# Life3R

## Circular economy ecosystem to Recover, Recycle and Re-use F-gases contributing to the depletion of greenhouse gases -LIFE 3R

## Deliverable: General setup and architecture

## Action C3

## Responsible for Deliverable: Daikin Central Europe (DACE)

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## Abstract

This deliverable focuses on the brief description of the designed F-gas circular economy ecosystem, which consists three (3) basic elements: A Self-certification platform with reliable F-gases declaration for composition/recovery/recycling, a F-gas identification and recycling IOT equipment and a 3R Marketplace platform to support and guide EU companies to Recover, Recycle/reclaim and Re-use F-gases (LIFE 3R). In addition, the general set up and architecture of the relevant web application is presented, including the front-end (client side) and the back-end (server, app, database), respectively. An overview of the 3R ECOSYSTEM as it will be after the implementation, is depicted in **Figure 1**:


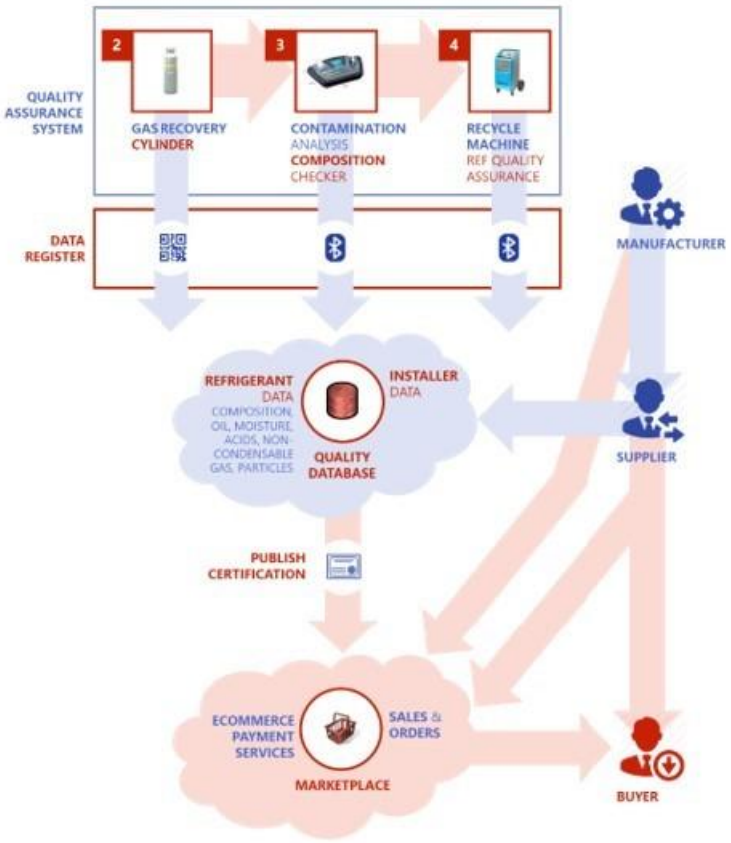


*Figure 1: Overview of the 3R ECOSYSTEM.*

# Contents

# 1 Self-certification platform

## *1.1 Basic principles*

It is a robust recovered process methodology, allowing to track F-gas handling within all European markets. Basically, it serves as an open access database (f-gas Logbook) as well as an appropriate market placement of the recovered F-gases. Hence, smoothening the transition phenomena from abundant F-gases market to phasing out F-gases market and creating a value proposition of the recovered F-gases. In addition, it plays the role of a corner stone in order to build a high-quality refrigerant circulation economy and eliminate low quality recycled refrigerant from the market by involving all stakeholders (installers, service companies, gas distributors, gas producers and manufacturers).

## *1.2 Database design and development*

The easy access to the Self-certification platform is one of the basic goals of the Retradeables project. During the database design process, the definition and categorisation of all individual parameters that will be considered as data entries will be realised. The structure and architecture of the database will encompass filtering, constraints, mandatory fields and other abilities that will assist the ease of access by users (mainly installers) and at the same time the supervision by the administrator.

The administrator of this platform will be a third party, such as LSBTP of NTUA. All necessary actions will be foreseen, assuring the traceability of all quantities during the recovery, analysis, data logging and re-usage process. In addition, an index value will be linked to every registered user. This index value will be updated regularly based on criteria such as on time delivery, stated quality of the F-gas, regularly calibrated analysers, other quantitative and qualitative criteria.

At a consecutive stage, when the database will be developed and finalised, all eligible stakeholders (mainly installers) will be able to insert prerequisite and optional additional details of all retrieved, analysed and/or classified batches of F-gas quantity. The basic idea is that stakeholders through a self-declaration scheme will be able to use the database. This database although it will operate as a standalone tool, it will be also linked to the 3R ECOSYSTEM platform, providing all necessary data.

# 2 F-gas identification & recycling units

## *2.1 Basic principles*

Currently in the market there are different solutions available for the air-conditioning and for automotive. For AC, there are refrigerant composition analysers available but they cannot perform also estimationof oil and moisture content. To do so a different device

needs to be used which adds complexity and also increases the cost of the intervention – more time spend to perform the required actions.

In the automotive sector there are tools that allow the identification of specific gases (e.g. R1234y) but do not perform a composition analysis. The prototype unit that will be developed during the project will combine the refrigerant composition analyser with the recovery and recycling unit allowing to simplify the procedure significantly for the installer, in real-time and on site. Furthermore, the unit will incorporate IoT technology that will allow the direct data transfer from the unit to the different platforms of the eco-system.

### *2.2 Upgrade units with Internet of Things (IoT)*

Especially, in the last stage of the development of the F-gas identification & recycling prototypes, IoT capabilities will be added to the unit that will allow the easy and quick transfer of the data from the unit to the Self-certification platform. These data will include the identification of the installer and also the composition of the gas prior any action, if the removal of oil and moisture takes place then a new composition analysis will be performed overwriting the previous one.

IoT equipment will be coupled with the unit and the protype will be tested in the laboratory and on field to verify a proper flow of data. This will be the final implementation on the unit allowing the user to have a quick access to the collected refrigerant and to measure its quality. These data will then be available for the 3R Marketplace platform.

## 3 3R Marketplace platform

### *3.1 Basic principles*

This platform is one of the innovations of the project as it ensures to sellers (primary air conditioning -AC- and refrigeration sector) as well as buyers(F-Gas Distribution companies), a reliable trade in real time and onsite guaranteeing legal frameworks, secured payments, transaction methods with transparency standards of recovered F-gases. In other words, the 3R Marketplace platform works like the stock market where demand and supply will be analysed and the average prices for the traded F-gases will be shown to all participants.

### *3.2 Development of the platform*

The development of the 3R Marketplace platform, from the general setup and architecture to the final solution will be based on the “Plan Do Check Act” cycle which is an iterative four-step management method used in business for the control and continuous improvement of processes and products. The platform will encompass a series of work packages to cover all the requirements defined, specifically:

- For Sellers: Company account management/ Company user accounts management/ Company R-Market /Installer account management.
- For Installers: R-Gas management.
- For Buyers: Company account management/Company user accounts management/ Company R-Market.
- Daikin Global Admin, Payment Gateway Solution, others.

The 3R Marketplace platform is based on state-of-the-art technology to provide best performance and easy usage (i.e. Ubuntu Server 18.04; PHP 7; MySQL 5.7; Nginx; Laravel 5; VueJS; HTML/CSS/JS). It will provide seamless process flows including:

1. Registration as an installer or distributor company.
2. Validation check of Refrigerant licenses.
3. Data input of extracted F-gas.
4. Quality check and validation of the extracted F-gas.
5. Stock management of F-gas which should be recycled.
6. Supply and demand management including aggregation of average prices on the market.
7. Selling process including payment solution via SEPA transaction.
8. Data processing of information which is not accessible as today there is no mechanism/platform that helps to aggregate and modulate data directly as it is entered.

# 4 Basic web architecture overview

First of all, the application is a Web Application accessed through the browser with the possibility to be also installed as a Progressive Web Application onto a mobile app, i.e. a slimmed down mobile version of the web site in a container. Thus, it is about a .NET Application built in the React framework on the frontend and with .NET Core on the backend. Data is stored on Azure in a SQL database which is accessed from the backend.

Basically, the Web Application has a frontend URL router built with the “react-router” library which based on the browser URL decides the screen that is appropriate to show to the user. Moreover, it is logically separated into screens which use a service layer to fetch data from the backend. That service layer uses HTTP POST and GET requests to fetch data from the backend and update data on the backend.Also, on the frontend, styling and theming of the app is handled by the Styled Components framework to guarantee reusability and easy swapping of themes in the future.

On the backend, the application is a .NET Web API application built with a layer of controllers between the frontend and the backend which takes requests from the frontend and transforms them into requests for the mediator framework, MediatR. The backend requests are then validated by the Fluent Validation framework, and if valid, processed by a MediatR handler, which uses Entity Framework to fetch and update data on an Azure SQL Server database which guarantees data consistency through relational constraints.

Finally, the application is deployed to a production Azure App Service as a single versioned package after it passes a suite of Unit Tests and additional testing on a quality assurance environment.A simplified system diagram is illustrated in **Figure 2**:

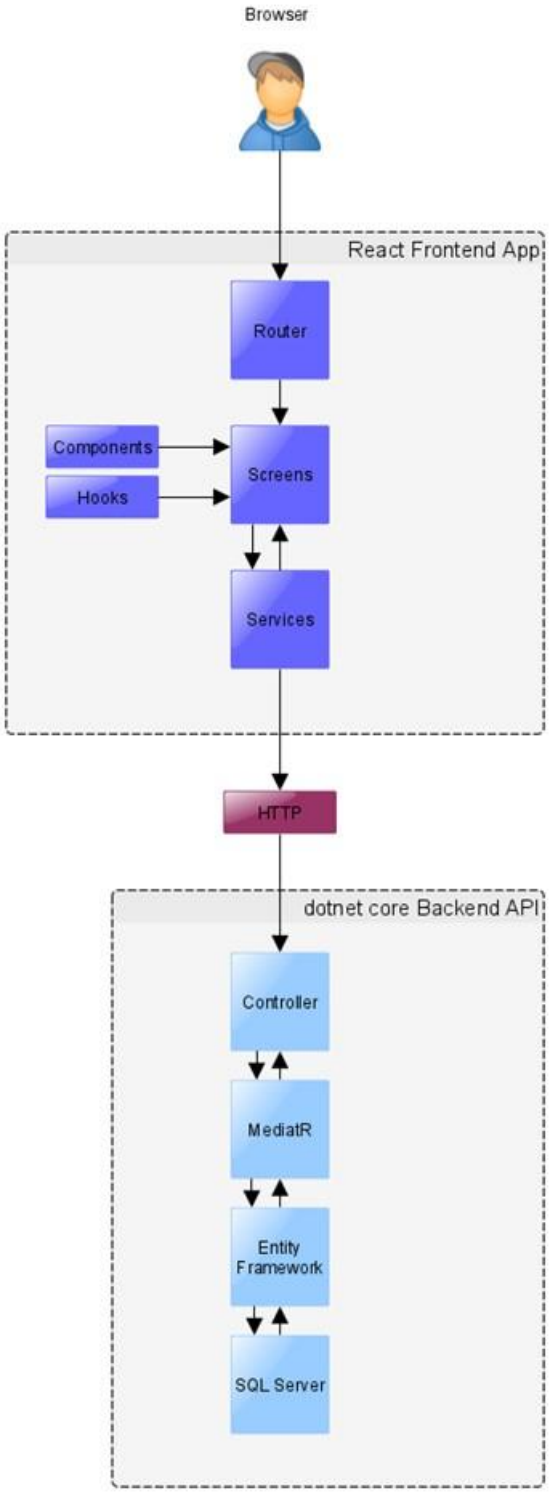


*Figure 2: Simplified system diagram of the applied web application.*