CLIMATE & CLEAN AIR COALITION
TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS

Estimating emissions of Black Carbon and other SLCFs within CCAC activities

V. Foltescu, Z. Klimont, H. Vallack

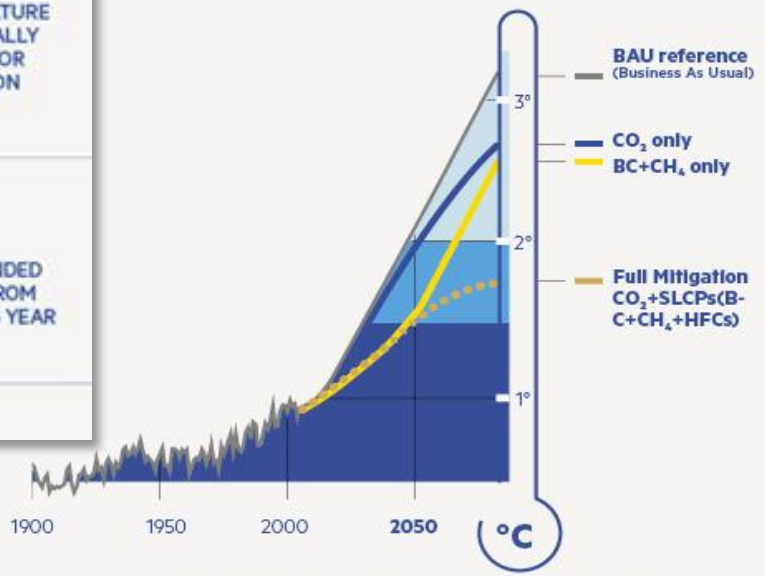
IPCC Expert Meeting on SLCF, Geneva, May, 2018

UN environment

Maximising Air & Climate Co-Benefits

ANNUAL BENEFITS
From large-scale mitigation **by 2030**

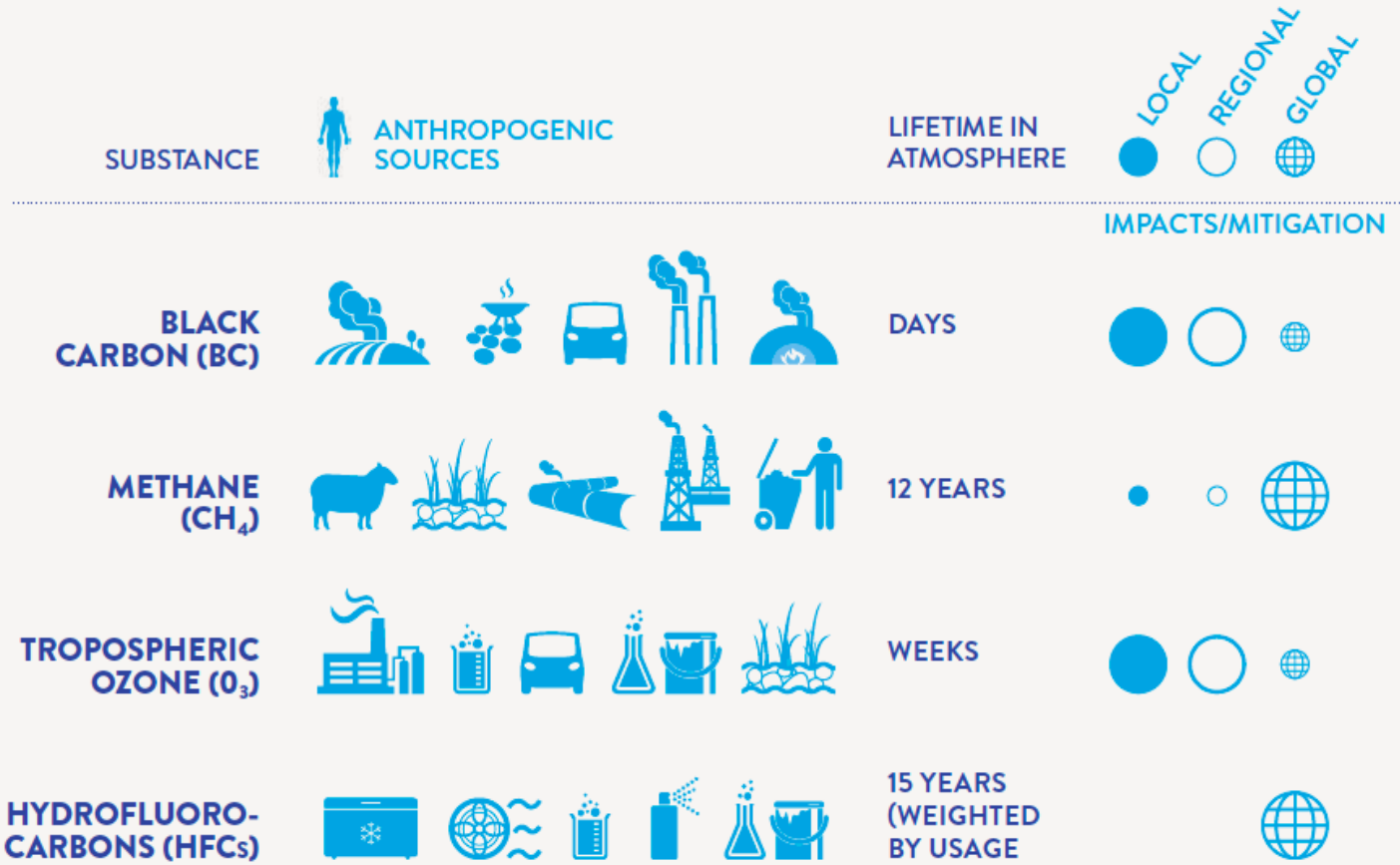
CLIMATE	AVOIDED WARMING	REDUCED RATE OF SEA-LEVEL RISE BY ~20% BY 2050
HEALTH	2.4 MILLION	AVOIDED PREMATURE DEATHS ANNUALLY FROM OUTDOOR AIR POLLUTION
CROPS	52 MILLION	TONNES OF AVOIDED CROP LOSSES FROM 4 MAJOR STAPLES YEAR



SIMULATED TEMPERATURE CHANGE
UNDER VARIOUS MITIGATION SCENARIOS

SHORT-LIVED CLIMATE POLLUTANTS

Near term response to mitigation



Need for comprehensive and harmonized methods to estimate SLCF emissions

BENEFITS

Authoritative guidance that includes the additional SLCF would improve:

- Integration and the internal consistency between GHGs emission inventories and non-GHGs emission inventories, within and across the various assessments (including IPCC's)
- Comparability in terms of the emissions inputs into the various climate models used to inform policies
- Consistency of climate mitigation strategies at global to local levels, and across sectors
- Consistency in providing uncertainty estimates for calculating emissions relevant to mitigation of climate change and air pollution
- Ability to monitor and evaluate progress in reducing emissions of those SLCFs not covered by the Kyoto or Montreal Protocols

Need for comprehensive and harmonized methods to estimate SLCF emissions

BENEFITS (cont)

Authoritative guidance on SLCF would improve:

- Ability to more reliably estimate wider benefits (health, food security, etc) by a harmonized approach for all emissions leading to formation of particulate matter and ozone
- Ability of countries to estimate emissions of black carbon and co-emitted substances according to authoritative global methodology and include black carbon emission reduction measures in the NDCs
- Transparency of national estimates, including potential future updates and recalculations based on revised/updated guidelines
- Ability for countries to include e.g. health benefits and food security along with other benefits supporting the SDGs

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TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS

CCAC has been relying on emission estimates from:

LEAP Integrated Benefits Calculator

GAINS Online
Greenhouse Gas - Air Pollution Interactions and Synergies

UN environment

LEAP Integrated Benefits Calculator

Using LEAP-IBC to develop emissions estimates for CCAC SNAP countries

Harry Vallack
Stockholm Environment Institute
University of York

SEI Stockholm Environment Institute

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TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS

LEAP Integrated Benefits Calculator

Model Pathway: Focus on impacts

Emissions

Transport

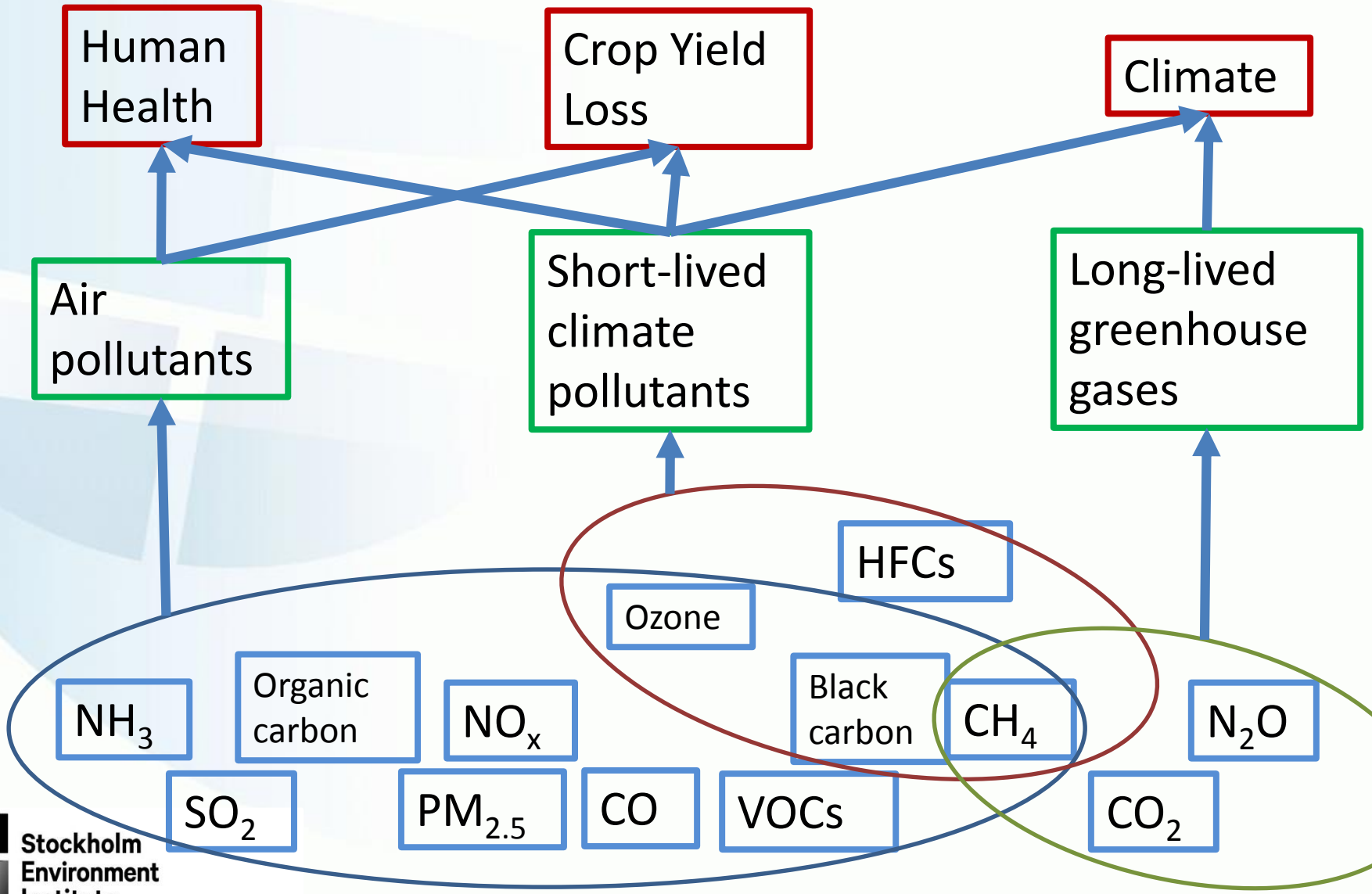
Exposure

Impacts: Climate

Impacts: Health and Vegetation

LEAP Integrated Benefits Calculator

Impact assessment of all emissions



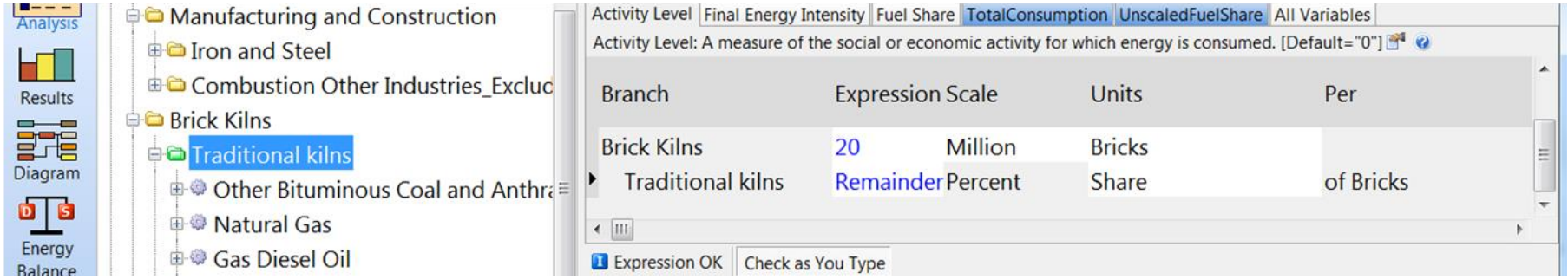
SEI Stockholm Environment Institute

Estimating emissions

LEAP Integrated Benefits Calculator

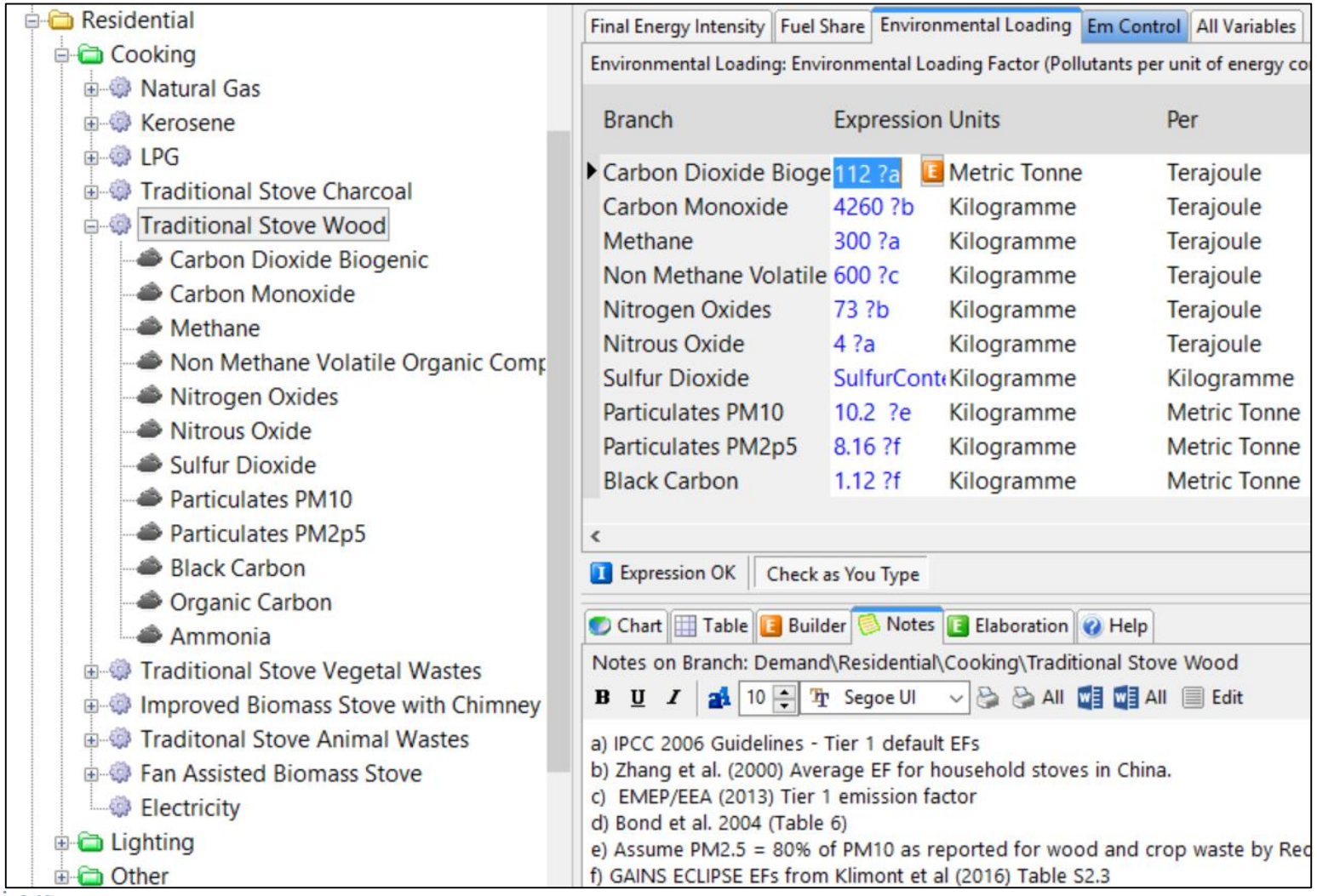
Emission = Activity rate x Emission factor

Data for level of activity (Activity rate)



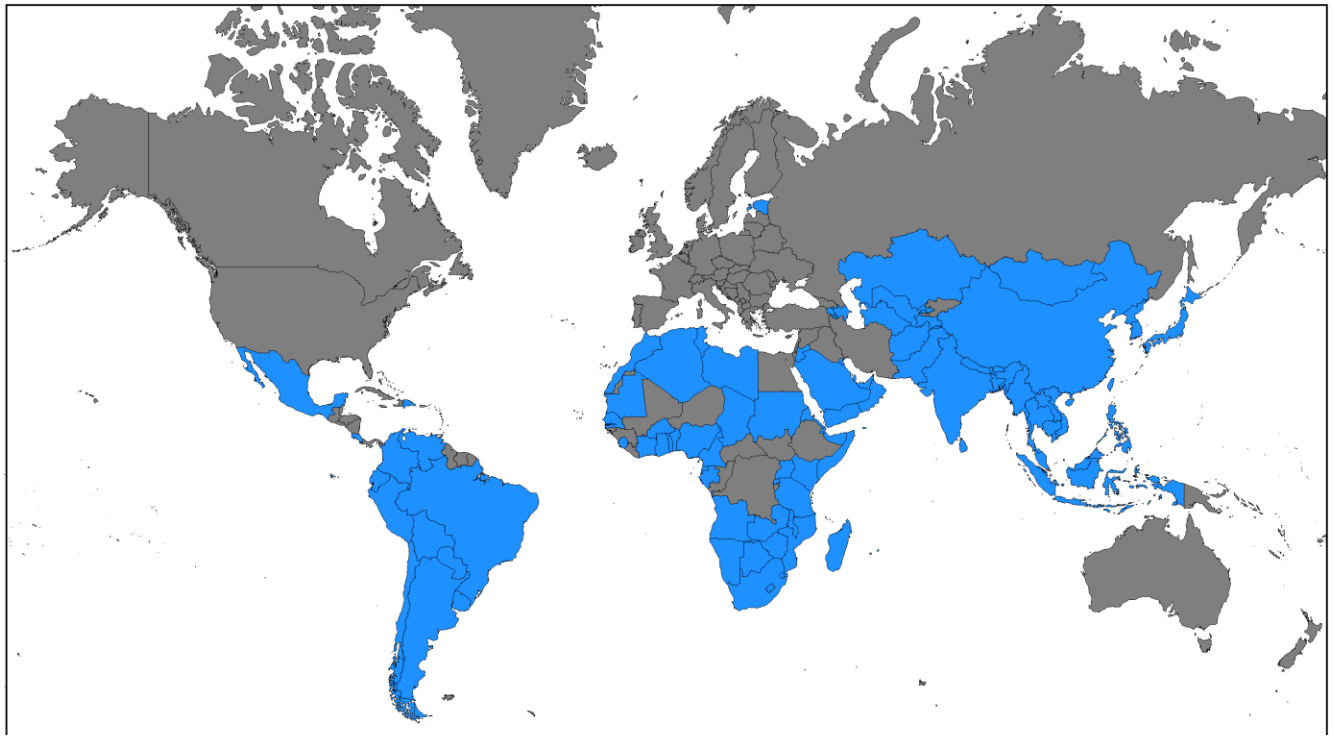
Estimating emissions: Emission factors

LEAP Integrated Benefits Calculator



Availability of LEAP-IBC for national air quality and climate change planning

- LEAP-IBC is now available to governments and organisations for the countries in the map, as these are countries for which we have $PM_{2.5}$ coefficients. Others will be added as further modelling is carried out



SEE https://www.energycommunity.org/ FOR DETAILS

Application of LEAP-IBC results in national planning (from Ghana national SLCP plan: benefits by 2040)

2,560 under PAM++

1,500 under PAM+

Avoided deaths

40% under PAM++

22% under PAM+

Reduction in crop loss

55% under PAM++

51% under PAM+

Temperature response

Actions to implement priority measures

Preliminary results, Daniel Benefor, Ghana EPA

Black carbon emissions from Ghana under different scenarios (from draft national plan)

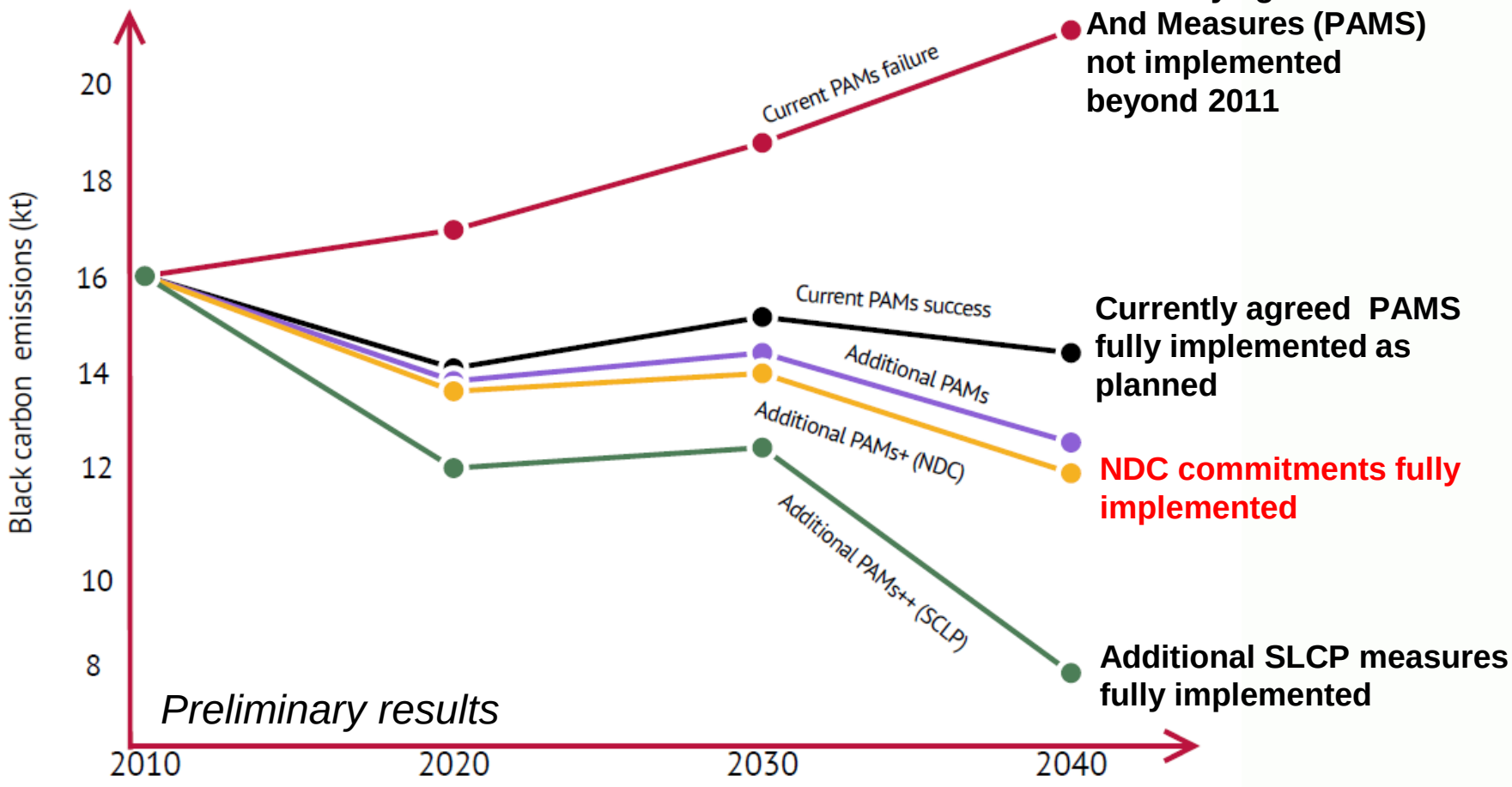


Fig 7 - Black carbon emission trajectories for five SLCP mitigation policy option

The national SLCP plan covers: success of current PAMS; success of implementing NDC commitments; promotion and implementation of additional SLCP measures

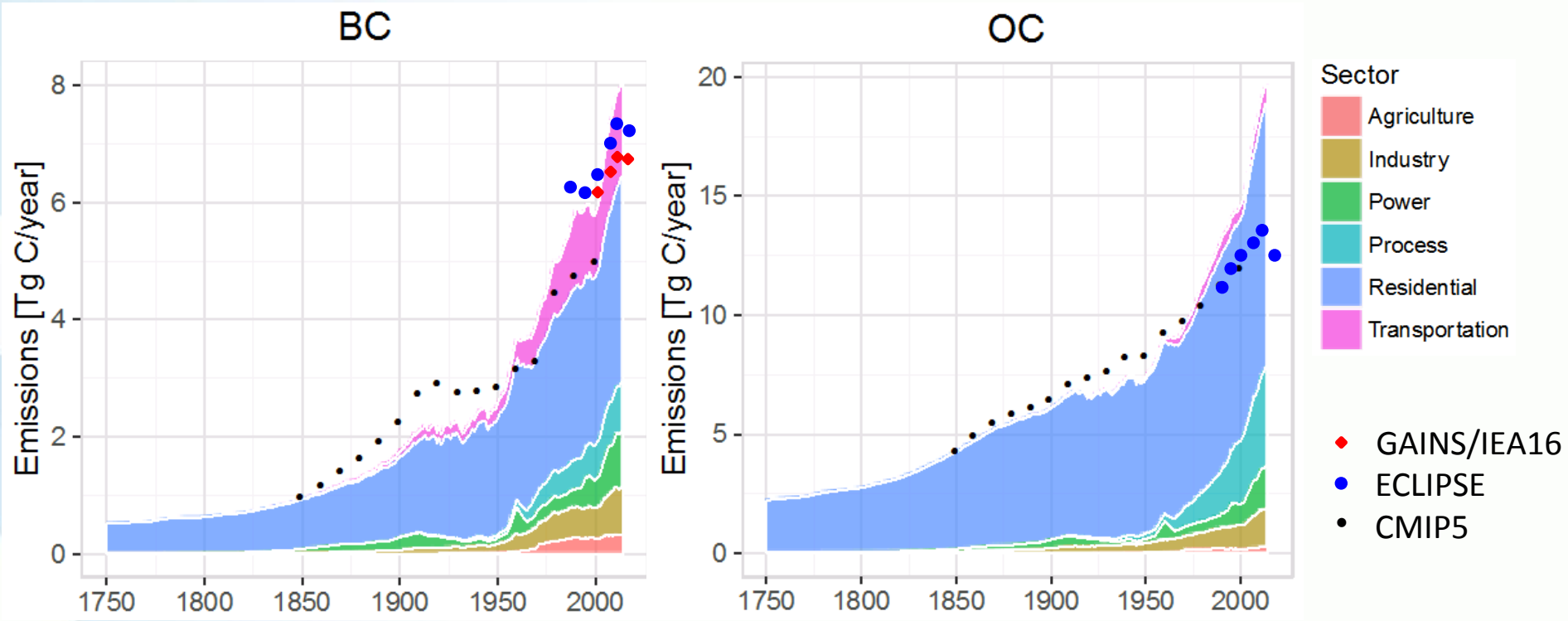
Summary

LEAP Integrated Benefits Calculator

- LEAP-IBC enables the estimation of emissions of BC (and co-emitted substances) - appropriate for countries in Asia, Africa and Latin America.
- The tool uses official sources (EMEP/EEA and IPCC) for default EFs where relevant, supplemented by factors from peer-reviewed literature.
- Within the SNAP initiative, 12 countries currently using LEAP-IBC to compile BC inventories and 18 more in the pipeline

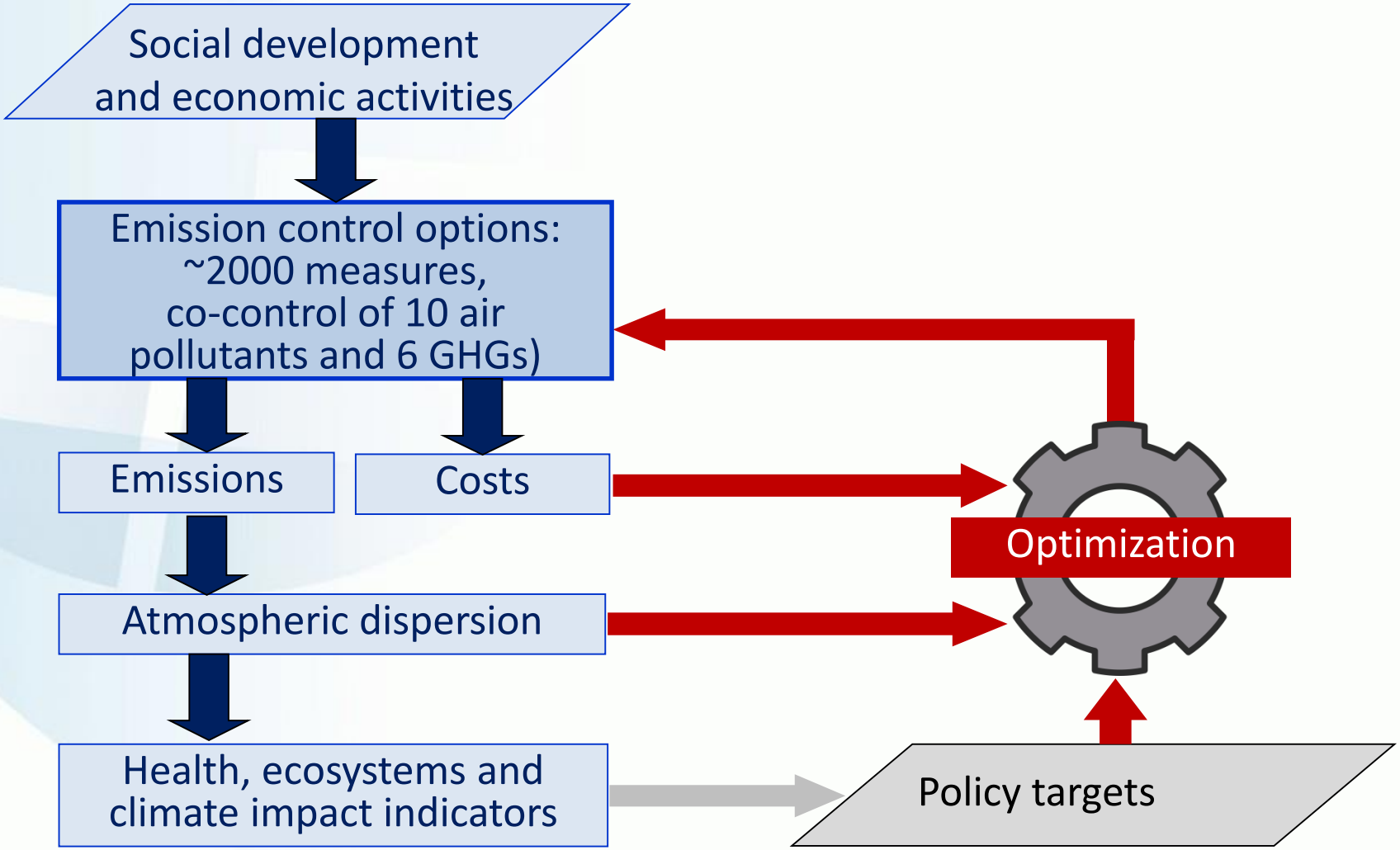
SEI Stockholm Environment Institute

Global estimates for CMIP5, CMIP6, ECLIPSE, GAINS/IEA16



CMIP6 - Hoesly et al. (2017) Community Emission Data Systems paper
CMIP5 - Lamarque et al. (2010, JGR)
ECLIPSE - Klimont et al. (2017, ACP)
GAINS/IEA16 – IEA (2016) Special Report on Air Pollution

Greenhouse gas–Air pollution Interactions and Synergies (GAINS)



Emission estimation method

- *How*….principally, *Emission=Activity*emission factors* but explicit incorporation of technology (*j, m*) in activity (*A*) *and emission factor (ef*), considering impact across all included pollutants (*y*), control measure efficiency (*eff*) and its application rate (*X*)

$$E_{i,y} = \sum_{j,k,m} E_{i,j,k,m,y}$$
$$= \sum_{j,k,m} A_{i,j,k} \mathrm{ef}_{i,j,k,y} (1 - \mathrm{eff}_{m,y}) X_{i,j,k,m}$$

For carbonaceous species considering also BC,OC, PM balance:

$$\mathrm{ef}_{\mathrm{OC}} = \left(\mathrm{ef}_{\mathrm{PM}_{2.5}} \times f_{\mathrm{carb}} - \mathrm{ef}_{\mathrm{BC}}\right) \div f_{\mathrm{OM}}$$

- *Pollutants*…SO_2, NO_x, NMVOC, CO, NH_3, PM (size fractions), BC, OC, and Kyoto GHG;

- *Sources*…~ 2000 sector-fuel-technology combinations; anthropogenic only

http://gains.iiasa.ac.at/models/gains_models3.html

GAINS Online

Greenhouse Gas - Air Pollution Interactions and Synergies

Choose a region for your GAINS analysis:

Europe

East Asia

South Asia

UNFCCC/Annex I

G20

Asia *

Global *

Local Models *

*) Research versions, only for
collaborators

GAINS Asia

Greenhouse Gas - Air Pollution Interactions and Synergies

You are logged in as **klimont** Logout

Basic mode | Advanced mode

- Activity data
- Emission controls
- Costs
- Emissions
  - National/region
  - Key sectors
  - Key fuels/activ
  - Key fuels/activi
  - Road transport
  - Non-road mobil
- International fo
  - UNFCCC-CRF
- Help center

GAINS Asia online: Key sectors - Opera

gains.iiasa.ac.at/gains/reporting/select

GAINS Asia

PM PM_BC emissions by key sector

Chart type: Stacked column | Switch Axis X/Y | Label | Legend | Toggle Legend | Close

Charts | Data table | Scenario description | Description

Emission scenario

ECLIPSE

ECLIPSE_V5a_CLE_base

Add Scenario

Region

Predefined group

China (all GAINS Regions)

Pollutant

PM

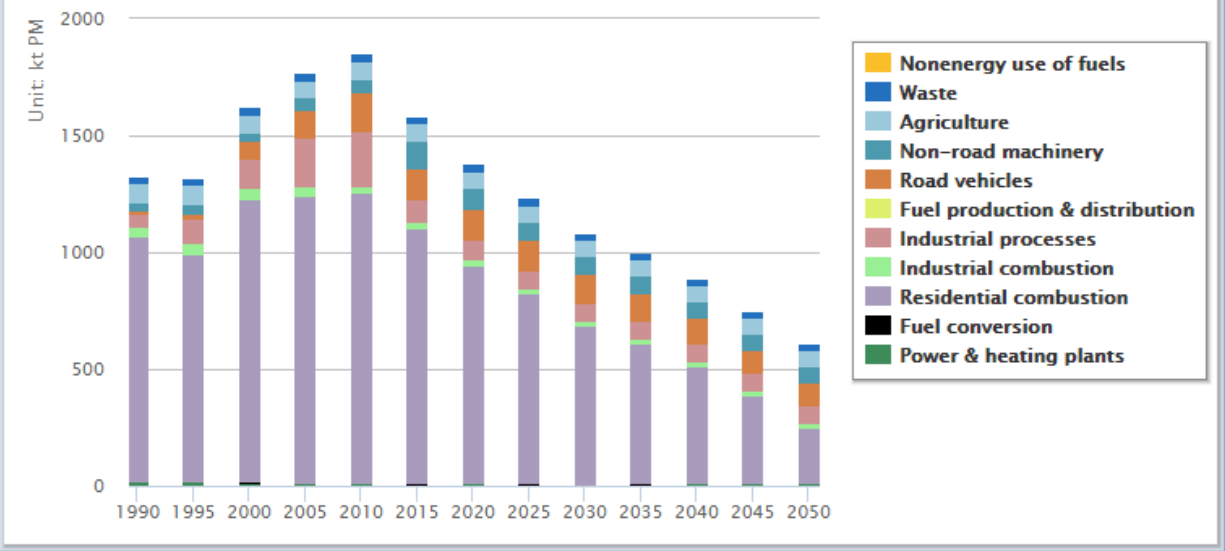
PM_BC

Show

Export data table

PM PM_BC emissions by key sector

Region: China (all GAINS Regions)
Scenario: ECLIPSE_V5a_CLE_base



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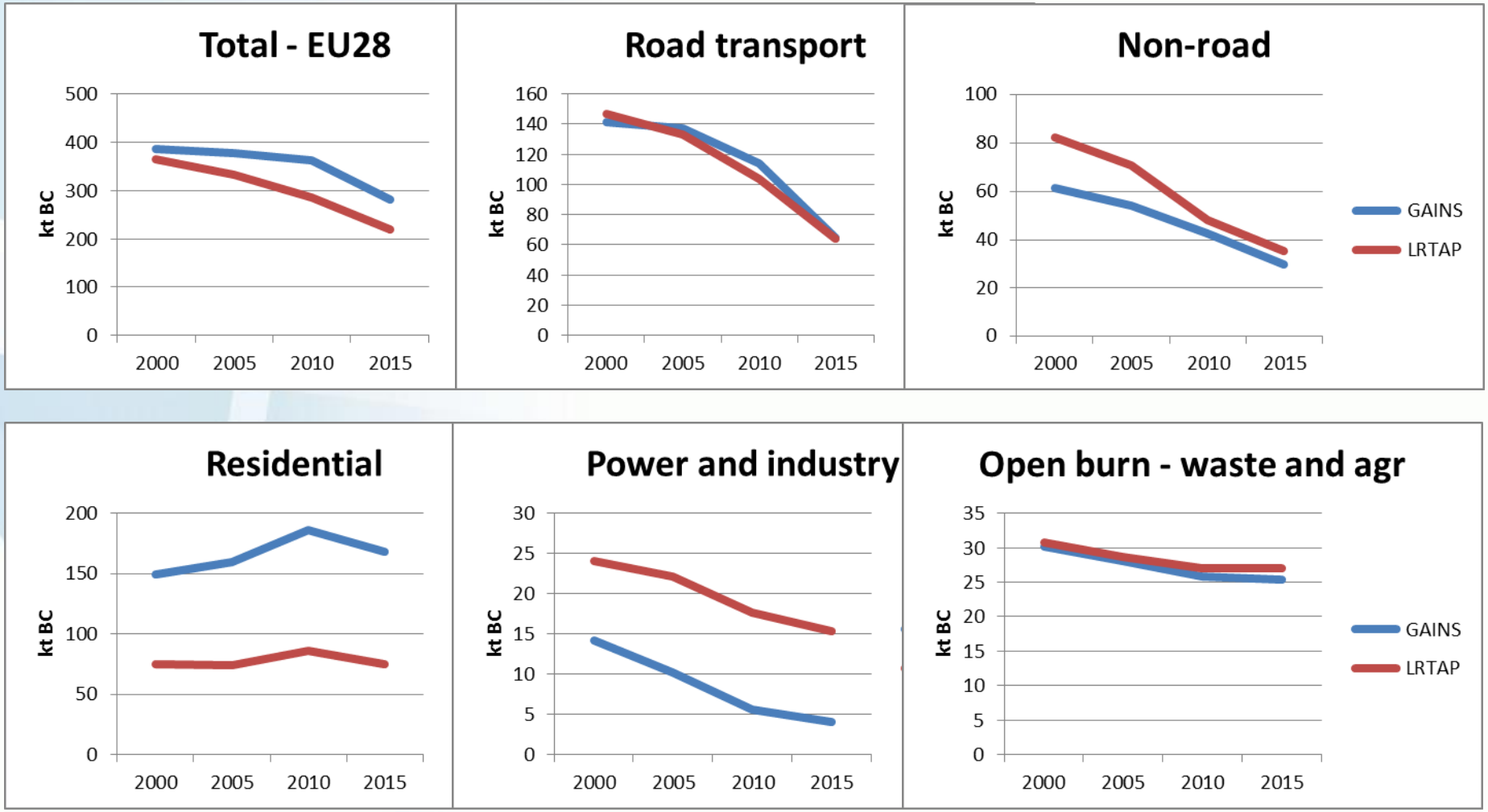
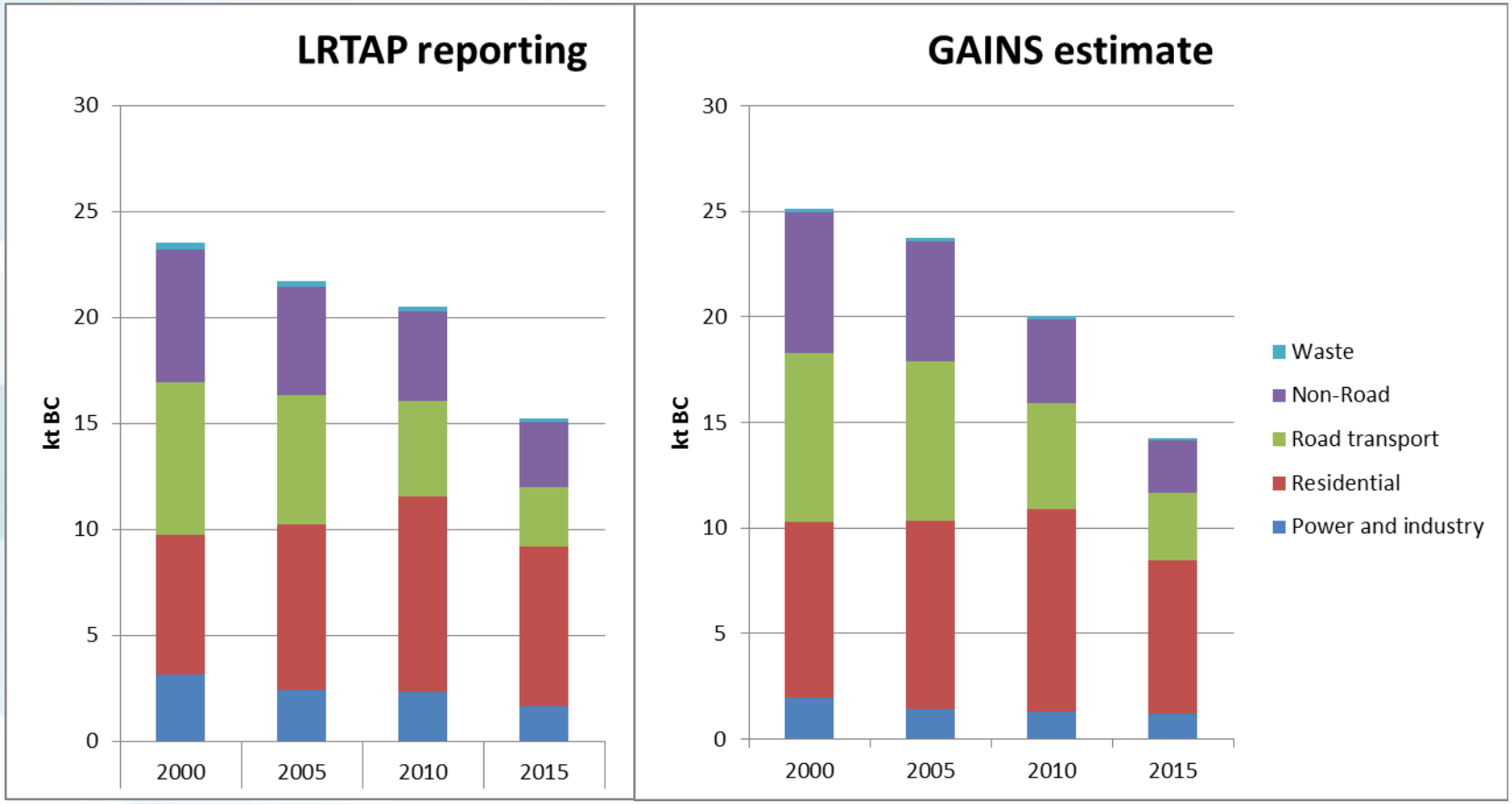
LRTAP vs GAINS for EU28;

Sectoral differences

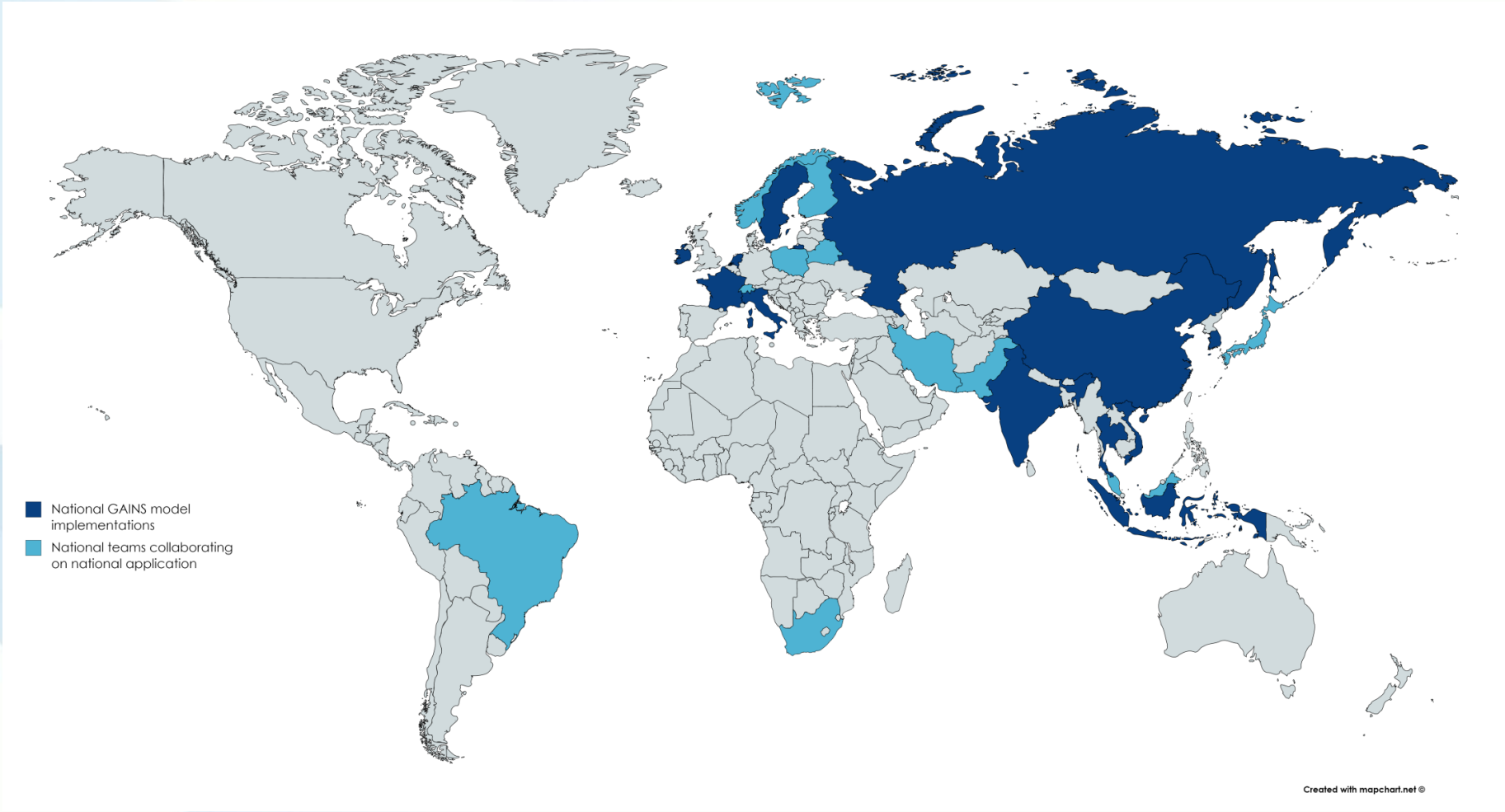


BC emission comparison, LRTAP vs GAINS

Nordic countries

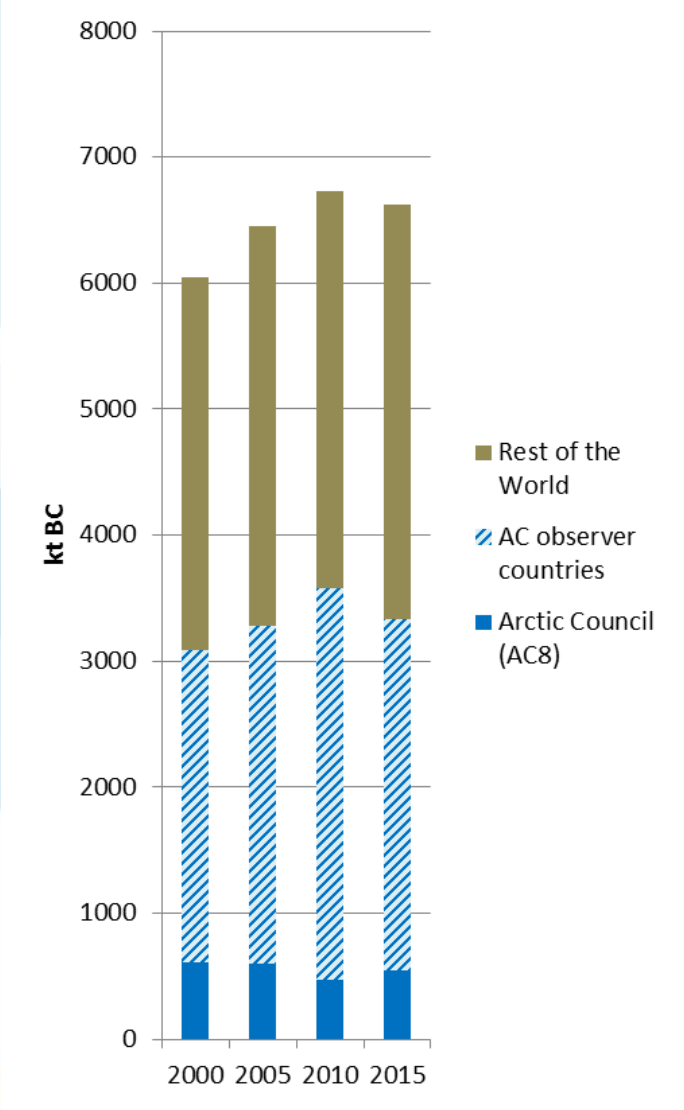


GAINS model has been also applied and further developed at the national level

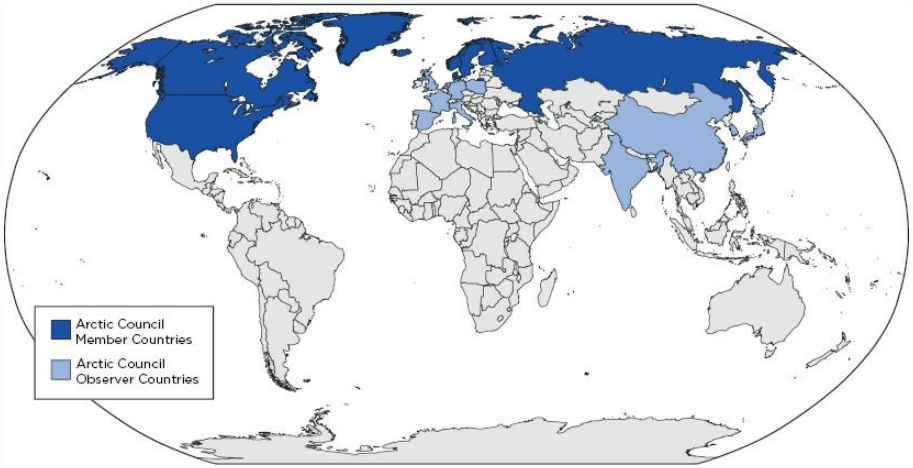


GAINS also applied in several regional and global research activities: e.g., EU funded (ACCENT, CityZen, ECLIPSE), IEA, UNEP/CCAC, GEA, RCP8.5, EMF, SSPs

New EU funded activity (started 2018) addressing BC knowledge gaps and policy support focusing on Arctic Council and observer countries



- While ***AC8 contribute less than 10%*** of global BC emissions, ***about 50% originates from AC8 and observer countries***



Map source: http://www.nap.edu/catalog.php?record_id=21717

- ***Good platform for further discussion***: IIASA-GAINS model has been applied in bilateral projects with most of the observer countries in Asia and Europe

Need for comprehensive and harmonized methods to estimate SLCF emissions

WHY?

- There is a large expressed demand from non-UNECE countries to develop emission inventories for additional SLCFs beyond those covered by the Kyoto or Montreal Protocols.
- A comprehensive methodology and a database of default emission factors for the additional SLCFs for all sectors, that has global coverage, with regional differentiation where appropriate, is currently lacking.
- A large pool of data and information on emissions is already available. It can be scrutinized, bundled and incorporated into a comprehensive emission inventory guidance.
- There is valuable experience in using existing UNECE-LRTAP black carbon guidelines that can serve the development of globally applicable guidelines for black carbon and co-emissions.
- Climate analyses such as those underlying IPCC Assessments or UNEP Gap Reports include all SLCFs but only as 'expert judgments'

Additional slides

Key data sources and assumptions in GAINS model and scenarios

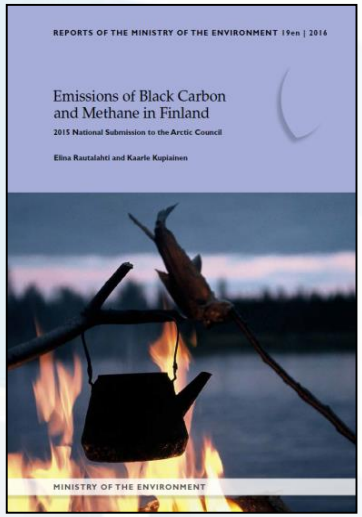
- **Methodology**
  - Principles of the GAINS model: Amann et al., 2011
  - PM, BC methodology: Klimont *et al.* (2002, 2017), Klimont and Kupiainen (2004, 2007)
  - Technical details in a number of earlier reports and papers available from http://gains.iiasa.ac.at
- **Activity data**
  - Energy: IEA World Energy Outlook (global); EUROSTAT and PRIMES model (EU); national experts inputs
  - Agriculture: FAO (global); EUROSTAT, EFMA, and CAPRI model (EU)
- **Legislation (regular updates)**
  - Published information about existing and committed emission limit values and reductions, e.g, diesel.net, CAI-Asia, EU Directives, etc.
- **Emission factors (regular updates)**
  - Peer reviewed papers, guidebooks, grey literature - documented in interim reports available from GAINS web, most values accessible from GAINS-online model

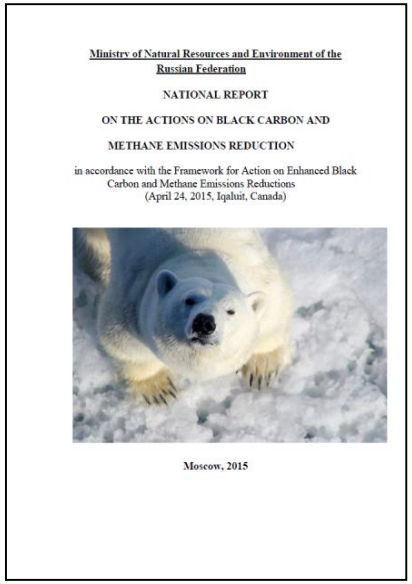
GAINS applications

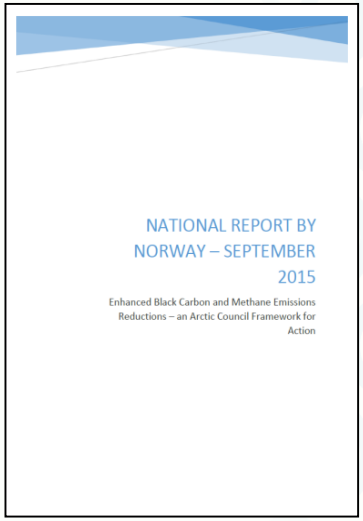
- **Europe** (UNECE LRTAP, NEC Directive, CAFE program)
- **Asia** (GAINS-Asia, UNEP/CCAC)
- **Annex I** (primarily GHG)
- **Arctic** (Arctic Council Task Force on SLCF; focus on BC and CH_4)
- **Italy, Netherlands, France, Sweden, Ireland, China, India, Thailand, Korea, Indonesia, Iran, Vietnam** (bilateral projects)
- and **global** (ACCENT, IEA, UNEP, GEA, CityZen, ECLIPSE, RCP8.5, EMF, SSPs)

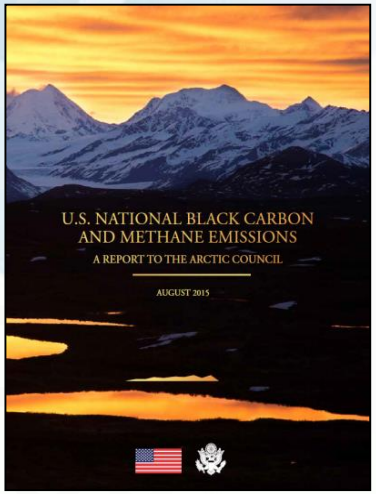
Arctic countries produce reports on SLCP emissions

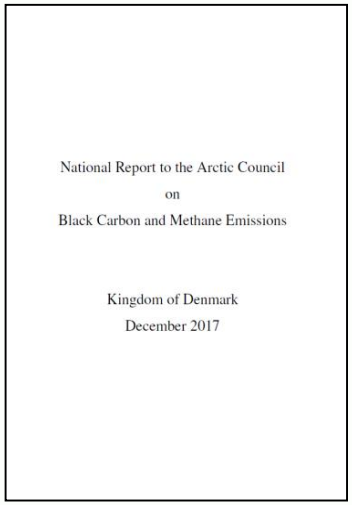
Reference method for emission factors is EMEP/EEE Guidebook

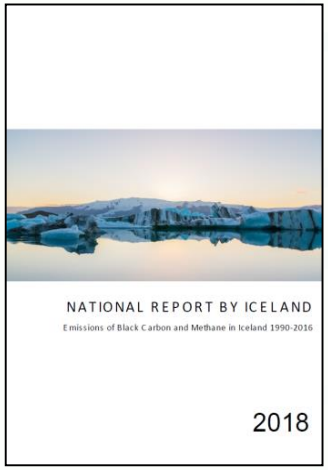












SYKE