approach, willingness to think “outside the box” and a team daring using/combining solutions and technologies not previously merged. With such an approach, the probability of unexpected effects will naturally be larger than if very conventional solutions and tested and proven technologies were used.

For the project looking at, and establishing a thorough understanding of the market (including completion), the type of targeted routes, limitations / regulations; as well as (untapped) opportunities was a natural staring point.

With Aqualiner (the Netherlands) as the project “end user / operator”- partner several interesting current and potential operations, and operational networks, were identified.

Focus for the BB GREEN phase one (concept feasibility demonstrator) was agreed to be on operations / routes with the following characteristics:

- Existing permission or potential to operating at high speed (25 – 30+ Knots).
- Sufficient travellers / market volume / size (current or potential) and acceptable spread over the day. (Number of passengers and potential for establishing a matching time-table).
- Route / route leg length matching the theoretically assessed 14 NM range of a commercial BB GREEN vessel (with a 400 kWh battery.) The total range of 14 NM for the operation could either be return route or a single leg, or the distance between recharging positions (if route is more than 14 NM).
- Routes where the benefit of high speed matters; where sufficient leg/route length is one factor.
- Routes where a BB GREEN vessel can be operated at high speed; and the wake wash and/or traffic conditions on route, allow for an acceptable, safe passage.
- Where the new waterborne transport can compete / assist other traffic modes and contribute to reduced congestion (rush hours / commuter travel), shorter and more pleasant travel or other community benefits.

Routes in the Netherlands, Italy, Germany, Great Britain, France, Norway, Sweden, Finland, Spain, Greece, Belgium and Portugal were studied.

Some were coastal routes while others were inland waterway / lake operations.

Most of the routes had certain common characteristics, but there were also quite different demands locally. I.e. in Sweden and Finland ice was normally a problem for a number of months each year.

Illustration: Waterborne transport route today in Hamburg, Germany.

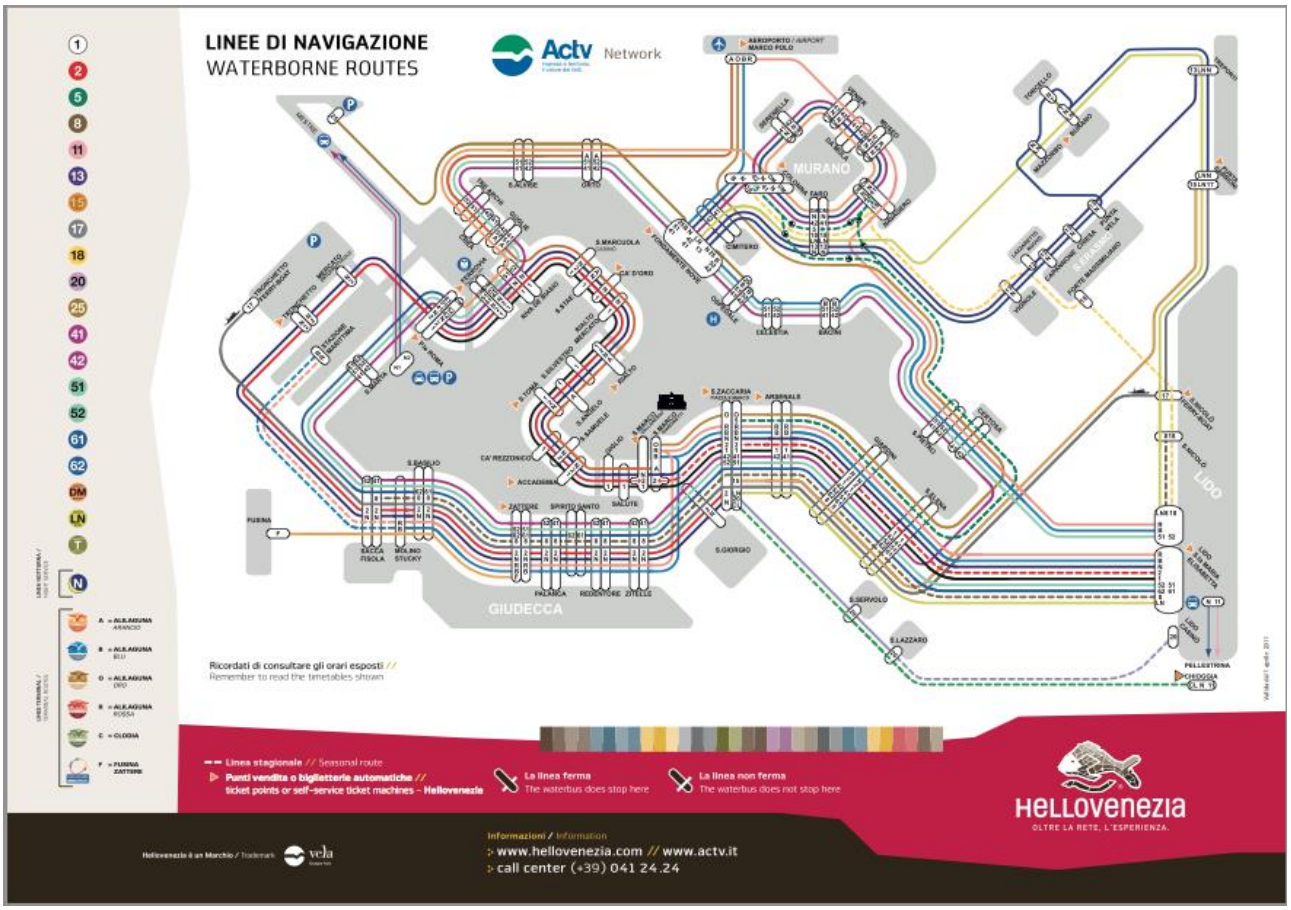


Illustration: Waterborne route network in Venice, Italy. More than 100 mill PAX per year.

Illustration: Local competition: Small ferry with diesel engines in Venice, Italy.

Illustration: Acceptable wake wash is important for obtaining permission to operate at high speed.

In parallel with the operational and route requirements SE conducted a study on factors assumed to be critical for a successful design development and operation of BB GREEN type of ferries.

Below is a list of some of the factors discussed:

- BB GREEN concept idea
- Battery pack issues
- Recharging time; possible and required
- Battery life (use and number of recharging cycles)
- Battery weight
- Power supply issues
- Propulsion, steering and drive-line issues.
- ASV concept, hull form, air enclosure, function and control
- Lift fan function and noise
- Embarkation and disembarkation
- Vessel handling and manoeuvrability
- Vessel redundancy in case of electric or other types of failures

Based upon the above the suggested propulsion system (a new large diameter surface piercing propulsion made from carbon composite) was agreed by the BB GREEN consortium to represent too high a technical risk, and also possible a maintenance – and operational safety issue.

The latter (safety & ease of manoeuvring) were the main reasons for moving to current propulsion.

Suitable hull / concept:

SE and SSPA had considerable know-how on Air Supported Vessel (ASV) hull forms and could with a high degree of probability deliver suitable hulls for the BB GREEN project and the identified operational requirements of the concept. Two main types of ASV's were investigated and analysed on the basis of suitability for BB GREEN, a catamaran and a mono variant. The better of the two, after tank testing offering best efficiency, on-board motions / comfort and meeting the other targeted goals would be the one to choose.

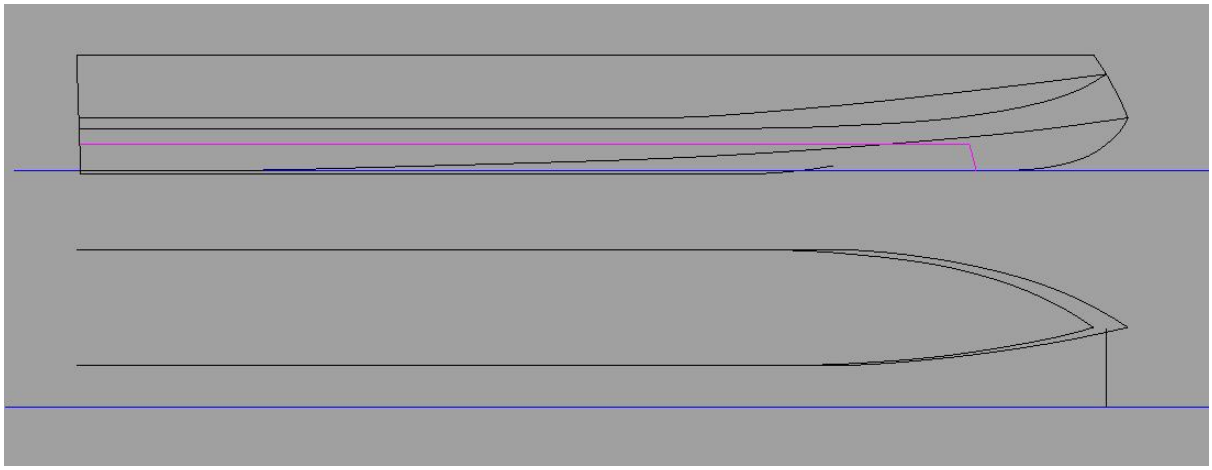


Illustration: Initial hull lines for the BB GREEN catamaran ASV.

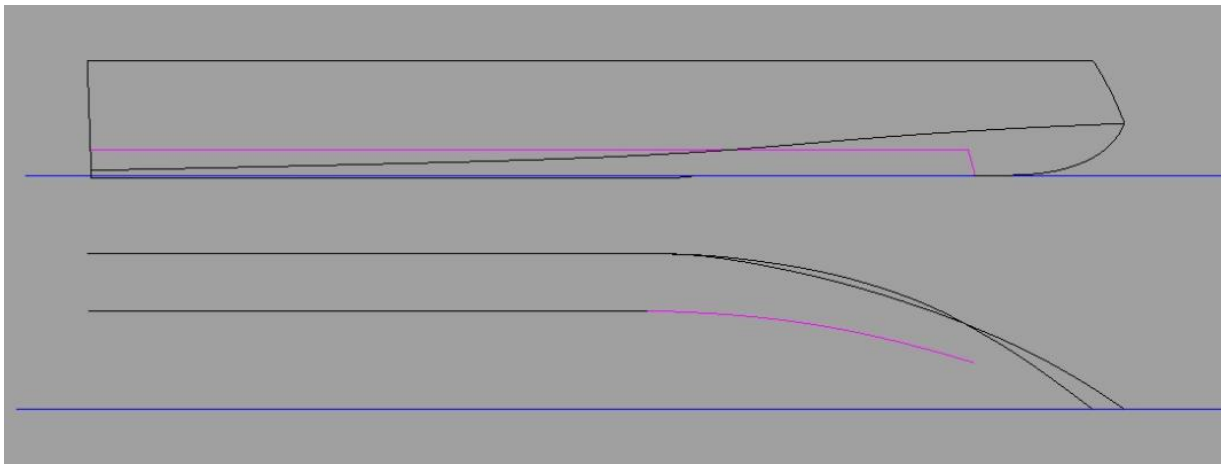


Illustration: Initial hull lines for the BB GREEN mono ASV

WP3: Design development and model testing.

As outlined in the DOW, two main ASV configurations should undergo a full design development and concept evaluation process, in order to find out which one performed best.

Based upon the initial ideas from WP2, SSPA and SE developed and investigated several alternative set of hull lines with complete Rhinoceros 3 D modelling for each hull; sharing main overall length of 20 m with a beam of 6 m.

Both concepts were designed to deliver a combination of air cushion support and dynamic support (lift when vessel is underway at medium/high speed). Another goal has been to reduce the wetted surface areas, achieve an acceptable (low) air cushion pressure and also incorporate / integrate the (at that time) selected propulsion system.

In addition to securing a low hull resistance, propulsion integration, manoeuvring / steering (at low and high speed), had a considerable bearing on the design development process. Below are some 3 D illustrations of the two main hull-forms used for construction of tank testing models.

Illustration: BB GREEN ASV catamaran, showing with 4 lift fan air ducts.

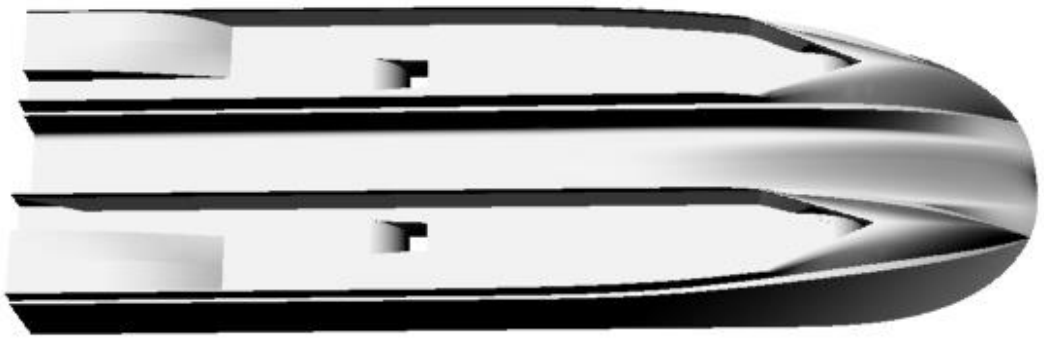


Illustration: BB GREEN ASV catamaran, showing with 4 air ducts and the propulsion bodies, where the large diameter surface piercing propeller should be located behind. Air cushion enclosure flaps are not showing.

Illustration: BB GREEN ASV mono for large diameter surface piercing showing without flap arrangement and with two fan ducts into the air cushion chamber.

Illustration: BB GREEN ASV mono rendering of first hull variant.

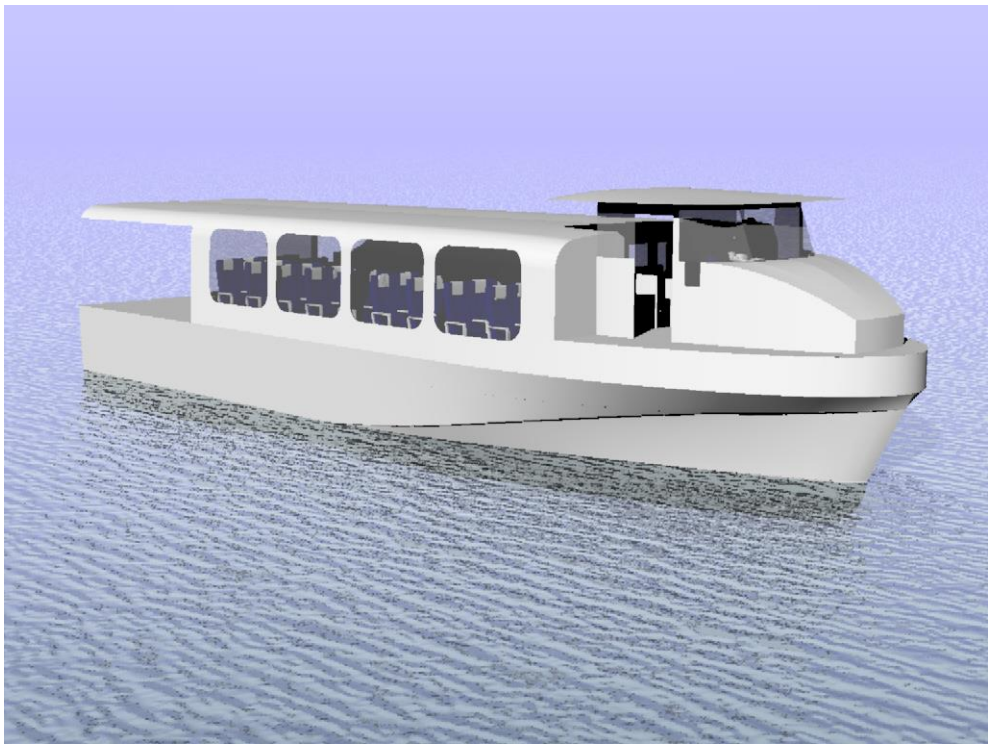


Illustration: Initial thoughts for the ASV Mono superstructure design / lay out

On the basis of the most promising two ASV designs, moulds for two 2,5 m tank testing models were produced using 5 axis milling, and thereafter the two tank testing models were build and outfitted at SSPA.

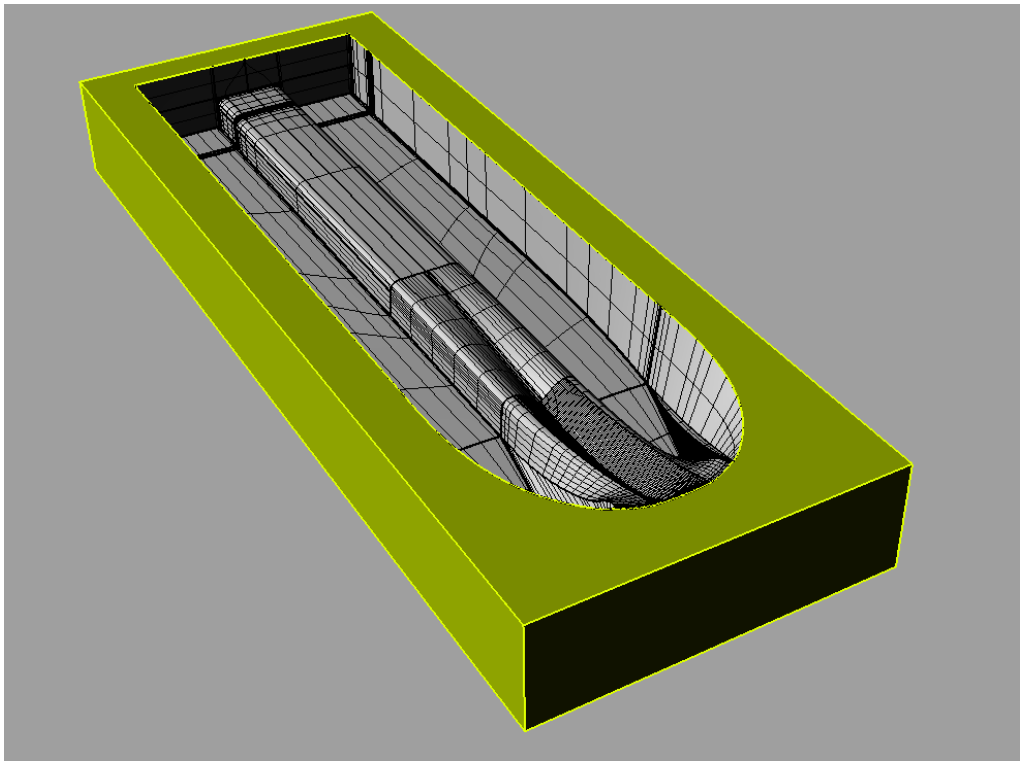


Illustration: Female mould for construction of lightweight BB GREEN ASV cat tank testing model.

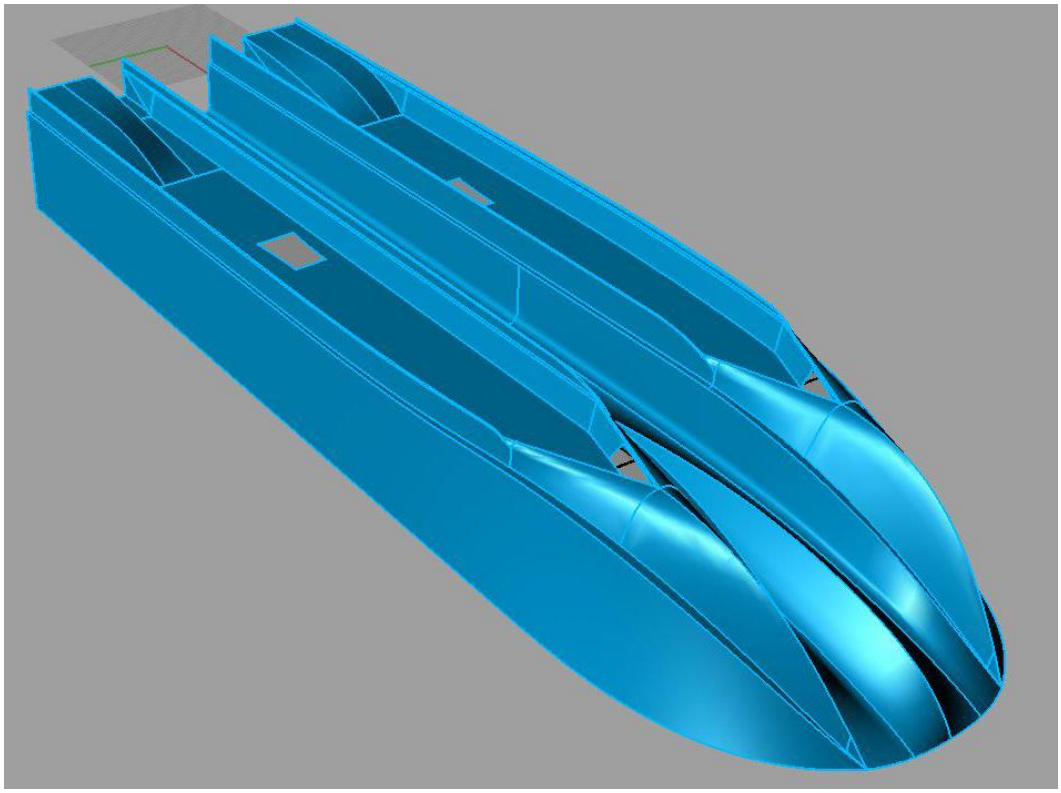


Illustration: The BB GREEN ASV Cat hull shape.

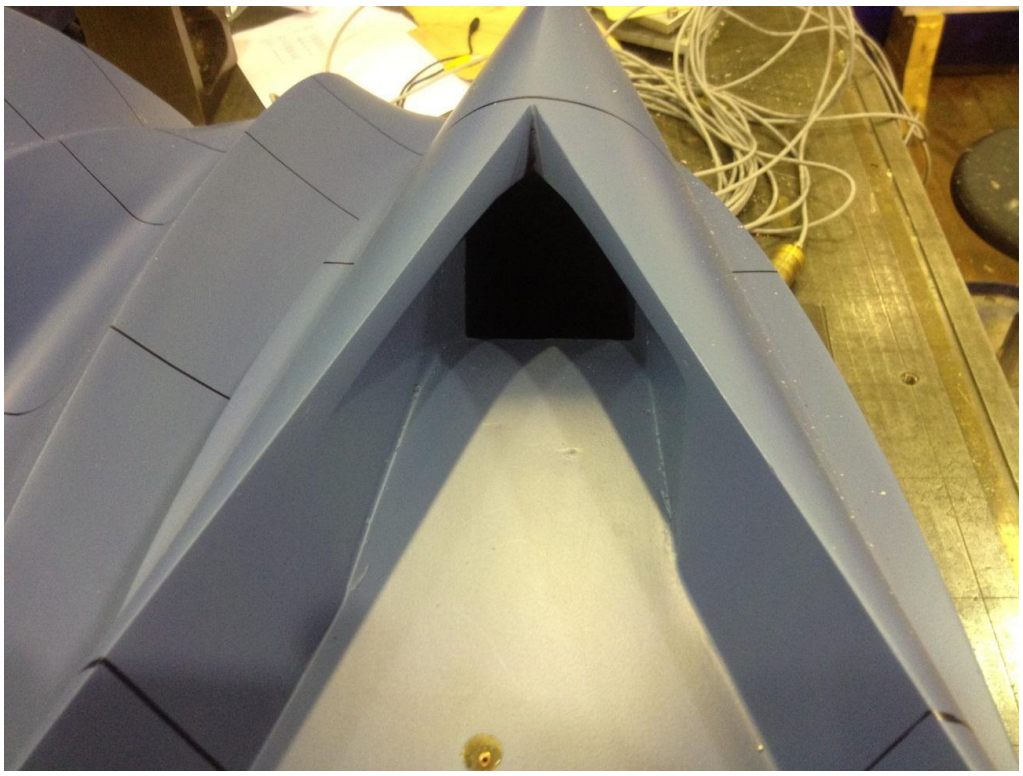


Illustration: Details from the forward part of the air cushion chamber, air duct BB GREEN cat.

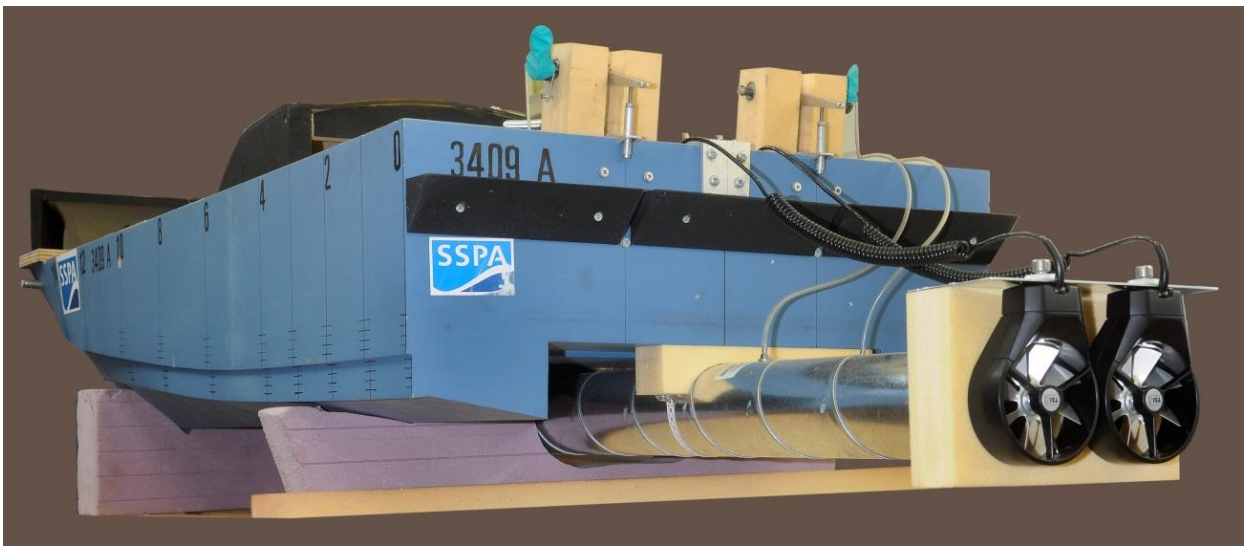


Illustration: Prior to tank testing, calibration of lift fan system on the BB GREEN Mono model.

During the process change from Surface Piercing Propulsion (initial) to contra rotating pod propulsion was thoroughly discussed from an efficiency point of view. Critics claimed the project would lose valuable efficiency, but SSPA analysed the situation and concluded on the contrary, with a propulsion efficiency meeting the objective for the project. See illustration below.

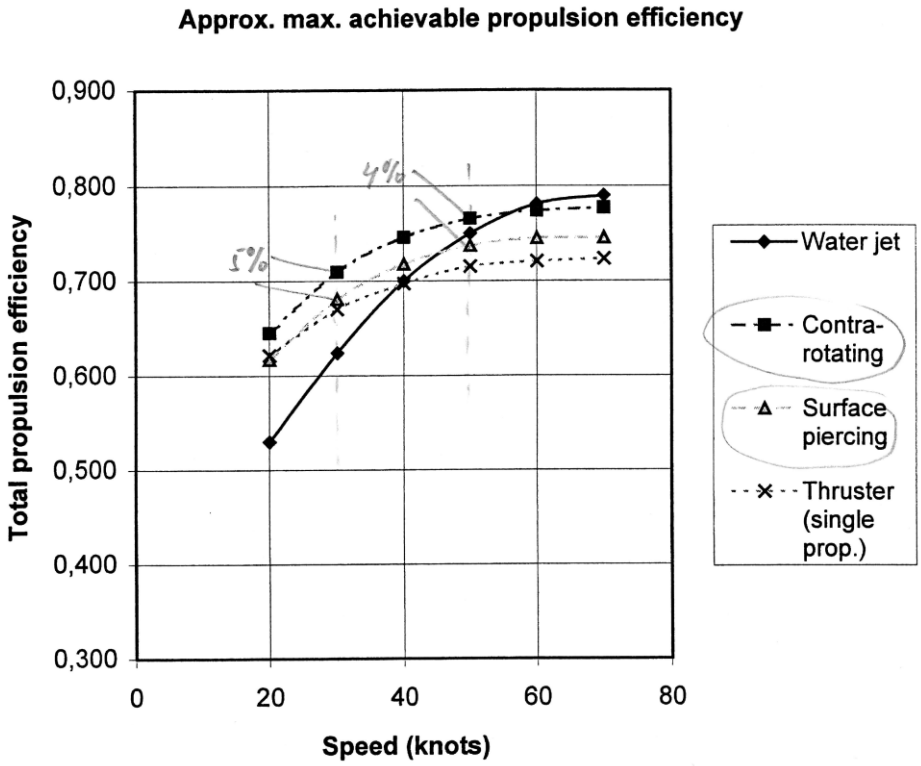


Illustration: Propulsion efficiency comparisons (SSPA Sweden – Hans Liljenberg).

The tank testing of the two models clearly documented that both the ASV Cat and the ASV Mono were considerably more efficient than State of the Art conventional hulls. The superiority of the ASV Mono variant is showing on the hull resistance comparisons below.

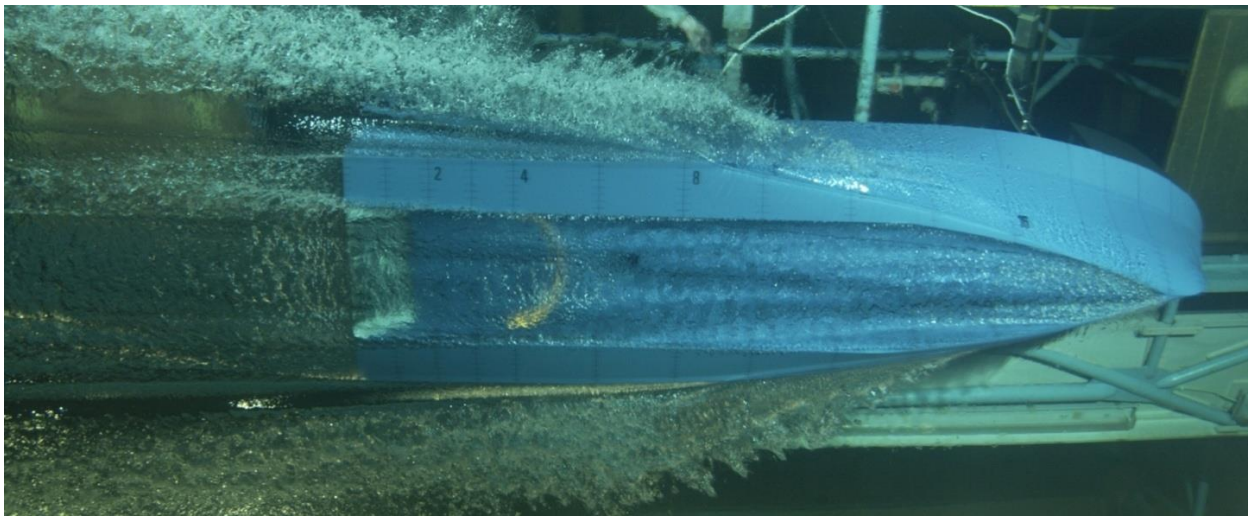


Illustration: BB GREEN ASV Mono. Underwater-picture from the towing tank. Full scale speed simulated: 30 knots, corresponding to design speed. The BB GREEN models were tested between 5 and 50 knots.

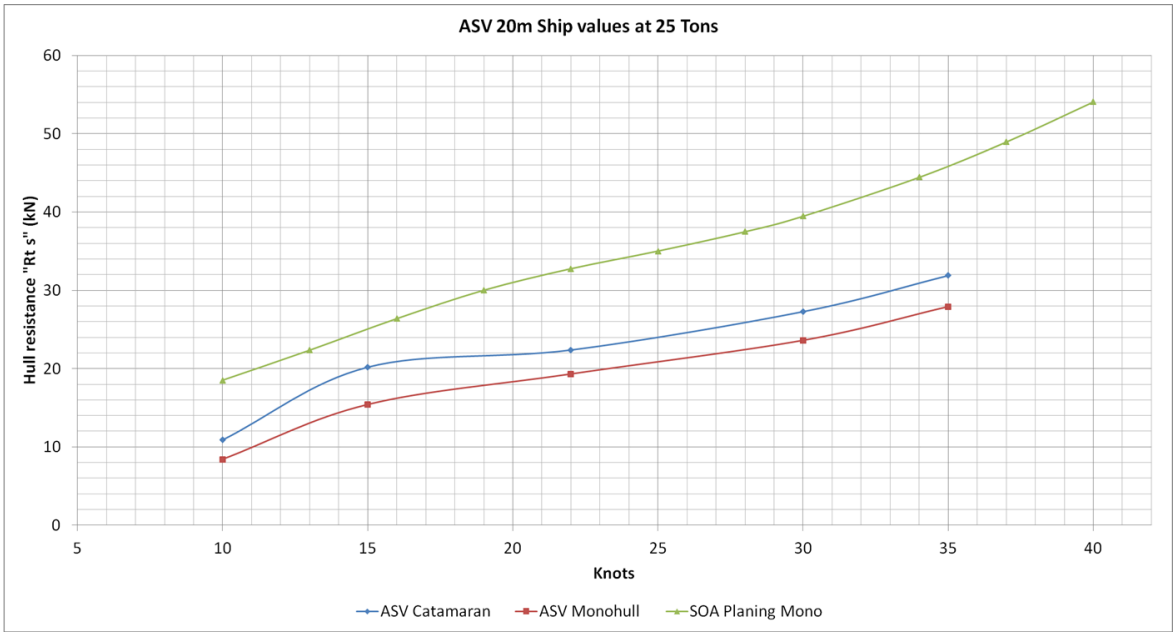


Illustration: Hull resistance full scale BB GREEN Cat and Mono vs. SOA conventional hulls. As can be seen hull resistance for the BB GREEN ASV's – and particularly the ASV mono show a remarkable reduction at all speeds, also at low speeds (red curve).

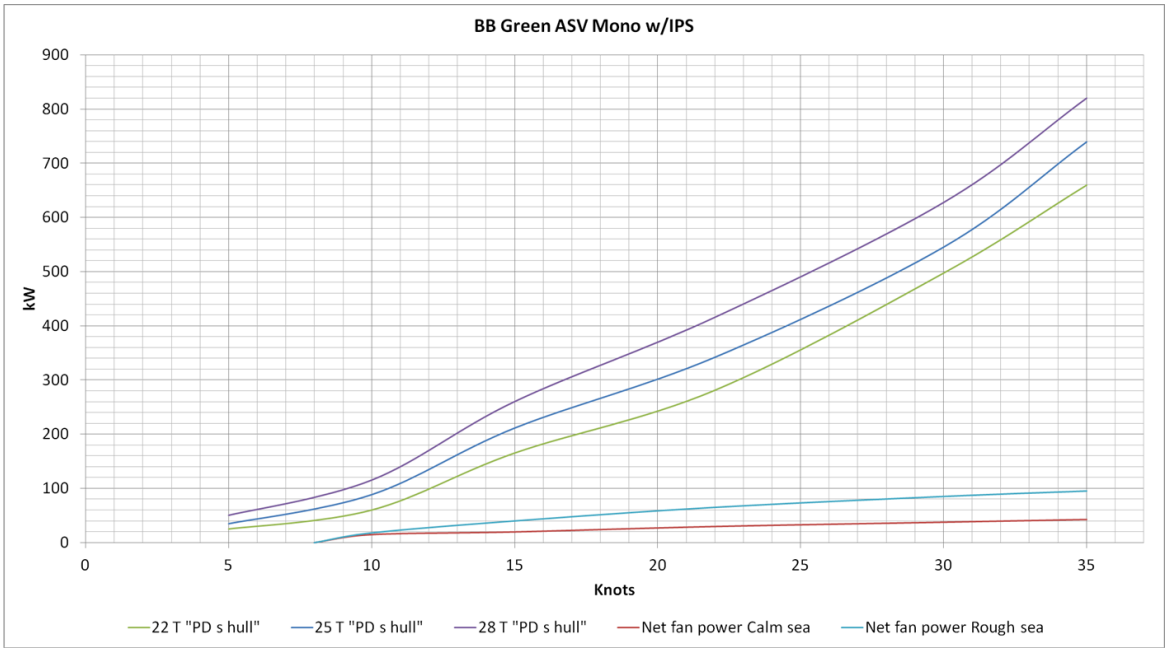


Illustration: BB GREEN, total power consumption vs. speed and with 3 different load conditions. In addition the graph shows the lift fan power consumption at calm seas (normal condition) and in rough seas (higher power demand due to more air cushion ventilation). At design load (25 tons) and design speed (30 knots) the total power (propulsion and lift fan) equals approx. 600 kW; giving with 10 % margin an energy demand of approx. 22 kWh per Nautical Mile travelled at 30 knots. Compared with a Norwegian project (conventional hull form) with a speed of 25 knots, the Norwegian competitor requires approx. 36 kWh (info from this project).

In conclusion:

The tank testing of two models as a matter of fact superseded expectations. The ASV cat was significantly better than conventional SOA hull forms; however the ASV mono was even better (approx. 15% better still than the ASV cat). The latter has therefore been chosen as the BB GREEN hull form.

Some highlights from the tank testing:

- Hull resistance reduction of more than 40% at design speed range (22 – 30 knots +).
- Equally favourable results also at lower speeds - down to 10 knots.
- Very low fan energy consumption (3-6% of total power).
- Low wake wash (particularly wake wash energy).
- Competitive on-board motions in sea state typical for the targeted operations.

Comfort aspects:

In terms of comfort aspects for passengers (and crew) it should be noted that the proposed BB GREEN vessel has been designed for sheltered waters.

A common way to evaluate comfort is by means of motion sickness incidence (MSI) the r.m.s. (root mean square or standard deviation) acceleration response in LCG has been plotted in ISO 2631/3-1985 (E) graphs, ref. [2], where also the limits for 10 % motion sickness incidence (MSI) with respect to exposure time are included:

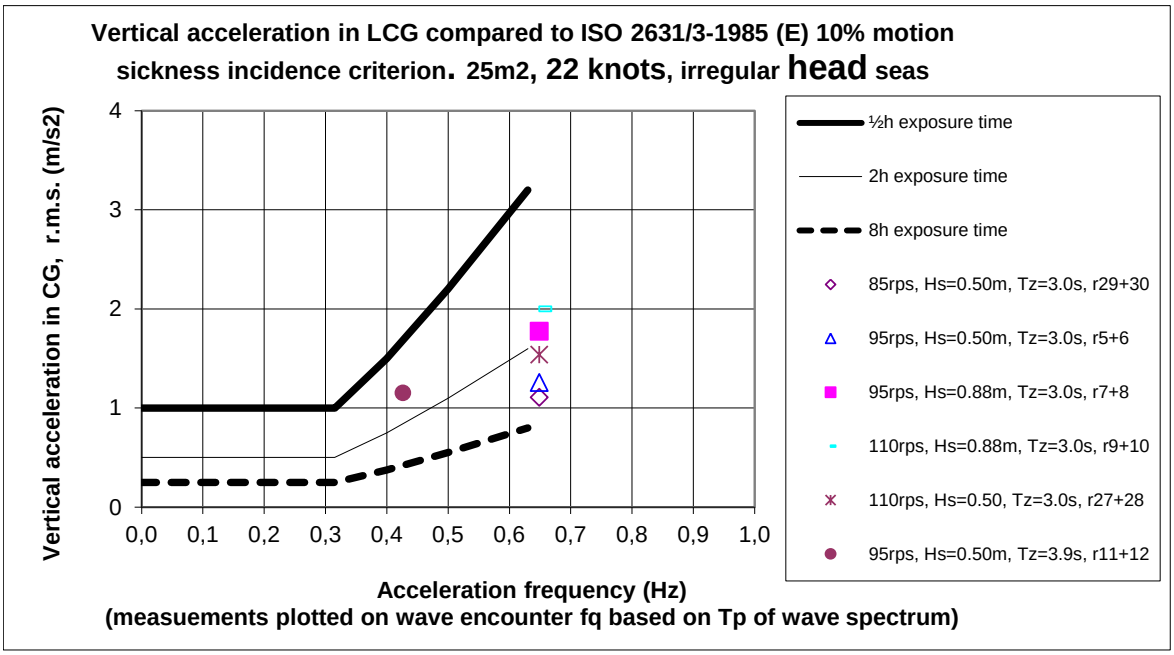


Illustration: The above graph shows IMS values for different sea states and conditions at 22 knots speed; a speed selected due to some local conditions (to manning requirements) in the Netherlands.

It should be remembered that the max operational time for the BB GREEN vessel will with a speed of 22 knots be less than half hour. At all the selected sea states the BB GREEN vessel is well below the critical values. I.e. with significant wave height of 0,88 m (extremely rear on the type of routes the vessel has been designed for), the passengers may stay on-board for up to approx. 2 hours (vs. half hour max); and still be within the IMS 10% motion sickness incident criterion.

Tests in the towing tank at even higher speeds, 30 knots and even 35 knots, show very acceptable values for significant wave heights of 0,5 m (single waves of 1 m).

The ASV concept clearly exhibit a motion damping effect, pitch motions and roll motions / accelerations are greatly reduced compared with a comparable planing vessel at same high speed; while less critical heave accelerations (for MSI) are also kept on an acceptable level.

Wake wash energy:

The wash waves from the BB Green mono ASV hull seems to be somewhat differently to (semi-) displacement mono- and catamaran hulls. The wave heights are comparatively high while the wave periods are comparatively low, resulting in a wave energy being lower than for most of the reference ships and also lower than for the BBG catamaran ASV. The wave period for the mono ASV also varies very little with Fn_D, contrary the rest of the reference ships.

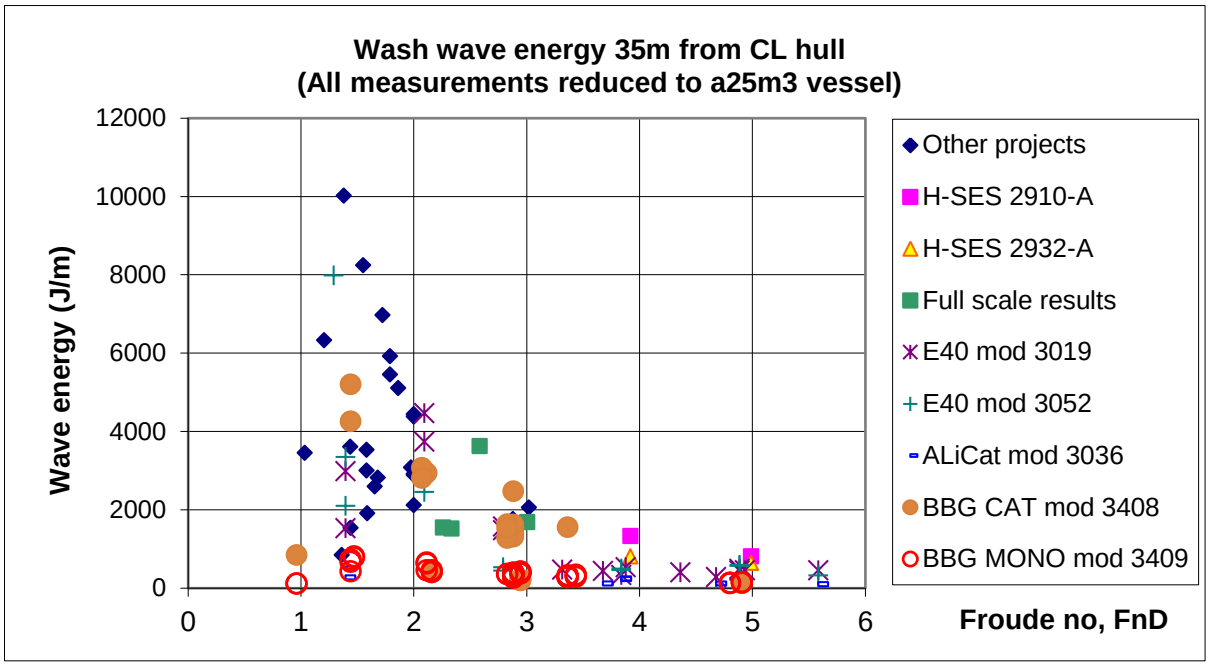


Illustration: Wake wash energy for the BB GREEN vessels and results from other projects (blue dots), full scale results (green squares) and other ASV projects tested in the SSPA towing tank.

In Task.3.4. SSPA has been responsible for developing a data model for optimizing and scaling of ASV / BB GREEN type of hulls. The development of such a scaling tool has been ongoing for as long at the ASV development with SE has been in force; for more than 15 years. In the beginning most of the data used were on ASV catamarans; later, as ASV mono-hulls proved in many cases to be even more efficient and suitable, focus was shifted towards the ASV mono-hulls. For the latter type of ASVs a vast amount of data, including ASV specific relations have gone into the development and fine-tuning of this useful tool. Data from two tank testing programs; the BB

GREEN program and another ASV Mono Soft Motion variant (tested within a Innovation Norway project with end use fast ferry operations along the Norwegian coast), and extensive tests with a full scale (20 m ASV mono); in different sizes / scales have been used.

In terms of assessment of overall resistance, the BB GREEN / ASV hull have been divided into different parts, each treated separately. The resistance related to each part calculated independently with their respective method of calculation. The sum of the resistance components represents the total hull resistance for the vessel. The new ASV optimization tool is a proprietary tool for SE, developed by SSPA.

This new and optimized scaling tool will be very important for the exploitation of the BB GREEN concept and tailor-making of most suitable hull forms / designs for respective vessel sizes, speeds, operational conditions and applications.

In WP3, classification society Lloyds Reg. has assessed the new concept against rules and regulations related to construction and operation; as well as carried out a theoretical assessment of safety aspects.

Based upon concept-, design -, hull form- and systems- developments, as well as test results, practical and documented experience from planned feasibility documentation of the BB GREEN test vessel, Lloyds has evaluated key features related to safety where the new vessel type may be differentiating from conventional vessels currently in use today on comparable routes and operations. The evaluations has resulted in recommendations to the designer and builder of BB GREEN vessels on how to construct safe and reliable vessels meeting current international rules (among other the High Speed Craft Code) for small and fast passenger ferries. In a similar manner suggestions to operation has been proposed.

During the course of the project, LR has also carried out a HAZID exercise (http://www.lr.org/en/consulting/risk-analysis/hazop-and-process-safety/) involving all project partners, looking at critical issues and remedy actions.

With the full scale test vessel in the water it is expected that LR will make a new review of the feasibility proving prototype systems and make suggestions on how the concept could be further optimized / modified to meet commercial criteria for design and operation of future BB GREEN vessels.

WP4. Development of systems.

The BB GREEN concept requires new developments, modification and mixing of systems and solutions not pervious combined before. Consequently the planning of the overall composition of concept (detail systems engineering and specification of solutions) is far from straight forward. Detail planning of the overall duties, time- and cost assessment proved extremely hard to get 100% right as the BB GREEN team had no previous design/ development example of similar kind to use to consult and compare with.

In addition, as normal in a complex innovation project, unexpected things have happened:

- A key system provider / integrator (Amber) went bankrupt and could not fulfil their obligations. Splitting up the obligations and finding equal capabilities within a very limited budget proved difficult.

- Technologies assumed to be available in the application phase of the project proved not to be (Altairnano battery cells).

- Change of propulsion system (a risk assessment decision); and influence on vessel design / construction for adapting the selected hull form to the chosen prop system.

- No Name contra rotating pod propulsion system was hold back for company internal / strategic reasons.

- Price developments on key input factors did not go in the expected direction; key factors / materials needed to fulfil the project obligations did not go down, but went considerably up, leaving the project coordinator (SE) with a very though challenge to bridge these gaps.

In retrospect it is also fair to say that the negotiations with EU on budget issues had cut the project down to the bone, leaving the project with an underfinancing and no financial margins to handle unexpected cost increases or financing of additional modification/research work needed. This has been substantiated under the discussions of financial issues elsewhere in the report.

Despite the above the project is proud to have been able to compose and integrate all the required system in a full scale feasibility demonstrator as planned. The three leading SME's SE , Echandia and Emrol have done excellent work in the WP to accomplish these tasks.

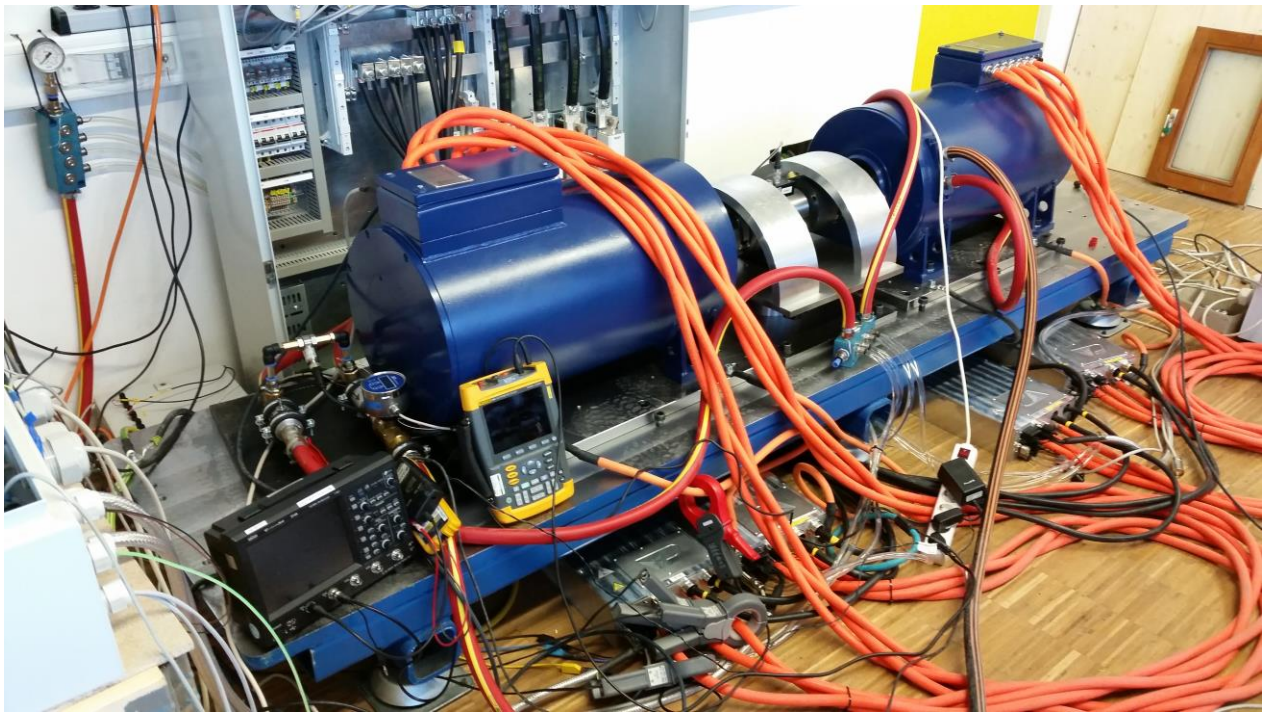


Illustration: First testing of the electric drivelines for BB GREEN test vessel.

To achieve a commercial success with the BB GREEN concept, choosing battery cell chemistry that could handle the tough use profile of a fast ferry, operated under heavy load for many hours per day throughout the full year, was essential. Not only should the battery be able to handle a continuous and repeatedly though energy consumption (each time for up to 30 minutes); it should be able to do

that for an acceptable number of cycles. And; it should immediately thereafter be able to take recharge at same or even higher C to fill up the battery again. Such a use profile is reducing the battery life considerably, so a suitable cooling arrangement has been required to keep the temperature down.

In the selection of most suitable cell chemistry there were several factors to consider, among other:

- Ability to handle high C energy consumption / recharging.
- Temperature and cooling aspects.
- Cell life at high C usage.
- Specific weight (kWh of usable capacity vs. battery system weight).
- Cost issues

Volume and battery-size were not a problem as there was plenty of space for battery storage in the BB GREEN hull.

For BB GREEN, Lithium Ion car battery life of 1.500 to 2.000 high C cycles was not sufficient, 20.000 cycles was considered to be a realistic and targeted level of life.

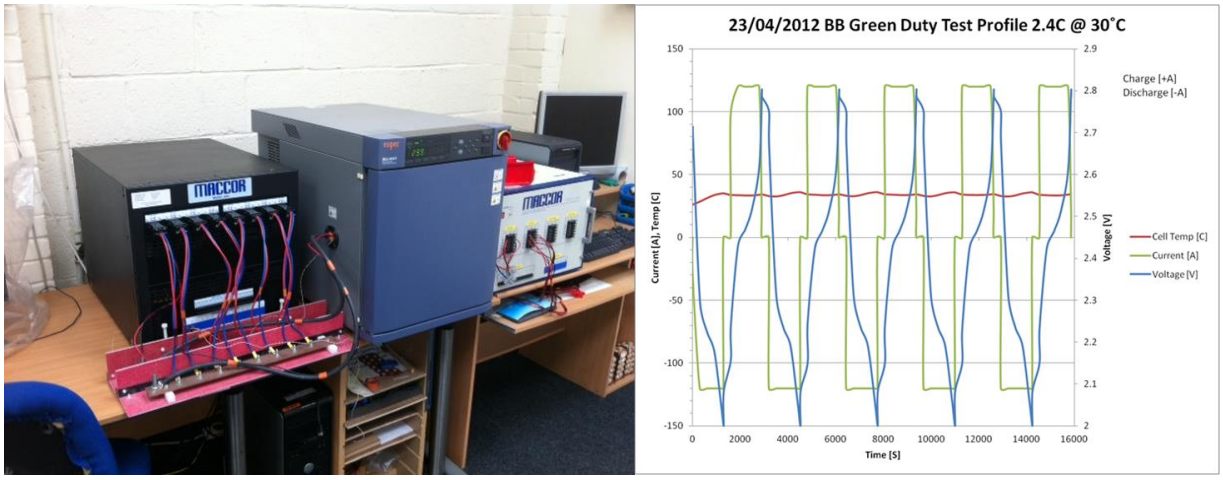


Illustration: From testing of BB GREEN cell technology (Amberjac Projects). Test apparatus (left) and duty profile (2,4 C tests@ 30 Degrees C) to the right.

Following the bankruptcy of Amber, Emrol took over the battery development lead; and carried out an impressive amount of work to design, develop, prototype and test on module and full scale (200 kWh) level a BB GREEN battery for use in the test vessel.

The funding made available proved to be far from sufficient to deliver what was specified in the DOW. Despite this fact Emrol stuck to their commitment and has carried out their obligations.

Below, please find some images and illustrations from design of first battery module prototype, battery management system (BMS) design and full size battery modules.

Illustrations: Prototype module from Emrol with open cover .

Illustration: Battery module, prototype from Emrol.

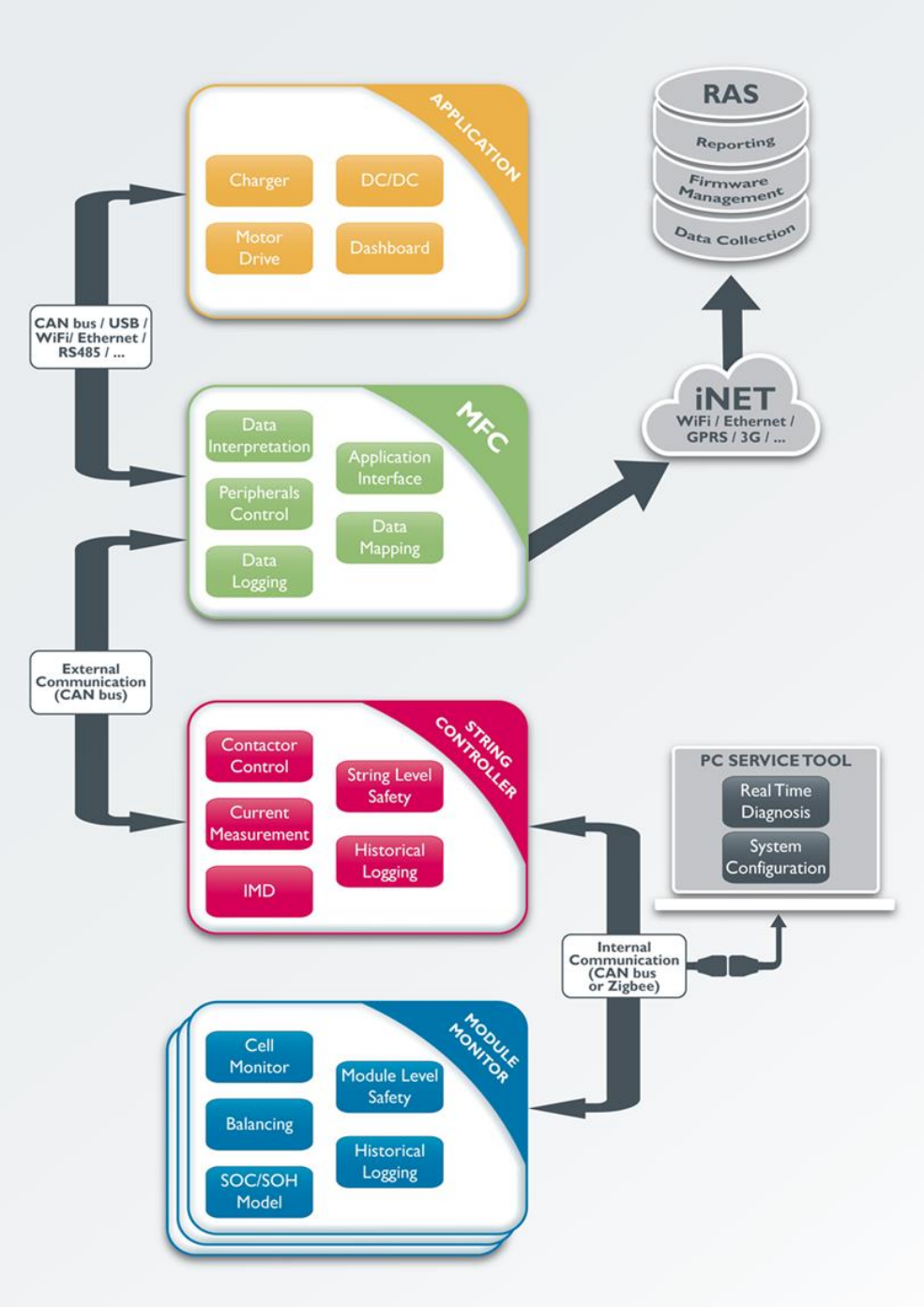


Illustration: BMS system architecture.

The battery pack needs to hold the battery modules in place, protecting them from dust and water and housing all the electronic components. Easy maintenance on the packs is required as some parts might have to be replaced during the life of the battery system. Also, all the connections to other components are integrated on the outside of the enclosure. These connections include tractive power connection, communication, service connection, and water cooling connections.

The pack needs to be very robust, as the G forces tend to get high in such applications, but it still needs to be lightweight because there is a direct correlation between the efficiency of the vessel and it's mass. Standardized aluminium profiles were used.

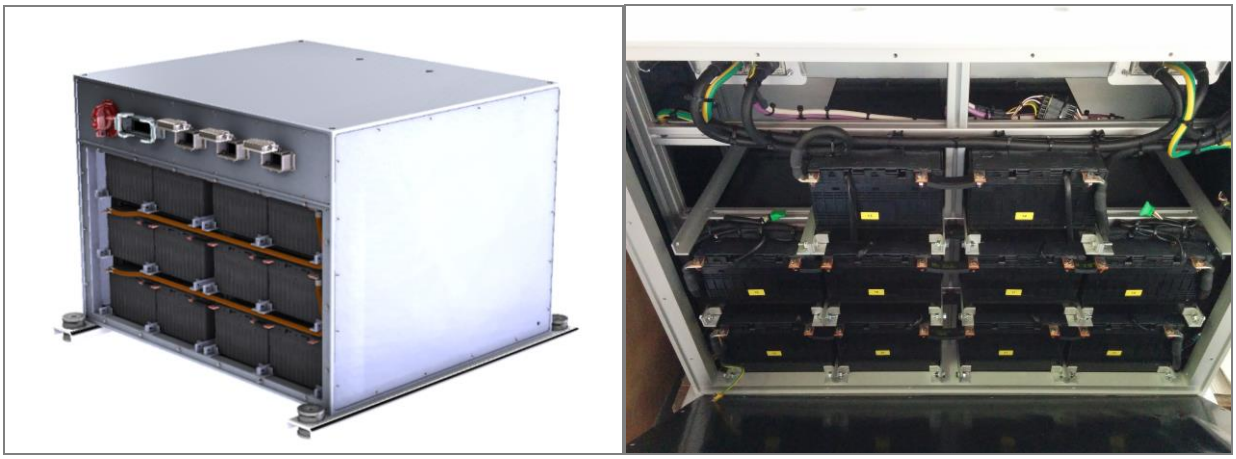


Illustration: Battery string render (left) and battery string assembly.

Illustration: Battery test set up prior to shipment to the yard for installation.

Illustration: The battery modules manoeuvred on place inside the BB GREEN test vessel connected and successfully tested. Each module unit has a weight of approx. 450 kg.

With the delivered product Emrol has met all the predefined requirements in the DOW:

- A 'marine' type 200kWh battery pack has been designed, developed and implemented, keeping in mind all requirements for standards and regulations (eg Lloyd's type approval)
- It is possible to fast charge the battery; in only 20 min the battery can be fully charged
- High cycle life of the battery is guaranteed: it can handle more than 10.000 cycles even when doing fast charging
- The battery is very safe: it is using the safest lithium technology on the market and incorporates all necessary safety components while being highly reliable
- The mass of the battery has been drastically reduced; the specific energy has been increased from 29Wh/kg to 54Wh/kg on system level.
- The system has been designed so it can be extended to the customer's requirement. Adding extra battery strings is very easy on a mechanical and electrical point of view ("plug and play")

Due to the issues with lack of supply from Altairnano, Emrol had to redesign the complete pack solution, which caused significant additional costs and delays. Specifications for the end solution has somewhat improved.

Echandia has developed a driveline design with two prototypes for propulsion of the BB GREEN tetst vessel, as well as produced with prototype an electric driveline for the lift fan system. The construction of the driveline has been in close relation to the pod propulsion system provider, with work related to both the hardware- and software systems and solutions.

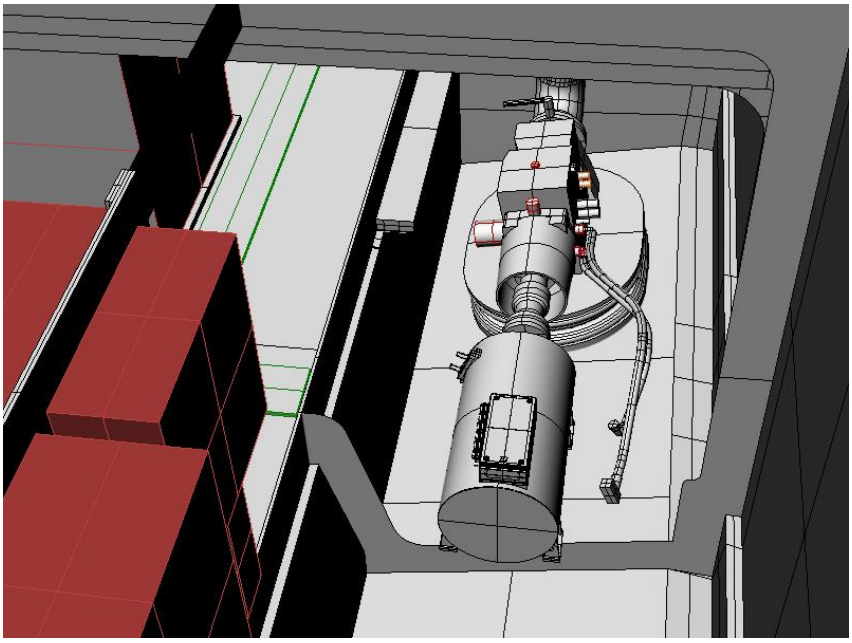


Illustration: An image of the driveline with pod propulsion (inner parts in the motor room) for one electric driveline.

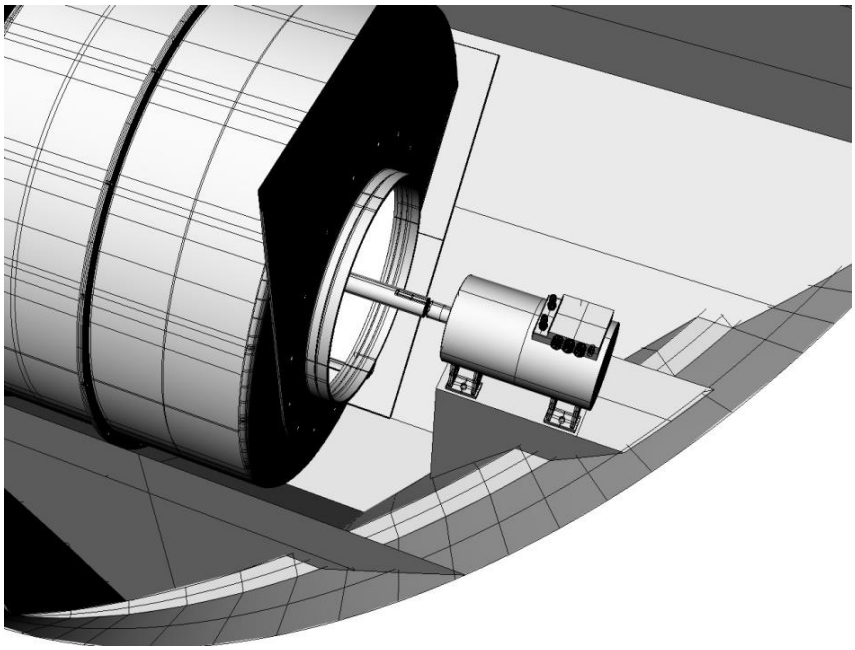


Illustration: Render of the electric motor connected to the lift fan system shaft; located in the lift fan room in the bow of the BB GREEN vessel.

For the charging of BB GREEN type of vessels with high kW use, frequent recharging with a capable recharging arrangement is required. Echandia has developed their own Supercharger System. A range of bespoke capacity units can be constructed and delivered to match each route and operation's requirements.

Echandia has also been responsible for developing a power management system to handle all on-board power requirements. Their MFC, or Multi Functional Controller, is the hub between the application controller and the BMS. The MFC is capable of communicating with different protocols and storing and sending critical information about the battery to the application and the cloud. Also charging protocols, multistring functionality and safety issues have been addressed.

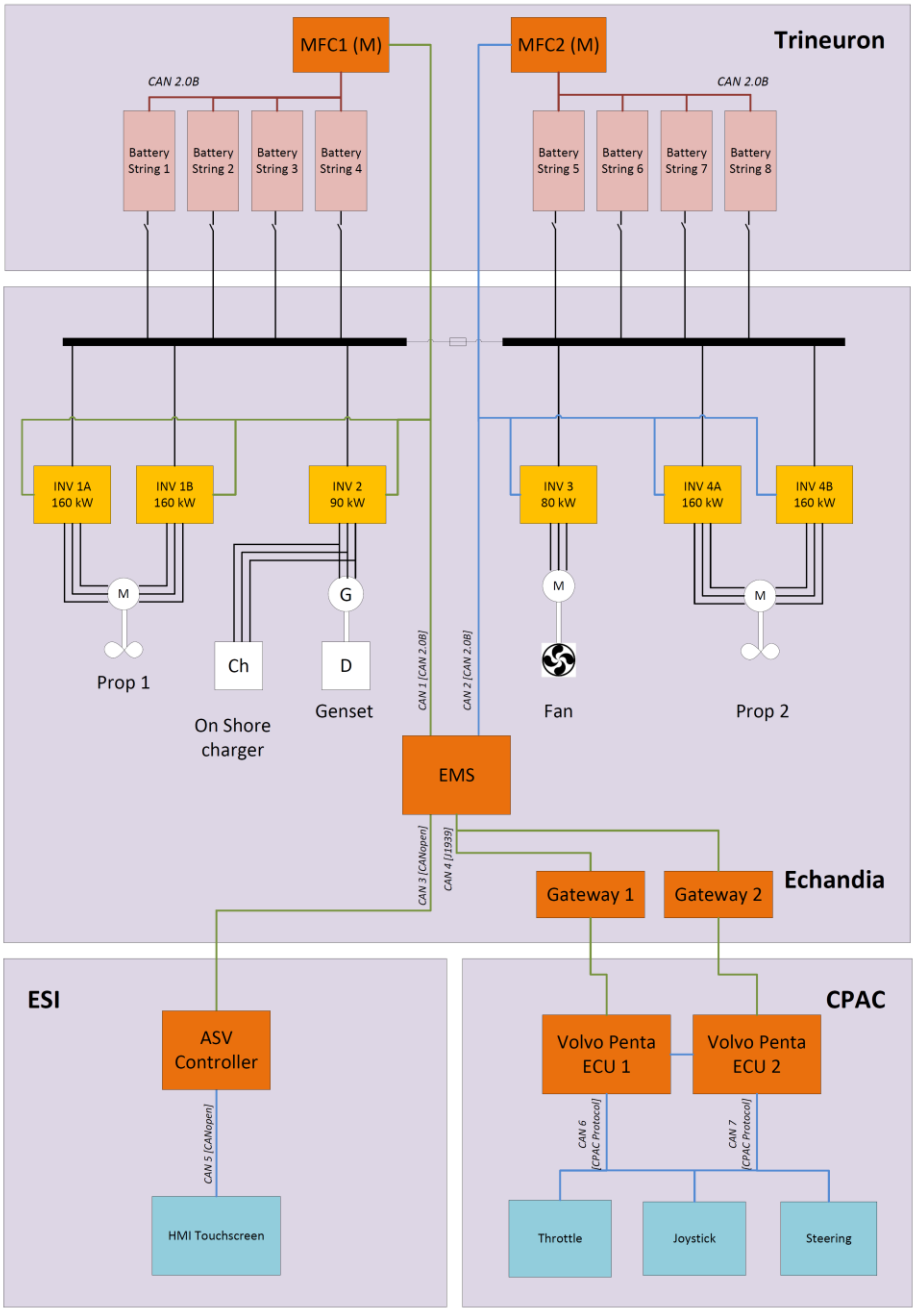
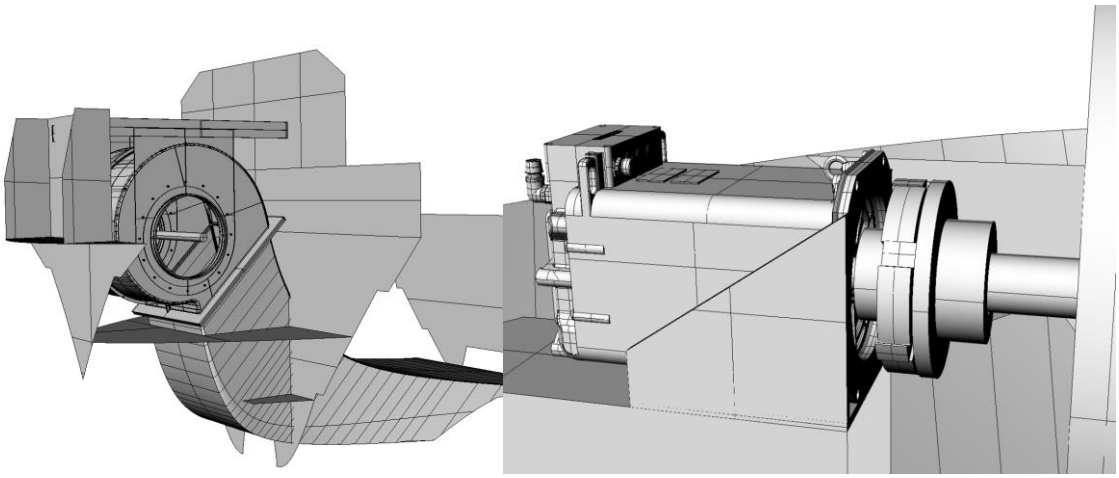


Illustration: The BB GREEN MFC design and functions.

SE has been responsible for the development and design of the lift fan system, designed to support up to 80% of the BB GREEN test vessel's operational weight on a cushion of air.



Illustrations: Lift fan, duct and lift fan supporting structure (left) and electric motor drive.

Illustration: Lift fan installed in the lift fan room forward, ready for priming and sound damping.

Illustration: Piture from inside the air channel up towards the lift fan impellers.

Echandia has been in charge of the propulsion system development and adaption to the BB GREEN concept. Together with SE and with significant help and assistance from a no name pod propulsion supplier a first of it's kind set of contra rotating pod propulsion units designed and adapted to battery electric operation have been delivered to the test vessel. The units are on loan to the project and will have to be returned to the owner after testing and demonstratons have been carried out. It has been agreed that the project shall keep a log of the experience with the drive and share this information with the owner of the drives.

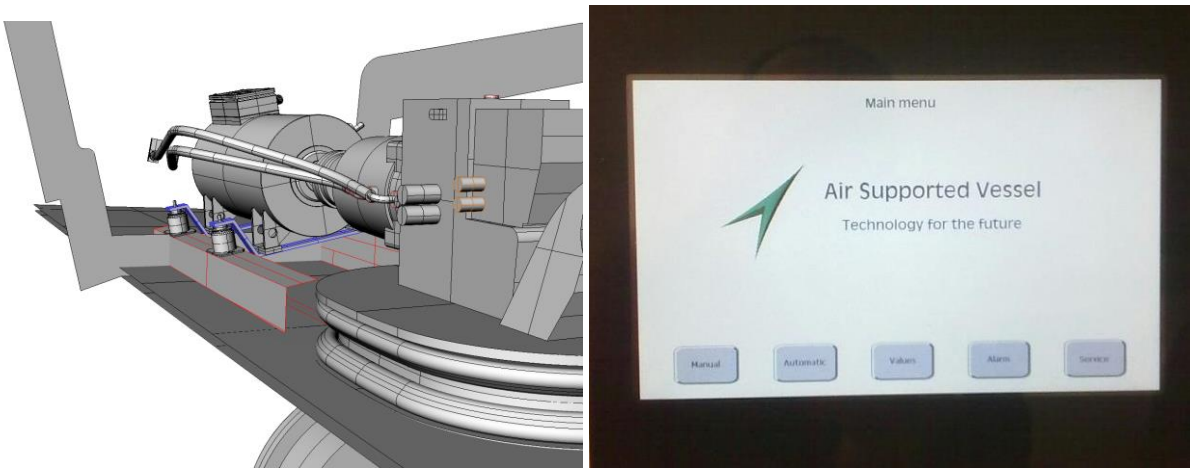


Illustration: Rendering of the electric motor, gearbox and upper part of pod propulsion drive (left) and ASV automation system monitor screen (right).

WP5. Test vessel construction, outfitting and testing

Originally, and before agreed change, it was described in the DOW to seek a construction yard on the basis of a European tender competition. The yard BJB delivered the most competitive offer, however the budget was considerably lower than the tender offer. The negotiations between Aqualiner (responsible for the test vessel construction subcontracting) unfortunately failed. However due to additional negotiations between SE and BJB, BJB was convinced to accept the low budget and join the project as a full partner. The change was accepted and approved by the scientific officer.

BJB has on the basis of a significantly too low budget carried out an excellent job in constructing and preparation of the test vessel; based upon a design made by Studio Sculli (under SE), with engineering from Diab and detail solutions from SE / Diab.

The final vessel design is a result of design process involving several changes and modifications.

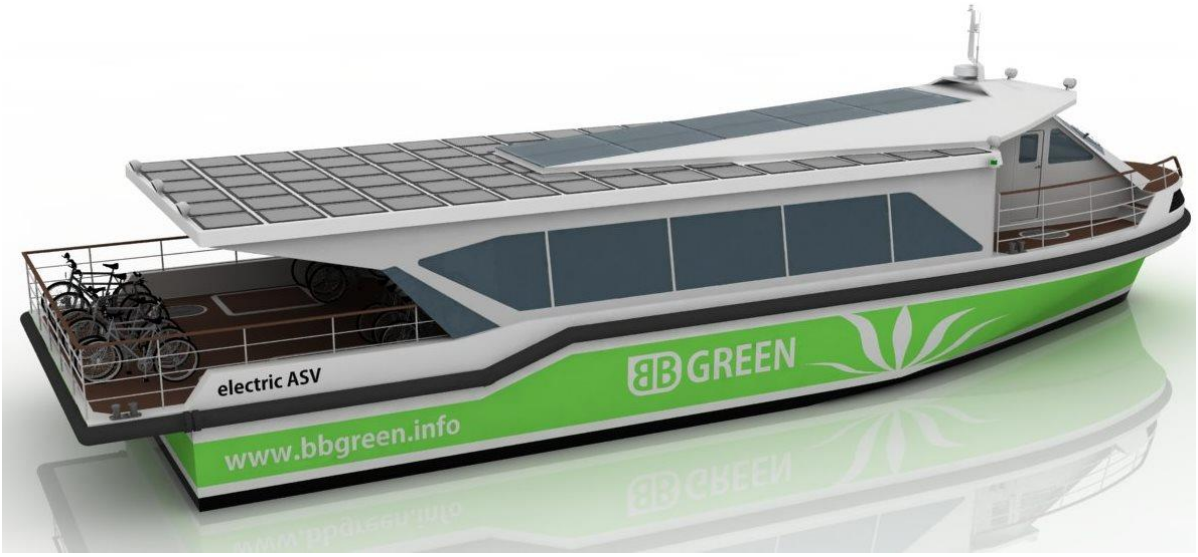


Illustration: Showing a render of the BB GREEN test vessel (with optional: Solar cell panels on the roof sections, heavy duty fenders and extended aft deck for more bicycle space). Paint: Jotun.

In order to seek reduction in light ship weight (for improved performance / efficiency), it was agreed to construct the vessel from carbon, Devinycell (core material) sandwich; using enclosed and construction friendly vacuum bagging / infusion techniques. Diab has been responsible for the overall and detail composite engineering, supplies of materials and consumables. Diab has also, in line with the DOW, given the yard a thorough instruction in use of this new environmental friendly, enclosed construction system.

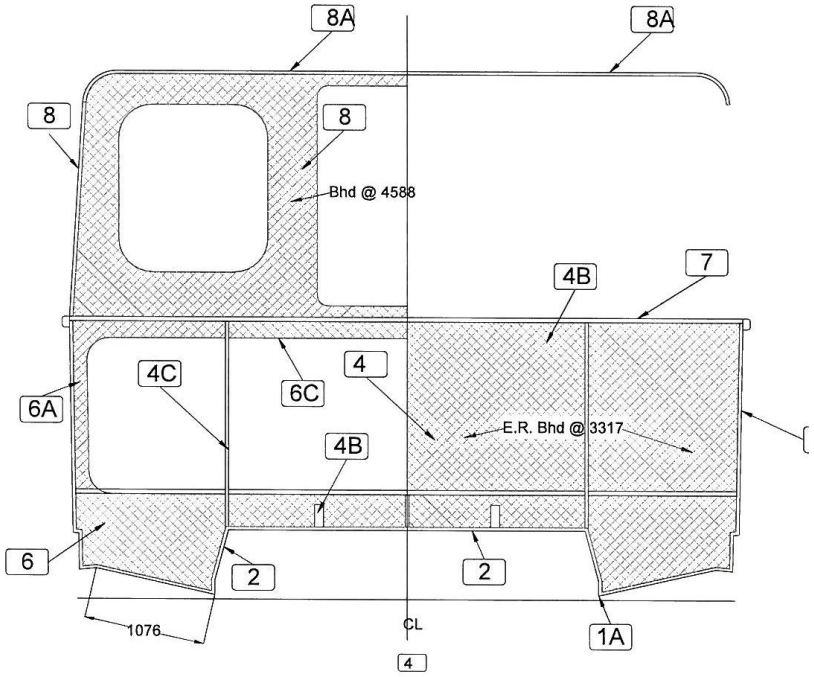


Illustration: Cross-section of the BB GREEN panels / hull engineering.

The construction of the hull has been done in a simplified female mould; build for construction of only the prototype vessel. The panel parts for the superstructure have been produced on a flat table using same vacuum infusion technique as the hull.

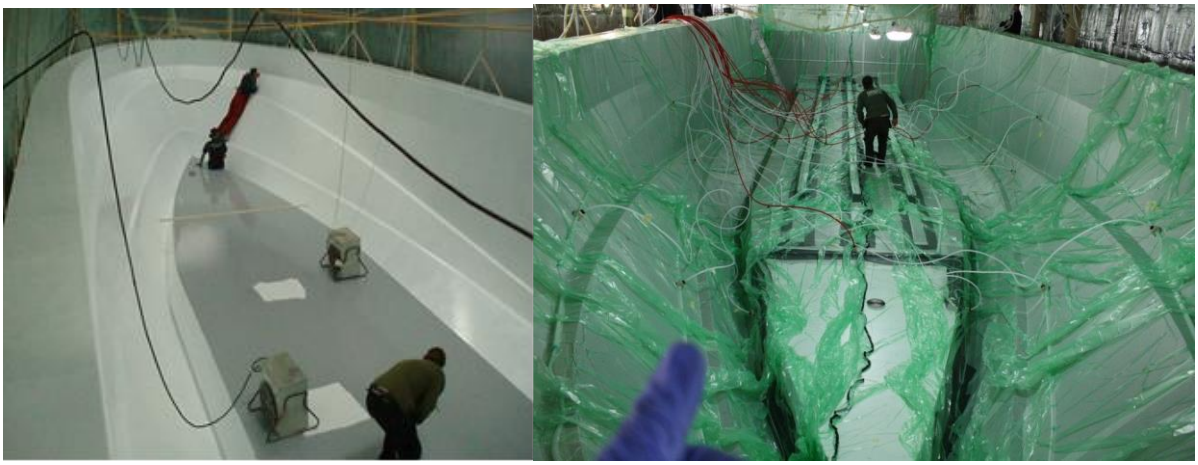


Illustration: Forward part of the female mould (left) and preparing for infusion.

Illustration: 265 minutes after start up, infusion of hull completed.

Illustration: Superstructure sides (left) and detail lamination for installation of pod propulsion.

Illustration: From fairing and priming of hull, ready for paint.

Illustration: Bow section (left) overview (right) - ready for paint.

Illustration: A part of the superstructure roof section for the BB GREEN test vessel going in.

Illustration: More installation work, from installation of generator set / range extender (wrapped in - left) and mounting of ASV control / flap system elements (yellow compressor wrapped in plastic to the right).

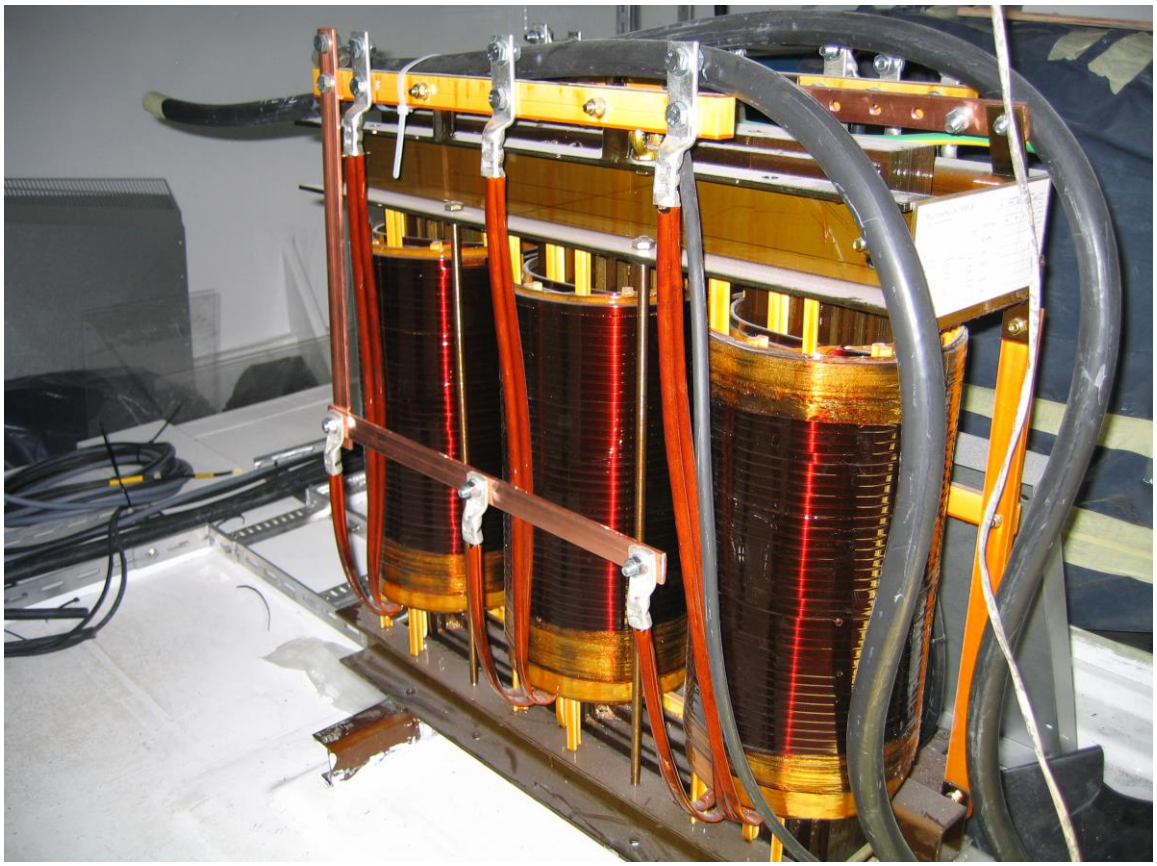
Illustration: Down below in the BB GREEN test vessel, cabling and mounting of systems.

Illustration: Down below in the BB GREEN test vessel, mounting of systems.

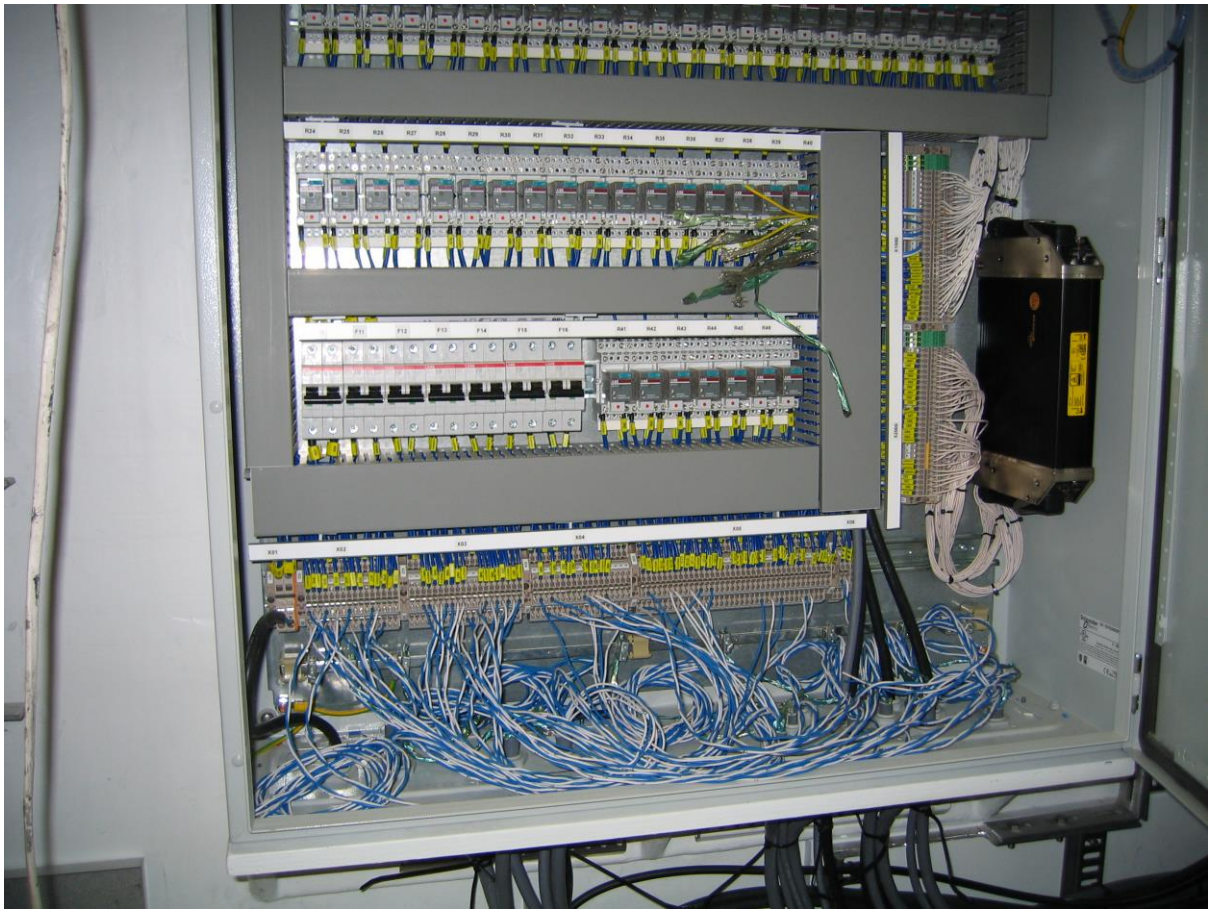
Illustration: From mounting of the electric driveline in the BB GREEN propulsion gondola.

Illustration: More pictures from the installation process.

Illustrations: More installation work: From inside port side cabinet (left) and SB side cabinet (right).



Illustrations: More installation work, picture shows the charger trafo with cover removed.



Illustrations: More cabinet installation- and wiring work: From inside PLC cabinet.

Illustrations: Left from installation of a part of the ASV automation system / flap control. Right; from the wheel house, the console mounted and ready for installation work.

Illustration: From mounting of pod propulsion leg underneath the BB GREEN test vessel; the part of shaft covered by white cloth is where the twin contra rotating propellers will sit.

Illustration: From mounting of pod propulsion; showing on the inside of the BB GREEN test vessel hull.

WP6. Demonstration activities.

The BB GREEN test vessel will, as soon as in house debugging has been carried out, be used extensively for demonstration of the new BB GREEN concept. Several demonstration actions are planned and will be carried out by SE, Echandia, Aqua and BJB. Applications for funding these activities have already been sent in.

WP7. Validation of project achievements.

A test procedure for evaluation of technical full scale performance has been prepared by SSPA, and will be used as soon as the vessel is ready for final tests.

Assessment of environmental effects from operation of BB GREEN type of vessels has been concluded very favourably for BB GREEN. The Zero emission of the vessel makes the concept very unique from an environmental point of view.

Recommendations in favour of introducing the BB GREEN concept as a mean to reduce traffic congestion and local and global emissions have been presented.

WP8. Dissemination activities.

The project has delivered a very impressive list of dissemination actions and activities during the 4 year life span of the project. Particularly beneficiary SE, but also Aqua and other beneficiaries have been very active in “spreading the word” about BB GREEN.

With a total of more than 120 dissemination actions involving all media and type of disseminations considerably more has been invested in the very important early phase of market introduction and S&T results dissemination than foreseen in the budget phase.

These actions have contributed strongly to build a positive attitude and high expectations for the BB GREEN concept; with several potential exploitation partners / cities / communities having expressed interest in testing out the concept, several with hope to test the demonstrator / prototype on “actual routes” to get a first-hand understanding of the performance and capabilities of the concept.

The mentioned application sent in under Horizon 2020 SME Phase 2, with the acronym GFFNOW, has focus on validation (WP 7 remaining issues), WP 6 Demonstrations and WP 8 Dissemination with exploitation and impact focus.

List of foregrounds by beneficiary:

- **SE:** A NDA has been signed between SE and each of the beneficiaries related to the ASV patents, IPR and ASV related solutions in general; including developments done under the BB GREEN project.

  Two new hull forms have been developed and documented representing new and proprietary IPR belonging to SE / ESI (Mother Company to SE). Any and all information related to the ASV hull form and proprietary related information and results shall remain the property of SE/ESI.

As part of the negotiations to enrol BJB as a new partner in the project, SE gave BJB certain ASV exploitation rights (BB GREEN and ASV's in general). The rights and obligations are outlined in a collaboration agreement between the SE and BJB.

- **SSPA Sweden**: In collaboration with SE / ESI (owner of the ASV IPR) SSPA has developed a proprietary ASV scaling and optimization tool, to be used by SE for future ASV developments.

- **Lloyds Reg:** No foregrounds developed.

- **Diab:** No patentable foregrounds developed. The carbon engineering for the BB GREEN vessel/hull is linked to the ASV geometry and solutions where SE will have a sole right to use. Diab will be a preferred partner in the exploitation of the BB GREEN concept also for upcoming projects.

- **Aqualiner:** No direct foregrounds developed. Proprietary information related to future routes and operations.

- **Emrol:** Emrol has developed a new battery module. Possible IPR securing actions will be considered. It has been agreed that Emrol shall be a preferred partner in the exploitation of the BB GREEN concept also in the future.

- **Echandia:** Echandia has developed new driveline and management system technology. The company will consider patenting or using key IPR developed in BB GREEN for IPR protection of new battery electric drivelines / solutions. Collaboration with SE, Aqualiner and BJB for future BB GREEN exploitation has been agreed. Echandia will be preferred partner for BB GREEN projects also in the future.

- **BJB**: Agreement with SE for ASV exploitation. No direct foreground developed. BJB will be a preferred exploitation partner / builder of BB GREEN / ASV vessels from carbon composites.

- **No Name Company:** This company will consider seeking additional IPR / patent protection for their new / adapted pod propulsion system for electric operation.

1.4. Potential impact, main dissemination activities and exploitation of results

Throughout the duration of the BB GREEN project creating market awareness of the new zero emission waterborne transport solution; and dissemination of progress achieved, have been key issues for the project team.

With its unique features and performances BB GREEN has been a popular case for the public press. The editors, paper magazines as well as WEB based dissemination channels, have seen the news value of the technology and have been keen to publish materials presented by the project as well as introducing their own angles to the technology, use potential and implications.

Main highlights frequently used in BB GREEN articles & publications, issued to this date:

- BB GREEN could be a way to reduce traffic congestion in a number of cities and communities.
- Waterborne transport with high performance
- 21st Century service with Zero emission
- Battery electric drive
- BB GREEN unique features and how they contribute to setting new SOA efficiency levels; including:
  - Air Supported Hulls to reduce resistance
  - Carbon sandwich light weight construction to reduce resistance
  - Battery technology able to take very fast recharge and with much more cycle life
  - Propulsion / drivelines combining highest efficiency and excellent joystick manoeuvrability
  - Spin off solutions for the near future (fast work boats, firefighting, ambulance boats etc.)

When the BB GREEN test vessel is ready for the water and demonstrations of concept as well as single features used in the project, the press part of the dissemination of the concept will move into another phase where “proving the concept through riding on the feasibility demonstrator” will be focal.

In addition to dissemination through the public press, dissemination directly to current and potential politicians, owners/operators, and other stakeholders have been frequently used; in the form of written and oral communication, meetings and introduction sessions.

The BB GREEN concept has also been frequently disseminated at various conferences, exhibitions, trade shows and other maritime/transport events throughout Europe and beyond.

With approx. 120 dissemination activities already listed, even before testing with the feasibility demonstrator is available, the zero emission fast waterborne transport idea / the new concept have been very well introduced and positive expectations for the continuation established.

The feasibility demonstrator represents a unique tool for dissemination- and exploitation activities.
All project partners, directly (SE, Echandia, Aqua and BJB) and indirectly (the rest of the team) have agreed to continue the efforts invested in BB GREEN also after the formal ending of the project. The test vessel will be prepared, debugged / optimized and outfitted first for final instrumented tests (WP7) and thereafter for extensive dissemination and demonstration- actions (WP6 and more).

Echandia / SE / Aqua and BJB have joined forces, prepared a RTD, dissemination and demonstration project with the BB GREEN test vessel in focus; and applied for a Horizon 2020 project under the SME Phase 2 (Transport) call. The application was submitted to the Commission in June 2015 and the main activities for this project with title / acronym Green Fast Ferries NOW (GFFNOW) will be:

- WP2: Market study, identification of suitable GFF routes and operations.
- WP3: Technical tests and scientific documentation.
- WP4: GFF concept dissemination.
- WP5: GFF concept demonstrations.
- WP6: Validation of project achievements.

Provided this project is accepted, the Commission as well as the beneficiaries will have an excellent opportunity to take full advantage of the massive efforts invested in BB GREEN to this date, and greatly increase the probability of securing a commercial as well as socio-economic success with the new zero emission transport solution BB GREEN represents.

A. The following communication and dissemination measures will be used towards listed main stakeholders - in summary:

- *Local-, regional- and national politicians, engaged in transport related issues:*
    - As the planned dissemination will cover several European countries, cities and communities; a careful prioritizing (based upon GFFNOW WP2 output) of the most relevant routes and operations will be made.
    - Establish contact with politicians likely to influence decision making in favour of the BB GREEN concept. Local BB GREEN contacts may be required for each targeted community.
    - First dissemination –of the BB GREEN idea and effects from introducing new waterborne transport.
    - Creating awareness of the benefits and potential socio/economic impacts will have priority.
    - Politician's close links and contact with local- and regional mass media and press will be exploited for creating a general awareness also among the general public.
    - When schedule for the BB GREEN "dissemination and demonstration tour" has been agreed, politicians and press will be directly invited for testing and demonstrations in the respective local communities.
    - Often the local BB GREEN contact, which in many cases will be an established ferry operator/owner, will be in charge and act on a local level.
- *Transport authorities engaged in passenger transport planning and decision making:*
    - Non-political personnel, managing passenger transport planning and day to day operation, on behalf of their respective communities, will in an early phase of the project be contacted.

- Starting with general BB GREEN information (to secure awareness) and followed up through direct contacts / meetings.
- In a similar manner as for the politicians, practical testing and demonstration with the BB GREEN prototype is expected to be crucial for their perception of the concept.
- The feedback, of a conceptual (generic) and local/practical level from this group will be vital for refining the prototype design and solutions towards the final commercial BB GREEN design.

- *Commercial commuter ferry owners and operators:*
  - In cities and communities with waterborne transport operations, identifying the owners/operators and current routes/operations will be straight forward. Detecting potential operators/routes and operations will be more demanding. Local knowledge will be essential.
  - Several owners and operators have already heard about the BB GREEN concept from either conference papers given; or from articles published in magazines and on the WEB.
  - The project team intends to contact the managing director / responsible person for business development to establish a dialogue around use of BB GREEN vessels; where demonstrations with the BB GREEN feasibility demonstrator is expected to be the best sales tool.
- *Transport service providers engaged also in other types of public transport:*
  - The fact that the BB GREEN concept in many communities may be complementary to other modes of passenger transport will be actively exploited.
  - Introducing BB GREEN may expand business and improve overall service offered to the local community and individual end users.
  - Knowledge about the BB GREEN concept will be provided through a combination of direct contacts with selected transport service providers, indirectly through media and press and invites to test the feasibility demonstrator.
- *Yards, builders and potential outfitters of BB GREEN type of vessels.*
  - To increase competitiveness (reduce price / secure a healthy profit margin) the plan is to prepare for BB GREEN standardization, modular construction and outfitting; -series production.
  - Partner BJB is a preferred BB GREEN partner, but SE will also allow BJB to build carbon sandwich ASV hulls on licence, for outfitting and completion elsewhere.
  - Echandia will allow a similar set up to increase the sales volume.
  - The communication between the project/partners and mentioned yards/outfitters will be a combination of technical and commercial dialogue; starting with convincing the yards about the capabilities and business opportunities with the concept. In this process the feasibility demonstrator will play a vital role, directly towards the yards and indirectly towards potential owners/operator clients identified by the yards.
- *Press and media:*
  - The dialogue and communication with press and media is already well underway.
  - The basic introduction to the BB GREEN concept is done and the editors and media representatives are now waiting for testing the BB GREEN concept in the water, and prepare their own stories on the basis of personal experience.

- *Travellers, current and potential end users of BB GREEN services.*
    - As the feasibility demonstrator is a prototype / concept demonstrator, a large number of travellers will not be allowed on board for testing.
    - Press representatives, from newspapers, television and others will receive in depth information on the concept, and will be invited on-board for tests. On the basis of articles and stories presented by the press, the travellers will obtain information on the BB GREEN concept, how it works and what it can do for the final end users of BB GREEN type of vessels.

1.5. Website

The project website is: www.bbgreen.info

1.6. Contact details for BB GREEN:

P1: SES Europe AS
3210 Sandefjord, Norway.
Office phone: Int. + 47 334 65650
Contact person: Technical manager Tor Livgard.
E-mail: tor.livgard@effectships.com,
Mobile phone: Int + 47 47 24 96 95.

Beneficiaries:

P2: SSPA Sweden AB
Gothenburg, Sweden.
Office phone: Int. + 46 31 772 9000
Contact person: Vice president Bjorn Allenstrom.
E-mail: bjorn.allenstrom@sspa.se

P3: Lloyds Register EMEA
London, England UK.
Contact phone: Int. + 44 20 7423 1923
Contact person: Senior Specialist Kim Tanneberger.
E-mail address: Kim.Tanneberger@lr.org
Mobile: Int + 44 (0)7795 427 352

P5: Diab AS
Oslo, Norway.
Contact number: Int + 47 66 98 19 30
Contact person: Man dir Ulf Kristiansen.
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Mobile phone: Int + 47 911 37 750

P6: Aqualiner
Rotterdam, The Netherlands.
Contact number: Int. + 31 88 277 6284
Contact person: Man dir Gerbrand Schutten.
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Mobile phone: Int. + 31 6 22 45 46 05

P8: Emrol bvba
Malle, Belgium.
Contact number: Int. + 32 3 309 24 24
Contact person: Business manager Stefan Louis.
E-mail address: slouis@emrol.com
Mobile phone: Int + 32 474 71 26 21

P9: Echandia Marine Sweden AB
Stockholm, Sweden.
Contact number: Int + 46 73 399 55 15
Contact person: CEO Magnus Eriksson.

E-mail address: magnus@echandiamarine.com

P10: BJB
Riga, Latvia.
Contact number: Int. + 371 67 35 35 44
Contact person: Project manager Alexander Busarov.
E-mail address: alexander@latitude-yachts.com
Mobile phone: Int + 371 29 43 66 22

1.7. Societal implications

A General Information *(completed automatically when **Grant Agreement number** is entered.*	
Grant Agreement Number:	234124
Title of Project:	Battery powered Boats, providing Greening, Resistance reduction, Electric, Efficient & Novelty.
Name and Title of Coordinator:	Tor Livgard, technical manager, SES Europe AS

B Ethics	
1. Did your project undergo an Ethics Review (and/or Screening)? • If Yes: have you described the progress of compliance with the relevant Ethics Review/Screening Requirements in the frame of the periodic/final project reports? Special Reminder: the progress of compliance with the Ethics Review/Screening Requirements should be described in the Period/Final Project Reports under the Section 3.2.2 *'Work Progress and Achievements'*	***No***
2. Please indicate whether your project involved any of the following issues (tick box) :	***YES***
RESEARCH ON HUMANS	
• Did the project involve children?	
• Did the project involve patients?	
• Did the project involve persons not able to give consent?	
• Did the project involve adult healthy volunteers?	
• Did the project involve Human genetic material?	
• Did the project involve Human biological samples?	
• Did the project involve Human data collection?	
RESEARCH ON HUMAN EMBRYO/FOETUS	
• Did the project involve Human Embryos?	
• Did the project involve Human Foetal Tissue / Cells?	
• Did the project involve Human Embryonic Stem Cells (hESCs)?	
• Did the project on human Embryonic Stem Cells involve cells in culture?	
• Did the project on human Embryonic Stem Cells involve the derivation of cells from Embryos?	
PRIVACY	
• Did the project involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	
• Did the project involve tracking the location or observation of people?	
RESEARCH ON ANIMALS	
• Did the project involve research on animals?	
• Were those animals transgenic small laboratory animals?	
• Were those animals transgenic farm animals?	
• Were those animals cloned farm animals?	
• Were those animals non-human primates?	
RESEARCH INVOLVING DEVELOPING COUNTRIES	
• Did the project involve the use of local resources (genetic, animal, plant etc)?	
• Was the project of benefit to local community (capacity building, access to healthcare, education etc)?	

DUAL USE	
• Research having direct military use	0 Yes 0 No
• Research having the potential for terrorist abuse	

C Workforce Statistics

3. Workforce statistics for the project: Please indicate in the table below the number of people who worked on the project (on a headcount basis).

Type of Position	Number of Women	Number of Men
Scientific Coordinator		2
Work package leaders	1	9
Experienced researchers (i.e. PhD holders)		15
PhD Students		
Other	3	10

4. How many additional researchers (in companies and universities) were recruited specifically for this project?	0
Of which, indicate the number of men:	

D Gender Aspects

5. Did you carry out specific Gender Equality Actions under the project? | | No

6. Which of the following actions did you carry out and how effective were they?

		Not at all effective				Very effective
❑	Design and implement an equal opportunity policy	○	○	○	○	○
❑	Set targets to achieve a gender balance in the workforce	○	○	○	○	○
❑	Organise conferences and workshops on gender	○	○	○	○	○
❑	Actions to improve work-life balance	○	○	○	○	○
○	Other:					

7. Was there a gender dimension associated with the research content – i.e. wherever people were the focus of the research as, for example, consumers, users, patients or in trials, was the issue of gender considered and addressed?

○ Yes- please specify

X No

E Synergies with Science Education

8. Did your project involve working with students and/or school pupils (e.g. open days, participation in science festivals and events, prizes/competitions or joint projects)?

X Yes- please specify Batchelor of Science design development work on the BB GREEN concept with HIV Vestfold University, Horten, Norway

○ No

9. Did the project generate any science education material (e.g. kits, websites, explanatory booklets, DVDs)?

○ Yes- please specify

X No

F Interdisciplinarity

10. Which disciplines (see list below) are involved in your project?

x Main discipline[1]: 2.7 Environmental engineering

x	Associated discipline[Feil! Bokmerke er ikke definert.]: 2.1 Civil engineering (transport) 2.5 Materials engineering 2.10 Nano-technology (battery chemistry)	○	Associated discipline[Feil! Bokmerke er ikke definert.]:

G Engaging with Civil society and policy makers

[1] Insert number from list below (Frascati Manual).

11a Did your project engage with societal actors beyond the research community? *(if 'No', go to Question 14)*	X	No

11b If yes, did you engage with citizens (citizens' panels / juries) or organised civil society (NGOs, patients' groups etc.)?

- ○ No
- ○ Yes- in determining what research should be performed
- ○ Yes - in implementing the research
- ○ Yes, in communicating /disseminating / using the results of the project

11c In doing so, did your project involve actors whose role is mainly to organise the dialogue with citizens and organised civil society (e.g. professional mediator; communication company, science museums)?	○ ○	Yes No

12. Did you engage with government / public bodies or policy makers (including international organisations)

- ○ No
- ○ Yes- in framing the research agenda
- ○ Yes - in implementing the research agenda
- ○ Yes, in communicating /disseminating / using the results of the project

13a Will the project generate outputs (expertise or scientific advice) which could be used by policy makers?

- ○ Yes – as a **primary** objective (please indicate areas below- multiple answers possible)
- ○ Yes – as a **secondary** objective (please indicate areas below - multiple answer possible)
- ○ No

13b If Yes, in which fields?

Agriculture		Energy		Human rights	
Audiovisual and Media		Enlargement		Information Society	
Budget		Enterprise		Institutional affairs	
Competition		Environment		Internal Market	
Consumers		External Relations		Justice, freedom and security	
Culture		External Trade		Public Health	
Customs		Fisheries and Maritime Affairs		Regional Policy	
Development Economic and Monetary Affairs		Food Safety		Research and Innovation	
		Foreign and Security Policy		Space	
Education, Training, Youth		Fraud		Taxation	
Employment and Social Affairs		Humanitarian aid		Transport	

13c If Yes, at which level?

- ○ Local / regional levels
- ○ National level
- ○ European level
- ○ International level

H Use and dissemination

14. How many Articles were published/accepted for publication in peer-reviewed journals?	4
To how many of these is open access[2] provided?	106
How many of these are published in open access journals?	106
How many of these are published in open repositories?	106
To how many of these is open access not provided?	0
Please check all applicable reasons for not providing open access:	
❑ publisher's licensing agreement would not permit publishing in a repository ❑ no suitable repository available ❑ no suitable open access journal available ❑ no funds available to publish in an open access journal ❑ lack of time and resources ❑ lack of information on open access ❑ other[3]: ……	

15. How many new patent applications ('priority filings') have been made? *("Technologically unique": multiple applications for the same invention in different jurisdictions should be counted as just one application of grant).*		0
16. Indicate how many of the following Intellectual Property Rights were applied for (give number in each box).	Trademark	0
	Registered design	0
	Other	0
17. How many spin-off companies were created / are planned as a direct result of the project?		0
Indicate the approximate number of additional jobs in these companies:		

18. Please indicate whether your project has a potential impact on employment, in comparison with the situation before your project:

❑	Increase in employment, or	❑	In small & medium-sized enterprises
❑	Safeguard employment, or	❑	In large companies
❑	Decrease in employment,	❑	None of the above / not relevant to the project
❑	Difficult to estimate / not possible to quantify		

[2] Open Access is defined as free of charge access for anyone via Internet.
[3] For instance: classification for security project.

19. For your project partnership please estimate the employment effect resulting directly from your participation in Full Time Equivalent (*FTE = one person working fulltime for a year*) jobs:	*Indicate figure:*
Difficult to estimate / not possible to quantify	X

I Media and Communication to the general public

20. As part of the project, were any of the beneficiaries professionals in communication or media relations?

X Yes ○ No

21. As part of the project, have any beneficiaries received professional media / communication training / advice to improve communication with the general public?

○ Yes X No

22 Which of the following have been used to communicate information about your project to the general public, or have resulted from your project?

❑	Press Release	❑	Coverage in specialist press
❑	Media briefing	❑	Coverage in general (non-specialist) press
❑	TV coverage / report	❑	Coverage in national press
❑	Radio coverage / report	❑	Coverage in international press
❑	Brochures /posters / flyers	❑	Website for the general public / internet
❑	DVD /Film /Multimedia	❑	Event targeting general public (festival, conference, exhibition, science café)

23 In which languages are the information products for the general public produced?

❑	Language of the coordinator	❑	English
❑	Other language(s) Dutch, German, Swedish		

2. Final report on the distribution of the European Union Financial contribution to BB GREEN

This report shall be submitted to the Commission within 30 days after receipt of the final payment of the European Union financial contribution.

2.1. BB GREEN budget, reported and received by the beneficiaries

Below please find a summary containing information on:

- Initial Project cost per beneficiary.
- Budget for EU contribution.
- Reallocations of obligations and funding between beneficiaries.
- Reported by each beneficiary in the project (Form Cs).
- Funding received by the coordinator from the Commission and distributed to the beneficiaries.
- Suggested final payment and split per beneficiary.

BB GREEN	Budget, reported and received by each beneficiary						
Text: (Euros)	Original Budget: Cost	Original EU Contribution	Internal reallocation of funding for work / cost	Revised EU contrib. after internal reallocations	Reported: Cost: (Form Cs)	Funding distrib. from coordinator to beneficiaries	Balance to be received / payed incl. final payment
SE	770 659	594 753	58 361	653 114	893 431	585 548	67 566
SSPA	335 530	251 648	-32 414	219 235	328 285	158 022	61 213
Lloyds	71 930	35 965	-13 642	22 323	44 646	30 353	-8 030
Ex Carbo	32 619	24 464	-	24 464	32 619	24 448	-
Diab	266 450	199 837	11 375	211 212	347 061	198 134	13 078
Aqua	67 270	50 452	-	50 452	63 078	64 889	-14 437
Ex Amber	50 304	37 728	-	37 728	100 606	146 054	-
Emrol	440 340	330 255	-3 595	326 660	712 364	360 172	-33 512
Echandia	358 780	269 085	15 438	284 523	478 708	252 772	31 751
BJB	731 780	537 845	-35 524	502 322	780 272	248 478	253 844
On bank account						21 577	-21 577
Final payment							-349 905
Sum:	3 125 662	2 332 032	-	2 332 032	3 781 069	2 090 447	349 895
Guarantee fund		108 326				-108 326	
Sum incl Guarantee fund		2 440 358			Net	1 982 121	

Total reported cost for the project (48 months) is Euro 3.781.069,- vs. budget Euro 3.125.662,- corresponding to Euro 655.407,-; (equivalent to 20 %) higher than the cost than budget. In addition several partners have spent additional cost and efforts not included in the above cost figures after the formal ending of the project (April 30th 2015).

According to the above expected final payment from the Commission corresponds to Euro 349.905,- The tabulation above shows that some beneficiaries, have received too much while others have received too little. SE has will carry out the project internal payments, and prepare a report on final amount of EU contribution per beneficiary in Euros within 30 days after receipt of final payment for distribution to the beneficiaries. (Ref tabulation clause 2.2.).

A total of 132,2 MM has been reported vs. budget of 118,5 MM. The actual MM consumption is higher because several of the partners have invested additional time and effort in project related RTD, dissemination and systems / solutions developments which has not been included in the reported. As an example; SE and Aqua has approx. 3 MM each extra in dissemination.

At the time of preparing the initial budget and project specifications several assumptions on the price / cost for technologies and input factors needed for carrying out the task obligations; (among other for construction of the test vessel) were needed. Items in this category are: Battery cells / components, carbon/ core materials / resin and consumables, electrical motors / driveline / propulsion / components; to mention a few.

In retrospect it is clear that the reason for underfunding of the project has been a combination of:

- Insufficient man months allocated for key tasks / size and complexity of the project
- Too low cost estimates
- No reserve for price increases from start up until main costs were due
- Too high cost reductions proposed by the Commission / scientific officers
- No margins for unforeseen costs or funding to handle unexpected challenges.

To illustrate; a large part of the items / input factors needed were not items one could buy in the public and fixed prices. Therefore in the application phase certain assessments had to be made on what the cost would be.

Unfortunately, for several of the beneficiaries, the final cost budget and corresponding EU funding were insufficient for carrying out all the obligations outlined. A resulting consequence for several of the partners (a major part SMEs) was to search for alternative equity / funding for financing the execution of their obligations.

In terms of budget vs. reported man months used for carrying out the activities of the project; please see below.

Beneficiary number and short name	**Budget WP1**	**WP2**	**WP3**	**WP4**	**WP5**	**WP6**	**WP7**	**WP8**	**Budget total / beneficiary**
1-SE	7	5,5	3	6	10	5	3	3	42,5
2-SSPA		1	14,5		4		2		21,5
3-Lloyds			7						7
4-Ex Carbo				2					2
5-Diab					8		1		9
6-Aqua		2	0,5						2,5
7-Ex Amber				2					2
8-Emrol				9	3				12
9-Echandia				7	1		1		9
10-BJB					5	2	3	1	11
Total:	**7**	**8,5**	**25**	**26**	**31**	**7**	**10**	**4**	**118,5**

Beneficiary number and short name	Actual WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	Actual per beneficiary
1-SE	14	5	3	11	10	0	2	3	48,2
2-SSPA		1	11		0		1		13,0
3-Lloyds			5						5,2
4-Ex Carbo				2					2,0
5-Diab					7		0		7,2
6-Aqua		2	1		1			2	5,5
7-Ex Amber				2					2,0
8-Emrol				31	1				31,7
9-Echandia				10					10,0
10-BJB					7		1		7,5
Total:	**14**	**7**	**20**	**55**	**26**	**0**	**4**	**5**	**132,2**

On behalf of the BB GREEN project; SE, as the project coordinator - will on behalf of all the project's beneficiaries express a sincere thanks to all the persons from the Commission that have assisted throughout the duration of the project.

As previously expressed, the BB GREEN team intends to continue the activities to secure unquestionable proof of the BB GREEN concept, and a massive European wide dissemination- and demonstration, with the ASV test vessel; hopefully with EU support via project GFFNOW applied for under Horizon 2020 SME Phase 2 in June 2015.

Sincerely yours

Tor Kolbjorn Livgard & Ulf Tudem

SES Europe AS

2.2. Report on the distribution of the European Union financial contribution between beneficiaries

Name of beneficiary	Final amount of EU contribution per beneficiary in Euros
1. SES Europe AS	
3. SSPA Sweden AB	
4. Lloyds Reg.	
5. Carbonia AB	
6. Diab AS	
7. Aqualiner	
8. Amberjac Projects Ltd (bankrupt)	
9. Emrol BVBA	
10. Echandia Marine Sweden AB	
11. BJB	
Total	

Section A. (public):

A1: LIST OF BB GREEN SCIENTIFIC PUBLICATIONS										
NO.	Title	Main author	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Year of publication	Relevant pages	Permanent identifiers[4] (if available)	Is/Will open access[5] provided to this publication?
1	International conference on construction and operation of fast vessels	Ulf Tudem	Air supported vessel – innovative hurtigbåtsteknologi	1. Presentation for approx. 70 from the fast vessel industry	Tekna	Copenhagen, Denmark	07/12-2011	Power point presentation		Yes
2	Norwegian Research Council and EU research Vestfold, info meeting	Ulf Tudem	Experience with EU projects	1.Presentation for approx. 60 industry delegates	Vestfold University	Horten; Norway	12/06-2012	Power Point Presentation		Yes
3	51st naval Architecture and the Maritime Industry Congress	Ulf Tudem	BB GREEN – development of the world's first zero emission air supported electric fast commuter ferry	1.Presentation for approx. 20 from European research	Local university	Gijon, Spain	18/10-2012	Power Point Presentation		Yes
4	International conference – Scandinavian Maritime Conference 12.	Thomas Andreassen	ASV technology, innovation, efficiency and environmental benefits combined	2.Presentation for 22 industry delegates	Vestfold University	Horten, Norway	30/11-2012	Power Point Presentation		Yes

[4] A permanent identifier should be a persistent link to the published version full text if open access or abstract if article is pay per view) or to the final manuscript accepted for publication (link to article in repository).

[5] Open Access is defined as free of charge access for anyone via Internet. Please answer "yes" if the open access to the publication is already established and also if the embargo period for open access is not yet over but you intend to establish open access afterwards.

A2: LIST OF BB GREEN DISSEMINATION ACTIVITIES								
NO.	Type of activities[6]	Main leader	Title	Date/ Period	Place	Type of audience[7]	Size of audience	Countries addressed
1	Web sites / applications	SE	EU Funds Construction of BB GREEN Vessels	2/8-2011	marine.link.com	Industry		World wide
2	Videos	Aqua	BB GREEN tank testing	25/1-2012	You Tube	Industry - all		World wide
3	Videos	Aqua	BB GREEN testing	25/1-2012	You Tube	Industry - all		World wide
4	Web sites / applications	SE	Welcome to support International Newsletter on the Web	5/1-2012	Support.project.eu	Industry - all		World wide
5	Web sites / applications	SE	Technologies and scenarios for low emission shipping	5/1-2012	Tefles.eu	Industry - all		World wide
6	Web sites / applications	SSPA	SSPA BB GREEN Battery powered boats, providing greening, resistance reduction, electric, efficient	30/1-2012	Sjofartsverket.se	Industry - all		Sweden mainly
7	Publication	SE	Ferry uses electric power and air support	2/4-2012	Motorship.com	Industry - all		World wide
8	Web sites / applications	SE	Clean-index. International newsletter on the web: Norwegian SES Europe gets EU funding	11/8-2011	Nordiggreen.net	Industry - all		Nordic countries and world wide
9	Publication	SE	ASV på Scroedingers Katt (TV)	6/2-2012	Maritim.com	Industry - all		Scandinavian
10	Publication	SE	Imponerende resultater fra tank testing av ASV teknologi	7/2-2012	Skipsrevyen.no	Industry - all		Scandinavian
11	Publication	SE	Air Supported Vessel på NRK	2/3-2012	Batliv.com	Industry - all		Scandinavian
12	Web sites / applications	SE	Gizmag: Int newsletter. ASV hull would	6/3-2012	Gizmag.com	Industry - all		World wide

[6] A drop down list allows choosing the dissemination activity: publications, conferences, workshops, web, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters, Other.

[7] A drop down list allows choosing the type of public: Scientific Community (higher education, Research), Industry, Civil Society, Policy makers, Medias, Other ('multiple choices' is possible).

			dramatically improve - .					
13	Publication	SE	Seilas: ASV på NRK	6/2-2012	Seilas.no	Industry - all		Scandinavia
14	Publication	SE	World tech International: ASV	6/3-2012	Worldtech-int.com	Industry - all		World wide
15	Web sites / applications	SE	High efficiency air supported hulls tank tested at SSPA Sweden	14/2-2012	Safety4sea.com	Industry - all		World wide
16	Web sites / applications	SE	Luftige visjoner ga millionstøtte fra EU	4/6-2011	Eu-norge.org	Industry - all		Norway
17	Web sites / applications	SE	ASV hulls would dramatically improve.. riding on a cushion of air	19/2-2012	Fiz1.com	Industry - all		World wide
18	Publication	SE	ASV hulls dramatically improve	7/5-2012	Moreinspiration. com	Industry - all		World wide
19	Web sites / applications	SE	A small Norwegian Company is ASV a breakthrough in hull design	5/11-2011	Mydig.imag.rrd.com	Industry - all		World wide
20	Web sites /applications	SE	Clean, green and lean designs are in progress	6//7-2011	Rivieramm.com	Industry - all		World wide
21	Publication	SE	Marine Design: ASV impress	10/2-2012	Richplazia.com	Industry - all		World wide
22	Web sites / applications	SE	Marine Design: Air supported vessels impress	13/2-2012	marinelink.com	Industry - all		World wide
23	Publication	SE	Marine Design: ASV impress	13/2-2012	3marinelink.com	Industry - all		World wide
24	Web sites / applications	SE	ASV hull would dramatically improve ship efficiency	15/3-2012	Plus.ibinws.com	Industry - all		World wide
25	Web sites / applications	SE	ASV hull would dramatically improve ship efficiency	15/3-2012	Innovationtoronto.type pad.com	Industry - all		World wide
26	TV clips	SE	National Norwegian TV – science program Schrodingers Katt	15/2-2012	NRK 1	Industry - all		Norway mainly
27	Videos	SE	Videos from tank testing at SSPA	5/3-2012	You Tube	Industry - all		World wide
28	Videos	SE	Videos from tank testing at SSPA	5/3-2012	You Tube	Industry - all		World wide
29	Publication	SE	ASV Newsletter July 2011	5/7-2011	Distribution list	Industry - all	1500	World wide
30	Publication	SE	ASV Newsletter No 1 - 2012	26/1-2012	Distribution list	Industry - all	1500	World wide
31	Web / applications	SE	BB GREEN: Design image of a commercial fast ferry	13/6-2012	You Tube	Industry - all		World wide
32	Presentations	Aqua	Kessel Granger / Dutch consul in San Francisco, USA	27/1-2012	Eindhoven; NL	Industry		NL and USA (national TV)
33	Presentations	Aqua	Research and presentation new connection Amsterdam Almere	15/3-2012	Amsterdam, NL	City council	14	Netherlands

34	Presentations	Aqua	Research presentation for new connection Amsterdam Almere	19/8-2012	Amsterdam, NL	Policy makers	4	Netherlands
35	Presentations	Aqua	Paris, bateaux Parisiens for new EU tender for ferry connections -12	4/4-2012	Paris, France	Industry	4	France
36	Presentations	Aqua	Stockholm Vattenbussen, New fast ferry service in Sweden	7/12-2011	Rotterdam; NL	Industry	3	Sweden
37	Presentations	Aqua	Province of Zeeland; advice for new fast ferry service	2/5-2012	Veere, NL	Policy makers	40	Netherlands
38	Presentations	Aqua	Rotterdam city council, transport dept. New ferry connection	7/3-2012	Rotterdam, NL	Policy makers	40	Netherlands
39	Presentations	Aqua	Rotterdam public transport fast ferry contract for 7 years	15/9-2012	Rotterdam, NL	Industry / policy mak	10	Netherlands
40	Presentations	Aqua	Meeting with policy makers	16/5-2012	Rotterdam, NL	Policy mak	5	Netherlands
41	Presentations	Aqua	London, Thames Clippers, possible new route London	11/4-2012	London, England	Industry	2	UK, England
42	Presentations	Aqua	BB GREEN info meeting with Damen Shipyards	21/5-2012	Gorichem, NL	Industry	5	Netherlands
43	Flyers	Aqua	Newsletters to stakeholders	19/4-2012	Int. dissemination	Industry - all		World wide
44	Publication	SE	Luftkudda minskar motstandet	15/6-2012	Sobefalsforen.	Industry all		Scandinavia
45	Article in pop press	SE	Luftkudde sparer 50% energi	19/2-2012	TUno./industri	Industry - all		Scandinavia
46	Web sites / applications	SE	Fast electric ferry rides on air support	14/4-2012	Maritimejournal. com	Industry - all		World wide
47	Publication	SE	BB GREEN Floating on Air	25/7-2012	Fairlplay Solutions Magazine	Industry - all		World wide
49	Conference paper and presentation	SE	HIPER 2012; BB GREEN development of the wold's first Zero emission ASV commuter ferry	27/9-2012	Duisburg, Germany	Industry - all		World wide
50	Key note presentation	SE	BB GREEN development of the world's first zero emission ferry	28/9-2012	Doordrecht;NL	Industry - al		Netherlands
51	Conference presentation	SE	BB GREEN development of the world's first zero emission fast ferry	18/10-12	Gijon, Spain	Industry - all		European
52	Publication	SE	Prof met elektrisch luchkussenschip	23/10-12	Enineuvs.gav.nl	Industry - all		Netherlands
53	Publication	SE	Binja-hovercraft voor Rotterdammse veerdienst	14/10-12	Technischeweekblad. nl	Industry - all		Netherlands

54	Publication	SE	Air Supported, all-electric fast ferry	15/9-2012	Ship & Boat International Mag	Industry - all		World wide
55	Publication	SE	Techniek en Innovative	15/11-12	Maritime NL Mag	Industry - all		Netherlands
56	Publication	SE	Light a Air EU's Ferry Initiative	12/12-12	Ship Building Industry Mag	Industry - all		Europe and beyond
57	Publication	Aqua	Elektrishe ferry in de mask voor regio	30/12-12	De Telegraf	Industry - all		Netherlands / France
58	Conference and presentation	SE	BB GREEN developments	8/1-2013	Colchester, UK	Industry - all		UK
59	Articles published in popular press	Aqua	Un Ferry 100% electrique	8/1-2013	Les Echos Newspaper	Industry - all		France
60	Publication	Aqua	Aquliner afwachten EU moet nog beslut nemen over luftkussen	23/1-2013	De weekkrant.nl	Industry - all		Netherlands
61	Publication	Aqua	Europees ondercoek naar veerschip met lufkussntekniek	24/1-2013	Ovpro.nl	Industry - all		Netherlands
62	TV clips	Aqua	Niuve waterbus wardt wereldprimeur	27/2-2013	Ijnmonde.nl	Industry - all		Netherlands
63	Web sites / applications	Aqua	Europese commissie enthousiast over onderzoeken… el.luchtkussen	27/2-2013	Waterbus.nl	Industry - all		Netherlands
64	Videos	Aqua	Nieuve waterbus wordt wereldprimeur	27/2-2013	You Tube	Industry - all		World wide
65	Publication	Aqua	Scheepwaartniuws:Nieuve waterbus	27/2-2013	Scheepvaartniuvs	Industry - all		Netherlands
66	Publication	SE	BB GREEN Vessels: Tender Process	20/3-2013	IBI Plus	Industry - all		World wide
67	Publication	SE	OG to start conctruction of world's first 30 kn el ASV commuter ferry	27/2-2013	ASV Newsletter no 2 - 2013	Industry - all	1800	World wide
68	Publication	SE	All electric air supported hull vessel comes closer to realiity	30/3-2013	Motorship.com	Industry - all		World wide
69	Publication	SE	Tender competition launched for BB GREEN project	14/3-2013	Maritime Journal	Industry - all		World wide
70	Publicataion	SE	Public Tender for ASV	21/3-2013	Marine Southeast.co.uk	Industry - all		World wide
71	Publication	LLoyds	Tender completion launched for BB GREEN project	14/3-2013	Marinescienceand technology.com	Industry - all		World wide
72	Publication	SE	Marine Design: ASV impress	12/2-2012	Marinescienceand	Industry - all		World wide

					technology.com			
73	Publication	SE	Air supported green ferries	8/3-2013	Cordis.europa.eu	Industry - all		World wide
74	Publication	SE	Studentprosjekt fra Vestfold sentralt I stort EU prosjekt	10/1-2013	Hive.no	Industry - all		World wide
75	Oral presentation to a wider public	Aqua	Mobility week (EU projecet) in Drechtcities, future of waterborne transport	17/9-2012	Dordrecht; NL	Industry - all		World wide
76	Videos	Aqua	Baptize new Waterbus with specific attention to BB GREEN	29/9-2012	Dorderecth, NL	Industry- all	250	European
77	Articles in popular press	Aqua	Waterbus more durable with BB GREEN	1/10-2012	Maraitimeneiews.nl	Media	5000	Netherlands
78	Articles published in popular press	Aqua	Article in Dutch Nautical Mag.	5/10-2012	Schuttevaer.nl	Industry	14000	Netherlands
79	Articles published in the popular press	Aqua	New waterbus world's premiere	5/3-2012	Telegraaf.nl	All	600000	Netherlands
80	Web sites / applications	Aqua	Project BB GREEN	28/4-2013	Aqualiner.nl	Civil society	2000	Netherlands
81	Oral presentation to a wider public	Aqua	Presentation new environmental friendly fast ferry for SF bay area	5/4-2013	San Francisco, USA	Industry - all	15	USA
82	Web sites / applications	SE	Project BB GREEN	24/7-2013	Ecoweb.info	Industry - all		World wide
83	Oral presentation to a scientific event	SE	The world's first ASV battery powered fast ferry. Plug-boat	10/10-13	Nice, France	Industry - all	110	Reps from 17 countries
84	Oral presentation to a scientific event	SE	ASV technology including presentation of BB GREEN	01/10-13	Abu Dhabi	Industry - all	200	World wide
85	Web sites / applications	SSPA	BB GREEN and Norwegian TV at SSPA towing tank recording	30/1-2013	Sspa.se/news	Industry - all		World wide
86	Web sites / applications	Aqua	BB GREEN concept design	9/1-2013	Orangegoesgreen.org	Industry - all		World wide
87	Web sites / applications	SE	Electric and Hybrid Marine Expo 2014 in Amsterdam	7/5-2014	Electricandhybridmarineworldexpo.com	Industry - all		World wide
88	Oral presentation to a scientific event	Echandia	Meeting with Swedish national politicians related to BB GREEN	22/4-2014	Stockholm, Sweden	Politicians		Swedish
89	Press releases	SSPA	Landstinget satser på eldrivne pendelbåter	28/4-2014	Skargardsbrygan.com	Industry - all		Sweden
90	Web sites / applications	SSPA	Stockholm får et net av pendelbåtar	23/5-2014	Batliv.se	Industry - all		Sweden

91	Oral presentation to a scientic event	SE	BB GREEN fast battery powered ASV ferry	26/6-2014	Electric and Hybrid World Marine Expo	Industry - all		In Amsterdam NL for a worldwide audience
92	Articles published in the popular press	Echandia	Supersnabb batteriferja til Malaren?	11/12-14	Skargardsredarna.se	Industry - all		Sweden
93	Oral presentation to a wider public	BJB	BB GREEN fast ferry for the Netherlands	13/3/2015	Ljmuiden, NL	Politicians & industry		Netherlands
94	Articles published in the popular press	Diab	BB GREEN – a fast ASV battery powered ferry with DIAB core	12/4-2015	Diabgroup.com	Industry - all		World wide
95	Articles published in the popular press	SE	Air Lubricated Ferry has Lithium Titanate Batteries	15/5-2015	The Maritime Executive	Industry - all		World wide
96	Articles published in the popular press	SE	Enter the BB GREEN ferry	7/3-2015	The world cargo news.com	Industry - all		World wide
97	Web sites / applications	SE	BB GREEN – a fast air supported and battery powered ferry..	1/9-2012	Maritimetransportresearch.com	Industry - all		World wide
98	Web sites / applications	SE	ASV BB GREEN ECO pass vessel	10/5-2015	Studiosculli.com	Industry - all		World wide
99	Web sites / applications	SE	ASV News. BB GREEN started	13/7-2011	Captken.wordpress.com	Industry - all		World wide
100	Articles published in the popular press	SE	Satser friskt med EU midler	20/9-2012	Byavisa, Vestfold, Norway	Industry - all		Norway
101	Web sites / applications	Aqua	Efficient varen op lucht	10/12-13	Verkeerskunde.nl	Industry - all		Netherlands
102	Web sites / applications	SSPA	Battery powered boats providing greening, resitance reduction, electric, efficient and novelty	10/12 – 12	Transport-research.info	Industry - all		World wide
103	Web sites / applications	Aqua	BB GREEN project	15/7-2013	Aqualiner.nl	Industry - all		Netherlands
104	Web sites / applications	Aqua	Aqualiner & Waterbus in afwachting electische ferry	15/12-13	Waterbus.nl	Industry - all		Netherlands
105	Web sites / applications	BJB	Vacuum infusion of BB GREEN Ferry hull is completed	9/2-2015	Latitude-yachts.com	Industry - all		World wide
106	Press releases	SE	Zero emission ASV commuter ferry	25/5-2015	Interferry.com	Industry - all		World wide

B. Plans for exploitation of BB GREEN foreground (Confidential - non publishable).

Part B1: At the time of completing the project no applications for patents, trademarks, registered designs, etc. have been submitted.

Part B2:

Type of Exploitable Foreground[8]	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application[9]	Timetable, commercial or any other use	Patents or other IPR exploitation (licences)	Owner & Other Beneficiary(s) involved
ASV hull form. and technical ASV control and monitoring solutions	*New and improved air supported hull forms offering reduced resistance and other benefits.*	*Yes*	*22/2/2022*	*ASV hull lines, geometry and control solutions*	*Waterborne transport*	*2015*	*Existing patents filed Feb 2002. Update patents considered*	*Owner: Effect Ships International AS Beneficiary: SES Europe AS Beneficiary / license agreement: BJB yard*
Lithium Ione Titianate battery module and technical solutions for commercial type of battery	*New light weigh battery module for marine use*	*Yes*	*6/6/2035*	*Battery module for construction of bespoke batteries for transport use*	*1: Waterborne commuter transport* *2: Other transport use*	*2016*	*Patent protection of part of the design considered.*	*Owner: Emrol BVBA Beneficiaries / licence: BB GREEN project partners on the basis of a commercial agreement*
Electric driveline and power management system for BB GREEN crafts	*Improved efficiency and handling units for electric driveline/ power management*	*Yes*	*6/6/2035*	*Driveline and power management units / systems for fast ASV ferries*	*1: Waterborne commuter transport*	*2016*	*Patent protection of part of the design considered.*	*Owner: Echandia Marine Sweden AB. Beneficiaries / license: BB GREEN project partners on the basis of a commercial agreement*

[19] A drop down list allows choosing the type of foreground: General advancement of knowledge, Commercial exploitation of R&D results, Exploitation of R&D results via standards, exploitation of results through EU policies, exploitation of results through (social) innovation.

[9] A drop down list allows choosing the type sector (NACE nomenclature) : http://ec.europa.eu/competition/mergers/cases/index/nace_all.html

C. Plans for exploitation of BB GREEN foreground (Confidential - non publishable).

Foreground purpose:	*Exploitation of foreground:*	*IPR measures taken/intended*	*Further research required:*	*Expected impact:*
New documented ASV hull form and technical ASV control and monitoring solutions.	*In construction of more efficient ship and vessel hulls for commuter transport and other vessel applications. Relevant for electric and non – electric type of vessels. Base: Licensing and collaboration agreements.*	*Disclosure of information, drawings and descriptions on the basis of Non-Disclosure Agreements (NDA). The base ASV technology is patented and additional patent protection is considered.*	*Scientific documentation of the BB GREEN hull in full scale and under realistic operational conditions (as proposed in GFFNOW)*	*Capture a significant part of a new and emerging battery electric commuter ferry market; as well as use the new solutions also on other spin off applications. Sell ASV technology for vessels with a ship value of 160 M Euro, within 2020. Licence income 5% of value.*
Lithium Ione Titianate battery module and technical solutions for commercial type of battery	*Design, development and sale of bespoke batteries based upon new module / technical solutions. Primarily for waterborne-, but also other modes of transport. Base: Deliver complete batteries.*	*Disclosure of information, drawings and descriptions on the basis of Non-Disclosure Agreements (NDA). Patent protection is considered.*	*With a cycle life expectance of approx. 20.000 cycles, long term testing (logged) under actual conditions will be required prior to commercial launch. Ref project application GFFNOW.*	*Be a complementary BB GREEN system and be installed in future battery electric commuter ferries. Be used also for other ASV spin offs and other transportation solutions.*
Electric driveline and power management systems for fast commuter ferries and other ASV spin off vessels.	*Design, development and sale of electric drivelines and power management systems for BB GREEN type of vessels. In addition system sales also for electric retrofitting of conventional vessels.*	*Disclosure of information, drawings and descriptions on the basis of Non-Disclosure Agreements (NDA). Patent protection is considered.*	*Long term testing (logged) under actual conditions (as planned for BB GREEN in project GFFNOW).*	*Capture a European market share for BB GREEN deliverables of 30% within a 5 year horizon (12 M Euro company turnover)*