Arup

CO2 Performance Ladder

Sustainability Portfolio

Issue | 4 September 2017

Job number

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Appendices

1 Introduction

For a sustainable future it is becoming more and more important to balance the crossroads of economic growth with social and environmental development. At Arup we strongly feel our responsibility to contribute to this transition. This resonates in our mission statement: **"We shape a better world".**

We have adopted the CO_2 -performance ladder as a tool to map and reduce our CO_2-emissions, within our organisation and the chain in which we operate. The ladder is intended as a management system to stimulate continuous improvement. Proper implementation of the system is awarded with a system certificate, which provides benefits in the procurement process of construction projects. Increased efforts regarding energy savings, use of sustainable energy and CO_2 reduction are rewarded with a higher score on the ladder.

This document is our **CO_2 -performance portfolio**, in which we demonstrate our compliance to the requirements of the ladder. This document is an update of our plan for the period of 2015-2017.

Objectives
The main aims of the performance ladder system are to stimulate companies to:

- gain insight into their own CO_2-emissions and those of their suppliers;
- identify CO_2-emission reduction opportunities and implement measures;
- share acquired knowledge and targets transparently;
- participate in an active search for opportunities to further reduce emissions with colleagues, knowledge institutions, network partners and governments;

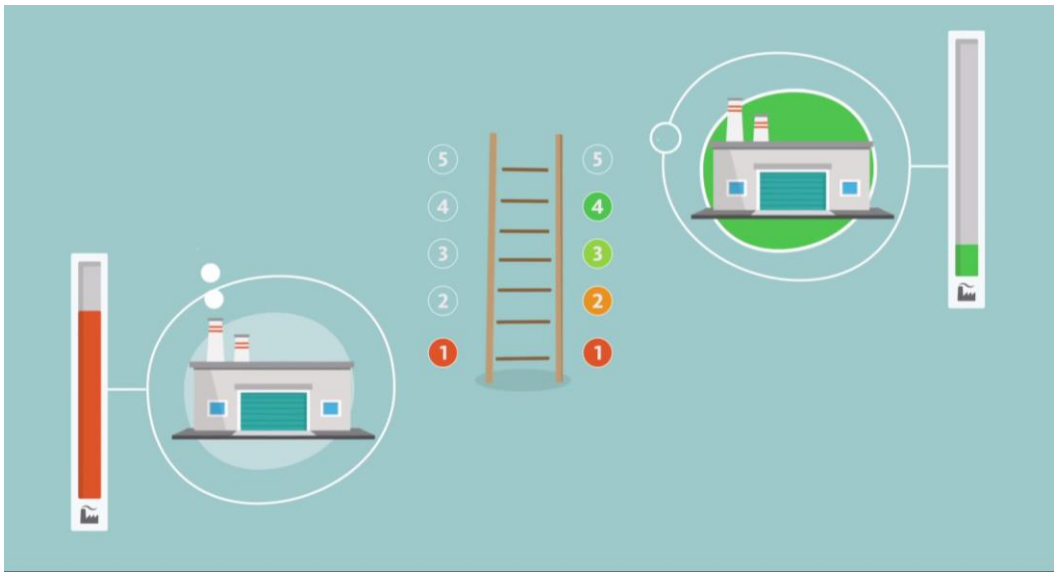

Figure 1 CO_2 Performance ladder (Source: SKAO)

Emissions

An important part of the CO_2-performance ladder compliance, is gaining insight into greenhouse gas emissions. For this purpose, CO_2-emissions are classified into the following scopes:

- **Scope 1:** direct emissions of the organization (business car fleet)
- **Scope 2:** indirect emissions of the organization, by installations not owned but used by the organization (generation of electricity, heating, business travel)
- **Scope 3:** other indirect emissions of the organization which arise from activities by the organization, although from sources not managed or owned by the company.

Scope 3 is further defined into upstream and downstream:

- **Upstream scope 3 emissions:** emissions arising from purchased or acquired materials and services (commuting, paper consumption)
- **Downstream scope 3 emissions:** emissions arising from the use of the project, service or delivery offered / sold by the organization. Therefore, emissions arising from the projects we work on as an engineering- and consultancy firm are classified as downstream scope 3.

The CO_2-emissions are calculated on the basis of a uniform list of CO_2-emission factors, published on www.co2emissiefactoren.nl.

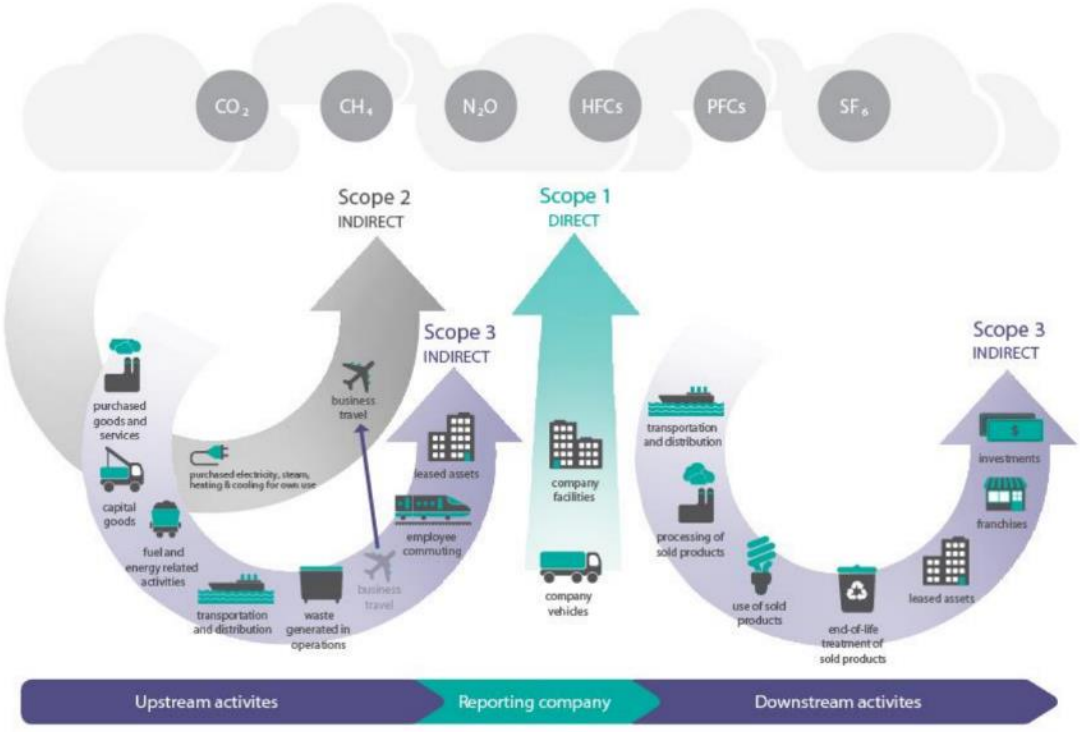

Figure 2 CO_2-performance ladder scope diagram (Source: Handbook CO2-performance ladder 3.0)

Certification

The certification of the CO_2-performance ladder contains 5 levels. To obtain a certain level, the organisation has to fulfil all the requirements associated with the levels below and the level pursued. Compliance is achieved when Arup receives >90% of the obtainable points for a certain level. Arup b.v. aims to comply to the highest level, nr. 5. The most important requirements for the levels are:

Level 1: Awareness of energy flows and possible measures

Level 2: Insight into own energy consumption and drive to reduce

Level 3: CO_2-inventory according to standards + quantitative reduction targets

Level 4: Research into CO_2 within the supply chain and CO_2 reduction in co-operation with chain partners.

Level 5: Participate in reduction programs and achieve CO_2-targets

Procurement

The CO_2-performance ladder tool can be used by the government or other businesses for the procurement process[1]. A higher score on the ladder is then rewarded with a concrete advantage in the procurement process, in the form of a fictional discount on the entry price. The contracting organization determines the award benefit per level of the ladder. At level 5, the awarded reduction on the bid price by ProRail is 10%. The most common reduction is 5% by most other parties such as Rijkswaterstaat.

Organizational boundaries

The CO_2-ladder certification will be applicable to the firm Arup b.v. in the Netherlands. Arup b.v. has a permanent facility in Amsterdam and a temporary facility in Groningen. The firm operates as a consultant for the planning, design, management and research of architectural and engineering related projects, primarily in the building- and infrastructure sector. There are no sub-companies operating under the control of Arup b.v.

Arup b.v. produces a total amount of CO_2 emissions above 500 tons a year, and below 2500 tons and therefore classifies as a medium sized company. The size classification determines the specific set of CO_2-ladder certification requirements.

[1] For further details, refer to the website http://www.skao.nl/

2 Requirements

The requirements are classified as **general requirements** and **audit-checklists.** The certification procedure is as follows:

Figure 3 Certification trajectory

2.1 General requirements

Management review

- The board of the organization must review the implementation of the CO_2-performance ladder. The Management overview in chapter 3 is set up to communicate the implementation of the ladder with the management board.

Internal audit

- The fulfilment of the CO_2-ladder requirements associated to the aimed level is reviewed internally
- Possibilities for improvement are identified.

External audit

- The report of the internal audit and management review are checked externally.
- The fulfilment of CO_2-ladder requirements associated to the aimed level are reviewed externally on the basis of the provided CO_2-ladder portfolio.

Contribution to SKAO

- The CO_2-performance certificate is valid if the yearly contribution is paid to SKAO.

2.2 Audit checklists

Besides the general requirements, the audit checklist exists of 4 core themes:


A. Insight B. Reduction C. Transparency D. Participation.

To communicate our compliance with the 4 themes this portfolio contains the following subchapters and documents:

Theme	Requirement documents
A: Insight	• Environmental data excelsheet (updated per quarter) • CO_2-inventory • Downstream scope 3 emissions • Operational chain analyses
B: Reduction	• Energy management plan (quantified reduction targets)
C:Transparency	• Communication plan (internal and external communication)
D: Participation	• Participation plan

3 Management overview

3.1 Introduction

This chapter provides an overview of the implementation status of the CO_2-performance ladder for the management team.

Changes relevant to CO2-performance ladder system
The internal Arup organisation of the CO2-performance ladder now falls under the scope of the QHSE; Environmental policy. Refer to: Energy management plan for the new team and organizational set-up.

The reporting period will be shifted from Jan-Dec to April-March in order to align with the Arup financial year. The change in reporting period solves the mismatch of the end of reporting year versus the time of audit (September). In this way the CO_2-portfolio will also align with the Arup Global CO_2-report, and the HWSABW-report. This report is a transition document reporting from Jan 2016 to March 2017; the CO2 emissions of Q1 2017 will be added as a separate chapter to the GHG-inventory.

3.2 A: Insight

The global Arup targets are to reduce CO2-emissions from the own organization to 3.0 tCO2e/employee/year for 2019. In order to meet the initial Arup Target we need to reduce our footprint significantly, by 15,7%.

The CO_2-inventory provides an overview of the emissions of the organization. The four main posts which account for 90% of the operational emissions are:

Scope 1:	Lease cars	12%
Scope 2:	Business air travel	25%
	Electricity	25%
Scope 3:	Commuting	28%

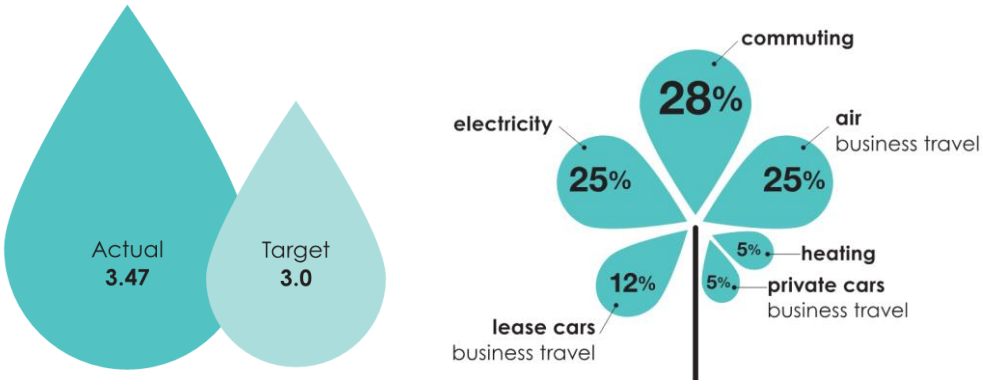

Figure 4 Left: Global Arup target for CO2 reduction /employee/year, vs. actual emission. 2016, right: Distribution of CO2-emissions for 2016

3.3 B: Reduction

Arup Operations

In 2014 internal goals were set for the period of 2014-2017 to reduce carbon with a total of 8% for all scopes. Emissions of scope 3 are decreased due to the reduction of commuting, but emissions of scope 1 + 2 have slightly increased, partially due to the rapid growth of the company.

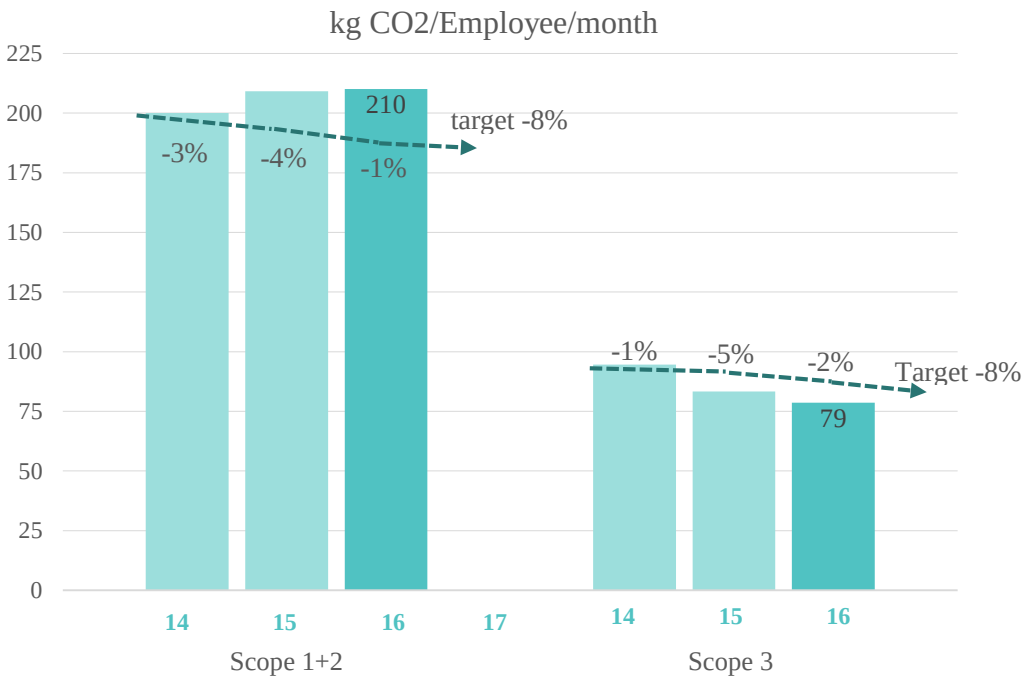

Figure 5 Reduction target of 8% for scope 1+2 and scope 3 vs. actual performance

A more effective strategy is needed to reach our targets. The new reduction strategies for our future operation are therefore based on the main emissions:

	Scope	Measures	Potential reduction	Progress
	Scope 1: Lease cars	Transition to electrical lease-cars	▼ 3%	● ○ ○
	Scope 2: Air travel	Reduction of business air travel, not related to client work	▼ 2%	● ○ ○
	Scope 2: Electricity	Transition to green energy / rehousing to 'green' office	▼ 25%	● ● ●
	Scope 3: commuting	Reduce commuting / rehousing to accessible public transport location	▼ 11%	● ○ ○

Progress 2016/2017

The most impactful reduction measure of the period 2015-2017 is the transition towards a green energy supplier (100% wind energy) for the Arup Amsterdam office in April 2017. A prognosis of our CO2-emissions for the year 2017/2018 shows that the yearly global Arup target of 3.0 tCO_2e/employee/ year for 1 April 2019 will be achieved. The focus of reduction measures for the period 2018-2020 will therefore be on the other 3 main drivers: lease cars, air travel and commuting (refer to Energy management plan 2018-2020).

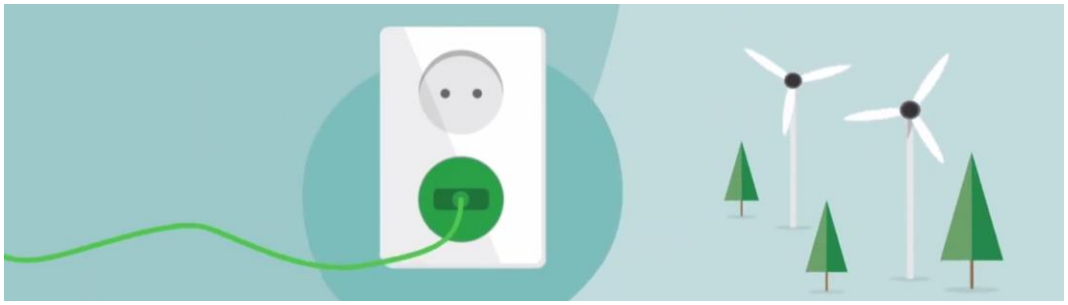

Figure 6 Towards Sustainable energy (Source: SKAO)

Arup projects

The main CO_2 mitigation measures for our projects (downstream scope 3) are:

	Scope	Measures	Progress
	Projects - Design	Perform supply chain analysis for building and infrastructure design	● ○ ○
	Projects - Design	50% of projects with a fee > €150k are setting sustainability objectives.	● ○ ○
	Awareness	How We Shape a Better World-report + awareness weeks in the office	● ● ●

Progress 2016/2017

Chain analyses are performed on an architectural steel bridge and a more practical concrete bridge. Two chain analyses are performed for a timber residential tower. In 2016, 24% out of the projects with a fee above €150 k have set sustainability objectives. Awareness is raised amongst employees by organizing an internal election on the 'most sustainable project' and a Sustainability week. Sustainable business travel is promoted by comparing transportation modes on CO_2 emissions, costs and duration.

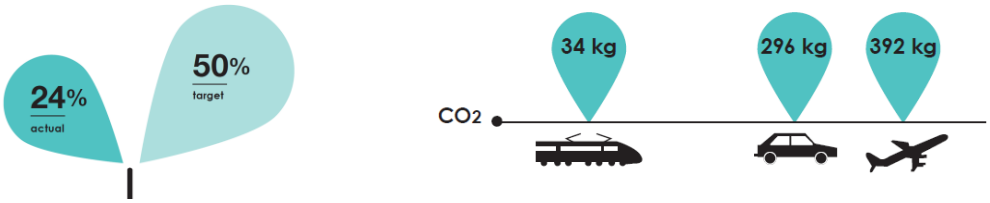

Figure 7 Infographics from the HWSABW-report

3.4 C: Transparency

Arup uses both internal and external channels to communicate the implementation of the CO2-performance ladder. The communication strategy is based on quarterly CO_2-performance updates, half yearly awareness weeks and yearly CO2-targets and portfolio update. Refer to: communication plan for more details.

	Internal				External	
Period	**CO_2-ladder**		**CO_2-awareness**		**CO_2-ladder**	
	Topic	Method	Topic	Method	Topic	Method
Q1	Update CO_2-performance	Screens			Targets and CL-portfolio	Arup site + SKAO
Q2	Update CO_2-performance	Screens + intranet	How we shape a better world-week	Report + lunchlecture		
Q3	Update CO_2-performance	Screens				
Q4	Update CO_2-performance	Screens + intranet	Sustainability -week	Campaign + lunchlecture		

Figure 8 Yearly communication calendar

3.5 D: Participation

Arup participates in a number of in-house research initiatives and network partnerships. For more information, refer to the Participation plan.

In-house research:
Simulation of cyclists, delivering green infrastructure, Approaches to health and well-being.

Participation to sector or chain initiatives:
Member of Dutch Green Building Council (DGBC), Member of Sustainability Commission to the Dutch Steel association (TC1 BmS), Ecodistr-ICT and Green Deal; Dutch Windwheel.

3.6 Audits

Internal
An internal audit was held on the 3rd of march 2017, by Paul van Horn. During this audit 8 deviations were observed, and 3 opportunities for improvement were identified.

External
An external audit was held by C.P. Glas of bureau Veritas on the 13th of December 2016. It was commented that several documents weren't compliant or up-to-date. After adjustments, the certification of level 5 was granted to Arup b.v..

3.7 Implementation of the CO2 performance ladder

- The sustainability portfolio is renewed to increase clarity and compactness of the information. In this way the portfolio will be more accessible and straightforward to update as part of the continuous improvement system.
- The cooperation with supporting teams as HR, facility management and communications will be increased, to integrate the reduction goals into their action plans (for example: mobility task force[2]).
- The transition towards green energy supplier for the Amsterdam facility will provide a significant reduction of emissions to successfully meet our targets.

Improvements after 2016/2017

- The reporting period is changed to match the financial year to align certification with yearly CO_2-registration target time slots.
- The reduction goals are set per 3-year time slot, to account for discrete steps in progress.
- The reduction targets are set per emission post, to track and gain more insight into actual progress.

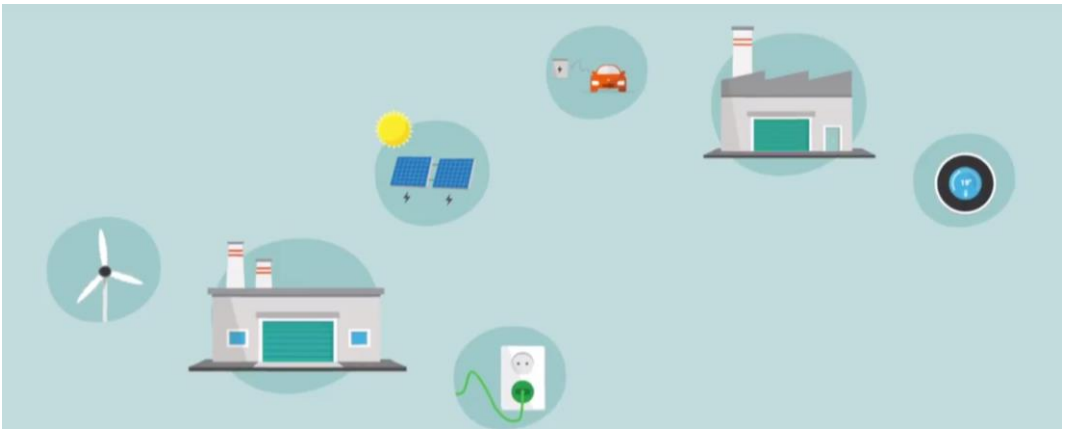

Figure 9 Possibilities to reduce CO_2-emissions (Source: SKAO)

[2] A mobility task force is set-up, with a main driver to reduce CO2-emissions related to transport. The mobility core team is formed by members of HR and Environmental, and is supported by colleagues from the master planning (transport), office upgrade team and facility management.

Appendix A

Insight

CO2-inventory

Arup

CO2 Performance ladder

GHG Inventory 2016 + 2017Q1

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Contents

Page

1 Introduction

At Arup we strongly feel the responsibility to contribute to the transition towards a more sustainable future. We have adopted the CO_2 -performance ladder as a tool to map and reduce our CO_2-emissions. Measuring and reporting of the carbon footprint of our organization is a fundamental first step in our action cycle. Our footprint is reported every year in accordance with the GHG-protocol and ISO 146064-1, as to comply with our CO_2 Performance ladder certification. The reporting period is January until December 2016, comparing performance to prior years 2014 and 2015. The reporting period will be shifted from Jan-Dec to April-March in order to align with the Arup financial year. Therefore, this report is a transition document reporting from Jan 2016 to March 2017; the CO2 emissions of Q1 2017 will be added as a separate chapter to the GHG-inventory.

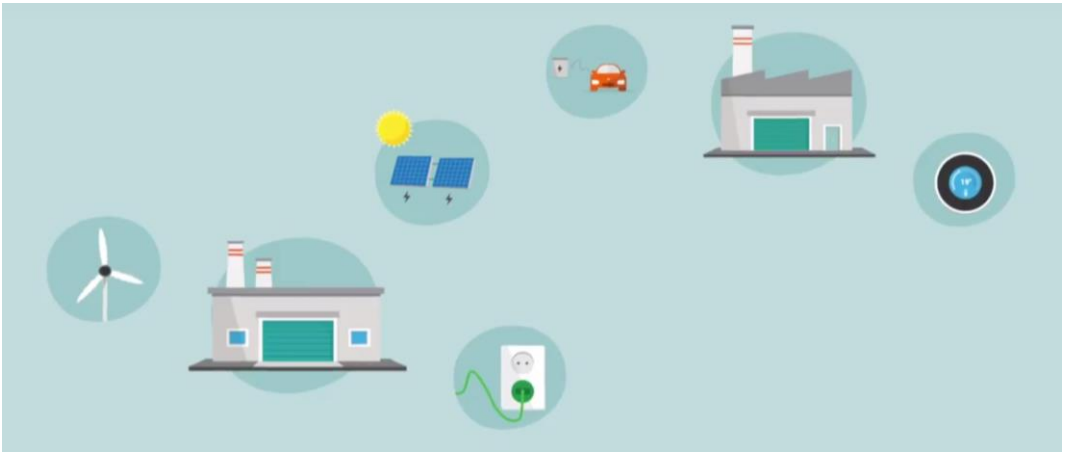

Figure 1 Identification of the emissions of our organization and chain (Source: SKAO)

1.1 Organization

Arup b.v. was established in the Netherlands, Amsterdam in 2001. The firm is currently under the leadership of Mr. Sander den Blanken and its management structure is divided into four cost-centres:

- Buildings and consulting;
- Infrastructure design;
- Groningen Earthquakes – Structural Upgrading;
- And business services.

1.1.1 Organizational boundaries

Refer to Chapter 1 of the CO_2-Performance Ladder Portfolio.

1.1.2 Operational boundaries

Arup b.v. is responsible for the carbon emission related to all activities and projects that fall under its direct **operational control.** Arup utilizes two facilities:

Facility location	Consolidation	Operational control
Amsterdam (permanent facility)	Equity share	Arup b.v. rents 4 office spaces. Energy suppliers not chosen by Arup b.v. Energy/ climate is controlled centrally for the whole building, not falling under control of Arup b.v. Furniture, lighting and all operational devices such as computers and printers are property of Arup b.v.
Groningen (temporary site office for P500)	Equity share	Energy suppliers, furniture, lighting devices are not chosen by Arup b.v. Office specific devices such as computers and printers are a property of Arup b.v.

1.2 Conformity to ISO-14064-1

This report is written such as the minimal requirements of GHG-emissions reporting according to ISO 146064-1 are satisfied.

ISO- 14064-1	Report section/ Remark
Organization, responsibility	1.1
Reporting period, base year	1
Organisational boundaries	CO2-portfolio H1
Direct emissions in ton CO2	3.2
Indirect emissions	3.2
CO2 emission related to biomass	None
Direct GHG removals	None
Excluded GHG emissions	All scope 3 other than commuting and paper. Business travel with public transportation is considered part of scope 2.
Reference to base year data	Not applicable.
Quantification methods and explanation	2.2/2.3
Change in quantification method	Not applicable
Reference literature conversion factors	https://co2emissiefactoren.nl/lijst-emissiefactoren/
Description influence uncertainties in quantification on accuracy	2.4
Statement on accuracy level and verification on the inventory	It will be certified with a limited level of assurance by DNV. GL.

2 Method, Scope & Assumptions

2.1 CO_2-emissions scopes

The inventory reports its CO_2-emissions for direct and indirect emissions:

Direct emissions
Scope 1

Business travel by lease cars

Indirect emissions
Scope 2

Facility energy consumption

Business travel (air, private car and public transportation)

Scope 3 (upstream)

Commuting

Paper use

2.2 Data Sources

The main sources of data used to calculate the CO_2 emissions are:

Aspect	Data	Source
Total surface facility [m2]	The office facility is part of a building managed by an external party. The surface occupied by Arup b.v. is based on the rent contract, plus a portion of the shared space.	Building owner
Number of employees	Direct employment contracts as well as under secondment conditions, both full- and part-time and free-lancers.	Human Resources
Scope 1		
Lease cars mileage total [km]	The fuel consumption is tracked through the lease company refuelling records.	Lease companies
Scope 2		
Facility heating [Gjoules]	Measurement devices are linked to each rented space unit.	Building Owner
Facility electricity [kWh]	Measurement devices are linked to each rented space unit.	Building Owner
Business air travel [km]	Flight distances are tracked for the categories <700 km, <2500 and >2500 km.	External travel agency
Business travel by private cars	Declared mileage for business trips. The fuel distribution is assumed to be 50/50 for petrol/diesel.	Finance
Business travel by public transport	A rough estimate is made.	
Upstream Scope 3		
Commuting travel [km] %	Distribution of commuting distances based on address register; Distribution of frequency of use of each transport mode for each distance-category /average	Human Resources (2016) Mobility survey (2014)
Paper consumed [kg]	Purchased paper	Paper supplier

2.3 Calculation methods

GHG emission	Quantification method
Facility energy consumption [kWn/Gj]	= Total measured energy (kWh/Gj) x % Arup floor space
Business air travel [km	= Total Mileage per category distance (≤700 km, > 2500 km, etc.)
Business travel by private cars [km]	= Total declared mileage x Average Conversion factor per fuel type
Business travel by public transport [km]	= Mileage / transport mode (TM) x conversion factor TM
Commuting [km]	= Average commuting distance per month x % transportation type

The conversion factors are obtained from: https://co2emissiefactoren.nl/

2.4 Uncertainties

Aspect	Uncertainty/ influence
Number of employees	The number of employees is not the same as the number of FTE's.
Lease car	The data delivered by the lease company consists of fuel consumption per lease car. This will include fuel consumption made for private trips.
The heating / electricity data for Groningen office	Heating / electricity data was only measured from Jan to September.
Electricity Amsterdam office	Consumption is measured for the whole building, Arup consumption is derived from % rented office space.
Commuting travel	Distribution of transport modes is based on a survey from 2014.

Most important possible improvements:

- Perform an up-to-date commuting survey amongst staff members.
- Gain full-year energy data from the Groningen office.

3 Carbon Footprint 2016

3.1 Distribution emissions

The distribution of emissions is shown in the figure below. The main sources are:

- Commuting (28%)
- Electricity (25%)
- Air travel (25%)
- Lease cars (12%)

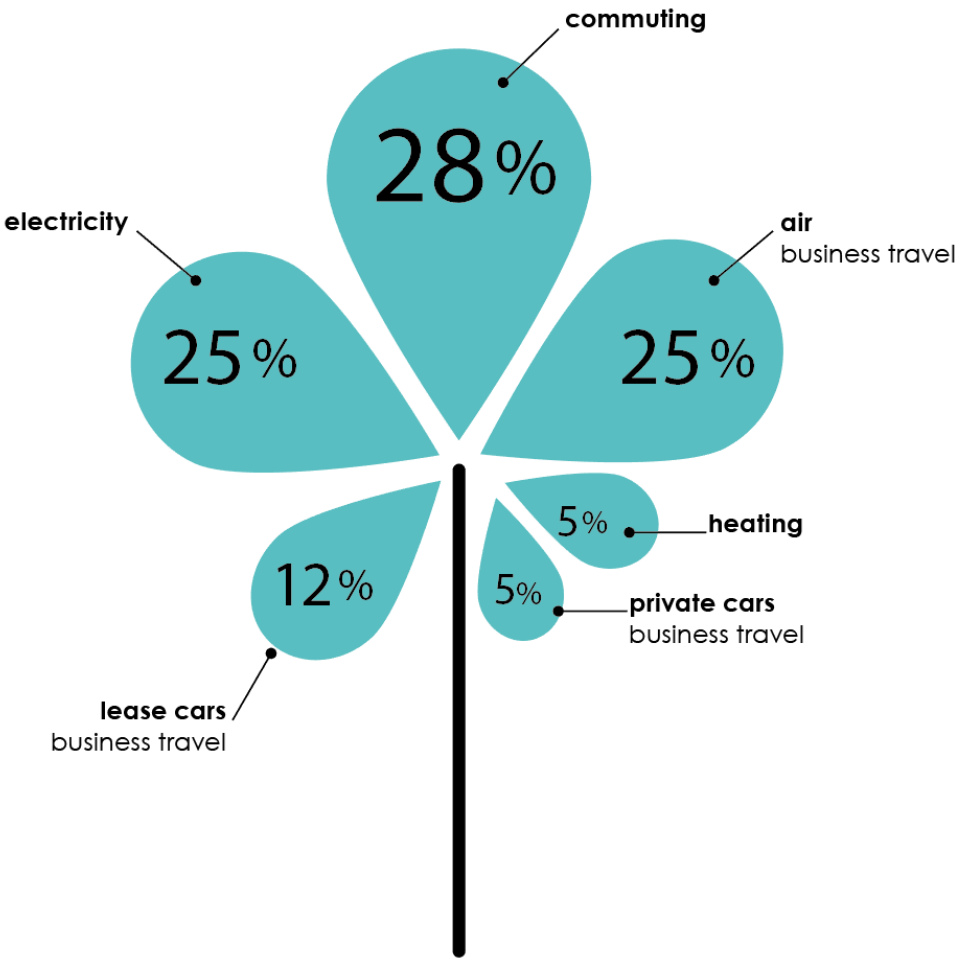

Figure 2 Distribution in scope 1+2+3 (2016)

3.2 Performance

The following table provides the quantified yearly emissions per category:

Scope / source GHG emissions		Emission [ton CO_2]
Scope 1	Business travel by lease cars	115
Scope 2	Business travel by private cars	42
	Business air travel	228
	Business travel by public transport	5
	Electricity	233
	Heating	43
Scope 3	Commuting	258
	Paper use	1
Total	**Scope 1, 2 and 3**	**925**

The trend in CO_2-emission performance is shown for the main emissions categories:

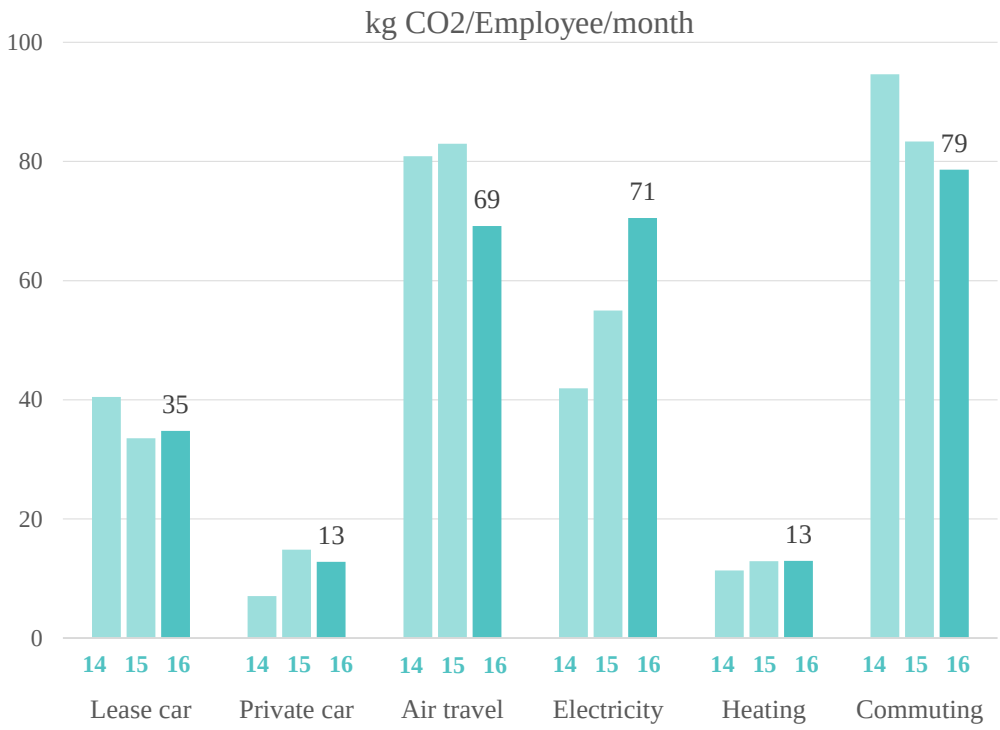

Figure 3 kgCO2 emissions for the main emission categories

The emissions due to lease cars, private cars and heating appear stable. Emissions due to air travel are reduced with 17%.

Electricity emissions have seen a significant increase. A plausible explanation is that in 2015 Arup b.v. started renting another floor space due to a rapid growth of the company. However, the floor space was not densely occupied, resulting in many m^2 per employee and inefficient electricity use.

Furthermore, many servers were needed for computer calculations, causing even further increase. As since then Arup has further grown, the floor area is now used more efficiently.

The commuting emissions are significantly reduced, however the distribution is based on an outdated survey and therefore needs to be replaced to gain more confidence in the results.

Scope performance

In 2014 goals were set for the period of 2014-2017 to reduce carbon with a total 8% for all scopes. For scope 1 + 2 the emissions increased with 4,6% in 2015 compared to 2014, after which the carbon reduction stabilized. Reasons include the internal moving in 2015 as mentioned above.

The emissions due to commuting of our staff has been reduced by 17% in the last 2 years and by 5% in comparison to 2015, exceeding the initial target set of 8%. However there is insecurity in these measurements which needs to be improved.

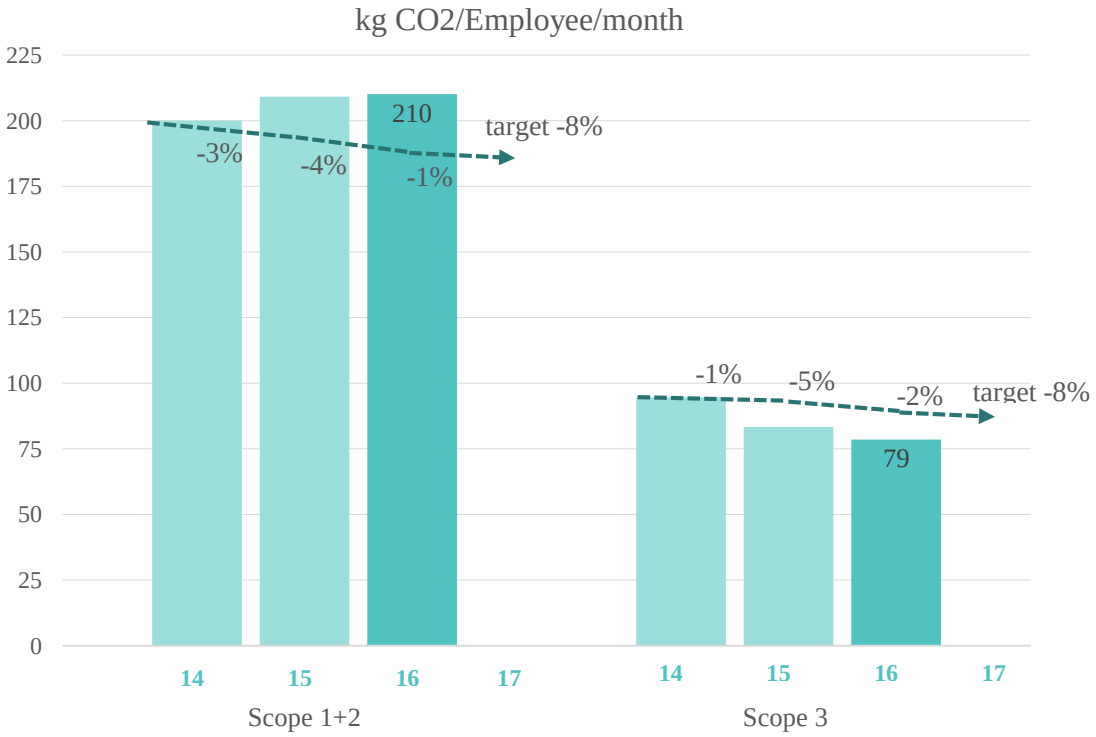

Figure 5 Reduction target of 8% for scope 1+2 and scope 3 vs. actual performance

The current trend is that the total amount of CO_2-emissions is slightly decreasing, but is practically stable, being around 3,5 tCO2/employee/year. Effective measures are needed to reach the Global Target. The sustainability strategy will focus on the 4 main sources of emissions which are: commuting, electricity, air travel and lease cars. Refer to the Energy Management plan.

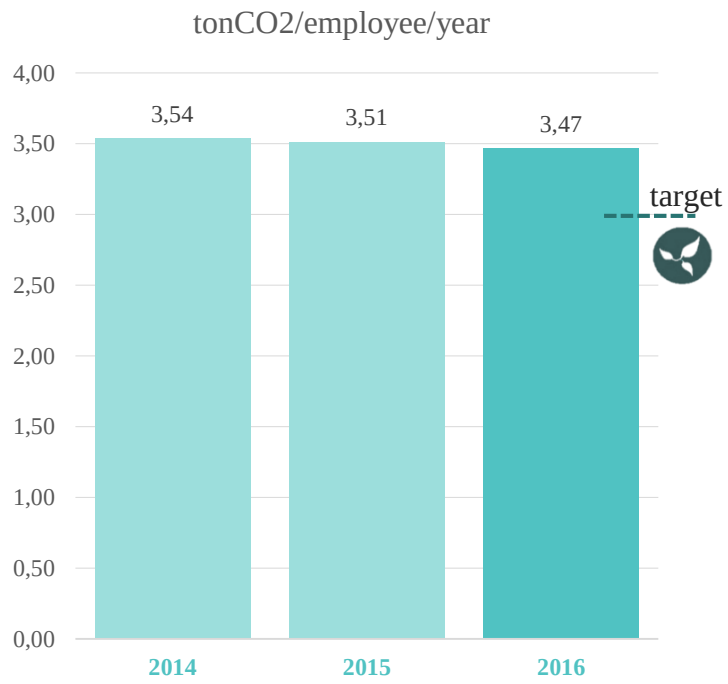

Figure 6 Total CO_2-emissions for scope 1+2+3

4 Carbon footprint 2017 Q1

4.1 Distribution emissions

The distribution of emissions is shown in the figure below. The main sources are:

- Air travel (28%)
- Commuting (27%)
- Electricity (24%)
- Lease cars (11%)

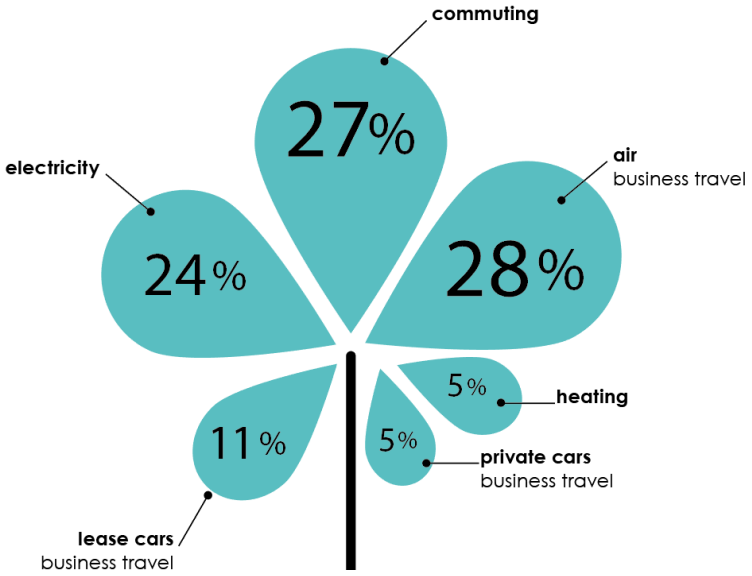

Figure 7 Distribution in scope 1+2+3 (2016)

4.2 Performance

The following table provides the quantified emissions of Q1 2017 per category:

Scope / source GHG emissions		**Emission [ton CO_2]**
Scope 1	Business travel by lease cars	26
Scope 2	Business travel by private cars	12
	Business air travel	65
	Business travel by public transport	8
	Electricity	58
	Heating	12
Scope 3	Commuting	63
	Paper use	0.0002
Total	**Scope 1, 2 and 3**	**244**

Scope 3 emissions

Arup Netherlands

CO2 Performance ladder

Value-chain analysis for Transport & Mobility and Buildings

4.A.1 and 5.A.1, 5.A.2-1, 5.A.2-2

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Contents

1 Introduction

1.1 Objective of this report

At Arup, we constantly challenge ourselves to push the boundaries of what is possible to fulfil our mission of shaping a better world. We are committed to carry our expertise and knowledge across to our clients to achieve 'green' solutions. Therefore, we aims by means of this report to draw a strategy to optimise our potential influence and participation in reducing carbon emissions of our societies.

In alignment with the carbon Performance ladder, this document is a requirement starting the 4th level of certification which is intended to have certified companies more involved in managing carbon emissions along their supply-chain. This document presents an analysis of the main down-stream carbon generating activities related to our projects for which reliable information is available. In addition (future) targets are set to improve the areas of influence where the maximum profit from carbon reduction can be achieved.

1.2 Scope

As an engineering consultancy firm in the built environment, our biggest influence on carbon emissions in our value-chain is downstream. The effects of our designs surpasses by far the effects of the products and services we acquire up-stream.

In order to obtain insight in the downstream CO_2 emissions, Arup carries out a scope 3 analysis of her value chain. Scope 3 emissions include all the indirect CO_2 emissions that occur after the delivery (completion) of our services (designs).

The scope of this analysis is to identify the possibilities of implementing more sustainable design methods which can potentially lead to the reduction of carbon emissions in the final product (service/structure).

This report is also the initiative for a long term approach. We have performed a value chain analysis for a specific part of Arup activities that can have a lot of impact on CO_2 emission. A two-year period (2014-2016) is set as the time frame in which improvements will be implemented.

In 2014, we had published a first scope 3 analysis targeting 'Road Transport' related emissions. In the current version, the relevance of 'Road Transport' for our sustainability strategy is evaluated based on progress on projects and market position.

Starting 2015, the total carbon footprint of Arup b.v. has exceeded 500 ton carbon/ year. This implies that two value chain-analysis have to be carried out. The second value-chain analysis focuses on 'Buildings'. The addition of another value-chain analysis implies also the incorporation of the results into our sustainability strategy.

1.3 Approach

The approach to define the scope 3 reduction possibilities within Arup is as follows:

1. Determine top 6 of scope 3 emissions through consultation with group leaders of most important departments (i.e. Infrastructure, Buildings & Consulting);
2. Use method described in 4.A.1 of CO_2-prestatieladder to define the size of emissions (qualitatively);

3. Based on the above analysis determine the sector/activity with the highest potential CO_2 reduction taking into account the influence of Arup within the market;
4. Prepare a value chain for the chosen activities;
5. Set targets and describe ways which will reduce the CO_2 emissions of the specific activity in the future.

1.4 Basis for scope 3 analysis

- The CO_2-prestatieladder handbook 3.0 is a reference are the reference documents for determining the top 6 activities of Arup with the most influence in CO_2 emissions. For the value-chain analysis the GHG-protocol is used as the basis.
- Arup has no significant influence on upstream scope 3 emissions so these are not included in the analysis. The downstream emissions are project related.

1.5 Boundaries downstream scope 3 analysis

Arup Netherlands uses the "operational control" approach laid down in the GHG-Protocol in the definition of its scope 3 emissions. This means that Arup is responsible for the emissions which result from office operations that Arup controls. Based on this, this document deals with the (indirect) emissions that are result from the design, engineering and consultancy work that is delivered by Arup.

The certification will cover Arup in the Netherlands registered as Arup BV. Arup BV has no authority on other Arup offices outside the Netherlands. Arup BV operates two facilities:

- Amsterdam;
- Groningen office.

Arup BV is organised internally in two main departments, 'Building & Consulting' and 'Infrastructure'. Building & Consulting is subdivided into multiple teams to deliver specialised services to different markets and clients. The teams within Building & Consulting are:

- Electrical engineering;
- Structural engineering;
- Mechanical Engineering and Plumbing;
- Acoustics;
- Computer Aided Design and Building Information Management;
- Building Physics;
- Fire engineering;
- Lighting;
- Master planning;
- Transport planning;
- Project management.

The Infrastructure department is not subdivided.

2 Relevant scope in the value-chain

2.1 Total value-chain

Arup Netherlands is an engineering consultancy firm providing a wide range of services including the design and construction of buildings and infrastructure as well as developing and advising on urban and transportation planning schemes. These services include design, technical advice and engineering for public and private clients nationally and internationally. Arup plans and undertakes projects from the policy and planning phase till the definitive design and the delivery phase . Besides that we also deliver consulting and engineering services in later stages for maintenance, renovation and disposal of existing structures. The general Arup approach per service provided to the client is generally treated in three main stages: Bid, Delivery (design/engineering) and Close-Out.

The downstream scope 3 emissions and the influence of Arup Netherlands on these emissions depend on the specific phase of the project at the moment of Arup's involvement. In Table 1 below the relevant services / products that Arup offers in each phase, the possible partners and the relevant emission category are given per activity according to GHG-protocol for downstream emissions.

Table 1 Arup services and emission categories

Phase	Products / services	Partner	Emission categories
Initiation	- Problem exploration - Inventory ambitions, desires, requirements, policies - Feasibility - Plan	Client, public or private	A B C D
Project definition	- Reports (individual studies) - Scenario analysis (design and measures of individual studies) - Program of Requirements	Client, public or private	A B C D
Design	- Preliminary design / plan (design and measures of individual studies) - Final design / plan (design and measures of individual studies) - Specifications (design and measures of individual studies)	Client, public or private Competent authority Suppliers	A B C D
Construction	- Guidance / back office (design and measures of individual studies) - Site supervision	Client, public or private, Contractor	A B C D
Operation	- Permits - Maintenance plans	Client, public or private, Contractor	A B C D
Demolition	- Demolition plan - Renovation plan - Management (possibly through exploration phase till demolition phase)	Client, public or private, Contractor	A B C D

Explanation of the emission categories:

A. Downstream Transportation and distribution of sold products;

B. Processing of sold products;
C. Use of sold products;
D. 'End-of-life treatment' of sold products;
E. Downstream leased assets;
F. Franchises.

2.2 Influence of Arup on the emission categories

In Table 2 the relevant influence of Arup Netherlands on the different emission categories is presented. The influence ranges from 'large' to 'negligible'.

Table 2 Downstream scope 3 emission categories and Arup influence

Emission category		Influence ARUP	Large (++)	Medium (+)	Small (-)	Negligible (--)
A	Downstream transportation and distribution of sold products	How we deliver our products/services for the next phases of the life of a project?		x		
B	Processing of sold products	Do we think about the processing of our products in the next phases? (e.g. maintenance)			x	
C	Use of sold products	What is the influence of our design choices in the use and maintenance of the product		x		
D	End-of-life treatment of sold products	Do we account for material disposal after the design life of the product?				x
E	Downstream leased assets	NA				
F	Franchises	NA				
G	Investments	NA				

Explanation of Table 2:

Downstream Transportation and Distribution of sold products (A)
Arup has limited influence on the way the services are delivered and handled in the next phases. The way data and information are exchanged is usually prescribed in the contract between the client and the contractor.

Processing of sold products (B)
Arup has limited influence on the way a design will be executed after completion of the design phase. Arup is never responsible for the construction itself. In the construction phase Arup can be involved as technical advisor to the Client or as technical advisor to the contractor.

As technical advisor to the client Arup generally provides support and guidance (back office) or delivers site supervision services. The contractor is responsible for the

construction. Responsibilities are recorded in service agreements between client and Arup and in construction contracts between client and contractor.

As contractor's consultant Arup provides technical advice and design services to the contractor. Responsibilities are recorded in service agreements between Contractor and Arup.

Use of Sold products (C)
The influence of Arup on the use of the product has technical and social aspects. Design choices can significantly influence the use of the end product and the resulting CO_2 emissions. So in this stage Arup has the largest influence in CO_2 emissions produced in the operational phase. In general, the actual design and construction of a product is only a fraction of the total CO2 emission taken over the lifetime of a product, in this case mostly buildings and civil structures with a lifespan of up to 100 years.

End-of-life-treatment (D)
Depending on the type of structure the design life time is about 50-100 years for new structures. In case of renovation of existing structures, the required residual life after renovation is usually 30 years. Life cycle cost analyses are based on the design life time. During design it is possible to account for the disposal of used structures and/or materials after their design life time. The influence of Arup on the "end-of-life" of a design is limited. Through a careful choice of materials the 'end-of-life-treatment' can be influenced but not significantly since we are talking about a long time-period after the design phase.

3 Analysis of influence potential downstream

In this section, the potential for improvement and maximizing our influence downstream is analysed. Based on the trends in our business, the clients and related services, the potential reduction of carbon emissions is studied.

The sustainability reviews of 2015, that were the core of the scope 3 emission related emission reduction, have revealed a number of relevant information about clients / value-chain partners and as well as a number of points have arose indicating possibilities for improvement. These improvements can either be explored together with our major partners (SKAO requirement 3.D) or as autonomous actions (SKAO requirement 5.A.2-2). The autonomous actions can be field specific but are not meant to target a single project. These are actions that help us increase our own knowledge capital to better address the environmental challenge. Our ultimate goal is increase our added value in the markets we operate in.

3.1 Business and Market trends

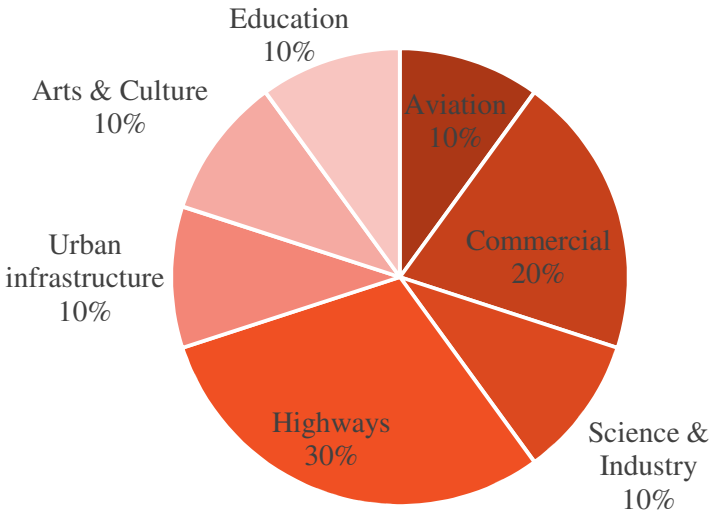


Figure 1: Proportion of different markets according to successful projects acquisition surpassing a certain fee threshold between October 2014 and May 2015.

3.2 Buildings

3.2.1 Services and Markets

The building related services in Arup Amsterdam are divers. The markets and services are listed below:

Markets

- Cultural
- Education

- Office / retail
- Residential
- Public / governmental
- Hotels

Associated services

- Sustainability consulting
- Façade design
- Installation, mechanical
- Fire engineering
- Structural engineering and structural upgrading
- Lighting
- Acoustics

3.2.2 Direct clients

The building services have often have initial sustainability criteria in their design scopes. These can arise from different motifs of the clients and applicable legal requirements related.

The different clients show interest in energy reduction of their buildings to different extends and level of ambition. Based on the sustainability sessions held internally in Arup Netherlands, different categories of clients were identified:

1- Clients with energy reduction ambitions with economic motifs, such as to reduce operational costs.

2- Clients with energy reduction ambitions driven by marketing motifs. These often require high standard certifications for their buildings (BREEAM, LEED, etc.)

3- Clients of semi-public sector such as municipalities. These are motivated by political reasons to increase the sustainability performance of their projects and/ or operational savings.

4- Clients with high ambitions because of own ethical convictions.

5- Architects and contractors, that are likely to depend on their respective clients. Contractors are most likely to focus on price and feasibility related aspects. Risk reduction is very important.

3.2.3 Indirect downstream partners

Often, Arup Building services do not specify products to be used with the exception of lighting, installations and acoustic related services. All other services are relying on material specification of the contractor. However, the manufacturing process, materials and related transport are relevant aspects to the quantification of downstream emissions.

The different requirements and regulations defined by the different Sustainable building Certification schemes and regulating bodies influence the performance and general practice and performance of downstream emissions.

The requirements and influence of end-users of office or residential buildings can also have an influence of the design choice. The suitability of solutions from an ownership point of view have been identified as relevant aspects to the criteria in the design process.

Indirect value chain partners are:

- Manufactures of lighting devices and equipment
- Manufactures of installation systems
- Building material manufactures
- Acoustic system manufacturers
- Contractors
- End-users of buildings
- Building Certification Schemes operators. (LEED, BREEAM, etc.)
- Municipalities/ authorities where the buildings are located.
- The regulating bodies
- Policy makers and politics at urban scale.

3.2.4 Relevance of carbon emissions

The building services consultancy team in Arup Netherlands has a variety of projects where energy performance is a central design topic. The relevance of the field in general relies on the fact that building use (office, residential, commercial, cultural and educational) has an important share in global carbon emissions 39 % according to the *Center for Climate and Energy Solutions.* See figure 2. The team in the Netherlands has built a considerable portfolio in Sustainability consultancy and participated in the design of a number of leading projects in the field of low-energy buildings in the Netherlands. Considering this exposure to larger scale projects and projects where innovative solutions are applicable, the team's potential influence in the market offers a good position to engage in a sector wide improvement of solutions.

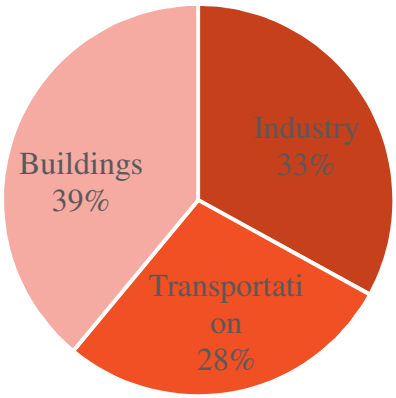


Figure 2: U.S. Department of Energy (DOE), 2008 Buildings Energy Data Book, Section 1.1.1, 2008.

3.3 Infrastructure

3.3.1 Services and Markets

The infrastructure services in Arup b.v. are concentrated around large scale bridge renovation. New build bridge and highway design are also among the services that are offered in the previous projects.

- Highways
- Renovation of steel bridges
- Urban infrastructure (pedestrian and cyclist bridge)
- Structural assessment of bridges

3.3.2 Client and direct partners

Due to the scale of infrastructure projects and their strategic role, the market is usually confined between operating/executive governmental bodies at national of regional levels. The involved regulations are well defined. Project scopes are usually limited to technical and environmental aspects concerned with acceptance and general suitability of the proposed plan. The related political concerns often concentrate on acoustic and visual aspects. The general health and carbon emissions have been slowly introduced. The applicability of these criteria is not in full implementation to date.

- Clients/ downstream partners
  - National governmental bodies (Rijkswaterstaat)
  - ProRail (future partner)
  - Contractors
  - Architects
  - Municipalities

3.3.3 Relevance of carbon emissions

To date, the carbon related criteria are incorporated in bids. The CO_2 Performance ladder tool was used to guide client and bidding party to incorporate carbon reduction goals into the scope of the projects. This has been first implanted by ProRail then followed by ‘Rijkswaterstaat’. Other major public sector clients have followed. However, the real implementation and relevance of the environmental impact is not given full attention in scope definition. The typical projects are often centred around technical feasibility and price reduction. Often, material reduction is a design criteria that influence the cost of the project. However, carbon performance of design alternatives is not criteria widely used.

Nevertheless, the commitment of different EU governments to carbon reduction over the coming years gives the indication that the carbon challenge will have to be carried out by the multiple governmental bodies including those involved in infrastructure design. The current quantifications of carbon emission indicate that the greatest share of emissions is due

to the use phase of infrastructure. Therefore, mobility and transport are dependent on the automotive industry rather than the performance of the physical infrastructure.

3.4 Transport planning

3.4.1 Analysis

- Clients/ downstream partners
  - Municipalities
  - Governmental bodies
  - Private- public sector partnerships (public transportation companies)
  - Investment/ development banks

- Project types
  - Transport planning projects for urban mobility
  - Bus-network optimisation
  - Traffic models for infrastructure design.
  - Vehicle choice/ selection consultancy, mainly vehicle running on alternative energy sources

3.4.2 Relevance of Carbon emissions

The transport planning field remains a major service to help cut down carbon emissions as it counts for 28 % of the global energy consumption.

The traffic route optimisation and vehicle type consultancy (using alternative energy sources) are relevant to improvement of the global performance of urban and national road networks. The team of Transport planning in Arup Netherlands is active in researching ways to improve the approach to design and modelling of different transport modes. Encouraging multi-modal transport and increasing the share of low-carbon transport modes are focus points. Our transport planning team works to improve infrastructure for pedestrians and cyclists. Despite the great share of cycling in the urban mobility in the Netherlands, little is known about the real behaviour and route choice of cyclists. In major cities, cyclist traffic jams occur frequently. The purpose of this research is to measure and quantify design parameters that are so far lacking in current models.

3.5 Masterplanning

3.5.1 Analysis

- Clients/ downstream partners
  - European Union/ European commission
  - Municipalities/ local governments of European cities (ex: Brussels, Amsterdam)

- Dutch Ministry of Transport
- Non-governmental bodies
- Private sector/ large corporate companies

- Services
  - Energy planning
  - Sustainability planning
  - Development of tools for decision making support.
  - Research

3.5.2 Relevance of Carbon emissions

The Masterplanning team in the Netherlands has an exposure to interesting projects with direct relevance to climate challenges in the built environment. Often, carbon emissions are not a pure topic of study. The team is often involved in projects related to energy planning and a more holistic approach to sustainable infrastructure design. The team has an interesting cross-European project portfolio which increases chances to gather experience and knowledge higher decision making level. With the increasing role of the European union in setting carbon reduction goals for its member states, more involvement with similar decision making bodies is interesting for a larger potential influence.

As an example, our Masterplanning team continues work on the European Commission's FP7 Ecodistr-ICT project. This projects aims to develop an open-source tool to support decision making in retrofitting and renewal projects of districts and their constituent buildings. The team is also involved in a research project for the Dutch Ministry of Transport to develop a more progressive approach to infrastructure design that will take into account a broader approach to health and quality of life.

3.6 Fields of strategic carbon emission reduction

In order to qualitatively determine the activities with the highest CO_2 impact within Arup's influence in the different sectors, there were a number of discussions sessions and meetings held within Arup Netherlands. In these meetings participated managers, directors, engineers, designers and planners of all the different departments provided input based on their experience, insight and knowledge of the market and the specific carbon emission challenges. Also, the sustainability reviews carried out in 2015 as an implementation of the strategy defined in 2014 in the scope 3 emission value chain analysis 'Road Transport' and Energy Management Plan have serve a support for the following analysis in defining the strategic fields for Arup Netherlands concerning carbon reduction. The outcome of this wider scale analysis for our services and market exposure, is analysed in the previous sections under this chapter 3.

The outcome is shown in Table 3 on the next page, which presents a summary of the six most important Arup activities in relation to Arup's potential influence on the CO_2 downstream scope 3 emissions. This table is reported to support the decision made upon the choice for topics of the herby presented value-chain analysis.

Table 3 Relative size of scope 3 emissions

Sectors and activities	**Description of activity that causes CO_2 emission**	**Relative importance of CO_2 loads of the sector and influence of the designs**		**Potential influence of Arup on CO_2 emission**	**Other criteria**	**Ranking**
a	b	c	d	e	f	g
Infrastructure	Construction	-	-	--	Our main clients, both public and private, support and stimulate measures for CO_2 control and reduction.	6
	Use	++	-	--		3
Buildings (incl. Structures, M&E, building physics, lighting, acoustics)	Construction	+	+	-		5
	Use	+	+	-		2
Master Planning	Use	++	+	--		3
Transport Planning	Use	++	+	--		1

Explanation column b:

Construction: In the design phase of a specific project some considerations are made based on the construction and execution phase (e.g. material used, connection types, possibilities for construction sequence, construction logistics.

Use: The design itself may have an effect on the use of the structure/service (e.g. it should be safe, accessible for future maintenance). Specifically in case of Master and Transport Planning there is a direct relation between Arup activities (technical advice from plan to procurement) and the operational phase.

We expect transport planning projects to have the largest potential impact on carbon emissions. Therefore we will focus on this type of activities for the chain analysis in the next section.

4 Chain Analysis Transport

4.1 Activities

The Transport Planning team of Arup is involved on an early project stage from plan to procurement. These are the most critical stages with significant influence on carbon emission. In these early phases (e.g. feasibility study phase, sketch design phase, preliminary design phase) Arup provides technical advisory services (consultancy) and plays an important role in the choices of clients (e.g. real estate developers, municipalities) by presenting them with evidence to support their decision making.

Arup can also be involved in a later project stage, such as the implementation (design) stage where the infrastructure department plays a major role. In general, design choices will be made based on client's functional requirements with these choices eventually influencing the way the project is built and how the end product is used (operation phase). We assess the influence of the decisions made at this stage on the following phases of the project and evaluate the possible effects.

Arup carries out Transport Planning projects both for national and international clients. Particularly in the Netherlands, spatial planning is a rigorous exercise and transport being an important part of any spatial planning project. Our current market position in transport planning in the Netherlands is limited.

The following are standard transport planning services of Arup in the Netherlands:

- Strategic modelling (static);
- Traffic modelling / assessment (static & dynamic);
- Road design (including extensive cycling infrastructure);
- Municipal and provincial transport plans.

4.2 Chain partners per project phase of Transport Planning

At each project phase multiple parties both from the private and public sector can be involved.

4.2.1 Policy

Policies are set based on social, economic and environmental criteria. Policy definition typically involves Ministries, Provinces and City regions. At each of these levels Arup provides advice and technical support to help set the policy strategy and define the overall target. Arup can influence the choices by pointing out solutions which are most beneficial to reducing carbon emissions.

4.2.2 Strategy

At this stage both public and private parties can be involved (municipalities, public transport operators, governmental agencies like Rijkswaterstaat, financial institutions, land owners). As soon as the main goal is defined at a policy level, the ways to achieve these targets need to be determined. Arup helps develop efficient and sustainable strategies and plans for achieving those targets.

4.2.3 Implementation

At this stage strategic plans are elaborated further. It mainly involves the preliminary and final design phases but there is still some room for choices that can influence the CO_2 impact in later phases (i.e. construction, operation, demolition). Arup provides full technical support and can play a crucial role in the design choices.

Figure 3 is a visual presentation of Arup's influence during the different stages of a project and its influence on CO_2 emissions. Obviously an earlier Arup involvement in the design process signifies a bigger influence on decisions and design choices related to reduction of CO_2 emissions.

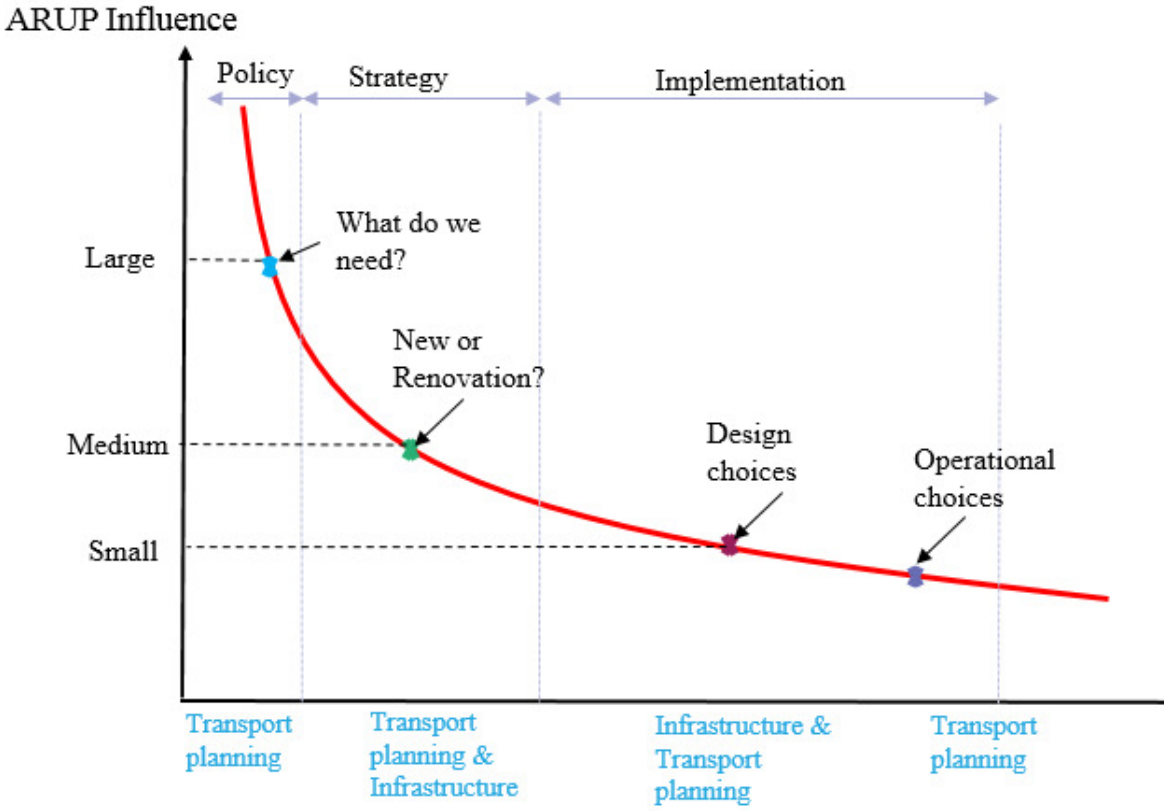


Figure 3 Arup's influence per project phase and activity

4.3 Quantification

4.3.1 Based on literature

Report "EU Transport GHG: Routes to 2050 II" [1]is taken as the basis for the quantification of the CO_2 emissions. According to this report, transport is responsible for a quarter of EU greenhouse gas emissions making it the second biggest greenhouse gas emitting sector after energy. Figure 4 presents the contribution of Transport to GHG emissions in 2009. The figures show that transport accounts for almost three-quarters of EU transport-related greenhouse gas emissions and over one-fifth of the EU's total emissions of carbon dioxide (CO_2), the main greenhouse gas.

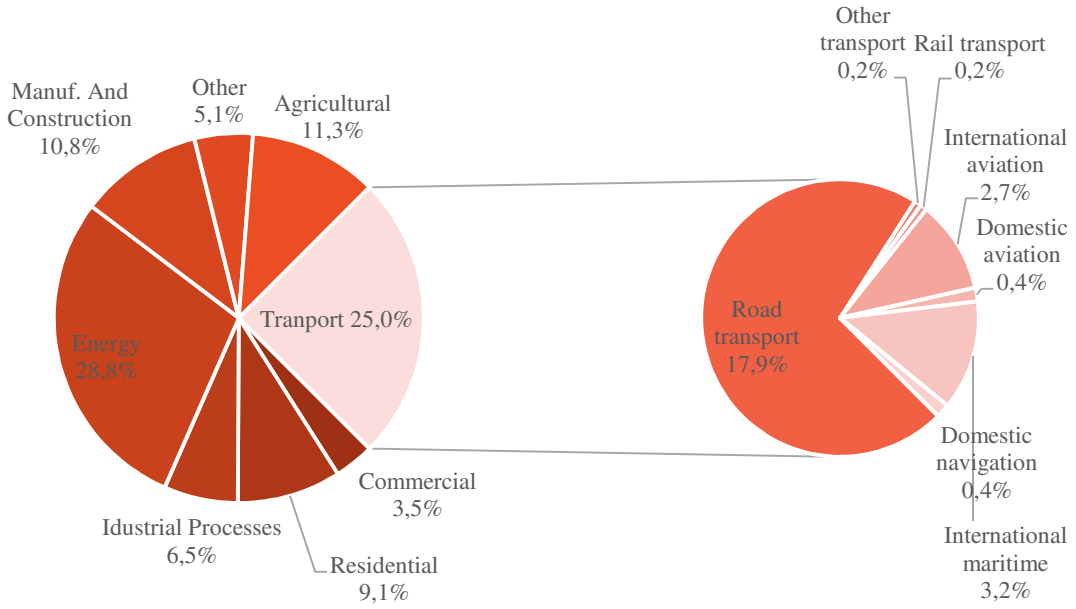


Figure 4 EU27 greenhouse gas emissions by sector and mode of transport, 2009 [1]

The report [1] emphasizes that the GHG emissions due to transport infrastructure and vehicle manufacturing and disposal are significant components of the current overall transport GHG footprint. These are likely to significantly increase in importance in the long term. Policy action should aim to minimize the degree to which future GHG emissions from these elements erode the GHG savings due to reductions in the operational energy use (and GHG intensity) of vehicles.

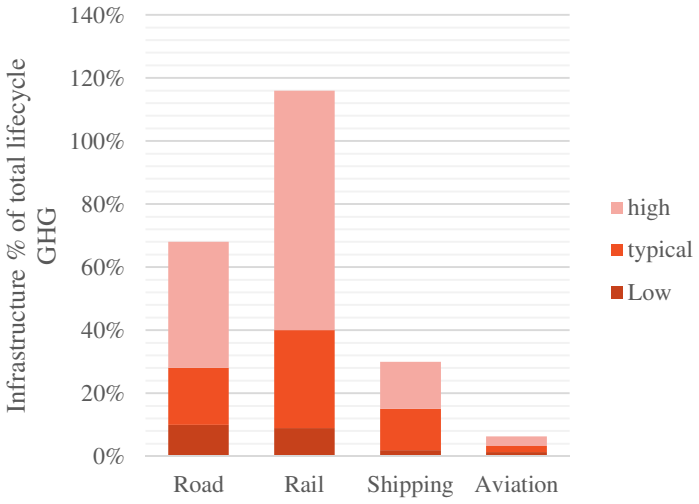


Figure 5: Comparison of the relative significance of GHG emissions from infrastructure development and operation as a proportion to overall lifecycle GHG emissions (including vehicle energy consumption). EU transport GHG: Routes to 2050 II 30 April 2012.

From the above shown figures, road transport seems to offer considerable potential for carbon emissions down-stream. Both transport planning and infrastructure design services are concerned with the outcome of this analysis. However, the two teams intervene in different stages of decision making and often deal with different design scopes. The study outcome of the one team, operating at earlier stages of design and consultancy form the grounds for the design scope presented to the later team further down along the decision making trajectory.

4.4 Chain analysis Road Transport

Within Arup Netherlands, the 'Transport Planning' team is the team that is closely involved in the early - and most influential - stages described above ('Policy' and 'Strategy') whereas the 'Infrastructure' department has a role later in the strategy phase when the question for 'new construction' or 'renovation' is raised. Additionally the 'Infrastructure' department plays a role in the choices made during the design phase.

Figure 6 presents the chain activities of Arup in relation to road transport CO_2 emissions. The colored boxes indicate the fields/activities where Arup has the most influence.

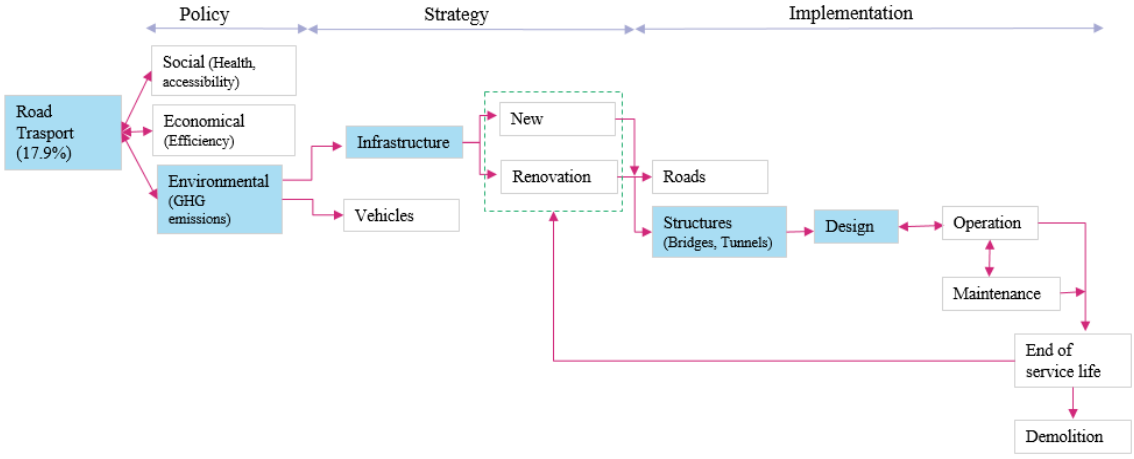


Figure 6 Chain analysis of infrastructure in relation to road transport emissions

4.5 Identified weak links and targets in 2014.

The chain analysis in figure 6 showed two main weaknesses in proposing innovative solutions to CO_2 emission reduction and sustainable designs in our projects. These two weak links were identified as follows:

- Time: the chain analysis shows a lengthy process from policy all the way down to operation. This process might take up to 30 years during which alterations to the original plans are likely. These alterations might occur because of a change in the composition of the team or change of the political environment and objectives.
- Budget: innovative ideas are usually associated with increased expenditure at both design, construction and operation stage. The return on investment is not always apparent. Both for clients (external) and Arup (internal) this could mean a lack of incentive to invest in innovative, CO_2 emission reduction ideas.

Arup Netherlands has implemented the following procedure:

- sustainability reviews for every project with a fee over € 100.000,-. The review will be carried out by our 'sustainability focus group' within a month after project inception. The group focuses on promoting sustainable design with members from our planning, infrastructure and buildings team. In the review a qualitative carbon footprint analysis will be incorporated and the 'sustainability focus group' will investigate jointly with the project team ways to reduce the carbon emissions. This will be monitored on a yearly basis. Results of the reviews will be discussed with our client.

This procedure will be implemented within the next three years (2015-2017). The first sustainability reviews carried out up to date, have not focused on specific 'Road transport' related projects. However, information was gathered about previous relevant work done internally about the question of renovation vs. new build in the infrastructure design in relation to carbon emissions.

4.6 Renovation vs. new built : Galecopper bridge

4.6.1 Introduction

The Galecopper Bridge (GCB) is a highway dual bridge near Utrecht in the Netherlands. Built in the early 1970s, it is suffering from static and fatigue problems. A renovation solution has been developed and is currently under final construction stage.

The aim of the renovation was to extend its life by 30 years. To solve the fatigue issues in the thin orthotropic steel deck the asphalt layer will be replaced by a 90mm thick High Strength Concrete (HSB) overlay on top of the steel deck. To deal with the increased weight and some static strength issues the dual bridge is strengthened using four pre-stressing steel box girders, together with few other steel strengthening measures. The renovation design allows for future widening of the motorway.

During the development of this solution a new build option was devised for comparison. The new build option consisted of two new skewed steel arch bridges. The dual bridge is designed with increased width, with two additional lanes on the parallel carriageway on each bridge.

The design team of Arup has proposed to the client an overview of the carbon implication of both solutions. A paper was produced to compare the two options in terms of sustainability. This approach considers four key objectives for a qualitative comparison:

- Energy efficiency and carbon reduction
- Materials & waste reduction
- Climate change adaption & resilience

4.6.2 Design options

This section compares two options for GCB in terms of sustainability. The first option

Figure 7: New build option

involves renovating the dual bridge, with the possibility of future widening.

The second option includes replacing the superstructure with a widened arch dual bridge. Any changes to the approach roads are not taken into account.

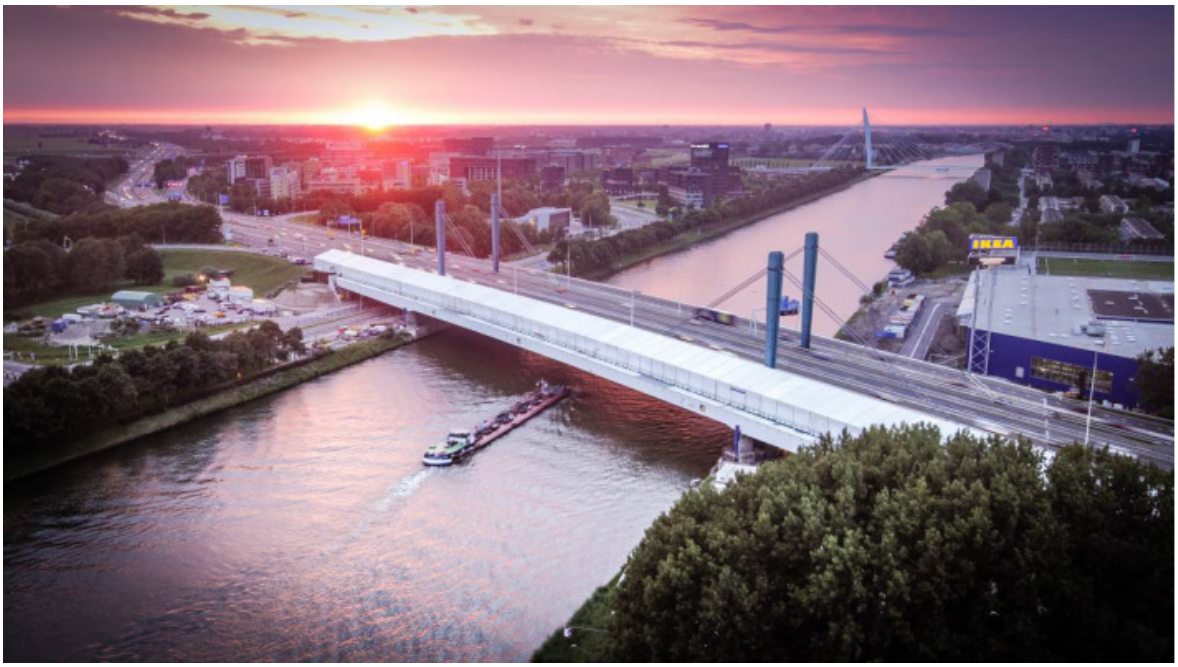


Figure 8: Renovation option

4.6.3 Sustainability approach: 9 objectives

A sustainability assessment of a project can be divided into four main aspects: social, economic, environmental and natural resources. The Arup Sustainability Strategy lists 9 objectives specifically for infrastructure projects that incorporate these considerations and that are used to assess embedded sustainability in infrastructure projects.

The Arup Infrastructure Sustainability Objectives are listed below:

1. Energy efficiency and carbon reduction
2. Robust water supply and enhanced aquatic environment
3. Materials & waste reduction
4. Climate change adaption & resilience
5. A positive contribution to the society and environment
6. Whole-life management
7. Economic viability
8. Integrated transport and resource delivery
9. Effective land use

Differences between the two options with regard to the Arup Infrastructure Sustainability Objectives are reported below. Only objectives considered most relevant for this project have been analysed. They are:

1. Energy efficiency and carbon reduction
3. Materials & waste reduction
4. Climate change adaption & resilience
5. A positive contribution to the society and environment

The outcome of the study related to Energy efficiency and carbon reduction are further reported in this report.

4.6.4 Assessment of options against selected objectives

- Energy efficiency and carbon reduction

Embedded Carbon of the two options

EC [106*kgCO2e/kg]	Renovation option strengthening	Renovation option widening	New build option
Superstructure	5.7	6.6	15.9
Substructure	2.0	2.0	2.0
Total	7.7	8.6	17.9
%	100%	112%	232%

EC [kgCO2e/kg] = quantity of CO2 and greenhouse gasses embedded in the materials used

Table 4 Embedded carbon of the two design options

- Materials and waste

The aim of the renovation option is to eliminate waste from demolition by utilizing innovative analysis and strengthening techniques to enable re-use of the superstructure. For this option the waste is due to the removal of asphalt and bearings removal.

For the new build option the foundations will be reused but the entire superstructure will be replaced, producing 5100 tons of waste per bridge that need to be moved and deposited. Even if all the steel were to be recycled it would still produce a great amount of energy and emissions.

4.6.5 Conclusions

The lifespan of the options are different. This makes the comparison difficult because it is not a direct comparison. With regard to lifespan the new build option is more sustainable as all embodied carbon of the materials is related to a longer period of use. The absolute embodied carbon is higher, but the embodied carbon spend per year is less. However the new build option provides the same road layout as the renovation option for 30 years, while the needs may change after 30 years' time. The new build design is not very adaptable to a possible increase in the number of lanes due to the super structure above deck. Renovation option is more sustainable in terms of embedded carbon of the materials used and minimizing waste production, by upcycling most of the structure. This reflects in the costs as well. From a landscape point of view renovation option does not have a big impact, while the new option would change completely the landscape of the area. The geometry of the proposed dual bridges has a large visual impact, especially due to the skew angle and varying heights of the arches.

In terms of widening the renovation option is more flexible, but the new option has the benefit of a wider bridge in the beginning, avoiding additional construction works when widening could become necessary.

The weighting of objectives is greatly determined by the client's vision of sustainability.

In Table 5, the final scoring is reported. This is based on a system that rates carbon reduction as more important than the other objectives. Second importance has been given to the contribution to the society, leaving at the same level materials and waste together with climate change.

Comparison

Objective	Renovation	New Built
Energy efficiency and carbon reduction		
A positive contribution to society and environment		
Materials and waste		
Climate change		

Table 5: Comparison of the two options against the set criteria.

5 Transport Chain Analyses Conclusions

For the chain analysis of downstream scope 3 CO_2 emissions Arup identified activities in the transport sector as having the largest impact. A chain analysis was made and resented for our activities related to road transport. The main services involved in this sector are :

- Infrastructure
    - Infrastructure team in involved in the design of the physical infrastructure. The construction and operation of this last accounts for a typical value of 33 % of the total GHG emissions related to road transport.
    - The design criteria to cut down these emissions are not clearly defined by the concerned sector partners. The carbon emissions and sustainability are still not formulated as design criteria and therefore are difficult to implement in the project scope.
    - The sector of infrastructure design and operation should be more aware of its impact and implement clear guidelines and procedures to facilitate carbon reduction.
- Transport planning :
    - As stated before, the transport planning discipline can intervene at more influential project and decision making stages.
    - The encouragement of shifting to low-carbon transport modes is essential to carbon reduction.

These conclusions are further discussed in section Carbon reduction strategies of this report.

6 Value-chain analysis for Buildings

6.1 Activities

The activities of the Arup Buildings department in Amsterdam consist of engineering consultancy in the areas of structures, building physics, mechanical engineering and plumbing, lighting and acoustics. Arup can advise the client in any of these areas throughout the various building phases.

6.1.1 Design

In the design stage, Arup can be involved in activities ranging from feasibility studies to detailed designs. The influence of Arup is greatest in this stage, but it is of course dependent on the scope of the specific activity: decisions that can be made in a preliminary design are of greater influence than those in a detailed design. In most cases, the architect is leading and Arup plays an advisory role. Based on the clients wishes, Arup can make important design decisions that will greatly impact the way that the building is constructed, and to a lesser extent, how it is used. Arup can design energy efficient buildings and accommodate for carbon reducing behaviour.

Through a tender, a contract is created to perform the construction works, which are carried out by a contractor. Arup can be involved with the contractor in the process of submitting a tender, providing technical advice. In the review of tenders, extra points or fictional cost reduction may be awarded to those tenders meeting sustainability targets. The CO2 Performance Ladder is a tool that is used in this context. Arup can help win a tender by giving advice aimed at meeting these targets.

6.1.2 Construction

When a contractor is selected based on the tender, construction can start. Arup can have a supervisory role during construction, but has no influence on how the construction itself is carried out at this stage.

6.1.3 Use

Arup has no direct influence on the way the building will be used in the future, or how its occupants will behave. During the time the building is in-use, maintenance may be carried out. Arup can give advice on how to make a building more energy efficient, reducing GHG emissions.

6.1.4 Demolition

Arup is not involved with the demolition, but can influence emissions in the demolition phase in the design, for example when the client asks for a cradle to cradle concept.

6.2 Chain Partners

The partners in the building chain are described below. For each type of partner, a few examples from actual projects are named.

- Client

  The client can be both a public and a private party, for example a local government or a real estate developer. Arup may also be asked to provide services to an architect or a contractor.
  As a service provider, Arup is dependent on the wishes of the client. Because of that, Arup will have to adapt its sustainability strategy to the client being served. Sometimes, the client will set high sustainability targets. In these cases, Arup can directly focus on these targets and work with the client to meet hem.
  When the client is not primarily interested in sustainability targets, Arup can use tools such as LCC in order to convince the client of the added value of a sustainable design, which reduces both GHG emissions and costs. The Breda courthouse project has set an example for the implementation of such a tool.
  Example: Rijksvastgoed bedrijf, Volker Wessels, Municipality of Tilburg, G&S Vastgoed
- Architect

  Architects often take a leading role in the conceptual design of a building. By working closely together with architects, and giving them advice on how to reduce emissions, sustainability targets set by the client can be met.
  Example: OMA, IAA, Paul de Ruiter

- Contractor

  The contractor is responsible for carrying out the construction works defined in a contract with the client, usually as a result of a tender. Arup can take an advisory or supervisory role.
  Example: Volker Wessels, BAM, Heijmans

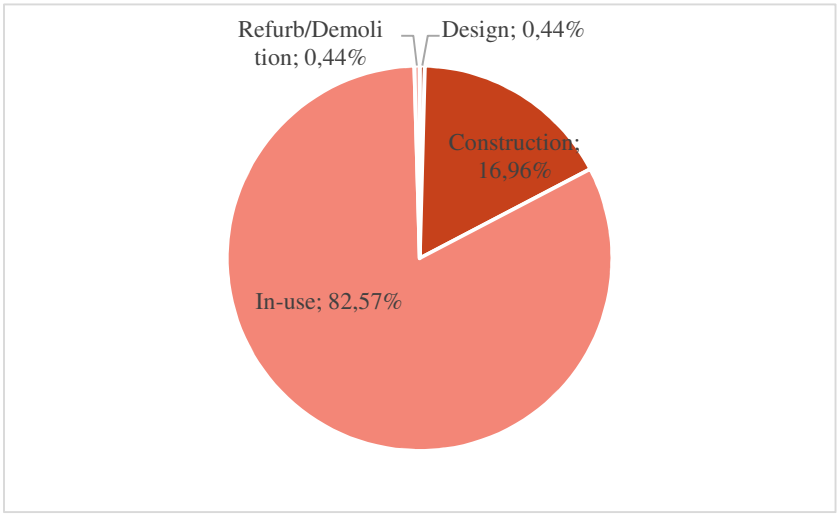
- End users

  Through their behavior, people who will make use of the building have the biggest impact on GHG emissions. Arup's ability to steer their behavior is very limited.

6.3 Quantification

Buildings are the greatest source of CO2 emissions in the Netherlands, accounting for over a third of the total emissions. Over the life-time of a building, most CO2 is produced when the building is in use. A significant proportion, however, is also embedded into the manufacture. The diagram below shows the relative percentages of CO2 emissions that the construction industry can influence, according to a study

by the Department for Business Innovation & Skills. Note that these are based on the UK market.



6.4 In-use

6.4.1 Chain analysis

The CO2 that is emitted in the in use stage of the building depends on many different things, including the type of usage, the climate it is situated in, and the access to energy resources. Therefore, the measures to reduce CO2 emissions will differ from project to project, but some of the main CO2 contributors are heating, air conditioning, ventilation, lighting and telecommunications (UNEP 2009, p.10). The chain analysis below shows that lighting and heating are the greatest contributors to the energy demand of an in-use office building.

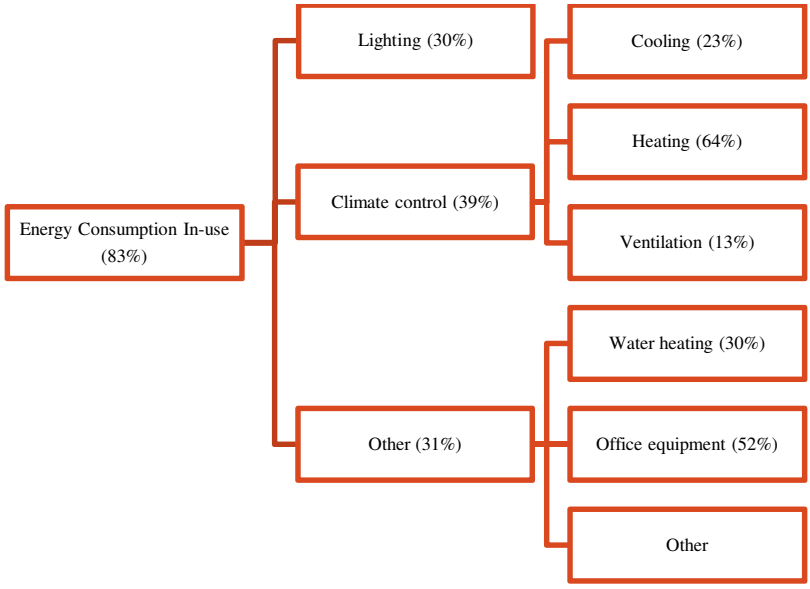


Figure 1: Relative energy consumption office building, based on bouwen met staal (2015)

6.4.2 Improvement of chain analysis

The chain analysis can be improved on the following aspects.

- Update the analysis for a typical Arup office building.
- Consider performing an analysis on various buildings designed by Arup. An office is only one building type, while the buildings department designs many different types of buildings with different uses.

6.4.3 Goals

Arup is aiming to reduce GHG emissions in the building chain. The focus will be on designing buildings that minimize the energy needed for heating, cooling and lighting. One can think of measures such as insulating the building, or positioning windows to regulate incoming heat from solar radiation. Furthermore, natural lighting will be encouraged, and the choice for sustainable lighting options promoted. The in-house lighting and acoustics department can make a valuable contribution to reduction of emissions associated with lighting.
The main goal will be to investigate the effect of these measures on the CO2 performance of a building by performing Energy modelling, SPeAR analyses, LCAs and LCCs on actual Arup projects.

6.5 Manufacture

6.5.1 Chain Analysis

The CO2 emitted in the construction stage is subdivided into three categories. Of these categories, the actual manufacture accounts for the greatest emissions, and it is most directly influenced by Arup design. Concrete, stone and metal products are the greatest carbon producers.

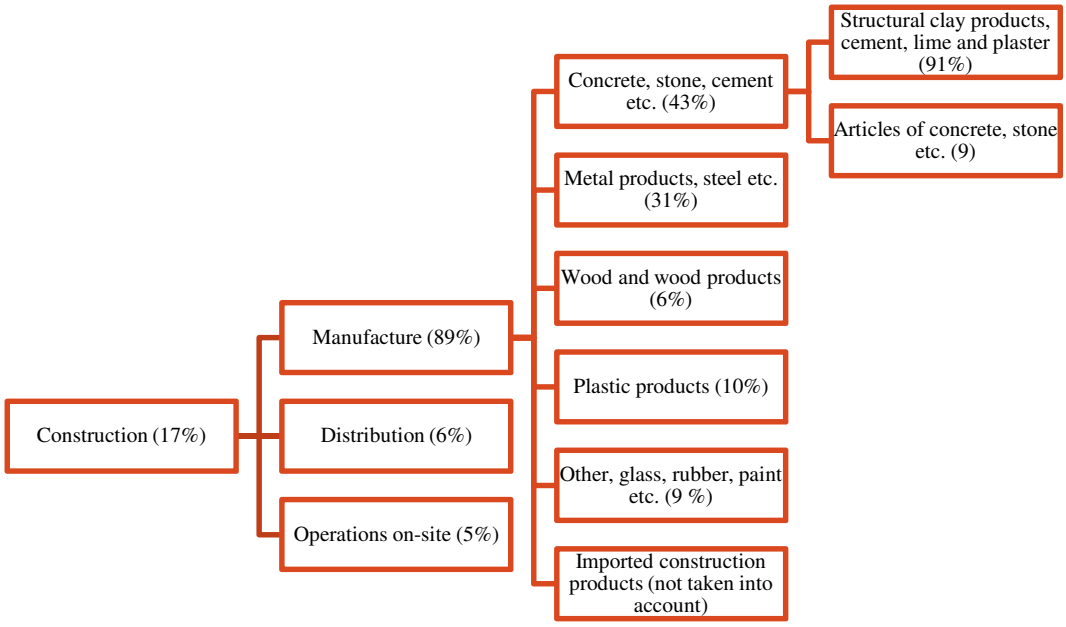


Figure 2: Relative emissions as a result of building construction, based on BIS data (2009)

6.5.2 Improvement of chain analysis

- Currently, the chain analysis is based on data from the UK market. Since the Dutch building practice, the main working area of the Arup buildings department, is expected to be different from the UK, Dutch market specific analyses should be carried out.

- Imported construction products are in this case not taken into account. The various percentages shown are only based on the internal market. It is desirable to get insight into the emissions from these products.

6.5.3 Goals

The greatest influence of Arup in the manufacturing stage is on building materials. In future projects, Arup will investigate whether measures to mitigate building material associated emissions are effective and add value to a project. This can be done using in-house tools such as SPeAR, or widely known tools LCA and LCC. Areas of interest include:

- Minimizing material usage in the design stage. This will also reduce emissions associated with material transport.
- Applying materials that can be sourced locally.
- Choosing sustainable materials. Consider alternative materials, such as timber instead of concrete or steel. Additionally, the use of fly ash to (partially) replace cement or the application of recycled or higher strength steels will improve the carbon performance.

7 Carbon reduction strategies

7.1 Strategy

Our strategy for the next years will focus on our infrastructure design team and the projects we do for the two main public clients in the Netherlands who work with the CO2 prestatieladder. We have no substantial influence on the in-use emissions of the infrastructure, but still have a significant influence on the emissions during construction. Our strategy is that in our design projects we will communicate to RWS and ProRail what the embodied carbon is of the design options we develop for them. Hence assisting them in having insight in a sustainable decision making process with opportunities to reduce their Carbon footprint.

We will continue our good work in the transportation group and keep focussing on low carbon transportations such as cycling and walking whenever we can. In the building group we also retain working with clients who appreciate low energy and energy efficient buildings. In both areas we will therefor contribute to a reduction in CO2 for the future.

7.2 Total emissions in target market

7.2.1 RWS

According to 'Duurzaamheidsrapportage Rijkswaterstaat 2015' [5] the following footprint data is available;

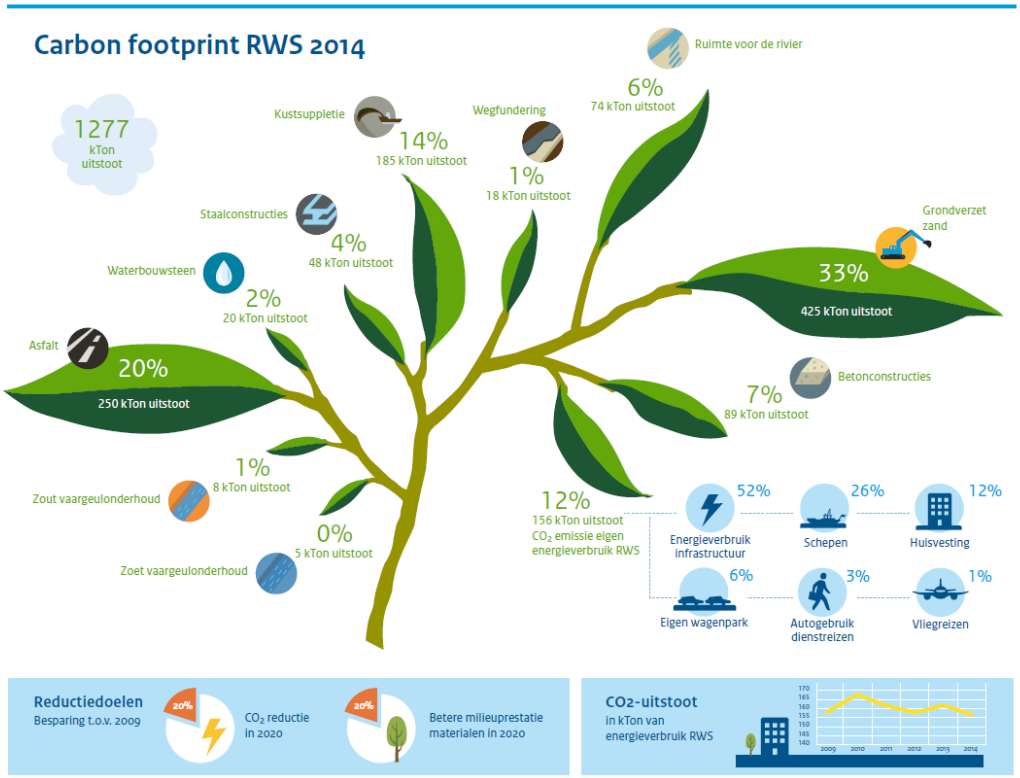


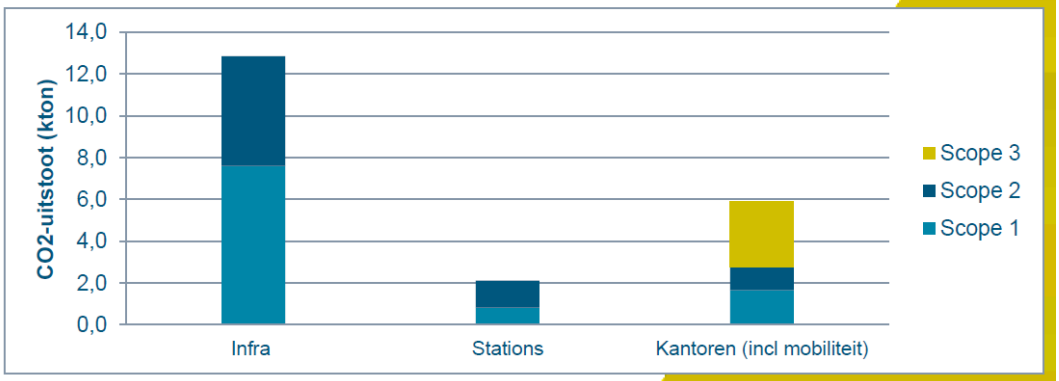
Figure 9 RWS footprint

7.2.2 Prorail

According to 'Emissieinventaris ProRail 2015' [6] the following footprint data is available;

Verdeling CO_2-emissie over kantoren (incl. mobiliteit), stations en infra

Figuur 1 toont de verdeling van de CO_2-emissie naar scope over de kantoren (incl. mobiliteit), stations en infra. Uit de figuur is af te lezen dat de meeste (75%) scope 1-emissie plaatsvindt binnen de infra. Deze emissie is bijna volledig toe te schrijven aan het aardgasverbruik (verbranding + lekkage) van de wisselverwarming. De scope 2-emissie vindt voor 69% plaats binnen de infra (Keyrail heeft een aandeel van 72% van de uitstoot van Infra-scope 2), voor 17% binnen de stations (voornamelijk elektriciteitsverbruik) en voor 14% binnen de kantoren (zakelijke reizen met vliegtuig, internationale treinen, privéauto, warmtevraag en elektriciteitsverbruik). De meegenomen scope 3-emissies zijn geheel kantoorgerelateerd (woon-werk verkeer en uitbestede servers).



Figuur 2: Verdeling CO2-emissie over infra, stations, kantoren naar scope, ProRail 2015.
** Scope 3 is alleen kantoorgerelateerd*

Figure 10 ProRail footprint

7.2.3 Main material suppliers CO2-emissions:

2014 data;
Cement production in the Netherlands = 2,8MtonCO2e/yr
Steel production in the Netherlands = 10,7MtonCO2e/yr

7.2.4 Rijksgebouwendienst

2014 data;
Total RGD carbon footprint in-use = 0,2Mton/yr

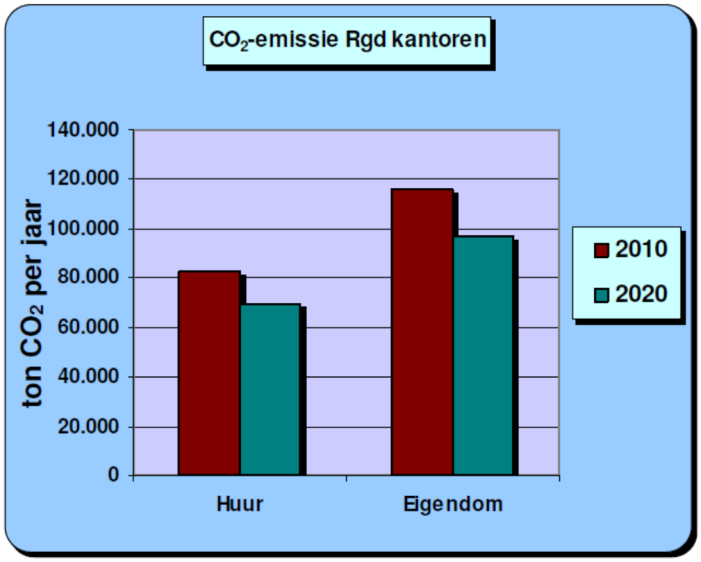


Figure 11 Footprint RGD

7.3 Reduction goals

We have identified the following project measurement that will result in a CO2 reduction downstream in our chain, these comply with the Arup Europe goals;

Measure	Action	By	Year
In at least 50% of the projects with a fee > € 150k there are sustainability objectives set	Monitor through IPP	Project PM	April 2019
Staff sustainability training is 2hr/employee/year	Identify standard training packages for staff	Group leader	April 2019

7.4 Plan

For 2017 we have set the following targets specifically for CO2 reduction downstream in our chain;

- Get involved in at least 1 Infrastructure projects with a sustainability objective to reduce CO2 emissions for our client
- Get involved in at least 2 Building projects with a sustainability objective to reduce CO2 emissions for our client

References

[1] EU Transport GHG: Routes to 2050 II, 29 July 2012

[2] www.ghgprotocol.org

[3] www.wbcsd.org

[4] A SUSTAINABILITY COMPARISON BETWEEN RENOVATION AND NEW BUILD OPTION FOR THE GALECOPPER BRIDGE . Alessandra Villa, Sander den Blanken, Edwin Thie , Arup, London, UK, Arup, Amsterdam, the Netherlands

[5] Duurzaamheidsrapportage Rijkswaterstaat en Duurzaamheid, 2015,

[6] Emissieinventaris ProRail 2015, 15 nov 2016, Finale versie, T&PBE7631R001F001

Appendix B

Reduction

Energy management plan

CO2 Performance Ladder

Sustainability Strategy and Energy Management Plan

Report Ref Energy Management Plan 2014-2017

Rev1 | 24 februari 2017

This report is made for internal purposes. All external communication based on the content of this document needs to be reviwed by communication office and office management. .

Opdracht nummer n.a

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ARUP

Inhoud

1 Introduction

This document helps capturing information critical to management of the carbon footprint of Arup BV. The environmental goals set until 2017 are set in this document based on our CO_2 footprint calculated for 2013 and 2014.

2 Carbon Emission Reduction Goals

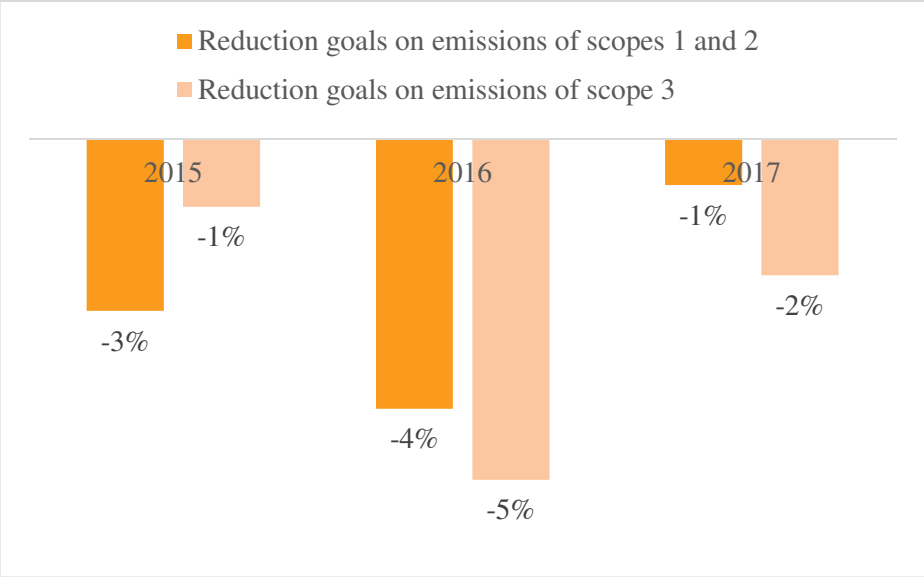
2.1 Introduction

In this section reduction goals are set per scope of emissions. The reference year for the reduction goals is 2013. The reduction goals are given per year until 2017. Unless précised otherwise, the reduction goals are given per employee. If another measure appear to be more relevant as a 'performance indicator' for our carbon emission reduction, we will report this in our 6 monthly performance review.

[Jan 2017] Reference year used is 2014 as mentioned in chapter 3.

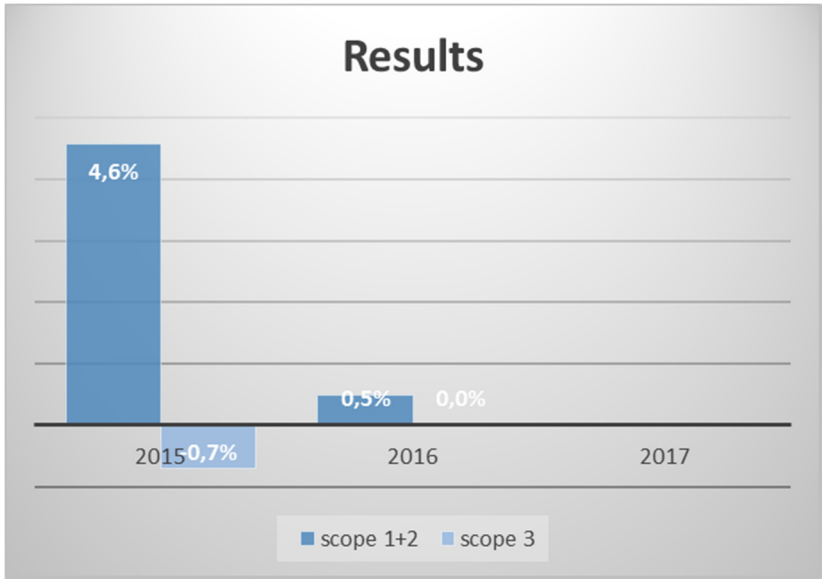
2.2 Reduction goals for scopes 1, 2 and 3 for the business

In the table below the reduction goals for the business are listed (reference year 2013). [Jan 2017] Reference year used is 2014 as mentioned in chapter 3.



Scope 3 in quantitative reduction goals concerns commuting and paper consumption. These are not a requirement under CO2 Performance ladder, but are part of the Arup Sustainability Goals for the Europe region.

[Jan 2017]



2.3 Reduction goals for scopes 1, 2 and 3 for the projects

In the table below our reduction goals for projects are listed. The reference year is 2013 [Jan 2017] Reference year used is 2014 as mentioned in chapter 3.

Scope	Source of emission	Reduction / Improvement goal	Term of realisation	[jan 2017] Result
Scope 1& 2	Business travel in general.	- 3% (related to general reduction of our business travel) - 4% (idem) - 1% (idem)	- In 2015 - In 2016 - In 2017	+4,6% +0,5% -

Scope 3	Projects	- Increasing the internal reviewing, support and financial support to project teams in setting sustainability targets for each project. **10% more projects per year will comply with this target.** [goal is replaced by the below goal in order to comply with Arup European Objectives; 50% of projects with a fee > €150k are setting sustainability objectives] - Use of sustainability assessment tools in early stage of projects identified under most influential the on cutting down carbon emissions. These are Master Planning and Transport planning services in Arup BV.	Per year until 2017	In 2016; 38 projects with fee > € 150k, 22 have indicated to have sustainability objectives, of which have 9 have actual details given in the IPP (Internet Project Plan). This is **24%**
	Projects	Obligatory for all projects that are done under '*CO_2 performance ladder*' requirements. Project specific assessment of life-cycle emissions will be done and potential reduction measures have to be communicated to the client. Tools such as SPeAR can be used. Alternative tools can be used if more relevant to the scope of the project (Dubocalc) when approved by client.	2015	No projects in 2015. In 2016; 1 project 'A16'. CO2 emissions of commute to clients office is monitored. Dubocalc is used on projects A6, A16 and N211. It was also used on a research project to investigate reduction of CO2 by using different materials on bridges.

3 Carbon Footprint Reduction Strategy

To achieve our goals in reducing carbon emission, the following strategies and measures are presented per scope and per category: for the business and the projects.

3.1 Reduction goals for scopes 1, 2 and 3 for the business

The reference year to all quantitative goals is 2014.

Scope	Source of emission	Strategy & measures	Responsible	[jan 2017] Update People
Scope 1	Lease cars	The upcoming Travel Policy in 2015 will introduce new requirements on the energy label of the cars. New incentives will be introduced to offer more flexibility to users, so that more optimal choices can be made under the idea of 'green transportation'.	**Human Resources** Gabrie Rietbergen Gabrie.Rietbergen@arup.com Emma Atkins Emma.atkins@arup.com	**HR** Tamara Gieze
Scope 2	Energy use	- The Energy Management Plan of Arup Netherlands, version 1.1 released in September 2014, defines the measures that will be taken into account to reduce our energy consumption in the facility in Amsterdam. This includes capital investments, operational savings strategies and an awareness plan.	**Office manager** Alexandra van Tintelen Alexandra.van.tintelen@arup.com	**Facility Manager** Leonie de Jong
		- It is unclear whether the current facility for the site office in Groningen will be used after 2014. (See the audit report of the site office in September 2014). Reduction of CO2 emission will be one of the criteria in choosing a new facility / upgrading the current together with health and safety and climate comfort.	**Site Office Manager Groningen** Marcel Damen Marcel.damen@arup.com	**Marcel Damen werkt niet meer voor Arup** Contact; Christha Luppens
	Business air travel	- Incentives to reduce unnecessary air travel. - Upgrading transparency and control in business travel to project leaders to assess the necessity of the travel planned. - Necessity of assessing alternatives to air travel.	Human Resources (see scope 1)	

Scope	Source of emission	Strategy & measures	Responsible	[jan 2017] Update People
		- Awareness plan trough communication of environmental impact of air travel through the future Real-time monitor in the office.		
	Business travel with private cars and public transportation	New Travel Guideline will introduce new measures in creating incentives to promote the use of public transportation for business travel and commuting. The Guideline Policy for the Europe Region will be released in 2015.	Human Resources (see scope 1)	
Scope 3	Commuting	Travel Guideline will create room for incentives to promote 'green' commuting. Encouraging travel by public transportation after analysing needs and possibilities, also to solve the parking capacity problem at the office.	Human Resources (see scope 1)	
	Paper	Introducing printing control by printing only after scan of ID, to reduce forgotten and redundant prints. Awareness campaigns on use and recycling of printing paper. Encouraging use of printed paper as scrap-paper.	Office management (see scope 1)	

3.2 Reduction goals for scopes 1, 2 and 3 for the projects

For projects, the reference year to all quantitative goals is 2014.

Scope	Source of emission	Strategy	Responsible	[jan 2017] Update People
Scope 1& 2	Business travel in general.	- Obligation for project managers to assess need for travels and to study of alternatives. - Communicating to clients our commitment in terms of reducing the travelling done for projects and looking into opportunities to find common grounds/ compromises in this aspect.	Project manager	

Scope	Source of emission	Strategy	Responsible	[jan 2017] Update People
Scope 3	Projects	- Set sustainability targets for projects. The number of projects for which sustainability targets are set, will increase yearly with 10%. - Assess needs within in Arup BV for trainings, tools and expertise to optimise the sustainability of our projects. - Use of sustainability assessment tools in early stage of projects identified under most influential on reducing carbon emissions. These are Master Planning and Transport planning services in Arup Netherlands.	- Sustainability Focus Group and Project Director - Sustainability Focus Group - Sustainability Focus Group	- Project PM and PD - Environmental PM -
	Projects	Draft sustainability reports for all projects that are procured under the 'CO_2 performance ladder'.	Project manager	

4 Energy Management Plan

4.1 Introduction

The energy management plan formalizes the thought process involved in understanding the relative magnitude of energy costs, the possible ways to reduce energy consumption, energy targets that are likely to be achievable, and other associated activities to our business that need to occur such as business travel. While stand-alone energy management projects are satisfying to complete, the energy management plan provides the "big picture" view as an ongoing framework for optimizing overall energy use and achieving success.

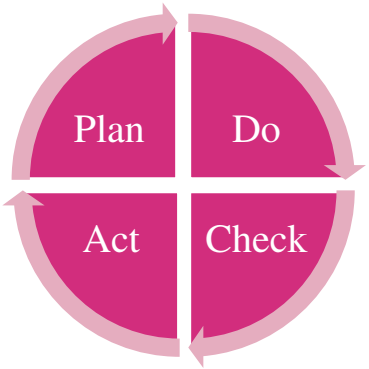
Energy management planning is intended to be a process of "continuous improvement". A closed-loop feedback approach is most effective in demonstrating results that will justify further investment in efficiency. The following diagram shows the circular steps that are recommended for adoption into the planning process:

Plan: Create the energy management plan ensuring budgets, resources, tan timelines for meeting the targets and objectives of the plan. Include tracking and monitoring processes within the plan to ensure effective reporting to management.

Do: Execute the plan by deploying the resources and budgets, preparing status reports, and implementing the communication strategy.

Check: Measure and monitor performance of projects and programs against the desired outcomes as planned and report to management with recommendations for improvements and course corrections

Act: Analyze the variances to the plan and their causes. Recommend improvements, course corrections, and modifications to the plan.



4.2 Background

4.2.1 Operational Boundaries

The energy use that falls under the operational boundaries of Arup BV are:

- Our office in Amsterdam;
- Since September 2013, a site office in Groningen. The site office is operational at the current location until December 2014. A decision will be made by the management team (of the project) whether to stay in the same location depending on the number of employees that has to be accommodated in relation to the capacity and the suitability of the currently rented facility.

For the following sections of the Energy Management plan, as part of our sustainability plan, we focused on our permanent location in Amsterdam which is definitely going to be under our operational boundaries for the coming 3 years which is also the time span of this Sustainability Plan.

Energy management requirements will be set for the site office in Groningen, depending on the progress of the project, until now under 'confidentiality' agreement.

4.2.2 Current state of energy management practice & influential factors

- Our energy management system is based on the measuring devices managed by the building owner/operator.
- HVAC system is centrally set up for the whole building.
- Multiple local/ individual control keys are made available to decrease or increase the temperature by a maximum of plus and minus 4°C.
- The lights are switched on at 06:15h in the morning and switched off at 21.00h.
- The automatic ventilation system switches off at 18.00h.
- All phone devices go on stand-by mode after 18.00h.
- The meeting rooms have sensors and timers that regulate the lighting time. No manual switches are available.
- The security is assigned to switch computers off unless requested otherwise at 21.00h.
- The monitors are not controlled. It is not noticed that a considerable number stays on when users leave the office.
- Most of computer devices are ultra-portable laptops which offer considerable energy savings compared to desktops. (Up to 70%)

- The light in the restrooms is partly centralised. Individual switches are available at each toilet space.
- The main energy consumption channels are:

  Direct:

  - HVAC (Heating, Ventilation and Air-conditioning);
  - Computers and monitors [jan 2017] and servers;
  - IT;
  - Printers;
  - Lighting full office space (light tubes in ceilings)
  - Lighting individual / controllable at desks;
  - Coffee machines;
  - Refrigerators;

  Indirect:

  - Sun /shading are controlled on the two façades with an automatic system of a brise-soleil. Other windows are individually controllable in terms of sun shading or ventilation.
- [Jan 2017] Charge station outside for Hybrid cars

4.2.3 Energy costs per month in euros

Our energy costs are shown in the figure below.

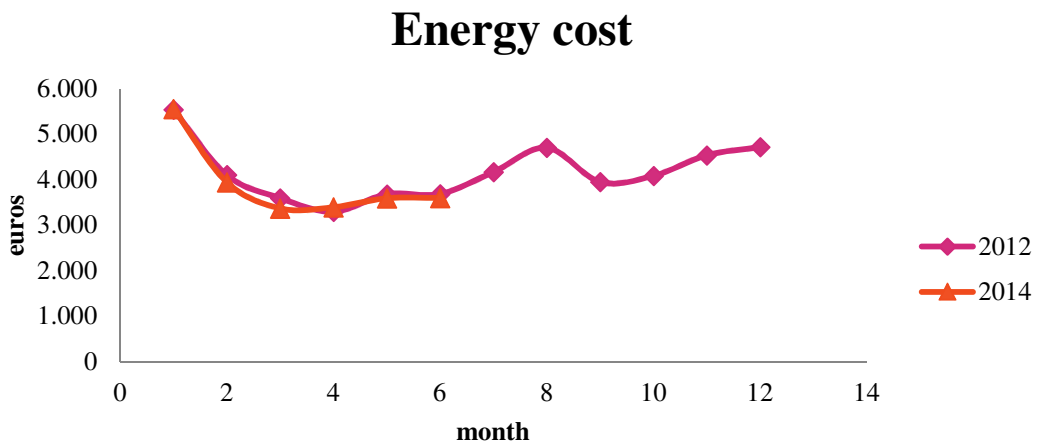


Figure 1 Energy costs

4.2.4 Physical location

The facility is split between the 3rd floor and 1st floor at Naritaweg 118 in Amsterdam. The building is divided into 3 floors plus a ground floor. Each of the floors has two office spaces. Each of the office spaces is divided into two wings.

[jan 2017] Since sept 2016 we occupy the 1st and 3rd floor, we went from 1850m2 to 3000m2.

In total Arup BV occupies:

- Ground floor: Part of the office space in the east wing. [jan 2017] 1st floor: full floor (both wings)
- 3rd floor: the full floor (both wings).

4.2.5 Energy information sources

The information on energy consumption is coming from the following sources

[jan 2017] the landlord supplies us with the energy use of the whole building and by % of occupation the Energy use for Arup is calculated.

1. **Utility invoices**
   The invoices are provided by the building owner according to the rented/ occupied space by Arup BV compared to the whole rentable area. The common space constituted by the stairs, hallways, lift and entrance are shared by all buildings tenants.
2. **Measuring / monitoring systems**
   The measuring system is assigned to each office space. The measuring device is an ABB OD4165 and is accessible by Arup staff as well.
3. **Knowledge and experience of our staff**
   Being a consulting firm in a wide range of services, we count among our staff highly qualified engineers in design of mechanical and electrical systems for buildings and building services. Also, our specialists in climate design and energy efficiency in buildings provide advice to the quality officers and management of the facility. The responsibility of monitoring the energy consumption is assigned to the office management.

4.2.6 Contact information

Office management		**Update [jan 2017]**
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4.2.7 Key (potential) challenges and constraints to achieving energy reduction goals

- The office space was rented on temporary conditions but Arup BV decided staying in this facility for longer than planned. The initial choice was made with this thought in mind. The contract has been renewed for 5 years starting January 2014.
- Long term capital investments are difficult because of the rent conditions and term. However, further investigation of possibilities seems to be worthwhile.
- Our office is situated in a relatively deserted area, especially in in the evening and night. This increases our energy use in contrast to the low occupancy level to ensure our employees the freedom to adjust their environment in a way they feel safe. This usually leads to higher lighting levels than necessary from a pure functional point of view.
- The initial configuration of the electrical system of the building does not allow detailed measuring, and therefore the possibility to monitor specific energy use in order to identify the major consumption activities or devices, is low.
- The interaction between the central control on the HVAC-system and the windows and the locally controllable 8 °C and windows form an inefficient system for climate control in an open office space like ours.

4.3 Energy Management Policy

Arup BV will endeavour through all available means a reduction of 5% of carbon footprint due to energy use by 2017 compared to 2013.

4.4 Energy Management Team

The energy management team is introduced in the table below. The team consists of our employees who will be concerned with achieving the energy policy and reduction ambition of Arup BV. The chair of the energy management team is the infrastructure team leader.

Name	Position	Update Name [jan 2017]
Paul van Horn (chair)	Infrastructure team leader	Sabine Delrue
Alexandra van Tintelen	Office Manager	Leonie de Jong
Ilektra Kouloumpi	Electrical engineer	MEP engineer on call when needed
Peter Mensinga	Leader electrical engineering	MEP engineer on call when needed
Sustainability Focus Group	Consulting engineers of different services in Arup	Edwin Thie (Environmental Champion)
Susheela Sankaram	Lighting designer	Engineer on call when needed

A new set up is in place since mid 2016 to improve the efficiency in the governance of the organisation;

Operations

Director Environmental (DE) = Chair Energy Management Team	Mathew Vola	Sets priorities and goals for the next 3 years Reviews governance policies Discusses with management team for approval of plans and implementation policies Audits if new projects meet the goals set by European board

		Yearly evaluates the goals Reports to Group Leader
Environmental Champion (EC)	Edwin Thie	Researches future scenarios Coordinates if goals meet CO2-prestatieladder Manages implementation of plans Checks governance with sustainability objectives Measures and monitors the effect of plans Analyses measurements Assists PM's of projects won with CO2-prestatieladder Reports to DE

Projects (won with CO2-prestatieladder)

Project Directeur	Includes the EC to review the sustainability objectives Monitors progress on the sustainability objectives
Project Manager	Implementation of sustainability objectives on projects Measures and monitors the objectives and acts accordingly

	Analyses non-conformances and advises PD Reports to EC and PD

4.5 Energy Baseline

In the table and graphs below our energy use for 2013 is explained.

Fuel Source	Total Annual Consumption	Total Annual Cost	Percentage of Total Plant Energy Cost
Electricity	429,114 [kWh]	48.517	68 %
Heating	920 [Gj]	22,650	32%

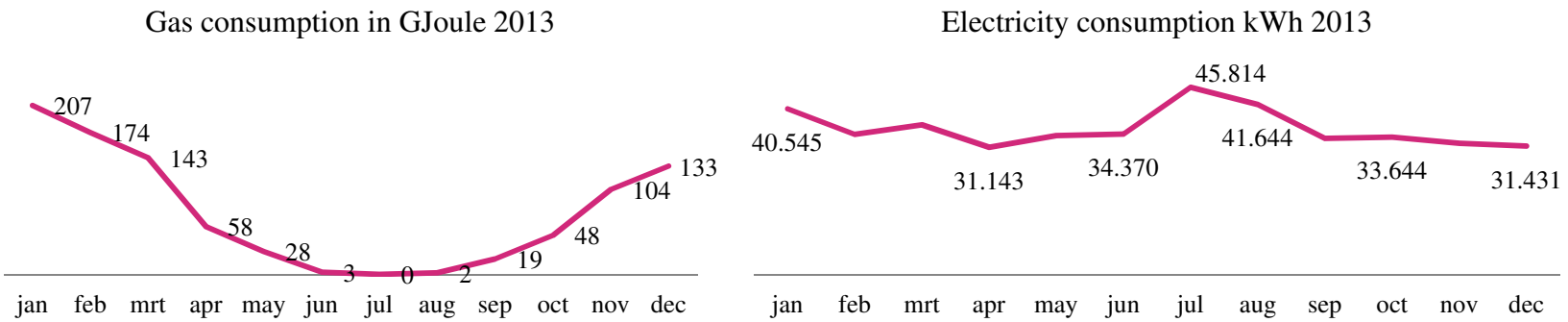


Figure 2 Gas and electricity consumption Amsterdam office

Reduction of electricity use will be targeted since it represents the highest part of our energy use.

4.6 Identified Reduction Capital Projects

System	Measure	Estimated Savings / benefit	Expected date / year implementation	Evaluation performance / extra measuring needed	Update [jan 2017]
Lighting meeting rooms	Increase controllability Change type lights	Decreased use of lighting	*2015*	Reduce use of electricity	Done
Lighting hallways (halogen lamps)	Change type lights	Decreased use of lighting	*2015*	Reduce use of electricity	Landlord doesn't agree
Lighting, desk lamps in the south wing (Philips lamps)	Change intensity to ensure a better comfort level. The lighting is experienced to be too intense.	Decrease use of lighting	*2015*	Reduce use of electricity	Done
Solar panels on roof of Beta building	Survey possibilities in collaboration with landlord.	Increase production of sustainable energy	*2017*	Reduce use of electricity	Landlord is open to collaborate and also investigate green energy
Modification control system facades of the building	Make shading controllable for each unit individually The centralised / automatic use is experienced as causing an uncomfortable climate and leads to unnecessary increase of cooling.	Less cooling necessary	*2016*	Reduce use of electricity	Landlord doesn't agree
Devices to measure use of electricity	Investigate possibilities to install more refined measuring devices	Monitor and track back possibly inefficient use of energy	*2015*	Reduce use of electricity	Has been investigated. The meters in the building are not smart meters, hence not possible.
Lighting in day-light poor areas in the office.	Investigate possibilities to introduce day-light in day-light poor areas in the office.	*Reduce need for lighting*	*2016*	Reduce of use of electricity	Investigated, but Landlord does not accept making holes in the roof.

4.7 Operational Savings and Employee Awareness Plan

4.7.1 Operational savings

Measure	Action	By	Year	Update [jan 2017]
Stimulate staff to switch of lights in meeting rooms and quiet rooms (if no automatic light switch on / off available)	- Attaching posters to wall near door in meeting rooms. - Inform by emails - Inform in group meetings	Office management Energy management team chair Group leader	2015	Email has been sent
Monitors will be switched off by security (unless requested)	- Inform staff - Instruct security	Energy management team chair Office manager	2015	Security informed
Apply minimal limits for office occupancy to avoid redundant energy use	Investigate how to implement.	Office manager	2016	Investigated, but no implementation actions set
Repeat 2014 travel survey	Prepare survey	Office manager	2016	Moved to 2017
More energy efficient company cars, by preference hybrid cars. (+25 % compared to 2013)	Lease car contract renewal based on incentives of new Travel Guideline in combination with company benefit package to relevant grades.	HR / Energy team chair	2015	In 2013; 2 hybrids In 2016; 9 hybrids = +450% Extra charging stations installed
Achieve more use of public transportation for business travel purposes	Find out possible car lease/ business train card possibilities with lease companies, NS- offers in accordance to the Travel Guideline and company benefit package.	HR / Energy team chair	2015	Investigated, but no implementation actions set.

4.7.2 Awareness plan

To increase the awareness of employees the following actions will be taken.

Action	When	By	Update [jan2017]

Employees will be informed on reduction goals, measures, savings and other results (like results of investigations)	In monthly group meeting Ongoing until improved	Group leader	Quarterly update on TV screens in both offices
Switch off monitors in lunch breaks	In monthly group meeting Ongoing until improved	Group leader	Not implemented
Operational saving measures will be announced	2014	Energy team chair	Not implemented
Real-time monitor of daily use of energy will be installed near reception desk	2015	Office manager	Quarterly update on TV screens in both offices

4.8 Action Plan

[jan 2017] see paragraph 4.6 for update

Action	Responsible	Start	Review action progress	Advise / follow-up
Modify lighting of meeting rooms: controllability and type of light	Susheela Sankaram	*Started*	Every two months until end 2015.	Paul van Horn Paul Coughlan
Modify lighting hallways (halogen lamps)	Susheela Sankaram	*Started*	Every two months until end 2015.	Paul van Horn Paul Coughlan
Investigate alternative for desk lamps in the south wing (Philips lamps). Realise higher efficiency.	Susheela Sankaram	*Started*	*Every two months until end 2015.*	Paul van Horn Paul Coughlan
Investigate possibilities of installation of solar panels on roof with landlord.	Alexandra van Tintelen	*2016*	*Every 3 months until July 2016*	Paul van Horn Paul Coughlan
Make the shading controllable for each unit / room individually. The centralised / automatic use is experienced cause uncomfortable climate, which results in unnecessary cooling.	Alexandra van Tintelen	*2016*	*Every 3 months from January 1st 2016 until end of 2016*	Paul van Horn Paul Coughlan

Investigate possibilities for more refined measuring devices to monitor and track-back possible inefficient energy consumption by category of equipment/ use.	Ilektra Kouloumpi	*2015*	*Every 3 months until July 2016*	Paul van Horn Paul Coughlan
Investigating possibilities to introduce day-light in day-light poor areas in the office.	Siegrid Siderius	*2016*	*Every 3 months from January 1st 2016 until end of 2016*	Paul van Horn Paul Coughlan
Survey the comfort experience in the office in terms of lighting, temperature and sun/ day-light. Identify the point of improvement from a comfort point of view	Alexandra van Tintelen / Leonie de Jong	*2015*	*Every two months until end 2015.*	Paul van Horn Paul Coughlan
Analyse results of survey and find possible energy saving targets and measures that match the comfort aspects to motivate collective actions and to view energy management as a pleasant experience instead of a limiting set of rules.	Peter Mensinga / Ouiam Rhersellah	*2015*	*Every two months until end 2015.*	Paul van Horn Paul Coughlan
Investigate how the energy label-improvement can be carried out for lease cars. The personal lease cars, can be improved by use of incentives. However, the main target is the project/ company cars. The renewal of lease contract to low carbon cars is a priority. The request/ measure should be communicated to Finances/ HR in appropriate term before end of current lease contracts.	Paul van Horn	*2015*	*January/ February 2015*	Emma Atkins Paul Coughlan
Find out possible car lease/ business train card possibilities with lease companies, NS- offers in accordance to the Travel Guideline and company benefit package. Communicate these findings to the relevant users of these benefits and services.	Paul van Horn	*2015*	*January/ February 2015*	Emma Atkins Paul Coughlan
Communication of business travel reduction goals to project managers.	Paul van Horn	*2015*	*November 2014*	Paul Coughlan

4.9 Energy Management Education and Training

The Energy Management Team chair and the office manager will follow a one day course on the CO_2 performance ladder or another CO_2 reduction program.

The other members of our energy management team are specialists in their field of expertise. They will be trained as part of their individual training program as determined in the yearly appraisals.

4.10 Expected Results and feasibility reduction goals

4.10.1 Expected feasible outcome of the implemented measures

Based on the measures taken to achieve the defined reduction goals, a study was made based on the reported numbers of 2013 and 2014 on business travel mileage, the records of used transport modes and the energy performance of the available lease cars to estimate the necessary modification for each emission category. The feasibility of the resulting number was discussed some of the Energy Team members to assess the feasibility of the carbon reduction goals, translated into modification of energy consumption aspects/ mileage for business travel.

To achieve the carbon reduction, the following scenario is predicted based on a progressive implementation of the measures mentioned in this report:

The first 3 % reduction on carbon emissions in 2015 is realisable by:

- 10% more of the business travel will be made by public transportation instead of cars.
- By the energy management measures for the office that are expected to realise 3% less energy per capita:
    - The lighting related measures are expected to achieve 2 % on the reduction of energy consumption.
    - Operational savings such occupancy of building and monitor switch off are expected to reduce 1% on the energy consumption per capita.

The second 4 % in 2016/2017 reduction on carbon emissions in 2015 is realisable by:

- Increasing the share of energy efficient cars, assumed herein to be hybrid, by 25% compared to 2013.
- Making the trips Amsterdan-London by train were found not have a large influence on the total footprint. However, a 2 % increase of the trips made de London by train is going to be promoted as part of raising awareness. The feasibility of our reduction goals is not depended on this specific interpretation/ solution for ‘green’ travelling.

At last, the last 1 % reduction on our footprint in 2017 is realisable by:

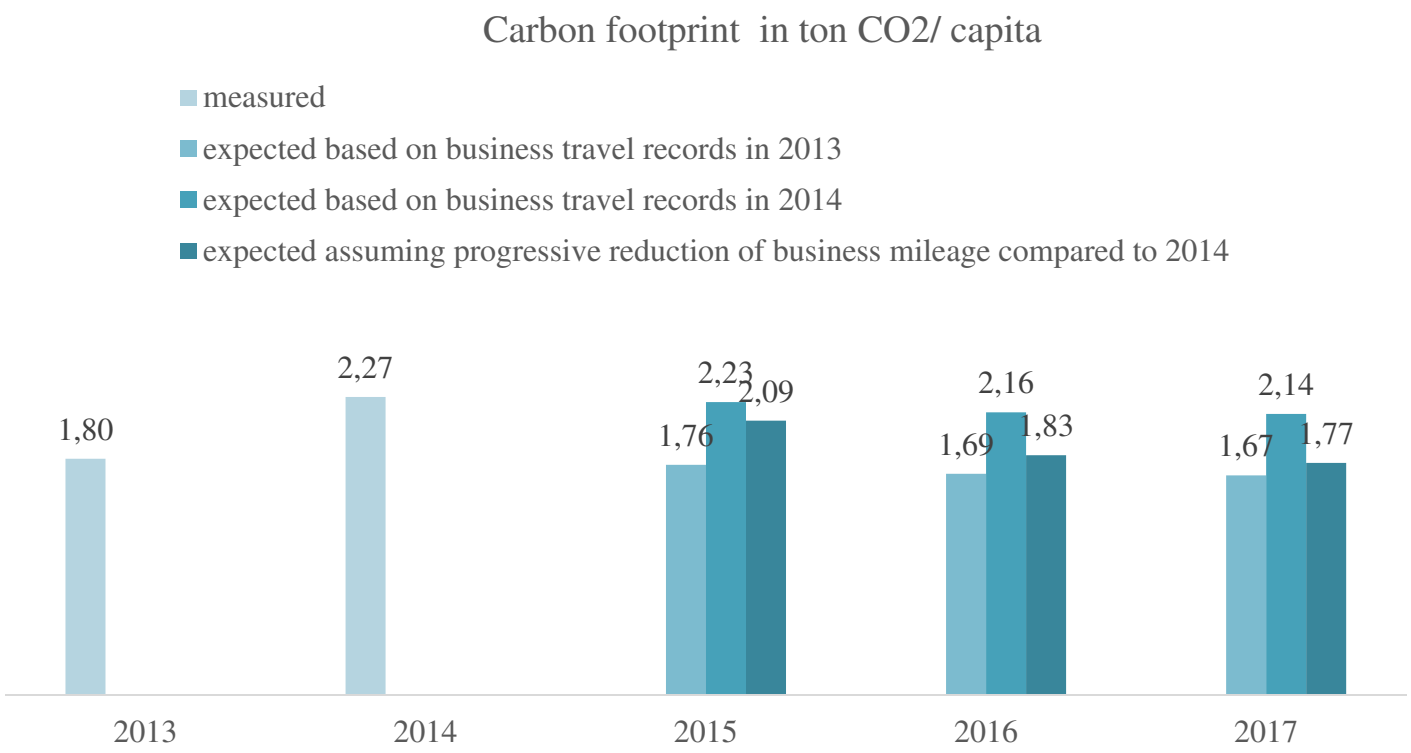
- Having 5% less air travel on the short distance category (700 [km]). The reduction of air travel seems not to be extendable to medium- and long distances since the business benefit and need for it are expected to be already well founded.

The reduction goals on scope 3 emissions of the business, considering paper consumption and commuting, are based on:

- The effect of higher efficiency cars as company/ lease cars. The same outcome of 25 % increase of energy efficient cars is expected to influence the commuting footprint positively.
- A 10% increase on use of public transportation of commuting is expected to be the outcome of increase of multi-mode transport possibilities within the Travel Guideline and the overview of company benefits.

4.10.2 Expected results on global footprint quantities

The results of the measures introduced in this energy management plan, are studies based on two different reference years. We want to be set ambitious goals for our firm, however it seemed difficult to estimate the baseline of our carbon footprint according to which these goals can be set. In 2014, the firm experienced a quick and large growth which has influenced our carbon footprint and specifically the business travel. We expect that the carbon footprint / capita will change after 2014 and converge to ones recorded in 2013 due to decrease in need for site inspection and business travel. Therefore it seemed unrealistic to based our reduction measures based on this year. As a solution, the goals are to achieve a decreasing trend in our carbon footprint over the coming years with the given reduction goals to achieve a 1,8 ton CO_2/ capita by 2017, which is constitutes an ambitious targets for our sector of practice. The Arup Global Sustainability target of 3 ton/ employee (including commuting) seems still out of reach in 2017. Arup Global has set the target to be met in April 2019.



[jan 2017] update; scope 1+2;

Correction on reference year in 2014, due to change in CO2 conversion factors by date 1-6-2016 and correction on heating in Groningen office;

2014 = 2,40 tCO2/employee

Target based on reduction goals;

2015 = -3% = 2,33 tCO2/employee

2016 = -4% = 2,23 tCO2/employee

2017 = -1% = 2.21 tCO2/employee

Actual:

2015 = 2,51 tCO2/employee (= + 4,6% on 2014 and + 7,7 on target)

2016 = 2,52 tCO2/employee (= + 0,4% on 2015 and +13,0% on target)

Mainly due to the internal move to more m2 per employee our electricity use has gone up compared to the original target.

The Arup goal of 3,0 tCO2/employee, including commuting (scope 3);

2014 = 3,54 tCO2/employee (including correction for new CO2 ladder version 3.0 and adjustment on heating for Groningen office)

2015 = 3,51 tCO2/employee (= + 17,0% on target Arup)

2016 = 3,47 tCO2/employee (= + 15,7% on target Arup)

To meet the targets set in this report, some rigorous actions need to be taken in 2017. See 'Management actions to reach operational CO2 targets_ Q1 2017 v0.1.docx' for further actions.

4.11 Energy Management Plan Document Maintenance

This energy management plan will be maintained by the energy management team [jan 2017] Environmental Champion under responsibility of the team chair [jan 2017] Environmental Champion. The plan will be evaluated yearly and updated if necessary.

[jan 2017] see updates throughout the plan in this format (Pink, with [date]). See 'Management actions to reach operational CO2 targets_ Q1 2017 v0.1.docx' for further actions in 2017. A new plan will be drafted in 2017 for the goals in period 2018-2020.

4.12 Project savings

We have identified the following project measurement that will result in a CO2 reduction downstream in our scope 3, these comply with the Arup Europe goals;

Measure	Action	By	Year
In at least 50% of the projects with a fee > € 150k there are sustainability objectives set	Monitor through IPP	Project PM	April 2019
Staff sustainability training is 2hr/employee/year	Identify standard training packages for staff	Group leader	April 2019

Appendix C

Transparency

Communication plan

Arup

CO2-prestatie ladder

Communication plan

Issue | 4 september 2017

Opdracht nummer

Arup bv
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ARUP

Inhoud

1 Introduction

In this document Arup Netherlands shares its communication plan for the period 2016-2017 within the frame of our sustainability strategy and the CO_2 - Performance ladder. This document is an update of the original plan from 2014.

Arup uses both internal and external channels to communicate the implementation of the CO2-performance ladder. The communication strategy is based on quarterly CO_2-performance updates, half yearly awareness weeks and yearly CO2-target updates.

Yearly calendar:

	Internal				External	
Period	**CO_2-ladder**		**CO_2-awareness**			
	Topic	Method	Topic	Method	Topic	Method
Q1	Update CO_2-performance	Screens			Information websites	Arup site + SKAO
Q2	Update CO_2-performance	Screens + intranet	How we shape a better world-week	Report + lunchlecture		
Q3	Update CO_2-performance	Screens				
Q4	Update CO_2-performance	Screens + intranet	Sustainability -week	Campaign + lunchlecture		

Figure 1 Yearly communication calender

2 Communication strategy

2.1 Target groups

	Target Group
Internal	• Employees • Project managers • Cost Centre Leaders • Management team
External	• Arup Global and Arup companies • Clients: public and private sector • Sector / network associations and knowledge exchange platforms: NLingenieurs, KiviNiria, etc. • SKAO “Stichting Klimaatvriendelijk Aanbesteden en Ondernemen: • Project partners: architects and engineering firms • Students and potential employees •

2.2 Content per Target Group

In the table below we explain the content of communication for each target group:

Target group	Content of communication
General	• Reduction target and progress of Arup BV in meeting these targets
Internal	• Actual footprint, reduction goals and measures to be taken to reduce emissions • Measured progress in reducing emissions • Expected / measured environmental performance of relevant projects • CO_2 Performance ladder requirements and reporting procedures • IPP "Internet Project Plans" (if procurement under CO2-performance ladder)
Arup Global and Arup companies	• Progress of Arup Netherlands in complying with Arup Regional and Global sustainability strategy and plans. • Progress of Arup BV in meeting reduction goals • Participation in setting new goals and feedback about results of locally implemented strategies.
Clients, Sector and knowledge exchange platform	• Carbon footprint, reduction targets and measures (to be) taken. • Progress in meeting reduction targets • Our measures and visions about a collaborative progress towards more sustainable designs
SKAO	• Documents and links required according to certified level requirements of CO2-performance ladder • Valid certificates
Partners and clients	• Continuous reporting on design propositions, feasibility studies and decisions to increase the sustainability outcome of a project

3 Internal communication channels

Arup uses multiple channels to convey information on the CO_2-performance ladder to employees.

3.1 TV-screens

Overviews of our CO2-footprint and our main emissions sources are shared by means of quarterly updates on internal tv screens at the coffee machines. Also important updates on the participation in the CO_2-performance ladder are communicated.

3.2 HWSAB-report

The yearly 'How We Shape A Better World'-report communicates the CO_2-performance of our office with our employees, clients and partners. Furthermore, it gives an overview of our most sustainable projects, on the basis of our

sustainability framework, and our sustainable initiatives. The report is shared on our intranet page.

3.3 Lunchlectures

Lunchlectures for all staff are organized to increase the awareness of employees on sustainable developments and our CO_2-performance.

4 External communication

4.1 Website Arup Netherlands

Arup communicates our participation in the CO_2-performance ladder system via the website of Arup Netherlands. The link towards the CO_2-information has a prominent position on our homepage.

http://www.arup.com/global_locations/netherlands

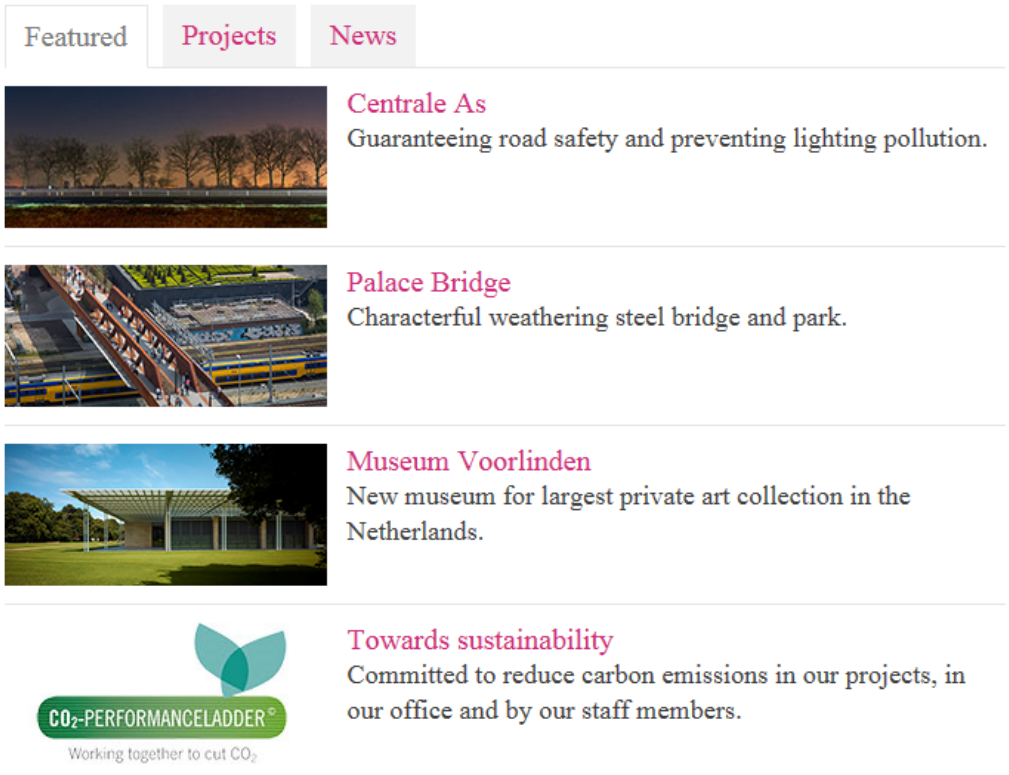

Figure 2 Printscreen of the Arup Netherlands homepage, taken on 2-5-2017. http://www.arup.com/global_locations/netherlands

4.2 SKAO

On the SKAO Arup b.v. shares the information according to the requirements of the audit checklist. The information stays available on the website for at least 2 years. Arup is listed on the website of SKAO as a level 5 certified company.

http://www.skao.nl/gecertificeerde-bedrijven?id=69

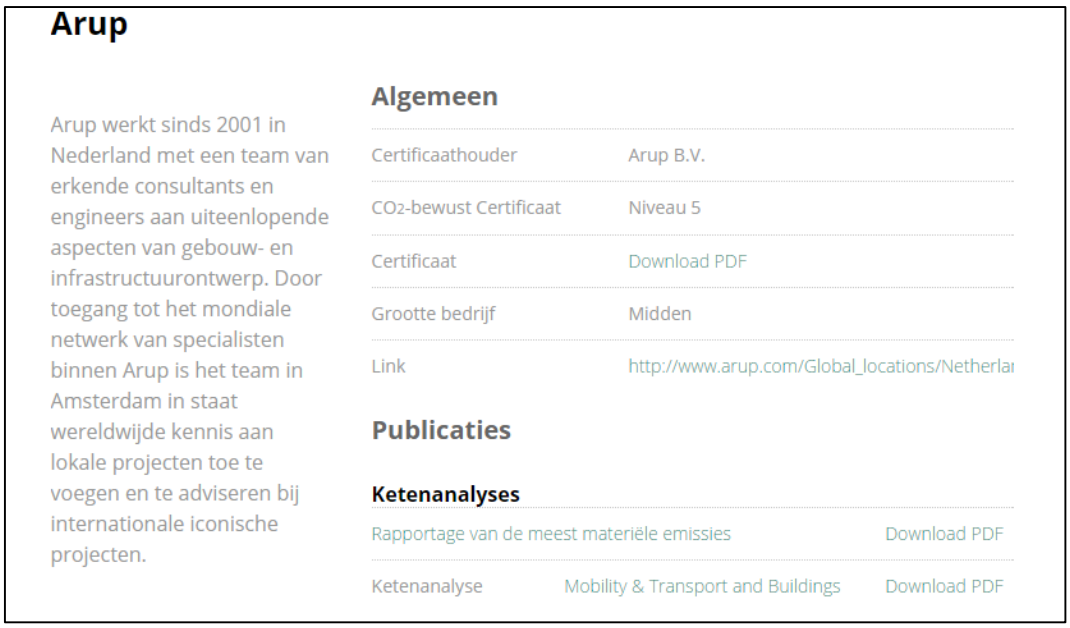

Figure 3 Arup information on the SKAO website (obtained on 05/05/2017)

Appendix D

Participation

Participation plan

Arup

CO2-performance ladder

Participation plan

Issue | 4 september 2017

Opdracht nummer

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ARUP

Inhoud

1 Introduction

As part of our sustainability strategy Arup b.v. is committed to the active participation in initiatives in the field of CO_2-reduction. This involves performing in-house research and employing partnerships with academic and industry partners.

2 In-house research

Arup has a wide range of in-house research projects, which resonate with our sustainable objectives. Some projects in which Arup b.v. is involved are outlined below.

2.1 Cyclist research

The team of Transport planning in Arup Netherlands is active in researching ways to improve the approach to design and modelling of different transport modes. Encouraging multi-modal transport and increasing the share of low-carbon transport modes are focus points. Our transport planning team works to improve infrastructure for pedestrians and cyclists. Despite the great share of cycling in the urban mobility in the Netherlands, little is known about the real behaviour and route choice of cyclists. In major cities, cyclist traffic jams occur frequently. The purpose of this research is to measure and quantify design parameters that are so far lacking in current models.

Contact: Thomas Paul

2.2 Delivering Green Infrastructure

Delivering Green Infrastructure Along Linear Assets

Strategic transport, water and energy assets provide opportunities for multi-functional green infrastructure networks, to enhance asset resilience and performance and secure social, environmental and economic outcomes. The research aims to identify, share and advise on the critical success factors for mainstreaming the delivery of green infrastructure along linear assets, learning from international case studies and applications and paramount comfort levels.

Contact: Hannah Wright *(IiA 15639)*

2.3 Approaches to health and well-being

How effectively do built environment interventions contribute to healthier cities? This research aims to facilitate evaluation and ultimately better health planning, by identifying effective approaches to addressing health and wellbeing planning priorities. It focusses on the successes, challenges and areas of improvement of project “follow up” in Amsterdam, London and Perth cases.

Contact: Ikumi Nakanishi *(IiA 14082)*

3 Initiatives

Arup b.v. participates in a number of initiatives aiming to reduce CO2-emissions.

3.1 Ecodistr-ICT project

As an example, our Masterplanning team continues work on the European Commission's FP7 Ecodistr-ICT project. This projects aims to develop an open-source tool to support decision making in retrofitting and renewal projects of districts and their constituent buildings. The team is also involved in a research project for the Dutch Ministry of Transport to develop a more progressive approach to infrastructure design that will take into account a broader approach to health and quality of life.

http://www.arup.com/projects/fp7_ecodistr-ict

Contact: Laurens Tait

3.2 Dutch Windwheel

Arup joined the innovation consortium for the realisation of the Dutch Wind Wheel. This 174-meter high building will be an icon of sustainability for Rotterdam; a true game changer for sustainable development. With our multidisciplinary team, we are examining how the ambitions for sustainability can be translated into a building through the application of advanced and efficient technological solutions.

http://www.arup.com/news/2016_12_december/02_december_dutch_windwheel_collaboration_agreement_signed

Contact: Filique Nijenmanting

3.3 Memberships

- Arup is a member of the Sustainability Committee TC1 of the Dutch Steel Association
- Participant of the Dutch Green Building Council (DGBC).

Top: Credit Thomas Graham
Left: City scape of London
Right: London park
Below: Credit Charles Aydlett