Climate-KIC **Innovation**

Decision Support Model (TCO) for Transition to Zero Emission Bus Transportation: Utrecht, Schiphol, London and Valencia. (DSM-TCO)

Pathfinder full proposal

30-1-2013

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1 PROJECT TEASER

Project Name	Decision Support Model (TCO) for Transition to Zero Emission Bus Transportation: Utrecht, Schiphol, London and Valencia. (DSM-TCO)
Challenge Platform(s)	Sustainable City Systems
Expected project duration	01/03/2013 – 01/03/2014 (12 months)
Lead partner (institution)	TU Delft
Project lead (name, mail)	Michiel Ytsma m.m.ytsma@tudelft.nl and Tineke de Vries tdv@tg.nl
Project type	Pathfinder
Total EIT request Euro (a)	210.000
Own Co-funding Euro (b)	
Total KAVA Euro (a)+(b)	210.000
Complementary funding	850.000

1.1 Concept

In order to achieve sustainable (public) transport systems, insight in total costs of zero emission bus transportation systems are required. A standardized European decision support model for investments (Total Cost of Ownership model) supports policy and investment decisions in the transition towards zero emission bus transportation systems. In this pathfinder project a standardized TCO model will be designed based on analysis of existing TCO models. And experiences with end-users that test and further develop the model in their project context are added. The TCO model provides an objective and comprehensive insight in cost and benefits. This includes societal costs and benefits and allows for economic comparison of conventional bus transportation systems to electric bus transportation systems.

The main goal of the project is to design a standardized decision support tool for transitions from traditional public bus transportation to zero emission bus transportation. The project will build upon general knowledge in the market and academia on TCO and is going to make tailor made TCO's for four cases in the UK, Spain and the Netherlands. This will be done with the purpose to test and refine the model and to demonstrate how it supports local decision making in different stages of the decision making process. The different stages in this pathfinder are: Ambition in Castelló (Greenfield), Planning procurement in Utrecht and London (almost mature) and Investment and Implementation at Schiphol Airport (Mature).

1.2 Climate and air quality relevance

Fossil fueled bus transportation systems are a major source of CO_2 emission. Within these systems, diesel fueled buses drive many millions of kilometers per day throughout the European Union with energy inefficient internal combustion engines. This results in huge quantities of emitted CO_2 and other pollutants such as particulate matter and NOx. Therefore, the transition towards zero emission bus transportation systems in Europe is important for two main reasons:

1. contributing to the improvement of air quality in urban areas;
2. contributing to a substantial lowering of CO_2 emissions.

Due to better insight in the total cost of ownership of zero emission buses and required energy infrastructure, the benefits and disadvantages of zero emission bus transport will be clearer. Moreover investment decisions can be made based upon transparent information. Therefore, the TCO model can support the decision making process in favour of zero emission buses and hence can contribute to an acceleration of the transition to zero emission bus transportation systems in Europe.

1.3 Demand

Due to significant higher purchase prices for zero emission buses as compared to diesel buses, the assumption is made that costs for this innovation are high. The financial benefits that zero emission buses brings during (a significantly longer) lifetime than current diesel buses is not clear. For instance, lower operation costs due to lower maintenance and energy costs are often not taken into account. Also, the climate and health care benefits are often not accounted for as a cost of diesel buses and a benefit of electric buses. A TCO model can provide insight in these matters.

Hence, there is need for a broadly accepted and standardized TCO model on different scale levels that governments and other end-users of buses can use for policy strategies concerning air quality and sustainability issues. They can also use the model to support investment decisions. Public Transport Authorities or Operators can use the model not only for investment decisions but also for the purpose of optimizing their procurement processes. Several end-users, like the Province of Utrecht, Schiphol and Transport for London (TfL), have already expressed their interest in such a model and are therefore partner in this pathfinder.

At this moment the Zero Emission Bus foundation has started a project in which a generally accepted TCO model is being developed. All potential end users of this model (national government, Public Transport Authorities, Public Transport Operators, Original Equipment Manufacturers provide information for this model.

The first developed model consist of four columns, containing information and calculations on (see figure 1 on page 9):

- Vehicle
- Energy and emissions
- Business models (e.g. concession contracts)
- Social costs and benefits

With this decision support model, conventional and zero emission buses can be objectively compared. Both the province of Utrecht (Public Transport Authority) and Schiphol airport have indicated to be willing to pay for such a model once it is on the market.

- Exploitation plan:

The final product of this pathfinder project is a standardized EU Total Cost of Ownership model that can be used by decision makers in the value chain of public bus transportation systems. The model is tested and designed with end-users in different stages of the investment decision process. The EU TCO model will be brought to market by strategic consultancy companies as a modeling tool for consulting PTA's and other types of end-users. Affiliate Climate-KIC partner Twynstra Gudde is a partner in this project because it sees a market for this model in its consultancy practice. Moreover, end-users (Schiphol, Province of Utrecht, Transport for London and the city of Castellón) are active partners in this pathfinder project because they desire its end product.

- Innovativeness:

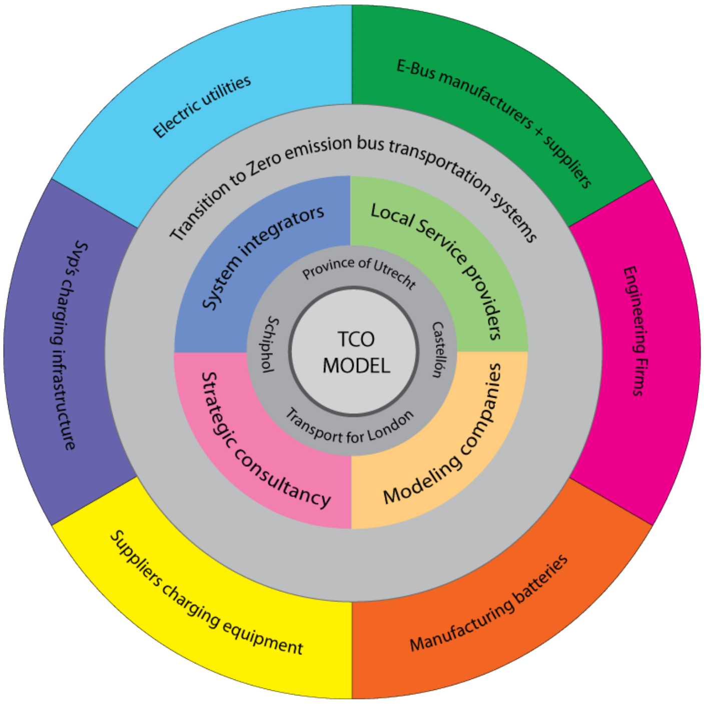
The key obstacles in transitions to electric- or zero emission bus transportation systems are no longer in technology but are grounded in the decision making process. There is not enough reliable data on the costs and benefits of running an electric bus fleet that allows for an objective comparison with conventionally fueled bus systems. This is causing uncertainties and that delays decisions on introducing new systems. A decision support tool for transitions to zero emission bus transportation systems is not on the market yet.

This Pathfinder will be the first to bridge this gap between technology and information in the decision making process.

Overview

Objective Design a standard TCO model that facilitates local transitions to Electric Public Bus Transportation. The TCO model is a decision support tool for decision makers and end users and facilitates transitions by redesigning the value chain of public bus transportation.

Fase	Analyze and develop	Test and refine:	Conceptualize	Scale up
Output	1. Analysis of TCO models 2. Tailormade TCO models for 4 cases	3. Tailor made TCO; - Case 1 Utrecht - Case 2 Schiphol - Case 3 London - Case 4 Spain	4. Design standard TCO model 5. Concluding report	6. Proposal for inno-vation project scale up implementation
Fase	Analyze and develop	Test and refine:	Conceptualize	Scale up
Activities	1. Analyze market for TCO models content and variables. 2. Design tailor made TCO's.	3. Apply TCO model per case, analayze data, compare, learn and refine.	4. Design standard TCO model 5. Concluding workshop and .report	6. Write exploitation plan and innovation proposal to scale up.



Main tangible outputs

- Analysis (market and academic) TCO models
- Tailor made TCO model for 4 cases (i.e. end users)
- Tested and Refined TCO models with end-users (4)
- Standardized TCO model supporting decision making on transitions to Zero Emission Bus Transportation.
- Concluding project partner workshop and report
- Proposal for Innovation project to scale up

KIC Partners[1]	Role in project and competences
TU Delft	✓ Academic Analysis of TCO Models and Variables. ✓ Research and development of the TCO model (including customizing TCO for cases), comparing data and variables, consumer behavioural aspects. ✓ Analysing institutional barriers to the inclusion of zero emission buses in public tenders. Analyses of Schiphol case. ➢ Joint project management with Twynstra Gudde. ➢ First contact for the climate-KIC.
Twynstra Gudde	Market Analysis of TCO Models, develop standardized TCO Model. Joint project management with the TU Delft.
Province Utrecht	Climate-KIC partner and responsible for a phased pilot of 28 buses in the city of Amersfoort. The province of Utrecht, in cooperation with the Taskforce Innovation and the TU Delft will gather and provide the data of this pilot.
Schiphol	In Q1 of 2013 Schiphol Airport is procuring an electric bus fleet for airside transportation of passengers. Schiphol will make relevant data of the procurement process available to the project team. The TCO model will be uses in the Schiphol case for comparing the outcome to their own procurement process, to evaluate learning opportunities and to improve their life-cycle cost analysis used in the procurement process.
ITE	The Energy Technological Institute is a research centre in Valencia involved in several projects regarding electro mobility and also in other fields of the energy world. ITE will use the TCO model to convince policy- and decision makers to invest in electric bus transportation systems. ITE will analyse the Castellón case together with the municipality.
Institute for Sustainability (IFS)	The Institute for Sustainability will perform a comparative TCO analysis of two electric buses purchased by the Transport for London (TfL) with London's diesel-electric hybrid fleet and hydrogen-fuelled buses, and projections for future markets.
Other involved actors	
ZEB foundation	ZEB has developed a tool for TCO calculations. ZEB will make this knowledge available with the purpose for the project to be used and build upon. In the end phase the ZEB foundation is going to market the findings and results from this European project within their supporters/founders. Note that ZEB is a networking organisation and has no budget of its own to spend on this transition.
Taskforce Innovation (TFI)	TFI will lead the case in Utrecht and perform the data research (together with the province of Utrecht and the TU Delft) and analyses (together with the TU Delft) of the Utrecht/Amersfoort location. TFI will use the TCO model to facilitate the implementation of the first four electric buses for Utrecht in Amersfoort.
Transport for London (TfL)	The Transport for London will use the TCO model to facilitate the implementation of 2 electric buses and to learn from this pilot and model in order to make policy decisions in the future.
Municipality of Castellón	The Municipality of Castellón is highly focused on the energy question and a new transport system for the City. They have recent experience using hybrid diesel-electric buses as a new transport system for the City. The Municipality is therefore very interested to have their situation analysed, also in order to support decision making in the future and to examine the feasibility of zero emission bus transportation.

[1] All institutions listed in the Partner section must be either KIC Partners or in the process of becoming KIC partners.

2 THE PROPOSITION

2.1 Problem and climate relevance

The negative impacts of mobility on our energy consumption and climate are a major societal concern. The transport sector is a large consumer of our fossil fuels and responsible for enormous emissions of CO_2 and particulate matter. In terms of global total emissions the contribution of buses to the pollution is small (about 1%) compared to passenger cars and trucks, but from a local perspective their impact is significant. Typically buses are used in urban (dense populated) regions, and these regions have the most urgent challenge to improve air quality. Improving the environmental performance of the current bus system, that is dominated by diesel buses, is therefore a major interest to urban authorities.

Among alternative fuels and drive trains, the electric bus can offer the best environmental performance, since it is a zero emission solution. Estimations indicate that an electric bus can save 500 tons CO_2 emission compared to a diesel bus on annual base. The fact that zero emission buses run on electric energy instead of fossil fuels also introduces an option to further enhance sustainability in the energy chain. These types of transportation systems are very suitable for using regional generated sustainable energy. When this is achieved (smart grid implementation required) a truly sustainable public transport system emerges.

Although the environmental benefits of electric buses are beyond doubt, its implementation into the market appears to be a very difficult process. The number of electric buses in operation is still marginal. For example, in The Netherlands the share of electric buses in the total bus fleet has remained less than 1% since 2009.

A major explanation for the fact that bus transport service providers are very reserved to operate electric buses is the perception that electric buses cannot be cost competitive to conventional diesel buses. It is true that the existing technology of electric buses involves higher investment costs. In addition, the large weight and space of the batteries limit the carrying capacity of electric buses, which potentially reduces revenues. Moreover, range limitations are assumed to increase operation costs, since electric buses may need to charge or swap their batteries in between the bus transport services. However, fuel and maintenance costs are expected to be lower than for conventional buses.

The balance of these factors on the operation costs of electric buses is still unclear and hence the competitiveness of electric buses to diesel buses are difficult to assess. Firstly, it requires insights in the **actual level of costs** of operating an electric bus. Secondly, and probably more crucial, the **conditions** under which an electric bus can be operated have to be taken into account. For example, electric buses are not sensitive to further tightening of European emission guidelines (current Euro 5, Euro 6 next year). Therefore, these buses can be used for their technical lifespan which can be up to 2,5 times longer than current use in public transport concessions. From extensive experience with electrical trolley buses in the Netherlands we know that buses and electric drive lines can easily function over a period of 16 years.

Up to now, there is a lack of knowledge about the actual costs of operating electric buses as well as the operational conditions for electric buses, which creates uncertainty about the cost competitiveness of electric buses. These circumstances make bus transport service providers hesitant or even reluctant to switch to electric buses. Hence, they cause a barrier for wider implementation of these buses.

On the other hand there are five main reasons why the public transport sector currently is a great starting point for the transition to electrification in the transportation sector:

1. Public transport buses generally run a fixed schedule with regular stops and dedicated lines. Therefore, these buses are able to charge or change the batteries at prefixed intervals.
2. In most cases public transport is tendered by local/regional public transport authorities. These tender procedures can be used to demand the phase-in of zero emission buses during concession periods.

3. The industry is rapidly increasing energy density in batteries, resulting in increasing range (250 km is achievable) on single charges and electric buses powered by hydrogen fuel cell technology are technically available.
4. Zero emission buses make use of an electric drive train instead of internal combustion engines. The energy efficiency of electric drive trains is substantially higher (80 – 90%) than the energy efficiency of internal combustion engines (15 – 25%)
5. Due to the fact that zero emission buses use electric energy, the option for combining these buses with regional decentralized generated sustainable energy (e.g. wind, sun, biomass) is feasible, resulting in a truly sustainable public transport system.

The 2011 European white paper on the transport system pointed to the large potential of passenger transport in realizing the necessary CO_2 reductions. Public transport buses are responsible for significant carbon emissions and local air pollutions and the white paper therefore argues that bus fleets "*are particularly suitable for the introduction of alternative propulsion systems and fuels. These could make a substantial contribution in reducing the carbon intensity of urban transport while providing a test bed for new technologies and opportunity for early market deployment*" [2]

2.2 Objective Project: route to solution

The specific objective of this proposal is to explore the costs, benefits and cost effectiveness of a transition to a zero- emission bus transportation system. Together with the end users we will develop and validate a tailored Total Cost of Ownership model for zero emission public buses and bases upon the experiences in these cases we will design a standardized European TCO model.

We will use the state of the art thinking on TCO modeling as developed by the ZEB foundation and the rest of the market and academia. The ZEB foundation TCO model for transportation is built upon four pillars (see the figure on the following page 9):

1. vehicle
2. energy and energy infrastructure
3. business models
4. societal effects (CO2 reduction, public health, air quality etc)

This model will be further developed on the basis of the general analyses and with end-users in the Netherlands, UK and Spain within their own specific local context. We selected partners that are currently in different stages of the decision making process (Greenfield, almost mature and mature). 'Greenfield' being in the stage of ambition development (Case Catellón), 'almost mature' being in a stage of planning (Province Utrecht and Transport for London), 'mature' being in the stage of procurement, investment and implementation (Schiphol airport). Using and comparing cases in different stages and countries will contribute to the quality of the European TCO model and the 'richness' of the data behind it. By doing this we will find out which of the variables in the pillars are more relevant than others, are context specific or are crucial in all circumstances and locations.

The output of the cases with end-users will be used as input for a standardized European TCO model that helps end-users to connect 'hard costs' related to procurement and operations to 'soft costs'. This enables improvement of the business case for zero emission bus transportation systems and to allocate finance and budgets from the public health, sustainability and innovation sectors.

[2] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0144:FIN:EN:PDF page 8, recommendation 32.

2.3 Output

1. Analysis of TCO models (Foundation ZEB, market and academia)
2. Tailor made TCO model per case (total of 4)
3. Tested and validated TCO model with end-users (total 4)
4. Standardized European TCO Model for zero emission bus transportation
5. Concluding workshop and report
6. Proposal for innovation project for up scaling.

2.3.1 Output 1 Analysis of TCO models (Foundation ZEB, market and academia)

The first output of this pathfinder project is an analysis of existing TCO models. This output starts with an inventory of the models in the market and the most important scientific articles about this subject. It is important to learn from the state of the art, but we limit ourselves to the most important models in the market and the main scientific research on this topic.
In order to deliver this output we take the Zero Emission Bus Foundations model as a starting point, which is available for the project as complementary knowledge and runs in a software program. The following figure shows the general framework. The market and academic inventory will adjust this model and on the basis of this, the researchers in this project can also choose to focus on several of the variables within this model.

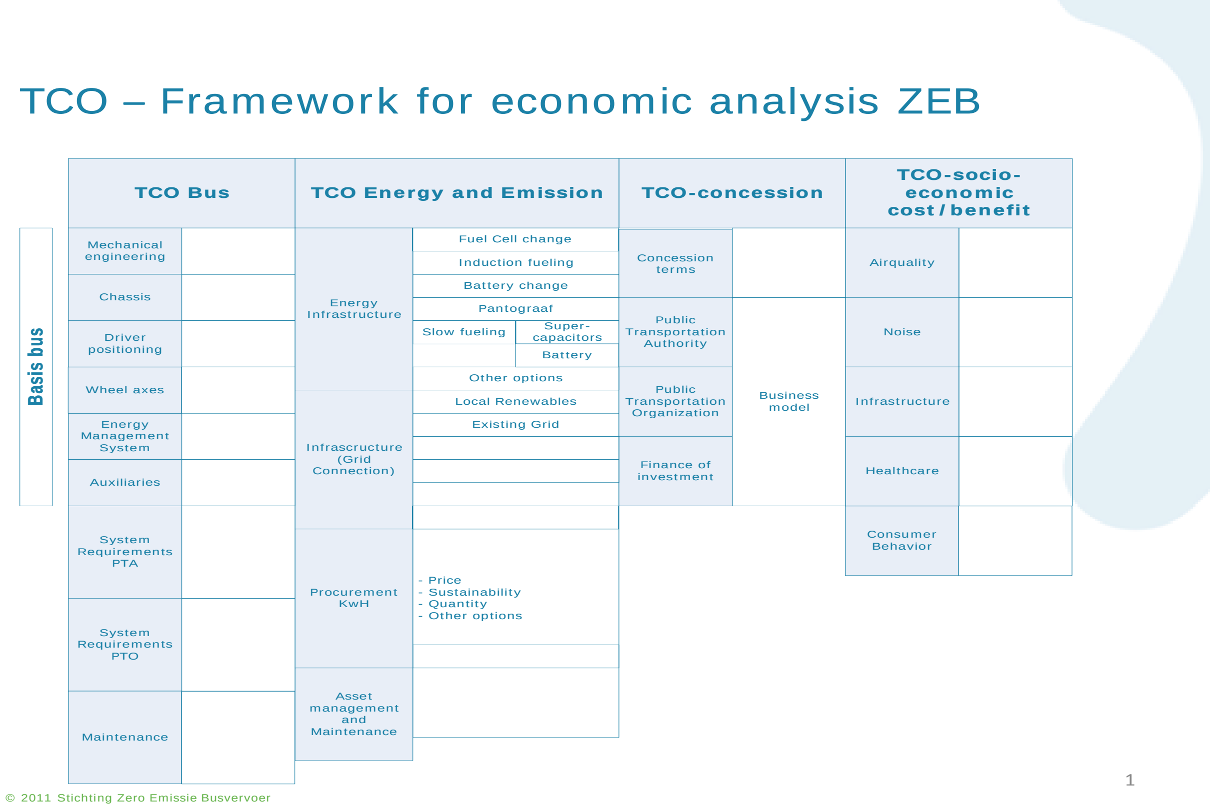


Figure 1: Framework Zero Emission Bus Foundation

2.3.2 Output 2: Tailor made TCO model per case (Schiphol, Utrecht, London, Castellón)

The total cost of ownership for zero emission buses is different for each situation, caused by the complex interplay of the combination of variables. The standardized TCO-model will be customized for the 4 cases in different countries and different stages of the decision making process on zero emission bus transportation. For each of the cases tailor made TCO models will be designed relevant to the specific context. These tailor made models will be based upon output 1: an further developed TCO framework for zero emission bus transportation.

2.3.3 Output 3: Tested and validated TCO model per case

The four cases will test the TCO model in their own project context by filling the TCO model with their own project data and by analyzing the outcome. The partners running the cases will help with their experience to refine the models and understand the variables and how they interact.

2.3.4 Output 4: Standardized European TCO model

Based upon the experiences end test results in the four cases a standardized TCO model is designed together with the partners and end-users participating in the test-cases.

2.3.5 Output 5: Concluding Workshop and report

A workshop will be held with the partners in the 4 cases to finalize the standardized TCO models, and to draw conclusions on the variables of the model. The result of the Workshop will be reflected in the final report. In this report the possible policy decisions are discusses on the basis of the model and all the other experiences in this European project.

2.3.4. Proposal for Innovation Project

In the proposal will be described how to scale up the standardized TCO Model and how to implement it in transitions taking place in EU countries. We realize that this depends on the outcome of this pathfinder project. The project management team will seek contact and have meetings with other decision makers in the field of bus transportation to investigate the possibilities for scaling up to an innovation project. Also, the project management team will organize an open workshop for the climate-KIC community to share the results of this project and to get more partners from different CLC and RIC areas involved in an innovation project.

2.3.5. Activities

The activities to deliver these outputs are summarized in the following overview, followed by a budget proposal. The specific activities in the four work packages (step 1, 2, 3 and the project management) are discussed in detail in chapter 4.

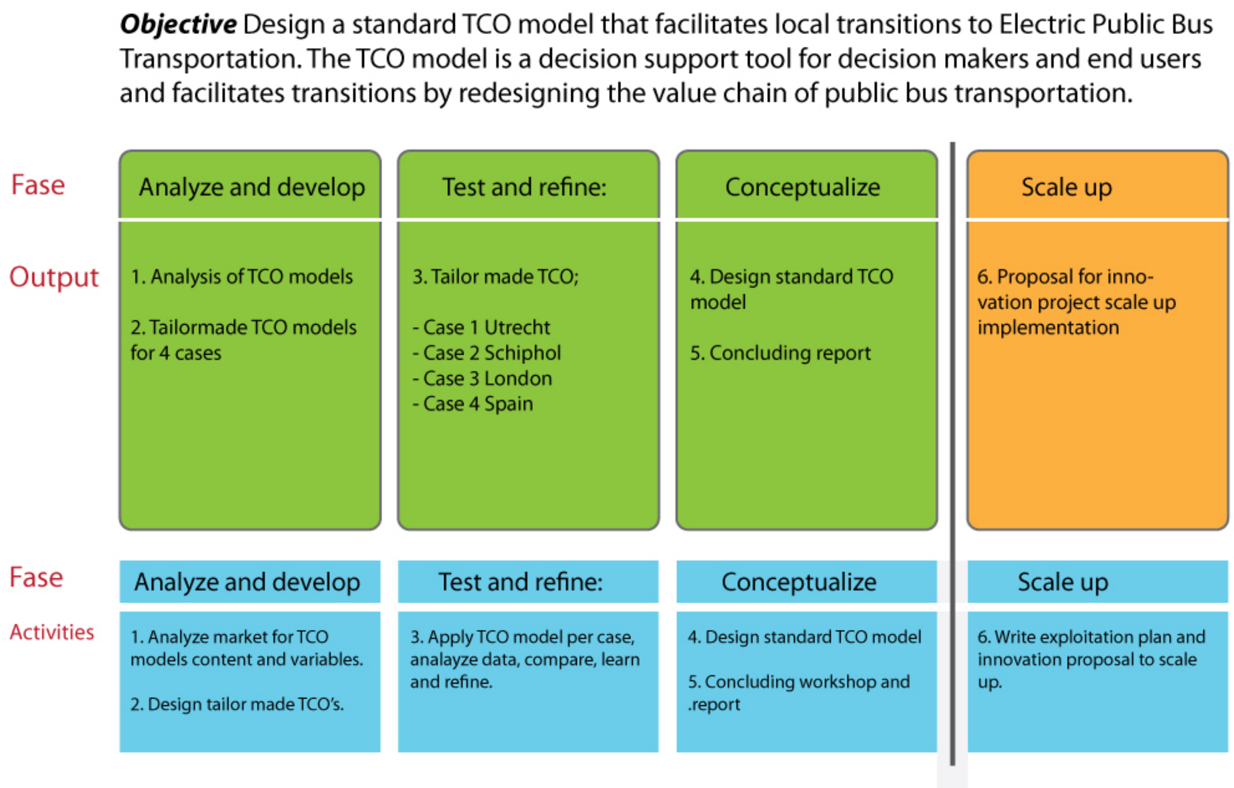


Figure 2: Overview of the pathfinder

2.4 Exploitation plan and demand

The roll out of the transition model on a European scale is expected to lead to a faster implementation of electric transportation systems benefitting the industry involved in electric transportation systems, material, technology and infrastructure:

- Bus manufacturers and their (electric drivetrain) suppliers
- Electric utilities and service providers that operate charging infrastructures
- Suppliers of (fast-)charging equipment
- Manufacturers of batteries
- Technology and Engineering firms – manufacturers of battery systems and software control systems
- Bus fleet operators

If for instance the city of Castellon in Valencia, or the other partners in the project, decides to demand for electric buses in a well thought-out way in the tender procedure, the entire business chain is stimulated. An innovation project aimed at creating a snowball effect could stimulate the industry even more and at a European level. In relatively new innovative value-chains, such as for electric transportation, new start-up firms are likely to enter the market as soon as a market emerges.

Directly benefitting from the roll out on a larger scale of the TCO Model supporting transitions to zero emission public bus transportation are strategic consultancy firms, local service providers and system integrators that help end users implement transitions in the local context such as Arcadis, Arup and Twynstra Gudde. These first two companies are doing similar projects in Europe. Twynstra Gudde is responsible for the process management for the ZEB foundation to make the transition to zero emission happen and is also involved in this project because they are convinced that developing new concepts that support change in value chains and facilitate transitions through new business models, are the cornerstone to their work in consultancy and management of complex projects, programs and partnerships in the field of housing, mobility and energy. So the first concrete product is the model itself.

The following figure shows these layers of demand for this product or the parties that benefit from this project. The outside layer is the industry we started this chapter 2.4 with. There could be a small effect for this layer as a result of decisions made by the cases Schiphol, Utrecht, London and Castellón as a direct result of this project. But the main effect will be when a real transition to a zero emission bus system occurs, a more distant goal this project is contributing to. The first layers benefitting from this pathfinder are the cases themselves and the consultancy firms/modeling companies, service providers and system integrators.

Figure 3: Beneficiaries of decision support model (TCO)

2.5 KPI's

In annex 1 the deliverables and their relation to KPI's of this pathfinder are summarized. Because we anticipate this pathfinder to develop into an innovation project, some of the KPI's are delivered after the end of this project. The project management team is going to monitor during the project to what extend the KPI's are already delivered during the project.

2.6 Strategic fit to the Sustainable City Systems platform priorities

A decision support tool enabling transitions to zero emission bus transportation systems to take place faster and on larger scale will directly lead to a higher resource efficiency in the local communities where these transitions are implemented and on EU level as a whole. Every conventionally fueled bus replaced by an electric bus contributes to a higher resource efficiency because electric engines are significantly more efficient compared to combustion engines. Even more so if the electric bus fleet can be integrated to local renewable energy sources in the city or community. For cities in particular the public health benefits replacing conventional bus fleets by zero emission bus fleet are significant because of the high asthma rates correlated to exhaust fumes of city buses.

2.7 Innovativeness and impact of the project

Besides the direct objective of this project a great deal of positive side effects for society are expected. This transition could also have spin-offs in other transportation sectors (taxi's, ferries etc.). The zero emission bus TCO is a good starting point for other sectors to analyze the total cost of ownership of their vehicles.

But direct benefits of transforming public bus transportation system from a conventional fuel based system to an electric transportation system are:

- Reduction of oil dependency: Net EU imports of oil and gas of around €500bn pa will continue to increase as energy costs grow in real terms. Producing electricity used by the transportation system by renewable resources (wind, solar) and use of smart charging tariffs
- Public health benefits because of the direct effect on improvement of air quality (no more exhaust fumes of public buses in the city).
- Reduced Noise pollution. Surveys with Residents in the N-DEMO project area indicate that traffic noise is the major concern.
- Better air quality in larger cities.
    - Latest estimates for London are that over 3000 deaths a year are due to air pollution, mainly PM10 and NOx. The contribution of buses to these pollutants is high because they are emitted at much higher levels through stop-start driving.
    - Urban Heat Island load may be reduced at least in theory, if electric vehicles operate at higher efficiency and if regenerative braking is used.
    - Reduced engine emissions of organics, NOx and Ozone will reduce photochemical smog episodes which are caused by traffic emissions, sunlight and temperature inversions which trap pollutants near ground level (common in London on bright winter days)

3 PROJECT ECOSYSTEM

3.1 Partnership

3.1.1 Project leads

Partner (+ contact person & mail)	**Capabilities, role and responsibilities***	**WP involvement**
TU Delft. Michiel Ytsma m.m.ytsma@tudelft.nl	Project Management together with Tineke de Vries of Twynstra Gudde Professor Paulien Herder and Professor Bert van Wee are responsible for the quality of the developed content in this project. Rob Konings and Sjoerd Bakker are the senior researcher and researcher executing the field work. Please find their capabilities in annex 4.	All WP A, WP B Coaching/support of other cases if necessary
Twynstra & Gudde. Tineke de Vries tdv@tg.nl	Project Management Market analyses of TCO's and opportunities for European zero emission bus TCO	All WP A

3.1.2 Involved KIC Partners that request Climate-KIC funding

Partner (+ contact person & mail)	**Capabilities, role and responsibilities***	**WP involvement**
Instituto Tecnológico de la Energía Sixto Santonja Hernández sixto.santonja@ite.es	Electro mobility projects experience, support to the Municipality of Castellón in their plan for a new transportation model.	WP E
Institute for Sustainability (IfS) Ed Metcalfe Ed.Metcalfe@instituteforsustainability.org.uk	The IfS is a facilitator, capturing and sharing learning from practical research and demonstration projects, and will provide management support to assist TfL.	WP D
Province of Utrecht. Sjaak Doornekamp sjaak.doornekamp@provincie-utrecht.nl	The province of Utrecht is going to tender electric buses in 2016. It needs a decision support model for this. Also, they will deliver data because they will start a pilot with four buses.	WP C
Schiphol Arno Veenema veenema@schiphol.nl	Schiphol will provide the data for the model and could adjust their tendering procedure on the basis of the outcome of this project. The analyses will be mainly done by the TU Delft. At this stage it is not totally clear if Schiphol needs part of the climate-KIC funding in order to free hours to deliver the data.	WP B

3.1.3 Other involved institutions not receiving KIC funding

Partner (+ contact person & mail)	**Capabilities, role and responsibilities***	**WP involvement**
Transport for London Mark Poulton MarkPoulton@tfl.gov.uk	In London a TCO model will be developed to compare costs of the conventional (diesel) bus fleet to the projected costs of an electric fleet to support decision making and policy development at Transport for London and the Greater London Authority (GLA) to justify the investment required to transition to zero emission public bus transportation. Tfl will work together with IfS to collect the data of two pilot buses and analyse these.	WP D
Municipality of Castellón Cristina Querol cristina.querol@castello.es	The Municipality of Castellón is involved on the new Transport system and is s reference in the region for Energy issues.	WP E
Taskforce Innovatie Regio Utrecht Irene ten Dam irene.tendam@taskforceinnovatie.nl	Task Force Innovation Utrecht Region(TFI) brings research institutes, government and businesses together and provides a stimulus for businesses, small and medium-sized enterprises (SMEs) in particular, to innovate with their product, service or process. In this role they are going to be responsible for the analyses of the Utrecht case.	WP C

3.2 Project Foundation

The project foundation or consortium is very diverse. It includes knowledge institutions, municipalities/transportation authorities, advisory organisations and an airport. Also, the people involved (Annex 4) have varying expertise and complementary background to make sure that this project will deliver the desired output. In Annex 2 the complementary activities are listed, which is the knowledge base this pathfinder builds upon. This group of organisations and professionals is very experienced and enthusiastic about the type and thematic content of the work that will be performed.

4 WORK PACKAGES & DELIVERABLES

4.1 Work Package A: Development of the TCO Model

4.1.1 Objective

The first step in the project is the development of a generic TCO model for zero emission buses. This model will be based on an earlier model that was developed by the Zero Emission Bus foundation (ZEB). For each of the case studies, the model will be adapted to the characteristics of the cases and the needs the local users of the model. A final step in this WP is the refinement of the model on the basis of the case studies. Also, final conclusions will be drawn with regard to the feasibility of electric buses.

4.1.2 Task 1 - Development of the generic TCO model

The ZEB model will be refined and augmented to meet the needs of European policy makers. This step is mostly done on the basis of a literature review concerning TCO modeling. The review includes TCO models for public bus transportation systems as well as those existing for electric (commercial) vehicles so far.

Furthermore, a literature review will be performed on the institutional setting with regard to the inclusion of sustainability criteria in tenders for public transport. On the one hand these barriers may relate to formal tender regulations. On the other hand, 'soft' factors, such as risk-aversive policy making, may also play a significant role. The relevant factors that are identified in this task will be included in the separate case analyses in task 2.

A third activity within this task is to review the possibilities and instruments to include socio-economic cost/benefits (internalization of external costs and benefits) in the TCO model.

The result of the activities is a comprehensive TCO model that provides a broader perspective on the exploitation costs than conventional exploitation models can do.

4.1.3 Task 2 – Tailored TCO models for the local cases

The generic TCO model will be modified for each of the local cases. In the different cases, buses are used in different settings and financial structures and these may impact the cost calculations. The types and numbers of buses matter and, for instance, the way in which they are recharged is likely to impact the TCO calculation as well. On a more practical level, the respective projects are likely to deliver cost-related data on different levels of detail. These differences in data quality must be accounted for in the TCO calculations so that they do not lead to any skewed output.

4.1.4 A refined generic model and final conclusions

The generic TCO model will be refined on the basis of the findings from the local cases. The findings serve the model in two ways. First, the model itself will be improved in terms of its structure and the components that are taken into account. Second, the model's predictive capacity should be improved by including more realistic figures on the actual costs of operations (e.g. fuel costs, depreciation, repair, use and maintenance).

On the basis of the analysis of institutional factors, a set of recommendations for policy makers will be compiled. These recommendations relate to EU tender regulations that may have to be altered to become more susceptible to sustainability innovations. They will also relate to local decision making in terms of criteria that should be included in the tender process and possible strategies to lower the costs of zero emission buses and to increase their economic benefits.

4.1.5 Deliverables :

1. Generic TCO model and assessment of institutional barriers and potential synergies
2. Four tailored TCO models for the local cases
3. Generic TCO Model and final conclusions

4.2 **Work Package B: Case Schiphol**

4.2.1 Objective

Schiphol is in the process to procure 35 electric buses for airside transportation of passengers. The TCO model that was developed in WP A will be fed with the actual data from the buses and TCO calculations will be made. Since theoretical TCO calculations were made by Schiphol, a comparison can be made between the theoretical and the actual costs. The outcome will be used by the project team to improve the generic TCO model. For Schiphol this is a way to test their own TCO calculations, to compare it with the other cases, possibly improve their tendering and procurement process to share their experience with the rest of the climate-KIC community.

Whereas the other cases represent the use of electric buses for public transport, the Schiphol buses are used on private grounds and exploited in a business-to-business setting. This implies that Schiphol procures the buses directly (instead of tendering for a service for which the buses are used). It also implies that additional benefits may be generated through the use of electric buses as some of Schiphol's business partners (the airlines) may be willing to pay a premium.

4.2.2 Task 1 – Data collection for Schiphol TCO

Data will be collected from the Schiphol bus fleet. Next to the quantitative data about the actual costs, qualitative data will be gathered about a) the decision making process and the actual tendering procedure and b) the opportunities and experiences of Schiphol to generate additional benefits through the use of electric buses. Airlines may for example be willing to pay a premium for the transport of their passengers by e-buses since this adds to their own CSR goals.

4.2.3 Task 2 – Run TCO Model

The TCO model will be fed with the actual data from the Schiphol fleet and TCO calculations will be made.

4.2.4 Task 3 – Analyze Data

The outcomes of the TCO calculations will be compared with the outcome of Schiphol's original calculations. On the basis of the comparison, an analysis is made of a) the differences between the theoretical values and the realized values in practice and b) the opportunities to lower costs. With regard to the procurement process, a set of recommendations will be formulated with regard to tender criteria and process management. If applicable, a cost-benefit analysis is made that takes into account any additional benefits that can be generated through the use of electric buses.

4.2.5 Deliverables

Deliverable 1: TCO calculations on the basis of real-use data and a comparison with the theoretical costs.
Deliverable 2: A report on the procurement process and potential additional benefits from electric buses.

4.3 **Work Package C: Case Utrecht**

4.3.1 Objective

In the Province of Utrecht the TCO model will be used to support the decision making process towards a public transport tender in the city of Amersfoort. This tender concerns a concession for zero emission buses, starting in 2016. The TCO model will thus be used for an ex ante evaluation of the use and exploitation of electric buses and the necessary infrastructure. The calculations will take into account a range of existing local projects concerning sustainable mobility, renewable energy and smart grids. Through such an integral approach, potential synergies between the projects can be explored and the TCO of the buses can be lowered so that no additional public investments are needed. One promising option is to share the infrastructural costs between the buses, e-taxis and the municipal fleet.
For the Provence of Utrecht it is very important to make the transition to 100% greenpublic transport. Connexxion, the current transporter in Amersfoort wants to become leading provider of green public transport in the Netherlands. For the municipality of Amersfoort a green image, the support of sustainability energy and the quality of life are very important. This project also has to support local employment in the Amersfoort region. New business is to be expected in the ICT-sector: the TCO-model needs to be build and also software-solutions for monitoring the use of energy by the buses are needed.

The Province's ambition is also to innovative with regards to the concession structure. Today's public transport concessions cover the full spectrum from operating the buses to supplying the fuel. In order to make full use of the possibilities that are offered by electric buses and their recharging stations, it may be necessary to tender separate concessions for the buses and their infrastructure. By doing so, additional business models can be explored more easily.

4.3.2 Task 1–Define needed scope and scale of pilot towards concession

An stakeholder analyse will be made: which interests needs to be defend, what kind of questions needs to be answers by the use of the TCO-model for the different stakeholders?

4.3.3 Task 2– Run basic model as a reference

Data to run the model needs to be select. If data is missing, assumptions by experts are to be made.

4.3.4 Task 3–Explore synergies with other projects and options for seperate concessions

Selection of relevant data from the smart grid project in the city of Amersfoort and new projects that will be developed. Defining what kind of roles can be distinguish (partners for infrastructure, energy supply, service provider etc.). Selecting relevant data from thess partners.

4.3.5 Task 4–Run model with potential synergies

Results of running the model will be used to make the decision if the outcome of the model is going to be used for the interrogation of the next concession.

4.3.6 Deliverables

Sufficient data to run the model including data from other projects in the area. Discussion about the outcome of running the model and exploring new roles in separate concessions. A decision to use the outcome of the model for the interrogation of the next concession or not. Recommendations to improve or extend the decision support model.

4.4 Work Package D: Case London

4.4.1 Objective

In London the tailor made TCO model will be developed to compare costs of the conventional (diesel) bus fleet to the projected costs of an electric fleet to support decision making and policy development at Transport for London and the Greater London Authority (GLA) to justify the investment required to transition to zero emission public bus transportation.

4.4.2 Task 1 – Data for London

Context: Transport for London (TfL) was created in 2000 and is the integrated body responsible for the UK Capital's transport system. With over 20,000 staff, TfL’s main role is to implement the Mayor's Transport Strategy for London and manage transport services across the Capital whose population is 8m. TfL’s role includes a strong programme of low carbon public transport, including electric vehicles and hydrogen fuel cell buses and taxis as part of London’s plan to reduce carbon, air and noise pollution and to contribute to the reduction of the pronounced urban heat island in London.

TfL’s services include:

- London's buses
- London Underground
- Docklands Light Railway (DLR)
- London Overground
- Tramlink
- London River Services
- Victoria Coach Station
- Managing the Congestion Charging Scheme
- Maintaining 580km of main roads and all of London’s traffic signals
- Regulating the city’s taxis and private hire trade.

Understanding TCO and life cycle costs will be key to the development of zero emission bus proposals, and TfL will be monitoring the performance of 2 pure electric buses in 2013/14 as part of a London bus operator-led trial which could provide data for the ZEB project on capital and operational costs. TfL is additionally planning demonstrations of range-extended hybrid diesel-electric buses, although the timing of these projects may be outside of this proposal.

4.4.3 Task 2 – Run TCO Model

Comparative TCO studies between electric buses, diesel buses and (range extended) hybrid diesel-electric buses will be carried out. In addition to capital and depreciation maintenance and downtime costs etc., particular attention will be paid to the short term charging infrastructure, current and projected fuel costs, and to life cycle costs. TfL intends to use aggregated data based on existing bus contracts, as well as preliminary data from the pure electric bus trials in 2013/14. TfL recognises that commercial confidentiality in respect of bus contracts and field trials must be respected, but will endeavour to supply as much relevant information as possible.

4.4.4 Task 3 – Analyze Data

Analysis of the TCO model outputs from the London case and other 3 cases will provide evidence to colleagues in planning and the investment community to support mode shift and

- influence future procurement policy to accelerate the transition to low carbon public transport
- Inform the road map for electric buses and other ultra-low carbon alternatives

4.4.5 Deliverables

- Enhanced future ultra-low carbon road map for London
- Identify the next steps needed to progress the road map

4.5 **Work Package E: Case Castellón**

4.5.1 Objective

In Castellón the TCO model will be used to engage decision makers and lobby for a transition to a zero emission bus fleet. The city of Castellón is in the process of implementing a new and more clean and efficient transport system. This Mobility Plan for the City is being developed together with the Regional Government and it will integrate the different transport modes (buses, trams and bicycles) that are currently in use in the city. The TCO model can support the development of the plan by providing the municipality and the Regional Government insight in the cost structure of zero emission buses and their infrastructure.

Today, the bus is the most important mode of public transport in Castellón and they are a major source of CO_2 emissions. The city already has the experience of running an experimental hybrid diesel-electric bus and is currently considering the use of full-electric buses. The ambition to realize this transition is inspired by the fact that Castellón is the first city in the region with a complete infrastructure for Smart Metering from the utility. This is considered a first step towards implementing new energy and transport services for the citizens.

Castellón has been positioned as a reference for the Energy efficiency in the Region, and an active partner in the Climate KIC, so the involvement in this project is in the line of the new approach for the City supported by the Municipality.

4.5.2 Task 1 – Data for Castellón

Data will be collected for an ex ante evaluation of the TCO of electric buses in the Castellón context. This means that data will be gathered in relation to the number and size of buses that are used in the city today and the infrastructure it would require. As much as possible, data will be gathered from other projects in Spain. Furthermore, qualitative data will be gathered about a) the decision making process and the tendering procedures in the city and the region and b) the synergies with the Smart Metering infrastructure and the opportunities to share costs with other applications of the recharging infrastructure.

4.5.3 Task 2 – Run TCO Model

The tailored TCO model will be used to calculate the TCO for the Castellón context with various technological and organizational designs.

4.5.4 Task 3 – Analyze Data

The data coming from the analysis of the TCO model will be compared to the actual costs of today's buses in the City. The outcomes of the model will be used to inform local decision makers.

4.5.5 Deliverables

A report on the evaluation of the TCO for electric buses in Castellon, including a discussion of possible synergies with existing infrastructures and other possible uses.

4.6 Work Package "Project Management"

The project management team (TU Delft and Twynstra Gudde) is responsible for the output of the project team. The project management will ensure that the market analysis (work package A), the case studies (works packages B, C, D and E) and the design of the standardized TCO Model (work package A) will be carried out in coordinated way and the each of the work packages contribute to the overall project goals.

WP/deliverables	Q1	Q2	Q3	Q4	After project	Responsible	Involved
Projectmanagement Reporting/monitoring Workshop Innovation proposal Project meetings CA						PM team	Climate-KIC and case partners
A. Analyses • Academic overview • Market analyses • Tailor made case TCO's • TCO • Report • Article draft						TU Delft Twynstra Gudde	Case partners
B. Schiphol • Case TCO						TU Delft	Schiphol
C. Utrecht • Case TCO						Tasforce Innovation	Province Utrecht
D. London • Case TCO						Institute for Sustainablilty	Transport for London
E. Castellon • Case TCO						ITE	Municipality

5 BUDGET

5.1 Budget overview

5.1.1 Distribution of project costs across partners

KAVA			
	Total project costs	EIT requested	Eligible co-funding
Tu Delft	*90*	*90*	*0*
Twynstra Gudde	*30*	*30*	*0*
Pronvince of Utrecht	*30*	*30*	*0*
Institute for Sustainability	*30*	*30*	*0*
Instituto Tecnológico de la Energía	*30*	*30*	*0*
Partner #6	*0*	*0*	*0*
Partner #7	*0*	*0*	*0*
Partner #8	*0*	*0*	*0*

5.1.2 Distribution of eligible project costs across Business Plan years

	Total project costs	EIT requested	Eligible co-funding
BP 2013	*170*	*170*	*0*
BP 2014	*40*	*40*	*0*
BP 2015	*0*	*0*	*0*
BP 2016	*0*	*0*	*0*

5.1.3 Distribution of project costs across work packages

	BP 2013		BP 2014		BP 2015		BP 2016		Total (K€)	
	Total eligible	EIT requested	Total eligible	EIT requested	Total eligible	EIT requested	Total eligible	EIT requested	Total project costs	EIT requested
WP1: TCO model	*32*	*32*	*10*	*10*	*0*	*0*	*0*	*0*	42	42
WP2: Case Schiphol	*27*	*27*	*5*	*5*	*0*	*0*	*0*	*0*	32	32
WP3: Case Utrecht	*27*	*27*	*5*	*5*	*0*	*0*	*0*	*0*	32	32
WP4: Case London	*27*	*27*	*5*	*5*	*0*	*0*	*0*	*0*	32	32
WP5: Case Castellón	*27*	*27*	*5*	*5*	*0*	*0*	*0*	*0*	32	32
WP6: Project management	*30*	*30*	*10*	*10*	*0*	*0*	*0*	*0*	40	40
WP7: (short description)	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0	0
Total	170	170	40	40	0	0	0	0	210	210

6 Risk and opportunity assessment

The proposed project offers an opportunity to develop a robust TCO model that is applicable to (and validated) in a variety of contexts of use of electric buses. Furthermore, this pathfinder project is able to show which variables are important in different stages of the decision making process and in different European countries. The contextual variety and the fact that all the cases have their own level of maturity, also presents a risk. The analyses of the different cases may be too specific to be generalized in the final step of the project. The way the work packages are organized aims to avoid this risk. We start with an academic analytical framework, which we customize for the different cases. After analysing the individual cases, we return to back to the general framework and analyse which variables and costs are context- and country-specific and which ones are generic. To make sure these work packages and their findings are well connected, a project kick-off meeting will be organized during which the project partners will develop a blueprint for data collection and analysis.

Part of the blueprint for the data collection is a detailed financial plan that is to ensure that each of the project partners is able to deliver the necessary data within the allocated budget. But the financial risks are low, because most of the budget is spend on working hours, and not on expensive materials.

Our case analyses are partly dependent on the actual deployment of the electric buses. We cannot exclude the possibility that in one of the cases some delay occurs with respect to this deployment. Although such a delay and its causes can be regarded as a learning opportunity in itself, it would pose a challenge to our data collection. Our contingency plan for such an incident is to collect similar data from other electric-bus projects with similar contexts. We are aware that such data may not be as detailed as the original data would have been and some contextual differences are likely to play a role as well. Nonetheless, such data would enable us to improve the TCO model and to assess the possibilities for lowering the TCO in the original case context.

ANNEX 1 – KEY PERFORMANCE INDICATORS AND RELATED DELIVERABLES

KPI	Target #	Explanation of expected KPIs	Timing		Deliverables leading to the KPI	Timing
			During	after		
# of demonstrations		Pilot services in one of the locations, which was not in planned for during the writing stage of this full proposal. Another KPI is extra buses at the demonstration sites	Pathfinder Pathfinder		A European TCO model based on the four cases and existing tco knowledge is produced. The data and analyses which is already developed by the Zero Emission Bus foundation and is put in the project as complementary activity.	End result project
		New pilot bus services in location outside the pathfinder cases		Pathfinder	Innovation proposal and the results of the pathfinder	After pathfinder
# of products or services launched		The direct service resulting from this project is strategic advisory to bus fleet owners. T G, affiliated KIC-partner, invests in the realization of this project because it sees a market for European strategic advisory. We expect that T G will deliver advisory projects based on the knowledge resulting from two deliverables.			A European TCO model based on the four cases and existing tco knowledge is produced.	End result project
		Because the model is open for everyone, we expect other commercial organisations to make use of the model and use it in there advisory work. This is a KPI to be expected later on when this pathfinder project is expanded to an innovation project with more cases and partners involved. The model is used by the involved cases to analyse decisions.	 During the project	End of the project, possibly during innovation project	Besides the purely cost based calculation model a end report is written in which barriers to make the transition happen are presented. These can also be related to policy structures and uncertainty effecting decision makers. Also country and context specific variables are analysed.	End result in Q4 of the project
		TCO model is used by decision makers involved in an innovation project		After the end of this project	Innovation project proposal	Initiated in Q4 of pathfinder
# of knowledge transfer agreements	1 KIC-partner 1 non	The aim is to deliver written statement of end users in which they declare that this project resulted in the fact that their policy	1 during project	1 after the project	As a part of this pathfinder we will organise a concluding workshop for climate-KIC partners and decision makers outside the community	Q4 of the project

	KIC-partner	changed, resulting from this project, the consultancy or academic deliverables such as an article or a presentation.			working in the field of bus transportation in which we will share the results and will examine the possibility to develop an innovation project, in which implementation in more cities and an even larger knowledge base is the goal. This workshop will be organised by the project management team.	
	2	Written statement of end-users outside the project		After the end of the project	The project management team is going to have consultations with bus fleet decision makers on the basis of the tco model and report. In this way the possibility of a continuation in the form of a innovation project is explored. Obviously consultations between researchers and the cases are part of the project. Also the results of this project are published on the zero emission bus transportation website.	Q4 of the project During the project Q3 and Q4 of the project
					Consortium Agreement in which the principles of knowledge transfer is arranges	Q1 of the project
# of start-ups		The project management team will monitor if one of the case partners in this pathfinder or in an innovation project used the services or products of a start-up company. (a company younger than 5 years)	Possibly	Possibly	Although start-ups are no direct deliverable from this project, it is likely that start-ups will emerge ones more and more buses are becoming electric. The electric transportation market is not mature and therefore there is are a lot of opportunities for start-up companies	
Amount of capital attracted					Most of the involved project partners, The TU Delft, the Institute for Sustainabiliy, etc, and zero emission bus foundation, are always working on funding opportunities for projects related to the energy and transport transition. This KIC-climate project gives a lot of the current work, see the list of complementary activities, a European dimension and a more implementation oriented way of working. This could lead to new attracted capital.	
# of new employees as a result		In the long run the transition to zero emission bus transportation is going to lead to a shift in employment. More and more people will be working in the field of			The project is too small to deliver new jobs. During this project it is expected that more time in existing jobs of the project partners is spend in relation to electric transportation. This is	Examined at the end of the project as

		more sustainable transportation.			monitored in the end report of the pathfinder. For instance: time spend by people directly involved in the project, but also possible a mechanic spending time on electric buses instead of conventional ones.	part of project reporting
# of policies or standards co-developed and / or implemented	1	Results of the project are incorporated in the policy of the involved bus fleet owners	During the project		Project interactions	During the project
	1	Results of the project are incorporated in the policy of bus fleet owners outside this pathfinder		Resulting from consultancy or innovation project	Resulting from the workshop, consultancy and meetings to develop an innovation. Possibly researchers speaking at conferences	During and after the project
Tons of GHG reduced		The project management team will monitor the amount of GHG reduced as a result of decisions made during and after the end project	Monitoring	Monitoring	The GHG reduction as a result of the service of pilot bus services in the cases of the project is monitored	During the project
# of partners with mitigation measures integrated in business strategy						
Contribution to resilience						
# of partners with mitigation measures integrated in business strategy						
# of new graduates	1	Employment of a part-time PhD position		Possibly part of an innovation project		
# publications	1	Conference contribution		After the project	The report mentioned above	During the

						project
	1	Publication		After the project	Basic outline scientific paper	During the project

ANNEX 2 – COMPLEMENTARY ACTIVITIES

Activity name	Activity description	Importance for project	Value
TU Delft	Interuniversity program: The feasibility and impact of the transition to electric mobility in the Randstad. Collaboration with the Free University Amsterdam and Groningen University. 2 postdocs, 2010-2013. Bert van Wee program manager.	The activity deals with the long-term development of electric mobility and the role of consumers and other (governmental and industrial) stakeholders therein. One of the activity's deliverables deals specifically with public procurement of electric vehicles.	364,000 euro
TU Delft	Interuniversity program: Electric Vehicles: early stage adoption processes. Collaboration with the Free University Amsterdam and Groningen University. 3 PhDs, 1 postdoc, 2010-2014. Bert van Wee program manager	This activity focuses on the early stages of the transition towards electro mobility in terms of locating early adopter markets and the coordination between vehicle supply and infrastructure build-up.	662,000 euro
TU Delft	E-Mobility NSR, Interreg IVB North Sea Region Program,	E_Mobility NSR aims to support the diffusion of e-mobility and to stimulate the use of public and private electric vehicle transport as well as freight across the North Sea Region (NSR). Especially outcomes related to electric urban distribution may be of interest to the various TCO cases in terms of anticipating vehicle reliability and organizational design of electric bus projects.	Total budget 7M euro, TU Delft 359.378 euro (50% financed so co-funding: 179,689 euro)
Institute for Sustainability	Low Carbon London. Smart grids programme linked to EVs. Funded by UK government (OFGEM).	Includes use of electric vehicles to manage peak loading in smart grids	Total budget €29m €360k for Institute
Institute for sustainability and Transport for London	Last mile logistics, INTERREG IVB project led by the Institute. In London retail and logistics companies to stimulate modal shift from Heavy Goods Vehicles to deliveries by rail to a consolidation centres	Includes electric vehicles for last mile delivery	Total budget €8m. €900k for Institute

			(co-financed), is 198k for TfL
Transport for London	FP7 project UNPLUGGED	Aims to investigate how the use of inductive charging of electric vehicles in urban environments improves the convenience and sustainability of road transport	€3.654M, of which TfL's share is €141k (co-funded).
Zero Emission Bus Foundation	Zero Emission Personal transportation TCO project funded by the Dutch government	Outcome available for this project	€100k
Zero Emission Bus Foundation	Green Deal with Dutch government	Outcome available for this project	€80k
Province of Utrecht/Taskforce	Project "Smart grid: profit for all" (started in 2012, 2 years left)	Developing profitable services and business cases around smart grids (also by using electric buses), implementing them in a living lab in Utrecht and Amersfoort. Research on and experiment with prosumers in their new roles.	2,3 m 750k a year

ANNEX 3 – INTEGRATION WITH EDUCATION AND ENTREPRENEURSHIP

We would like to explore the opportunities for integration during this pathfinder project. Below some of our first thoughts.

Education
For this pathfinder proposal integration with Education is not explored. TU Delft will try to seek involvement of master students to collect and analyse the data. Therefore students could do a large portion of this work, together with the researchers, in order to get more work done in this pathfinder project. But we foresee that this work is more fit for students of applied sciences universities. The TU Delft participates in D-INCERT, which combines the knowledge in the field of electric transportation of the three technical universities and two Universities of applied sciences. So if we want to make these students part of this project, there are existing and warm relations with relevant knowledge institutions in the field of electric transportation.
PhD's could be part of a larger innovation project. We are open on suggestions how to participate in education projects and the journey on the basis of this pathfinder project.
Also, the TU Delft has its own education division which organizes master classes for professionals: Delft TopTech. In the future the knowledge generated in this pathfinder and in a follow-up innovation project could be part such a master class.

Entrepreneurship
Also, the integration with Entrepreneurship is not explored. It would be great if we could involve actual suppliers of for instance charging infrastructure, and in that case its best to have a start-up company participating in this initiative.

ANNEX 4 – PROFILES OF PEOPLE INVOLVED IN THE PROJECT

TU Delft

Prof. Dr. Bert van Wee is professor in Transport Policy at Delft University of Technology, faculty Technology, Policy and Management. In addition he is scientific director of TRAIL research school. His main interests are in long-term developments in transport, large infrastructure projects, accessibility, the environment, and safety, and in policy analyses.

Prof. Dr. Paulien Herder is professor in Engineering Systems Design in Energy & Industry at Delft University of Technology, faculty Technology, Policy and Management. In addition she is director of research for the faculty of TPM and scientific director of Next Generation Infrastructures, a multinational public private research program on design and management of infrastructures (M€ 40 for 10 years) where scientists work closely with practitioners and policy makers. Her main research interests are in energy transition, climate change, smartgrids and asset management (incl total cost of ownership and tendering) for energy grids and other infrastructures. She serves on the Board of the Delft Energy Initiative (700 fte energy researchers in Delft), in particular to synergize energy network research in Delft. She is co-initiator of PowerWeb, a interfaculty research program on smartgrids, involving various electricity network operators (currently 5 PhD students, 1 postdoc). She is involved in various other projects as project leader or co-worker concerning climate change and smartgrids (Knowledge for Climate program; Energy Delta Gas Research program).

Dr. Rob Konings is senior researcher at Delft University of Technology. He is an economist with specialization in spatial and transport economics. His core research field is intermodal transport and related topics. In recent years he has extended his field of activities to sustainability issues regarding transport systems, including the analysis and evaluation of innovations in transport systems.

Dr. Sjoerd Bakker is a researcher at Delft University of Technology. The focus of his research is on the transition towards low carbon mobility and in particular the electrification of road transport. He does so from a range of socio-economic perspectives including transition studies and innovation policy. In his PhD thesis 'Competing Expectations – The case of the hydrogen car' he investigated the role of technological expectations in the competition between emerging technologies. He holds an MA degree in Philosophy of Science, Technology and Society from Twente University.

Michiel Ytsma holds a MA degree in Political History from the University of Groningen and a MA degree in Public Policy from the University of Utrecht. He is an Infrastructures & Mobility project coordinator at the Valorisation Centre of the Delft University of Technology. Michiel coordinates projects for D-INCERT, a network organization of technical universities and universities of applied science in the field of electric transportation. He is coordinator of a joint research centre on Urban Systems and Environments (USE), founded by the TU Delft and the South-China University of Technology and of the climate-KIC project Smart Urban Water. He is editor for the magazine *Infra.* At the Technical University of Delft he is participating in a management traineeship program.

Twynstra Gudde

With a law degree, an international career and a passion for sustainability, **Tineke de Vries** is a committed advocate for the environment and the responsible industries that impact it. Currently, at Twynstra Gudde working with clients on strategic public-private partnerships in the intersecting world of sustainable economic development, clean technology and public policy. Over the last two years she has been involved in several projects in the field of energy transition. As a projectmanager she was involved transforming a neighborhood of 700 households to an energy-neutral system. With the EURBANLAB consortium she is leading the workpackage on 'Products and Services', assisting the consortium in developing a business model for products and services facilitating urban renewal in cities. Specialties:

- Strategic public-private partnerships
- International relations
- Law
- Environmental sustainability, energy, water(front) management EU and US Network

Zero Emission Bus Transportation Foundation

Frederik de Vries holds a MSc degree in soil science. His career has led him via complex water management and infrastructure projects to the public transport sector. Currently working for consulting firm Twynstra Gudde, Frederik fills his days with instigating and managing public private partnerships within the public transport sector. These PPP's are based on implementing new business models for sustainable, innovative techniques. General principle for these techniques is the fact that they are contributing to sustainability and that the business case for these techniques is profitable compared to business cases of current techniques. TCO calculations are used as investment decision support systems. The last years Frederik has been working as project manager for the Zero Emission Bus Foundation. Within this foundation Frederik currently holds the position as project manager for a zero emission bus project in Maastricht. He also works as project manager for a complex multi stakeholder project that has as goal to establish a broadly accepted TCO model for person vehicles. Specialties:

- Strategic public-private partnerships, process- and project management
- TCO decision support models
- Public transport network (PTA's, PTO's, OEM's, national government)

Institute for Sustainability

Ed Metcalfe is a founding trustee of the Institute for Sustainability. As its Director for Research and Business Development he is responsible for strategic project development in resource efficient buildings, and sustainable infrastructure, including transport and logistics, with a cross-cutting focus on measurement, monitoring and evaluation. From 2002, Ed worked for the South East England Development Agency (SEEDA) where he was Chief Scientific Advisor and Innovation lead for the UK Regional Development Agencies. Previously he was Head of Department and Professor of Materials Chemistry at the University of Greenwich.

Detlef Golletz is Head of European Programmes at the Institute for Sustainability, and is responsible for around €30m Interreg funded projects led or co-led by the Institute on sustainable transport and logistics. Detlef has been practising in planning and transport for over 25 years, firstly in the private sector in England, Scotland and Wales, Ireland, Germany and the Caribbean. His work in the public sector concentrated on large regeneration programmes in London and the South East of England. He studied in Berlin, Oxford and Glasgow and is a Member of the Royal Town Planning Institute.

Transport for London

Mark Poulton, Vehicle Technology Manager in the Surface Environment Team, is a Chartered Mechanical Engineer. With 25 years' career in the transport & automotive industries – working for both private and public sectors, Mark has a breadth of experience from light duty commercial vehicle engineering, air quality research, power-train research & development, engine certification, government-sponsored accreditation programmes to world-leading environmental projects. Mark was involved in designing and implementing London's Low Emission Zone (LEZ) to improve air quality, and in 2009 worked extensively with the Greater London Authority, helping to develop the Mayor's Electric Vehicle Delivery Plan. Mark now works to promote EVs and to identify opportunities to trial and exploit vehicle technology to contribute towards London's sustainable transport goals.

ITE

Mr. Sixto Santonja, Project Manager. He is Electrical Engineer, with more than twenty years of experience on the telecommunications and energy sector, working on different projects with Amper and Lucent Technologies in Spain and Saudi Arabia. In the last years, he has been involved in different European R&D projects mainly focused on the electric vehicles, as EPV (Electrically Powered Vehicles). Currently, he is performing the coordination tasks in the SMARTV2G and MOBINCITY, both FP7 projects

Mr. Patricio Peral: Project Manager in automation, control and energy sector. Automation and Industrial Electronic Engineer. He participates and coordinates projects in the field of demand side management and sustainable mobility such as GAD, EPV, SMARTV2G and SURTIDOR. He is volunteer in the IEEE Standards Working Groups.

Ms. Anabel Soria-Esteve: Electrical Engineer at ITE. Head of the laboratory testing and calibration. Auditor Designated Expert in Metrology for resolution of June 28, 2007 by Chairman of the Committee of Legal Metrology Metrology Superior Council. He has participated in 95 research projects, and as main investigator in 15 of them. Projects have focused on several areas of research of the in the field of electric vehicles, industrial safety, metrology, calibration, partial discharges electromagnetic fields and methods of measurement.

Mr. Andrés Lluna: Senior researcher. Coordination of Automation Department. He is Automation and Industrial Electronic Engineer and has carried out post-graduation studies on Automation and Industrial Information. He has long experience in the private industry working on industrial automation and monitoring systems implementation. His expertise focuses on energy control developments, mainly artificial intelligence to optimize energy systems. He is also working in ambient intelligence applied to tertiary buildings in order to achieve better energy efficiency in the use of the systems.

Mr. Ignacio Benítez: Senior researcher. He is in charge of Advanced Control Techniques team, integrated in Smart Grid Department. Automation and Industrial Electronic Engineer. He is earning his doctorate in Automation and Information Systems. His research team is working in applying methodologies and control theories to the fields of energy efficiency and renewable resources integration.

Province Utrecht

Sjaak Doornekamp
Policymaker and project-manager at the Province of Utrecht. Holds a degree in Business administration and works already more than 10 years in the world of public transport.

Irene ten Dam
Programm-manager sustainability at the Taskforce Innovation (network organization, business development/aiming system change by developing public private partnerships, advising policymakers and connecting projects and activities by coordinating propositions). She holds a degree of Economics and in the past she had different commercial jobs in the trade and industry.

Marco Cowan
Manager new markets at Connexxion public transportation. He works already more than ten year in the world of public transport. He knows a lot of different bus technologies and will be involved in the decision making process of ordering four buses within the current concession.