



Greensolver BESS Case Studies

CASE STUDY 1

Due Diligence for Belgium's biggest BESS project : 50MW / 100MWh (BL)

Greensolver performed the technical due diligence for the **largest BESS project in Belgium** in the context of the project's financing.

This audit covered both:

✓ **Technical aspects:**

- Site assessment & permitting : grid connection agreement, permits, EIA, connection signal with TSO, compensatory measures
- Review of the selected equipment
- Design review and capacity to operate on primary reserve markets, calculation of "puissances valorisables"
- Contracts review: BESS supply & maintenance, construction, RTM, TSO
- Insurance policy coherence with technological risks

✓ **Financial/aspects:**

- Audit of the revenue scenarios and Assumption sheet (revenue stacking), including FCR, aFRR, CRM, voltage supply markets, imbalance market
- Review of the inputs of the financial model and validation of the Assumption sheet : CAPEX, OPEX, budgets, revenues, IRR

Based on the reviewed technical capabilities of the BESS project, **Greensolver audited its expected revenue streams**. Our experts analysed the detailed financial models provided by the project developer, encompassing all the types of (ancillary) services required in the project.

We detected many inconsistencies & issues in the financial model due to assumptions which needed to be modified and discussed with the project's sponsors, its consultant and the potential lenders.

These **discussions resulted in a more robust financial model**. Our expert has also **identified points of attention** to be discussed and negotiated with the RTM operator and the TSO, in order to achieve the revenues and the economics of the BESS.



CASE STUDY 2

Technical Due Diligence for BESS project: 17.75MW / 35.5MWh (FR)

Greensolver performed the **technical due diligence** for a standalone BESS asset **under development in France**.

The scope of the work covered:

✓ **Regulatory:**

- Review of ICPE requirements and tracking of its development
- Implication of evolving regulatory requirements to technical specifications and suggested modifications

✓ **Technical:**

- Review of CATL's BESS Model: EnerOne+
- Site Assessment and Review of the proposed layout
- Design review and capacity to operate on primary reserve markets
- Contracts review (Warranty, EPC, and O&M)
- Augmentation strategy evaluation
- Review of compliance with evolving regulatory requirements

Through the review of the regulatory requirements and their anticipated changes, the technical capabilities of the BESS project were optimised to ensure compliance and mitigate potential risks. We assisted the owner in:

- Acquiring rights to neighbouring land to facilitate regulatory developments
- Amending site layout to ensure safety
- Considering additional sub-systems
- Negotiate improved terms for the warranty and O&M terms



CASE STUDY 3

Root Cause Analysis – Internal Communication issue: 20MW / 20MWh (UK)

The client was looking for an **independent third party to review a 20MW/20MWh BESS asset's** capability to enter and participate in ancillary services (DC/DM/DR) as well as assessing the overall reliability of the control systems (comms between RTM, SCADA and BESS/PCS)

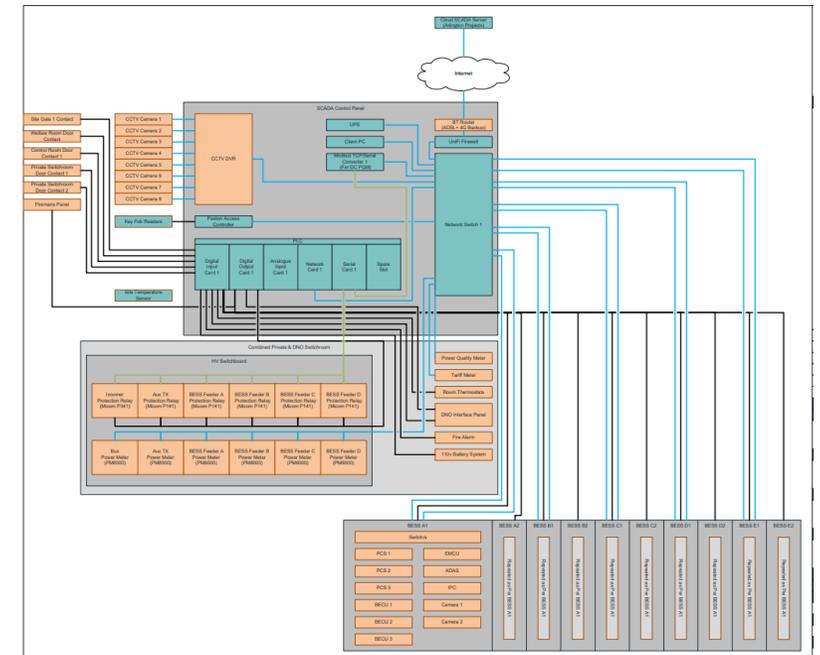
Greensolver team was appointed to **establish the root cause** of 3 main issues encountered during the SAT period, and **evaluate the reliability** of the mitigation action carried out:

- ✓ **Issue 1:** communication malfunction between the Battery OEM's BMS and the PLC of the SCADA
 - ✓ **Issue 2:** inability to pass the tests for DC, DM and DR services
 - ✓ **Issue 3:** communication outage between battery containers and the PLC of the SCADA
- In parallel, Greensolver also **assessed the balancing strategy** of the Battery OEM.

Greensolver team conducted the analysis by flagging the root causes and mitigation actions:

- ✓ **Issue 1:** bad MODBUS protocol configuration due to uncompliant MSS setting in the Battery OEM BMS
- ✓ **Issue 2:** uncompliant operational policy of the Battery BMS during standby period leading to greater latency of the system response and preventing being compliant with DC/DM/DR requirements
- ✓ **Issue 3:** uncompliant MODBUS protocol configuration following the mitigation action done to solve issue 2

For the **balancing strategy**, we suggested improving the **SOC calibration** and **SOC calculation accuracy** to mitigate risks.



CASE STUDY 4

Pre-planning permission application review: 100MW / 100MWh (UK)

The client was looking for an **independent third party to review a 100MW/100MWh BESS asset's general layout and design** before pre-planning application to identify any key design flaws/red flags and discuss findings.

Greensolver team reviewed the **planning drawings**, the **flood risk assessment**, the **noise impact assessment** and the **fire risk management strategy**.

Greensolver team conducted the analysis by flagging key things to anticipate before planning application, such as :

✓ General Layout :

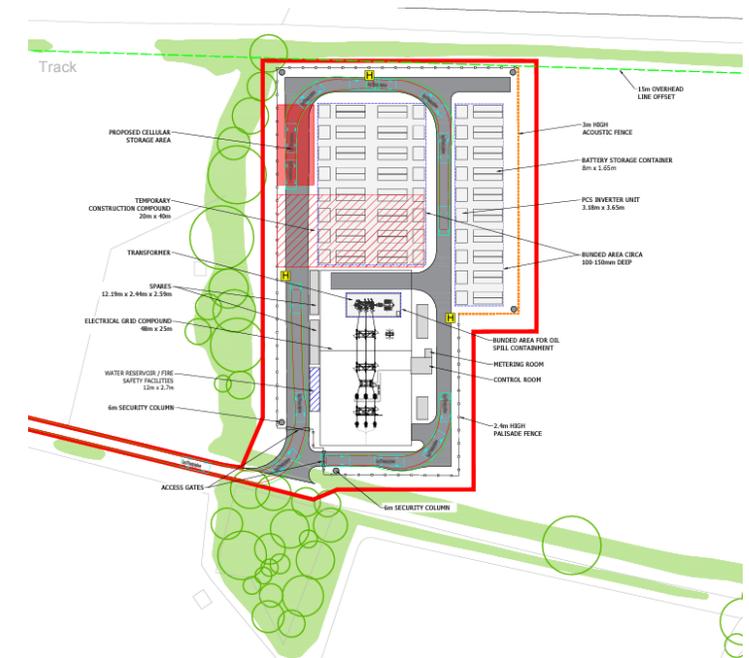
- Land area : ensure compatible activity presence around the site
- Access : ensure efficient access during construction (trucks and construction equipment) and during operation (fire safety services, O&M provider vehicle)
- Internal circulation : ensure operational efficiency safety and manutention
- Noise mitigation : ensure noise level mitigation
- Vegetation management : ensure consistency between regulation (National Plant Specification) and operation

✓ Flood Risk :

- Compatibility of the equipment Layout with the Local Flood Risk Assessment
- Consistency of the Drainage equipment to be installed

✓ Fire Risk : as per Standards (NFPA855) and battery OEM requirements

- Procedure : ensure Safety of personnel and equipment
- Equipment design : ensure Detection and Suppression
- Site layout : mitigation of Fire Spread and efficient evacuation



CASE STUDY 5

Technical Due Diligence on two Greek BESS assets: 100MW / 250MWh (GRC)

Greensolver performed the technical due diligence of two standalone BESS assets to support the project's financing.

This audit covered both:

✓ **Technical aspects:**

- Site assessment & permitting: grid connection agreement, permits, EIA, connection signal with TSO, compensatory measures
- Review of the selected equipment
- Design review and capacity to operate on primary reserve markets
- Contracts review: BESS supply & maintenance, construction, RTM, TSO
- Insurance policy coherence with technological risks

✓ **Financial/aspects:**

- Audit of the revenue scenarios and assumption sheet (revenue stacking), including FCR, aFRR, CRM, voltage supply markets, imbalance market
- Review of the inputs of the financial model and validation of the assumption sheet : CAPEX, OPEX, budgets, revenues, IRR

Based on the reviewed technical capabilities of the BESS projects, **Greensolver audited their expected revenue streams**. Our experts analysed the detailed financial models provided by the project developer, encompassing all types of (ancillary) services, according to its capabilities.

Our expert detected many inconsistencies & issues in the financial model due to assumptions with needed to be modified and discussed with the project's sponsors, its consultant and the potential lenders.

These **discussions ensured a robust financial model**. Our expertise also **identified points of attention** to be discussed and negotiated with the RTM operator and the TSO, in order to maximise the potential revenues for the BESS.



CASE STUDY 6

Safety & Performance Analysis under TAM contract: 32MW / 32MWh (UK)

The BESS is operated by the **Technical Asset Management team of Greensolver** on the behalf of the Asset owner.

As part of the TAM scope of services, **Greensolver team** led an analysis to check the Safety & Performance status of the plant, throughout an 8 months operational period.

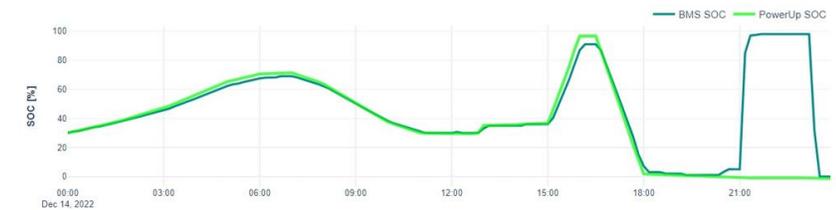
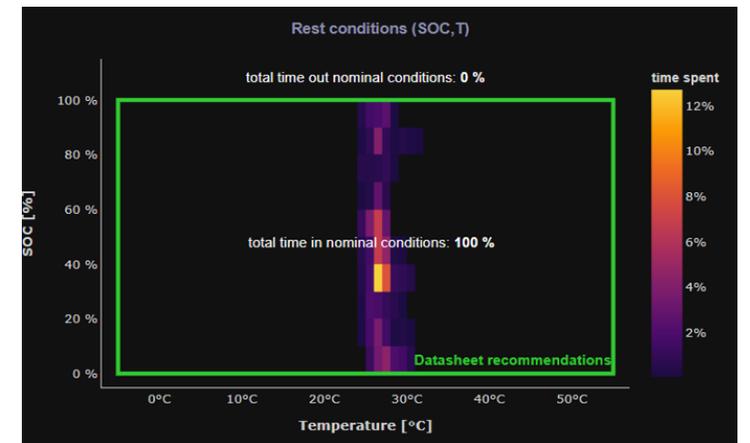
Greensolver team conducted the analysis with the support of an Analytic tool provided by a third-party partner.

Thanks to the **temperature, voltage and current** data given by the SCADA at battery rack level, Greensolver was able to analyse :

- ✓ **State-of-Safety:** by tracking **over-voltage / over-temperature / cell imbalance** to prevent Thermal Runaway
- ✓ **Performance:** by checking estimation and accuracy of **SOC** and **SOH / BMS faults**
- ✓ **Lifetime:** by checking **operational condition vs battery OEM requirements** (temperature, C-Rate)

This **Safety & Performance analysis** allowed us to highlight issues, which were subsequently raised to the battery OEM :

- ✓ **State-of-Safety:** **frequent cell imbalance** caused by weak cells, which could then lead to over-voltage and over-charge in the Battery cells and at the end **Thermal Runaway**
- ✓ **Performance:** **remaining useful capacity (SOH) below the warranty** of the battery OEM / frequent faulty measurement of the BMS, leading to **SOC deviation** (wrong voltage measurement)
- ✓ **Lifetime:** **higher temperature** of the battery module than recommended, which could accelerate ageing



CASE STUDY 7

Root Cause Analysis under TAM contract: 6MW / 6MWh (UK)

We recently supported one of our client managing a **problem he had with communications**.

The problem was that when the **RTM operator issued a power regulation or frequency regulation command**, the EMS system did not send the data in the time required to **comply with the obligations of the Ancillary services terms**.

As part of the TAM scope of services, **Greensolver team** led an analysis to check the communication protocols between:

- ✓ BMS and EMS
- ✓ EMS and Bachmann controller
- ✓ Bachmann controller and VPP controller of the RTM operator

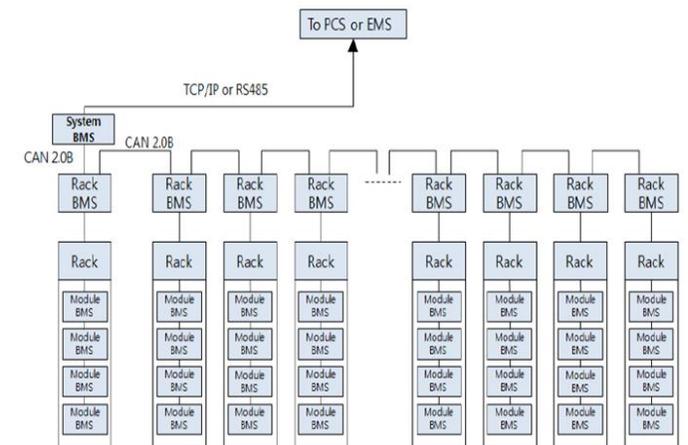
We saw that all the protocols met the requirements, they were all IEC104.

Then we analyze the main equipment involved: BMS (Samsung), including ModuleBMS, the RackBMS and the BankBMS/SystemBMS.

We found that the EMS allowed 7 modes and we gone through the way in which the different modes change depending on the commands received (again checking the communication equipment and protocols). They **did not correctly send the orders to the batteries**, so they do **not comply with the timeframe**.

The **EMS system and the Bachmann controller had to be reconfigured** and the system worked correctly again.

We also noticed that the minimum operational SOC is 0% as usually the minimum operational SOC should be 5%. In theory if the SOC is 0% then the power output drops to zero immediately and affecting the frequency response capability.



[Fig 16] Communication block diagram

CASE STUDY 8

SOC discrepancy : 32MW / 32MWh (UK)

The BESS is operated by the **Technical Asset Management team of Greensolver** on the behalf of the Asset owner.

As part of the TAM scope of services, **Greensolver team** used the Safety & Performance analytic tool BatteryInsight on daily basis to ensure the SOC accuracy.

Wrong SOC figures given by the **BMS** and **used by the RTM operator** led to **operational discrepancies and imbalances** for the WM position and DFR services, which resulted in **lost of revenue**.

Thanks to **Temperature, Voltage and Current** data provided by the SCADA/BMS at battery rack level, Greensolver team was able to highlight significant **SOC deviation** between the figures given by the BMS on site and the SOC figures calculated by **BatteryInsight**.

As part of the **Performance feature** of the tool, **recurrent SOC deviation** alarms were triggered, highlighting potential SOC calculation issue by the BMS from commissioning date. The **action plan managed** by **Greensolver team** included:

- ✓ **First**: by tracking those alarms, **Greensolver team** could focus **cause on the BMS**
- ✓ **Second**: **Greensolver team** requested **remedial action to the Battery OEM**
- ✓ **Third**: **Battery OEM performed a software update** of the BMS to improve the SOC calculation

From the **date of the software update**, **no more critical SOC deviation** alarm have been raised. The **RTM operator gained visibility** of the position the asset in the market, reducing the risk of discrepancy.



CASE STUDY 9

Invoicing Statements control: 20MW / 20MWh (UK)

The BESS is operated by the **Technical Asset Management team of Greensolver** on the behalf of the Asset owner.

As part of the TAM scope, the **Greensolver team** reviews monthly invoicing statements to ensure the accuracy and reliability of the figures.

Complexity of the **invoicing process** due to **multiple market applications and multiple data sources** could lead to substantial **missing revenue**.

Thanks to our **expertise of the UK market** and **comprehension of market rules**, **Greensolver team** highlighted **multiple errors in the invoicing statements** in the last 8 months.

Those errors represented around **£180,000 of missing revenues** for the SPV and its Owner.

Greensolver team claimed the missing revenues to the **RTM operator**, which proceeded to **reimburse the lost revenue**.



CASE STUDY 10

Technical Due Diligence on two Greek BESS projects: 200MW / 400MWh (GRC)

As the Lender Technical Advisor, Greensolver conducted **Technical Due Diligence** for **two standalone BESS assets** during the project's financing.

The scope of the work covered:

- ✓ **Regulatory:**
 - Review of grant requirements and tracking of its development
 - Application of evolving regulatory requirements to technical specifications and financial model

- ✓ **Technical:**
 - Review of Narada's BESS
 - Review of the permits and licenses
 - Site Assessment and Review of the proposed layout
 - Design review and capacity to operate on primary reserve markets
 - Contracts review (Supply Agreement, EPC, O&M, LTSA, and Aggregation)
 - Augmentation Strategy Evaluation
 - Review of grant compliance

- ✓ **Financial:**
 - Review of the financial model, validating assumptions and proposing suitable parameters where required (CAPEX, OPEX, budgets, revenues)
 - Review of grant compliance

Through the Greensolver's audit of the project, the technical review resulted in:

- Site layout and system design revision, ensuring regulatory and grant compliance
- Revision of Financial Model parameters, reflecting realistic-world conditions and up-to-date market information



CASE STUDY 11

Technical Due Diligence on two Greek BESS projects: 100MW / 200MWh (GRC)

As the Lender Technical Advisor, Greensolver conducted **Technical Due Diligence** for **two standalone BESS assets** during the project's financing.

The scope of the work covered:

✓ **Regulatory:**

- Review of grant requirements and tracking of their development
- Application of evolving regulatory requirements to technical specifications and financial model

✓ **Technical:**

- Review of CATL's BESS (Model: EnerC+)
- Review of the permits and licenses
- Site Assessment and review of the proposed layout
- Design review and capacity to operate on primary reserve markets
- Contracts review (Supply Agreement, EPC, and O&M)
- Augmentation strategy evaluation
- Review of grant compliance

✓ **Financial:**

- Review of the financial model, validating assumptions and proposing suitable parameters where required (CAPEX, OPEX, budgets, revenues)
- Review of grant compliance

Through the Greensolver's audit of the project, the proposed system was found to be aligned with industry standards. Minor risk from the selected site was identified, with mitigation investigated and proposed. The Financial Model was found to require revision and was therefore updated to better reflect local conditions.





Carla Vico Rico

CEO

carla.vico@greensolver.net

Paris HQ

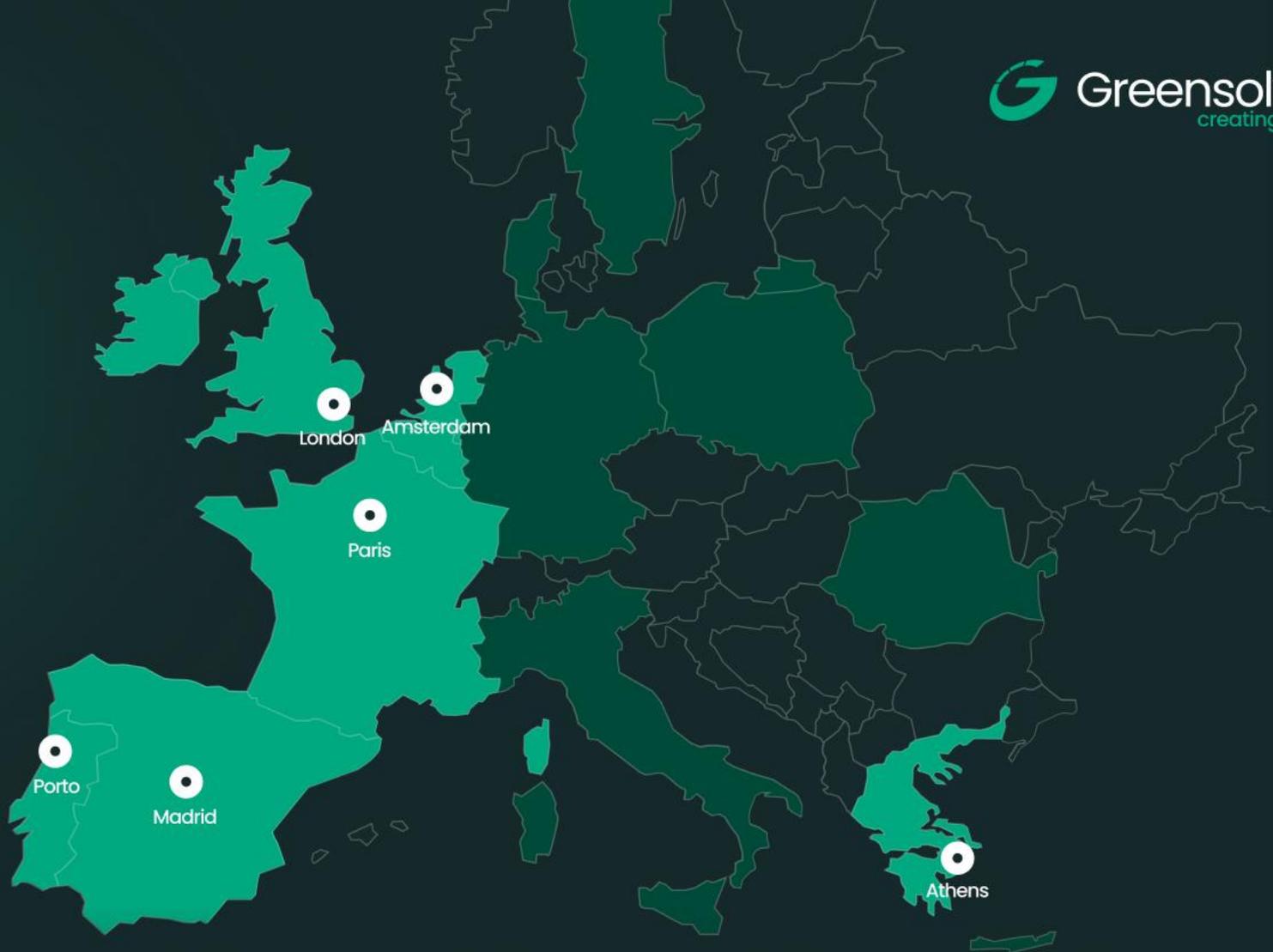
16 Place de la République,

75010 Paris

France

+33 (0)1 80 87 85 60

www.greensolver.net



Greensolver
creating value

London

27 Clement's Lane
EC4N 7AE London
United Kingdom
+44 (0)20 3966 1380

Amsterdam

Leonard Springerlaan 35
9727 KB Groningen
The Netherlands
+31 (0)854 019 650

Athens

Solonos 53 & Sina Str
Athens
106 72
Greece

Porto

Avenida do Marechal
Gomes da Costa, nº 1177
4150-360 Porto
Portugal

Madrid

Calle Princesa 17, 4º
28008 Madrid
Spain