



DECARBONISING AIRPORT REGIONS



SURFACE ACCESS



AIRPORT OPERATIONS



INNOVATION



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Foreword



Sergi Alegre Calero,
vice-mayor El Prat de Llobregat
Airport Regions Conference President
on behalf of the dAIR partnership

Dear Colleagues and Friends,

What made me appreciate the dAIR project from the beginning is the fact that it aims at tackling an important issue – the carbon reduction nearby airports – through cooperation. Cooperation matters because it is very clear to me that a sole actor cannot solve the problem on his / her very own. The dAIR partnership gathers organisations of all types: municipalities, regions, airport operators, and public transport operators. Altogether, they agreed to unite forces, expertise and experience towards a same goal.

When the project was further developed, what I deeply appreciated was its pragmatism. The partners have really focussed on what can actually be done and is currently being done. Partners neglected no small lead: they explored with equal eagerness costly solutions requiring major infrastructure changes as well as quick wins.

What I like about the project now, is the concrete results. Several outcomes are already visible, be it new buses, or new signage, and I know that other partners are now exploring new policies to be implemented in their region or in their airport.

For these reasons, this document is not only the summary of what has been done during the 3 year duration of the project, it is also the starting point for other types of cooperation and projects of interest for many, inside the dAIR partnership and inside the larger ARC partnership, and hopefully also for all those who are committed to reducing carbon emissions.

The reduction of carbon emissions is increasingly higher on the agenda of policy makers. We knew that addressing it properly was a long-distance race, but with dAIR we proved that local politicians and airport managers are ready to take the lead in this race.

Introduction

Project Premise

In December 2010, the Dutch government approved the expansion of traffic at Eindhoven Airport by allowing an extra 25.000 flight movements by 2020. This corresponding to a doubling of the capacity at the time. A number of conditions, mostly regarding sustainability, were linked to this strong growth scenario:

- Achieving carbon neutrality of Eindhoven Airport's operator regarding its own activities;
- The improvement of surface accessibility, with roads to and from the airport already congested, this meant a focus on public transport links.
- Accompanying the traffic growth by creating new business opportunities to the region's innovative companies through 10 regional innovation clusters implementing a triple helix strategy (ie partnering companies, knowledge institutes and public authorities).

Project initiators from the region have been strongly committed to create Europe's greenest civil airport on their territory, and optimise at the same time the synergies between environmental protection and the economy. It was nonetheless clear from this early stage that, whilst the project was deeply rooted in the Eindhoven area, the projected growth of aviation industry's overall activities, its significance in terms of employment and its potential negative environmental effects, sustainable airport development are a Europe-wide challenge for each city and region hosting an airport. Inspiration from all Europe was needed to meet this ambitious goal

Therefore, the City of Eindhoven, with the support from ARC (Airport Regions Conference), called for an interregional co-operation project with airport regions that share these sustainability ambitions. The criteria for participating into the project were the following:

- Airport regions motivated to draw up concrete action plans;
- Organisations having direct influence on regional policy-making with regards to CO₂ neutrality of airports and surface accessibility, 2 major topics related to decarbonisation;
- More and less experienced partners, meaningly, having reached different stage of decarbonisation in order to facilitate optimal exchange of experience;
- Wide geographical coverage;
- Airports with mixed profiles and different parameters in terms of size, capacities, miles travelled, catchment areas, travellers' profiles.

Through an intensive exchange and transfer of knowledge and experience by a consortium representing 10 airport regions with public authorities and airport operators on board, dAIR

and its partners had the ambition to pioneer partnership between stakeholders and to develop approaches and policies to be shared with all other interested parties.

The issue at hand

Since 1970 worldwide aviation industry has marked a 5% average annual growth in activities. For the last 20 years, airports have undergone major changes. Their operators are no longer mere infrastructure providers facilitating airplanes to land and take off. They have become businesses in their own right that act as competitive dynamos for growth. Airports not only support their local economy, more and more, they are defining it. Research shows that airports have a positive influence on local business development, specifically on strengthening clusters and supply chains, which are major backbones for regional economies.

The aviation industry's rapid evolution has already had far reaching repercussions on environment. Total greenhouse gas emission has fallen by 3% since 1990, but emissions from civil aviation have increased. Greenhouse gas emission from international aviation has grown by 87% since 1990. In EU27, about a quarter of CO₂ emission comes from the transport sector, and civil aviation accounts for cc. 12% of this. Thus, civil aviation is cc.3% of total CO₂ emission. Regarding their contribution to carbon footprint, airport activities are responsible for 5%–17% of CO₂ emissions at a given airport. Surface access is the 2nd largest source of the overall CO₂ emissions in most airport regions (with air traffic itself situated in n°1 position), amounting up to 50% of total emissions. As air traffic is forecasted to more than double by 2020, lack of proper ecological policy measures will lead to even higher greenhouse gas emissions from aviation and the surface

transport linked to it, even if technical improvements reduce the growth rate of emissions.

In the context of airport operations, 3 elements need to be considered regarding CO₂ emissions:

- Air traffic
- Airport activities
- Transport to and from airport areas

Given this complex nature of airport operations, no single party can solve CO₂ issues alone. To ensure successful measures, airports airlines, manufacturers, knowledge institutes and regions need to cooperate, each in their own sphere of competence. Cities/regions have a pivotal role to start dialogue with/between these actors in their regions.

dAIR focuses on airport activities and surface access as public authorities, and airport operator have direct influence on regional policy-making in these 2 issues. Public authorities, with the involvement of relevant stakeholders, can shape local/regional policies on surface accessibility. Airport operators partners have a major say in shaping policies linked to airport activities, specifically in relation to CO₂ neutrality of airport terminals.

Greening of transport modes represents an ambitious yet necessary policy objective. For aviation, this is an unprecedented challenge with far reaching technological and economic consequences. If done right, this challenge can trigger new and substantial economic activities. But with the wrong approach airports will become bottlenecks, unable to deliver sustainable mobility and economic growth needed for Europe to compete in the global market.

The methodology of the project

The methodology used in this report derives from experience of previous pro-

jects and from the studies undertaken by some of the partners within the ARC, where it was concluded that measures dealing with both airport operations and surface access have greater impact when dealt with jointly, rather than when addressing a sole leg of the issue.

Each partner provided a start position report, which included the status quo and how they saw their CO₂ situation from both perspectives of surface access and airport operations. In this document they also provided what they thought at the time to be their best practices in attempting to reduce these factors.

Each partner also hosted a study visit where they shared their best practices with the rest of the partners, involved stakeholders of the project in the discussion and debated as to what best courses of action can be taken to achieve their targets. At the end of the study visit, reports were forwarded by all partners, which had time to comment and expand on each other's practices.

A number of criteria was set for considering a practice good or best, and these included the proven value of the practice, how innovative it is, the external costs it would bring about, the reduction in CO₂ it would lead to, the benefits identified overall as well as the process identified, its ease of implementation, and its maturity and transferability. All these factors put together led the partners to decide whether their practice is a good or best practice and can be transferred to others.

What you see in this document is the combination of the lessons learned from all study visits, together with the partner's input in every step of the way. The partners intend it to be a contribution to the overall European effort for meeting carbon reduction objectives, a contribution to the improvement of the quality of life within their region and to a sustainable growth of the aviation.

The project partner regions of the d-AIR project are:

City of Eindhoven, Eindhoven Airport N.V, Airport Regions Conference, Communauté d'agglomération Terres de France, Stockholm Public Transport Authority, Stockholm-Arlanda Airport/Swedavia, City of Leipzig, Mitteldeutsche Airport Holding, City of Vienna, Province of Bologna, City of El Prat de Llobregat, Transport Malta, Mazovia Voivodship and Prague Airport Region.



POLICY RECOMMENDATIONS

The dAIR project aims to share information between project partners on measures implemented to reduce CO₂ emissions from airport operation activities and surface access. The project identifies 20 good practices, and at least 4 of them will be transferred and implemented by a number of partners.

The project pays special attention to the optimal involvement of businesses, R&D communities and universities in creating well-connected green airports.

Through study visits, workshops and stakeholder fora, the 14 member organisations were able to exchange experiences and see what CO₂ reduction solutions have been used and have worked at other airports. They then examined how these solutions can be applied to their own region.

Reports – completed before and after the study visits – gave partners an opportunity to explain the characteristics and impacts of their own practices and to get feedback from other project partners. Based on these reports, a methodology was designed to identify good practices within the project.

The study visits led to fruitful discussions between the participants. The recommendations that follow are the result of these discussions:



These recommendations are the result of a thorough analysis of the practices presented by Project Partners during their study visits. The list of good practices, together with a description of each practice, is available online at www.dairproject.eu

A. GENERAL RECOMMENDATIONS

1. Implement existing policies and legislation concerning CO₂ emissions in the Member States. Economic efficiency is, in fact, the only tool that can force or even enable stakeholders to implement CO₂ reduction measures. If the measures are economically negative or neutral, no actions tend to be taken. For example, state owned enterprises, like Prague airport, are not even allowed to implement any measure which will lead to higher costs unless required by law.

2. CO₂ reduction should be carefully planned and be part of a long-haul strategy. In this context, there is a need to calculate the carbon footprint and establish the emissions generated by the various activities within the airport and its surroundings, not only by airport activities but also by surface access. These are some of the most efficient plans seen during the project:

- Mitteldeutsche Airport Holding Good Practice 'Energy Management System';
- Eindhoven Airport Additional Activity 'Towards Zero Emission'.

3. Establish stringent goals and measurable objectives/targets to achieve the best results. Stockholm's Arlanda Airport, for example, operates under a CO₂ emissions cap and is the only airport in the world to do so. This cap means that emissions from different sources may not exceed the level produced in 1990. However, the cap has to be achievable by limiting CO₂ emissions which can be controlled by the airport and its local authority.

4. Have realistic objectives for the return on investments. CO₂ reduction projects may require investments of varying magnitudes. The dAIR project revealed that companies pay close at-

tention to return on investments (ROI) and only approve investments that will prove profitable. The timeframe given for the ROI may vary substantially between 3 and 9 years. The project showed that a long ROI period prevents companies from investing with a sane economic rationale, whilst a short ROI period may have a very small environmental impact. No strict guidelines or recommendations can be drawn up on the exact duration of the ROI period, as all situations differ. At the same time, however, dose-effect should be taken into account.

5. Introduce a policy for sustainable tendering. Suppliers and subcontractors should be asked about the sustainability features of their products and services. They need to meet a number of criteria relating to environmental performance, quality, safety and security in order to be awarded a contract. The project revealed that sustainable tendering improves efficiency, reduces CO₂ emissions and allows for financial savings. [See end of document]

6. Encourage cooperation between public authorities, universities and businesses in order to develop innovative solutions. [See end of document]

7. Transport and the reduction of CO₂ emissions is a territorial issue that covers several administrative entities. The project showed the usefulness of developing a **cooperative planning culture and governance** that includes all relevant authorities within a given airport area. For instance, Prague airport, as a state owned enterprise, cannot cooperate with surrounding regions, communities and the city of Prague solely on the basis of a decision taken by its owner to support work in the surrounding area. Any airport investment to improve the quali-

ty of the environment around the airport can only be made if it is legally necessary or economically efficient. With this in mind, the Central Bohemian region and the city of Prague need to be involved in the ownership or management of the airport area in order to focus development not only on profitability, but also on environmental efficiency.

8. Build on people's involvement and participation regarding all issues pertaining to their mobility and accessibility needs during the planning and implementation processes.

9. Ensure the energy source is green before implementing projects. The project revealed that it is not sufficient to implement green solutions if the energy sources themselves are not green. Therefore, clear information on the "greenness of the energy" should be a prerequisite of any project/measure.

10. Avoid buzz investments. Do not invest in projects/measures that get a lot of publicity without being backed up by concrete facts attesting their medium and long-term benefits. Costly and complex options that do not offer proportionate benefits should not be pursued.

11. Benchmark in order to offer insight into the different levels of airport energy consumptions and emissions. This is a baseline for defining strategies that can save CO₂ emissions and money.

12. Inform the travellers of what has already been done to reduce CO₂, what's going on for the moment and the future plans. The amount CO₂ saved or planned to be saved should be included. Not in brochures, but on screens placed where people are waiting for trains, planes, buses.

B. AIRPORT OPERATION ACTIVITIES

1. Maximise the use of the existing infrastructure instead of building additional infrastructure.

2. Implement a clearly phased decarbonisation plan. Such a process is described in **the Airport Carbon Accreditation Programme (ACA)**. This is a private scheme endorsed by ACI that helps airports reduce costs, consumptions and emissions while being the baseline for a long-term sustainability strategy. In 2013, ACA was named one of the top 3 low-carbon projects in Europe, out of 269 entries. At the moment, there is no equivalent to the ACA Scheme.

3. Use the **Collaborative Decision Making** or a similar Process to improve

operational efficiency at airports. It reduces delays, improves the predictability of events during the progress of a flight and optimises the utilisation of resources. However, the dAIR project has showed that proper coordination must be ensured among all stakeholders, both at the airport and network level, in order for CDM to be fully effective and deliver the expected environmental benefits (fuel and emissions savings).

4. Improve **energy efficiency of buildings**. There are several certified or non-certified ways of improving building efficiency. The dAIR project revealed that energy efficient buildings are essential in reducing CO₂ emissions. The building efficiency is part of the terms of reference.

5. Promote **intelligent building management systems** to provide optimal control of heating, ventilating, air-conditioning and lighting systems.

6. Use local specificities to encourage the use of **sustainable heating and cooling solutions**.

7. Promote the use of **renewable fuels** for transport (biofuels, ethanol, methanol etc.). These are more sustainable than conventional fuels and only make a low contribution to the carbon cycle.

8. Promote sustainable **winter management techniques**.

C. SURFACE ACCESS

1. Start with low hanging fruits before implementing long and often cost-intensive projects. For example:

- a bus on-demand system is easier to implement than a new metro line.
- maximise the use of the existing infrastructure instead of building additional ones:
 - » **Peak-hour lanes** can reduce the amount of congestion on motorways leading to the airport;
 - » **Express buses** to and from the airport reduce travel time for passengers.

2. Do not rely on the goodwill of passengers to use public transport as they are more inclined to choose convenience over CO₂ reduction. The greenness of their choice is the cherry on top, not the main reason for their choice. In this perspective, **incentives have to be given to passengers to encourage the use of environmentally friendly modes**. These can be financial in nature, since the attractiveness of public transport partly depends on its price.

- Encourage sustainable transport pricing policies that can ensure a fair competition between all transport modes.
- Encourage fair and efficient pricing in transport by giving users and manufacturers incentives to adjust their transport behaviour. By reducing the negative side-effects of transport – such as congestion, accident and CO₂ emissions – the real costs of transport will decrease.

3. Improve **passengers' access to public transport** by:

- overcoming regulatory and other barriers preventing operators from offering intermodal journey solutions (differing insurance requirements, questions related to liability and differing passenger rights legislation applicable to different transport modes);
- introducing multimodal journey planners and reservation systems;
- promoting integrated ticketing (passengers should have the possibility to purchase bus/rail tickets when purchasing their flight or on board the flight);

improving the **availability of travel information and communication towards users** [see also the end of this document];

- **aligning rail, bus, and air transport schedules** to avoid long journeys and change-over times;
- supporting a public transport system to and from the airport that is:
 - » compatible with the mobility needs of passengers and able to quickly adapt to changes;
 - » flexible and integrated with other forms of mobility to allow easy access to the city, its centre and immediate surroundings;
 - » efficient and with high quality standards;
 - » easy to use and reasonably priced.

4. Airports and companies working in or near the airport area need to provide adapted transport systems and solutions

for their employees.

- Reducing mobility needs is a key contribution to a more sustainable mobility. This can be achieved by promoting, where possible, tele-working for staff.
- Develop Mobility Plans for staff and passengers. These are integrated packages of measures designed to support a change in individual and/or group travel behaviour and promote more sustainable transport modes.

5. Take into account the demand, ticket prices and the types of vehicles used when **designing new bus services**.

6. Improve the availability of taxis at the airport terminal and encourage companies to provide **clean taxis**.

7. Promote solutions encouraging the **energy efficient use of vehicles** – such as [eco-driving](#) – to reduce fuel consumption.

8. Introduce **electric cars** only if the energy production is green (renewable energy).

9. Promote **check-in and baggage drop-off arrangements at railway stations**.

10. Go **beyond conventional transport** systems. The dAIR project showed that walking, cycling, and shared modes can be promoted by projects in order to contribute to the reduction of CO₂ emissions.

D. INNOVATION

Innovation is the main driver of economic growth in the EU. Decoupling economic growth from environmental pollution (often translated in CO₂ emissions) is an ambition shared by many. Since airports, and their enlargement, are a spearhead in most local and regional economic growth agendas of the dAIR regions, they constitute a unique test case to realise this ambition, in which innovation – doing things differently and in cooperation, since no one party is able to realise this goal by itself – is key as well.

Public authorities are not the principle actors in innovations, but they have a unique role in fostering and facilitating innovation activities in their territories. Public authorities and local and regional public authorities in particular, have a key role in **shaping the right framework conditions** for innovation:

- **Develop a regional innovation ecosystem working on a common agenda:** Local/regional public authorities are positioned at a unique intersection between private businesses, knowledge and research institutions, and intermediary organisations.

» Bring these relevant actors together and use the combined strength of critical mass and physical proximity to jointly develop a shared vision and strategy for sustainable airport development.

» Build on local/regional expertise and facilitate knowledge spill-over during the implementation.

- **Make citizens and end-users active agents in the innovation process:** Demand-led innovation has a higher success rate and integrated end-user knowledge from the start accelerates the market uptake of new products and services. Involve citizens and end-users from the very start.
- **Create structures to allow the co-creation of innovations:** Living Labs (LLs) are environments used by companies and knowledge institutes to develop products and

services in close cooperation with end users. LLs often operate within a territorial context, such as cities or regions. Public authorities can facilitate the emergence and operation of LLs by providing the necessary (ICT) infrastructure, such as broadband networks, and by providing service support to LL actors.

At the same time, public authorities do have a **role to play in their own right**:

- **Take position in a multi-level governance context**

Due to their proximity to and experience with local actors and institutions, local/regional public authorities play a key role in connecting their territories to the national and European level. Influence policy and decision-making at those levels to enable the implementation of local/regional action plans.

- **Public Procurement of Innovation (PPI) : use your purchasing power to stimulate the market uptake of innovation**

Public authorities can act as launch customer for innovative goods or services which are not yet available on a large-scale commercial basis and may include conformance testing. PPI results in the first application/commercialisation of innovative solutions (goods or services with better performance than existing products on the market). Authorities should do so since a big, stable demand through government procurement can create demand long before a commercial market is established. This has several advantages:

» By acting as the first buyer or lead customer, a contracting authority can spur a particular market to stimulate the economy and increase competitiveness of firms in new markets. In turn, it will help to create new businesses and increase employment.

» Producing better products and services. The public will ben-

efit directly by being offered new and innovative public services, cheaper and provided more efficiently and effectively.

- **Pre-commercial Public Procurement: create new knowledge**

The procurement of research and development (R&D) is an important tool to stimulate innovation. It allows public authorities to steer the development of new solutions, tailored directly to their needs. PCP is the procurement of research and development services. It involves different suppliers competing through different phases of development, while the risks and benefits are shared between the procurers and the suppliers under market conditions.

Risk-benefit sharing under market conditions refers to the approach in PCP where procurers share with suppliers, at market price, the benefits and risks related to the intellectual property rights resulting from the R&D.

By acting as technologically demanding first buyers of new R&D, public procurers can drive innovation from the demand side. This enables European public authorities to innovate the provision of public services faster and creates opportunities for companies in Europe to take international leadership in new markets.

- **Open up public data**

The reuse of public sector information has great economic potential. By playing a leading role in implementing open data policies, local/regional authorities can improve liveability, stimulate business and engage and empower citizens. Authorities can use data to provide (real time) information in order to address issues from traffic congestion to peak load electricity management. Making data available has the potential to address a number of societal challenges, stimulates behavioural change and, moreover, can be at the origin of the creation of new economic activities.

IMPROVING AIRPORT OPERATIONS

Reducing fossil and renewable CO₂ emissions from airport operations is a major concern for airport operators. Over the past years, airport operators have taken measures contributing to the reduction of emissions generated for example by taxiing, airport vehicles, heating and cooling of airport buildings as well as by many other activities falling within their control and accounted for within their footprint calculation.



Airport operators have taken measures contributing to reduce emissions

I. Introduction: dAIR solutions to reduce CO₂ emissions from airport operations¹

The dAIR project showed that while obligations and targets are set out at national and European level – such as the EU Emissions Trading System, EU Effort-Sharing Decision and the Renewable Energy Sources Directive – there are also many voluntary regulatory drivers that play a significant role in reducing fossil and renewable CO₂ emissions. These include carbon certification schemes such as ACI-Europe Airport Carbon Accreditation.

Energy efficiency technologies and practices are of primary importance for airports as they allow savings in terms of energy costs and CO₂ emissions. To this end, the dAIR project partners have implemented a series of measures that rely on clean production of energy such as solar farms and biomass plants. In addition, measures such as demand-controlled ventilation and the implementation of an Energy Management System led to the decrease of CO₂ emissions through the reduction of energy consumption.

Overall, the measures implemented by dAIR project partners led to a reduction of fossil and renewable CO₂ emissions for airport operations. These measures were aimed at: Setting emission standards or prescribing procedures

¹ Eurotran has introduced the distinction fossil vs renewable CO₂ emissions wherever it was possible. In the absence of certainty as regards the origin of CO₂ we have left them out.

for reducing CO₂ emissions;

- setting emission standards or prescribing procedures for reducing CO₂ emissions;
- reducing CO₂ emissions from aircraft handling operations (ground support equipment and airside traffic); and
- reducing CO₂ emissions from stationary sources by using renewable energy for the airport buildings (changes as regards power/heating/cooling sources).

II. The EU legislative framework

This chapter aims to provide a short overview of the legislation adopted by the European Union that focuses on decarbonisation and has a direct impact on airport operations.

1. European Strategies and Roadmaps (not legally binding)

a. 2011 Transport White Paper

Today, aviation accounts for 2% of the world's carbon dioxide emissions. The European Commission's 2011 White Paper on Transport aims to achieve a 60% reduction of greenhouse gas (GHG) emitted by the transport sector by 2050. As far as aviation is concerned, there is a global agreement that aviation emissions will not be allowed to increase after 2020, and that the aviation industry has to cut its global carbon dioxide emissions by half by 2050 compared to 2005.

b. Communication on a policy framework for climate and energy in the period from 2020 to 2030

The Communication COM (2014) 15 on the policy framework for climate and energy in the 2020-2030 period sets out the following targets for GHG reduction and renewables development:

- By 2030, GHG emissions have to be reduced by 40% as compared with 1990 levels. This will take place entirely through the implementation of reduction measures :
 - » The sectors subject to the EU-ETS, such as the aviation sector, must reduce their GHG emissions by 43% as compared with 2005 levels.
 - » The other sectors, such as

transport, trade and services, must reduce their GHG emissions by 30% as compared with 2005 levels.

- By 2030, at least 27% of overall energy consumption has to be provided by renewables.

c. Energy Roadmap 2050

The Energy Roadmap 2050² sets out a cost-efficient method to reach the target of reducing greenhouse gas emissions by 80-95% below the 1990 level by 2050. This means near total decarbonisation of the energy system. The roadmap proposes 5 decarbonisation scenarios without choosing one option over another. This decision is being left to EU Member States. High renewable energy sources: strong support for renewable energy leading to a very high share of renewables in gross final energy and electricity consumption

- Delayed Carbon Capture Storage (CCS): technology competes on a market basis, but CCS is delayed, leading to more nuclear
- Low Nuclear: technology competes on a market basis but assuming non new nuclear and requiring more CCS

d. Forthcoming European Commission proposals

Upcoming reports that will be published by the European Commission by the end of 2014 also deal with decarbonisation:

- **Commission Report on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling.** The general objective is to achieve the EU target of increasing the share of renewable energy to 20% by 2020 and contribute to reducing GHG emissions. More particularly, the target is to:
 - » optimise GHG savings and prevent adverse land use change;
 - » lift barriers to biomass trade and prevent potential disruptions and distortions to the internal market;
 - » ensure industry is given the certainty in investment conditions they need in order to meet the 2020 renewable energy target and deliver security of supply.

² COM (2011) 885 final, COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Energy Roadmap 2050

2. EU law

a. EU Emissions Trading System (EU ETS)³

To create incentives to cut emissions from gate to gate, the EU has introduced a market-based approach whereby airlines must buy emissions permits. Since 2012 all emissions from flights to/from EU and EEA (28 Member States, Iceland, Lichtenstein and Norway) are included in the EU Emissions Trading System (EU ETS). Until 2016 however, only flights within the EU/EEA are included.

- Airports may be covered if operating combustion units of total rated thermal input is less than 20MW (probably rare situation).
- Airports sourcing energy from 3rd party providers falling under the EU ETS are (very likely) subject to pass-through of EU ETS compliance costs.
- Alternative energy sources/energy efficiency measures become an important consideration for airport operators (especially with full auctioning).

b. The Effort-Sharing Decision

The Effort Sharing Decision (ESD) was a result of the 2009 EU Climate and Energy Package which sets out the EU's commitments towards 20% greenhouse gas emissions reduction below 1990 levels by 2020. ESD sets out binding national targets for GHG emissions (including CO₂ emissions) not covered by EU ETS. It includes:

- Airport emissions directly covered by ESD: vehicles and other ground equipment, buildings, own (non-EU ETS) power generators and own waste incineration/treatment.
- Activities associated with airports also covered: emissions from road network and off-site waste management.

Member States are expected to implement their own policies, but there are several EU level policies that will assist in reaching the overall 10% EU GHG emissions reduction by 2020 compared to 2005. Among these are the Energy Performance of Buildings Directive and the Directive on Landfill and Waste.

Member States must report their

³ DIRECTIVE 2009/29/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community



EU Commission's
Energy Roadmap for
2050

emissions in the ESD sectors on an annual basis. The first national inventories reflecting ESD compliance are due on 15 March 2015.

c. Renewable energy sources directive (RES)

In January 2007, the Renewable Energy Roadmap was published, outlining a long-term strategy. It called for a mandatory target of a 20% share of renewable energies in the EU's energy mix by 2020. The EU Directive 2009/28/EC on renewable energy sources also required Member States to have submitted national renewable energy action plans by 30 June 2010 and national overall targets for the share of energy from renewable sources in gross final consumption of energy in 2020.

According to the RES directive, the renewable energies are: wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant, gas and biogases.

*

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Many airport regions support these goals and are starting to implement certain measures in order to meet the objectives set by the European Union. The

following chapters address some of the projects and measures implemented by the dAIR project partners in accordance with the EU and national CO₂ reduction objectives, and as a result of their own, sometimes stricter and more ambitious, policy goals.

III. Managerial incentives that reduce CO₂ emissions

1. Optimise airport operations through cooperation and certification

a. Airport Collaborative Decision Making

Airport Collaborative Decision Making (CDM) allows airport operators, aircraft operators and ground handlers to exchange information more efficiently and transparently. More particularly this process: Optimises the aircraft turnaround process and improves operational efficiency,

- optimises the aircraft turnaround process and improves operational efficiency;

- improves accuracy and predictability of arrival and departure information; and
- improves punctuality as airport partners work together as an aircraft turnaround team.

At the airport of Barcelona El Prat, the CDM project is still in the early stages of implementation (scheduled for the 2nd quarter of 2015) therefore there is no data that will allow a reliable assessment of the reduction of emissions quantified in terms of fossil CO₂ (tonnes/year). However, Charles de Gaulle airport in Paris, which received the CDM European label on 20 June 2011, has managed to save about 17,000 tonnes of fossil CO₂ per year thanks to CDM. Other benefits connected to the implementation of CDM at Charles de Gaulle airport include:

- improvements in the punctuality of flights. Departure schedules are respected in 85% of cases, with peaks at 91% (against 80% previously).
- reduced taxiing time by up to 2-4 minutes per plane. This leads to the reduction of fuel consumption and CO₂ emissions.

Collaborative Decision Making is high on the aviation agenda. However,

proper coordination must be ensured among all stakeholders, both at the airport and network level, in order for CDM to be fully effective and deliver the expected environmental benefits (fuel and emissions reduction).

b. Certification : Airport Carbon Accreditation Scheme

Several airports are implementing a clearly phased decarbonisation plan. Such a process is described in the **Airport Carbon Accreditation Programme (ACA)**. This is a private scheme endorsed by ACI that helps airports decrease costs, consumptions and emissions and is the baseline for a long-term sustainability strategy. The scheme encourages the assessment and recognition of participating airports' efforts to manage and reduce their CO₂ emissions with four levels of certification:

- Level 1: Mapping (footprint measurement),
- Level 2: Reduction (carbon management towards a reduced footprint),
- Level 3: Optimisation (third party engagement in carbon footprint reduction),
- Level 3+: Neutrality (carbon neutrality for direct emissions by offsetting).

The scheme is quite demanding and requires assessable efforts and investments by the airports. The scheme allows for the reduction of fossil and renewable CO₂ emissions from a number of different sources:

- airport own operations,
- staff business travel emissions.

As an example, Bologna airport joined the scheme in order to develop specific internal expertise in the field of carbon emission calculation and management and to improve strategic energy management decisions. The implementation of the scheme required the investment of financial and professional resources, and included the direct involvement of the Ministry of Environment. In the beginning, Bologna airport decided to join the scheme at Level 1 although Level 2 was within reach. This decision was taken in order to give enough time to the airport to obtain and consolidate the internal competences needed for the calculation and verification of energy consumption and related carbon emissions. Since then, Bologna has reached level 2 and an upgrade to level 3 is planned. This will



The Airport Carbon Accreditation scheme encourages the assessment and recognition of participating airports' efforts to manage and reduce their CO₂ emissions with four levels of certification.

ACA Scheme in Bologna:

- Between 2001 and 2012 (13% CO₂ emissions saved) the energy efficiency measures undertaken have focused on the :
 - » inverter on the air treatment systems,
 - » chiller and evaporative towers,
 - » revamping land side lighting towers
 - » replacement of the terminal thermal plant.
- Between 2012 and 2013 the airport focused on the revamping of the lights at the terminal. This led to a 6% reduction of CO₂ emissions.
- For the 2013-2020 period, several measures, which can reduce CO₂ emissions by about 14%, have been identified. Some of these measures are:
 - » Replacement of the diesel fuel power stations with a heat pump system,
 - » Installation of electrostatic filters on air unit system,
 - » Replacement of parking and beacon towers lights,
 - » Implementation of Photovoltaic systems.

NOTE: All of the savings estimated refer to the 2008 airport CO₂ emissions.

be partly achieved through studies and programmes developed within the dAIR project, with particular reference to the indirect emissions (road traffic and public transport connections).

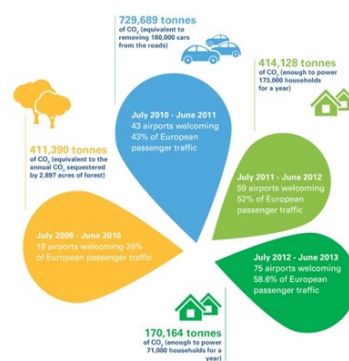
As part of the Airport Carbon Accreditation Scheme, **Prague** Airport has advanced to the level of reducing the carbon footprint (Level 2). Overall, since joining the initiative in 2010, the airport has managed to cut its carbon footprint by 2%. Prague Airport has set itself the target of a 9% reduction in its carbon footprint by 2017 as compared to 2009.

Barcelona El Prat airport's current level of ACA accreditation (Level 1: Mapping) requires the calculation of its carbon footprint. This calculation reports on the carbon footprint and represents an activity that requires the use of the airport's own resources but does not bring about any direct economic benefits. The economic benefits come from the constant improvements or sustainable energy management (reduction of energy consumption: fuel and electricity). In November 2009, Stockholm Arlanda became the first airport to achieve the highest level of certification (Level 3+: Neutrality). Certification at ACA's highest level (3+) means that the airport can give an account of its own fossil carbon dioxide emissions as well as emission sources that the airport can influence. All emission sources are verified by an independent auditor. The airport must also be able to show reductions in its own emissions and involve other companies and organisations at the airport in reducing their own emissions. Finally, the airport should be climate-neutral in its own operations. In other words, the net carbon dioxide emissions over an entire year at Stockholm Arlanda airport are fully offset.

Examples of improvements carried out at Stockholm Arlanda airport include the:

- replacement of heating systems, vehicles, ventilation and climate control systems;
- installation of motion detectors for lighting and LED light bulbs;
- purchase of electricity from wind power facilities and carbon dioxide-neutral district heating; and
- increased use of renewable fuel for vehicles.

When Stockholm Arlanda airport joined the ACA Programme the processes for mapping and follow-up as well as a reduction plan were more or less in place. This led to a smooth im-



NB: Amount of CO₂ saved due to the use of the ACA Scheme

Source: Airport Carbon Accreditation

2. Incentives for airlines : WheelTug

The WheelTug system has been in use at **Prague** airport since 2010. Traditionally, pushback vehicles move aircraft backward from gates while the engines power taxiing. The WheelTug on the other hand is an electric built-in motor which is attached to the nose wheel of the aircraft. It is able to move the aircraft backward and forward without having to engage the main engines or tugs. It allows aircrafts to taxi with the engines off, from the apron to the runway (take-off) or from the runway to the gate (landing).

The aim of the WheelTug system is to save time, fuel and money for airlines and airport operators while at the same time simplifying operations. The resulting improvements in efficiency, flexibility, and the reduction of fossil CO₂ emissions promise annual savings of more than € 381,000 per aircraft. The cost of the measure will be defined by the producer, as at the moment only one prototype is available.

The challenges that could be encountered when implementing this measure include:

- making the plane heavier and thus influencing fuel consumption;
- limited benefits when taxiing in whole cycles is less than 6 minutes;
- producing large benefits only at big



airports; and

- requiring two ground crew members using existing approved powered pushback procedures that visually (and/or with Communications & Information) guide the pilot, compared to the one driver required for a pushback tractor.

Overall, WheelTug allows for:

- time and cost savings for operators; and
- higher safety and lower emissions at the airport.

Despite high fossil CO₂ savings (up to 53% reduction), WheelTug has so far mostly been used when airlines received an incentive to do so by the airport.

3. Taxiing time reduction and electric GPUs

Airport operations can have considerable effects on the environment. Long taxiing times and Ground Power Units (GPUs), for example, are responsible for noise and fossil CO₂ emissions. Several solutions were proposed by the dAIR project partners to tackle these problems.

Historically, GPUs have been powered by diesel engines. From 1976 onwards, the diesel GPUs at Stockholm Arlanda airport were gradually replaced by electric ones. Today less than 5% of Stockholm Arlanda's GPUs are diesel powered and are only used in exceptional circumstances (e.g. when an aircraft has to be parked further away than the extension cable allows). As Swedavia only uses "green" electricity, fossil CO₂ emissions have been cut.

Another approach has been to reduce taxiing time and therefore the need to use GPUs for aircraft taxiing. At **Charles de Gaulle Airport** a one kilometre long new taxiway called Echo 4 was built in 2008. The new taxiway is located to the East of Paris Charles de Gaulle airport, between La Galerie Parisienne and the regional terminal 2G (opened in September 2008). This new taxiway helps reduce taxi time and the number of stops as well as fuel consumption.

From 2008 to 2009, the airlines operating from Terminal 2 at Paris-Charles de Gaulle airport reduced their taxi time by 90,000 minutes (1,500 hours). Based on an average taxiing consumption of 12 to 14 kg/minute for medium haul flights and 25 to 60 kg/minute for long haul flights, nearly 1.1 million litres of fuel can be saved each year.

Outside the dAIR project, the Green



WheelTug allows for time and cost savings for operators and lower emissions



Despite high fossil CO₂ savings (up to 53% reduction), WheelTug has so far mostly been used when airlines received an incentive to do so by the airport.



Malta has high potential for making use of solar energy through the installation of photovoltaic (PV) units.

Sustainable Airports project has developed a joint strategy, toolkit and model on eco-efficient airport operations. As part of this project, Groningen Airport, has started developing and testing bio-diesel powered GPUs.

IV. Less CO₂ intensive energy solutions: sustainable energy production and consumption

1. Introduction of new energy sources

a. Renewable energy

i. Heating solutions: Biomass plant

A biomass plant works by recovering green waste and converting it into heat. This type of heating system implemented at **Paris Charles de Gaulle** airport replaced the gas boilers previously used

by the airport. The biomass plant allows Aéroports de Paris (airport operator) to produce heat through the combustion of wood waste from tree pruning which is supplied in the form of wood chips. The ashes are reused as agricultural fertiliser by the company providing the wood chips for the biomass plant.

35,000 to 40,000 tonnes of wood are needed each year for the operation of the biomass plant. The wood is transported by truck from the forest around the airport (50km to 100km away from the airport) to the biomass plant.

With a 78,000 MWh capacity, the plant is capable of meeting 26% of the airport's annual heat production needs.

ii. Heating and cooling solutions

i. Solar farm

Solar farms have a variety of usages such as producing electricity and hot water for the airport buildings at a reduced cost while at the same time saving CO₂ emissions. In fact, Malta International Airport,

Charles de Gaulle Airport, Barcelona Airport and Bologna Airport have all implemented or are planning to extend the implementation of solar farms. The generation of energy through renewable sources results in fewer emissions than conventional electricity generation.

In Malta for example, land area is very limited due to the small size of the island and the high population density. However, within the airport area, there are large tracts of open land that cannot be used since they are within the flight safety zones. Solar panels are relatively small and flat and it is possible to install a number of these within the unused areas around the runway. The roofs of Malta International Airport have already been covered with such panels. These generate 165,000 kW of annual electricity.

Malta has favourable climate conditions and almost-guaranteed sunlight. Therefore there is a high potential for making use of solar energy through the installation of photovoltaic (PV) units. In fact, in Malta there has been a drive for the uptake of PV units with the govern-

ment offering schemes towards this end.

As a general rule, a standard 1m x 1.5m PV panel is rated at about 250Wp although there are both less efficient panels and others which can go as high as 340Wp. In Malta, for each kWp of panels installed the annual yield is 1,600kWh. The affordability of the investment depends on the cost. In general PV panel prices vary considerably depending on brand however an average price of 1,500Euros/kWp is considered reasonable for a relatively large PV farm with a panel life expectancy of 20 years.

The airport operator has already installed a number of PV panels on the roof of the Malta International Airport (MIA) building and is considering the installation of more panels within the airport boundary. Other stakeholders within the boundary are also considering the adoption of this measure. Based on discussions held with these stakeholders there is the possibility for a total of 16.991MWp of PV panel installations in addition to the existing 0.096MWp. This however depends on the definition of what area is considered to be critical or non-critical. These proposed installations would be capable of generating 27,186MWh/per year and could cost about €25.5 million.

Moreover the PV panels would also offset the generation of 10,440 tonnes of CO₂ emissions. Translating the carbon emissions into monetary terms based on the shadow price of carbon at a discount rate of 5.5% over a twenty year period generates a value of €3.1 million in NPV terms.

The direct benefit of this measure is lower carbon emissions resulting from the airport activities since the PV installations will substitute the use of fossil fuel generated electricity with renewable energy.

Monitoring is quite straightforward since the PV systems would need to be checked to ensure that the annual yield of green electricity is in accordance with the PV systems' guarantee. Annual yield in the case of PV systems can be very reliably predicted.

The **G Marconi airport in Bologna** has also set up a photovoltaic plant as the consumption of electric energy in the terminal was high and the airport had many free areas on various roofs. This photovoltaic system is part of a general plan to reduce electric energy consumption at the airport. The system allows for the reduction of 260 tonnes of CO₂ per year.

Aéroports de Paris set up a photovoltaic plant at CDG airport in 2013 com-

posed of 792 panels and covering a total surface area of 4,000 m². This ground solar power plant produces 167,530 MWh of electricity which is injected directly into the Aéroports de Paris network. The airport intends to reduce CO₂ emissions by 25% compared to 2009 and reach the goal of 15% renewable energy in its internal energy consumption.

Carried out in partnership with the French Civil Aviation Authority, the design uses polycrystalline solar panels containing special glass to limit optical reflection. There has been considerable debate and various studies on a potential 'glint and glare' problem caused by some types of solar panels that could lead to temporary 'flash blindness' in air traffic controllers at airports or pilots.

The direct benefits of this measure are:

- lower carbon emissions resulting from the airport activities (substitution of fossil fuel generated electricity with renewable energy);
- a lowering of the electricity bill of the airport; and
- possible sale of energy through the grid.

The following challenges were identified by the dAIR project partners:

- Production of solar panels can be polluting.
- The panels have a lower efficiency than fossil fuel.
- Solar panels may be used simply as a marketing ploy.

- There are safety issues related to glare and reflection.
- Adequate surfaces are needed for solar panels.

ii. Aquifer

An aquifer provides the airport with low temperature thermal energy used for air conditioning and preheating of ventilation air. The aquifer is a groundwater reservoir that functions like a thermos flask: Water that is pumped out of the aquifer delivers cooling to the airport during summer and heating during winter. Cold water is pumped out of the aquifer in the summer to be used in the airport's district cooling network. Warmed-up water then flows back and is pumped underground and stored until winter when it is needed to melt the snow in aircraft parking stands and pre-warm the ventilation air in buildings.

Stockholm Arlanda's aquifer has been in service since 2009. The aquifer, which is located in the nearby boulder ridge known as Brunkebergsåsen, makes energy production at Stockholm Arlanda both cheaper and more environmentally friendly. The utilisation of the Aquifer reduces energy costs by about €1 million per year. Stockholm Arlanda airport obtained local funding and a return on investment will be achieved after approximately 10 years. Since 2005, Sweden has been using only "green" electricity and since 2006 only district heating based on biofuel is being used at Stockholm



The aquifer, makes energy production at Stockholm Arlanda both cheaper and more environmentally friendly. The utilisation of the Aquifer reduces energy costs by about €1 million per year. The airport obtained local funding and a return on investment will be achieved after approximately 10 years.

Arlanda. The aquifer makes it possible for this volume of green electricity and biofuel-based district heating to become available for others to buy.

At **Eindhoven** airport, an aquifer has been installed to control the temperature in the terminal. The water is drawn from a depth of 65 meters and connected to the floor heating in the terminal via a heat exchanger and heat pump. The heated water is then stored by the aquifer. In summer this facility provides the necessary cooling.

It is worth noting that in order to build aquifers, permits are required notably to minimize environmental impact. In Sweden, only 10 to 15% of the country area is suitable for aquifers. In the Netherlands depth and water temperature restrictions exist.

b. Electric heating and cooling pump: Thermo-frigo pump

Since 2012, an electric thermo-frigo pump (or thermo-refrigerating pump) is used to heat and cool the **Paris Charles de Gaulle airport**.

This is a type of heat pump that uses a small amount of energy to move heat from one location (air or ground) to another (airport terminal building), but it can be reversed to cool a building. Charles de Gaulle airport decided to implement a thermo-refrigerating pump in order to obtain the HQE (High Quality Environmental standard) building certification for terminal 2E.

Advantages of a heat pump over a standard heating ventilating and air conditioning (HVAC) unit include:

- the lack of a need to install separate systems to heat and cool; and
- high efficiency, as it simply transfers heat rather than burning fuel to create it.

ate it.

At Charles de Gaulle airport the practice allows:

- savings of 1600 tonnes of CO₂ per year; and
- savings of 10 000 MWh/year of gas for heating, and 10,000 m³ of water.

The other terminals of CDG airport could be equipped with a similar thermo-frigo pump in the future.

2. Means to reduce the consumption of energy

a. Energy Management System

The implementation of an energy management system at the airport is a solution to improve the energy-related performance and transparency in power consumption. This system consists of targets, measures and results aimed at

reducing energy consumption.

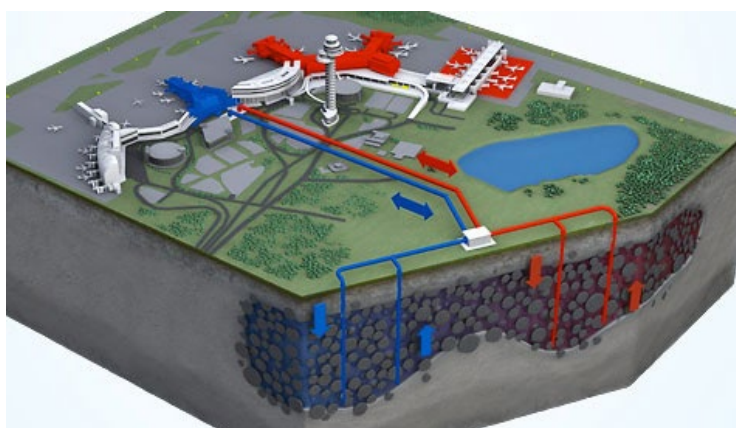
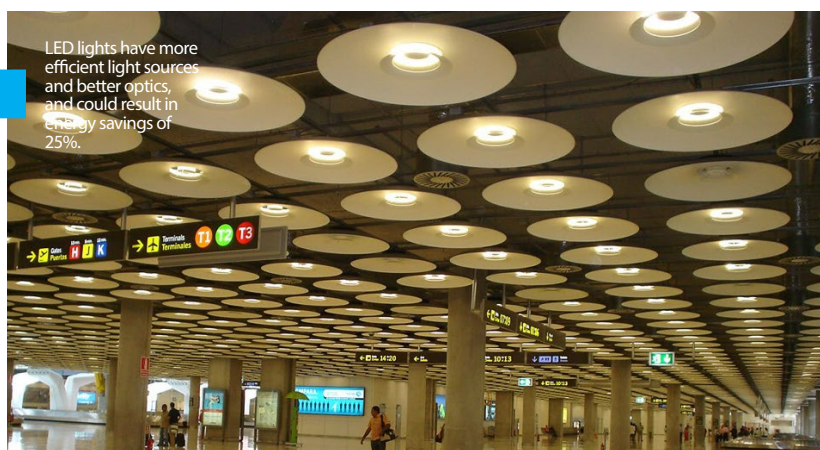
An energy reduction programme is developed annually and approved by the upper management. The programme contains detailed information on facilities and processes that need to be analysed. On the basis of these analyses the adequate implementation measures are identified. The achieved reductions are monitored and documented for further measures.

The definition of processes with formalised procedures increases reliability, continuity and allows for the recording of all results. Initially rejected suggestions for measures can be rated again within the framework of the realised research if the boundary conditions change.

At **Leipzig/Halle** Airport and all other airports operated by Mitteldeutsche Airport Holding, several measures were taken in accordance with the Energy Management System:

- the creation of an annual action plan documenting relevant activities and monitoring results achieved
- the definition and implementation of internal targets for the process management, which requires a clear allocation of responsibility between actors

At **Bologna** airport an EnMS compliant with ISO50001 standard was implemented in November 2013 thanks to an initiative promoted by the Environmental Ministry. The certification process was done in strict alignment with the activities of D-AIR project. Moreover, the EnMS is now fully integrated with





Malta plans to replace their fluorescent tubes with LED lights, which have more efficient light sources and better optics and could result in energy savings of 25%. It is estimated that lighting within the MIA accounts for about 17.2% of the overall building energy consumption. Therefore, the replacement of the existing lighting with LED lights may result in potential energy savings of 4.3%.

other systems ISO9001-ISO14001-OH-SAS18001-ACAScheme in order to optimize the resources invested in the whole management of the organisation

b. Air-based heating and cooling: demand controlled ventilation

At **Stockholm Arlanda** airport ventilation is optimised according to operational needs and adapted to the number of people, time of day, weather conditions and climate. Air flow is regulated according to quality and temperature. This practice reduces air flow by 30% and electricity for air blow engines by 50% or 150,000 KWh each year per terminal (thereby reducing CO₂ emissions).

Although a demand controlled ventilation system reduces CO₂ emissions, the main reason for its introduction is cost effectiveness. These savings do not only derive from energy cost reduction (according to the Swedish Energy Authorities a building can reduce its energy consumption to almost one third by installing demand controlled ventilation), but also from more productive and healthier employees.

Today all ventilation systems at **Stockholm Arlanda** are demand controlled. Since demand controlled ventilation was first introduced at Swedavia (formerly LFV) at the end of the 90's, on average one system has been implemented in a terminal per decade. There was a noticeable change in the reduction of fossil CO₂ consumption until 2005. Since then, "green" electricity derived from renewable energy sources or geothermal energy has been used for ventilation.

Similarly, in order to reduce CO₂

emissions, **Prague Airport** has been reducing the energy consumption of the heating, ventilation, and air conditioning Unit (HVAC Unit) since 2010. At night, 60% of the HVAC Units in selected areas of terminals 1 and 2 are switched off. As fewer passengers are present at the airport overnight, there is less of a need for fresh or hot air. In Prague, this leads to savings of:

- 5,567 GJ (thermal energy)
- 1,480 MWh (electrical energy).
- **1,076,48 tonnes of CO₂ (2% less CO₂)**

c. Lighting solutions

i. Airport building

There are several lighting solutions that aim to reduce CO₂ emissions. While the practices are different, they are part of a common logic. They include:

- avoiding the use of artificial light;
- the use of artificial light only on the premises or at the locations where it is needed; and
- the use of only energy efficient lighting sources. In particular, the use of LEDs resulting in low maintenance costs and 60% energy savings.

Malta airport, for example, aims to increase the use of LED lights in the airport building. The lighting system installed in the Malta International Airport building and also in buildings around the airfield is relatively old and equipped with fluorescent tubes with magnetic ballasts. Their replacement with LED lights, which have more efficient light sources and better optics, could result in energy savings of 25%. It is estimated

that lighting within the MIA accounts for about 17.2% of the overall building energy consumption. Therefore, the replacement of the existing lighting with LED lights may result in potential energy savings of 4.3%.

Certain operators including MIA have already embarked on this initiative which will continue to be implemented gradually as the most inefficient lights are replaced with LED lamps. On this basis there is a possibility to save 958,619kWh which would result in a reduction of 368 tonnes of CO₂ emissions.

At **Eindhoven Airport** different lighting solutions exist to reduce CO₂ emissions. These include:

- the replacement of lights on the platform with LEDs;
- use of motion sensor lighting placed in the offices and terminal.

Prague Airport has also implemented a new lighting system between Piers A and B. It has replaced the fluorescent light sources with LED light sources. This allows annual energy savings of:

- 50MWh (electrical energy); and
- 269,12 tonnes of CO₂.

The improvement and management of lighting (parking garage, administration building, passengers' area, terminal area) at Leipzig/Halle Airport is based on intelligent and needs-based lighting control, which entails:

- using a minimum level of lighting necessary for safety reasons at the airport;
- the analysis of lighting regulation (software programme); and
- the use of new lighting technology (substitution of previous lighting with LED) at the parking garage.

ii. Parking

At **Stockholm Arlanda Airport**, the implementation of lighting control and the purchase and change of lamps and fittings started around 2006. Today there are 120 apron lights, of which all are of high pressure sodium. The airport staff at the ramp tower can control the light remotely and adjust it, by dimming 50% at the aircraft parking stand. The reason for not turning the light off completely is because of security reasons. Earlier, the light was off during the day and on during the night, regardless of whether there was an aircraft parked there or not. This new control system also operates the engine preheaters for snow vehicles, which were implemented at the same time. These two measures have reduced both energy use and maintenance by approximately 50%.

As the light from high pressure sodium lamps is bright orange, they will be replaced by LED flood lights in 2015-2016 with better light and with 40-50% lower energy consumption.

At **Eindhoven** airport on the other hand, the standard lighting armatures of the emergency exits, information signs and car park P3, P5 and P8 have been replaced with LED lighting. Bologna airport has also revamped the lighting of the parking lots by replacing the current lighting system with LEDs. This has allowed the reduction of 120 tonnes of CO₂ per year.

In **Leipzig**, the improvement and management of lighting at the car park for one storey have led to total savings of approximately 100,000 kWh/year (≈ 60 tonnes of CO₂/year). 255 tonnes of CO₂

can be saved per year if LEDs are used in the whole multi-storeyed car park.

V. Physical changes to the surroundings, infrastructure and vehicles

1. New requirements for buildings: building certification

Most fossil and renewable CO₂ reduction measures can be easily implemented at the design stage of a building. In order to account for the numerous sustainable measures that have been adopted within new buildings, several certified or non-certified approaches are available in Europe.

In **Malta**, for example, BREEAM certification⁴ was awarded to Skyparks (building at Malta airport), a subsidiary of the airport operator, which is located within the boundary and accommodates a number of firms and retail outlets. The certification has been awarded in view of the environmentally conscious measures adopted within the building. It should be noted that this building was designed

⁴ BREEAM is an environmental assessment method and rating system for buildings, with 250,000 buildings with certified BREEAM assessment ratings and over a million registered for assessment since it was first launched in 1990. BREEAM sets the standard for best practice in sustainable building design, construction and operation and has become one of the most comprehensive and widely recognised measures of a building's environmental performance. It encourages designers, clients and others to think about low carbon and low impact design, minimising the energy demands created by a building before considering energy efficiency and low carbon technologies.

and constructed with the aim and purpose of achieving BREEAM certification (at a cost of € 100,000). Most of the measures were established at the design stage of the building, so this is a good example of a purpose-built environmentally-friendly building. The example of this site may be adapted to other sites, particularly in the case of new-buildings.

Examples of BREEAM requirements include:

- kicker plates on doors
- noise attenuation
- adequate storage of waste
- ventilation strategy
- glare control

Of course, other building certifications aimed at reducing fossil and renewable CO₂ emissions exist such as



the HQE® Tertiary Buildings certificate used in Paris. This type of certificate was awarded to Gate M, the new Terminal 2E departure lounge at Paris-Charles de Gaulle Airport which opened in June 2012. In order to reach a level of low environmental impact, the 100,000 m² building uses several CO₂ reduction systems, such as:

- energy production by a thermo-refrigerating pump – a high performance electrical system which can be used simultaneously for heating and cooling (see above).
- air-conditioning systems that are supplied by 45 air handling units with energy-recovery wheels or using the free cooling system. By using the displacement ventilation cool-

ing system, the temperature is only controlled up to two metres above floor-level.

- an innovative envelope for the building and large glass surfaces, chosen for its insulation and UV filtration qualities.
- underfloor heating – a network of tubes embedded in the floor disperses heat.

2. Greener airport vehicles

a. Cargo: electric vehicles

Electric vehicles are a viable alternative to oil-powered ones and help reduce CO₂ emissions. Warsaw Modlin airport and Malta International Airport have both acquired electric vehicles for transport-

ing cargo within the airport premises.

Modlin airport has purchased a number of electric vehicles made in Poland that run on batteries. They are used inside the airport to transport light cargo needed for operations as well as staff around the hangars and the main terminal building.

In recent years, ground-handling at Malta International Airport has moved towards a more fuel-efficient fleet by introducing electrically-powered vehicles at the airport. Furthermore, a scissor lift has been changed from a diesel powered unit to an electric one and Medavia plans to replace a diesel forklift with a gas or electricity powered one in the near future.



Electric vehicles are a viable alternative to oil-powered ones and help reduce CO₂ emissions. Modlin airport and Malta International Airport have both acquired electric vehicles for transporting cargo within the airport premises.



A biogas-powered vehicle emits 50-90% less greenhouse gases (carbon dioxide and unburned methane) than conventional technology (unleaded or diesel).

a. Passengers: renewable fuel airport buses

Swedavia (Stockholm Arlanda airport operator) has set the strategic goal of having zero fossil carbon dioxide emissions from the airport's own operations by 2020. An important activity to reach this goal is to have all airport vehicles run on renewable fuels. One project was to convert the buses operating in the airport to renewable fuels.

This implied a two-step process:

- Initially, half of the fleet was changed to biogas buses. Nine biogas buses were purchased between 2006 and 2009.
- Next, nine more buses (the rest of the fleet) were changed during the period 2012-2013. These are hybrid buses powered with FAME (Fatty Acid Methyl Esters).

The availability of fuels was an important factor in the decision-making process. Having only biogas buses would have left the airport too vulnerable. Initially, the public fuel station (Statoil) at Stockholm Arlanda only had one small biogas tank that could not accommodate all users. The buses therefore had to go to the second closest biogas fuel station which is in Uppsala (a 36 km drive from Arlanda) for refilling. Therefore, a new and bigger public biogas station, built by Stockholm Gas close to the original one at Arlanda, was inaugurated in 2010.

There is still a risk that even the new biogas fuel station might run out of biogas. Consequently, the airport does not plan to replace the hybrid buses with biogas buses in the near future. Stockholm

Arlanda airport is considering electrical or biogas hybrid buses to replace the biogas buses in the future.

By replacing diesel buses with biogas and hybrid RME (Rape Methyl Ester) buses, the proportion of renewable fuel reached approximately 70%. The savings in fossil CO₂ emissions amount to 750 tonnes per year. A biogas-powered vehicle emits 50-90 % less greenhouse gases (carbon dioxide and unburned methane) than conventional technology (unleaded or diesel). Emission variations depend on how the gas is produced and on the efficiency of the engine. The amount of CO₂ emissions from "tank to wheel" is known,

but it is harder to find out the amount of CO₂ emissions resulting from the production and transportation of the different fuels. Compared with conventional petrol-fuelled vehicles, the CO₂ emissions of a vehicle using 100% biogas are about 65% lower.

The main challenges are related to the:

- availability of biogas. This was a challenge especially in the beginning of the project as diesel is still a lot more accessible than biogas.
- organisational issues linked to frequency and time for filling. Filling up



By replacing diesel buses with biogas and hybrid RME (Rape Methyl Ester) buses, the proportion of renewable fuel reached approximately 70%.



with gas is more time consuming and has to be done more frequently than with diesel. The biogas fuel station at Stockholm Arlanda airport is the only one in the neighbourhood. Therefore, this situation may cause long waiting lines that are especially unprofitable for taxis. In order to minimise this problem, biogas buses refill at night.

- inability to use RME at temperatures below – 15 Centigrade due to thickening. To prevent the RME from going rancid, a special cleaning process has been integrated within the tank at the fuel station.

c. Airport maintenance: Engine pre-heaters and clean fuel for snow sweepers

Starting the engine heaters for snow re-

moval vehicles can be planned according to the weather. Stockholm [Arlanda](#) airport has implemented this measure which has had a significant impact on fossil CO₂ emissions. It is estimated that the measure led to an energy consumption reduction of approximately 140 Mwh per year, which is equivalent to 14 tonnes of CO₂.

The implementation of the control of engine preheaters in different areas took place between 2006 and 2008. Today, there are 19 snow removal vehicles and all are equipped with engine preheaters. Previously, these vehicles' engine preheaters were connected 24 hours a day during October-March, but today they are only connected 4 hours/day on average over the same period. The control of engine preheaters is planned according to the weather and

using a computer. They can also be controlled via a mobile phone.

The reason for preheating is to decrease the wear of the engine and hydraulics, but also to increase the combustion of fuel. The snow removal vehicles run on conventional diesel and may save up to 1 litre of fuel when starting with a warm engine instead of a cold one. Exhaust from cold engines is rich in carbon monoxide and toxic air contaminants. But the preheating of engines for 2 to 3 hours before starting reduces carbon monoxide emissions by nearly 60%. The measure has reduced the energy use by approximately 80%.

It took some time for the operators to get used to handling the system and the system had some boot problems in the beginning. There is perhaps a possibility of lowering the connecting time to 3 hours/day on average.

Similarly, as part of its strategy to reach zero fossil carbon dioxide emissions in 2020, Stockholm Arlanda airport aims to introduce clean fuel for its snow sweepers. In this perspective, a biogas-powered snow sweeper prototype has been tested in Kiruna. This showed positive results, and in the upcoming winter season eight snow sweepers running on biogas will operate at Swedavia's Airports. Two of these actually belong to Stockholm Arlanda, but cannot be used there until a biogas fuel station is built on the airside. The one on the landside is not only too far away, it also does not have enough capacity to serve these snow sweepers.



AIRPORT OPERATIONS: QUICK WINS

These are short term measures that can be implemented relatively quickly, have good visibility, and can contribute to the sustainability goals.

- Implement fast closing exit doors (so as to avoid thermal loss)
- Green IT (reducing the environmental impact of IT operations: computers, servers, printers, etc.)
- Insulation and green roofs covered with vegetation
- Power transformers switch off
- Service area eco-design
- Lights operate only when there is movement in a certain area. This reduces the time that lights are switched on.
- Electrical equipment that is not required to be in use 24hrs can be fitted with a timer so that it switches on only when necessary.





Prague
Airport



CZ 2AC 4911

IMPROVING SURFACE ACCESS TO AND FROM THE AIRPORT

For most of the dAIR project partners, decarbonisation is one of the main policy drivers. Decarbonisation is not just an environmental issue, it has an effect on the economy as a whole. There are numerous long term gains that can result from the decarbonisation of transport to and from the airport.

I. Introduction: dAIR solutions to reduce CO₂ emissions from surface access

While the aim of the dAIR project is to reduce fossil CO₂ emissions, some project partners have not only reduced CO₂ emissions, but have actually achieved carbon neutrality through the use of renewable sources. Measures such as the implementation of electric vehicles can contribute to such results.

The dAIR project has also clearly demonstrated that besides the imposed regulatory drivers at EU and national level, voluntary environmental commitments play an important role in reducing fossil CO₂ emissions. Furthermore, when local or regional authorities, transport companies and airport operators work together to increase public transport coverage the effect is even greater.

Getting prices right and avoiding distortions is necessary when it comes to increasing the use of public transport to and from the airport. The full and mandatory internalisation of external costs (including noise, local pollution and congestion on top of the mandatory recovery of wear and tear costs) for road, rail and air transport is therefore a step in the right direction. With this in mind, it is also useful to develop mar-

ket-based approaches to further reduce greenhouse gas (GHG) emissions.

The dAIR Project has compiled a list of effective solutions to (among other things) increase the market share of public transport while reducing fossil CO₂ emissions. These measures deal with:

- volume of public transport services (quantity, frequency, inconvenient hours);
- attractiveness of public transport (quality, WiFi, quiet compartments);
- competitiveness of public transport (price, incentives, faster, working during travel);
- environmental performance of public transport (greening, fleet renewal);
- a better match between supply and demand (create services where demand exists and is not sufficiently met);
- internalisation of the external costs of private vehicles (tolls for road use or higher parking fees); and

- although not linked to public transport per se, the optimization of the use of private transport (i.e. raising the number of persons per car).

Besides their environmental effects, these measures have an impact on:

- passengers (lower prices, higher quality); and
- companies (need to adapt to new incentive systems for eco-taxis or transport operators).

Cutting fossil CO₂ emissions originating from surface access is of paramount importance as these emissions account, on average, for 50% of the total CO₂ emissions of dAir airports. For example, in the case of Stockholm Arlanda, 97% of non-air traffic emissions originate from surface access.

II. The EU legislative framework

This chapter aims to provide a short overview of the legislation adopted by the European Union focusing on the decarbonisation of transport and which has a direct impact on the dAIR project partners.

a. Europe 2020 Strategy

The European Union has set the following targets in its Europe 2020 Strategy¹:

- limiting greenhouse gas emissions by 20 % or even 30 % compared to 1990 levels;
- supplying 20 % of the energy needs from renewable sources; and
- increasing energy efficiency by 20 %.

Moreover, the flagship initiative 'Resource-efficient Europe', which is part of the Europe 2020 Strategy, aims to decouple economic growth from the use of resources. It supports the shift towards a low-carbon economy through an increased use of renewable energy sources, the development of green technologies and a modernised transport sector.

b. Roadmap for moving to a competitive low-carbon economy in 2050

¹ COM(2010) 2020, Europe 2020 Strategy is a 10-year strategy adopted by the European Council on 17 June 2010 which aims to achieve "smart, sustainable, inclusive growth" for the EU's economy. It is the successor of the Lisbon Strategy 2000-2010.

With its *Roadmap for moving to a competitive low-carbon economy in 2050*² the European Commission is looking beyond these 2020 objectives and has set out a plan to cut transport emissions by more than 60% by 2050 compared to 1990 levels. Further improvements in fuel efficiency for traditional petrol and diesel engines are being promoted for private cars and a shift to plug-in hybrid cars and electric cars will allow CO₂ emissions from cars to be cut after 2025. A more wide-spread use of biofuels to power planes is also one of the roadmap's targets.

c. Transport White Paper

The European Commission's 2011 Transport White Paper³ includes an array of actions aimed at reducing CO₂ emissions.

- The paper notably calls for a mixed strategy to reduce congestion and emissions involving:
 - » land-use planning;
 - » pricing schemes;
 - » efficient public transport services; and
 - » infrastructure and charging/refuelling of clean vehicles.
- It therefore encourages cities above a certain size to develop Mobility Plans to address these issues.
- Carbon Footprint Calculators are another element of the 2011 Transport White Paper. The paper encourages the development of common

² COM(2011) 112 final, "A Roadmap for moving to a competitive low carbon economy in 2050" published on 8 March 2011

³ COM(2011) 144 final, European Commission White Paper "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system" published on 28 March 2011

EU standards in order to estimate the carbon footprint of companies and individuals. This will allow better choices and easier marketing of cleaner transport solutions (see below).

2. EU law

a. Directive on ambient air quality and cleaner air for Europe

Directive 2008/50/EC on ambient air quality and cleaner air for Europe includes the following elements:

- The merging of most of the existing legislation into a single directive (except for the Fourth Daughter Directive) with no change to existing air quality objectives.
- New air quality objectives for PM_{2.5} (fine particles) including a limit and exposure related objectives – exposure concentration obligations and an exposure reduction target.
- The possibility to discount natural sources of pollution when assessing compliance against limit values.
- The possibility of time extensions of three years (PM₁₀) or up to five years (NO₂, benzene) for complying with limit values, based on certain conditions and the European Commission's assessment.

b. Alternative fuels Directive

The Directive on alternative fuels for transport was adopted by Parliament and Council in the first semester of 2014. Once published in the EU Official Journal, member states will have 24 months



The European Union has set targets in its Europe 2020 strategy that include limiting greenhouse gas emissions by 20 % or even 30 % compared to 1990 levels as well as supplying 20 % of the energy needs from renewable sources and increasing energy efficiency by 20%



The European Commission has set out a plan to cut transport emissions by more than 60% by 2050 compared to 1990 levels.

to implement it. Broadly speaking, the directive facilitates the development of a single market for alternative fuels for transport. It aims to give the EU enough charging points for electric cars and alternative fuel stations (liquefied natural gas, hydrogen-powered cars, etc). The directive does not set binding targets for infrastructure. Member States will have to define their own targets through the adoption of national plans.

c. Forthcoming European Commission proposals

Some upcoming proposals to be published by the European Commission by the end of 2014 also deal with decarbonisation:

- **Review of Directive 2003/59 on training of professional drivers**, including eco-driving requirements. Eco-driving aims at educating drivers on how to use their vehicles efficiently in order to reduce fuel consumption and accidents.
- **Regulation on access to public and private transport data**. This initiative aims to facilitate the re-use of traffic and travel data leading to better modal choices and to a more efficient use of the transport infrastructure. This will help to reduce the environmental impact of the transport sector.

- **A non-legislative communication on a harmonised computerised information and reservation system for rail transport**. The EU aims to establish common rules to ensure that rail operators and ticket vendors adapt their system to exchange harmonised and reliable data on timetables and fares. Passengers will be able to easily plan and book a rail journey.

3. EU Financial support

Reducing CO₂ emissions from transport is high on the EU's agenda. On top of quantitative targets, EU financial support has been made available to support research and innovation efforts in the field. Several calls for proposals have been launched under the "Horizon 2020" programme:

- **Horizon 2020: "Smart, Integrated and Green Transport" Work Programme, including 'Green Vehicles'**
- **Horizon 2020: "Secure, clean and efficient Energy" Work Programme**

It is worth noting that the European Innovation Partnership on Smart Cities and Communities (EIP-SCC) is financed under this work programme. This initiative brings together cities, industry and citizens to improve urban life through more sustainable integrated solutions. This includes applied innovation, bet-

ter planning, a more participatory approach, higher energy efficiency, better transport solutions, and the intelligent use of Information and Communication Technologies (ICT)

*
**

Some European countries have decided to set environmental targets of even greater ambition than the EU. By 2020, Sweden for example is committed to achieving 50% renewable energies in its energy-mix and to reducing GHG emissions by 40% compared to 1990. Bottom-up initiatives have also been launched all over Europe, such as the Covenant of Mayors which promotes sustainable energy solutions and which many dAir local authorities are part of.

Many airport regions, including dAIR regions, support all of these goals and have not waited until the various legislative initiatives entered into force. These regions have pro-actively started to implement measures in order to meet the objectives set (or to be set in the near future) at European or national level. The following chapters address some of these projects and measures.

European Commission launched a stakeholder consultation on the introduction of a standardised carbon footprint methodology

FOCUS ON: CARBON FOOTPRINT CALCULATIONS

One of the aims of the 2011 White Paper on transport is to significantly reduce greenhouse gas (GHG) emissions in the transport sector over the next decades.



The current difficulties in comparing transport services and operators make it hard for users to choose the optimal transport mode, transport service or service provider. This results in higher greenhouse gas emissions, fuel consumption and fuels costs.



The result of this study is important as it will have a clear impact on the reduction of CO₂ emissions from transport activities.

A list of objectives has been announced, including:

- carbon free city distribution;
- reduction of vehicle fuel consumption; and
- a modal shift towards rail transport for long distances.

One of the initiatives illustrated in the White Paper to reach these objectives is aimed at harmonising carbon “footprinting” practices. To this end, on 21 March 2014, the European Commission launched a stakeholder consultation on the introduction of a standardised carbon footprint methodology for both freight and passenger transport services in Europe.

The current difficulties in comparing transport services and operators (due to different methodologies and data used) make it hard for users to choose the op-

timal transport mode, transport service or service provider. This results in higher greenhouse gas emissions, fuel consumption and fuels costs. Increasing the GHG efficiency for transport services can only be achieved if:

- companies report GHG emissions; and
- the reported carbon footprints are comparable and reliable (as was experienced in the dAIR project with the definition and description of good practices).

This consultation is part of a Commission study to improve the harmonisation of carbon footprint calculations.

The objectives of this study are to:

- provide an **overview** of the state of the art of carbon footprint calculators and methodologies and related con-

cepts and to carry out a **comparative analysis of these tools**.

- define **minimum requirements** and guidelines for carbon footprint calculators. Note that a **European Standard**¹ already exists for the calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers).
- develop concrete **policy options** to meet these objectives.

Currently, the 2 main options envisaged are:

1. increased harmonisation of carbon calculation; and
 2. increased use of carbon calculation in general.
- assess the mobility/logistic, economic, social, environmental and other impacts of these policy options. Several findings of the dAIR project cover these aspects.
 - provide a clear comparison between the various policy options
 - provide the Commission with clear **policy recommendations**.

The result of this study is important as it will have a clear impact on the reduction of CO₂ emissions from transport activities.

¹ The European Committee for Standardisation (CEN) standard EN 16258 was published in 2013. It covers a “Methodology for calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers)”. EN 16258 is the first European standard on this issue and it specifies general principles, definitions, system boundaries, calculation methods, apportionment rules (allocation) and data recommendations, with the objective of promoting standardised, accurate, credible and verifiable declarations, regarding energy consumption and GHG emissions related to any transport service.

III. Managerial incentives inducing behavioural changes

1. Optimise surface access and reduce CO₂ emissions through cooperation

- a. Letter of Intent between transport providers and public authorities

Public transport coverage is a key element in addressing sustainability.

A shift from (individual) private vehicles to (common) public transport can only be achieved if passengers using private vehicles and those using public transport have similar access opportunities. Besides increasing public transport coverage, cooperation between all stakeholders can lead to:

- more effective price structures;
- enhanced travel comfort;
- better suitability and convenience of service; and
- reductions in travel time.

One example of such cooperation is the Letter of Intent signed by Stockholm Arlanda Airport, public transport providers, the Swedish Road Administration (SRA) and local and regional planning authorities in September 2008. This Letter of Intent aims at improving public transport connections to the airport and discouraging the use of private cars. It supports a specific Action Programme that includes measures to:

- increase accessibility to Stockholm Arlanda Airport; reduce carbon emissions from ground transport; and achieve the zero vision for CO₂ (from heating, electricity consumption and airport vehicles).

One of the measures that resulted from this cooperation is the implementation of **Workplace Travel Plans for Arlanda based companies**. Signatories meet twice a year in the **Arlanda forum** to take stock of the progress and decide on next steps.

In order to obtain significant results, all stakeholders have to benefit from the same conditions when entering into cooperation agreements. It is also important to clarify that stakeholders are responsible for identifying the problems as well as finding adequate solutions.

b. Triple Helix

Another example of cooperation is the one between municipalities, knowledge institutes and private businesses. The aim of this so-called “triple helix cooperation” is to achieve a particular goal or product in relation to surface access to the airport better and faster. More information on this type of cooperation will be provided in the chapter on innovation.

2. Influence mobility patterns of staff and travellers

- a. Mobility plans in general and

their drivers

Airport regions have specific mobility plans for land transport to and from the airport. The cooperation with airport authorities has a leverage effect on decarbonisation. A specific example can be taken from the city of El Prat. AENA aeropuertos (AENA) is a state-owned company that operates Barcelona’s El Prat airport facility. AENA is responsible, among other things, for the planning, coordination, operation, maintenance, management and administration of Barcelona airport.

AENA’s awareness of environmental



A shift from (individual) private vehicles to (common) public transport can only be achieved if passengers using private vehicles and those using public transport have similar access opportunities.

aspects (as part of the implementation of the airport's environmental management system, certified by ISO 14001) was a significant factor that brought about the company's involvement in the development of the Mobility Plan. This policy improved AENA's corporate image significantly and provided a policy model for other sectors and operating authorities.

Other factors affecting AENA's move towards sustainable mobility were the growth in social concern for environmental and social problems associated with transport, and increased awareness of the fact that an overwhelming majority of journeys were related to commut-

ing. This also affected the intervention of trade unions in favour of an alternative mobility model. As a result, since 2003 the Trade Union Confederation of Workers' Commissions (CCOO) has demanded the improvement of access to airport facilities and has suggested a number of measures, among them the proposal to develop a Mobility Plan.

Another significant motivation was the adoption by the Parliament of Catalonia of the Mobility Act in 2003 to promote sustainable mobility for all citizens. The act included the **development of a governing mobility plan for Barcelona's metropolitan area which**

required that the airport develop its own sustainable mobility plan.

The transposition of EU Directives (see above) into Catalanian legislation to improve the quality of the air in Barcelona's metropolitan area was one more motivation to promote sustainable mobility to the airport.

The Spanish strategy on energy savings and efficiency developed by the Institute for Diversification and Energy saving (IDAE) of the Spanish Ministry of Industry promoted mobility plans in economic activity centers and funded Barcelona Airport's Mobility Plan.





b. Mobility Plans for employees

Within dAiR, project partners are well aware of the benefits of public transport and some have developed (El Prat and Paris airports) or plan to develop (Malta airport) Mobility Plans tailored to the specific needs of their staff. These are integrated packages of measures designed to support a change in individual and/or group travel behaviour and promote more sustainable transport modes.

In other words, stakeholders and public authorities with powers in the field of mobility in El Prat and Paris have promoted the development of Mobility Plans to encourage sustainable mobility for the commuters who travel daily to workplaces located in the airport area.

These Mobility Plans quantified the different sustainable mobility services and infrastructures to detect commuters' problems in accessing the airport. Subsequently, an action plan was developed that included strategies and intervention measures to promote sustainable mobility. In El Prat, for example, a Mobility Commission was set up as a stable participatory negotiation body for the development and monitoring of a mobility plan encompassing the whole airport. Within this mobility plan, a specific chapter covers the mobility of employees.

The Mobility Plans developed in El Prat, Paris and by the University of Malta aim among other things to:

- promote carpooling;
- improve information about access to the airport;

- reduce unnecessary trips through video-conferences and teleworking; and
- enhance possibilities to use non-motorised transport modes such as cycling and walking.

The El Prat Mobility Plan showed that most airport workers used private motor vehicles to commute and just over a quarter (27%) used some form of public transport. This was due to a limited and not very effective public transport

service unfit to meet commuters' needs. Therefore, the Mobility Plan includes several actions to solve these problems such as:

- pedestrian and bicycle routes;
- extension of the railway line to reach the new airport terminal; and
- increasing the running frequency of night bus lines.

The improvement of transport services has contributed to a significant increase in the number of users:

	2006	2014
Train	14%	16%
Bus	13%	20%
Car	73%	64%

One of the first results of the Paris Mobility Plan was better information for employees on their public transport options to and from the airport area, through the circulation of information sheets including maps and schedules for the:

- connections between the work areas/ companies within the airport platform (day and night buses, shuttle rail service CDG Val); and
- connections between the airport platform and surrounding municipalities.

Malta does not currently have an Airport Mobility Plan, but is planning to develop a Green Travel Plan (GTP) for



The mobility plan of El Prat showed that most airport workers used private motor vehicles to commute. The actions the plan looks at that could solve this issue include pedestrian and bicycle routes, extension of the railway in order to reach the airport terminal as well as increasing the frequency of night buses.

airport employees to reduce the reliance on private cars. Transport Malta (TM) is working closely with the University of Malta on the GTP that was prepared for the University and plans to establish a similar GTP for the airport region.

c. Mobility Manager for employees

The *Mobility Manager* software implemented in Bologna surveys the mobility of workers through a web platform. It analyses the answers given on commuting options and decides what actions are most efficient in order to increase environmental sustainability.

The software⁴ was created by SIS-TeMA (spin-off of the University La Sapienza of Rome) to manage, develop and implement the Transport Action Plan for the employees of public and private companies.

Mobility Manager, which was initially created to handle a single company, is now being applied for the first time at the G. Marconi airport in Bologna, and being adapted to a multi-company system. The software is used to:

- create a questionnaire to be completed by employees on a dedicated web platform;
- get real-time progress on the investigation and the geo-location of the

movements recorded;

- obtain a report on the survey results related to more than 40 specific indicators of workers movement system;
- **select the most effective actions/measures through a simulation model integrated in the software. In fact, the software selects those territorial and company-related mobility actions for which the best cost-benefit ratio has been estimated; and**
- **calculate the benefit in terms of emission reduction for each specific action.**

In addition to providing information on current mobility patterns, the practice has allowed to collect information and opinions on the future mobility needs of staff.

As the *Mobility Manager* gives insight into the travel needs of staff, the survey can be used in relation to the implementation of Transport Mobility Plans.

d. Multimodal Journey Planners and Reservation Systems

Travel information systems offer suitable transport choices and are key elements in sustainable mobility planning. According to the **European Commission's Roadmap** "Intelligent Transport Systems (ITS) for more efficient, safer and cleaner road transport" from 2007,

numerous ITS applications, such as the multimodal journey planning and information system, can improve transport services.

In fact, journey planners identify the best public transport routes to and from the airport and can help staff and passengers organise their trips in the most efficient way. The provision of real-time information on connections and arrival times has an impact on the attractiveness of transport services and in making trip-planning more efficient and sustainable.

A multimodal journey planner and reservation system, such as the national system implemented by Samtrafik in Sweden, can facilitate the use of public transport and incentivise a shift from private cars to less polluting transport modes. The main components of this system are:

- **Coordinated planning** (service ResPlus): framework for cooperation between operators for journeys involving the services of more than one operator. This service enables the coordination of transfer times (bus, train, ferry).
- **Passenger information (national journey planner ResRobot)**: information for customers on all forms of transport (99% of all domestic public transport: trains, buses, planes, metros, trams, and directions for motorists), including information on transfer points to rail stations in

⁴ Mobility Manager is based on the actions and measures experienced by the platform EPOMM (European Platform on Mobility Management) the European benchmark for mobility management.



Journey planners identify the best public transport routes to and from the airport and can help staff and passengers organise their trips in the most efficient way.



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Thanks to the cooperation between regional transport associations and public or private organisations, monthly or annual public transport subscriptions are made more affordable. Companies allow their employees to use existing public transport for free (effectively subsidising employee's travel to work) or to buy tickets at a preferential rate.

Norway, Denmark and Northern Germany. This system is also available on smartphones.

- **Ticketing (service Resplus):** joint ticketing scheme combining different transport modes and operators on the same ticket. Resplus companies are mutually responsible for the trips. Bookings can be done on the Internet, over the phone or at the counter.

Similar systems to Sweden's national journey planner ResRobot exist for example in the United Kingdom (Transport Direct), Finland (journey.fi), the Netherlands (9292), Austria (Verkehrspilot), Poland (SiTkol) and the Czech Republic (IDOS). France aims to introduce a national journey planner by 2015.

The latest generation of multimodal journey planners, which are still in a development and testing phase, combine information available from public transport providers with that of private vehicle drivers. One such example from the dAIR project is the Instant Mobility project – developed within the EU's Future Internet Public Private Partnership – which enables persons looking for transport solutions to cover a larger range of possibilities, while increasing the occupancy of private cars.

3. Incentives to use environmentally friendly transport

a. Collective transport

i. For employees working around the airport

Financial incentives can encourage staff to use environmentally friendly modes of transport, since the attractiveness of public transport also depends on the price of the transport services. In this perspective, job-tickets are increasingly being used. Thanks to the cooperation between regional transport associations and public or private organisations, monthly or annual public transport subscriptions are made more affordable. Companies allow their employees to use existing public transport for free (effectively subsidising employee's travel to work) or to buy tickets at a preferential rate. Additional benefits can be arranged for larger companies such as new bus routes to connect major employment sites.

Employees of the Vienna airport company as well as those of Austrian Airlines can use the CAT (City Airport

Train) between the city and the airport for free. They can also use certain bus lines for free. Any other company willing to finance the cost of the tickets can join this scheme.

In Leipzig, for example, a rising number of employees at the DHL-Hub are using the advantages of job-tickets. The ticket is free for DHL employees travelling within the first two tariff zones and it can also be used on weekends to travel with family members. The schedule has been tailored to the hours of the various shifts and to facilitate transfers. DHL and Aerologic started using job-tickets in 2008 (50 % of employees – 1,500 contracts).

The City of Leipzig wants to extend the job-ticket to all employees of the airport and companies based in the airport area. Since October 2013, the employees of Leipzig/Halle Airport have benefited from a 10% monthly reduction on travel cards through the job-ticket system. The project is being carried out in collaboration with Deutsche Bahn and Mitteldeutscher Verkehrsverbund (the public transport operator for the entire area).

However, acceptance is not very high among Leipzig/Halle Airport employees because of the:

- low reduction offered for the monthly pass; and
- disadvantages compared to the ordinary subscription ticket (transferability, possibility to take somebody along for free, validity for several modes of public transport) provided by Mitteldeutscher Verkehrsverbund.

Prague and Bologna airports also have systems encouraging employees to use public transport. The employees of Prague airport can use the public transport within the area of the airport and in the close vicinity of the airport for free. In Bologna on the other hand, there is an agreement between the airport operator and the company that runs the shuttle bus BLQ to provide discounted transport passes for airport employees.

In Sweden, the company that owns and operates Arlanda Airport, Swedavia, also has a job-ticket for its employees. The decision to implement job-tickets was taken in 2009 and the programme was implemented in 2010. During the first year the number of employees using public transport increased by 40%. Since then, the number of operators has increased and new routes have been added.

In fact, Stockholm Arlanda airport provides its staff with up to €110 (1000

SEK) per month to cover all or part of their public transport costs. Swedavia is trying to persuade other companies at Arlanda Airport to subsidise job-tickets for their employees too. Several of the public transport companies serving Stockholm Arlanda Airport offer a reduction of up to 50% (as a minimum) on the monthly travel card for all employees at Stockholm Arlanda Airport. Swedavia's employees can combine these two kinds of attractive job-tickets.

In order for job-tickets to have a high acceptance rate among workers, the employer needs to support this type of system by providing a significant reduction compared to the normal price of a ticket or monthly pass (e.g. the employer and public transport company each pay 50% of the subsidy).

ii. For all travellers

While job-tickets are aimed at staff working in the companies around the airport, the Unireso ticket offered by Geneva In-

ternational Airport allows passengers to use public transport in Geneva for free for a period of 80 minutes. Some conditions need to be met in order to be able to obtain such a ticket, namely:

- passengers must hold a valid plane ticket; and
- passengers may only travel in the "Tout Genève" zone.

Stockholm PTA, a public company serving Stockholm Arlanda Airport, has set a low price for the combined Stockholm-Arlanda monthly card for anyone travelling to and from Arlanda. It even includes free transport for two additional persons aged under 19 years. If one has an ordinary Stockholm regional monthly travel card and buys two separate return tickets to Stockholm Arlanda, it costs just as much as a combined monthly travel card. This is attractive for those who fly or travel frequently to the airport.



A rising number of employees at the DHL-Hub in Leipzig are using the advantages of job-tickets.

b. Individual transport:

i. Eco-taxi

Taxi services are often regarded as luxury or special transport services. Nevertheless, taxi services play an important role in sustainability planning:

- Collective taxi services are a way of offering tailored services where mass-transport is inefficient or lacking.
- Taxi services are also used in Demand Responsive Transport catering specifically to the demands of users with little or no access to conventional public transport.
- The high turn-over in fleets associated with taxi services offers a great opportunity for new sustainable vehicle technologies to enter the market and have an impact.

Through incentives, the eco-taxi project implemented at the Stockholm Arlanda Airport regulated the taxi fleets in order to reduce fossil CO₂ emissions. The main reasons for the project were:

- the Carbon dioxide emissions cap in Stockholm Arlanda Airport's environmental permit. This means that emissions from airport operations and surface access to the airport may not exceed the level produced in 1990.
- Stockholm Arlanda's own sustainability policy. It therefore wanted to take on environmental responsibility for surface access by creating incentives for taxi companies to **progressively replace their conventional fuel taxis with hybrid taxis or taxis powered by renewable fuels.**
- to improve the tough competitive work situation of taxi drivers. This also affects the passengers negatively as from time to time taxi drivers might argue about which one of them should pick up certain passengers. The situation has however improved due to the implementation of a strict computer aided priority system. The system is based on points that rank the vehicles higher or lower in the queue according to criteria such as emissions, passengers (e.g. arrival at the airport with a passenger), or returning to the airport within a certain time even without passengers.

The project started in 2005 with the aim to favour eco-taxis serving the airport. Before the start of the system, only 1 % of taxis registered at the airport were eco-taxis and today all 6,500 registered



Liftago is a taxi management system that improves taxi services for passengers, decreases costs and avoids empty rides.



Eco taxis emit less greenhouse gases than regular taxis



taxis are eco-classed. Incentives were created at the start of the project by introducing separate lanes outside the terminals depending on the type of vehicle (eco-taxi or ordinary taxi). Priority was given to the eco-taxi lane (mostly powered by biogas, then hybrid, eco-diesel, ethanol and pine oil). The inauguration of a biogas filling station at the airport in September 2010 improved the infrastructure for renewable fuel and made the use of green fuel taxis easier.

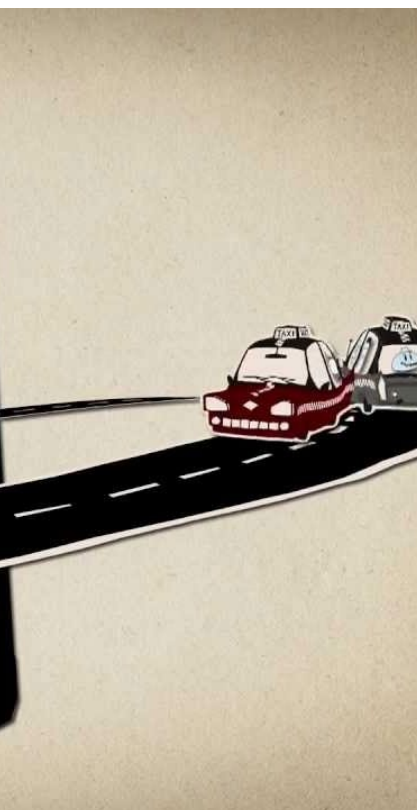
Now, all taxis picking up passengers at the airport are eco-taxi ("environmental cars" according to the Swedish definition). Non eco-taxi are still allowed to drop passengers off, but since they are not allowed to pick up any new ones at the airport this is not a profitable route for them. There are currently eight lanes and priority is set according to the CO₂ efficiency of the vehicles. The fastest lane is reserved for electric cars. This practice has led to 12,000 tonnes of CO₂ reduction at the airport in 2012. It has also had a strong positive effect on the region as a whole by cutting CO₂ emissions by 44,781 tonnes. The programme was extended to Gothenburg, Malmö and Bromma airports in 2012.

ii. Taxi management

The Liftago Technology Platform is a taxi management system that improves taxi services for passengers, decreases costs and avoids empty rides. It is a mobile application that allows each traveller to choose from a selection of taxis closest to their location (and not necessarily one which is parked at a taxi spot in town). The passenger can choose nearby drivers by price, arrival time or rating. The route tracking option and a virtual taximeter give passengers control over the entire ride. The passengers can review the drivers, thereby improving the service for everyone.

With this system, a one way taxi ride can be reduced by about 2 km. There are approximately 2,500 daily taxi trips to Prague airport. This can result in annual savings of around 300 tonnes of CO₂.

Taxi services to Prague airport are governed by an airport regulated monopoly to ensure higher standards of service. The higher price of such taxi services leads to the usage of private cars including kiss & ride practices that have a high environmental impact. Prague air-



The eco-taxi project at Stockholm Arlanda Airport started in 2005 with the aim to favour eco-taxis serving the airport. Before the start of the system, only 1 % of taxis registered at the airport were eco-taxis and today all 6,500 registered taxis are eco-classed. This practice has led to 12,000 tonnes of CO₂ reduction at the airport in 2012. It has also had a strong positive effect on the region as a whole by cutting CO₂ emissions by 44,781 tonnes.



port is not prepared to offer any special conditions or spaces for ordered taxis outside of their contracted companies. In spite of this, Liftago or similar systems represent good solutions for traveling to the airport and reducing fossil CO₂ emissions.

iii. Discourage the use of cars for journeys to the airport

Car parking fees based on the emissions of vehicles

Setting high car parking fees at airports for high emission vehicles can encourage passengers and staff to use public transport wherever possible or encourage a shift towards clean vehicles. The following actions implemented at Bologna's Marconi Airport are aimed at increasing the use of low fossil and renewable CO₂ emission vehicles:

- Reduced parking rates for hybrid/electric vehicles.
- Reserved parking slots for hybrid/electric vehicles (with stalls for electric charging).

At Stockholm Arlanda Airport the number of electric chargers in parking areas is continuously increasing. Today there are 92 electric chargers located close to the terminals and free of charge. The parking lot itself is also free for electric cars. Stockholm Arlanda has a concept of differentiated pricing for travelers' car parking: distance to terminals, number of available parking lots, supply and demand at pre-bookings. Moreover, Swedavia is also preparing to set up a differentiated pricing system depending on whether the car is eco-labelled or

not. The higher the CO₂ efficiency of the car, the lower the price. The system for identifying the cars' registration number is already in place (due to the eco-taxis), but the procurement of the new camera system, which will be able to read the cars' number plates, will not take place until autumn 2014. The service will not be up and running until 2015-2016.

Airport tolls based on the emissions of vehicles

The so-called "kiss and fly" practice, which consists of accompanying passengers to and from the airport, generates twice the number of car journeys compared to those of passengers who use an airport car parking. As the kiss-and-fly contingent pays no fees when picking-up or dropping-off passengers, this is a widely used method as it is much cheaper than a taxi and generally does not require the payment of any parking fee.

The G. Marconi Airport in Bologna currently has a "Kiss and Fly Drop-off zone" which offers free parking for the first 10 minutes and charges € 3.50 per hour afterwards.

At Stockholm Arlanda Airport the possibility of "Kiss & Fly" parking is progressively being removed. This was already carried out in Terminal 5 in June 2014. Drivers there are now referred to an already existing parking lot further away where they cannot avoid paying due to the automatic barriers that control the access (like the rest of the car parks at Stockholm Arlanda Airport). In 2015, the same will be done in the other terminals.

Congestion pricing, which is a vari-



able road toll based on the level of congestion, aims to reduce peak-period traffic volumes to optimal levels. Using this measure in combination with measures to increase the use of public transport can influence behavioural patterns thereby reducing emissions.



4. Actions to raise awareness

a. Passengers

As it causes less pollution and congestion, a greater use of public transport benefits the environment and the surrounding communities as well. Targeted actions aimed at raising awareness can, over time, change the mobility behaviour of passengers, staff and citizens in general.

Awareness campaigns, from user feedback systems to user education, can have important effects on shifting passengers towards more sustainable modes. However, awareness campaigns are not only confined to promoting public transport. Numerous companies and cities have undertaken information and educational campaigns such as, for example, on eco-driving (personal, public transport).

Providing information on the current available alternatives to access the airport allows users to make informed decisions and can lead to an increased use of public transport. The G. Marconi Airport in Bologna has a communication and information plan that focuses on the available transport modes for airport accessibility. The airport aims to raise user awareness through the following communication channels:

- information points at the airport, railway station, tourist information offices; and
- smart services and green apps on smartphones that allow passengers to purchase a ticket or reserve a seat using the most sustainable transport mode (an example is the mycicero portal which is active for parking in Bologna), being aware of their contribution to fossil CO₂ emissions.

Stockholm Arlanda Airport, on the other hand, conducts surveys among passengers in order to gather information on the global market and the airport's environmental impact. Every year 100,000 departing passengers are interviewed at Stockholm Arlanda Airport (90% international and 10% domestic travellers). For 2016, the goal is to have at least 90% of passengers consider the environmental impact of aviation and that

Providing information on the current available alternatives to access the airport allows users to make informed decisions and can lead to an increased use of public transport.

the airport is deemed acceptable relative to its benefits to society. In its communication with passengers, the airport emphasizes environmental arguments along with the benefits of aviation.

The City Airport Train that connects the Vienna International Airport to the city centre has a C-Club programme which is free of charge. It provides passengers with several advantages for using the train to and from the airport:

- For every trip with the CAT, passengers get points credited to their account. As of 1 March 2010, passengers can exchange these points for prizes.
- It allows passengers to keep track of their latest bookings by providing a summary of all recorded tickets in the ticket history.

b. Staff

The Plan de Déplacements Inter-Entreprises (Mobility Plan) in the area of Paris-Charles de Gaulle airport includes several actions aimed at raising staff awareness. Some of the actions introduced by the airport companies include:

- workshops and events on different topics related to public transport (e.g. quality of the taxi services around the airport);
- exchanges of good practices and information on the modes of transport available; and
- information sheets on public transport within and to/from the airport area which are regularly updated.

5. Sustainable Procurement

Sustainability considerations are increasingly being incorporated into the procurement process. Suppliers and subcontractors are asked about the sustainability features of their products and services. They need to meet a number of criteria relating to environmental performance, quality, safety and security. Sustainable procurement improves efficiency, reduces fossil and renewable CO₂ emissions and allows for financial savings.

Tenders offer a unique opportunity to:

- incorporate sustainability into the purchasing process in a structured and systematic manner;
- embed sustainability for the duration of a contract period;
- request sustainability data and information directly from suppliers; and
- demonstrate that organisations take sustainability seriously.

For instance, Swedavia's Code of Conduct for suppliers describes the most important areas for responsible conduct. It places demands on suppliers and in return suppliers have confidence in Swedavia as a customer. According to this Code of Conduct, Swedavia is legally obliged to:

- be objective and business-minded in the procurement procedure;
- have a good understanding of its purchases and relations with suppliers through statistics and monitoring; and to



- maintain good ethics in the procurement work.

In Barcelona, the public call for tenders to provide bus services to and from the El Prat airport for the next 8 years published in spring 2014 included the need for an environmental sustainability plan. The environmental impact of the service put out for tender consisted of two basic elements:

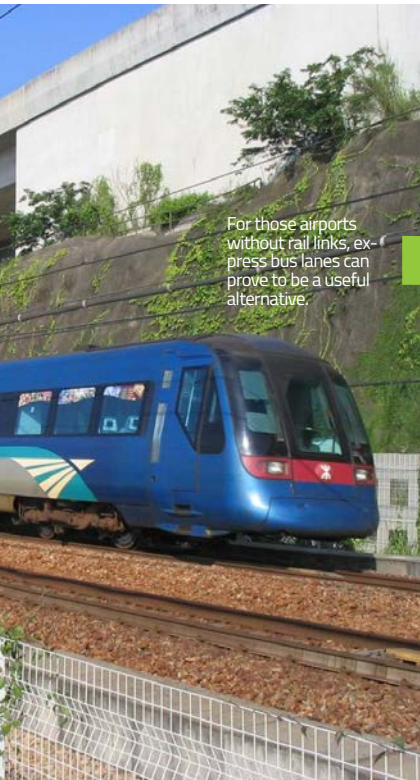
1. Energy consumption.
2. Environmental pollution.

Regarding the former, the bidder had to demonstrate its stated commitment to conduct audits on the consumption of vehicles aimed at reducing emissions related to energy consumption and pollution across the entire fleet. As regards environmental pollution, the tender stated that the air quality plans in force have to be applied. The proposal had to indicate the contribution of the service as a whole to the metropolitan

air pollution as well as the emission reduction targets for the upcoming years.

Special attention has been paid to the following aspects:

- a) commitments in the plan for the application of environmental and energy saving criteria;
- b) plan for the reduction of energy consumption;
- c) introduction of electric energy in auxiliary vehicles; and
- d) plan for the reduction of polluting emissions.



IV. Physical changes to infrastructures, vehicles, and technologies

1. Optimise existing infrastructure and services: encourage bus and rail transport to induce modal shift

a. Dedicated bus lanes

Optimising existing infrastructure by the reallocation of road space to public transport through dedicated bus lanes is a cost effective measure to encourage public transport use and therefore reduce fossil CO₂ emissions. This increases the level of service and the speed of buses and has a clear impact on shifting passengers towards public transport instead of private cars.

b. Express buses

Several partners involved in the dAIR

project have express buses connecting the airport to the city centre. These types of buses offer several advantages compared to normal buses. They are faster, more frequent and provide enough space for luggage. One such example is Aerobus, Barcelona Airport's express shuttle bus. Transport by bus to and from Barcelona airport has led to:

- 4,600 tonnes of CO₂ saved in 2009 and 7,600 t in 2011. 62% less CO₂ emissions;
- savings of 1.43 t (82%) of fine particles in 2009 and 2.29 t (84%) in 2011; and
- savings of 13.46 t of NO_x in 2009 and 17.93 t in 2011. This represents an approximate saving of 48%.

Malta, Eindhoven, Mazovia, Stockholm Arlanda and Bologna airports also have express buses connecting the airport to the city centre. In Bologna for instance, BLQ Aerobus is an express bus service that connects the Bologna central railway station to the airport, with only a few stops in the urban area. This Aerobus service runs daily with a frequency of about 15 minutes. The first



departure from the airport is at 06:00 while the last one is at 23:45. As a result of this service there has been an increase in passengers arriving and departing from the airport using collective transport. In 2013, 935,000 passengers used this express bus and it has allowed approximately 4,359,171 tonnes of CO₂ to be saved.

Some of the planned future improvements include:

- the purchase of tickets online and from vending machines located at the major stops to eliminate the issuance of tickets on board;
- the issuing of job-tickets and more affordable monthly passes for airport employees; and
- the gradual replacement of traditional vehicles with low CO₂ emissions vehicles.

In Malta, a new public bus trans-

port system was launched in July 2011. As part of the new system, six EXPRESS routes were created which operate between various localities to and from the airport. The routes connect the airport both to localities where the main tourist resorts are located as well as to main transport hubs such as Valletta, Ċirkewwa (where the Gozo ferry terminal is located) and Marsa Park and Ride (a central bus interchange). The frequency of the six routes varies between 30 minutes to 60 minutes depending on the localities it services.

Originally, articulated buses were used to operate these routes due to their high capacity, low floor and space for luggage. However, due to a series of technical problems, all articulated buses had to be removed from Maltese roads as they were deemed unsafe. Moreover, Arriva has now halted its operations from Malta and the entire public transport ser-

vice is temporarily being operated by a government company set up specifically for this purpose. The six EXPRESS routes are still in operation with 58,272 total annual trips.

The Paris Charles de Gaulle (CDG) Airport, on the other hand, aims to introduce an express bus (COMET) to connect the different hotels located in the vicinity of the airport to the airport.

Bus-on-demand

Demand responsive bus services, where users can book their own trip by making a simple phone call or by going online and choosing their origin and destination, are being increasingly used in different cities in Europe. On-demand bus services are designed for maximum flexibility as they have no fixed route or schedule. These bus services are used by employees and passengers travelling to

BLQ Aerobus is an express bus service that connects the Bologna central railway station to the airport, with only a few stops in the urban area.





and from the airport.

In Paris, for example, the FILEO system provides on-demand bus services to staff working in the airport area. Employees working in the airport area cannot use public transport because their shifts begin or end outside the normal public transportation schedules. There-

fore as 75% of employees working in the Charles de Gaulle airport area have staggered working hours (work after 11 PM, before 5 AM and during holidays), people cannot use public transport. The bus on-demand system FILEO creates an alternative as it enables employees to use buses at night. This service enables a

modal shift from personal cars to public transport or is simply the only possible means of transport for some employees. Besides, as it only runs when there is a demand for it, the system saves the fossil CO₂ that a regular service would emit.

Workers can take FILEO from 19 cities around the airport, but a booking



“

On-demand bus services are designed for maximum flexibility as they have no fixed route or schedule. These bus services are used by employees and passengers travelling to and from the airport.

Bus on demand
FILEO arrives at
CDG Bus terminal,
together with other
private and public
buses



has to be made at least one and a half hours before taking the bus (16% of all bookings are made online). The company has a database with the names and addresses of its clients. In order **to book, clients have to identify themselves in the system**. A side advantage of the booking system is that every client that uses the bus is known, and hence there is very little, or even no, fraud or vandalism.

The system is flexible and allows for modifications:

- If 30 people ask for FILEO on a specific route for a year then a normal bus is introduced on that route.
- If less than 30 people use the normal bus then FILEO can be introduced on that route at night.

A ticket costs 2 Euros when bought on the bus (the same price as the normal bus system), and monthly passes vary depending on the various tariff zones. The FILEO bus on-demand system has a significant impact with 510,000 reservations in 2012 (+14% between 2010 and 2012) and 355,000 validations (+ 16% between 2010 and 2012). According to a survey, 88% of passengers are satisfied with the service.

Even though the buses are not 'green buses', the system as a whole is green and allows savings of 30,000

tonnes of CO₂. Green buses could be considered, but then the whole system would be much more expensive as green technology buses are 5-10 times more expensive than normal buses and require specific maintenance. As a result of the dAIR project, the FILEO project has been transferred to El Prat.

Unscheduled transport services are provided at Malta International Airport (MIA). This is not a traditional bus-on-demand system, but is aimed specifically at travellers passing through MIA. Unscheduled transport services are offered as a pre-booked service normally included in a package, typically with a hotel stay. Basically, each individual hotel (or group of hotels within the same geographic location) organises private transport to transfer guests between the hotel and the airport. The system was originally set up as a 'bonus feature' to attract guests to a particular hotel. It was also developed at a time when many flights arrived at unsuitable hours (e.g. 4:00 AM) when the usual public transport is not in operation. The system was also developed by hotels/tour operators because, at that time, there was no dedicated public transport for airport customers. The public transport service was based on a radial system, with all trips starting and ending in

Valletta, with no direct routes to other locations, thus making the transfer between the airport and the hotel a very convoluted journey.

The vehicles used are powered by traditional engines and vary according to the number of guests. Most hotels have their own liveried mini-buses (usually seating up to 12 passengers). In the case of large groups/package tours, a tourist coach is used (up to approximately 50 passengers).

91% of incoming tourists are recorded to use this service, which therefore dramatically reduces the need for private taxi or car rentals (especially when flights arrive off-peak). The service contributes 702 tonnes of CO₂ to the total airport related emissions which translates into 9% of the total surface access emissions to and from the airport.

The effects of fossil CO₂ reduction depend on the age of the fleet. In 2009, a reform of coaches and mini-buses was therefore passed so as to promote a shift towards newer vehicles, especially those with a Euro IV or V emission level. The following incentives were introduced:

- No registration tax is applicable when registering Euro IV or V vehicles.
- No entry fee is applicable for new vehicles registered.

- Newly registered vehicles on the unscheduled service must not be older than 5 years.
- Registration of vehicles between 5 to 10 years is only permitted through the replacement of an older vehicle which is removed from service. In 2015, vehicles older than 35 years will need to be decommissioned.

Pre-evening check-in at the rail station

Pre-evening check-in is being offered by railway companies on routes to the airport in various cities around Europe. This system allows passengers to drop their luggage off in the city centre up to 24 hours before taking off. As it makes the check-in of luggage and its haulage to the airport easier, the system encourages passengers to use public transport to travel to the airport instead of private cars.

In Vienna this system is the result of cooperation between Vienna Airport and the company that runs the City Airport Train (CAT). The general rules for the City Check-In are the following:

- check-in up to 75 minutes prior to departure;
- pre-evening-check-in from 6:00 PM (for all Austrian-flights 24 hours before departure); and
- passenger must have a valid CAT ticket.

Other examples in Europe:

- **AIRrail service in Germany**, an intermodal transport service by Lufthansa, the German railway company Deutsche Bahn and Fraport.
- **Railway station check-in inclusive baggage drop in Switzerland**, available at 50 Swiss railway stations.

2. Extension of infrastructure leading to modal shift

a. Medium/Long distance transport to the airport: railway connection to the airport

Rail links with airports are opportunities for travel and tourism. Encouraging people to use trains rather than cars is an important means of reducing overall CO₂ emissions. As rail transport is increasingly being electrified to phase out the use of diesel trains, using this mode represents a way of cutting down on CO₂ emissions and speeding up journeys.

The existence of a rail connection to the airport means an increase in the use

of public transport. The introduction of the commuter rail service from Stockholm Central Station to Stockholm Arlanda airport in December 2012 helped the airport achieve its target of having at least half of its passengers travel by public transport. As of 2013, 52% of Stockholm Arlanda's passengers take public transport to and from the airport, an increase of almost 4% compared to the third quarter of 2012. The rail connection and train services have not only increased the share of passengers using public transport to and from Arlanda airport instead of cars or taxis, but the railway link has also decreased the use of and need for national connecting flights to and from Stockholm Arlanda airport. For instance, passengers who used to take a connecting flight from the city of Borlänge to Arlanda and on to London can now take the SJ train from Borlänge to Arlanda and then the flight to London.

While the Paris Charles de Gaulle airport is already connected to the Regional Express Network (RER B), there are plans to introduce a high-speed train to connect the airport and the Gare de l'Est in Paris. The implementation of this CDG Express project will mean journey times of **around 20 minutes and trains running every 15 minutes** compared to the RER B (journey time is now about 25-35 minutes and trains run every 10-15 minutes).

Mazovia and Prague airports intend to introduce a rail connection that stops directly at the airport. In their case, a railway connection can strongly influ-

ence modal split and will increase the share of public transport. As there is no highway connection from the city centre to Prague airport, a train connection to the airport will shorten travel time and increase comfort compared to private vehicles.

In Leipzig, the S-Bahn offers a direct connection between different parts of the city and the airport.

b. Short distance transport to the airport

In Bologna, a monorail electric shuttle that is planned in the long term is regarded as an efficient option to connect the G. Marconi Airport to the main railway station located 6 km away from the airport. This monorail electric shuttle called People Mover will replace the current Aerobus shuttle and will connect the two points in about 7.5 minutes. The People Mover is expected to carry around 17%-19% of passengers and save between 1.200 – 1.500 tonnes of CO₂ per year.

The city of Barcelona is currently extending the metro line 9 to El Prat airport. Once construction is completed, the airport will be directly connected to the city centre. The new service is expected to start in 2016.

c. Transport within the airport: electric airport shuttle

Electric airport shuttles can be used to replace diesel buses between the airport



Mazovia and Prague airports intend to introduce a rail connection that stops directly at the airport. In their case, a railway connection can strongly influence modal split and will increase the share of public transport.

terminals, thereby reducing CO₂ emissions. Several airports around Europe use this type of shuttle such as Paris and London.

CDG Val is a 100% electric airport shuttle used between the different terminals of the Charles de Gaulle Airport in Paris. It is not a new product, just the latest version of an existing product that was already in use in Rennes, Lille, Toulouse and Torino. CDG VAL largely replaces the diesel shuttle buses which were used until 2007. Each of these buses travelled 120,000 kilometres per year. With CDG VAL, 750 tonnes of fuel will be saved annually. CDG VAL will also prevent the release into the atmosphere of 15 tonnes of nitrogen oxides and 2,500 tonnes of CO₂ per year.

London Heathrow airport has a system similar to CDG VAL, namely the "POD Car", an automated electric personal shuttle system between terminal five and the business parking lot. These electric pods operate only when passengers summon them and have replaced two diesel buses that were running 24/7.

3. Sustainable public transport services

a. Clean buses

Buses that run on renewable fuels are essential for a sustainable public transport service. In Sweden, the Flygbussarna buses, connecting Stockholm Arlanda airport to Stockholm city centre, have been running on RME (part of the FAME fuels) since 2003. This is a fuel made out of rapeseed grown in Sweden and is a viable option at the moment to lower fossil emissions. It reduces carbon dioxide by up to 60 %.

Flygbussarna tested an electric bus, constructed by EBUSCO, on the routes to Stockholm Arlanda and Bromma airports. The bus can run up to 250 km on one charge and it takes 2.5 hours to charge the battery. Tests with Volvo Hybrid buses have also been undertaken to see how these might fit into the company's operations.

b. Eco-driving

Additionally, all of Flygbussarna's drivers are trained in eco-driving. The benefits of eco-driving are:

- reduced fuel consumption;
- increased passenger comfort; and
- reduced wear on the fleet.

All buses have been equipped with

on-board computers that measure the fuel consumption. To ensure the commitment of all drivers, the company has set up a bonus programme based on how green they drive. So far, the implementation of eco-driving has reduced fuel consumption by about 8%.

As such, this measure is beneficial not only for professional drivers, but also for private drivers. According to the EPOMM database, eco-driving reduces fuel consumption by 15 to 25%.

4. Electric vehicles and charging stations

Transport is responsible for around a quarter of EU greenhouse gas emissions and is highly dependent on oil. Electric vehicles are a viable alternative to oil-powered ones and help reduce CO₂ emissions. However, there is a need to make electric cars more affordable and efforts are required on the construction side.

The island of Malta can be considered as a mini laboratory for electric vehicles. Transport Malta, the Ministry for Resources and Rural Affairs, Enemalta



(Electricity Provider) and the Ministry for the island of Gozo launched the DEMO EV project in September 2011. The project aims to introduce and promote the use of electric vehicles in the Maltese Islands by demonstrating the feasibility of full electric vehicles and encouraging their market uptake. To this end, 100 charging stations have been installed and 24 full electric vehicles of different sizes and segments have been distributed among volunteers ranging from private households and commercial delivery companies to government entities. The uniqueness of this project lies in the

fact that the vehicles are driven free of charge by private citizens and companies for a period of three months. The demonstration part of the project started in August 2013 and will end in December 2014. At the end of the project, a national campaign will promote the results achieved during the demonstration and feasibility testing period.

Another project involving electric vehicles is being carried out by the University of Bologna. Although still in an early phase, the project aims to set up a distribution network of electric charging stations around Bologna. The project

idea is to:

- have electric charging stations hosted by companies such as car dealers; and
- replace the batteries instead of re-charging them.

5. Development of soft transport modes: bike accessibility to the airport

Cycling infrastructure is developing around Europe, however, there are great disparities between cities in terms of modal share. In certain cities, the availability of bike lanes has led to a growth in popularity of bike sharing schemes over the past years. They represent an alternative to public transport for staff and passengers living near the airport.

Vienna International Airport for example has 5 bike sharing stations around the airport. In the future, it aims to improve the length of the current 17 km bike route opened in 2013 and increase the number of bike sharing stations.

El Prat airport inaugurated its first bike lane in March 2014. A second one will be opened in September 2014 showing the commitment of the airport to alternative transports.

Eindhoven airport is also equipped with bike lanes. Bologna and Mazovia airports are currently considering building some. In Bologna for example, a pre-feasibility study for a bike path between Via Emilia Ponente and the airport was undertaken. The practice is part of a wider programme of joint actions to reduce CO₂ emissions in the airport area and is integrated with stretches of cycle paths already constructed (railway underpass on via del Trionvirato) or designed (cycle path for the employees inside the airport area). The implementation of bike lanes at Bologna airport should allow an annual reduction of 37 tonnes of CO₂.

Infrastructure measures for cycling have an impact on economic and social objectives, but have rather a limited impact on environmental objectives notably because they de facto exclude passengers for whom travelling to/from the airport by bike is not a realistic alternative. In fact, cycling tends to attract only employees who would otherwise commute by public transport. Cycling still appears to be unappealing to those employees who use private cars.



El Prat airport inaugurated its first bike lane in March 2014. A second one will be opened in September 2014 showing the commitment of the airport to alternative transports.



In El Prat, thanks to the dAIR project both a bus on demand and a bike lane system to the airport have been implemented



Additional activities in the project were developed with innovation in mind



1. Introduction

Since exchanging experiences is one of the Interreg IVC programme's main goals, the identification of good practices and the organisation of study visits have proven to be excellent ways of discovering inspiring activities implemented within the dAIR partnership. The additional possibility offered by the programme to develop, within the lifetime of the project, a limited number of pilot actions aimed at exploring further possibilities was grasped by a group of four dAIR partner regions (Bologna, Eindhoven, El Prat de Llobregat and Leipzig). They did so by developing additional activities with innovation in mind. Within this chapter, we will take a look at these innovation-inspired additional activities developed by these 4 regions and their stakeholders as well as at existing practices in this field within the larger partnership, and sometimes beyond. This



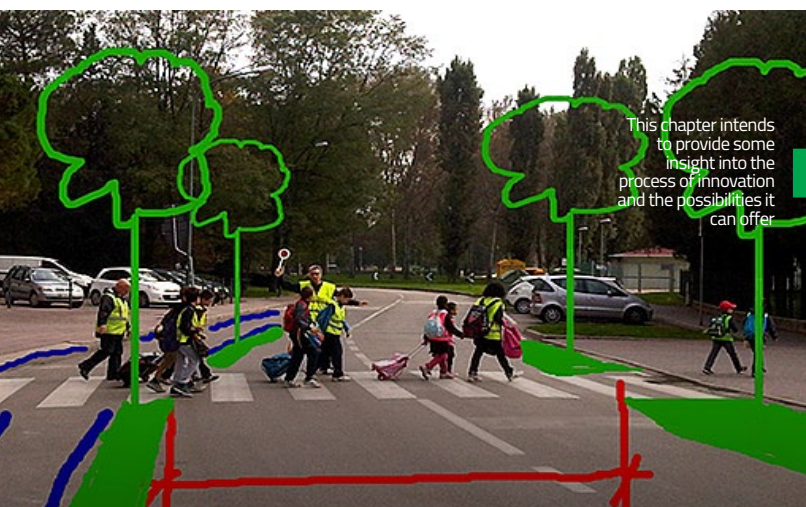
THE INNOVATION ASPECTS OF THE dAIR PROJECT

Innovation can spur the achievement of dAIR's goal to quickly realise well connected green airport regions. dAIR partners have grasped the opportunity to act on this and dive into innovation activities during the project.

chapter also intends to provide some insight into the process of innovation and the possibilities it can offer, giving the reader inspiration and a helping hand to engage in the process itself.

2. Innovation from a dAIR perspective

Creating well connected green airport regions by lowering CO₂ emissions from airport operations and realising sustainable landside access to and from the airport is a tremendously ambitious goal. Moreover, results cannot wait too long, as they are required by a number of legislative initiatives (cfr. reference to legislation in chapters 'Airport Operations' and 'Surface Access'). dAIR partners realise that results cannot be achieved by acting alone, but require the involvement



of other partners. dAIR partners also understand that this environmental challenge creates incredible economic opportunities, which transcend the sole interest of airport related activities and their environmental impact.

Therefore, “innovation” – a concept with many definitions – has been defined within the dAIR project from the priority perspective of “cooperation”.

Numerous studies and (legislative) initiatives provide back-up for this perspective:

The European Union’s 2020 Strategy¹ outlines the ‘smart, sustainable and inclusive’ future for the EU and its Member States. One of its 7 Flagship Initiatives, ‘Resource-efficient Europe’,² aims to decouple economic growth from the use of resources. It supports the shift towards a low-carbon economy through

1 <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF>

2 http://ec.europa.eu/resource-efficient-europe/pdf/resource_efficient_europe_en.pdf

an increased use of renewable energy sources, the development of green technologies and a modernised transport sector. Another Flagship Initiative within the EU 2020 Strategy, the ‘Innovation Union’, highlights the importance of partnering in European Research & Innovation (R&I) as a means of “pooling forces to achieve breakthroughs”.

The 2011 EC Communication ‘Partnering in Research and Innovation’³ states that partnering is about bringing players together to build critical mass and that this approach can help address major societal challenges – such as mobility, resource efficiency, etc. – and strengthen Europe’s competitive position by making the R&I cycle more efficient and shortening time from research to market. From the European Commission’s DG Enterprise study on ‘Lessons from a Decade of Innovation

3 http://ec.europa.eu/research/era/pdf/partnering_communication.pdf

Policy’ (2013) we learn that measures aiming to foster collaboration between public organisations and businesses are among the top three funding measures in the EU Member States.

The 2014 EC Communication ‘Research and Innovation as sources of renewed Growth’ stresses that new growth opportunities come from providing new products and services derived from technological breakthroughs; new processes and business models; non-technological innovation and innovation in the services sector. The above is to be combined with and driven by creativity, flair and talent. In other words, growth opportunities stem from innovation in its broadest sense. Continuing evidence shows that many recent productivity gains come from innovation and that, on average, countries that invested more in research and innovation before and during the crisis have been the most resilient during the economic downturn.

The Green Vehicle Public Private



“The project pays special attention to the optimal involvement of business and R&D communities in creating well-connected green airports, by contributing to new innovative products and services needed to realize prompt actions on the ground.”

“An overall special point of attention within the project’s 2 sub-objectives is ‘innovation’, and more specifically, the way for public actors to engage business and R&D institutions in reaching the ambitious goals of creating well connected green airport regions. Intelligent co-operation models between project partners, business and the R&D community can lead to easy access to existing state-of-the-art solutions and/or development of new products/services and their rapid market uptake”.

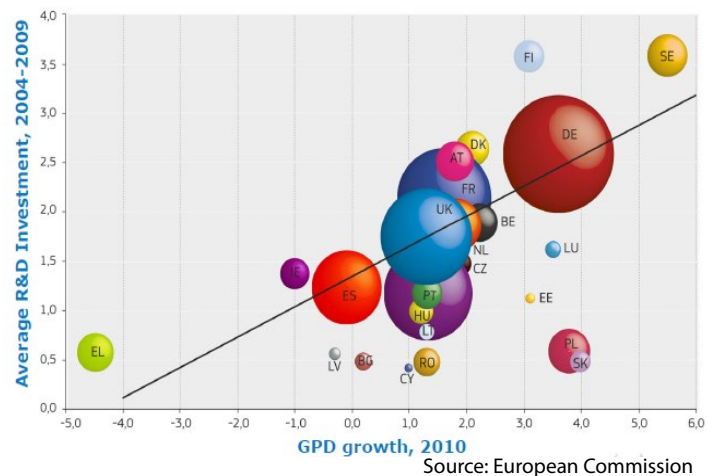


Figure 1: Investment in R&D is part of the solution from the economic crisis.

Partnership⁴, originally set up in 2009 as part of the European Economy Recovery Plan 2010-2013 (under the initial name 'Green Cars'), is a good example of joint forces of the EC (government), industry and research community within a commonly defined programme aimed at accelerating research, development and the demonstration of technologies, in order to tackle a certain issue (including the matching of public and private budgets) in a domain relevant to dAIR.

In the same automotive domain, there is a well-known recent case where tough EU environmental legislation on CO₂ emissions from passenger cars was (also) adopted with a clear intention to act as a driving force for innovation.⁵ Although disputed to some extent, a study⁶ shows that European car manufacturers overtake most Asian competitors in the 'green race', thus strengthening their worldwide competitive position.

To conclude, it perhaps needs to be underlined that the strong emphasis on

(predominantly) technological innovation as demonstrated by dAIR is not an ideology. An OECD study⁷ demonstrated that while 'avoiding mobility' could indeed account for 24% of CO₂ reduction in transport, 41% of needed reductions can be realised through 'technology'.

Although the dAIR project has demonstrated the positive leverage effect of stringent measures imposed/negotiated on a local level – for example Stockholm's CO₂ cap – in this innovation perspective dAIR partners are aiming at voluntary means of cooperation.

3. Main driver: Brainport Eindhoven region

The driving force that supported the inclusion of the innovation aspect into the dAIR project was the (lead) partner region of Eindhoven. In 2010, Eindhoven Airport, the largest regional airport in the Netherlands, received authorisation from the national government to increase its capacity in two phases. In phase 1, 10,000 aircraft movements will be added

until 2015. After a positive evaluation, phase 2 can proceed with the addition of another 15,000 aircraft movements. Indeed, a number of conditions, many of which are linked to sustainability, have been imposed by the so-called "Alders Advisory Board" (set up by the Dutch government to guide the airport growth process) and need to be respected before entering phase 2.

"Innovation" also is one of the Alders Advisory Board conditions, fully embraced by Eindhoven Airport. Therefore an "Umbrella Group Innovation", a "Coalition of the Willing" composed of stakeholders from the regional knowledge and business community was installed. The Umbrella Group Innovation is to act as an accelerator to reach the sustainability goals. This approach was largely inspired by the successful and multi-awarded⁸ Brainport Eindhoven model of triple helix cooperation between public authorities, private business and knowledge institutes.

Brainport Foundation: Ensuring the commitment of businesses

The published regional strategies and

4 see: www.egvi.eu

5 see: European Commission (2007): "Commission Staff Working Document: Accompanying document to the Proposal From The Commission To The European Parliament And Council for a regulation to reduce CO₂ emissions from passenger cars. Impact Assessment"

6 European Federation for Transport and Environment (2012), "How Clean are Europe's Cars? An Analysis of Car Maker Progress towards EU CO₂ Targets in 2011"

7 OECD (2002), "Policy Instruments for Achieving Environmentally Sustainable Transport", 172p.

8 2010 Eurocities Award 'cooperation' ; 2011 ICF title "Most Intelligent Community of the Year"

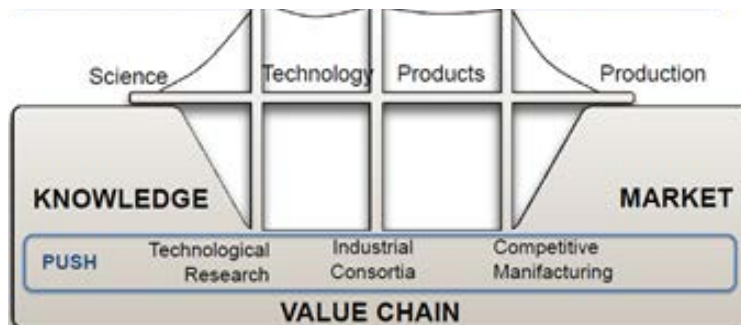


Figure 2: From knowledge to market

programmes within the Dutch province of Noord-Brabant are presented quite informally. They are not laws or legally binding documents, but 'pacts' signed by public-private, 'triple-helix' partnerships involving a broad range of actors. Since the regional government has limited budget and autonomy, bottom-up initiatives from the grassroots level are very important in the region, and the collaborative initiatives are numerous. Among the many organisations of the well developed intermediate landscape, Brainport Development gives a good example of how innovation policy strategies in the region are governed and developed.

Brainport can be characterised as a "horizontal triple helix collaboration" partnership, since large companies and SMEs, knowledge institutes and governmental organisations collaborate at various levels in the Dutch region of Noord-Brabant. Out of all triple helix parties, the regional authority (provincial government) is perhaps the least dominant and most limited actor in terms of resources. The project management approach builds on the model of a former FP7 project which consisted of a large number of bottom-up initiatives with external project owners. Brainport tries to persuade the involved firms or knowledge institutes to take ownership of individual initiatives or projects. For this innovative approach, Brainport region Eindhoven has won the Eurocities Award 2010 in the 'cooperation' category for their very promising cooperation among companies, knowledge institutions and government. In line with the limited role of public government and public R&D investments, the innovation system of the region is privately-driven, although public-private initiatives like Holst Centre and Solliance play an important role. The development of the most recently published innova-

tion strategy, Brainport 2020, was led by the former vice president of the multinational company DSM and the steering group also included a former manager of Philips. In line with the approach of the Brainport agency to appoint external people as 'project-owners', many initiatives and projects are led, or 'driven', by businessmen. Private companies like Philips have become important actors in the governance of RTD policy in Noord-Brabant. source: Wintjes, R. (2011), 'Regional Innovation Monitor: Noord-Brabant', Technopolis Group

In line with this regional successful approach, Eindhoven Airport and its closest regional partners were strongly committed to taking this opportunity to invest in sustainable airport development by taking measures that would allow the airport to become an innovation hub of development for the larger Brainport region and support regional economic growth.

4. Participating in the innovation process

"New stuff that is made useful"⁹ is about the shortest definition of the concept of 'innovation', and there are many more. This chapter will not elaborate a complete study on the concept itself. The description "the successful introduction of new forms of added value", however, covers about all the essentials of innovation, indicating that this is about the successful result (often, but not always, measured by commercial market success) of a series of activities, leading to a

⁹ McKEOWN, M. (2008) "The Truth about Innovation. A Small Book about Big Ideas", Prentice Hall, 264p.

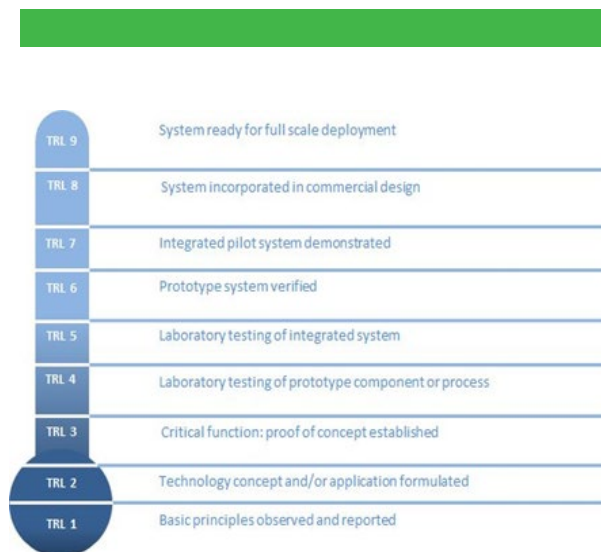


Figure 3: Technology Readiness Levels

product, technology or service that has a certain use.

4.1 Technology Push

Traditionally a lot of attention – and public money in the form of subsidies – is being paid to stimulating (technological) Research and Development (R&D) activities, and to speeding up the market uptake of these R&D results.

This process of technological innovation was considered as a rather linear one, in which several stages/levels were to be distinguished, each one assessing/evaluating the maturity of the technology. NASA's 'Technology Readiness Level' (TRL)¹⁰ is the most famous and commonly used classification in this respect.

As soon as a new technology has arrived at TRL level 9, it is ready for full scale development, and thus market introduction. The most important question then becomes: will it be a successful (profitable) market introduction? At this

¹⁰ See: www.nasa.gov/content/technology-readiness-level

9	Actual technology proven through successful deployment in an operational setting	Actual technology proven through successful deployment in an operational setting. At this level there is actual application of the technology in its final form and under real-life conditions, such as those encountered in operational test and evaluations. Activities include using the innovation under operational conditions.
8	Actual technology completed and qualified through tests and demonstrations	Actual technology completed and qualified through tests and demonstrations. At this level the technology has been proven to work in its final form and under expected conditions. Activities include developmental testing and evaluation of whether it will meet operational requirements.
7	Prototype ready for demonstration in an appropriate operational environment	Prototype ready for demonstration in an appropriate operational environment. At this level the prototype should be at planned operational level and is ready for demonstration of an actual prototype in an operational environment. Activities include prototype field testing.
6	System/subsystem model or prototype demonstration in a simulated environment	System/subsystem model or prototype demonstration in a simulated environment. At this level a model or prototype is developed that represents a near desired configuration. Activities include testing in a simulated operational environment or laboratory.
5	Component and/or validation in a simulated environment	Component and/or validation in a simulated environment. At this level the basic technological components are integrated for testing in a simulated environment. Activities include laboratory integration of components.
4	Component and/or validation in a laboratory environment	Component and/or validation in a laboratory environment. At this level basic technological components are integrated to establish that they will work together. Activities include integration of "ad hoc" hardware in the laboratory.
3	Analytical and experimental critical function and/or proof of concept	Analytical and experimental critical function and/or proof of concept. At this level active research and development is initiated. Activities might include components that are not yet integrated or representative.
2	Technology concept and/or application formulated	Technology concept and/or application formulated. At this level invention begins. Once the basic principles are observed, practical applications can be invented. Activities are limited to analytical studies.
1	Basic principles of concept observed and reported	Basic principles of concept are observed and reported. At this level scientific research begins to translate into applied research and development. Activities might include paper studies of a technology's basic properties.

Source: Build in Canada Innovation Program

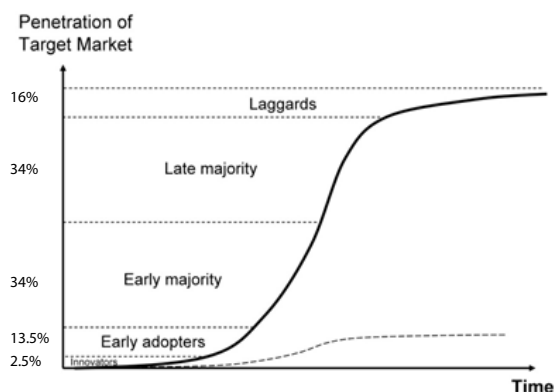


Figure 4: Technology Adoption Life Cycle "S-curve" and Diffusion of Innovations

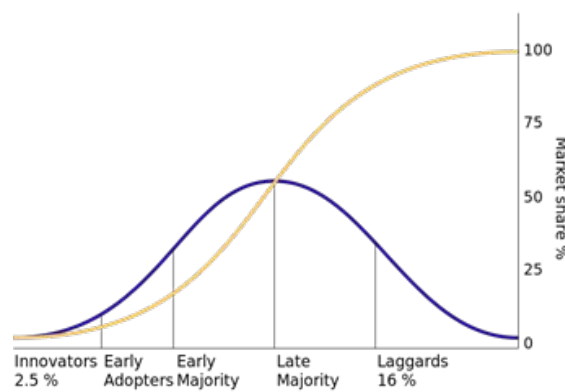


Figure 5: Diffusion of Innovations

point the Technology (Adoption) Life Cycle (TALC) becomes important. TALC differentiates between several types of customers, such as the:

- innovators (technology enthusiasts);
- early adopters (visionaries);
- early majority (pragmatics);
- late majority (conservatives); and
- laggards (sceptics).

4.2 The power of public purchasing

Public authorities or public equivalent bodies (such as all of the dAIR partners) have the potential to play a major role in helping innovative solutions enter the market. They can do so by using the power of their purchasing behaviour.

Public procurement accounts for some 19% of GDP in the EU and offers an enormous (currently to a large extent overlooked) potential market for innovative products and services. As regards spending in specific sectors, this figure can rise up to 40% (construction) and even nearly 100% (defence, civil security and emergency operations).

Yet, there is a market failure which is hindering the successful deployment of innovative products and services on the market. To start with, the benefits they offer are often unknown, or difficult to evaluate. Within the dAIR project,

a number of interesting cases deal with this problem.

To reduce CO₂ emissions in the two airports it manages, Mitteldeutsche Airport Holding (MAH) investigated the potential and feasibility of new available technologies for its own electricity generation (at Dresden Airport) and for its vehicle fleet (at Leipzig/Halle Airport). Since these are complex issues, MAH called for the help of by external experts to commonly evaluate the possibilities. At Dresden Airport, it was thus concluded that a Fuel Cell Cogeneration Unit¹¹ has a high degree of effectiveness and rarely produces emissions (due to the missing process of combustion), and the construction and stable long-term running of a plant are basically feasible. Nevertheless, the remaining technical risk and the high financial risk have led MAH to the conclusion that it needs to temporarily halt these plans in order to proceed with further analysis. A similar situation occurred at Leipzig/Halle Airport, where the Leipzig University of Applied Sciences was called for help. The plans to invest in hydrogen technology for the airport's vehicle fleet were stopped, as it became

clear that from a mere economic point of view (high investment and operating costs) it is not yet sensible to make use of hydrogen technology in the mobility sector. From an ecological point of view, other questions remained (the use of hydrogen only makes sense if it is produced from pure renewable resources). Therefore, plans to invest are on hold.

In 1999, the City of Vienna set up a city-wide programme called ÖkoKauf Wien (Eco Buy Vienna) covering all fields of its administration to advance the application of ecological criteria in procurement, i.e. the purchase of goods, products and services.¹² With 5 billion euro to spend every year, Vienna is in a position (that it actively wants to use) to influence the quality and properties of products and to promote the development and wider availability of eco-friendly products. In order to better know and evaluate the offer on the market, 25 (!) thematic working groups have been set up. The results of their work are translated into lists of specialised eco-friendly criteria that must be taken into account in all public procurement and contracting activities of the City of Vienna.

The importance of criteria to be included in procurement procedures was equally demonstrated during a study visit

¹¹ A **fuel cell** is a device that converts the chemical energy from a fuel into electricity through a chemical reaction with oxygen or another oxidizing agent; **Cogeneration** or **combined heat and power (CHP)** is the use of a heat engine or power station to simultaneously generate electricity and useful heat

¹² see: www.wien.gv.at/english/environment/klip/pdf/ecobuy.pdf

to Stockholm. Once the offer on the market is known, a tender can be launched. Such tender contracts do however not only have to relate to the mere purchasing of products (regarding the purchasing of new and innovative products, cfr. infra section 4.4.1) and services. Tender contracts themselves can also serve the purpose of service innovation. Stockholm Public Transport Authority's model of tendering contracts to private traffic suppliers, for example, used to clearly stipulate the payment of contractors per produced kilometre, hour and number of vehicles. The new contract, however, rewards contractors per transported and paying passenger. This will stimulate contractors to make traffic more efficient as well as to provide a higher level of service to get more passengers on board and thus increase their revenues. Within certain limits, contractors are also allowed

to operate changes in service supply and the route network.

Eco Buy Vienna is an excellent but intense and time consuming approach to gaining access to the existing state-of-the-art. www.innovatiemarkt.nl (only available in Dutch) is a Dutch digital platform where public authorities and companies can meet in order to request or offer innovative solutions. As such, providers (offer) and procurers (demand) of sustainable innovative solutions can meet with each other, after which contracts can follow.

For procurers, taking on such an active and steering role can be quite challenging. In order to support them, Pianoo, the Dutch Public Procurement Expertise Centre, has published a useful

guide titled "Know the Market".¹³ Procurers can also become part of "Buyers Groups" or "Networks of Procurers" (the establishment of such groups is actively promoted by the European Commission through dedicated project calls), or become members of, for example, the Working Group on Public Procurement that is set up by the city network organisation Eurocities.

While there is no doubt that dAIR's partners (and the four 'innovation regions' and their stakeholders in particular) potentially belong to the customer groups of 'innovators' and 'early adopters', there is no guarantee that these two groups of customers will actually buy a newly launched product. "Being

¹³ www.pianoo.nl/sites/default/files/documents/gerelateerd/know_the_market.pdf

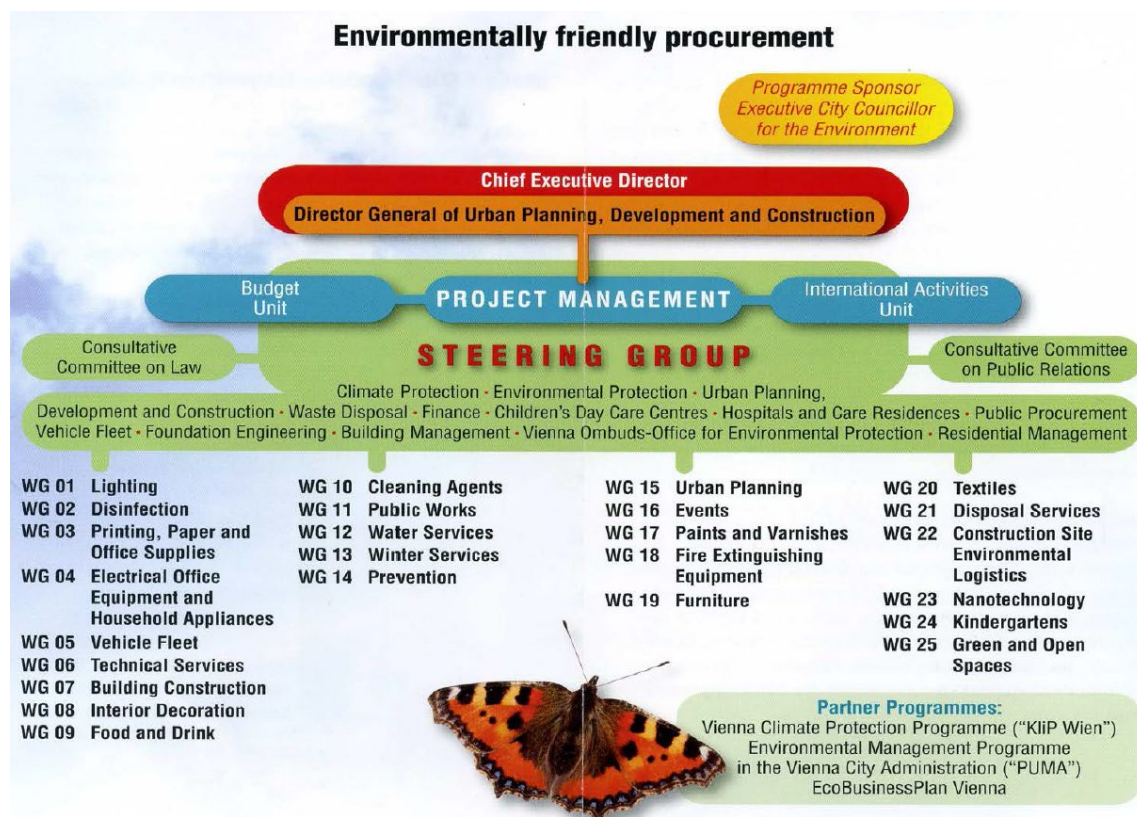


Figure 5: Eco Buy Vienna Programme Structure

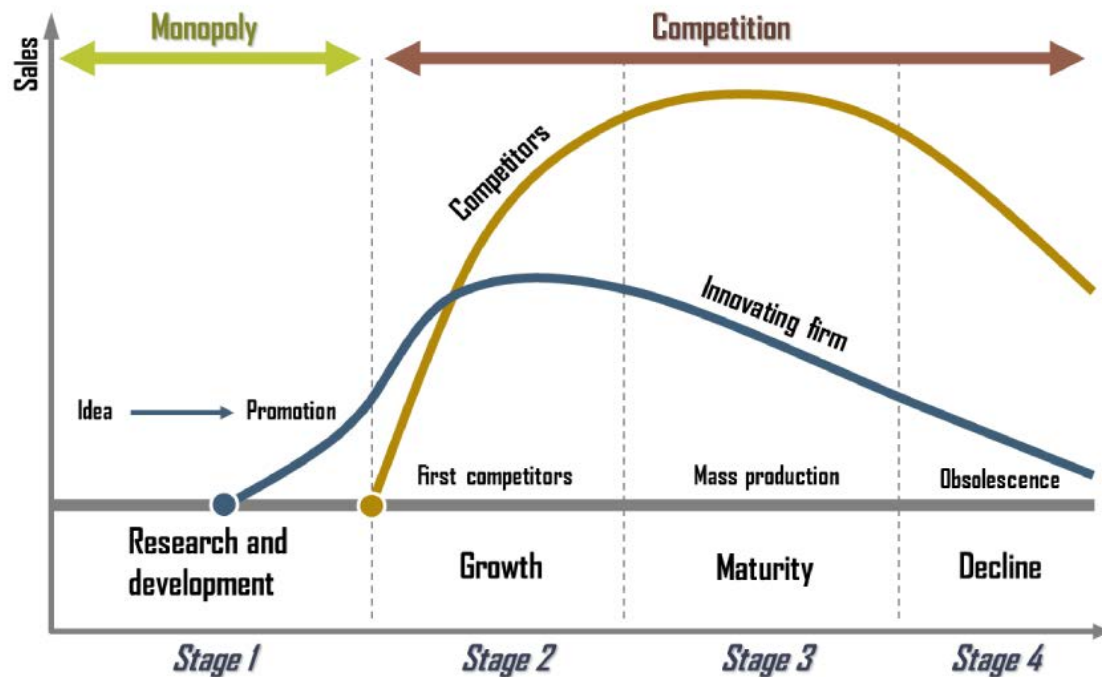


Figure 7: the Technology Life Cycle Path

unknown” is only one aspect of market failure. Indeed, in this so-called ‘technology push’ model as described above, the potential offer by suppliers is often valued more than the actual demand of the potential customer. This can often lead to products or services for which there finally appears to be no market or user need. As market introduction is preceded by a – costly – investment period, this is not in the interest of the supplier (who might have difficulties in keeping his business running) or in the interest of the client (who does not obtain the expected solution).

In view of this issue, greater attention needs to be paid to the interest of the client, by shifting from a “Technology Push” model to a “Market Pull” model, in which more attention is given to the real needs of the customer, and in which the latter is also being helped to express

these needs in a better way.

4.3 Market Pull

‘The problem that needs to be solved’ is the starting point within the market pull model. Asking the right question (from the supplier’s point of view), or formulating the real need (from the customer’s point of view) often is already a large part of the answer.

Matti Kaulio (1998)¹⁴ developed an easy framework, distinguishing the level of user involvement in product/service design processes:

- Design for: users are still seen as objects, on which information and data relating to their preferences, needs

and requirements are applied.

- Design with: users are shown different concepts and prototypes and are asked for their opinion. A formal dialogue with users is established during this iterative approach.
- Design by: in this participative approach users, that are real lead-users, are actively being involved as team members of the design process.

The following section will develop these concepts further and will provide a number of illustrative examples as seen within and outside the dAIR project.

4.3.1 Detecting the customer’s need

4.3.1.1 Ask the customer what he/she wants

¹⁴ Kaulio, M.A., (1998) “Customer, consumer and user involvement in product development: A framework and a review of selected methods”, in ‘Total Quality Management’, Vol. 9, pp. 141–150.

The customer is asked what is needed or wanted. By analysing the (portrayed) activities and behaviour a product/service can be (re)designed in a way that meets the requirements of the customer. The answers collected also constitute important input for a profitable business model to be built, if at least the portrayed behaviour corresponds to the actual behaviour.

'Mobility Manager' is a software package operating through a web platform that was designed to investigate the mobility of workers. This is an interesting innovation developed within the framework of the dAIR project. The original developer SISTeMA (a spin-off company of La Sapienza University of Rome) adapted the system to enable it not only to cover the employees of one single company, but to implement a survey in a multi-company context such as G. Marconi Airport in Bologna. The software analyses the answers given by workers on commuting options and decides what actions are most efficient for each individual case, in order to increase environmental sustainability. Even more interestingly, in addition to the availability of information on current methods of commuting, Mobility Manager also allows users to collect information and opinions on the future mobility intentions of the interviewees, especially with respect to possible changes in the use of means of transport and the actions that would trigger them to change current or envisioned behaviour. On the basis of this inside information, new or adapted sustainable mobility solutions that would actually be used by passengers can be designed.

The Filéo bus-on-demand system in the Paris Charles de Gaulle airport area is a good example of providing a flexible public transport offer to employees working outside of regular transport

schedules. Detailed analysis of the bookings over a certain period can lead to a change in schedules, such as in the following cases:

- If 30 people ask for Filéo on a specific route for a year then a normal bus is introduced on that route.
- If fewer than 30 people use the normal bus then Filéo can be introduced on that route at night.

As such, the offer is adapted to the demand, and STIF (the transport company) can maintain a more profitable (i.e. depend less on subsidies) business model through the cutting of costs.

4.3.1.2 Analyse the (hidden) needs of the customer(s)

This approach looks at the actual behaviour of customers, and not merely at what they say they are doing. In order to do this, data is collected and analysed in order to detect patterns that enable the supplier to have a full insight. In this way, solutions can be designed for which the customer has never asked, but by which he is fascinated or even attracted to such extent that he will buy them.

Liftago is a Prague based company that was visited during the project and which developed a taxi app "that gives you the superpower to see through walls for available taxis so that you don't have to wait". Liftago built a transparent taxi market which enables users to choose the best available nearby taxi. The app helps reduce unnecessary taxi movements, saves customers precious time and reduces traffic congestion. Liftago is a free app, but the company acknowledges plans to use the collected data to build a platform which, at a later stage, will allow the development of additional (paying) services.

Liftago is one of many companies worldwide with such plans. As is demonstrated in this video¹⁵, these extra services could go well beyond the mobility market. Evolutions in that core mobility market, however, demonstrate a fascinating potential that can meet customer needs, create business and contribute to well-connected green airports:

- Hailo is an app operating in US cities that allows customers to connect to rides in several (car based) mobility solutions, including airport shuttles.
- During the Paris study visit, dAIR partners were introduced to the 'Instant Mobility' project which was developed by a Europe-wide consortium led by Thales, within the framework of the EU's Public Private Partnership 'Future Internet' project. Using the Instant Mobility app (once it is fully operational), users can find mobility solutions provided by different modes, including public transport and private car drivers.

In the Instant Mobility vision, every journey and every transport movement is part of a fully connected and self-optimising ecosystem. Whatever the traveller's situation (office, home, on-trip...), Instant Mobility will deliver useful Future Internet enabled information and services.

The traveller will receive personalised and real-time solutions to support him in reaching his destination according to current personal preferences and constraints, real-time traffic status and public transport availability along his journey. These real time-solutions will be proactively updated

15 see: skift.com/2013/08/06/are-uber-hailo-and-other-taxi-apps-going-after-a-big-enough-market/
In August 2014 the Uber company started with the 'Uber Corner Store' experiment in a few US cities: a delivery service system using the Uber drivers, see: www.wired.com/2014/08/uber-corner-store/?mbid=social_fb



The customer is asked what is needed or wanted. By analysing the (portrayed) activities and behaviour a product/service can be (re)designed in a way that meets the requirements of the customer.

during the traveller journey based on his effective progression.

Local authorities, public transport operators and professional drivers will all benefit from the open information platform that Instant Mobility will provide to publish information regarding immediate and near future mobility requests as well as effective availability and location of all means of transportation. This will allow new ways to optimize urban traffic while enhancing safety and privacy of the travellers and promoting car sharing and car-pooling on a new scale.
www.instant-mobility.com

A major condition for applications such as Instant Mobility to be able to work is the availability of data. As such, public authorities and public transport companies that 'own' a large number of relevant data sets play a crucial facilitating role in stimulating innovation in mobility solutions.

Open data is public sector information that is made available to everyone in standard open digital formats with a clear structure, so it can be understood. This facilitates access to information and encourages people to reuse it. In this way society — the public, businesses or any institution — can access data easily, to find out information or create new services that add to their social value and may also add to their commercial value.

Open data goes beyond the simple process of allowing it to be reused. It returns public data to society and encourages people to reuse the data in whatever way they want.

Oarion – a 'real time air quality monitoring system' R&D project operated by

Prometeo and Ingenieros Asesores that was presented during the El Prat de Llobregat study visit – measures air pollution in real time through sensors that are attached to vehicles, and can combine the gathered data with (publicly available) traffic information. On top of the scientific value of the project to link air quality data with traffic information under specific (weather) conditions, Oarion allows to formulate specific travel advice to diminish pollution in a specific area.

Leading European cities such as Barcelona and Helsinki have gathered all their data in a single portal and made it available to the public and to companies that want to build new services.

- OpenDataBCN: opendata.bcn.cat/opendata/en/catalog
- Helsinki Region Infoshare: www.hri.fi/en

These two cities, together with a number of other leading European partners, are developing the CityDSK project, in which the interoperability of the data sets between the participating cities (which often have their own format) is central, thus contributing to future standards¹⁶. CityDSK is working in three domains, including mobility. See: www.citysdk.eu/about-the-project

Projects such as Transport Innova-

¹⁶ Standards facilitate interoperability: this is important for competition. Furthermore, by setting ground rules, a common terminology, development methods and measurement techniques, standards enable the development of follow-up innovations and the diffusion of innovations. Standardisation may also help create critical mass in the formative stages of a given market. However, setting standards can also pose risks: they may lead to undesirable lock-in into sub-optimal technologies and allow incumbents to create barriers to market entry with negative implications for innovation.

tion Deployment for Europe (TIDE)¹⁷ in which Eurocities and Polis take part, have produced and published good examples of open data related mobility projects, operated by partners including dAIR partner City of Vienna.

Due to its importance, and the enormous potential in terms of mobility, environment and economy, the European Union is preparing a new regulation on access to public and private transport data. With this initiative the EU aims to facilitate the re-use of traffic and travel data leading to better modal choices and to a more efficient use of the transport infrastructure. This will help reduce the environmental impact of the transport sector.¹⁸

4.3.2 Formulate your actual needs

When on the lookout for a solution to their problems, customers often have the exact product or service they want to buy in mind. This is not the right approach to find the best solution. Do not over-specify, as this can kill innovation. Performance-based or functional specifications are a way of allowing more flexibility for suppliers to propose solutions.

In functional procurement, the procurement is formulated in terms of goals rather than resources.

Development of a specification (what do I want to buy?) places us at the beginning of a careful and complete procurement process. The functional specification

¹⁷ see: www.tide-innovation.eu/en/upload/Results/TIDE-InnovationToolbox-ENG-lite.pdf (pages 22-29)

¹⁸ EU Background Document, see: ec.europa.eu/transport/media/consultations/doc/2013-03-12-mtpis/background.pdf

Open-access data for traveller information

- stimulates the private sector app developers to innovate and provide apps according to user needs;
- provides an option to disseminate multi-modal traveller information in a cost-effective way;
- allows travellers to make more informed decisions and could encourage the choice of more sustainable modes of travel;
- shows the willingness of the local authority to honour its obligations under “freedom of information”; and
- avoids developers needing to apply (and pay) for data to create applications — as long as they follow the terms of agreement.

City network organisations such as Eurocities and Polis are supporting their members (that include several dAIR project partners) in their open data policy.¹

The City of Eindhoven has recently started to design and implement an open data policy, in full respect of privacy issues. The policy towards the data the city owns itself is quite straightforward: “all data is open, unless”. The Open Data Platform, in which all this information is gathered, is connected with the ‘city dashboard’ that has been developed and which is a testimony of ultimate transparency: it shows residents how effectively all of the city services are performing. Next to this passive approach, and on top of the ‘rather traditional’ app-development using city open data, the Eindhoven open data approach is very much aimed at re-using data and stimulating data analytics by third parties. The results of data analysis will become a driving force for decision making in and by the city, thus improving the quality of life. As such, the Open Data Platform can and is already facilitating diverse Living Lab projects and environments. The use of open data is also part of the city’s Future Mobility Roadmap ‘Eindhoven en Route’.²

In order to raise awareness of this still rather new policy and the opportunities it offers to all external stakeholders, the city has launched ‘open data challenges’, and is communicating actively through the organisation of conferences and its website <http://openeindhoven.nl/english/>.

As part of the city’s open data policy, municipal data (such as Geofundament, Police) is made available through the Open Data Platform ‘Socrata’ (<https://data.eindhoven.nl>). Today, Socrata already contains >40 data sets. Socrata processes this data and presents it on a 2D-platform and through other formats (csv, kml, kmz, json, etc.). In this way, openness and transparency are being created and first steps for citizen participation and the further development of an app-ecosystem are created. Currently the app-ecosystem involves several large Eindhoven based enterprises (Philips), Brainport Development, App developers (mostly small sized SMEs), educational institutions such as the Eindhoven University of Technology, Fontys University of Applied Sciences and several secondary schools, as well as the local sensor industry.

The ultimate aim is to hand over the Socrata platform to the city and its partners. Every partner can then upload data and re-use the data for different projects and subjects. Partners can then have their own websites, but for interaction and collaboration the data platform can (should) be the central point. The data can be put into the platform in different formats and can also be used in different formats. All the data can be visualized in different ways (graphs, etc) and all other websites can copy and paste this on their own websites. The latest development is to try to make sensor data available and use 3D visualisation into the open data platform.

During the lifetime of the dAIR project, the City of Eindhoven has become the president of Eurocities’ Open Data Working Group.

Transport for London (TfL), the UK’s capital government body responsible for most aspects of the transport system in Greater London, is a global leader in its open approach to data, with live information shared freely with developers, around 6,000 of whom have registered to take feeds from the Tube and roads control rooms. This has not only led to an array of brilliant apps for passengers, but their use has helped TfL monitor shifts in demand as passengers monitor information about the whereabouts of their tube trains, Boris bikes and buses, in a way that suits them.

Source: The Guardian, 13 August 2014.

For more examples of innovation in transport, and TfL’s role in it in the same article; see: www.theguardian.com/uk-news/2014/aug/13/transport-london-tube-bus-oyster-data?CMP=fb_gu

Road networks, public transport, local trains but also Velo’v (bike sharing service in Lyon), car-sharing, car pooling: the agglomeration of **Lyon** offers a wide range of modes of transport and services, organised into a meshed network, promoting connections. However, the dissemination of information on travel conditions is quite disorganised today. The challenge taken on by Optimod’Lyon is to centralise all mobility data within a single data centre, aiming at producing integrated user information, in real time, about all modes of transport. Additionally Optimod’Lyon – a triple helix partnership of 12 members, initiated by GrandLyon – will be able to make 1 hour traffic predictions in an urban context.

www.optimodlyon.com/en/accueil

¹ Eurocities Guidebook on Open Data: eurocities.eu/eurocities/publications/EUROCITIES-open-data-guidebook-open-data-working-group-publication-WSPO-9CTHZE
Eurocities Statement on Open Data: nws.eurocities.eu/MediaShell/media/EUROCITIES%20Statement%20on%20Open%20Data.pdf
Polis Position Paper on Open Data: www.polisnetwork.eu/uploads/Modules/PublicDocuments/polis-position-paper-open-transport-data.pdf

² See: www.eindhovenopweg.nl

describes the functions that the product or service must fulfil for the user, in other words: what should the product do? Functional specifications say nothing about “how” this need should be met.

A functional specification allows great freedom for both suppliers and the buying organisation. With functional specifications usually more suppliers can be found than with tightly defined, detailed specifications, reducing the chance of a monopolistic situation. Working with functional specifications also reduces the risk of neglecting alternatives.

source: Pianoo's Functional Specification Guide: Developing a sustainable functional specification in 6 steps.¹⁹

The City of Barcelona is one of Europe's leading actors in this respect. The city is not telling contractors what they want to buy. They are laying out problems they want to fix. Barcelona's less proscriptive approach turns the old system on its head. Rather than laying out exactly what it wants to buy (say, bike lockers), Barcelona is laying out six problems it wants to fix (such as reducing bike theft). Responses could involve buying products, but they might also suggest new services, regulatory changes or any other means of accomplishing the goal. Anyone around the world with a creative idea, including start-up companies or even individuals, has a shot at a contract and all the market legitimacy that comes with that. The City of Barcelona is even taking it a step further, as winning bidders also get free space to set up their business. As such the city is contributing to the creation of new business. See: <http://bcnopenchallenge.org/>

For more interesting examples, see <http://citymart.com/DiscoverSolutions>

There is a fine balance between making sure the market knows exactly what your requirements are and leaving the door open to different and new ways of meeting those requirements. Before you are able to translate your requirements into functional terms and ask the market what it can deliver, it is necessary to have a clear picture of the real need or problem. In order to get this picture, collecting and consulting several sources of information, building your own information by making a study, and/or engaging in a dialogue with colleagues and stakeholders within and outside your sector are all useful steps allowing you to get the need or problem clear, and possibly

redefining it.

Eindhoven Airport: “reculer pour mieux sauter”

Eindhoven Airport has counted on the implementation of innovative solutions in its premises to meet the Alders Advisory Board's sustainability conditions right from the start. It has, however, become clear by now that some of the solutions collected – and partly implemented – by the Umbrella Group Innovation which is coordinating this task (cfr. intra) will not – today or in the future – be sufficient to meet the overall goal. Supply and demand did not meet, in large part because the demand was not reflecting the real problem.

In December 2013 Eindhoven Airport obtained the highest level within ACI's Airport Carbon Accreditation Scheme, and

reached ‘CO₂ emission neutrality’. ‘Zero Emission’ now is the next goal in the overall ambition to be among the top airports in terms of sustainability in Europe. In order to be able to realise this Zero Emission ambition by upgrading its own efforts and reducing the use of carbon credits, in February 2014 Eindhoven Airport started with the development of a “Strategic Plan for CO₂ Reduction towards Zero Emissions”. The first phase of the Plan consists of a more detailed research of current and future energy consumption (needs). The result of this exercise, which may have delayed the Umbrella Group Innovation's original timing, will allow to make bigger and faster steps forward in collecting and (co)developing innovative solutions for and at Eindhoven Airport.

With the functional specifications



The City of Barcelona is not telling contractors what they want to buy. They are laying out problems they want to fix. Barcelona's less proscriptive approach turns the old system on its head. Rather than laying out exactly what it wants to buy (say, bike lockers), Barcelona is laying out six problems it wants to fix (such as reducing bike theft)

¹⁹ see: www.pianoo.nl/sites/default/files/documents/documents/ienmhandvatfunctioneelspecificereneng.pdf

ready, a regular purchase or procurement process can start. In section 4.2 of this chapter a number of enlightening examples were given on how such market dialogue can be entered into.

If the result of this exercise is such that the distance between the identified need or problem and readymade solutions available on the market is too large, it may be time to stimulate the development of new, currently non-existing solutions and to become part of their development.

4.4 Partnering in innovation

At the beginning of this chapter, it was pointed out that “innovation” within the dAIR context is mainly about the cooperation of public authorities and airport

operators with knowledge institutes and private businesses. It is about reaching out to them in order to have the right products and services in the right place as soon as possible, in order to quickly reach the ambitious goal of well-connected green airport regions. In most cases, dAIR partners are not the leading actors in the innovation game, but they can play a majorly important contributing and facilitating role. For this, the customer – public authorities and airport operators in the case of dAIR – needs to be included in the – sometimes risky – development phases preceding the actual full commercial deployment on the market. They are given a backstage pass to the innovation festival and become partners.

Next steps

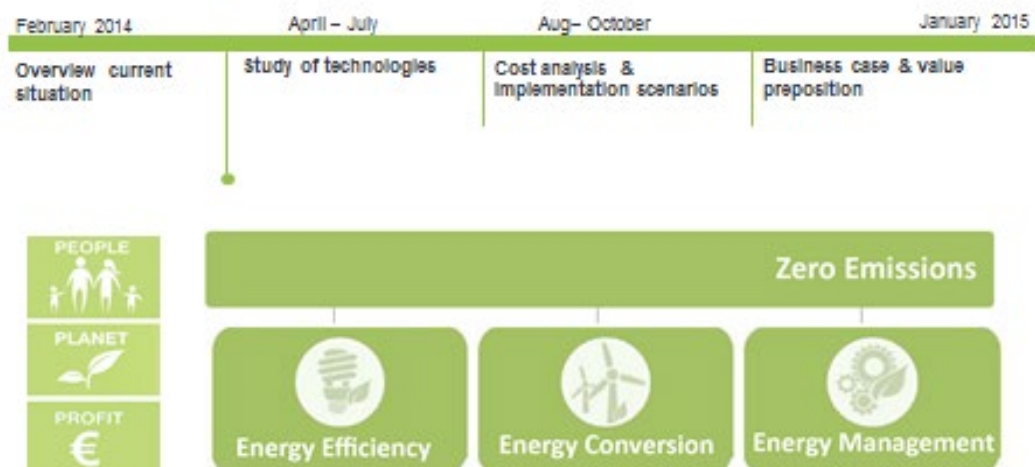


Figure 8: Eindhoven Airport “Strategic Plan for CO₂ Reduction towards Zero Emissions”; time schedule

The Nordic Consumer Policy Research Conference, organised in 2007 in Helsinki, devoted 3 days to the central question: “Consumers in Product Development: Empowered or Exploited?” Even though the conference was much about private persons as consumers, the following conclusions do have value for public authorities and airport operators as well:

a) Benefits to consumers involved in product development

Consumers involved in product development do not often receive monetary compensation for their input. Instead, they presumably gain many kinds of other benefits from their involvement. The most apparent benefit seems to be the fact that they gain products that better meet their needs because they have been involved in their design. At the same time, their relationship with the product may become more intense.

Involvement in product development may be rewarding due to the creativity required by the process. Learning and creating new things must be a good reason for many consumers to participate in product development. The social nature of the product development process may also be a pleasant experience. Product development is usually carried out in a social forum in which it is possible, for example, to bring forward one's expertise and gain peer recognition.

The benefit gained by consumers involved in product development may also be something other than a personal gain. They may participate in product development in order to ensure that the views of their own reference group are taken into account. This way, they have an opportunity to have a say and provide “common good” through their own input.

b) Costs to consumers involved in product development

Naturally, consumers taking part in product development also face costs or disadvantages. They may spend a lot of time and effort assisting the company in the product development process. As consumers are not professionals in product development, they do this in their own time. Consumers taking part in product development do not usually receive monetary compensation for their involvement, but the company they have helped may earn rather large sums with these products.

c) Benefits to consumers not involved in product development

Consumers not involved in product development themselves may, nevertheless, gain benefits from the fact that other consumers have introduced a consumer's point of view into the product development process. Presumably, they too can enjoy the better products that should be created through product development along with consumer participation. On the other hand, it is true that only a certain group of consumers takes part in product development, and it is not self-evident that their needs are the same as those of a wider consumer group.

d) Costs to consumers not involved in product development

It can be presumed that consumers not involved in product development would have no disadvantages from the fact that some other consumers introduce the consumer's viewpoint to product development. However, increased consumer involvement may also have indirect impacts on consumers who have not participated in the product development process. If new products have been designed on the terms of active lead users, they are not necessarily suitable for every person.

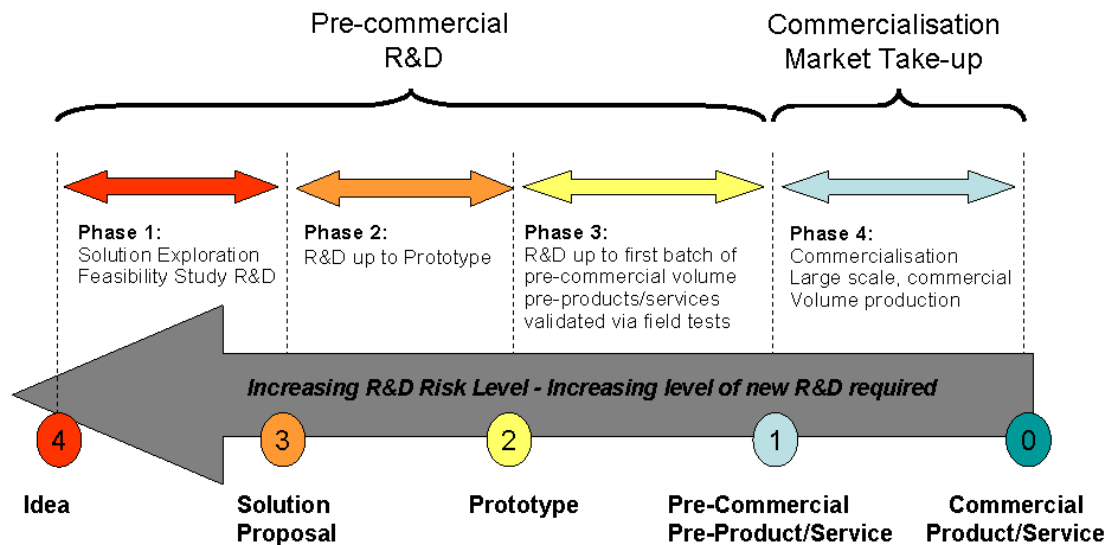


Figure 9: Typical Research and Innovation life-cycle transforming an idea into a product/service

This chapter highlights a few possibilities to take part in the innovation process.

4.4.1 Procurement of Innovation²⁰

The bulk of public procurements consists of off-the-shelf products that have passed TRL level 9 and that remain with R&D risk level '0' (see figure 9 above). As stated before, not every challenge can find its solution in a product which is already commercially largely available.

4.4.1.1 Public Procurement of Innovation

Public procurement of innovation (PPI) occurs when public authorities act as a launch customer: a first buyer of innovative products or services that are newly

arriving on the market and are not yet available on a large-scale commercial basis. PPI may include conformance testing.

PPI does not involve any R&D activities. The role of the public sector is to generate the critical mass needed to trigger industry to scale up its production in order to bring products of the desired quality onto the market.

PPI is a good first step for parties entering the innovation game, since it may be able to make open-minded public procurers buy 'innovative' products for which the financial and technological development risks can be ascertained beforehand within controllable limits of uncertainty (risk level 1). Innovative procurement thus ensures the take-up (phase 4) of pre-commercial R&D pre-products/services which are ready to be commercially deployed (risk level 1).

4.4.1.2 Pre-commercial Public Procurement

The public sector in the EU, as elsewhere in the world, is faced with important societal challenges, such as the ones relating to energy and mobility. Addressing such challenges requires new and innovative solutions. Some of these required improvements are so technologically demanding that either no commercially

stable solution yet exists on the market, or existing solutions exhibit shortcomings which require new R&D. In such situations public actors willing to take a step forward on these societal challenges, can make use of pre-commercial procurement (PCP).

PCP is an approach to the procurement of R&D services. It precedes the commercial public procurement in the product and procurers buying process. PCP refers to innovation up to and including a first pre-commercial volume batch of products and/or services validated via field tests. Pre-commercial procurement involves direct public R&D investment in the first three phases (pre-commercial part) of a typical R&D project life cycle (figure 9). As such, PCP is an important complement to PPI, which corresponds to phase 4 in a typical R&D project life cycle and that ensures the wide take-up of newly developed pre-commercial R&D pre-products/services.

It is clear that pre-commercial procurement involves a higher degree of risk than PPI, both in terms of technological risks (it requires earlier stage R&D, prototyping, testing, etc) and/or in terms of non-technological risks (more uncertain return on investment period, higher risk of uncertainty in cost estimations, etc). The way to get pre-commercial procure-

²⁰ Figure 9 shows the typical Research and Innovation life cycle of the transformation of a new idea into a commercial product or service. The R&D risk level associated with each stage of the life cycle is indicated on the graph. The research and development work carried out in phases 1 to 4 increases the Technology Readiness Level step by step – that was introduced earlier in this paper and that can be mapped to the 5 risk levels in figure 9 – of the R&D results: initial idea, solution proposal, prototype, pre-commercial product/service (also called pre-product/service), commercially ready product/service. Phases 1, 2 and 3 comprise pre-commercial research and development work. Phase 4 corresponds to commercialisation, the take-up of the first pre-commercially tested products and services by the market.

Why buy innovation?

Public procurement accounts for about 19% of GDP in the European Union and offers an enormous potential market for innovative products and services. Public procurement practices can help foster market uptake of innovative products and services, whilst improving the quality of public services in markets where the public sector is a significant purchaser.

The powerful benefits of PPI

Seeking more innovative procurement solutions can yield benefits for both public authorities and the private sector, as well as society at large. These include:

- **Increasing economic growth**

The power of demand (e.g. first buyer or lead customer) can move the market to stimulate the economy and increase competitiveness of firms in future markets, creating new businesses and increasing the level of employment.

- **Better products and services**

Direct benefits to the public as the users of public services can be the result of bringing new ideas onto the market. These can then be provided more efficiently and effectively and at a lower cost.

- **Solving the challenges facing society**

Scientific and technological breakthroughs can be the result of PPI and PCP processes. The outcome of these can help tackle key societal challenges such as health and well-being; food security, sustainable agriculture, clean and efficient energy; sustainable and integrated transport; or climate change and resource efficiency.

ment going is to share not only the risks, but also the benefits of R&D between procurers and suppliers.²¹

One of the best known and most successful pre-commercial procurement approaches is the US Small Business Innovation Research (SBIR) programme. European frontrunner countries in PCP, such as the UK and the Netherlands, have largely been inspired by the US example

21 For more details on sharing risks and benefits, see BOS, L., CORVERS, S. (2006) 'Pre-commercial public procurement. A missing link in the European Innovation Cycle. Public Needs as a Driver for Innovation', p. 14-16; article based on a report of an ad-hoc group of independent national experts, commissioned by the European Commission (see: http://ftp.cordis.europa.eu/pub/fp7/ict/docs/pcp/precommercial-procurement-of-innovation_en.pdf)

in their national legislation. Other countries active in PCP, such as Belgium, are guided by the EU's Recommendations that are being developed.²² In general, a PCP process looks like this:

To tackle the technological uncertainties inherent in procuring yet-to-be-developed technology in steps, a three-stage process (as shown in figure 10) is proposed, each stage with multiple suppliers in competition with each other:

- Phase 1: Solution Exploration / Re-

22 See also: OECD Innovation Policy Platform (2010) "Public Procurement programmes for small firms – SBIR-type programmes" Policy Brief; www.innovationpolicyplatform.org/sites/default/files/rdf_imported_documents/PublicProcurementProgrammesForSmallFirms.pdf

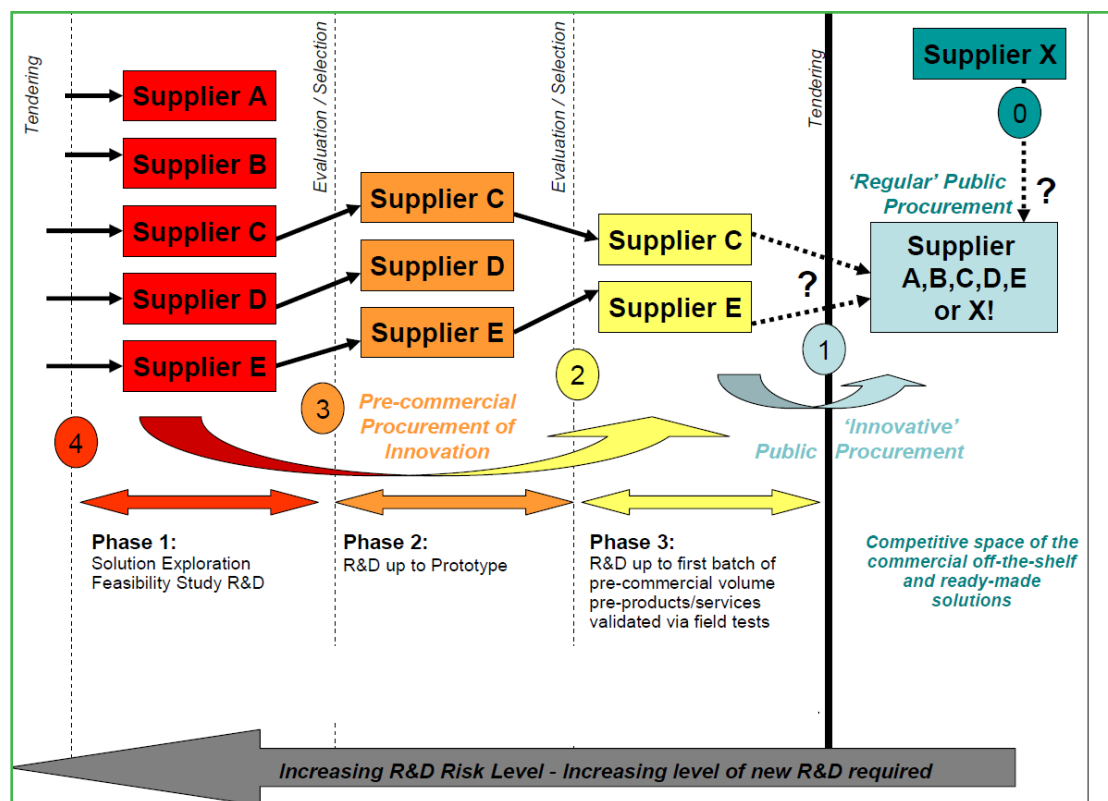


Figure 10: Pre-commercial procurement: a phase shared risk/shared benefit approach

search (minimum 3-5 competing suppliers)

- Phase 2: R&D up to Prototype (minimum 2-3 competing suppliers)
- Phase 3: R&D up to first pre-commercial volume batch of pre-products/services validated in a field test series (minimum 2 competing suppliers)

At the end of phase 1 and phase 2 an evaluation filters out the best projects based on their performance in the previous phase and the 'quality' of the project proposal for the next phase. The 'quality' criterion assesses the project's degree of technological innovation, commercialisation potential and the ability to address the problem of public interest posed in the tender. Once the three-step process is started, normally no other suppliers would be asked to submit offers. For

each of the three phases of the pre-commercial procurement process a fixed price is predefined in the initial tender publication. The companies are bidding in competition based on a (joint) tender request from the procurer (or group of procurers).

Technically speaking the three-stage pre-commercial procurement process is implemented as a single public procurement procedure with two intermediate evaluation points. The definition of R&D services can range from 'research (laboratory) services' through 'experimental development services' to 'design and execution of research and development', thus covering all three phases of the pre-commercial procurement process.

Figure 10 shows the life-cycle of a project that starts from scratch, from

the early research stage of solution exploration. In cases where state-of-the-art research has already progressed beyond risk-level 4, the pre-commercial process does not have to be started at phase 1, but can start at phase 2 or even at phase 3.

To encourage an organic wave of innovativeness among the supplier base, market demand is pooled up to contract values that trigger supplier imagination. Hence the added value of forming a group of procurers. Nevertheless, to make sure that the pooled market demand also opens up opportunities for SMEs, the group of procurers requires and helps suppliers to advertise parts of the contract which can be subcontracted to SMEs.

To make sure that the exercise re-

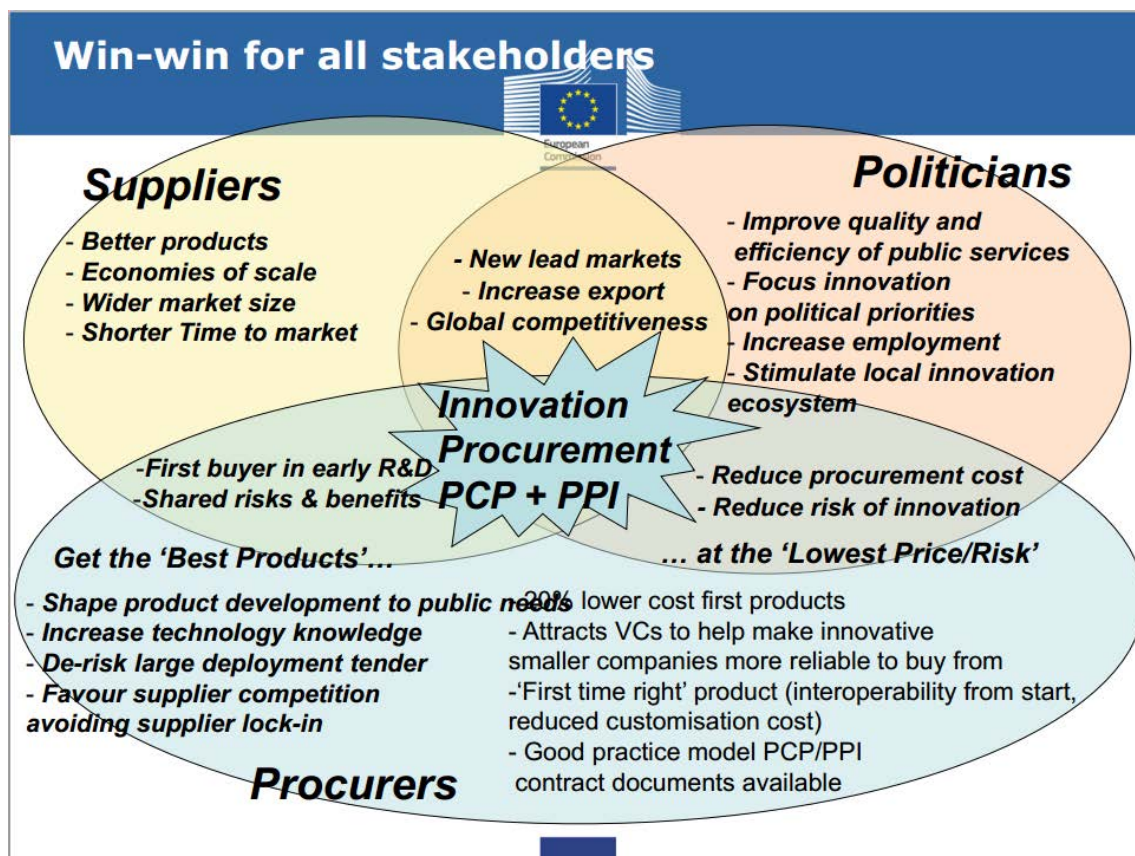


Figure 11: PPI and PCP, a win-win for all stakeholders

sults in products and/or services that can be deployed in a reasonable time, the three consecutive phases in the pre-commercial procurement process each have a well-specified focus and a limited duration.

- The aim of phase 1 (~ 6 months) is to verify the technical, economic and organisational feasibility of the proposal and to weigh it against the pros and cons of potential alternative solutions, as well as examining the proposal's ability to solve the problem of public interest. The output of phase 1 includes a technology evaluation, as well as an organisational plan (how to plan the R&D in phase 2) and an estimate of the economic impact of the proposed solution (development costs versus market potential).
- In phase 2 (~ 2 years) the actual development starts, up to the realisation of a first not yet commercially usable prototype. The main outputs of phase 2 are a product specification, a tested prototype and a production plan (limited production). In phase 2 the preliminary business plan of the company is also scrutinized.
- In phase 3 (~ 2 years) research and development continues beyond the first prototype up to a first batch of pre-products/services (pre-commercial volume production) that are validated through field tests and original development.²³ In step 3 the companies are also evaluated on their full business and production plans (for full scale volume production), marketing and communication plans as well as their ability to attract interest from investors/first buyers. This last evaluation criterion assures the take-up (diffusion) of solutions by commercial operation at the end of phase 3. This ensures the link between pre-commercial procurement (risk level '4' to '1') and PPI (risk level '1' to '0').

The three consecutive steps are a learning process, both for suppliers and potential buyer(s). It enables the potential buyer(s) to evaluate the pros and cons of the proposals made by different suppliers. Each step helps the procurer to adapt and fine-tune the requirements to fit the common specifications, which

he agrees should form the basis of any subsequent commercial procurement for the rollout of the final product/service. In the final pre-commercial procurement phase 3 at least two contractors would remain to ensure a future competitive market.

Within the dAIR project we have not encountered or (started to) developed 'pure' PPI or PCP projects. The City of Eindhoven, however, is one of Europe's frontrunner cities in PPI and PCP processes, and is actively involved in a number of projects that – once they have delivered their results – will be of relevance to dAIR's objectives:

SPEA – Smart Procurement European Alliance

Together with the cities of Barcelona and Birmingham, Eindhoven is implementing the public procurement of innovative solutions in the area of energy efficiency (and its management) in municipal buildings. It is thereby increasing the demand for innovation in this field and enhancing innovation of public services in relation to the improvement in quality/efficiency of municipal buildings. SMEs are equally being provided with opportunities to get involved in public procurement as direct beneficiaries/clients of a purchasing authority.

Other specific objectives of the project, also aligned with the programme objectives, are:

- to improve the capacity of contracting authorities as well as SMEs regarding the procurement of innovation;
- to create buyers groups of innovative solutions;
- to build cooperation with other stakeholders at a local and European level;
- to deliver recommendations to the EU regarding the barriers for developing a joint/coordinated procurement; and
- to raise awareness of the procurement results among policy makers.

www.speaproject.eu/en

ENIGMA – Enlightenment and Innovation ensured through Pre-Commercial Procurement in Cities

Together with four partner cities (Stavanger, Bassano del Grappa, Espoo and Malmö) the city of Eindhoven is looking for integrated solutions to their lighting, ICT, environmental and safety concerns.

In their search for an all-encompassing public lighting system, the five cities invite businesses across Europe to put forward their best ideas and to compete in a pre-commercial procurement process. www.enigma-project.eu/en

SILVER – Supporting Independent Living for the Elderly through Robotics

SILVER is the EU's first ever funded PCP project. Together with their partners, the City of Eindhoven and Brainport Development are searching for new technologies to assist elderly people in their everyday lives. Through the use of robotics or other related technologies, the elderly can continue living independently at home even if they have physical or cognitive disabilities. The new technologies and solutions are being sought through a Pre-Commercial Procurement (PCP) process.

SILVER has no content related link with dAIR. But apart from creating and implementing a specific call to improve independent living, SILVER is very much a pioneer learning project pursuing these other objectives:

1. understanding PCP and sharing this amongst the participants in order to develop a foundation of understanding;
2. synthesising an agreed process that fits within the legal and political framework of the EU and participating countries; and
3. generating required documents and templates suitable for further use of cross-national PCP calls by other organisations.

www.silverpcp.eu

In conclusion:

- Innovation-oriented public procurement stimulates innovation by creating a demand for innovative products or services. Demand-pull theories suggest that the ability to produce innovations often requires market opportunity (i.e. demand). Demand then directs resources and capabilities to innovations in order to meet market needs.
- Innovation-oriented public procurement can help firms with easier access to private third-party funding. Indeed, the provision of a market through the awarding of a contract and positive evaluation by a public agency can help attract additional financing from private sources.
- Public procurement can also help

²³ Original development of a first product or service may include limited production or supply in order to incorporate the results of field testing and to demonstrate that the product or service is suitable for production or supply in quantity to acceptable quality standards. It does not extend to quantity production or supply to establish commercial viability or to recover research and development costs.

innovative businesses bridge the pre-commercialisation gap for their innovative products and services by awarding contracts for pre-commercial innovations (i.e. first sales of technology). Pre-commercial contracts allow innovative companies to test their products and services on public organizations and to get feedback on their performance. These tests and the ensuing feedback may be essential for improving the products and services, and for providing firms with the opportunity to enter the marketplace with a successful application of their new products and services. Overall, public procurement reduces possible concerns about the perceived risk of adopting a new technology. Customer concerns about a firm's or innovation's viability often prevent innovative companies from selling their products, even if the product, process or service is technically superior to that of their rivals.

- Public procurement can help innovative firms achieve the critical mass and competitiveness needed to bring down prices, which may be a key factor in the commercialisation and adoption of an innovation.

If applied as a strategic policy tool to boost innovation from the demand side, innovative procurement (PPI and PCP) can open up opportunities for European companies to take a leadership position in new markets in the context of global competition, and thus create jobs and growth. At the same time it contributes to consolidating market needs, facilitating interoperability and supporting the creation of standards.

The European Commission is therefore giving high priority to PPI and PCP. It is included as one of the 34 Action Points of the EU's Innovation Union Flagship Initiative. In order to support public authorities to engage in PPI and PCP processes, a Procurement of Innovation Platform has been established (website: www.innovation-procurement.org), which also produced guidelines²⁴ for public authorities.

4.5 Push meets Pull

In the two previous sections, the theoretical push and pull models have been

²⁴ see: www.innovation-procurement.org/fileadmin/editor-content/Guides/PPI-Platform_Guide_new-final_download.pdf

explained and illustrated. In real life practice, there is always a bit of both. In order to visualise this and to counterbalance the omnipresent Technology Readiness Level (push) approach, Florin Paun (2011)²⁵ – working at Onera, the French Aero Space Research Centre and thus part of the same industry that was at the origin of the TRL scale – has developed the “Demand Readiness Level” (DRL).

The Demand Readiness Level (DRL) is an additional scale to the Technology Readiness Level, which relates to the degree of maturity for the expression of a need by a customer on a given market, including the lead markets for eco-innovation.

Experience has shown that the straight Technology Push approach was not the most appropriate one to place newly developed technologies on other market domains. Onera therefore started to not promote its newly developed technologies but its competencies, especially in relation to its cooperation with SMEs. The SME cluster around On-

²⁵ PAUL, F. (2011) “Demand Readiness Level, a new Tool to hybridize Market Pull and Technology Push approaches. Introspective Analysis of new Trends in Technology Transfer practices”; see www.yumpu.com/en/document/view/17062019/demand-readiness-level-drl-a-new-tool-to-hybridize-market-pull –

Demand Level	Demand Readiness Level
1	Occurrence of feeling “something is missing”
2	Identification of specific needs
3	Identification of expected functionalities for new product/service
4	Quantification of expected functionalities
5	Identification of system capabilities
6	Translation of expected functionalities into needed capabilities to build the response
7	Definition of the necessary and sufficient competence and resources
8	Identification of the Experts possessing the competencies
9	Building the adapted answer to the expressed need in the market

Figure 12: Demand Readiness Levels

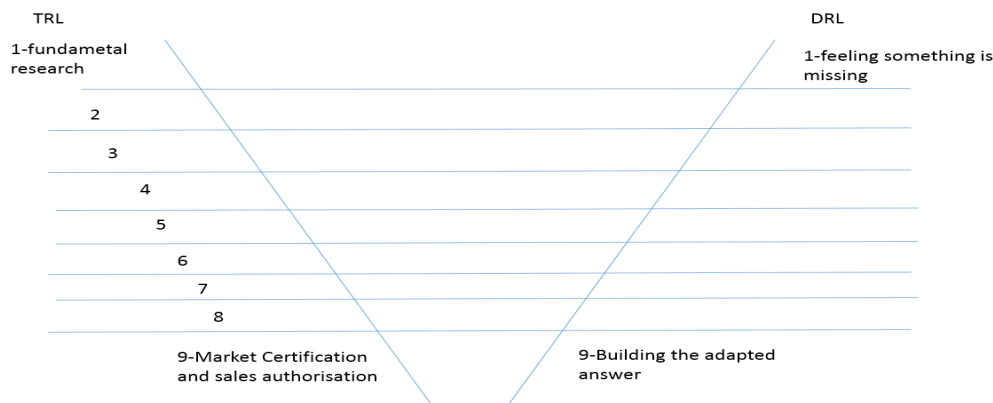


Figure 13: when TRL and DRL meet

era became the “eyes and ears” on the Market for the perceived technological needs, while Onera became a knowledge provider for SMEs in their innovative development projects, and it proved to work. Previously to this new orientation, Onera signed about one technology transfer agreement every two years in a technology push. In the two years after the introduction of the new way of working, Onera signed about 10 agreements per year, 8 brought about by the market pull approach and 2 through technology push.

The fundamental generally observed fact on each of the technology transfer agreements signed was that none of the obtained deals could be classified as a pure technology push or market pull approach. Indeed, all the agreements were obtained around a given moment when a technology push approach met an existing market pull approach made in parallel by the industrial partner.

Paun therefore introduced a new concept for understanding and measuring the market pull approach: the “Demand Readiness Level”. DRL assesses the maturity of evolving demands identified

by potential innovation actors at an appropriate stage of conceptualisation. It thereby provides a matching point, at which scientific research teams can propose solutions, either by adapting an existing scientific achievement through technology transfer, or by translating the demand into new R&D projects.

DRL is also relevant in relation to the sustainability goals of dAIR. In the context of sustainable development, DRL offers the opportunity to orient part of the research and innovation investments towards sustainable solutions, since the demand side integrates new regulations concerning compatibility with environmental and social values ex ante. Thus, the sustainability effect on R&D projects through their valorisation by DRL could make this new tool a lever for generalizing eco-innovation.

4.6 Facilitating the innovation process: about Living Labs and brokers/mediators

The creation of today’s complex systems of products, services and processes re-

quires a merger of knowledge from diverse perspectives. Innovation is seldom an individual responsibility, given the increasingly distributed knowledge. Hence the need for partnering. Strategies for knowledge-sharing and knowledge-creation need to be built.

In section 4.4, “partnering in innovation”, public authorities were very much described as being in the lead of the innovation process, given their role as initiating procuring parties. It was also made clear that (unfortunately) PPI and PCP are not yet applied to a large extent, and that experience within the dAIR partnership is present, but limited. dAIR partners can and do also contribute to innovation processes in a non-leading role: as partners, by opening up their premises for innovation activities, or by taking on unique roles in promoting collaboration between other parties.

4.6.1 Living Labs

The basic idea of Living Labs is to gain access to creativity and ideas, experiences and knowledge that (end) users²⁶ possess, based on their daily needs for products, services or applications. A Living Lab is a shared arena in which businesses, authorities and users work together on the creation, validation, and testing of new products, services, business ideas, markets and technologies in real-life-contexts.²⁷ The aim is to involve a mix of user representatives in the different development stages of products and prototypes, before the innovations are launched on the real market.

In Living Labs activities go on around the clock: this means that users get the opportunity to gain an understanding of a new product or service in their everyday life. Therefore, Living Labs can be seen as an instrument to sustain an efficient and dynamic innovation process where the Living Lab provides an environment for companies to test their innovations at different development stages (for these different stages, see again figure 9). In addition, it is an environment allowing potential users to influence the final design of products through close cooperation and clear

feedback processes with the company. The core of Living Labs is the involvement of users throughout innovation processes; the innovation system thereby becomes user-centric, in contrast to technology-centric, which is a better way of ensuring the potential adoption by users.

The key components of a Living Lab – which can take many different forms – are:

- **Users** – Those who actually use a product or service. This includes end-users, consumers and companies/organisations.
- **Structured working methods** – Constituted of the appropriate methods, knowledge and expertise when involving users in their own environments for cooperation in the development process. These methods facilitate the creation of knowledge



26 'Users' can relate to consumers (individuals or a group), but also to other companies (in a business-to-business context). There is no single type of 'user' in the context of a Living Lab.

27 A Living Lab, as such, contrasts with the concept of a 'test bed', which is "a standardized laboratory environment used for testing new technologies, products and services and protected from the hazards of testing in a live or production environment". This definition implies that the environment in which the tests are performed, is a closed and controlled environment. In a test bed, users are not necessarily involved, while they are active co-producers in a Living Lab.

which is transferable to new areas and new markets.

- **Organisational structure** – The Living Lab environment is viewed as an innovation system. It is based on a sound strategic concept and fronted by suitable representatives with a significant role to play in long term objects.
- **Technical platforms** – Constituted by the fact that there is sufficient

technological equipment in order to facilitate the necessary communication between the user and the innovation system to obtain the view of the user.

Within the dAIR partnership, we have encountered a number of Living Lab (inspired) projects and experiences: “Clúster6m” is one of Catalonia’s ten “Pòles de Competitivitat” and operates

as the Enhanced Mobility Cluster in the Llobregat Delta, “an exceptional area for testing mobility” as in such a concentrated area there is a mixture of highways, mountain roads, city centres, a port area, an airport, commercial zones, industry parks, agricultural production sites and beaches. Clúster6m was launched by five municipalities within the Llobregat Delta, including dAIR partner El Prat de Llobregat, and incorporates universities, knowledge centres and companies in its structure. In varying compositions the partners are working on nine pilot projects in three domains (Sustainable Mobility, Smart Cities Mobility, Personal Mobility), each one of these incorporates Living Lab aspects to enhance mobility in the area. Due to a lack of financial means, Clúster6m unfortunately had to stop its activities recently.

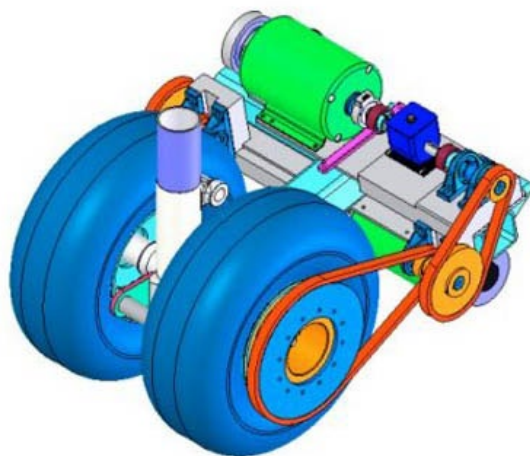
Flygbussarna Airport Coaches is a Swedish company operating bus services to nine cities and eight airports in Sweden, including Arlanda Airport. As part of its constant ‘future possibilities’ research, Flygbussarna AB is in close contact with its bus suppliers. In the same context, Ebusco – a Dutch company located in dAIR partner region Eindhoven – was recently approached and, with a potential purchase in mind, its newly developed electric bus was tested on aspects such as charging speed and driving range. Similarly, the Prague Public Transport Company is executing a 2-year trial operation of two hybrid busses, and three different types of electric busses have recently been tested. A more intense, longer lasting and structural (co-development) relationship is the one between Flygbussarna AB and the famous Swedish company Volvo. Flygbussarna AB activities are part of Volvo’s test operations for its new Hybrid bus.

The EcoTram project is an R&D programme coordinated by the Technical University of Vienna and executed in co-operation with Wiener Linien (the Vienna Public Transport Company), Siemens, Vossloh Kiepe, Rail Tec Arsenal and Schig, with the aim of refining knowledge on the potential savings in heating, cooling, ventilation and air-conditioning in low-floor trams (which currently account for 30% of a tram’s energy use). In the first phase of the project that started in 2009, an ultra-low-floor tram was equipped with numerous sensors and was tested in a climatic wind tunnel. It was then tested out on the tracks operating under different conditions, so as to collect important data about energy consumption. Subsequently, measures were developed to





WheelTug is a unique new concept in airport ground operations. This patented electric drive system incorporates high performance electric motors installed in the nose wheel of an aircraft and is operated by the pilot with the help of a control panel, providing it with full mobility on the ground without the use of aircraft engines or tugs for gate push-back and taxi operations.



improve levels of efficiency and comfort and were incorporated into a prototype that was again tested in a climatic wind tunnel and, during spring 2014, on line 62 in the city. The project has now delivered its results, and (potential) energy savings are said to amount up to 13% of the tram's total energy consumption. This new knowledge can and will now be used by Wiener Linien in tenders relating to the purchase of new trams and the upgrade of existing trams.

WheelTug is a unique new concept in airport ground operations. This patented electric drive system incorporates high performance electric motors installed in the nose wheel of an aircraft and is operated by the pilot with the help of a control panel, providing it with full mobility on the ground without the use of aircraft engines or tugs for gate push-back and taxi operations. The new WheelTug system is expected to reduce aircraft emissions, fuel consumption and noise at airports, and it will improve safety, enhance airlines' schedule reliability, and contribute to both airline

and customer convenience at airports. Prague Airport is the world's first airport to support the development of this new technology enabling aircraft to use on-board electric motors to taxi between terminal gates and runways. Prague Airport is serving as a testing ground for the WheelTug prototype.

The German Airport Alliance (which includes dAIR partner Mitteldeutsche Airport Holding) is involved in a Lighthouse Project of the German "National Hydrogen and Fuel Cell Technology Innovation Programme" (NIP). Industry and government in Germany consider hydrogen and fuel cell technologies as part of an overall technology mix that supports a robust energy strategy taking into account economic, environmental, energy security and industrial development aspects. Since 2006, all federal activities related to fuel cells and hydrogen have been coordinated through the NIP, which is a strategic alliance between government, industry, and science. Over the period between 2007 and 2016 a total amount of € 1.4 billion will be made



Melex is a nice (soft, but still valuable) example of Design Driven innovation. Most literature on innovation, including this chapter, focuses either on (radical) innovation pushed by technology or (incremental) innovation pulled by the market. With Design Driven Innovation a third strategy is introduced, one which presents a radical shift in perspective and introduces a bold new way of competing. Design driven innovations do not come from the market, but create new markets. They do not push new technologies, they push new meanings.

available for research, development and demonstration projects, with the objective of preparing the market for hydrogen and fuel cell technologies.

The NIP is an integrated programme in which R&D and demonstrations are closely tied together: R&D results provide the basis for demonstration projects, and experiences gained through demonstrations provide input into the direction of R&D. In order to advance hydrogen and fuel cell products and technologies in multiple applications in equal measure, the demonstration part of the NIP is divided into three areas: Transport and Hydrogen Infrastructure, Stationary Energy Supply and Special Markets. R&D projects and coordinated demonstrations are carried out in each programme area in order to advance the technology, promote market readiness, and strengthen the supply industry.

Demonstrations in each area are grouped into "lighthouse projects" to encourage collaboration and information sharing among project partners to more efficiently overcome barriers to commercialisation. Airports are defined as a Special Market, and the airports that are part of the German Airport Alliance have opened up their premises for Hydrogen and Fuel Cell demonstration projects, relating to busses and the handling of

luggage.²⁸

"Swap and Go" is the answer to one of the biggest problems with electric driven vehicles: their limited action radius. "Swap and Go" does not focus primarily on the enlargement of battery capacity or on (ultra)fast charging. The consortium behind this research and demonstration project in Bologna and six neighbouring 'Local Solar Communities' (comunità solari locali) is building an electric recharging station network where electricity-powered bicycles and logistic vehicles (in order to realise a sustainable "last mile" in the distribution sector) can exchange an empty battery for a new fully charged one. G. Marconi Airport is part of the recharging station network, with a specific objective of achieving (electric) bus transport to the railway station and to the six Solar Communities. This project separates the life cycle of the battery from the life cycle of the vehicle, and reduces the cost of electric vehicles considerably. Prototypes are being tested in 2014.

Modlin airport bought a number of electric vehicles made in Poland, that work on batteries and that will be used inside the airport for transporting light cargo necessary for operations and staff

around the hangars and the main terminal building. The vehicles are produced by Melex, who until recently produced its vehicles for golf courses. In this market Melex is a big player. The company then started to expand to new niche markets, including airports. The product was adapted to the needs of the new customers, and tested on their premises (the testing did not happen at Modlin airport, but at other airports).

Living Labs always operate in a context which can be a territorial one such as a city or a region. Ever more cities and regions are making their territory 'Living Lab Friendly.' The newly elected Eindhoven city government integrated "The City as a Living Lab" as one of its core objectives for the years to come. This approach is built on the strong belief that the real-life testing of products that (preferably) originate in the Brainport Eindhoven region will help solve the societal challenges the city and its citizens are facing. The city is thereby supporting the economy and enhancing quality of life as well.

This clear policy objective is not necessarily an easy one to put into practice as an overall mode of operation. In this context, the city of Eindhoven applied for and was accepted, in September 2014, as a member of the European Network of Living Labs (ENoLL)²⁹, in order to:

- learn from best practices in the definition, set up, management and

²⁸ For a full description of NIP objectives and activities, see the report: DEASON, K., NEEF, H.-J., "Hydrogen and Fuel Cell Market Preparation Activities in Germany" (www.gwu.edu/~eemnews/previousissues/f11_art5_Kristin%20Deason%20paper.pdf); and also: bz.vdma.org/documents/266669/906967/Presentation_Fuel%20Cells%20Special%20markets%202012.pdf/e10bd835-748f-4577-a18f-f008e65da481

²⁹ www.openlivinglabs.eu

Engaging in the innovation process can help public authorities and airport operators realise the goal of creating a well-connected green airport region



- follow-up of Living Labs;
 - become an active member of a Europe-wide specialised network, leading to project-based and permanent partnership co-operations; and
 - be in the front row as regards to receiving and shaping (policy) information;
- thereby:**
- upgrading the quality of its current and future Living Labs;
 - upscaling the engagement to its current and future partners;
 - broadening the scope of current and future Living Labs; and
 - enabling a larger number of future Living Labs to flourish.

4.6.2 Brokers/Mediators

Innovation processes are complex. In order to be successful, they often (need to) involve several partners – indispensable partners that are unknown to each other, or that on the contrary ‘have a past’. In some cases, the introduction of a neutral, external point of view can trigger new possibilities previously unimaginable. Public authorities, or public equivalent-bodies, are in a unique position to bring together partners and to stimulate them or to mediate between them. Within the dAIR project we have seen a number of excellent examples in which a partner has actively taken on this ‘brokerage’ role.

DHL and Aerologic have a successful long-lasting cooperation with the public transport association Mitteldeutscher Verkehrsverbund regarding reduced prices of transport tickets for their employees (free travel in first two tariff zones; strongly reduced price – employer pays as well – for longer trips). 50% of all employees of these two companies (1.500 people) use such employer-subsidized job tickets and thus use public transport to commute. The City of Leipzig would like to see other employ-

ers in the airport zone doing the same. It therefore conducted a survey amongst workers, and launched a PR campaign. Results so far are limited: Leipzig/Halle Airport joined the ‘normal’ job ticket scheme of DB-Deutsche Bahn (German Railway), although only offering a 10% reduction on the regular price. An important other target at the airport zone is the smaller employers, who cannot even join the job ticket scheme since DB imposes a minimum of 20 job tickets per employer. If the City of Leipzig could succeed in having DB change its set of rules and to accept the pooling of (smaller) employers into one contract, the city would book a great success as a broker between several parties that are unable to reach an agreement today.

Although exceeding the scope of dAIR, the “Renewable Jet Fuel” initiative in Sweden, and the role Swedavia is playing in it, is an excellent example of the facilitator and accelerator role a public actor can play.

The technology to produce renewable jet fuel already exists. Producing it in a way that makes commercial sense is less evident, although not impossible: as part of a consortium, Swedavia has financed a commercial feasibility study, the result of which has not been contested yet. The study shows that when produced in the right spot (close to the natural resources, close to the customer and a short distance away from potential clients for the surplus heat that results from the production process) the production of renewable jet fuel is commercially feasible (and even advantageous, as it is a high margin product) and is in fact cheaper than conventional fuel.

Since producing fuel is not a core business of Swedavia, the Swedish airport operator showed no interest in launching such an initiative. Swedavia did, however, play a brokering role between an interested US based company

(Solena), and a number of interested Swedish parties that would otherwise not have met (or only at a significantly later date). Project progress is looking good (final results to be expected in 5-10 years). Airplane constructors have lost their scepticism towards bio-jet fuels, and airline companies such as SAS and others, all of which are facing integration into the ETS-European Emissions Trading Scheme, have already indicated their intention to start using renewable jet fuels as soon as the product is available. This initiative, compared to other ongoing research and pilot production initiatives, has the additional advantage that it would allow the set up of a rather local supply chain, since it involves the use of local biomass products (forest waste products) and a Swedish paper production company which is on the lookout for new markets.

Renewable jet fuel relates to CO₂ emissions as well as to other emissions produced by airplanes. It therefore exceeds the scope of dAIR which ‘only’ looks at CO₂ emissions relating to airport operator activities. However, the initiative is not without importance: the same technology would allow to produce bio-diesel, an energy resource relevant to airport operators.

5. Innovation Skills

This chapter has tried to clarify that engaging in the innovation process can help public authorities and airport operators realise the goal of creating a well-connected green airport region. It demonstrated this through real-life examples taken from within and outside of the dAIR partnership. The chapter also made it clear that such involvement is not necessarily an easy task, and does not automatically lead to immediate success. In order to increase the chances of success, organisations can (and need) to work on their ‘innovation skills’.

A complete overview of ‘innovation skills’ extends the scope of this chapter. The Dutch “SME Service Desk” has developed an easy online tool for SMEs “to determine your position on the innovation ladder”: <https://scans.mkb servicedesk.nl/innovatieladder> (only in Dutch). The questions of this short scanning tool give an idea about the categories that count. The result can help identify the aspects that need to be improved.

- Organisation
 - » dedicated time and/or capacity within the organisation, and involving others
 - » budget available
 - » monitoring of results
 - » clear picture of the benefits
- Outer world
 - » active/pro-active/reactive attitude
 - » market/client research
- Cooperation & Networking
 - » with triple helix partners/within the sector/within the value chain
 - » inspiration in other branches/countries/through training

Since innovation is a means to an end, and not a goal in itself, having a crystal clear vision of the goal to be reached is the main starting point. In addition, when other partners are involved, a common shared vision is key. In order to reach the ultimate dAIR goal, stakeholders are essential. The organisation of several Mobility Stakeholders Forums in each of the participating regions has undoubtedly contributed to shared visions and wide support. Once a vision is shared by all, the implementation through projects can be done via partnerships in variable geometry. Some dAIR partners have a longer tradition in this, and can serve as good examples:

The emissions cap that is part of Stockholm Arlanda Airport's environmental permit strengthened the sense of urgency: cooperation was needed to achieve success. In 2008, a Letter of Intent was signed by Arlanda Airport, public transport providers, the Swedish Road Administration and local and regional planning authorities. This Letter of Intent aims at increasing accessibility to the Airport and at the same time reducing carbon emissions from ground transports. The Letter of Intent was trans-

lated into a specific action programme and the implementation of a series of projects leading to impressive results, including being the world's first airport to reach the 3+ level of carbon neutrality in ACI's ACA scheme in 2009. Signatories to the Letter meet twice per year, when progress is monitored and the next steps to be taken are decided on.

The creation of a Mobility Commission, gathering once per year on average, was the final piece of the Mobility Plan for the airport area around Barcelona El Prat Airport. The first mobility plan was developed in 2006-2008 in order to cope with the environmental, societal and economic challenges linked to 21,000 workers commuting daily (and largely by car) to their workplace in the airport area as well as to all the other (millions of) users of the airport. All stakeholders with powers in the field of mobility (AENA, Barcelona Metropolitan Area, ATM, Prat de Llobregat Town Council, Barcelona City Council, Ministry of Territory and Sustainability, Ministry of Development, RENFE, etc.) are part of the Mobility Commission. The actions resulting from the mobility plan have led to an impressive list of results today.

Within the dAIR project there have also been a few interesting cases in which a clear common vision and the presence of strong innovation skills coincide:

TINA Vienna is an organisation external to the City of Vienna, but is 100% owned by the City. It is a service organisation and competence centre that supports the City of Vienna in its services and operations in three areas: 'Smart City', 'Energy Planning' and 'Mobility and Transport Planning'. TINA Vienna brings planning expertise and (strategic) intelligence capacity to the city and provides support during the implementation of measures.

TINA Vienna also has an external

mission to serve as a hub to share strategic innovations and innovative urban and environmental technologies that were developed by city departments or Vienna-based companies, and that were successfully used in the Vienna area. These proven solutions are exported, in partnership with the companies concerned, to other cities and authorities and customised to their own specific needs.

As such, TINA Vienna is in the process of developing a self-financing business model that serves and strengthens its owner, the City of Vienna. For more information please consult: www.tinavienna.at/en

The Schiphol Group's initiative theGROUNDS was set up in 2010 as a platform for sustainable development and innovation. The purpose of theGROUNDS is to help Amsterdam Airport Schiphol become a sustainable airport. As this requires an enterprising attitude and an unconventional approach, theGROUNDS has been set up as a separate, independently operating organisation within Schiphol Group. theGROUNDS works on innovative applications with other companies and knowledge institutes. It has 3 lines of action:

- Driving force: initiating projects and organising events.
- Breeding ground: an own incubator providing an inspiring space for companies and institutions to work together.
- Testing lab: a test environment for pilot projects and experiments at Amsterdam Airport Schiphol.

The 'Mainport Innovation Fund' is ready to co-invest in promising technology companies and their breakthrough solutions.

www.thegrounds.com/en; www.mainportinnovationfund.nl/en/home

OUT OF THE BOX

Innovation can be realised in many aspects. Partnering in innovation does not always refer to companies and knowledge institutes. The "Green Belt" that is planned in the northern part of G. Marconi Airport in Bologna is quite a different, yet valuable example of an activity contributing to the realisation of a CO2 emission free airport.

The aim of the Green Belt is to compensate for airport emissions through the absorption of CO2 by vegetation and soil.

The Green Belt is a strip of vegetation on the northern perimeter of G. Marconi Airport, consisting of woodland planted with tree species with a good CO2 absorption capacity. The area will be almost 36 hectares large, with a length of about 3.5 km and an average depth of 100 meter.

The Green Belt will combine different functions:

- CO2 absorption
- air pollutant screen
- improvement of the local landscape
- enhancing the local ecological functionality
- leisure activities to discourage the presence of birds
-

In order to enhance the functions assigned to the woodland area, the green belt could be completed and definitely improved in its functions allocating agricultural land between the trees and the airport grounds. Thus, an area of about 49 hectares can be covered by *Miscanthus*, a so called "energy crop" due to its remarkable CO2 sequestration capacity.

Farmers, who are new partners to the airport, can be involved in the management of the agricultural crops. This cooperation could also lead to the production of biofuel derived from the crops available in the Green Belt - a technology which would then first be applied at Bologna Airport.



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