Establishing an Inventory of Consumption and Emission of F-gases in Thailand

"Methodology and Preliminary Results"

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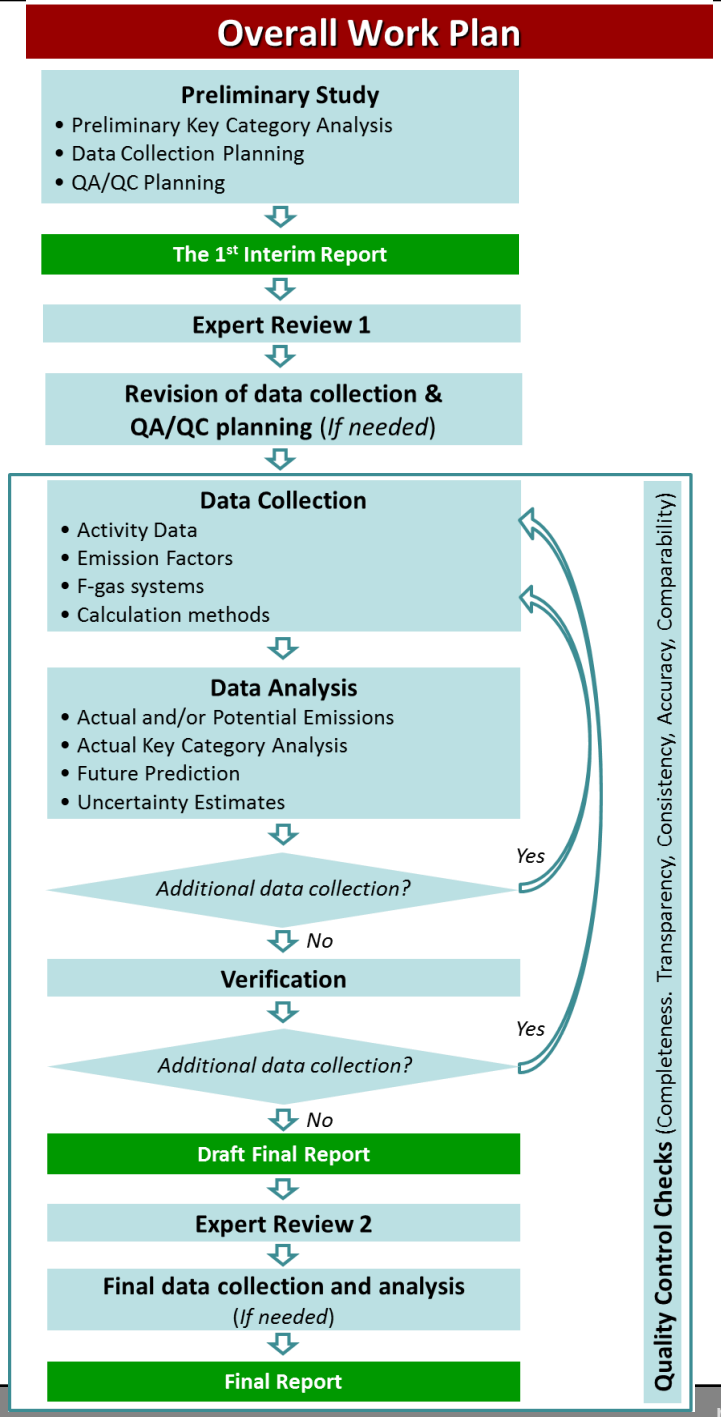
Agenda

- Overview of the inventory development
- Methodology
- Preliminary results
- Barriers for the inventory development
- Present status and future steps for inventory development

Overview of the inventory development

F-Gas Inventory Development Procedure



F-Gas Inventory Development Procedure

Overall Work Plan

Preliminary Study

- Preliminary Key Category Analysis
- Data Collection Planning
- QA/QC Planning

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The 1st Interim Report

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Expert Review 1

⇩

Revision of data collection & QA/QC planning (*If needed*)

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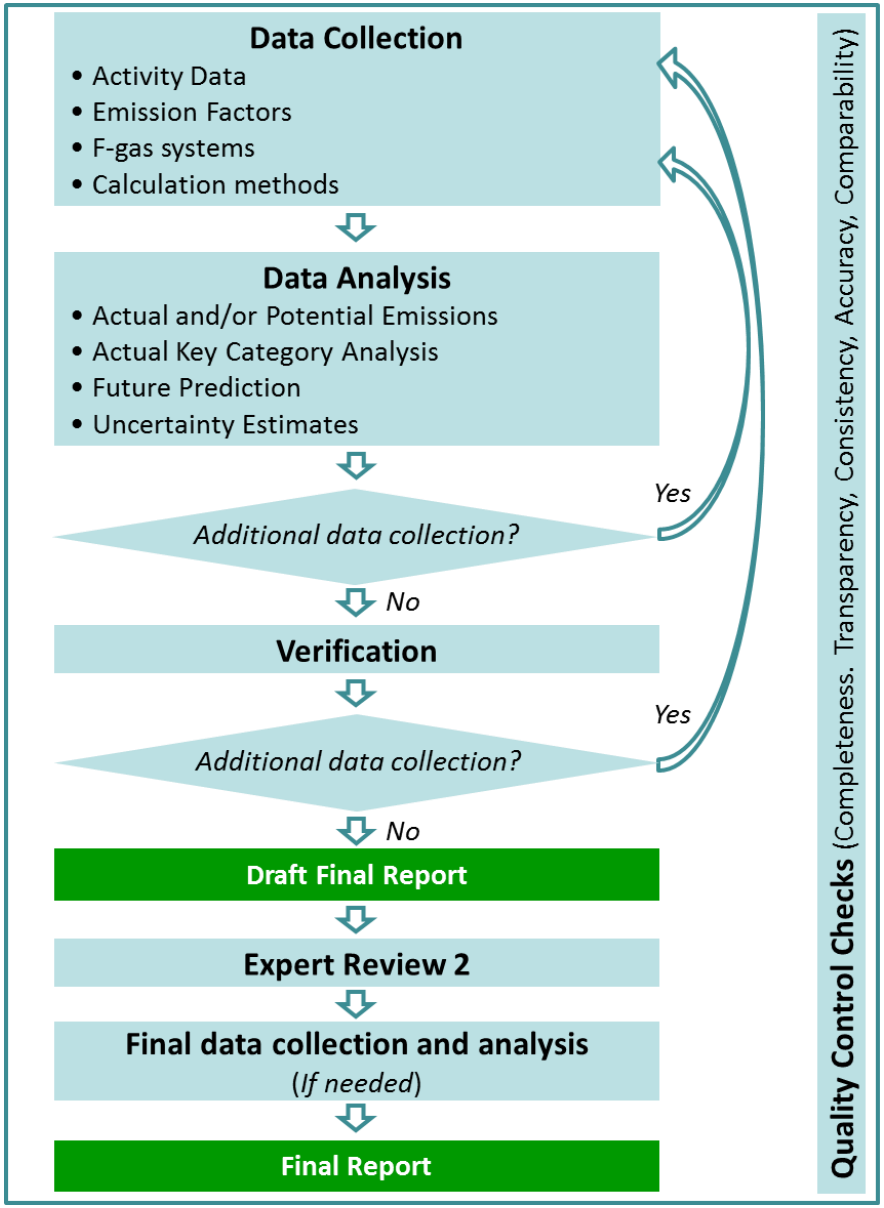
F-Gas Inventory Development Procedure

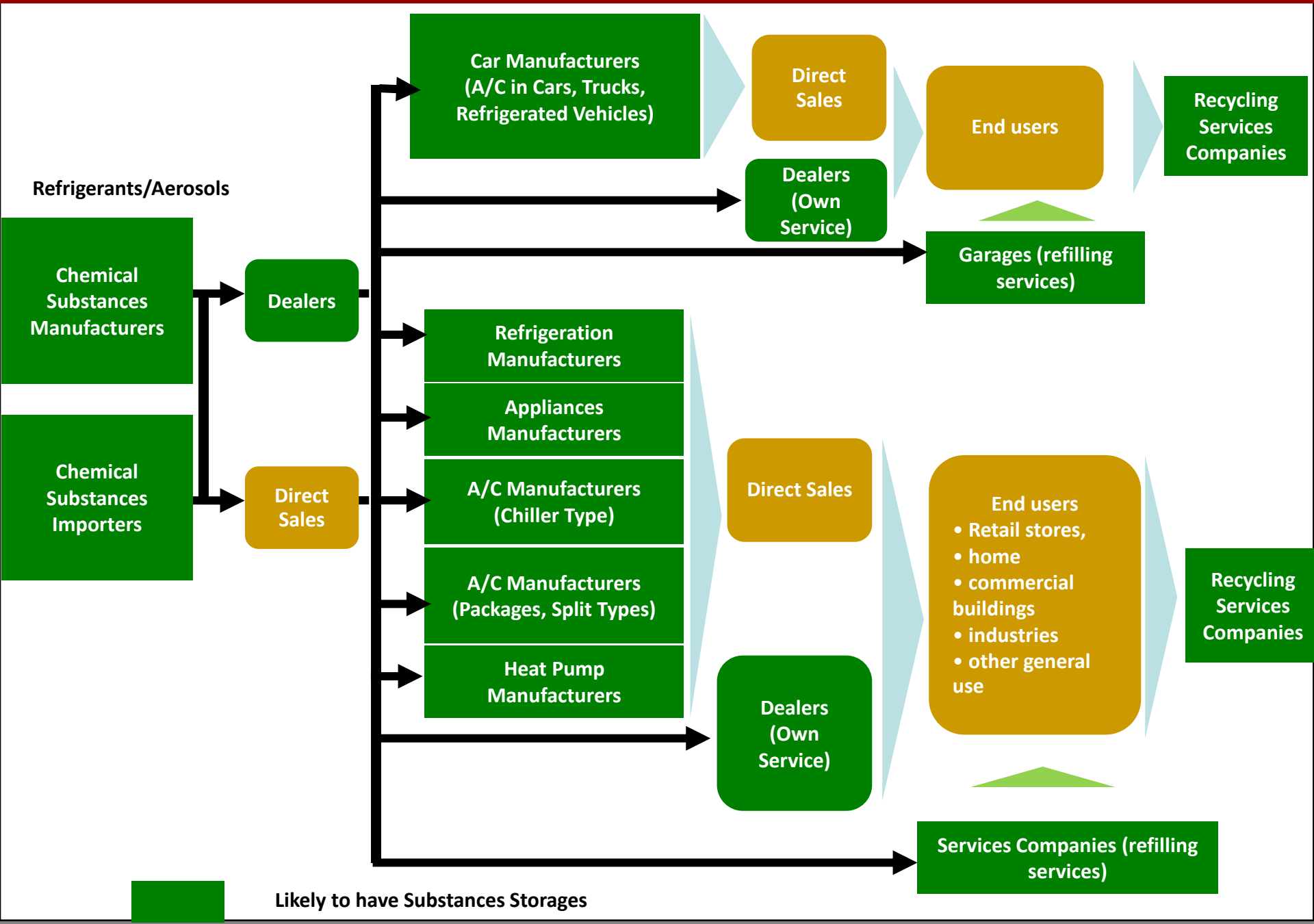


Sectors and subsectors for data collection in this project

Sectors and sub-sectors (S)	Appliance systems / Applications
S1 RAC, Unitary air conditioning	Self-contained air conditioners Spilt residential air conditioners Split commercial air conditioners Duct split residential air conditioners Commercial ducted splits Rooftop ducted Multi-splits
S2 RAC, Chillers	Air conditioning chillers Process chillers
S3 RAC, Mobile air-conditioning	Car air conditioning Large vehicle air conditioning
S4 RAC, Domestic Refrigeration	Domestic Refrigeration
S5 RAC, Commercial Refrigeration	Stand-alone equipment Condensing units Centralised systems for supermarkets

Sectors and sub-sectors (S)	Appliance systems / Applications
S6 RAC, Industrial Refrigeration	Integral Condensing units Centralised systems for supermarkets
S7 RAC, Transport Refrigeration	Refrigerated trucks/trailers
S8 Foams	PU Flexible Foam Continuous/Discontinuous PU Flexible Moulded Foam PU Integral Skin Foam PU Continuous Panel/Flexible panel PU Discontinuous Panel PU Appliance Foam PU Continuous/Discontinuous Block PU Spray Foam PU Pipe-in-Pipe PU OCF (bottle foam) PU Rigid foam all other applications XPS Extruded Polystyrene boards
S9 Other sectors	Electrical power systems (Gas insulated switch gear and circuit breakers) Aerosols Metered dose inhalers Solvent cleaning Fire suppression

F-Gas Distribution Flow Chart



Methodology

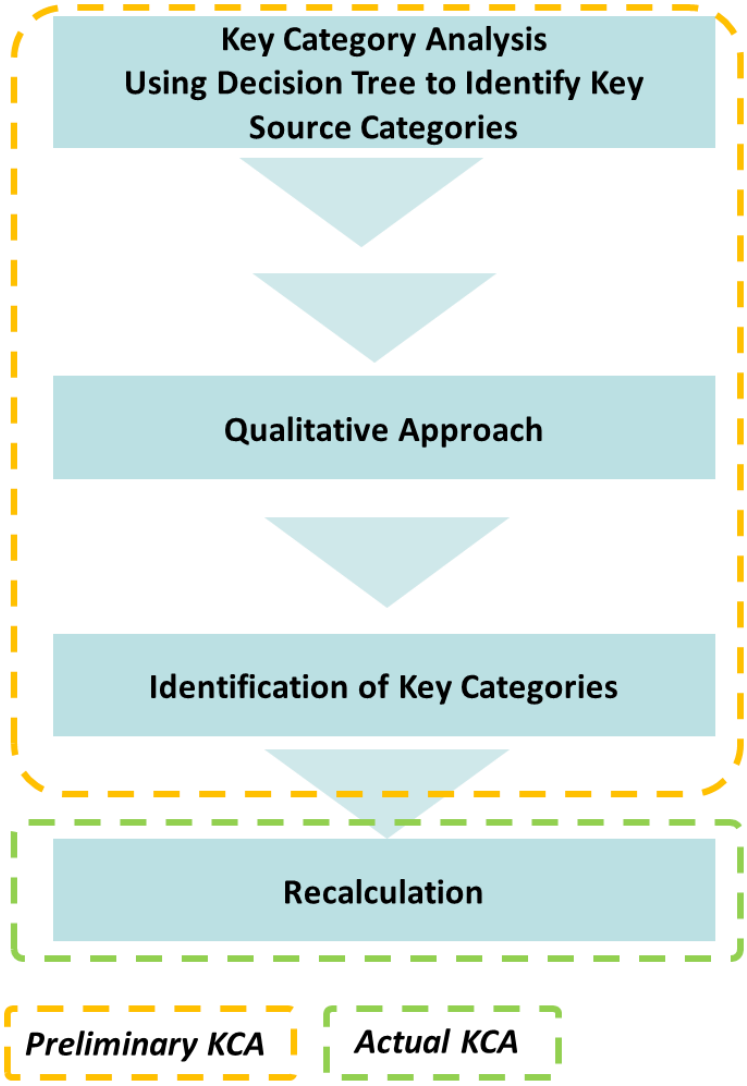
- **IPCC (1997),** Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Intergovernmental Panel on Climate Change (IPCC), United Nations Environment Programme (UNEP), Organization for Economic Co-operation and Development, International Energy Agency. Paris.

- **IPCC (2000),** IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. IPCC, National Greenhouse Gas Inventories Programme, Montreal, IPCC-XVI/Doc.10 (1.IV.2000). May 2000.

Methodology

- Key category analysis approach
- Inventory data management
- Data collection activities
- Data analysis
- QA/QC process
- Verification process

Methodology: Key Category Analysis Approach



Key Consideration

- Inventory Data Availability
- Country Specific Uncertainties

Using Tier 1

- Source Level Assessment (>95%)
- Trend Assessment (>95%)

or Tier 2 to identify key categories

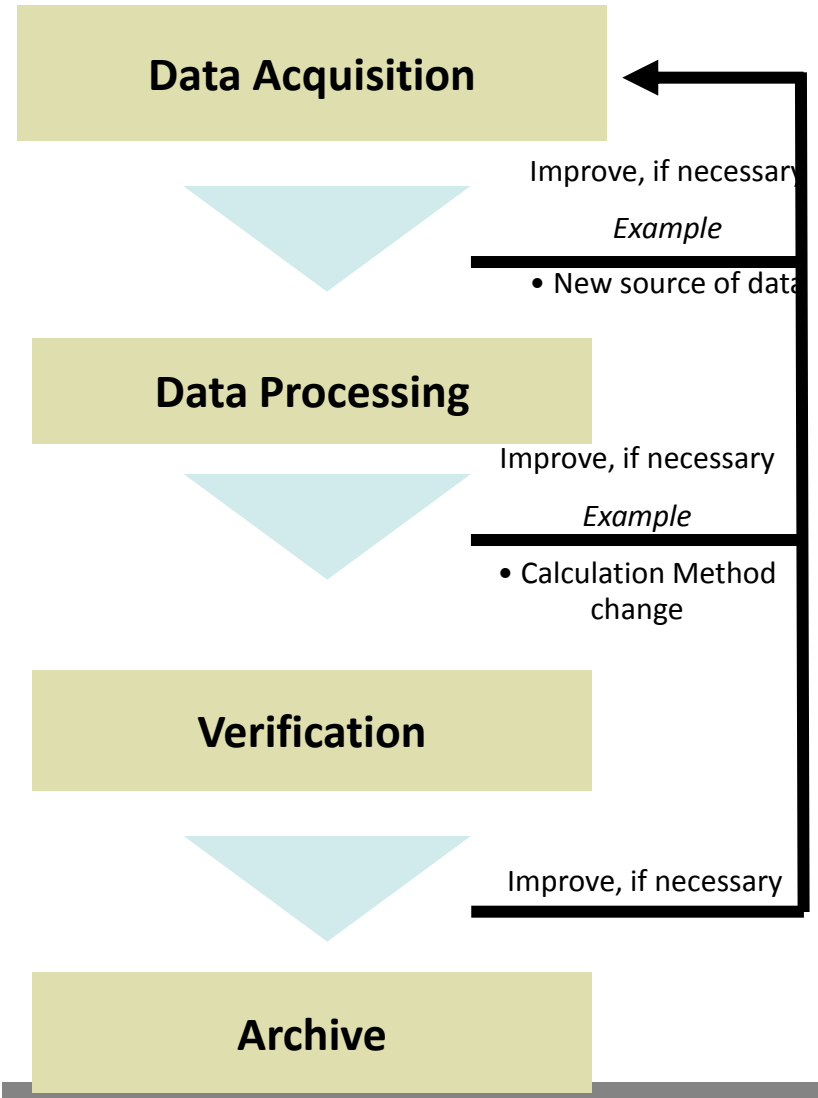
Key Consideration

- Mitigation techniques and technologies
- High expected emission growth
- High uncertainty
- Unexpectedly low or high emission

Key Consideration

- Available data have changed
- Change of Methods
- New Source
- Errors

F-Gas Inventory Data Management



Data/Parameter	QC/QA Plan
• Activity Data • Emission Factor • Emission • Calculation Method	• Completeness Check • Transparency Check • Consistency Check • Method Selection Check
• Calculation Method • Emission • Uncertainties ✓ Adopt Revised IPCC 1996 ✓ Adopt Good Practice Guide	• Completeness Check • Transparency Check • Consistency Check • Accuracy Check • Comparability Check
• Activity Data • Emission Factor • Emission • Calculation Method • Uncertainties • Assumptions, Criteria • Supporting Documents	• Completeness Check • Transparency Check • Consistency Check • Accuracy Check • Comparability Check

Data Collection Activities for Manufacturers, Suppliers and Service Providers

Prepare questionnaire for each sector

Invitation for Focus Group Meetings

Focus Group Meetings with different sectors

Contact to gather inventory data

Send questionnaires

Comments and revisions based on meetings/interviews with Air Con Club, FTI, TRA, TATA, EEI, GIZ Proklima

- Project brief, Explain data collection method and data analysis,
- Questionnaire tests
- Describe mutual benefits for providing data

Non Disclosure Agreement

Interviews | Site-visits | Questionnaire

Data Analysis

Tools Used

- Revised IPCC 1996
- Mass Balance Method
- Estimation Method

Data Input

Data Preparation
- Develop set of questions relevant to each sector
- List name of manufacturers, suppliers, end users

Decision Tree

Related data
- Type of refrigerants
- Quantities of refrigerants
- Types of equipment used refrigerant
- Numbers of equipment
- Handling method
- Storage method
- Equipment age
- Maintenance and service record on refrigerant refill
- Report of chemicals substances to regulators – Hazardous Substances Control Bureau

CHOICE OF METHOD

CHOICE OF EMISSION FACTORS

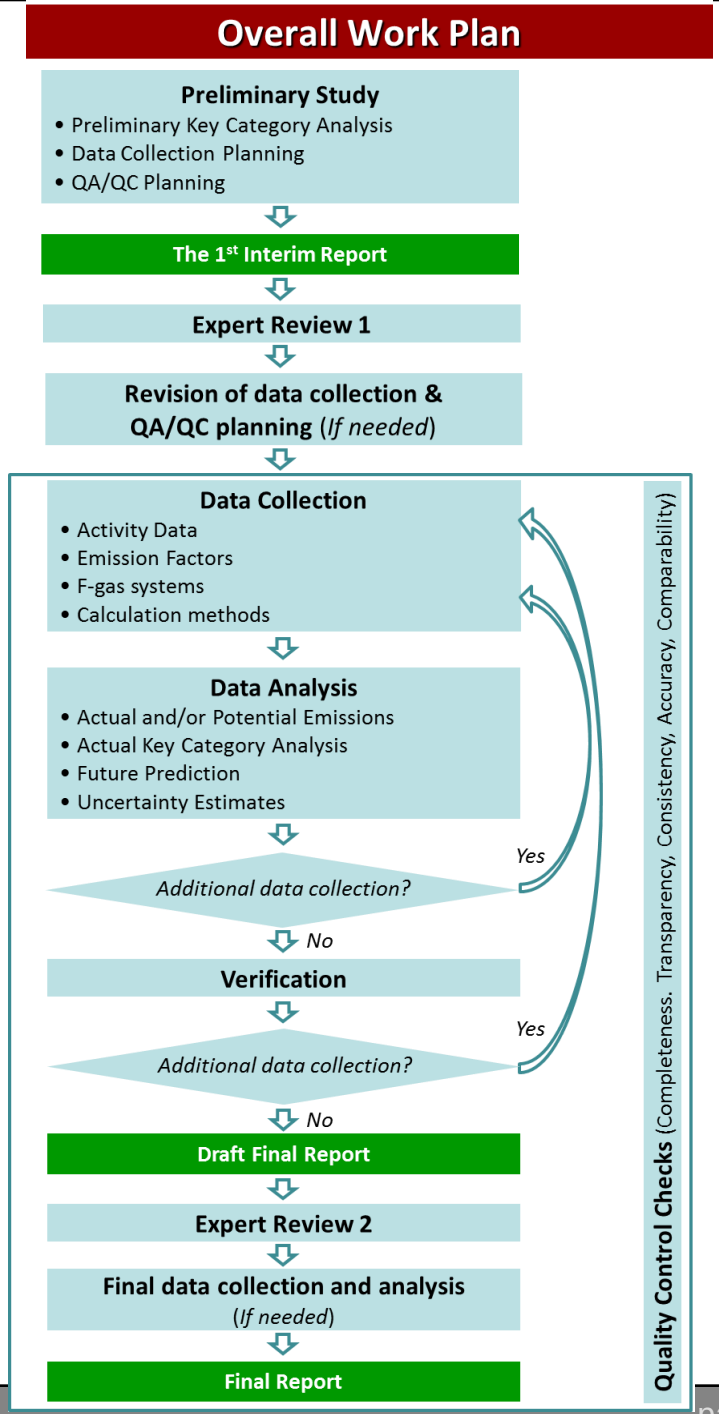
CHOICE OF ACTIVITY DATA

COMPLETENESS

DEVELOPING A CONSISTENT TIME SERIES

UNCERTAINTY ASSESSMENT

QA/QC Process



Verification process

- National level

⇒ Comparisons with other national emissions data

⇒ Comparison with national scientific and other publications

- Bottom-up comparisons using international comparative tools

⇒ Comparisons of top-down and bottom-up estimate

⇒ Comparisons of national emission inventories with independently complied, international datasets

⇒ Comparisons of emission factors between countries

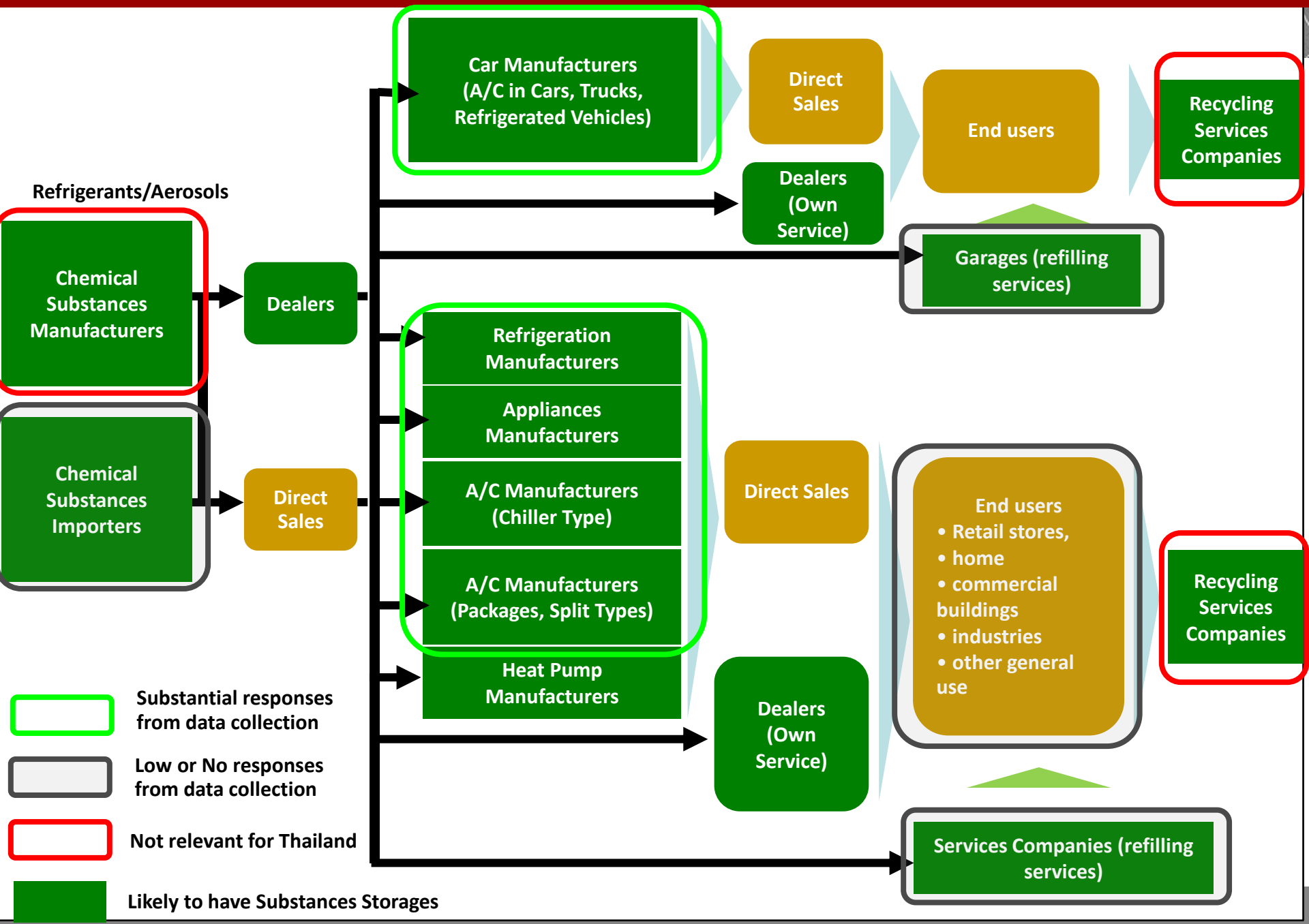
- Comparisons with international scientific publications, global or regional budgets and source trends

⇒ Check activity data completeness, accuracy and correlate to calculation method selected

Preliminary Results: Key Category Analysis

Sector (S)	Description	Key Category Flag *		
		HFC, PFC and SF_6 Emissions	CFCs Emissions	HCFCs Emissions
S1	RAC, Unitary air conditioning	Yes (Level, Trend)	Yes (Level)	Yes (Level, Trend)
S2	RAC, Chillers			
S3	RAC, Mobile AC			
S4	RAC, Domestic Refrigeration			
S5	RAC, Commercial Refrigeration			
S6	RAC, Industrial Refrigeration			
S7	RAC, Transport Refrigeration			
S8	Foams	No	Yes (Level)	Yes (Level, Trend)
S9	Other sectors (Electrical power systems, Aerosols, MDI (Metered dose inhalers), Solvent cleaning, Fire suppression)	Yes (Level, Trend) ***Only for Electrical power systems*** Yes (Trend) ***Only for MDI and Solvent***	No	No

F-Gas Distribution Flow Chart



Preliminary results: F gas consumption

All sectors (t)

F-gas type	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CFCs		4,281	2,269	1,862	1,381	1,242	444	300	190	141	0
HCFCs					4,222	12,547	13,553	9,966	12,460	11,281	13,895
HFCs		307	1,082	1,700	1,788	2,042	2,305	2,435	3,401	3,619	4,219
PFCs										8	18
SF6										24	43

RAC sectors (t)

F-gas type	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CFCs		3,395	1,799	1,476	1,095	985	352	238	151	112	0
HCFCs					3,348	9,950	10,748	7,903	9,880	8,945	11,019
HFCs		294	1,036	1,629	1,713	1,956	2,208	2,333	3,259	3,467	4,041

Foam sectors (t)

F-gas type	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CFCs		788	417	343	254	229	82	55	35	26	0
HCFCs					777	2,309	2,494	1,834	2,293	2,076	2,557

* Data from Thai Custom Department and the Department of Industrial Works

Consumption = Production + Import – Export

Preliminary results: RAC Production Figures

S	Appliance systems/Applications	2005	2006	2007	2008	2009	Upscale 2010
S1	Self-contained air conditioners	19,825	23,791	28,549	34,258	41,110	49,332
	Split residential air conditioners	2,232,315	2,678,778	3,214,534	3,857,441	4,628,929	5,554,715
	Split commercial air conditioners	115,154	138,184	165,821	198,985	238,782	286,539
	Duct split residential air conditioners	956,707	1,148,048	1,377,657	1,653,189	1,983,827	2,380,592
	Commercial ducted splits	49,352	59,222	71,066	85,279	102,335	122,802
	Rooftop ducted	0	0	0	0	0	-
	Multi-splits	69,633	83,559	100,271	120,325	144,390	173,268
S2	Air conditioning chillers	43	51	61	74	88	106
	Process chillers	-	-	-	-	-	-
S3	Car air conditioning	638,960	766,752	920,102	1,104,122	1,324,947	1,589,936
	Large vehicle air conditioning	24,801	29,761	35,713	42,856	51,427	61,712
S4	Domestic refrigeration	2,270,145	2,724,173	3,269,008	3,922,810	4,707,372	5,648,846
S5	Stand-alone equipment	91,494	109,793	131,751	158,101	189,722	227,666
	Condensing units (End user)	589	707	721	737	655	706
	Centralised systems for supermarkets (End users)	18	31	36	38	29	68
S6	Cold Storage Industry (End-users)	24	27	24	18	9	18
	Food Processing Industry (End-users)	-	-	-	-	-	-
	Centralised systems	-	-	-	-	-	-
S7	Refrigerated trucks/trailers	357	357	286	286	429	500

Preliminary results: RAC Domestic Sales Figures

S	Appliance systems/Applications	2005	2006	2007	2008	2009	Upscale 2010
S1	Self-contained air conditioners	4,499	5,399	6,478	7,774	9,329	11,195
	Split residential air conditioners	747,254	896,705	1,076,046	1,291,256	1,549,507	1,859,408
	Split commercial air conditioners	91,657	109,989	131,987	158,384	190,061	228,073
	Duct split residential air conditioners	320,252	384,302	461,163	553,395	664,074	796,889
	Commercial ducted splits	39,282	47,138	56,566	67,879	81,455	97,745
	Rooftop ducted	0	0	0	0	0	0
	Multi-splits	37,592	45,111	54,133	64,959	77,951	93,542
S2	Air conditioning chillers	132	159	191	229	274	329
	Process chillers	0	0	0	0	0	0
S3	Car air conditioning	342,407	410,888	493,066	591,679	710,015	852,018
	Large vehicle air conditioning	34,733	41,679	50,015	49,617	48,544	61,712
S4	Domestic refrigeration	261,242	313,491	376,189	451,426	541,712	650,054
S5	Stand-alone equipment	40,519	48,623	58,347	70,017	84,020	100,824
	Condensing units	589	707	721	737	655	706
	Centralised systems for supermarkets	18	31	36	38	29	68
S6	Cold Storage Industry (End-users)	24	27	24	18	9	18
	Food Processing Industry (End-users)						-
	Centralised systems						-
S7	Refrigerated trucks/trailers	357	357	286	286	429	500

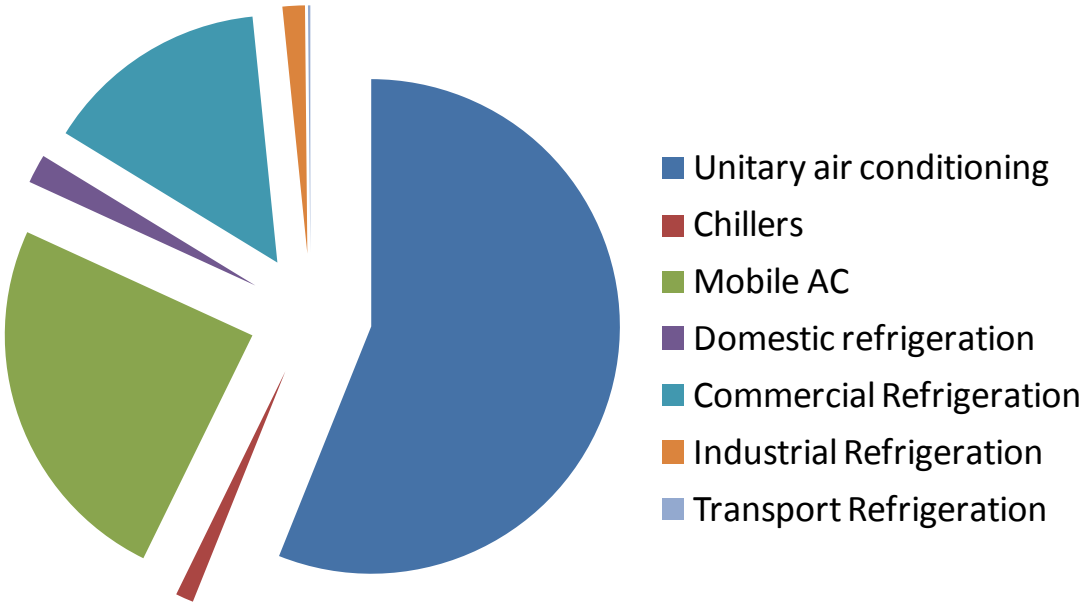
Domestic Sales = Production + Import – Export

Preliminary results: RAC Stock Figures

S	Appliance systems/Applications	2005	2006	2007	2008	2009	Upscale 2010
S1	Self-contained air conditioners	15,870	19,047	22,858	27,432	32,920	39,505
	Split residential air conditioners	3,706,669	4,145,034	4,696,320	5,381,006	6,223,845	7,254,698
	Split commercial air conditioners	323,330	388,043	465,695	558,873	670,684	804,855
	Duct split residential air conditioners	1,129,718	1,355,826	1,627,143	1,952,711	2,343,380	2,812,173
	Commercial ducted splits	138,570	166,304	199,583	239,517	287,436	344,938
	Rooftop ducted						
	Multi-splits	132,610	159,152	191,000	229,216	275,074	330,103
S2	Air conditioning chillers	903	975	1,069	1,188	1,337	1,522
	Process chillers						
S3	Car air conditioning	4,686,910	4,716,856	4,813,287	4,985,467	5,244,782	5,605,145
	Large vehicle air conditioning	426,236	432,553	445,395	465,717	484,286	500,544
S4	Domestic refrigeration	16,065,498	15,255,707	14,552,150	13,958,196	13,479,076	13,122,182
S5	Stand-alone equipment	124,657	149,594	179,518	215,425	258,514	310,220
	Condensing units	3902	4609	5329	6066	6721	7427
	Centralised systems for supermarkets	198	229	265	302	332	400
S6	Cold Storage Industry (End-users)	182	206	233	258	276	285
	Food Processing Industry (End-users)						
	Centralised systems						
S7	Refrigerated trucks/trailers	2509	2699	2876	2970	3057	3282

Preliminary results: HFC emissions

- Current HFC emissions (CO_2eq) in the year 2012



- Contribution of HFC emissions to overall GHG emissions: 1.3%
- **3.4 $MtCO_2$** out of 266 $MtCO_2$eq (year 2004; source: TGO 2012)
- 4.3% considering HCFC and HFC (11.5 $MtCO_2$eq)

Barriers for the inventory development

- Top-down data collection

⇒ Only aggregated data at national level are accessible. Sectoral data cannot be obtained

⇒ Difficulties in data collection from the 1st order distributors (F-gas traders)

⇒ Total production data are not always available for all sub-sectors

Barriers for the inventory development

- Bottom-up data collection

⇒ Difficulties in “historical” and “stock” data collection (for primary data)

⇒ Time-demanding processes (for all data collection activities)

⇒ Primary data from companies are often incomplete and required additional data treatment

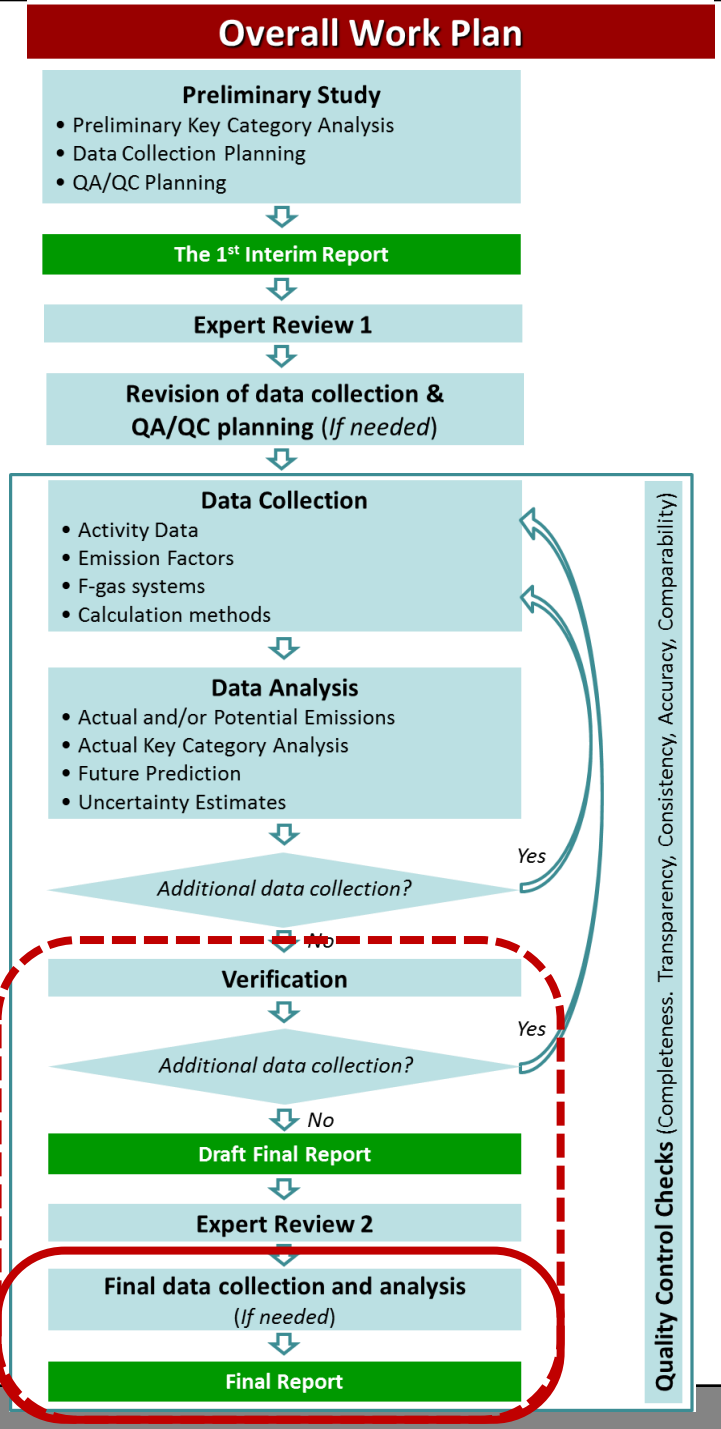
⇒ The most problematic sectors

1) Industrial Refrigeration Sector

2) Foam Sector

Present status and future steps for inventory development

F-Gas Inventory Development Procedure



Questions, Comments and Suggestions

Thank you