Green EFFORTS

Green and Effective Operations at Terminals and in Ports

FP7-285687

Deliverable 8.2

Energy Management in Transport Sectors Other than Ports

Organisation name of lead contractor for this deliverable: IHS/CML

Due date of deliverable: [30/06/2014]
Actual submission date: [30/07/2014]

Call (part) identifier: FP7-SST-2011-RTD-1
Funding Scheme: Collaborative Project
Start date of project: 01/01/2012 Duration: 30 months

Revision: [final]

Project co-funded by the European Commission within the Seventh Framework Programme (2007-2013)		
Dissemination Level		
PU	Public	x
PP	Restricted to other programme participants (including the Commission Services)	

RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

DOCUMENT INFORMATION

Deliverable 8.2

Energy Management in Transport Sectors Other than Ports

Author(s):	JULIA PAHL
Issuing entity:	CML
Document Code:	GREEN EFFORTS 8.2 ENERGY MANAGEMENT IN TRANSPORT SECTORS OTHER THAN PORTS
Date of Issue:	[05/06/2014]
Status:	FINAL
Revision:	[0]

Contributing Partners / Authors	CML

Pages	13
Figures	1
Tables	1
Annexes	0

RECORD OF CHANGES

This is a controlled document for any changes and amendments done for the deliverable.

Amendment shall be by whole document replacement.

Version	Status	Date	Authorized by
0.1	Draft version – Consortium review	30.06.2014	
0.2	Final version	30.07.2014	

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Executive summary

Energy management is an urging topic regarding the overall climate debate, especially regarding the transport sector. Reducing energy consumption in transport as a result of energy efficiency progress and other factors such as modal shift, etc., can lead to significant reductions in environmental pressures, such as greenhouse gas and air pollution emissions.

Energy efficiency and energy consumption are intrinsically linked. Increased energy efficiency can lead to significant reductions in energy consumption provided that measures are in place to discourage the occurrence of rebound effects.

The GREEN EFFORTS project aims at exploring the reduction of energy consumption and improving a clear energy mix in seaports and terminals. In this paper, those results are compared to other fields of interest, e.g., airport energy reduction measurements.

Results show that there are many similarities of activities undertaken in the ports and terminal sector as well as the airport sector. For instance, the replacement of equipment driven by diesel with equipment running on electricity or hybrid systems is an issue taken into account by both sectors.

Differences in activities are mainly due to the infrastructure of airports including large airport terminals that need cooling/heating systems. These are very energy intensive. Therefore the main focus of energy management activities of airports is in improving the technological infrastructure of buildings. This includes the production of energy as well rendering airport terminal building energy independent creating autonomous, intrinsic systems.

1 Introduction

This deliverable investigates current and planned activities regarding energy management in transport sectors other than ports and terminals in order to compare results and solutions of the GREEN EFFORTS project with those in other fields. The overall objective is directed towards the energy management for all transport processes not restricted to the port and terminal processes [DOW, "Objective WP8," p. 27]. This should ensure that the port domain does not follow developments which might conflict or even become counter-productive with/to efforts in other transport sectors.

2 GREEN EFFORTS Approach and Energy Management Activities: Analyzed Areas of Interest

Current and planned activities regarding other transport sectors are investigated following the process domains developed in WP 3 of the GREEN EFFORTS project and documented in Deliverable 3.2 "Process capturing, management and visualization" authored by CML and JUB.

The aviation sector is selected – more specifically the airport sector – in order to compare their energy management and related reduction efforts to those of ports and terminals. Issues and processes that are similar to both sectors are selected for comparison.

The process domains taken into account in the GREEN EFFORTS project are presented in Figure 1. Analyzed processes of a container terminal include the following:

1. Berth Operations,
2. Quay operations,
3. Apron,
4. Stacking,
5. Interchange Operations,
6. Gate,
7. Equipment Maintenance,
8. Administration,
9. Staff Services including off-terminal storage and special services. The latter mentioned encompasses value added services such as container repair, container leasing, labelling, packing, stuffing, stripping, cross docking.

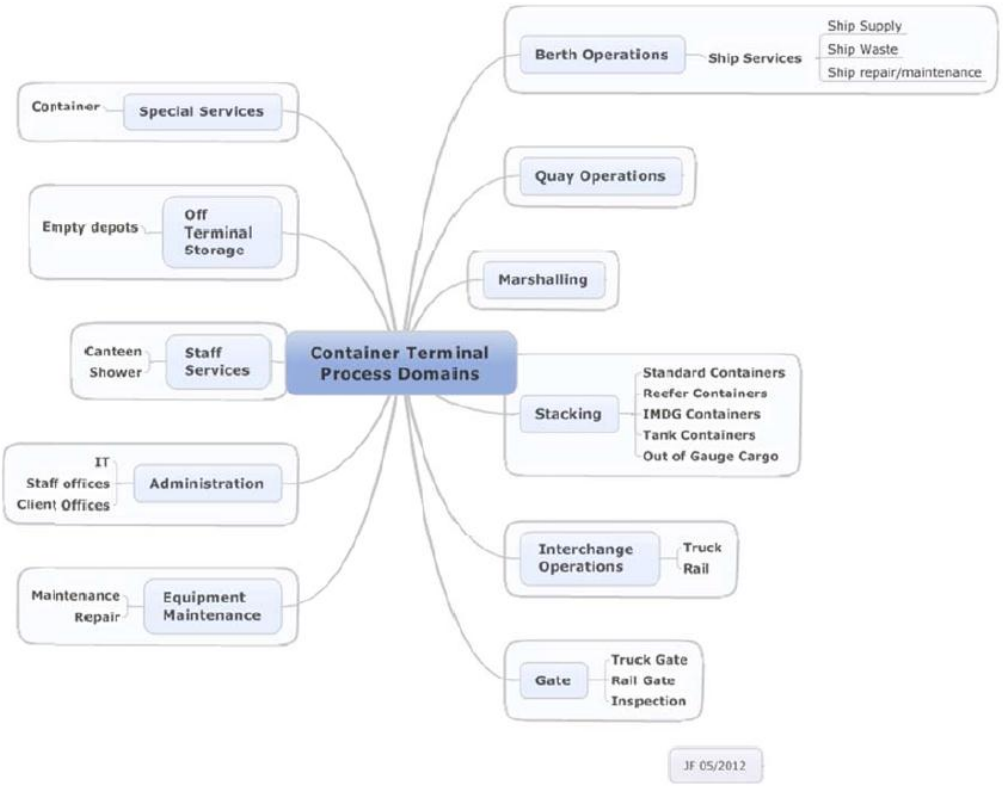

Figure 1: Container Terminal Process Domains; see WP 3.2, p. 8.

Airports and ports have similar processes when taking into account the following abstraction of the overall process: a vehicle arrives (ship or aircraft) that delivers/unloads cargo (containers or passengers and/or similar "items") that are processed at the (air-) port while new items are loaded into/onto the vehicle before it departs. This overall process needs supporting and administrating processes.

The processes given in Table 1 are selected and aggregated wherever appropriate.

Port	Airport
Berth/Quay/Gate operations	Gate operations at the terminal
Apron operations (stacking, interchange)	Apron operations (cargo loading/unloading, fueling, etc.)
Administration	Administration
Staff services	Staff services

Table 1 Process Matching for Comparison

Additionally, the infrastructure and terminal equipment for the comparison of current and planned activities regarding energy management is taken into account. This encompasses buildings including air condition (heating/cooling) systems as well as lighting of buildings and aprons and yards, respectively.

There are two different aspects of energy management: the *production* and the *consumption side*. The production side comprises the way of creating energy such as wind/water turbines, solar panels, nuclear power plants, fossil fuels refining (diesel, LNG, gasoline, jet fuel, avgas, etc.), or biogas plants. The consumption side includes electricity and fossil fuels.

Activities of improving the overall energy consumption balance can be categorized the following way:

1. Avoidance or reduction of consuming energy, e.g., by improving processes, changing layouts/designs of areas (e.g. the apron),
2. Substitution of energy coming from environmentally (or politically) unfavorable sources such as nuclear power plants or fossil fuel refining plants.

The structure for comparing energy management efforts of ports/terminals versus airports first analyses **energy consumption** including *infrastructure, equipment,* and *processes* and, second, investigates **energy production** substitution comprising the above mentioned technologies.

2.1 State-of-the-Art Energy Management of Airports

Airports account for 5% of the aviation's global carbon emissions[1]. They have great opportunities for improvement regarding energy saving and implementation of renewable energy projects[2].

Many alliances and organizations have been launched with the scope of advancing energy management and carbon footprint reduction in the airport/aviation industry. For instance, the *Airports Council International* Europe (ACI) is a worldwide professional association of airport operators representing 450 airports in 44 European countries. In their policy outlook, they state that the greening of all transportation modes represents an unambiguous yet necessary policy objective[3]. ACI Europe and its members have formally committed to carbon neutrality for all activities controlled by airport operators. In 2009, they launched the *Airport Carbon Accreditation* that comprises an institutionally-endorsed program that assesses and recognizes efforts by airports to manage and reduce their carbon emissions. For instance, Germany's biggest airport hub, Frankfurt Airport (IATA code: FRA), has received level 3 of the

[1] Source: https://www.ase.org/resources/air-travel-and-efficiency-how-us-airports-are-saving-energy, last call 17.06.2014, 9:56
[2] Source: http://www.airport-business.com/2011/06/planning-for-a-sustainable-future/
[3] Source: https://www.aci-europe.org/component/downloads/downloads/70.html

Airport Carbon Accreditation. This level includes the optimization of carbon reduction activities and thus their extension to parts of the process that are not in the responsibility of the airport operator, e.g., arrival or departure of passengers to the airport or employees of the airport[4]. In this regard, level 3 of the Airport Carbon Accreditation includes stakeholder engagement activities such as the Fraport Energy Award, an award presented by the Energy Air GmbH,[5] which decorates best energy saving and energy efficiency projects.

Besides, there exists an international cooperation project concentrating on accelerating the process of greening airport operations named "Green Sustainable Airports" (GSA), formerly known as "Sustainable Airport Solutions" (SAS). The project aims at improving the sustainability development of regional airports and to establish strategies and solutions for a more eco-efficient and green regional aviation industry[6].

As presented in Figure 2, the GSA project defines three categories for activities, i.e. airport management, airport operations, and public transport[7] that influence energy consumption.

[4] Source: http://www.fraport.de/content/fraport/de/misc/binaer/nachhaltigkeit/nachhaltigkeit/Umwelterklaerung2012/jcr:content.file/verkuerzte-umwelterklaerung-2012.pdf, last call 23.06.2014, 11:53

[5] The Energy Air GmbH is a 100% daughter company of Fraport AG.

[6] Source: http://www.greenairports.eu/about-gsa/project-introduction/, last call 17.06.2014, 14:25

[7] Source: www.greenairports.eu/publish/pages/43814/romn13103001-gsa_catalogue_of_measures-lr.pdf, last call 17.06.20104, 15:27

Figure 2: GSA Catalogue of Measures, Source: www.greenairports.eu/publish/pages/43814/romn13103001-gsa_catalogue_of_measures-lr.pdf, p.2.

For instance, regarding airport management, the project reveals that benchmarking enables transparency on eco-efficient airport operations although methodical challenges prevail. Insights into different levels of airport-related energy consumptions and emissions are provided that serve as baselines for defining own strategies in order to save energy, emissions, and money. Moreover, a CO_2 calculator is developed in order to leverage long lasting reductions of energy and cost savings, and as a baseline for supporting a long-term sustainability strategy. Besides, the tool can be used to mitigate risks regarding tighter EU regulations.

Concerning airport operations, the project assesses and analyses equipment used in airport operations such as ground power units (GPUs), as well as infrastructure and plant management from heating/cooling, LED technologies to plant forming concepts. The latter offers superior operational performance over tungsten halogen lighting. Nevertheless, their benefits depend on the operation and size of the airport.

Assessment of new public transport concepts are analysed, too. Results present the implementation of quick win solutions as well as responsive bus services. The overall imperative lies in the cooperation with regional authorities.

2.1.1 Activities concerning the improvement of energy consumption

This chapter describes the individuated activities of airports regarding the energy consumption side encompassing infrastructure issues, equipment, and processes.

2.1.1.1 Infrastructure

Airports' most common energy saving measures focus on the **buildings infrastructure**, i.e., in heating, ventilation and air condition (HVAC) systems. These systems are able to condition and circulate air in large spaces such as airport terminals with extreme swings in occupancy[8].

Another issue in focus regarding energy efficiency is **lighting** in large spaces which is the same for both container terminals as well as airport terminals. LEDs are used together with daylighting technique[9].

A study regarding the use of LEDs for taxiways at the London Southend Airport (IATA code: LSA) is presented within the project "Green Airports." The study focusses on the comparisons between standard Tungsten and Halogen Lights as well as LEDs together with understanding the credibility of the claims of manufacturers and experiences of other airfields[10]. A business case model is developed which allows airports that wish to install or change lights to input real data to understand whether there is a real saving to be made by installing LEDs.

Various examples of airports can be mentioned that undertake activities rendering their business (more) environmentally friendly. One of these airports is *Boston Logan International airport*[11] (BOS) which became the world's first **LEED**-certified airport terminal in 2006. LEED stands for *leadership in energy and environmental design* which is a standard for green building design[12]. Additionally, Denver International Airport (IATA code: DIA) is the first US airport that implemented an ISO 14001-certified environmental management system comprising the whole airport. For instance, a state-of-the-art parking canopy is installed that is lit by LEDs. Moreover, it features geothermal heating and cooling[13].

[8] Source: https://www.ase.org/resources/air-travel-and-efficiency-how-us-airports-are-saving-energy, last call 17.06.2014, 9:56

[9] Source: https://www.ase.org/resources/air-travel-and-efficiency-how-us-airports-are-saving-energy, last call 17.06.2014, 9:56

[10] Source: http://www.greenairports.eu/publish/pages/43814/ romn13102402-gsa_mag-lr.pdf, last call 23.06.2014, 15:05

[11] IATA airport code: BOS.

[12] Source: http://en.wikipedia.org/wiki/LEED, last call 16.06.2014, 16:38

[13] Source: https://www.ase.org/resources/air-travel-and-efficiency-how-us-airports-are-saving-energy, last call 17.06.2014, 9:56

As for **on-shore power supply** to ships, DIA has installed plug-in power and pre-conditioned air for aircrafts at mainline gates, so that these can turn off their on-board auxiliary power units and save fuel[14].

Features of BOS buildings comprise the following selection of activities related to the selected focus:

- Roofing materials that reflect the heat of the sun,
- Automated and/or self-dimming lights throughout the facility.

The management of BOS installed special controllers that reduce the power draw of the electric motors of moving walkways that work on a 24 hours basis and were able to save about 60.000 kWh per year[15].

At Dallas-Fort Worth (Texas) International Airport (IATA code: DFW), a **building control system** is installed that continuously monitors key areas and equipment regarding inefficiencies. For instance, the system senses changes in the surrounding weather and occupancy of the building in order to trigger reprogramming in the building automation system. This already saved $6 million of energy costs[16].

Chattanooga (Tennessee) Airport (IATA code: CHA) is LEED-certified, too. It has special energy efficiency measures including reserved parking for fuel-efficient vehicles as well as renewable energy measures which involve three MW solar arrays that power the whole airport.

2.1.2 Equipment

Advances regarding equipment concentrate on fuel-efficient ground transport, e.g., fuel-cell powered baggage vehicles[17]. For instance, the US Department of Energy provides $2.5 Million to major American airports in order to invest in and operate fuel-cell electric towing tractors that transport passenger baggage.

[14] Source: https://www.ase.org/resources/air-travel-and-efficiency-how-us-airports-are-saving-energy, last call 17.06.2014, 9:56
[15] Source: https://www.ase.org/resources/air-travel-and-efficiency-how-us-airports-are-saving-energy, last call 17.06.2014, 9:56
[16] Source: https://www.ase.org/resources/air-travel-and-efficiency-how-us-airports-are-saving-energy, last call 17.06.2014, 9:56
[17] Source: https://www.ase.org/resources/air-travel-and-efficiency-how-us-airports-are-saving-energy, last call 17.06.2014, 9:56

In order to save fuel in ground transport, DIA conduct fleet vehicle retrofits that lead to replacements with hybrid and electric vehicles.

At Billund Airport (IATA code: BLL), there exist a number of older diesel heaters/coolers for aircrafts that are replaced by others with a better, more eco-efficient technology, e.g., using biomass, biogas, and/or solar panels as well as electricity-based cooling that has been developed in cooperation with the Nilan company[18] using the airport's ground water cooling system (Aquifer Thermal Energy Storage) and/or using existing district heating. A preliminary impact analysis presents a potential reduction of nearly 80% of CO_2-emissions.

Together with the contribution of biomass production (see 2.1.3 Processes, Page 9), BLL envisions to reduce CO_2-emissions of heating activities by 90% until 2020.

Regarding *ground power units* (GPU), the BLL airport department for ground support equipment has developed an electric GPU with a cable-cooling system whereby improving the possibility to use electricity rather than diesel[19].

2.1.3 Processes

The Chicago Department of Aviation has launched the *sustainable airport manual* (SAM) that gives guidelines to integrate innovative and progressive sustainable measures in aviation industry into all administrative, planning, design, construction, daily operations, and maintenance activities for the Chicago Department of Aviation as well as its tenants[20].

BOS promotes eco-friendly transportation options to arrive at or depart from the airport, e.g., hybrid cabs of which 400 are servicing the airport. Moreover, passengers can exchange information via a free iPhone app in order to share a cab.

A process that is somewhat indirectly in the influence of airports is the definition of approach procedures of aircrafts. For instance, a "green measure" introduced at Groningen Airport Eelde (IATA code: GAE) is the continuous decent approach (CDA), also known as Continuous Decent Operations (CDO). The CDA is an aircraft operating technique in which an arriving aircraft descends from an optimal position, with minimum thrust and avoiding level flight. The descending procedure is designed in a way that reduces fuel consumption and noise levels in comparison to a conventional

[18] Source: http://www.greenairports.eu/publish/pages/43814/ romn13102402-gsa_mag-lr.pdf, last call 23.06.2004, 15:26, see also http://www.nilan.dk/en-gb/frontpage.aspx
[19] Source: http://www.greenairports.eu/publish/pages/43814/romn13102402-gsa_mag-lr.pdf, last call 23.06.2014, 15:54
[20] Source: http://www.airportsgoinggreen.org/ documents/2013/CDA%20SAM%20v3.1%20-%20November%2012,%202013%20-%20FINAL.pdf, last call 17.06.2014, 13:49

approach. Instead of approaching the airport in a stair-step fashion, the CDA allows for a smooth, constant angle of descent towards the landing strip. It is designed in cooperation with Air Traffic Control Nederland (LVNL), Eurocontrol, and transavia.com and incorporates environmental as well as economic advantages for both airports and airline operators[21].

2.1.4 Activities concerning the improvement of energy production

There are various options that can be and are adopted by airports concerning energy production. For instance, the DFW has a cooling plant that includes a thermal energy storage system that shifts electrical loads to off-peak hours. This increases the efficiency of cooling operations and, therefore, decreases related costs[22].

At BLL, willows trees are planted in order to enhance eco-friendly landscaping[23]. Willow trees are energy crop and planted with the aim of delivering wood chips to produce heat at a local heating plant in order to replace fossil energy with more CO_2-friendly energy sources.[24]

3 Comparison of Results of GREEN EFFORTS and Airports/Aviation

Various analogies to the GREEN EFFORTS project regarding the aviation sector exist. For instance, to counteract global warming, the International Air Transport Association (IATA) adopted carbon neutral growth in 2020 while the European Environment ministers set the target to cut greenhouse gas emissions from aviation by 10% by the same year. In order to comply with the European policies concerning the reduction of CO_2 emissions, effort from suppliers need to be increased. The GSA project aims at contributing to these targets before the end of the time period[25].

[21] Source: http://www.greenairports.eu/publish/pages/43814/ romn13102402-gsa_mag-lr.pdf, last call 23.06.2014, 14:35

[22] Source: https://www.ase.org/resources/air-travel-and-efficiency-how-us-airports-are-saving-energy, last call 17.06.2014, 9:56

[23] Source: http://www.greenairports.eu/publish/pages/43814/romn13102402-gsa_mag-lr.pdf, last call 23.06.2014, 15:19

[24] There are other advantages regarding an eco-friendly environment such as the attraction of wildlife and birds of willow trees. Nevertheless, such issues are excluded from this analysis.

[25] Source: http://www.greenairports.eu/about-gsa/project-history/, last call 17.06.2014, 14:25

Comparison	Airports	Terminals / Ports
Standards / Standard Measures	Airport Carbon Accreditation; CO_2 Calculator; LEED certification; ISO 14001-certification of environmental management system	CO_2 Calculators
Energy Consumption		
- **Infrastructure**	(geothermal) Heating/cooling/ventilation (HVAC) systems of terminal buildings; LEDs used at runways/taxiways, parking areas etc. compared to the usage of tungsten halogen lighting; Roofing materials to reflect the heat of the sun; Automated self-dimming lights throughout terminal buildings; Installation of controller units in electric walkways; Building control system to monitor key areas and equipment;	LEDs used in terminal areas;
- **Equipment**	Ground power units (GPU) analysis and substitution with electric ones; Replacement and retrofit to hybrid and electric vehicles; Fuel-cell powered baggage vehicles; Saving fuel through on-shore power supply for aircrafts; Hybrid cabs;	Terminal equipment substitution from diesel to electric consumption motors; Saving fuel through on-shore power supply for ships

- **Processes**	Public transport concepts to and from airport also employing hybrid cabs; iPhone App to share a cab; continuous descent approach;	Hinterland traffic analysis;
Energy Production	Solar arrays/panels; biomass, biogas; thermal energy storage system; plantation of willow trees as energy crop to deliver wood chips;	Solar arrays/panels, biomass, biogas; thermal energy storage system;

Table 2: Comparison of Activities and Results

4 Conclusions

Energy Management is an important issue for ports and terminals. The issues taken into account regarding energy management proposed by the project GREEN EFFORTS are very similar to the issues concerning the energy management activities of airports.

A rather great difference that can be observed lies in the fact that airports have very large airport terminals that need cooling/heating systems that are very energy intensive, so that a main focus is on how to improve energy efficiency around these buildings. This includes the production of energy as well, so that such systems become autonomous or, better, intrinsic systems.

Other issues are nearly the same for airports in comparison to ports and terminals such as the replacement of diesel-driven equipment by hybrid or electric-driven ones.

Regarding processes, the development of integrated logistic concepts including transportation to and from airports or ports and terminals, respectively, are taken into account, too. Nevertheless, airports seem more advanced regarding this topic as they provide special apps to passengers for a better transportation to and from the airport, so that waiting times or extra tours consuming energy are avoided.

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