

Methodological Choice and Key Categories Analysis GHG Training Workshop

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Outline

1. Methods: Tier 1, 2, 3

2. *Key Category*

3. How to define *Key Categories*: Approach 1, 2

4. Conclusion

Methods: Tier 1, 2, 3

➤ **Tiers:** A tier represents a level of methodological complexity.

Usually three tiers are provided:

- Tier 1 is the basic method,
- Tier 2 - intermediate and
- Tier 3 - most demanding in terms of complexity and data requirements

Tiers 2 and 3 are sometimes referred to as higher tier methods and are generally considered to be more accurate

Methodological Choice

- **Methodological choice for individual source and sink categories is important in managing overall inventory uncertainty** (it is lower when emissions and removals are estimated using the most rigorous methods)
- **However, these methods generally require more extensive resources for data collection, so it may not be feasible to use more rigorous method for every category** (therefore it is good practice to identify those categories that have the greatest contribution to overall inventory)
- **By identifying these key categories in a systematic and objective manner, inventory compilers can prioritise their efforts and improve their overall estimates** (it is good practice to use results of key category analysis as a basis for methodological choice to improve inventory quality and to increase confidence in the GHG estimates)

Key Category

A *key category* is one that is prioritised within the national inventory system because its estimate has a significant influence on a country's total inventory of greenhouse gases in terms of:

- *the absolute level,*
- *the trend, or*
- *the uncertainty in emissions and removals.*

Key Category

- *Key Categories* should be the priority for countries during inventory resource allocation for data collection, compilation, quality assurance/quality control and reporting.
- In general, more detailed *higher tier methods* should be selected for *key categories*

How to Define Key Categories

1. Disaggregate categories to the lowest possible level:

- to sub-category (e.g., to a fuel type – liquid, gaseous, solid)
- to individual gas (use GWP).

2. Apply two Approaches:

- Approach 1 – Level and Trend Assessment
- Approach 2 – Level/Trend + Uncertainty Assessment

Key categories: Approach 1, 2

- Approach 1 – Level and Trend Assessment:
Key categories - 95% cumulative effect
- Approach 2 – Level/Trend + Uncertainty Assessment:
Key categories - 90% cumulative effect

Removals: expressed as positive numbers
(inclusion/exclusion)

Example of Level Assessment

			Emission/ Removal
1A1	Fuel Combustion Activities - Energy Industries: Solid	CO ₂	10000
1A1	Fuel Combustion Activities - Energy Industries: Liquid	CO ₂	200
1A2	Fuel Combustion Activities - Manufacturing Industries and Construction: Solid	CO ₂	1300
1A2	Fuel Combustion Activities - Manufacturing Industries and Construction: Gas	CO ₂	123
1A3a	Fuel Combustion Activities - Transport - Civil Aviation	CO ₂	5502
3A2	Manure Management	CH ₄	543
3B1a	Forest Land Remaining Forest Land	CO ₂	-2345
3B1b	Land Converted to Forest Land	CO ₂	879

Example of Level Assessment

			Emission/ Removal	Absolute
1A1	Fuel Combustion Activities - Energy Industries: Solid	CO ₂	10000	10000
1A1	Fuel Combustion Activities - Energy Industries: Liquid	CO ₂	200	200
1A2	Fuel Combustion Activities - Manufacturing Industries and Construction: Solid	CO ₂	1300	1300
1A2	Fuel Combustion Activities - Manufacturing Industries and Construction: Gas	CO ₂	123	123
1A3a	Fuel Combustion Activities - Transport - Civil Aviation	CO ₂	5502	5502
3A2	Manure Management	CH ₄	543	543
3B1a	Forest Land Remaining Forest Land	CO ₂	-2345	2345
3B1b	Land Converted to Forest Land	CO ₂	879	879
				20892

Example of Level Assessment

			Emission/ Removal	Absolute	Level
1A1	Fuel Combustion Activities - Energy Industries: Solid	CO ₂	10000	10000	47.9%
1A1	Fuel Combustion Activities - Energy Industries: Liquid	CO ₂	200	200	1.0%
1A2	Fuel Combustion Activities - Manufacturing Industries and Construction: Solid	CO ₂	1300	1300	6.2%
1A2	Fuel Combustion Activities - Manufacturing Industries and Construction: Gas	CO ₂	123	123	0.6%
1A3a	Fuel Combustion Activities - Transport - Civil Aviation	CO ₂	5502	5502	26.3%
3A2	Manure Management	CH ₄	543	543	2.6%
3B1a	Forest Land Remaining Forest Land	CO ₂	-2345	2345	11.2%
3B1b	Land Converted to Forest Land	CO ₂	879	879	4.2%
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Example of Level Assessment

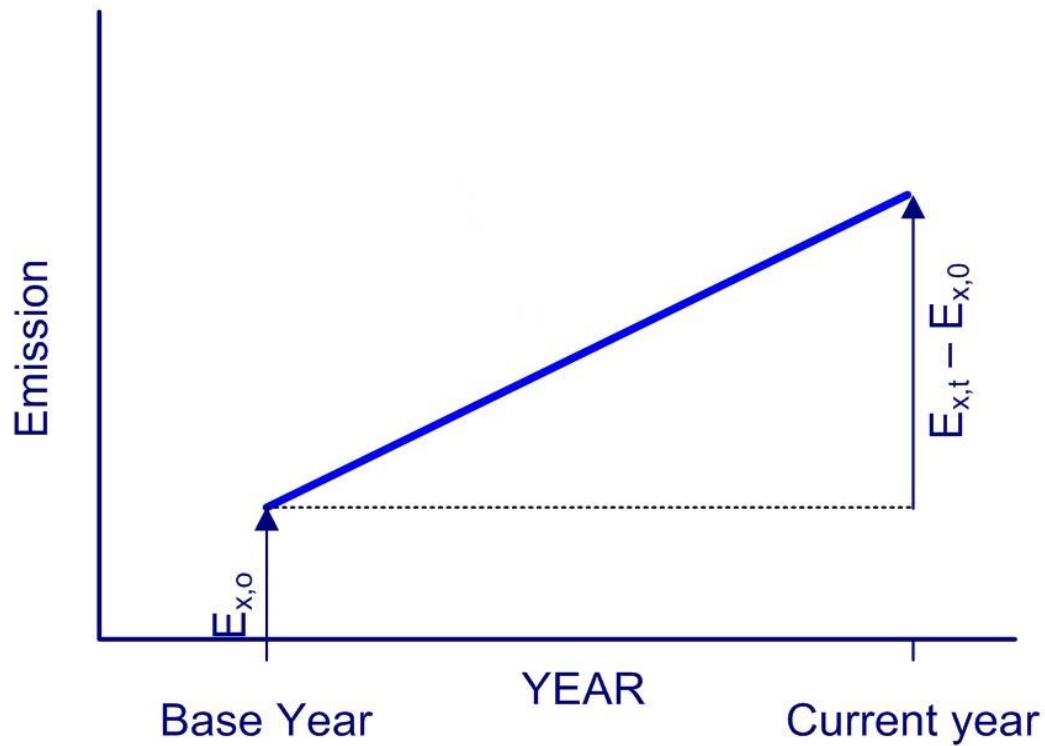
			Emission/ Removal	Absolute	Level
1A1	Fuel Combustion Activities - Energy Industries: Solid	CO ₂	10000	10000	47.9%
1A3a	Fuel Combustion Activities - Transport - Civil Aviation	CO ₂	5502	5502	26.3%
3B1a	Forest Land Remaining Forest Land	CO ₂	-2345	2345	11.2%
1A2	Fuel Combustion Activities - Manufacturing Industries and Construction: Solid	CO ₂	1300	1300	6.2%
3B1b	Land Converted to Forest Land	CO ₂	879	879	4.2%
3A2	Manure Management	CH ₄	543	543	2.6%
1A1	Fuel Combustion Activities - Energy Industries: Liquid	CO ₂	200	200	1.0%
1A2	Fuel Combustion Activities - Manufacturing Industries and Construction: Gas	CO ₂	123	123	0.6%
				20892	

Example of Level Assessment

			Emission/ Removal	Absolute	Level	Cumulative
1A1	Fuel Combustion Activities - Energy Industries: Solid	CO ₂	10000	10000	47.9%	47.9%
1A3a	Fuel Combustion Activities - Transport - Civil Aviation	CO ₂	5502	5502	26.3%	74.2%
3B1a	Forest Land Remaining Forest Land	CO ₂	-2345	2345	11.2%	85.4%
1A2	Fuel Combustion Activities - Manufacturing Industries and Construction: Solid	CO ₂	1300	1300	6.2%	91.6%
3B1b	Land Converted to Forest Land	CO ₂	879	879	4.2%	95.8%
3A2	Manure Management	CH ₄	543	543	2.6%	98.4%
1A1	Fuel Combustion Activities - Energy Industries: Liquid	CO ₂	200	200	1.0%	99.4%
1A2	Fuel Combustion Activities - Manufacturing Industries and Construction: Gas	CO ₂	123	123	0.6%	100.0%
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Approach 1 : Trend

- The trend assessment identifies categories whose trend is different from the trend of the total inventory, regardless whether category trend is increasing or decreasing, or is a sink or source.
- Categories whose trend diverges most from the total trend should be identified as **key**, when this difference is weighted by the level of emissions or removals of the category in the base year.



$$T_{x,t} = \frac{|E_{x,0}|}{\sum_y |E_{y,0}|} \cdot \left| \left[\frac{(E_{x,t} - E_{x,0})}{|E_{x,0}|} \right] - \frac{\left(\frac{\sum_y E_{y,t} - \sum_y E_{y,0}}{\sum_y |E_{y,0}|} \right)}{\left| \frac{\sum_y E_{y,0}}{\sum_y |E_{y,0}|} \right|} \right|$$

Category
Significance

Category Trend

Overall Trend

IPCC Category Code	IPCC Category	Greenhouse Gas	$E_{x,0}$	$E_{x,t}$	Trend assessment	% Contribution to Trend	Cumulative Total of Column G
			(Gg CO ₂ eq)	(Gg CO ₂ eq)	$T_{x,t}$		
1A1	Energy Industries: Solid	CO ₂	9 279	17 311	0.086	0.194	0.194
1A1	Energy Industries: Peat	CO ₂	3 972	9 047	0.060	0.135	0.329
1A1	Energy Industries: Gas	CO ₂	2 659	6 580	0.048	0.107	0.436
1A4	Other Sectors: Liquid	CO ₂	6 714	5 651	0.035	0.078	0.514
1A2	Manufacturing Industries and Construction: Solid	CO ₂	6 410	5 416	0.033	0.074	0.588
4A	Solid Waste Disposal	CH ₄	3 678	2 497	0.028	0.062	0.650
3C4	Direct N ₂ O Emissions from Managed Soils	N ₂ O	3 513	2 619	0.023	0.052	0.702
1A3b	Road Transportation	CO ₂	10 800	11 447	0.023	0.051	0.752
1A2	Manufacturing Industries and Construction: Liquid	CO ₂	4 861	4 736	0.016	0.036	0.788
3A1	Enteric Fermentation	CH ₄	1 868	1 537	0.010	0.023	0.811
2F1	Refrigeration and Air Conditioning	HFCs, PFCs	0	578	0.008	0.018	0.830
2B2	Nitric Acid Production	N ₂ O	1 595	1 396	0.008	0.017	0.846
3C2	Liming	CO ₂	618	277	0.007	0.015	0.861
2A1	Cement Production	CO ₂	786	500	0.006	0.014	0.876
1A2	Manufacturing Industries and Construction: Peat	CO ₂	1 561	1 498	0.005	0.012	0.888
1A2	Manufacturing Industries and Construction: Gas	CO ₂	2 094	2 174	0.005	0.011	0.899
1A3b	Road Transportation	N ₂ O	160	516	0.005	0.010	0.909
3C5	Indirect N ₂ O Emissions from Managed Soils	N ₂ O	735	592	0.004	0.009	0.919
3A2	Manure Management	N ₂ O	623	461	0.004	0.009	0.928
1A5	Non-Specified: Liquid	CO ₂	734	1 083	0.003	0.006	0.934
3C1	Biomass Burning	CO ₂	180	91	0.002	0.004	0.938
1A3e	Other Transportation	CO ₂	644	651	0.002	0.004	0.942
1A4	Other Sectors: Gas	CO ₂	98	225	0.001	0.003	0.946
1A3c	Railways	CO ₂	191	134	0.001	0.003	0.949
1A5	Non-Specified: Gas	CO ₂	222	363	0.001	0.003	0.952
Total			70 692	85 352	0.445	1	

Approach 2: Level/Trend + Uncertainty

$$LU_{x,t} = \left(L_{x,t} \cdot U_{x,t} \right) / \sum_y \left[\left(L_{y,t} \cdot U_{y,t} \right) \right]$$

$$TU_{x,t} = \left(T_{x,t} \cdot U_{x,t} \right)$$

L and *T* - the level and trend assessment,
U - the uncertainty for category *x* in year *t*

IPCC Category Code	IPCC Category	Greenhouse Gas	$E_{x,t}$ (Gg CO ₂ eq)	$ E_{x,t} $ (Gg CO ₂ eq)	LU _{x,t}	Cumulative Total of Column F
3B1a	Forest Land Remaining Forest Land: carbon stock change in biomass	CO ₂	-21 354	21 354	0.23	0.23
3C4	Direct N ₂ O Emissions from Managed Soils: Agricultural Soils	N ₂ O	2 608	2 608	0.18	0.41
3B3a	Grassland Remaining Grassland: net carbon stock change in mineral soils	CO ₂	2 907	2 907	0.09	0.50
3C5	Indirect N ₂ O Emissions from Managed Soils	N ₂ O	592	592	0.06	0.56
1A3b	Road Transportation: Cars with Catalytic Converters	N ₂ O	410	410	0.05	0.61
2B2	Nitric Acid Production	N ₂ O	1 396	1 396	0.04	0.66
3B2a	Cropland Remaining Cropland: net carbon stock change in organic soils	CO ₂	1 324	1 324	0.04	0.70
3B4ai	Peatlands Remaining Peatlands	CO ₂	547	547	0.04	0.73
3B2a	Cropland Remaining Cropland: net carbon stock change in mineral soils	CO ₂	-1 113	1 113	0.03	0.77
4A	Solid Waste Disposal	CH ₄	2 497	2 497	0.03	0.80
1A	Fuel Combustion Activities: Liquid	CO ₂	27 640	27 640	0.02	0.82
1A	Fuel Combustion Activities: Solid	CO ₂	22 753	22 753	0.02	0.85
1A	Fuel Combustion Activities: Peat	CO ₂	10 676	10 676	0.02	0.87
3A1	Enteric Fermentation	CH ₄	1 537	1 537	0.01	0.88
1A4	Other Sectors: Biomass	CH ₄	307	307	0.01	0.90

Qualitative Analysis

Besides a quantitative analysis, there is a **qualitative analysis** of categories.

Some hints:

- ✓ Mitigation techniques and technologies
- ✓ Expected growth
- ✓ No quantitative assessment of uncertainty performed
- ✓ Completeness (*incomplete inventory gives incorrect results*)

Results

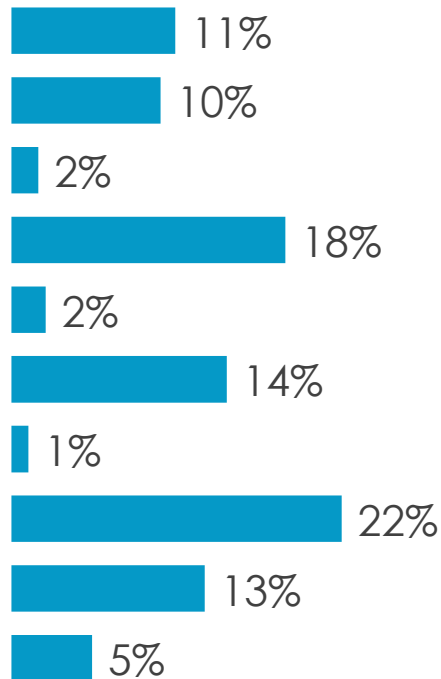
IPCC Category Code	IPCC Category	Greenhouse gas	Identification criteria
1A	Fuel Combustion Activities: Liquid	CO ₂	L2, T2
1A	Fuel Combustion Activities: Solid	CO ₂	L2
1A	Fuel Combustion Activities: Peat	CO ₂	L2
1A1	Energy Industries: Solid	CO ₂	L1, T1
1A1	Energy Industries: Peat	CO ₂	L1, T1
1A1	Energy Industries: Gas	CO ₂	L1, T1
1A1	Energy Industries: Liquid	CO ₂	L1, T1
1A2	Manufacturing Industries and Construction: Solid	CO ₂	L1, T1
1A2	Manufacturing Industries and Construction: Liquid	CO ₂	L1, T1
1A2	Manufacturing Industries and Construction: Gas	CO ₂	L1, T1
1A2	Manufacturing Industries and Construction: Peat	CO ₂	L1, T1
1A3b	Road Transportation	CO ₂	L1, T1
1A3b	Road Transportation	N ₂ O	L1, T1
1A3b	Road Transportation: Cars with Catalytic Converters	N ₂ O	L2, T2

IPCC categories	direct greenhouse gas	1990 estimate	2011 estimate	trend assessment 1990-2011	contribution to trend	cumulative total
		Gg CO ₂ eq	Gg CO ₂ eq		%	%
Sum		142 118	118 978	0.75		
1.A.3 Transport / b. Road Transportation	CO ₂	19 487.1	25 839.9	0.0956	12.76	12.76
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Solid Fuels	CO ₂	19 344.9	6 875.0	0.0936	12.48	25.24
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Gaseous Fuels	CO ₂	2 750.9	9 692.5	0.0742	9.90	35.14
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Solid Fuels	CO ₂	11 062.1	4 795.8	0.0448	5.98	41.12
1.A.4 Other Sectors / b. Residential / Gaseous Fuels	CO ₂	5 824.2	7 275.5	0.0241	3.21	44.33
2B. Chemical Industry / 2. Nitric Acid Production	N ₂ O	3 561.9	624.7	0.0237	3.16	47.49
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Other Fuels	CO ₂	1 833.6	3 808.5	0.0228	3.04	50.53
1.A.4 Other Sectors / b. Residential / Liquid Fuels	CO ₂	12 664.5	8 421.7	0.0219	2.92	53.45
1.A.4 Other Sectors / a. Commercial and institutional / Gaseous Fuels	CO ₂	1 923.8	3 660.3	0.0206	2.75	56.20
6A1 Managed Waste Disposal on Land	CH ₄	2 449.7	577.8	0.0148	1.97	58.17
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries / Solid Fuels	CO ₂	2 015.9	243.2	0.0145	1.93	60.11
2E1 By-product Emissions / Other	SF ₆	1 559.4		0.0131	1.75	61.85
2C. Metal Production / 1. Iron and Steel Production	CO ₂	2 022.4	539.8	0.0116	1.54	63.40
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Liquid Fuels	CO ₂	1 671.1	247.2	0.0116	1.54	64.94
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Other Fuels	CO ₂	714.3	1 749.1	0.0116	1.54	66.48
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Liquid Fuels	CO ₂	1 835.1	398.7	0.0114	1.52	68.01
1.A.4 Other Sectors / b. Residential / Solid Fuels	CO ₂	1 759.2	368.5	0.0111	1.48	69.49
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Gaseous Fuels	CO ₂	680.7	1 673.6	0.0111	1.48	70.96
1.A.1. Energy Industries / b. Petroleum Refining / Gaseous Fuels	CO ₂	13.8	995.3	0.0099	1.32	72.28
2B. Chemical Industry / 5. Other / Other non-specified	CO ₂	224.2	1 169.1	0.0099	1.31	73.60
5A1 Forest Land remaining Forest Land	CO ₂	-3 118.1	-3 511.1	0.0090	1.21	74.80
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Liquid Fuels	CO ₂	2 490.1	1 200.2	0.0089	1.18	75.99
5B2 Land converted to Cropland	CO ₂	112.8	922.1	0.0083	1.11	77.10
2B. Chemical Industry / 1. Ammonia Production	CO ₂	422.7	1 108.9	0.0076	1.01	78.11

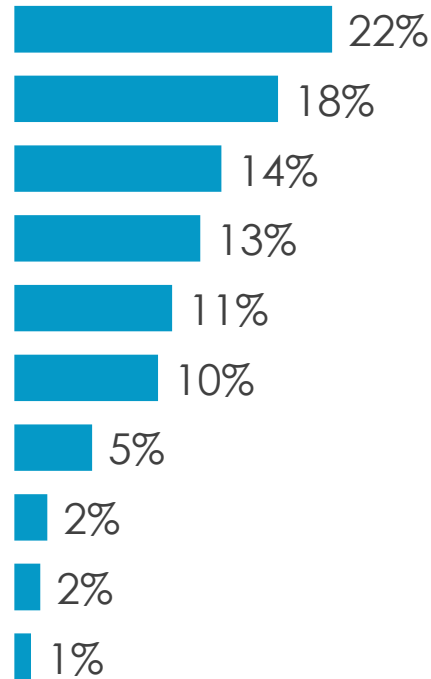
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Gaseous Fuels	CO2	2 519.3	2 863.2	0.0076	1.01	79.12
2F1. Refrigeration and Air Conditioning Equipment	HFC-134a		736.6	0.0074	0.99	80.10
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Liquid Fuels	CO2	878.4	39.6	0.0070	0.93	81.04
1.A.2 Manufacturing Industries and Construction / f. Other / Liquid Fuels	CO2	3 063.8	1 872.6	0.0070	0.93	81.96
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Gaseous Fuels	CO2	67.0	732.5	0.0068	0.91	82.87
2F1. Refrigeration and Air Conditioning Equipment	HFC-143a		588.7	0.0059	0.79	83.66
5C2 Land converted to Grassland	CO2	73.7	-505.0	0.0057	0.76	84.42
2F1. Refrigeration and Air Conditioning Equipment	HFC-125		541.7	0.0054	0.73	85.14
1.A.2 Manufacturing Industries and Construction / f. Other / Solid Fuels	CO2	2 537.3	1 624.1	0.0050	0.67	85.81
1.A.2 Manufacturing Industries and Construction / f. Other / Gaseous Fuels	CO2	2 555.6	2 630.8	0.0049	0.66	86.47
1.A.2 Manufacturing Industries and Construction / f. Other / Other Fuels	CO2	186.5	633.0	0.0048	0.64	87.11
1.A.4 Other Sectors / a. Commercial and institutional / Liquid Fuels	CO2	2 290.1	1 452.4	0.0047	0.62	87.73
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Liquid Fuels	CO2	659.3	89.8	0.0046	0.62	88.35
2B. Chemical Industry / 5. Other / Caprolactam	N2O	372.0	751.8	0.0044	0.59	88.94
2E1 By-product Emissions / Other	C2F6	506.7		0.0043	0.57	89.51
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Solid Fuels	CO2	637.9	127.5	0.0041	0.54	90.05
2A. Mineral Products / 1. Cement Production	CO2	2 823.8	2 761.6	0.0040	0.53	90.58
5E2 Land converted to Settlements	CO2	248.0	585.4	0.0038	0.51	91.09
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Solid Fuels	CO2	396.7	3.5	0.0033	0.44	91.53
1.A.1. Energy Industries / b. Petroleum Refining / Liquid Fuels	CO2	4 285.3	3 271.9	0.0032	0.42	91.95
6C Waste Incineration	CO2	287.8	528.1	0.0029	0.38	92.34
5A2 Land converted to Forest Land	CO2	-19.7	-295.9	0.0028	0.37	92.71
4A1 Non-Dairy Cattle	CH4	2 172.0	2 095.2	0.0028	0.37	93.08
2E1 By-product Emissions / Other	CF4	323.7	5.3	0.0027	0.36	93.44
1. B. 1. a. Coal Mining and Handling	CH4	298.8		0.0025	0.34	93.77
2E2 Fugitive Emissions	C5F12	287.8	0.0068	0.0024	0.32	94.10
4A1 Dairy Cattle	CH4	1 808.2	1 274.9	0.0024	0.32	94.42
4D3 Indirect Emissions	N2O	1 248.4	825.5	0.0022	0.29	94.71
4B8 Swine	CH4	1 065.4	1 074.2	0.0018	0.24	94.95
5C1 Grassland remaining Grassland	CO2	680.39	396.66	0.0017	0.23	95.19

How does KCA work?

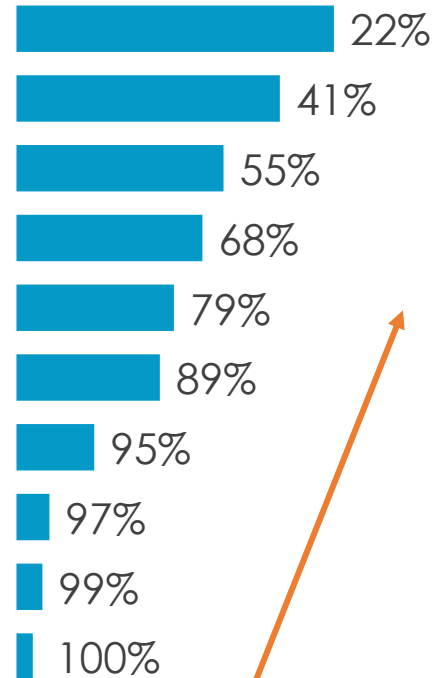
1. Calculate emissions as % of total



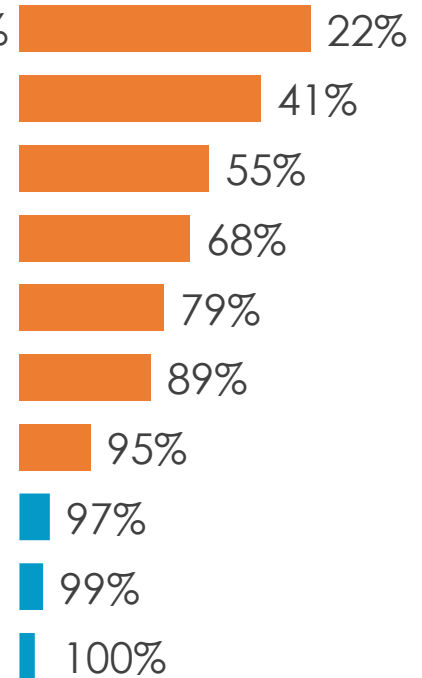
2. Order by magnitude



3. Calculate cumulative total



4. Highlight categories until 95% of estimates are included



These are our key categories for a "Level Assessment" – looks at one year

Reporting

CRF Code	Category	GHG	Identification Criteria
3B1	Forest land	CO ₂	L1_1990, L1_2018, T1
3B2	Cropland	CO ₂	L1_1990, L1_2018, T1
1A3b	Road transportation_Liquid Fuels	CO ₂	L1_1990, L1_2018, T1
3B3	Grassland	CO ₂	L1_1990, L1_2018, T1
1A2	Manufacturing Industries and Construction_Solid Fuels	CO ₂	L1_1990, L1_2018, T1
3D1	Harvested wood products	CO ₂	L1_1990, L1_2018, T1
3A1aii	Enteric Fermentation_Non-Dairy Cattle	CH ₄	L1_1990, L1_2018, T1
4A	Solid waste disposal on land	CH ₄	L1_1990, L1_2018, T1
1A4	Other Sectors_Liquid Fuels	CO ₂	L1_1990, L1_2018, T1
4D	Wastewater_Domestic Wastewater handling	CH ₄	L1_1990, L1_2018, T1
1A2	Manufacturing Industries and Construction_Liquid Fuels	CO ₂	L1_1990, L1_2018, T1
1A3c	Railways_Liquid Fuels	CO ₂	L1_2018, T1
3B4	Wetland	CO ₂	L1_2018, T1
3C4	Direct N ₂ O MS_N inputs	N ₂ O	L1_1990, L1_2018, T1
4C2	MSW Open burning	CO ₂	L1_1990, L1_2018, T1
3B6	Other lands	CO ₂	L1_2018, T1
3A2aii	Manure Management_Non-Dairy Cattle	N ₂ O	L1_1990, L1_2018
3C6	Indirect N ₂ O from MM_Non-Dairy Cattle	N ₂ O	L1_1990, L1_2018
1A4	Other Sectors_Biofuels	CH ₄	L1_1990, L1_2018
3C4	Direct N ₂ O MS_Organic fertilisers_Urine&Dung	N ₂ O	L1_1990, L1_2018
3A1d	Enteric Fermentation_Goats	CH ₄	L1_2018
1B1	Solid Fuels	CH ₄	L1_2018
3A2d	Manure Management_Goats	N ₂ O	L1_2018

Conclusion

- **Key categories are extremely important:**
 - mistakes will lead to significant under-/over- estimates
 - improvements will significantly improve overall inventory quality
- **Higher tiers (*Tier 2 and Tier 3*) should be used for estimating *key categories***
- **Resources of national inventory compilers are (*in many cases*) limited → focus on *key categories***



Thank you for your attention!
Any questions?