D4.2: Workflows for sensor data integration into emission inventories: Options for ClearPath and GPC

Carbon Track and Trace 2.0 (CTT2.0) Deliverable

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1. Preface

1.1. About LoCaL

This report was written through support from Low Carbon City Lab (LoCaL). LoCaL aims to reduce 1Gt of CO2 and mobilize €25 billion of climate finance for cities annually by 2050. It is an innovation platform aiming to provide cities with better tools for assessing greenhouse gas emissions, planning, investing and evaluating progress. Started in 2015, LoCaL is a growing community of more than 20 organisations dedicated to unlocking climate finance for cities. This report was realized as part of the project Closing the Gap through Transformative LoCaL Action (CGTLA) under LoCaL. LoCaL is a Climate-KIC flagship programme.

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1.2. About Climate KIC

Climate-KIC is the EU's largest public private partnership addressing climate change through innovation to build a zero carbon economy. We address climate change across four priority themes: urban areas, land use, production systems, climate metrics and finance. Education is at the heart of these themes to inspire and empower the next generation of climate leaders. We run programmes for students, start-ups and innovators across Europe via centres in major cities, convening a community of the best people and organisations. Our approach starts with improving the way people live in cities. Our focus on industry creates the products required for a better living environment, and we look to optimise land use to produce the food people need. Climate-KIC is supported by the European Institute of Innovation and Technology (EIT), a body of the European Union.

1.3. About Carbon Track and Trace

The Carbon Track and Trace (CTT) project is intended to provide cities with real-time greenhouse gas (GHG) measurement capability. Traditional methods of building and maintaining municipal GHG emission inventories are expensive, time-consuming, and are of questionable utility for mitigation decision and planning support processes. CTT couples low-cost, open source sensors to a Big Data analytics platform that provides cities and regions with a unique capacity to directly measure the impacts of their policy and planning decisions and to develop a semi-autonomous system for building, maintaining, and reporting their annual GHG emissions.

2. Executive Summary

Data on GHG emissions has become the cornerstone for implementation of mitigation projects on key scopes such as Energy consumption or Transport.

The need for offering tools (both on and off-line) for data capturing is increasing worldwide, as there are several standards for data reporting, collection and communication. Aligning standards plus reliable tools provides leverage for both researchers and policy makers in the continuous process of reducing emissions through the implementation of effective actions and policies on mitigation.

This report discusses the importance of sensor-based data to be integrated into GHG inventories. It examines the example of the ClearPath tool as its purpose is to develop GHG inventories, and how the integration could be pivotal for monitoring policy impact.

3. Intro

A number of tools and protocols support cities and municipalities in aggregating yearly emission data into a single yearly report. Such tools are the basis of the discussion here on how to integrate such yearly inventories with ongoing emission measurements on the ground.

ClearPath is a Web based tool created and managed by ICLEI USA that provides a standard aligned way of reporting an emission inventory aligned with the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). The tool provides a platform that allows users such as cities to report several inventory years and compare, model, track, and analyse data according to their needs, opening opportunities for collaboration and data integration. ClearPath is fully integrated with the carbon*n* Climate Registry and supports further standards than GPC.

As part of this study, the requirements and features of ClearPath will be described and the Transport sector particular requirements alignment will be analysed according to the Carbon Track and Trace project. Since the main focus of CTT is ground level transport at city, the compulsory requirements for GPC reporting using ClearPath will be examined and summarized for the purpose of the document. This reports is based on the findings from the report "*GPC inventory data quality assessment report - Special Focus on Transport Sector*[1]" which studied how the cities modelled their data for transport in order to fill data gaps as well as the limitation of not having On-ground measuring devices/facilities that would easily allow mapping of emissions and why is important to integrate such measuring into a reporting tool.

[1] Source: GPC inventory data quality assessment report - Special Focus on Transport Sector, CTT Deliverable 4.1, Carreño, Deng-Beck (2016)

4. ClearPath™

4.1. Description

ICLEI USA's ClearPath™ (CP) was developed as an all-in-one suite taking into account the need of a tool that allowed the accurate reporting of GHG emissions at city level, considering all of the community related standards existing; CP assists in the conversion from any other standard to GPC requirements. ICLEI USA[2] developed and manages the tool which has been vastly promoted inside the United States and currently at global level on its free of charge ClearPath Global[3] version. The main difference between CP and CP Global is that; thanks to the integration of ClearPath as authorized tool for developing and reporting GHG Inventories for the Compact of Mayors the GPC module in CP Global is available free of charge until 2019). This means that the tool is strictly oriented to Local Governments use. Protocol compliance is the main goal of the tool, providing precise allocation of scopes and sectors as required by GPC.

Compact of Mayors and the GPC

The Compact of Mayors is a global city initiative that relies on GPC inventories to publicize cities emissions. Cities should demonstrate commitment for taking action against climate change in both mitigation and adaptation. Cities must develop a BASIC inventory as minimum requirement for the first year and have further 2 years to reach BASIC + inventories.

GPC is the only accepted protocol for reporting community based inventories on this initiative, totals and sector final values are later made public on their website along with Adaptation related documentation such as Action Plan and Vulnerability Assessment.

4.2. User requirements

In order to start using CP, the user must register and prove that is part of a local government's staff. This requires an official e-mail from the local authority including key information listed below:

Organization information:

- Local government name

[2] Link: http://icleiusa.org/
[3] Link: http://www.clearpath.global/

- Geographic area
- Latitude/longitude
- Country
- Local government type

Contact information:

- First name
- Last name
- Title
- Department/division
- E-mail
- Phone
- Preferred language[4]

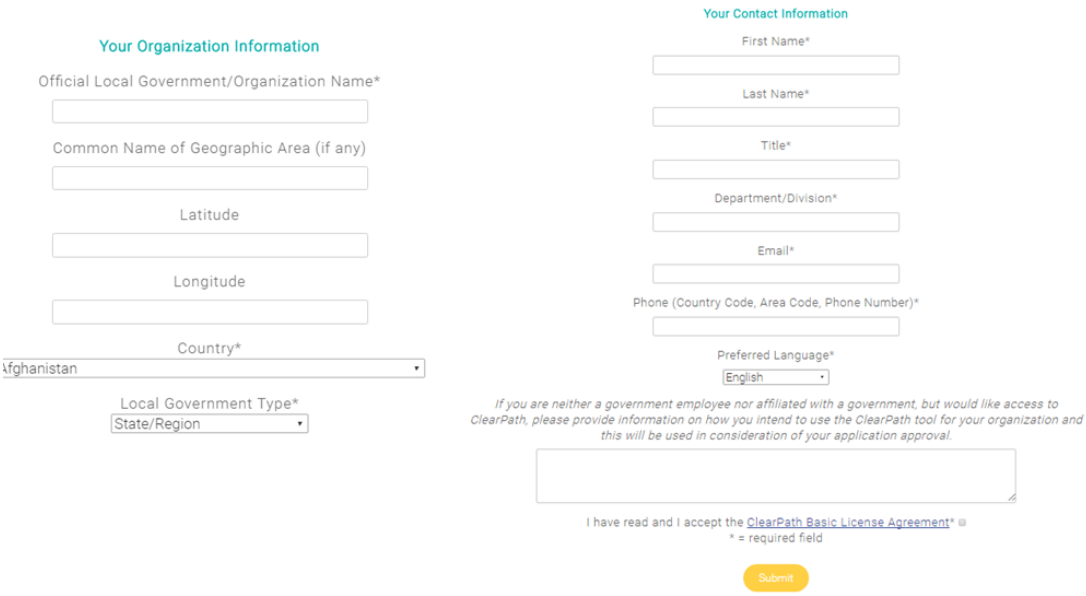


Image 1 Screenshot of registering screen for ClearPath global[5]

Once the registration data has been received, a notification is delivered to the web manager for the program and any related partner (this may vary between initiatives). The web manager follows up and replies with an activation email granting authorization for using the tool.

Researchers and government representing professionals can request access to the tool, but its availability is limited to these two groups in order to maintain high quality data and usefulness of the tool.

4 Clear-Path currently offers English and Portuguese
5 Source: http://www.clearpath.global/

5. Data requirements for transport sector GHG emissions

According to data input from GPC users, the sector with most challenges for first hand data collection is transportation. The main constraint is proper quantification for fuel volume which counts with several variables such as:

- Fuel volume
- Engine efficiency
- Data disaggregation for proper allocation
- Lack of accurate local data

Although not common practice, inventory developers rely on modelling from downscaling national available data; mirroring similar scenarios or heavy use of ASIF (Activity, share, intensity and Fuel) model.

This reflects the need of establishing proxy data that will enhance final results. The inclusion of a second flow of first-hand information for calculation is needed. Addition of extra data to extrapolate values for a more accurate estimation is deeply needed as at the moment local governments and inventory developers are still limited by data constraints for activity and later on for allocation.

5.1. Fuel Sales methodology

This methodology calculates emissions on the basis of fuel combusted in-boundary; CP provides special options for this particular sub-sector:

- Gasoline records reveal tailpipe control characterization options
- Activity Location field sets Scope
- Electricity Records can be for Use and T&D loss which further refines Scope and GPC Reference Number
- Travel Type Field is for informational purposes only
-

Requirements for this sector are shown below:

- Gasoline records require knowledge of the proportion of fuel consumed with different tailpipe controls (Advanced, Oxidation Catalyst, or Uncontrolled). These must add to 100%
- Biofuel Blends require blend percentage

This methodology is consistent with national and international practices for GHG measuring, less costly and the technical requirement for calculation is not as high as its counterpart.

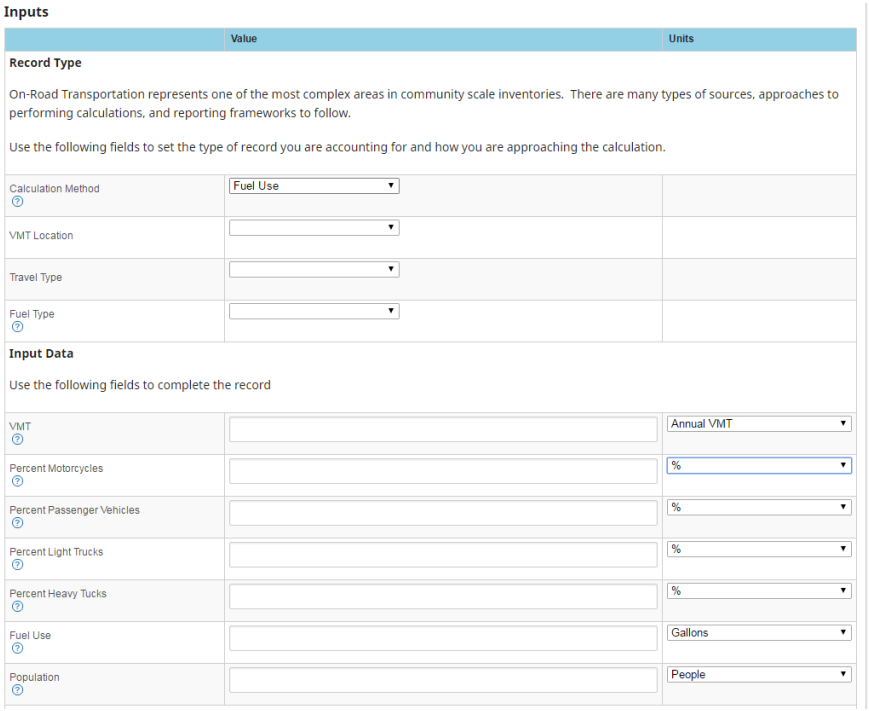


Image 8 Data entry for Fuel sale methodology[6]

5.2. Vehicle Kilometre Travelled

This methodology calculates emissions on the basis of distance and user-supplied on-road emissions factor.

Special options provided for this methodology are described below.

- Activity Location field sets Scope
- Multiple records will be needed to support different vehicle classes and fuels

This methodology can be adjusted using International Metric or Imperial system (Km vs Miles). It can produce detailed and actionable information for further planning. Although integrates better with transport model, it requires time and more financial resources that Fuel Sales Method.

[6] Source: http://www.clearpath.global/

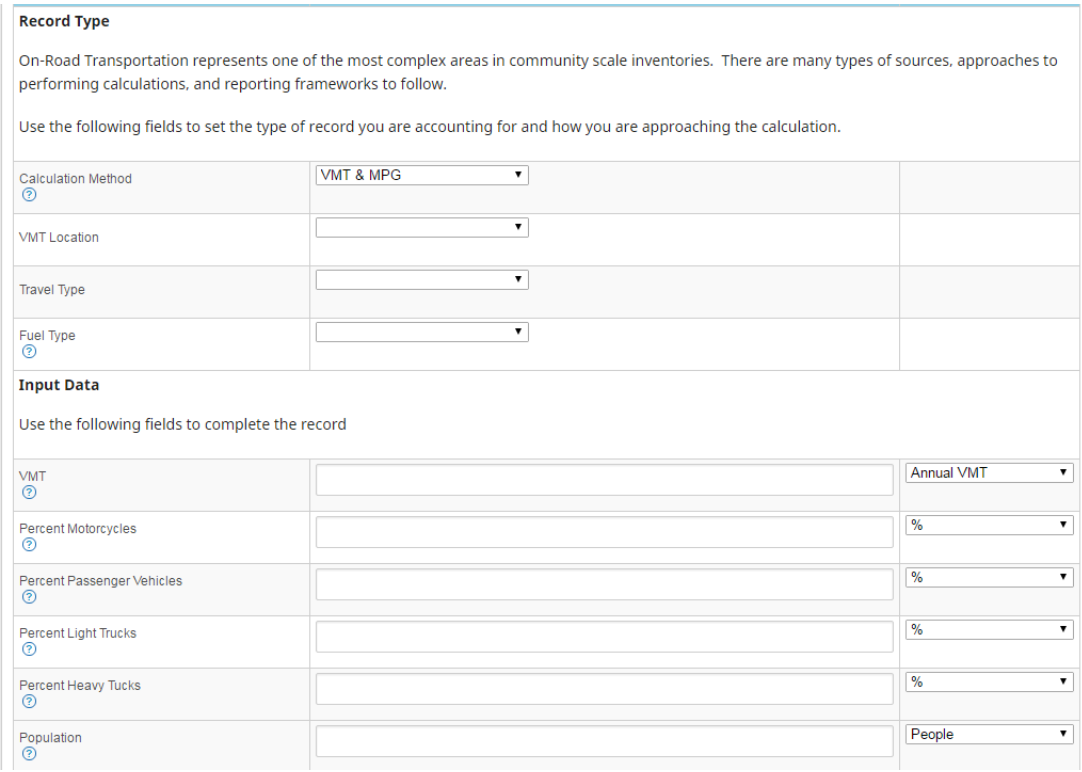


Image 9 Data Entry for VKT Methodology (Shown as VMT for Miles on imperial system)[7]

6. Alternatives for data enhancement

6.1. Sensor based data

Sensor-obtained data is considered first-hand information which aids in modelling and tracking down progress and achievements.

Measures of emissions can be done through well established and recognized methodologies that can provide estimation, but the need of enhancing and implementing actions against climate change is based on the assumption that Data cannot be disaggregated as needed. Mapping of emissions is a key factor for such activity and On-site data capturing provides accurate overview of when and where are the emissions happening.

As nodes are deployed throughout the local government boundaries, information can be obtained and transmitted on real time to a central data collection facility, aiding in the mapping of emissions against complying local/national environmental regulations and facilitating the development of further mitigation actions.

[7] Source: http://www.clearpath.global/

The utilization of integrated sensor services offers a unique opportunity for data storing without the inconveniences of compiling information from thousands of sources depending on the methodology and the limitations for geographical scope e.g. fuel volume invoices. All information provided from sensors can feed a data stream on real time, adding key variables that have been proven useful against climate change and urban health issues. As depicted in flow-chart 1, using data from two different sources enhances data quality and reporting communication. Two data sources with different indicators on a particular scope can improve modelling.

Earlier versions of the carbon*n* Climate Registry (cCR) captured indicators for air quality under a community performance tab; this capturing process is currently being updated to allow representation on cities profile available at the cCR website. ClearPath is a reporting tool fully integrated to the cCR GPC tab through a fully functioning API (Application program interface) ,which was implemented in 2016 as part of the joint efforts with Compact of Mayors initiative to amplify the use of the tool by simplifying the reporting process between the calculation (ClearPath) and the reporting (cCR) tool[8], if reported. This means that the data captured through sensors can be modelled to demonstrate the behaviour of the ppm concentration against the monthly emissions accounted during the inventory development exercise.

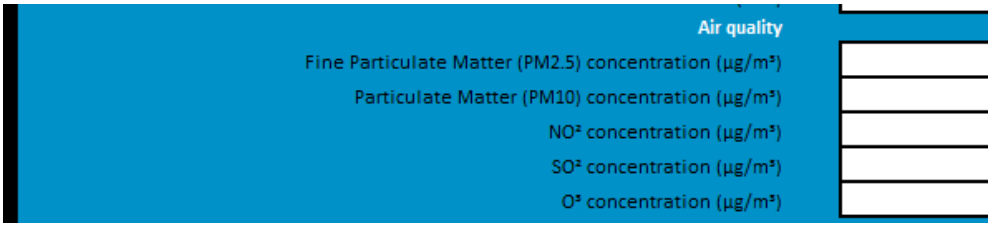


Image 1 Air quality section of cCR Off Line reporting sheet version 2.0

The output for Transport sector provided by ClearPath produces a set of indicators depending on the methodology used for calculation. This is an initial summary of the data available for the calculation, visual representation of the output table below on image 2.

Outputs

Name	Value
On Road VMT	
Fossil Fuel Energy Equivalent (MMBtu)	
Biofuel Energy (MMBtu)	
CO2 (MT)	0
CH4 (MT)	
N2O (MT)	
Biogenic-CO2 (MT)	0
Biofuel CH4 (MT)	0
Biofuel N2O (MT)	0
CO2e (MT)	0
Emissions per Capita (MT CO2 per Person)	
GPC Scope	
GPC Reference Number	
US-CP Reporting Framework	

Image 2 ClearPath outputs for transport sector for calculation

[8] ClearPath offers a One-click data transfer to cCR through the use of a pre-defined token which serves as the id for the reporting city and links both platforms allowing data exchange that can be added to the city profile in carbon*n* Climate Registry.

ClearPath also produces a monitoring output on the achievements of policy implementation; with the condition that more than one inventory is reported on the tool. This output provides a summarized breakdown of sources of emissions, allocated to fuel type for on road transportation.

Outputs

Name	Value
On Road Gasoline VMT Reduced	0
On Road Gasoline CO2e Reduced	0
On Road Diesel VMT Reduced	0
On Road Diesel CO2e Reduced	0
Transit Gasoline VMT Reduced	0
Transit Gasoline CO2e Reduced (MT)	0
Transit Diesel VMT Reduced	0
Transit Diesel CO2e Reduced (MT)	0
Transit CNG VMT Reduced	0
Transit CNG CO2e Reduced (MT)	0
Transit LNG VMT Reduced	0
Transit LNG CO2e Reduced (MT)	0
Transit LPG VMT Reduced	0
Transit LPG CO2e Reduced (MT)	0
Transit Ethanol VMT Reduced	0
Transit Ethanol CO2e Reduced (MT)	0
Transit Biodiesel VMT Reduced	0
Transit Biodiesel CO2e Reduced (MT)	0
Transit Electric VMT Reduced	0
Transit Electric CO2e Reduced (MT)	0
Total Emissions Reduced (MT CO2e)	0
Cost Effectiveness (MTCO2e Reduced / $)	

Image 2 ClearPath outputs for monitoring record for transport sector

Constraints for data and complexity of allocation (geographical scope) are the two key factors that limit accurate results on transport sector. This has been identified using the quality assessment provided by reporting cities using GPC and cCR, activity data and emission factors have gone through a quality assessment provided by the reporting city where the reliability of the data is identified according to their source and tier[9].

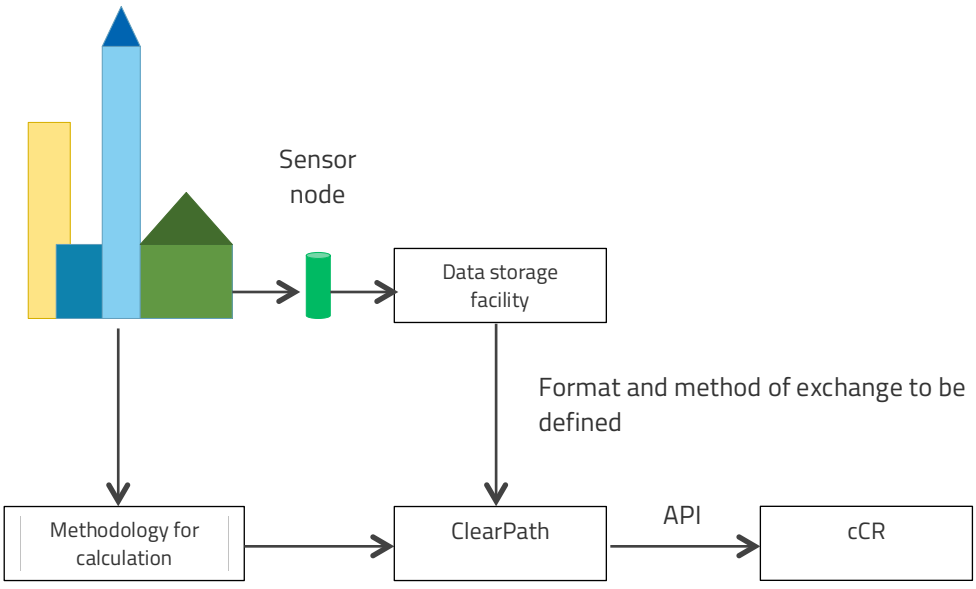
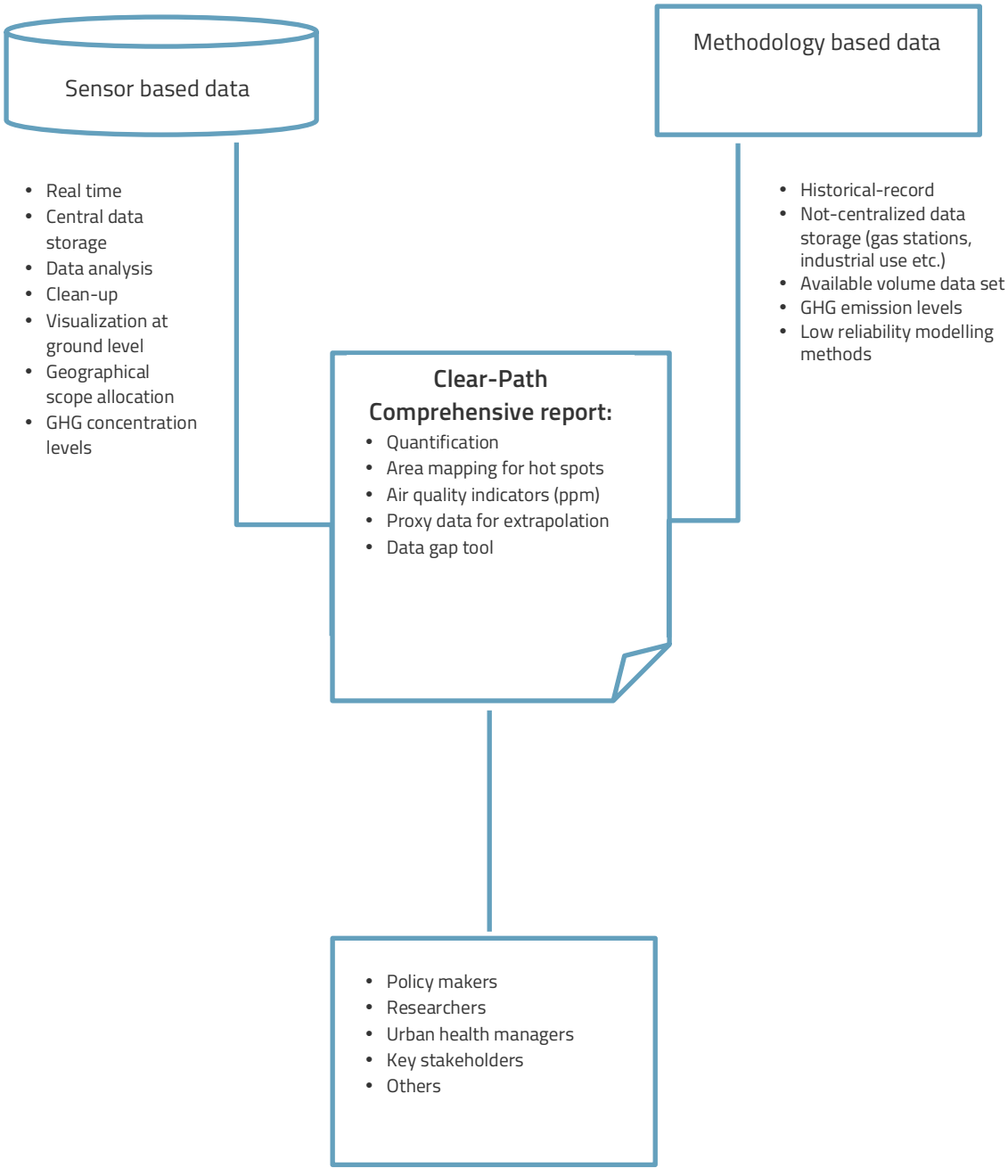


Image 3 Plausible scenario for direct data feed into ClearPath and its connection to cCR report showing two flow streams

[9] Source: Source: GPC inventory data quality assessment report - Special Focus on Transport Sector, CTT Deliverable 4.1, Carreño, Deng-Beck (2016)



Flowchart 1 Key aspects of sensor data integration for GHG Inventory development

6.2. Sensor data benefits

The inclusion of sensors distributed as nodes on a geographically defined region is expected to be useful for transparency purposes[10].

The integration of sensor based data on tools such as ClearPath through data packages delivery using platform to platform exchange facility or simplified manual input by the user; would be a powerful for GHG measurement and reporting, as such, it empowers the user (researcher, policy maker, general public) by providing clear overview of emissions and a friendly interface. Allowing data entry on GHG concentrations can enable comparability to establish co-relation between the quantified emissions value and the air quality (concentration of CO_2 ppm); this will aid to develop indicators for a proper monitoring of effectiveness of policy implementation in both health and environmental scopes.

GPC´s Summary tables created by ClearPath could also include for example CO_2 ppm measured values suited for validation of data which ensures data quality as the tool allows the inclusion of supporting documents including the integration of real time data to enhance data quality. ClearPath includes an integrated component that allows the upload of supporting documentation for reported data in each sector and sub sector; adding extra layers for quality check, providing transparency and consequently, allowing further updates of methodologies for transport calculation.

The export feature could provide stand-alone tables and files that could integrate visualization of data and links and references to supporting documents, rounding up the data package for interpretation and consolidation. ClearPath is currently on an amplification stage among new users as is currently available free of charge for its module on GHG Emissions reporting and modelling; this favours data capture on a standardized format that allows data integration vertically (Sub-national + national) and horizontally (group of sub-national governments) and comparability among similar communities. Although useful for annual comparability the inclusion of a more organic data record evolution will enhance its capabilities.

The wide range of data analysis opportunities could help establish a correlation, between volume and spatial impact of the emissions allowing detailed graphic representation with integrated indicators to observe emissions behaviour on a pre-defined time period as well as concentrations for spatial planning.

Integrating sensor-based data into an online platform can be done through delivery of data packages on a regular basis, pre-defined by the platform user in coordination with the managers of both platforms. Tools such as ClearPath can generate .csv and .xls files which can be easily used as the preferred mean to capture numbers on both parties for data exchange as well as export for interpretation by third parties.

[10] Libelium CTT Case Study: http://www.libelium.com/enhancing-environmental-control-and-reducing-emissions-in-nordic-smart-cities/, CTT project page: http://carbontrackandtrace.com/

7. Conclusions

The inclusion of first hand data aligned with proxy data for modelling will enable the development of accurate emission levels.

Although based on file data (fuel sales) or modelled data (VKT), the process can be enhanced with the inclusion of similar parameters that will provide enhance co-benefits such as measurements for Air Quality control for monitoring the effectiveness of climate policies for new engines and fuels. First hand data can also enhance comparability between cities which may vary their methodology based on induced activity.

Piloting real time sensor data projects will enable both researchers and policy makers to map out needs and develop effective policies for reducing GHG emissions while tackling other urban issues such as air quality. The advantage of having a unified system centralizing information which will be fed to a GHG reporting tool is that it can provide a more accurate result on real time with unified streams of information; hence, reducing quality uncertainty.

Data from multiple sources can enhance and improve results of modelling scenarios; not only reproducing accurate data but providing a trace for real-time first hand data. The ability of collecting samples on a 24 hours period adds traceability of emissions unlike volume based calculations which can trace emissions per type of fuel but not impact per geographical scope e.g. ppm concentrations on key sectors of the urban scope. If data is properly interpreted and managed it can demonstrate slight variations in concentration during the analysis period that can support the development of early adopted and future urban GHG mitigation policies as it will adapt to the organic progression of the data flow.

Transparent monitoring and verification of policy impact is the cornerstone of responsible policy making attracting interest of both public and private sector in order to look for further quality improving of fuel, engines and urban transit planning to reduce focus of low quality air in heavily dense cities.

For example, some car engine manufacturers are looking for new ways of reducing emissions which will have an impact only demonstrable by ground measuring by various means such as modelling methodologies, exhaust pipe measuring and concentrations on the urban atmosphere which is only achievable by the use of sensors at street level. Some organizations representatives have stated that the technology to lower emissions by 50% is already in existence, which depends on coordination of efforts of industry and policy makers[11]. A change towards the use of Electric Vehicles is also part of the GHG reducing strategies implemented in several countries but all of these are more of a long term goal that rather immediate solution, hence, its impact on the ground will be seen in years from now instead of immediate results; which can be observed on fuel switch and transit related projects.

It is important to establish an integrated measuring system due to increasing national governments pressure for the reduction of CO2e emissions; the means to produce reliable data need to diversify and improve on reliable measuring and modelling. This involves many sectors such as scientific/industrial (engine development, Bio fuel, fuel saving strategies), public (policy development, raise awareness) NGO (initiatives, recognition) and Financial (availability of

[11] Source: https://www.scientificamerican.com/article/how-to-reduce-car-made-pollution/

resources for key projects) as it has been recognized that decarbonisation is associated with both environmental and health benefits.

In conclusion, adding continuously measured data to yearly inventories can serve as a valuable complementary activity. The systems are not yet fully ready, but some initial work has been done and a certain integration of the reporting can be made. A fuller integration or a second data stream to fully validate emission inventories would need better data quality on both sides and a stronger integration to fully integrate this workflow in future inventory and reporting systems.

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