

LEAP-IBC

An integrated assessment tool for emission scenario and benefit estimation

Climate and Clean Air Coalition Scientific Advisory Panel Expert Workshop
“Metrics for Evaluating and Reporting on Black Carbon and Methane Interventions” 16-17 March 2017

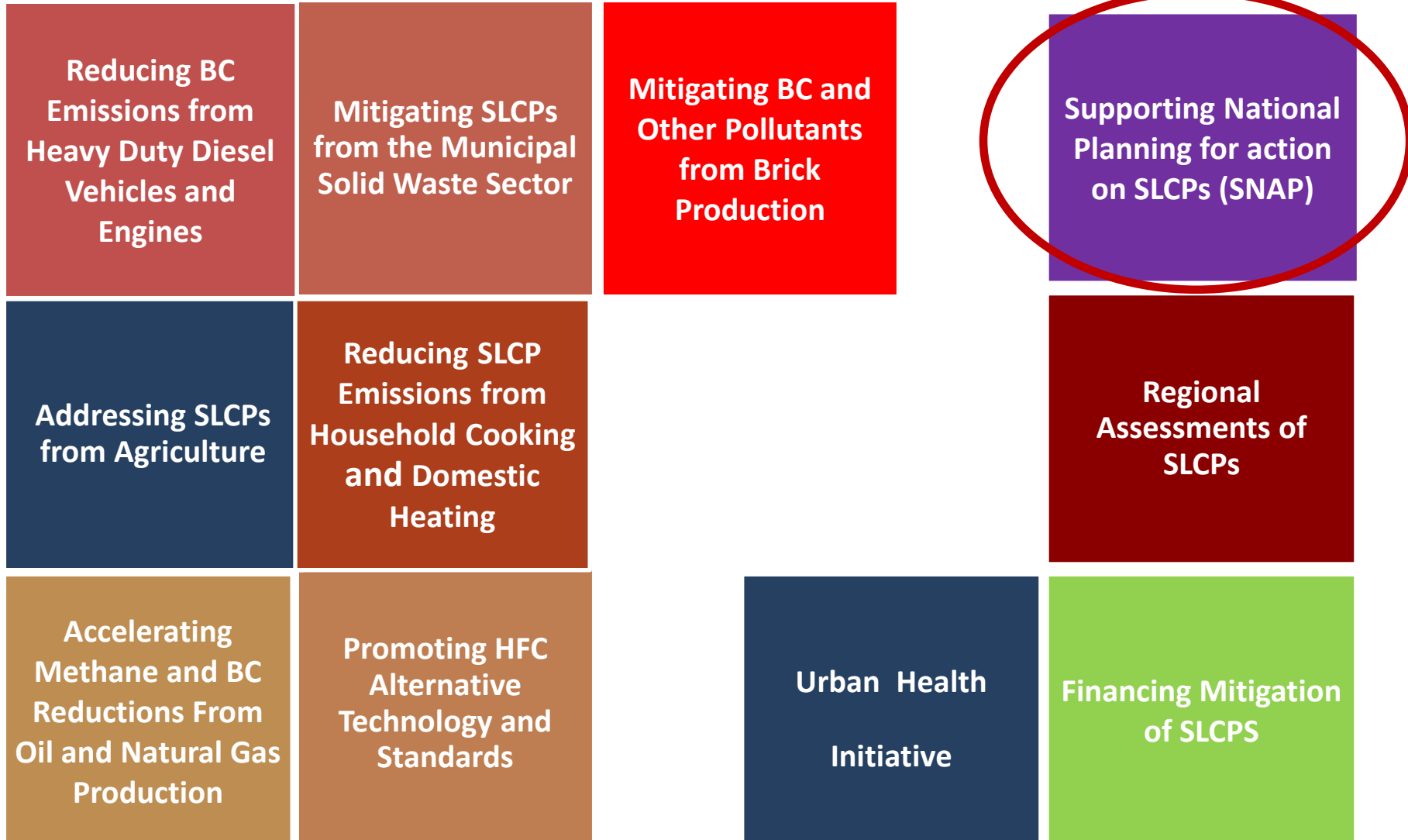
Session 5B Inventory reporting: Examples; Gaps and Challenges; Emerging Solutions

Harry Vallack
Stockholm Environment Institute (SEI)

LEAP-IBC has been developed through a collaboration between SEI, USEPA and Daven Henze at the University of Colorado, and funded by SEI, USEPA and the CCAC Trust Fund through the SNAP Initiative

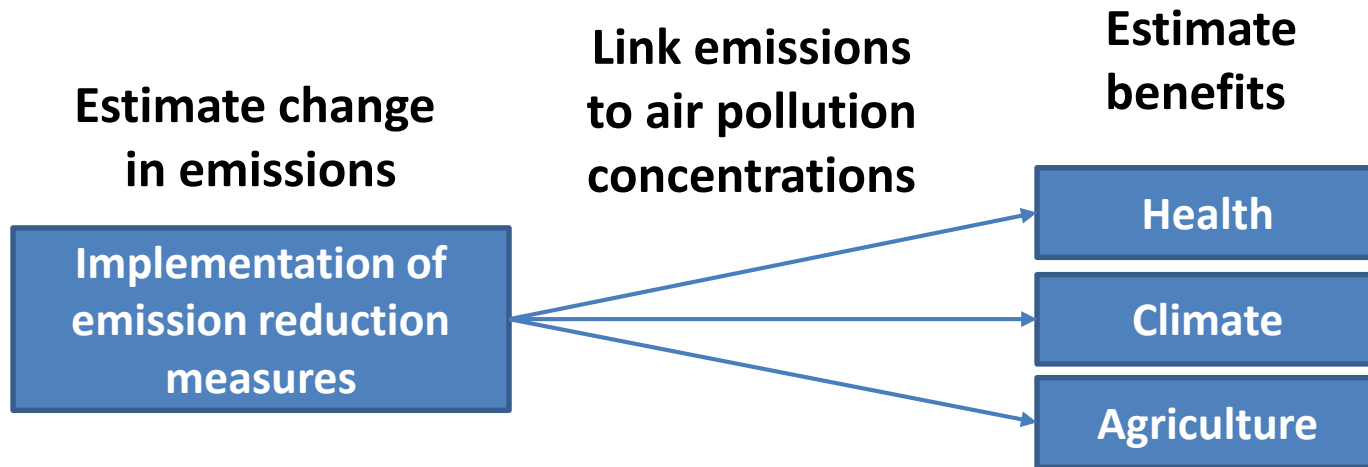


CCAC Initiatives



LEAP-IBC

Overview



‘Long-range Energy Alternatives Planning system - Integrated Benefits Calculator’

A. LEAP – Emissions and Scenarios Tool

- User-friendly energy and emissions planning software – already widely used
- Provides the interface for entire tool

B. LEAP emission inventory template for SLCPs

- SEI has developed a default data structure for SLCP inventory and emissions scenario analysis in LEAP
- Covers all key sectors and contains default emission factors for all key pollutants

C. Integrated Benefits Calculator

- Concentrations of PM_{2.5} and O₃ derived from in-built coefficients generated by a global atmospheric chemistry transport model (GEOS-Chem Adjoint)
- Determines impacts on health, crops, and climate
- Requires limited user inputs - default data available for most parameters



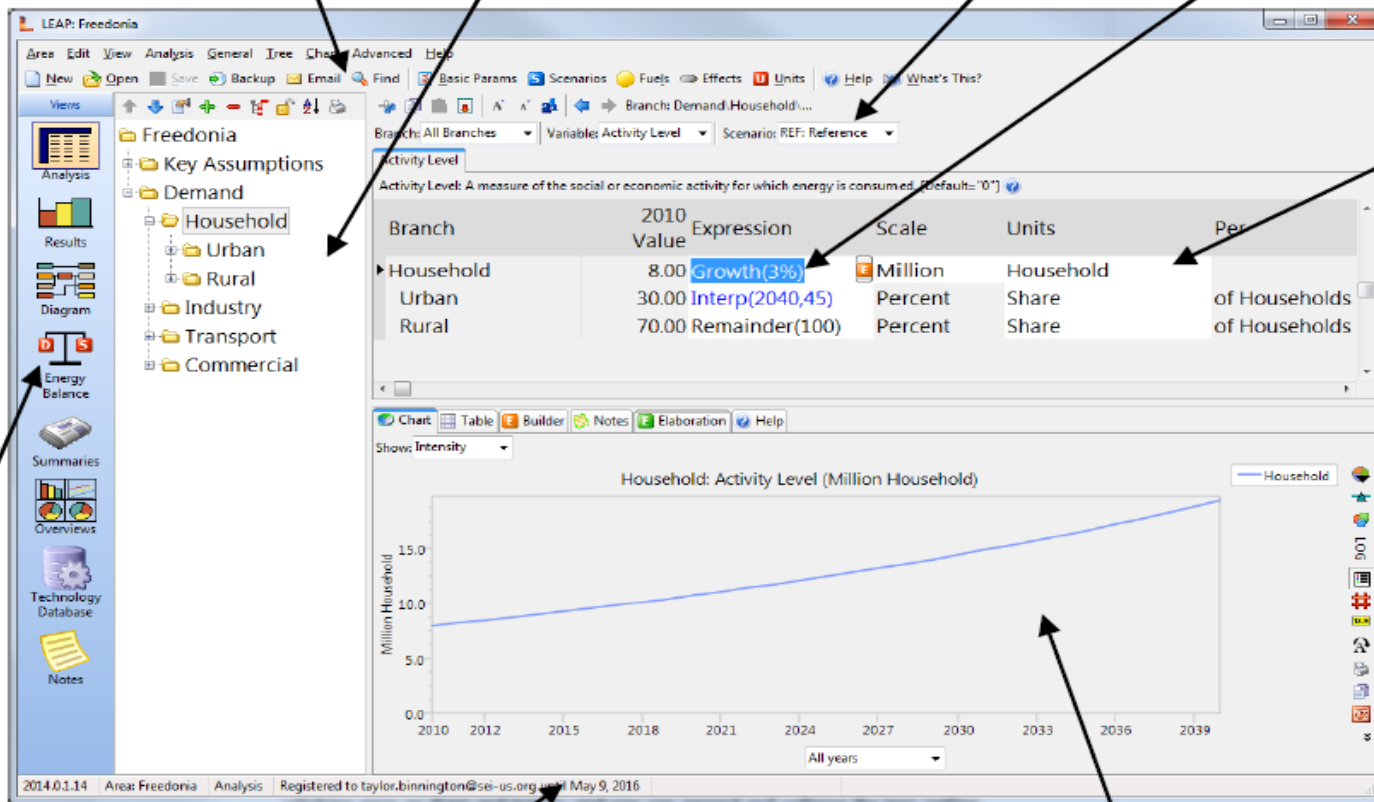
LEAP-IBC User interface

The main menu and toolbar give access to major options.

Data are organized in a tree.

Select scenarios here.

Edit data by typing here.



Switch between views of the area here.

Select units and scaling factors here.

The status bar notes the current Area and View.

Data can be reviewed in chart or table format.

Emissions template for SLCPs

LEAP: Asiana template 3.9.2

The screenshot displays the LEAP software interface with the following components:

- Menu Bar:** Area, Edit, View, Analysis, Tags, General, Tree, Chart, Advanced, Help
- Views Panel (Left):** Analysis, Results, Energy Balance, Summaries, Overviews
- Tree View (Main):**
 - Key Assumptions
 - Demand
 - Energy Industry Own Use
 - Manufacturing and Construction
 - Brick Kilns
 - Traditional kilns** (highlighted)
 - Improved Kilns_Zigzag_Hoffman_VS
 - Transport
 - Residential
 - Commercial and Public Services
 - Agriculture Forestry and Fishing
 - Non Specified Other
 - Transformation
 - Resources
 - Non Energy
 - Indicators
 - Non Energy
 - Fugitive
 - Detailed Transport
 - Industrial Process Emissions
 - Solvents and Other Product Use
 - Agriculture
 - Livestock Enteric Fermentation and Manure
 - Particulates from Animal Housing
 - Fertilizer Application
 - Agricultural Residue Burning
 - Methane from Rice Cultivation
 - Savanna Burning
 - On Site Burning of Forests and Grassland
 - Waste Incineration
 - Ammonia from Human Excreta
 - Methane from MSW in Landfills
 - Methane from Domestic Water
 - Indicators

Estimating emissions

$$\text{Emission} = \text{Activity rate} \times \text{Emission factor}$$

Data for level of activity (Activity rate)

The screenshot shows a software interface with a tree view on the left and a data table on the right. The tree view includes 'Manufacturing and Construction', 'Iron and Steel', 'Combustion Other Industries_Exclud', 'Brick Kilns', and 'Traditional kilns' (highlighted). The data table has columns for Branch, Expression, Scale, Units, and Per. The 'Traditional kilns' row shows an expression of 'Remainder' with a scale of 'Percent' and units of 'Share of Bricks'. The 'Brick Kilns' row shows an expression of '20' with a scale of 'Million' and units of 'Bricks'.

Branch	Expression	Scale	Units	Per
Brick Kilns	20	Million	Bricks	
Traditional kilns	Remainder	Percent	Share	of Bricks

Estimating emissions: Emission factors (Environmental loading)

The screenshot displays the 'Environmental Loading' software interface. On the left is a tree view of the 'Residential' category, with 'Cooking' expanded to show 'Traditional Stove Wood'. The right pane shows the 'Em Control' tab with a table of emission factors for this category.

Branch	Expression	Units	Per
▶ Carbon Dioxide Biogenic	112 ?a	Metric Tonne	Terajoule
Carbon Monoxide	4260 ?b	Kilogramme	Terajoule
Methane	300 ?a	Kilogramme	Terajoule
Non Methane Volatile	600 ?c	Kilogramme	Terajoule
Nitrogen Oxides	73 ?b	Kilogramme	Terajoule
Nitrous Oxide	4 ?a	Kilogramme	Terajoule
Sulfur Dioxide	SulfurCont	Kilogramme	Kilogramme
Particulates PM10	10.2 ?e	Kilogramme	Metric Tonne
Particulates PM2p5	8.16 ?f	Kilogramme	Metric Tonne
Black Carbon	1.12 ?f	Kilogramme	Metric Tonne

Below the table is a notes section titled 'Notes on Branch: Demand\Residential\Cooking\Traditional Stove Wood' with a rich text editor. The notes contain the following references:

- a) IPCC 2006 Guidelines - Tier 1 default EFs
- b) Zhang et al. (2000) Average EF for household stoves in China.
- c) EMEP/EEA (2013) Tier 1 emission factor
- d) Bond et al. 2004 (Table 6)
- e) Assume PM2.5 = 80% of PM10 as reported for wood and crop waste by Rec
- f) GAINS ECLIPSE EFs from Klimont et al (2016) Table S2.3

Estimating emissions: fuel share scenario for cooking

LEAP: Ecowasia template 3.8.6

Area Edit View Analysis General Tree Chart Advanced Help

New Open Save Email Backup Find Basic Params Scenarios Fuels Effects Units What's This?

Views

- Analysis
- Results
- Energy Balance
- Summaries
- Overviews
- Technology Database
- Notes

Key Assumptions

- Demand
 - Energy Industry Own Use
 - Manufacturing and Construction
 - Brick Kilns
 - Transport
 - Residential
 - Cooking
 - Natural Gas
 - Kerosene
 - LPG
 - Traditional Stove Charcoal
 - Traditional Stove Wood
 - Traditional Stove Vegetal Wastes
 - Improved Biomass Stove with Chimney
 - Traditional Stove Animal Wastes
 - Fan Assisted Biomass Stove
 - Electricity
 - Lighting
 - Other
 - Commercial and Public Services
 - Agriculture Forestry and Fishing
 - Non Specified Other
 - Transformation
 - Resources
 - Non Energy
 - Indicators
 - Benefit Calculator Results
 - Concentrations
 - PM2p5
 - From National Emissions
 - From Rest of World Emissions

Branch: Demand Residential Cooking...

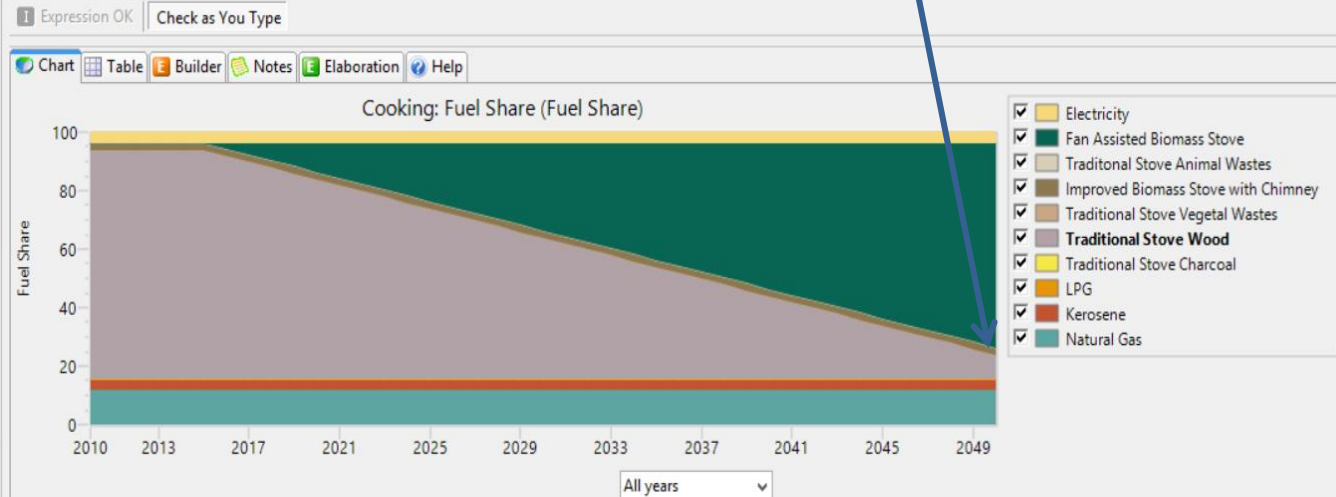
Branch: All Branches Variable: Fuel Share Scenario: COOK: Clean Cookstoves

Activity Level Final Energy Intensity Fuel Share TotalConsumption UnscaledFuelShare All Variables

Fuel Share: Device's share of total annual energy used in all neighboring devices (%) [Default="0"]

Branch	Fuel	2010 Value	Expression	Scale	Units
Natural Gas	Natural Gas	12.00	12	Percent	Fuel Share
Kerosene	Kerosene	3.50	3.5	Percent	Fuel Share
LPG	LPG Liquefied Petr	0.10	0.1	Percent	Fuel Share
Traditional Stove	Char Charcoal	0.00	0	Percent	Fuel Share
Traditional Stove	WocWood	78.27	Remainder(100)	Percent	Fuel Share
Traditional Stove	VegVegetal Material a	0.00	0	Percent	Fuel Share
Improved Biomass Stc	Wood	2.53	2.53	Percent	Fuel Share
Traditional Stove Anim	Animal Products a	0.00	0	Percent	Fuel Share
Fan Assisted Biomass	Wood	0.00	Interp(2015, BaselineValue, EndYear, 70)	Percent	Fuel Share
Electricity	Electricity	3.60	3.6	Percent	Fuel Share
Total:		100	100.00 in 2050		

By 2050 70% of stoves will be improved



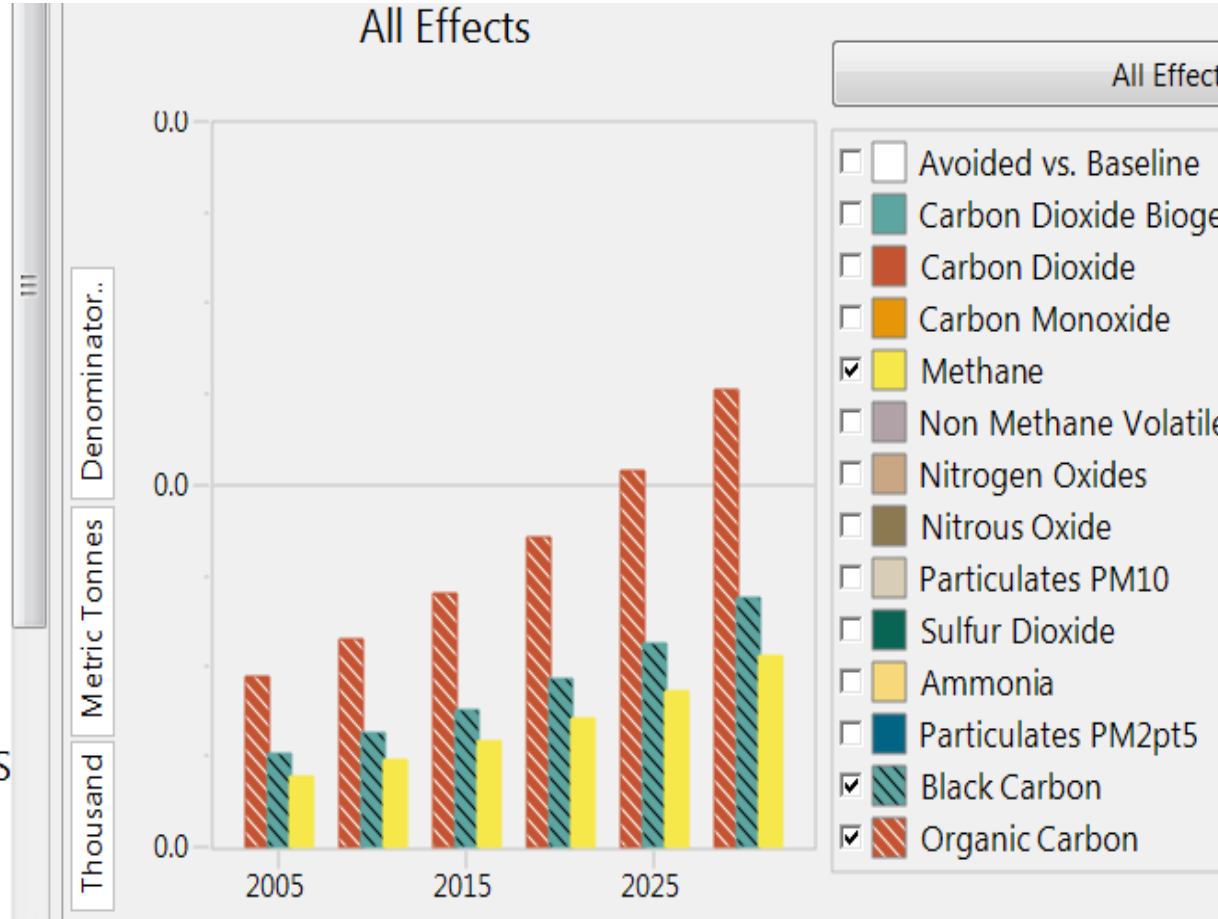
2015.0.28.0 Area: Ecowasia template 3.8.6 Analysis Registered to harry.vallack@york.ac.uk until January 8, 2017

Windows taskbar with icons for R, calculator, Chrome, Excel, PowerPoint, Word, and other applications. System tray shows date 20/10/2016 and time 14:55.

Baseline emission scenarios

Example: BC, OC and CH₄ emission progression

- [-] GDP MER
- [+] ValueAdded
 - [K] Agriculture
 - [K] Services
 - [K] Industry
- [K] Population
- [K] SimpleTransport
- [+] Benefit Calculator Inputs
- [+] Demand
 - [+] Manufacturing and Construction
 - [+] Brick Kilns
 - [+] Traditional kilns
 - [+] Improved Kilns_Zigzag_Hoffman_VS
 - [+] Transport
 - [+] Residential



Views

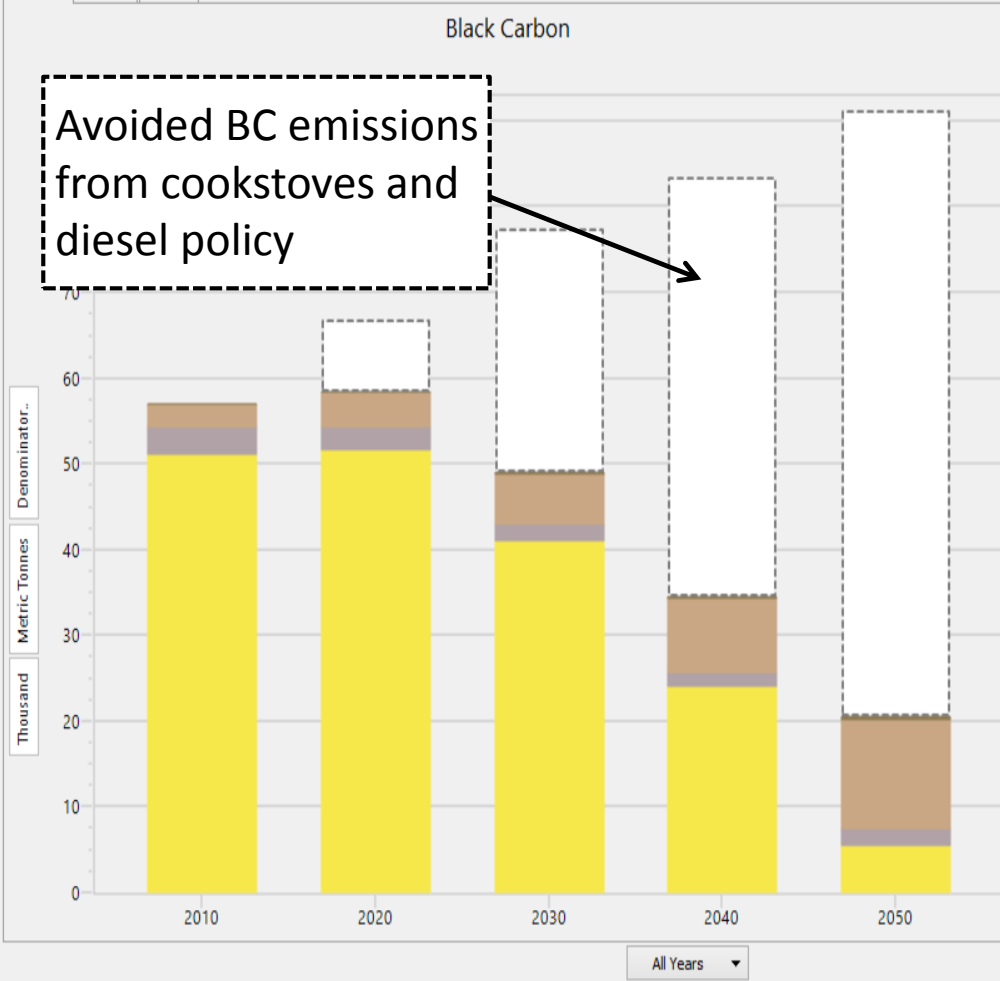
Tags:

- Ecowasia template 3.8.6
 - Key Assumptions
 - Demand**
 - Energy Industry Own Use
 - Manufacturing and Construction
 - Brick Kilns
 - Transport
 - Domestic Aviation Simple
 - Road Transport Simple
 - Baseline
 - Motor Gasoline
 - Gas Diesel Oil
 - Natural Gas
 - LPG Liquefied Petroleum Gas
 - Gas and Liquids from Biomass and Wa
 - Electricity
 - Policies
 - Road Transport Simple SO2
 - Railways
 - Domestic Shipping
 - Pipelines
 - Other or Non Specified Transport
 - Residential
 - Commercial and Public Services
 - Agriculture Forestry and Fishing
 - Non Specified Other
 - Transformation
 - Resources
 - Non Energy
 - Indicators

Black Carbon Levels: 1 Clean Cookstoves Scenario All Fuels Black Carbon Less...

Absolute Values Avoided vs. Baseline

Chart Table Split



All Branches

- Avoided vs. Baseline
- Energy Industry Own Use
- Manufacturing and Construction**
- Brick Kilns
- Transport
- Residential
- Commercial and Public Services
- Agriculture Forestry and Fishing
- Non Specified Other

Views

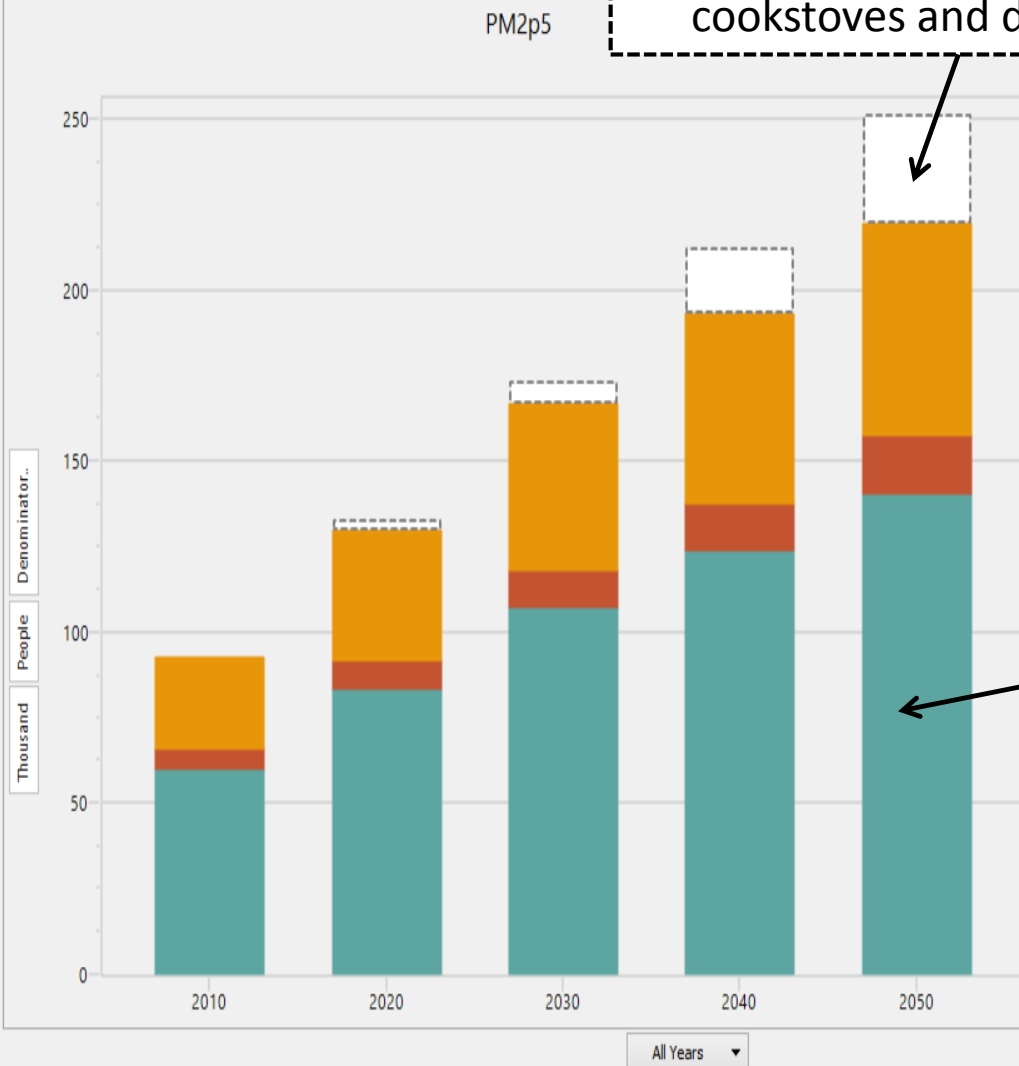
Tags:

- Domestic Aviation Simple
- Road Transport Simple
 - Baseline
 - Motor Gasoline
 - Gas Diesel Oil
 - Natural Gas
 - LPG Liquefied Petroleum Gas
 - Gas and Liquids from Biomass and V
 - Electricity
 - Policies
- Road Transport Simple SO2
- Railways
- Domestic Shipping
- Pipelines
- Other or Non Specified Transport
- Residential
- Commercial and Public Services
- Agriculture Forestry and Fishing
- Non Specified Other
- Transformation
- Resources
- Non Energy
- Indicators
 - Benefit Calculator Results
 - Concentrations
 - PM2p5
 - From National Emissions
 - From Rest of World Emissions
 - From Natural Background
 - Deaths
 - PM2p5
 - From National Emissions
 - From Rest of World Emissions
 - From Natural Background

PM2p5 Levels: 1 Clean Cookstoves Scenario Less...

Absolute Values Avoided vs. Baseline

Chart Table Split



Avoided premature deaths from cookstoves and diesel policy

All Branches

- Avoided vs. Baseline
- From National Emissions
- From Rest of World Emissions
- From Natural Background

Increase in deaths due to population increase

LEAP-IBC: Progress so far

- ❖ 15 countries now participating in SNAP national planning using LEAP-IBC.
- ❖ LEAP-IBC training workshops already held for Colombia, Côte d'Ivoire, Ghana, Morocco, Nigeria, Peru and Togo (plus Estonia and Nepal). Training for Bangladesh, Mexico and Philippines to follow shortly.
- ❖ Quote from Daniel Tutu Benefoh, EPA, Ghana:

“LEAP-IBC is a one stop shop. Rather than using multiple tools, I use LEAP-IBC which allows both energy and non-energy emissions from all sectors to be calculated with the added ability to assess impacts of mitigation scenarios. LEAP-IBC can easily be modified to capture the impact of specific activities a convenience you can't find in any other software. This means that LEAP-IBC can effectively serve the interests of local users ”

Emissions inventory development in LEAP-IBC (1)

Not just an emissions inventory of Black Carbon and Methane – must also include all relevant co-emitted substances to determine net impacts:

- ❖ For **BC mitigation** strategies, must also include emissions of:
 - All **primary particulate matter** (PM) emissions (BC, OC and other PM_{2.5}), and,
 - The major **precursors of secondary PM** (SO₂, NO_x, and NH₃)
- ❖ Similarly, emissions of all the major **ozone (O₃) precursors** (NO_x, CO, and NMVOC as well as CH₄) are needed to model O₃ formation and impacts on health and crops.
- ❖ For net **climate impacts**, the change in **radiative forcing all co-emitted substances** (both warming and cooling) must be included.
- ❖ **Challenge:** for some key sources (e.g. cookstoves) the emission factors reported in the literature rarely include all of the above species.

Emissions inventory development in LEAP-IBC (2)

Most default emission factors (EFs) are from the EMEP/EEA 2016 Air Pollutant Emission Inventory Guidebook and IPCC 2006 Guidelines

- ❖ **Challenge:** These EFs may not be appropriate for regions outside Europe and N. America
- ❖ **Solutions:**
 - a) For key sectors, include more appropriate EFs from the literature, e.g.
 - Domestic tradition woodstoves: Klimont et al (2016), Zhang et al (2000)
 - Brick kilns: Weyant et al (2014)
 - Coke ovens (PM, BC, OC): Bond et al (2004)
 - b) Encourage use of locally determined EFs where possible
 - c) Continue to liaise with the other CCAC initiatives to improve EFs/methods
 - d) Continue to develop an EF database within LEAP-IBC so users can select alternative factors

Emissions inventory development in LEAP-IBC (3)

'Accuracy' versus 'Usability'

- ❖ LEAP-IBC is intentionally designed not be 'data hungry' – finding reliable and sufficiently disaggregated data is often the biggest challenge for users.
- ❖ The need to develop SLCP mitigation scenarios also constrains the level of detail of the EI approach - users will need to create a story of how each variable will change over time.
- ❖ No such thing as a 'final' emission inventory with the 'right' number. It improves iteratively with improved data and scientific knowledge.
- ❖ In general, LEAP-IBC uses the same sources of activity data and EFs as international inventory efforts.
- ❖ Inclusion of uncertainty is being looked at – but primary purpose of the tool is to allow users to compare likely impacts of alternative SLCP mitigation scenarios.

Thank You



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



SEI STOCKHOLM
ENVIRONMENT
INSTITUTE