

Seeing the Invisible: Provision of Environmental Information in Transport

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ABSTRACT

Recent technological developments are enabling travellers to access previously unavailable sources of transport information. Advancements in areas such as on-line journey planners, smartphones applications, and dedicated satellite navigation devices allows users to access a wide range of information such as current traffic conditions, predicted public transport arrival times, and estimated travel times. These technological innovations also offer a platform for the promotion of sustainable travel by highlighting the environmental impact of available routes and modes, specifically in terms of educating individuals about transport related carbon dioxide emissions. This paper provides an examination of the methods currently available to inform travellers about the ecological impact of their transport decisions and how they can change their behaviour. An audit of existing technologies demonstrates a wide range of relatively new methods currently available on the market, whiling comparing and categorising the approaches being undertaken in terms of the role of ecological information within the technology.

INTRODUCTION

It is now nearly universally accepted that greenhouse gas emissions arising from human activity are causing a reduction in the stability of the global climate (1). The transport sector is responsible for approximately 23% (2) of total global carbon dioxide emissions. To achieve necessary but ambitious carbon reduction targets, such as the European Union's planned 2050 reductions (3), a wide range of behavioural and infrastructural changes will be required. One of the barriers to the desired modal shift has been identified as the lack of tailored and targeted information to allow both individuals and society to reduce their carbon footprints (4; 5).

Due to the physical nature of carbon dioxide, as both an invisible and odourless gas, it is very easy to ignore associated emissions when contemplating available transport options. When it is also considered that a large proportion of emissions are generated at a distance from the provided service (i.e. electrified rail), individuals can be forgiven for not considering their impact upon the environment when choosing how to travel. One approach that appears to be becoming more common is the provision of information to help nudge individuals into making more sustainable transport choices.

Nudging

The idea of the "Nudge" was popularised in the 2008 book of the same title by Richard Thaler and Cass R. Sunstein (6). In essence what is advocated is a liberal paternalistic approach which, while supporting the individual's right to make a choice, suggests that this choice may be influenced by carefully manipulating the choice architecture. Thaler and Sunstein acknowledge that ordinary individuals do not act in accordance with the idea of the rational man put forward in many economic theories, rather that individuals employ cognitive shortcuts to save time and energy, and therefore it may be possible to take advantage of this to alter behaviour. It can be argued that the provision of emissions information is a method of nudging travellers, without restricting their freedom to choose between modes.

A number of organisations are now attempting to encourage sustainable travel behaviour by providing individuals with emissions information. This information comes in a wide variety of forms and is being provided across a number of different platforms. The following section examines some of the methods currently being employed within the transport sector to increase awareness of the environmental impact of travel options.

Sources of Information

As many new sources of emissions information are currently emerging, and therefore there are not yet clearly defined categories into which to place them. Manzoni et al (7), when looking specifically at smartphones, proposed a classification for applications as either "aggregated data, personal diaries, and trip-by-trip applications". In reality a method of information provision may fall into multiple categories, however for the purpose of this analysis, five largely distinct areas were identified: Legislated Product Labelling, Multiple Activity Carbon Footprint Calculators, Journey Planners (both Online and Smartphone Applications), Emissions Tracking Applications, and In Car Devices. Although this cannot claim to be an exhaustive list, as new information sources are constantly emerging, it does aim to provide a good overview of approaches currently being adopted.

1. Legislated Product Labelling

Under EU Directive 92/75/EC (8) all new cars must be accompanied by a sticker that indicates the carbon emissions associated with the vehicle as well as the fuel consumption of the vehicle for both urban and extra urban driving environments. Similarly in the United States new vehicles must have an associated Fuel Economy Label or “Monrooney Sticker” (9) that, among other things, discloses the fuel efficiency of the vehicle and the corresponding carbon footprint. Both schemes represent legislative requirements to provide consumers with environmental information to enable more informed purchases.

2. Multiple Activity Carbon Footprint Calculators

There are presently a wide range of websites and applications that allow individuals to enter lifestyle details, which then calculate an associated carbon footprint. Most of these websites examine various activity areas such as home energy use, food and waste, and consumption of retail goods, as well as estimates relating to transport emissions. Information is often provided for each separate activity area and individuals can input potential behaviour changes and receive feedback on related likely emissions reductions. These functions provide an opportunity for individuals to identify the areas of their lives where they can make the greatest emissions reductions with the smallest amount of distribution to their current lifestyles. This approach has the advantage of enabling those individuals who possess limited transport alternatives, to reduce their carbon footprint a more achievable manner. One drawback of these calculators is that they tend to make assumptions with respect to transport habits and therefore may lose a certain degree of accuracy. Examples include websites such as Carbon Fund (10), Urban Eco Map (Urban EcoMap), and the World Wildlife Fund (11) carbon calculators.

3. Journey Planners (Online and Smartphone Applications)

The past few years has seen the emergence of a huge number of electronic journey planning services. The popularity of these services is now beyond doubt with recent findings indicating that Google’s Maps application is the most used smartphone application in the world (12), and that in the United States 46.2% of all smartphone users have downloaded this app, while 27% have downloaded Apple’s equivalent application (13).

Journey planners can come in the form of websites or smartphone applications. Such services are provided by a wide range of organisations, ranging from local authorities and public transport providers to private sector software developers.

Utilising an ever increasing supply of real time transport information, combined with public transport timetables, many of these applications are able to generate a selection of routing options between a desired origin and destination. Results may include only driving and walking routes, or may also include information such as scheduled and real time public transport information depending on the application provider’s remit.

These applications also offer a previously unavailable opportunity to push or “nudge” (6) individuals towards making more sustainable choices by providing them with information regarding the carbon footprints of the various modes and routes available to them for a given trip in tandem with more desirable information. While emissions information cannot yet be considered to be a common feature of journey planning applications, there are already a number of applications that provide emissions information as part of their service. Websites such as the UK’s Transport Direct (14), the Helsinki journey planner Reittiopas (Reittiopas, 2013), or the Brighton and Hove based JourneyOn (15) are primarily journey planners, but also provide emissions estimates for each of the recommended modes. The secondary

importance of emissions information can be seen more clearly in some instances such as the San Francisco journey planner 511.org (16) where emissions information is only available in the enhanced beta version (as of February 2014), or the Dublin based Hit the Road where emissions information included in the website is not displayed as part of the corresponding smartphone application (17). In situations where emissions information is not initially present, it is sometimes possible for individuals to upgrade the journey planners, such as the installation of the Google Maps extension (18) that creates emissions estimates based on the produced by the applications recommendation engine.

While this information may not directly influence individuals' transport choices, it does help to alert them to the presence of the environmental impact of their choices. As carbon emissions can be considered to be somewhat an abstract concept, the inclusion of emissions information in journey planning interfaces represents at the very least an opportunity to highlight the link between transport choices and emissions that requires little effort on behalf of the user.

While the incorporation of emissions information into journey planner interfaces appears to be increasing, it cannot yet be considered a common feature. Table 1 displays an audit of off online journey planners for a number of major cities and regions. A number of international journey planning websites are chosen as not all journey planners are region specific. While this cannot claim to be an exhaustive audit it does indicate that emissions information are being provided in a number of regions but is still not a given output for journey planners.

TABLE 1: JOURNEY PLANNERS AND EMISSIONS INFORMATION

City/Region	Application/Provider	Emissions Information
Dublin	Hit the Road	Yes
Ireland	National Transport Authority	No
London	Transport for London	No
UK	Transport Direct	Yes
Scotland	Traffic Scotland	Yes
Milan	ATM	No
Berlin	BVG	No
Madrid	CTM	No
Vienna	AnachB	No
Netherlands	9292	No
Helsinki	Reittiopas	Yes
Stockholm	SL	Yes
Toronto	TTC	No
San Francisco	511	Yes (Beta)*
Montreal	STM	No**
New York	MTA	No
Sydney	131500	No
Melbourne	PTV	No

Singapore	SBS Transit	No
International	Google Maps	No (Extension Available)** *
International	Bing Maps	No
International	RAC UK	Yes
International	AA UK	No

* *Emissions information is available as part of the Beta version*

** *STM provides general information about CO2 but not for specific trips*

*** *Google Maps does not provide emissions information, however Oiworld.org have developed a extension to calculate this information*

EMISSIONS TRACKING APPLICATIONS

The rise of smartphone devices in recent years has allowed for the design of applications that enable users to track their transport related carbon footprint. Unlike other carbon footprint calculators, which often produce emissions estimates based upon national averages and estimated trip lengths, these applications are able to record the trips taken by individuals, and produce a post trip carbon footprint estimate. This may be done using GPS traces, mobile network and Wifi location detection, or the phone's accelerometer. An example of this is the application Ride Off Carbon (19) which asks the user to select whether their trip will be a car, bicycle, or walking trip, and uses GPS location services to determine the user's trip length and corresponding carbon dioxide emissions. Applications such as Carbon Diem (20) have added features such as the ability to set emissions reductions goals which are then compared to the emissions estimates produced by the application. The application also allows users to examine their historic trips and plot their emissions reduction graphically as time passes. These applications allow users to create much more precise and personalised indications of their transport related carbon footprints.

IN CAR DEVICES

A number of in-car satellite navigation devices have been designed to allow users to alter their driving routes and driving styles to reduce their carbon emissions. Unlike the other digital applications, these devices tend to relate only to car trips. The promotion of less fuel intensive or "eco" driving behaviour is also financially advantageous to the driver as reduced emissions are related to a decrease in fuel consumption, and therefore reduced expenditure for the individual. This coaching can take a number of forms. One approach is where the device provides a number of potential routes and produces an estimate of fuel efficiency and emissions based on factors such as the driving environment i.e. motorway driving or suburban driving, and historic traffic conditions. With the increased availability of real time traffic data it is possible to estimate routes based upon current traffic conditions and create more accurate predictions.

Other devices go one step further and provide feedback to the driver on his/her driving style. Unlike simply suggesting potential routes, this approach is less generalised and able to suggest changes specific to the users driving style. These suggestions may take the form instructions regarding gear changes or excessive breaking. Examples of this are the Vexia Econav system (21) and the ecoPlus device from TomTom (22).

INFORMATION PROVISION

Push and Pull

One important distinction that should be made between the modes of information under consideration is whether the information is “pushed” to the user by the service provider, or whether it is “pulled” by the user. When a user navigates to a website or downloads smartphone application with the intended purpose of informing themselves about their carbon footprint they can be said to be pulling this information, as they have to make a consensus effort to access the service. This “pull” behaviour applies primarily to dedicated carbon calculators websites and emissions tracking applications, as well as fitted driving coaching equipment such as ecoPlus (22). In all cases the individual has made the decision to gather information about how their actions impact upon the environment. It is therefore likely that such individuals will possess a higher level of environmental concern than an average member of the population.

In contrast, individuals tend to access journey planning applications with the primary intention of gaining a better understanding of the transport options available to them (23). Users do not necessarily have to seek out emissions information, rather this information is highlighted in tandem with more desirable travel time and route information. Therefore such information is likely to be viewed by individuals who are not specifically interested in actively learning about their carbon footprint, as well as those who access carbon calculators. As these applications and journey planners provide immediate personal benefit to the user, rather than longer term social benefit, they are likely to have the ability to reach out to more individuals than dedicated carbon calculators ever can.

Information Methods

Table 2 presents an analysis of current methods of providing individuals with information about the environmental consequences of their transport choices. The following characteristics were used to analyse current information sources:

Transport Specific: Does the source deal solely with transport or, as is the case with many carbon calculators, it provides information on emissions arising from multiple activities.

Personalised: Is the information calculated based upon specific characteristics of the user? This could include information relating to driving style, car model or recordings of actual trips taken.

Information Supplied: Does the source only provide emissions information, or whether it is provided in tandem with other data.

Trip Specific: Does the source provide information on a trip specific basis; this may be calculated based on a specific origin-destination pair.

Recommendation/ Alternative Supplied: Does the source supply alternatives to the mode or route that the user has inputted. While it is important to highlight the impact of a trip, it is more useful to make users aware of more sustainable options available to them.

Primary Function: Is the primary purpose of the source to provide emissions information, or is it provided to supplement primary information such as trip time or cost.

Push/Pull: Is the user required to actively seek out emissions information (pull) or is it automatically presented to them as a default (push). Sources where emissions information can be calculated, but is not presented automatically is considered to require a pull.

TABLE 2 DETAILS OF JOURNEY PLANNERS

Resource	Format	Trip Specific	Personalised	Information Supplied	Transport Specific	Recommendations/ Alternatives Supplied	Modes Covered	Primary Function	Push/ Pull
EU Labels ¹	Eco Label	Passive	No	CO2	No	No	Car	Yes	Push
Fuel Economy Label ²	Eco Label	Passive	No	CO2	Yes	No	Car	Yes	Push
Hitheroad.ie ³	Online Journey Planner	Active	No	CO2 & Routes	Yes	Yes	Rail, Light Rail, Bus	No	Push
Route Rank ⁴	Online Journey Planner	Active	No	CO2, Routes & Cost	Yes	Yes	Rail, Car, Air Travel	No	Push
Urban EcoMap ⁵	Online Carbon Calculator	Active	Yes	Heuristics	No	No	Walk, Car, Bike, Public Transport, Hybrid Cars	Yes	Pull
Carbon Diem ⁶	Smartphone Application	Active	Yes	CO2	Yes	No	Walk, Car, Cycle, Metro, Rail, Ferry, Air Travel	Yes	Pull
Ride Off Carbon ⁷	Smartphone Carbon Calculator	Active	Yes	CO2	Yes	No	Car, Walk, Cycle	Yes	Pull
EcoNav ⁸	Dedicated Device	Active	Yes	CO2, Driving	Yes	Yes	Car	No	Push

¹ Council Directive 92/75/EEC of 22 September 1992 on the indication by labelling and standard product information of the consumption of energy and other resources by household appliances

² Environmental Protection Agency. Last retrieved 11.02.2014. <http://www.epa.gov/otaq/carlabel/index.htm>

³ HittheRoad.ie. Last Accessed 15.02.2014

⁴ RouteRANK. Last accessed 13.02.2014. <http://www.routerank.com/en/>

				Recommendations					
Tom-Tom ecoPlus ⁹	Dedicated Device	Active	Yes	CO ₂ , Driving Characteristics	Yes	No	Car	No	Pull
Transport Direct ¹⁰	Online Journey Planner	Active	No	CO ₂ , Routes, and Costs	Yes	Yes	Car, Bus, Light Rail, Metro, Walk	No	Pull
Reittiopas ¹¹	Online Journey Planner	Active	No	CO ₂ , Routes, and Energy Consumption	Yes	Yes	Metro, Bus, Walk, Cycle, Car	No	Push
Google Maps Plug In (REF) ¹²	Extension for Online Journey Planner	Active	No	CO ₂ and Routes	Yes	Yes	Car	No	Pull
Traffic Scotland ¹³	Online Carbon Calculator	Active	No	CO ₂	Yes	Yes	Car, Coach, Rail, Motorbike	No	Pull
Carbon Fund ¹⁴	Online Carbon Calculator	Active	Yes	CO ₂	No	No	Car, Bus, Rail, Air Travel	Yes	Pull
Carbon Footprint.com ¹⁵	Online Carbon Calculator	Active	Yes	CO ₂	No	No	Car, Bus, Rail, Motorbike, Air Travel	Yes	Pull
Loco2.com ¹⁶	Online Journey Planner	Active	Yes	CO ₂ , Route and Cost	Yes	No	Rail	No	Push

⁹ Tom Tom, ecoPlus last accessed 11.02.2014 http://business.tomtom.com/en_ie/products/ecoplus/highlights/

¹⁰ Transport Direct. CO₂ Emissions Calculator <http://www.transportdirect.info/Web2/JourneyPlanning/JourneyEmissionsCompare.aspx?&repeatingloop=Y> . Last accessed 10.02.2014

¹¹ Reittiopas Journey Planner. Last accessed 15.08.2013 <http://www.reittiopas.fi/en>

¹² Oiworld.org. Carbon Footprint for Google Maps. Retrieved from Chrome Web Store 13.02.2014 <https://chrome.google.com/webstore/detail/carbon-footprint-forgoog/ednfpjleanokkjcgjlbmamhlbkddcgh?hl=en>

¹³ Traffic Scotland. CO₂ Emissions Calculator www.trafficscotland.org/carboncalculator/ Accessed 10.02.2014

¹⁴ Carbon Fund Calculator. Last accessed 10.02.2014. <https://www.carbonfund.org/individuals>

¹⁵ Carbon Footprint. Carbon Footprint Calculator. Last accessed 20.02.2014

¹⁶ Loco2. Loco2.com. Last accessed 13.02.2014. <https://loco2.com/>

JourneyOn.co.uk ¹⁷	Online Journey Planner	Active	Yes	CO2, Route, Energy Consumption and Cost	Yes	Yes	Walk, Cycle, Car, Public Transport	No	Push
511 (BETA) SF Bay ¹⁸	Online Journey Planner	Active	Yes	CO2, Route and Cost	Yes	Yes	Walk, Bus, Car, Rail, Ferry, Cable Car	No	Push
CO2GO ¹⁹	Smartphone Application	Active	Yes	CO2	Yes	No	Bus, Metro, Walk, Cycle, Rail, Motorbike, Car	Yes	Pull
Green Meter ²⁰	Smartphone Application	Active	Yes	Fuel Efficiency, CO2, Driving Statistics	Yes	No	Car	Yes	Push
Commute Greener ²¹	Smartphone Application	Active	Yes	CO2 and Route	Yes	Yes	Car, Public Transport, Cycle, Rideshare	Yes	Push
RAC UK ²²	Online Journey Planner	Active	No	Routes and CO2	Yes	Yes	Car, Walking	No	Push

¹⁷ JourneyOn Journey Planner. Accessed 10.02.2014. www.journeyon.co.uk/jplanner#journeytop

¹⁸ 511.org Enhanced Planner (Beta) <http://enhancedtripplanner.transit.511.org/transitmtp/tripplanner/index.aspx#>. Accessed 10.02.2014

¹⁹ CO2GO. Last accessed 13.02.2014. <http://senseable.mit.edu/co2go/>

²⁰ Hunter Research and technology, LLC (2009). greenMeter. [Mobile Software Application]. Retrieved from: <https://itunes.apple.com/en/app/greenmeter/id289973918?mt=8>

²¹ Volvo information Technology. 2013. Commute Greener. [Mobile Software Application]. Retrieved from: <https://play.google.com/store/apps/details?id=com.commutegreener.facebook&hl=en>

²² RAC Route Planner. Last accessed 13.02.2014. <http://www.rac.co.uk/route-planner/>

1 IMPACT OF EMISSIONS INFORMATION

2 As the provision of emissions information is still an emerging area, there are relatively few
3 empirical studies present in the literature concerning the impact that emissions information
4 (24). A number of studies have been conducted with regard to impact of in car coaching to
5 promoting changes in driving technique. Both Boriboonsomsin et al (25) and Martin et al
6 (26) carried out trials of eco driving coaching and saw modest reductions in emissions over
7 the trial period. Fewer studies have been undertaken regarding the impact of emissions
8 information as part of journey planning applications; however experiences in the retail sector
9 have showed mixed results with regard to the provision on emissions information. Studies
10 have indicated that consumers can often find emissions information to be quite confusing
11 (27) and that it is unlikely that this information will play a major role in the purchase of retail
12 goods. Issues such as the “fragmented and haphazard” (28) approach continue to hamper
13 efforts at educating the general population to transport emissions. Findings for Chatterton et
14 al (29) indicate while individuals have knowledge about carbon emissions, other factors such
15 as time, cost, comfort and convenience play greater roles in decision making.

16 CONCLUSIONS

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19 This paper aimed at examining the methods that are currently being employed to increase
20 awareness of the environmental impact of various modes of transport. This analysis has
21 revealed that a wide range of organisations are producing emissions estimates and making
22 these figures available to individuals, in order to help encourage more sustainable transport
23 choices. The internet and smartphone applications provide these organisations with new
24 opportunities to supply more accurate and personalised information at a time close to the user
25 making his/her decision. Many of the organisations that provide emissions information do so
26 as secondary service, and the inclusion of CO₂ estimates into journey planner interfaces
27 provides a prime example of how to an application can be environmentally informative
28 without losing its primary functionality. The combination of emissions estimates with other,
29 potential more desirable information, constitutes an opportunity to inform both concerned
30 individuals and those who are not actively seeking environmental information.

31
32 While these methods cannot alone be expected to create significant alterations in terms of
33 behaviour change, they do mark the recognition of the fact that before individuals can be
34 asked to make sustainable transport decisions, they must first be supplied with the relevant
35 information to do so. As these methods provide individuals with information that may
36 otherwise have been hidden or buried, and therefore absent from consideration during the
37 decision making process, they must be considered as a positive step in terms of encouraging
38 individuals to make sustainable transport choices.

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45 REFERENCES

- 46 1. Bray, D. 2010. The scientific consensus of climate change revisited. *Environmental*
47 *Science and Policy*, Vol. 13, 2010, pp340-350.

2. Kahn Ribeiro, S., S. Kobayashi, M. Beuthe, J. Gasca, D. Greene, D. S. Lee, Y. Muromachi, P. J. Newton, S. Plotkin, D. Sperling, R. Wit, P. J. Zhou, 2007: Transport and its infrastructure. In *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
3. European Commission. 2013. Communication from the commission to the European Parliament, the Council, the European Economic and social committee and the Committee of the Regions: A Roadmap for moving to a competitive low carbon economy in 2050. Brussels. 08.03.2011
4. Anable, J., Lane, B., Kelay, T., 2006. An Evidence Base Review of Public Attitudes to Climate Change and Transport Behaviour. Department for Transport
5. Lorenzoni, I., S. Nicholson-Cole, and L. Whitmarsh. Barriers perceived to engaging with climate change among the UK public and their policy implications. *Global Environmental Change*, Vol. 17, 2007, pp.445-459
6. Thaler, R.H., Sunstein, C.R., 2008. *Nudge: Improving Decisions about Health, Wealth and Happiness*. Yale University Press, New Haven, CT.
7. Manzoni, V., Manilo, D., Kloeckl, K. and Ratti, C. 2011. Transportation mode identification and real-time CO2 emission estimation using smartphones: How CO2GO works (Technical Report), SENSEable City Lab, MIT and Dipartimento di Elettronica e Informazione, Politecnico di Milano, Milan, Italy, 2011.
8. Council Directive 92/75/EEC of 22 September 1992 on the indication by labelling and standard product information of the consumption of energy and other resources by household appliances
9. Environmental Protection Agency. Last retrieved 11.02.2014. <http://www.epa.gov/otaq/carlabel/index.htm>
10. Carbon Fund Calculator. Accessed 10.02.2014. <https://www.carbonfund.org/individuals>
11. World Wildlife Fund. Footprint Calculator. Last accessed 18.02.2014. <http://footprint.wwf.org.uk/>
12. Itproportal. 2013. Retrieved from: <http://www.itproportal.com/2013/08/08/google-maps-is-the-worlds-most-popular-smartphone-app/>
13. Statista. 2013. Facebook leads US app rankings. <http://www.statista.com/topics/840/smartphones/chart/1450/top-15-smartphone-apps-in-the-us/>
14. Transport Direct. CO2 Emissions Calculator <http://www.transportdirect.info/Web2/JourneyPlanning/JourneyEmissionsCompare.aspx?&repeatingloop=Y> . Accessed 10.02.2014
15. JourneyOn Journey Planner. Accessed 10.02.2014. www.journeyon.co.uk/jplanner#journeytop
16. 511.org Enhanced Planner (Beta) <http://enhancedtripplanner.transit.511.org/transitmtp/tripplanner/index.aspx#>. Accessed 10.02.2014

17. Hittheroad.ie Last accessed 15.08.2013 hittheroad.ie
18. Oiworld.org. Carbon Footprint for Google Maps. Retrieved from Chrome Web Store
13.02.2014 <https://chrome.google.com/webstore/detail/carbon-footprint-for-goog/ednfpjleaanokkjcglibmamhlbkddcgh?hl=en>
19. CityRyde LLC (2011). Ride off Carbon (Beta). [Mobile Software Application].
Retrieved from: <https://play.google.com/store/apps/details?id=cityryde.app&hl=en>
20. Carbon Hero Limited. (2013) Carbon Diem {Mobile Software Application}.
Retrieved from: <https://play.google.com/store/apps/details?id=com.carbonhero.carbondiem.ui.android&hl=en>
21. Vexia econav, last accessed 11.02.2014 <https://www.vexia.eu/en/content/8-econav>
22. Tom-Tom, ecoPlus last accessed 11.02.2014
http://business.tomtom.com/en_ie/products/ecoplus/highlights/
23. Brazil, W., Caulfield., B. , Factors affecting the use of transport related smartphone applications, *9th ITS European Congress, Dublin, 2013*
24. Avineri, E., Waygood, E.O.D. 2013. Applying valence framing to enhance the effect of information on transport related carbon dioxide emissions. *Transportation Research Part A* (48), 31-48.
25. Boriboonsomsin, K., Barth, M., Vu, A., Evaluation of driving behaviour and attitude towards eco-driving: A Southern California Limited Case Study. *90th Annual Meeting of the Transportation Research Board, Washington, D.C, January, 2011*
26. Martin, E., Chan, N., Shaheen, S. 2012. Understanding how ecodriving public education can result in reduced fuel use and greenhouse gas emissions. *91st Annual Meeting of the Transportation Research Board-Washington D.C, January 2012.*
27. Upham,P., Dendler, L., and M. Bleda. 2011 Carbon labelling of grocery products: public perceptions and potential emissions reductions. *Journal of Cleaner Production*, Vol. 19, 2011, pp348-355.
28. Gadema, Z., and D. Oglethorpe. The use and usefulness of carbon labeling food: A policy perspective from a survey of UK supermarkets. *Food Policy*, Vol. 36, 2011, pp 815-822
29. Chatterton, T.J. A. Coulter, C. Musselwhite, G. Lyons, S. Clegg. 2009. Understanding how Transport Choices are Affected by the Environment and Health: Views Expressed in a Study on the Use of Carbon Calculators. *Public Health*, Vol. 123, 2009, e45-49.