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# Aggregate exposure assessment: tiered approaches and illustration for indoor environments

Rudi Torfs, VITO

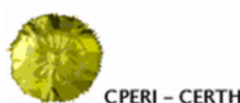
# CEFIC-LRI projects B4-CERTH & B5-THL (2010-2012)



Tiered AGgregate exposure aSsessment



Integrated Exposure For Risk  
Assessment In Indoor Environments



AEA: an assessment of exposure to a single agent from all potential sources and pathways (the physical course taken by an agent as it moves from a source to a point of contact with a person) and the related exposure routes

# Context

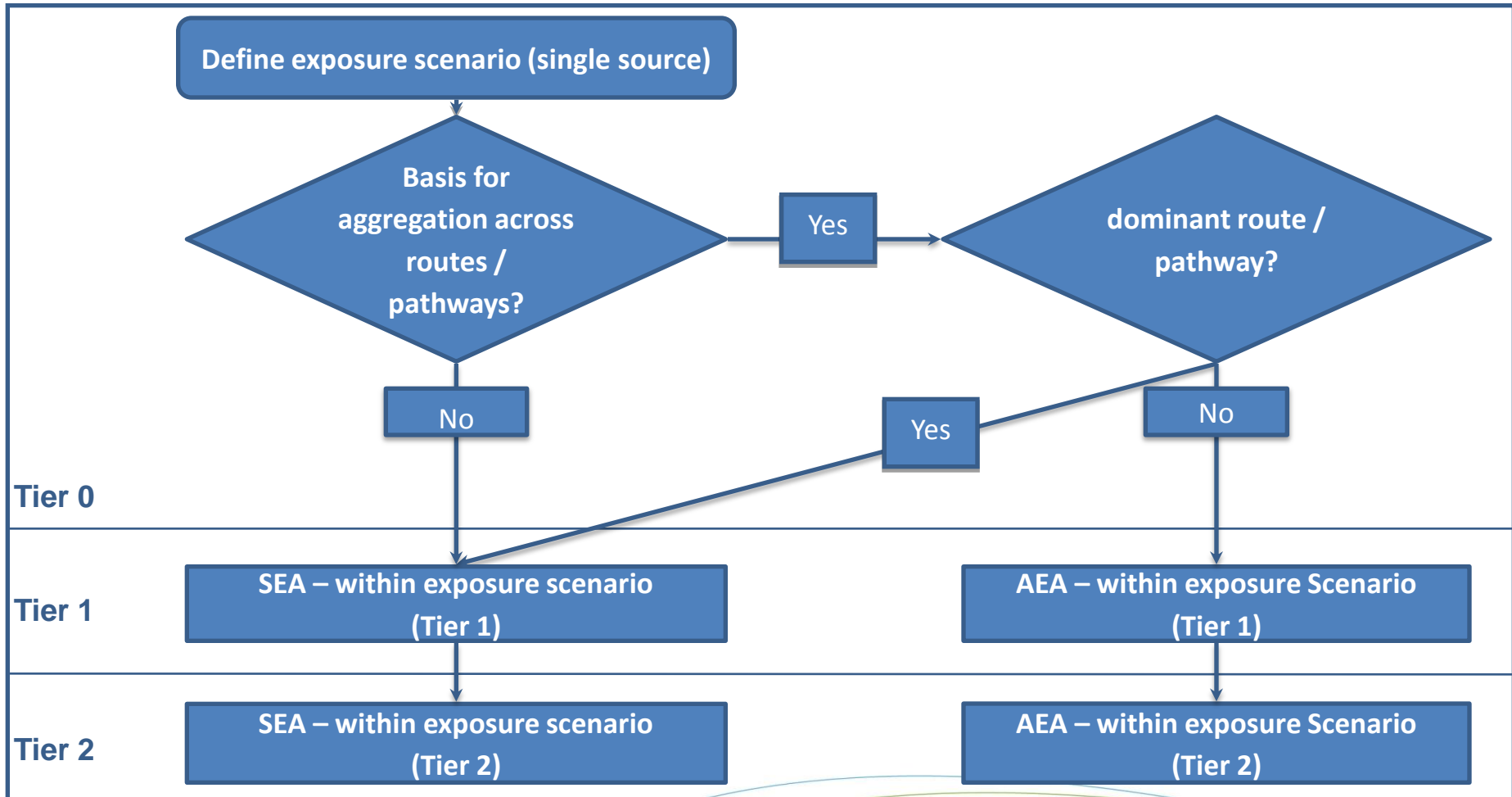
- » ECETOC: Contribute to the development of a pragmatic, realistic, and science-based framework for the risk assessment of chemical mixtures.
- » CEFIC-LRI: 21st Century Approaches to Risk Sciences
  - » Health impact of complex environments
  - » Exposure to mixtures, from multiple sources, indoor...
- » Why? → the need to have a better representation of exposure
  - » REACH (Biocides, food safety...)
  - » Moving towards integrated exposure science ('the exposome')



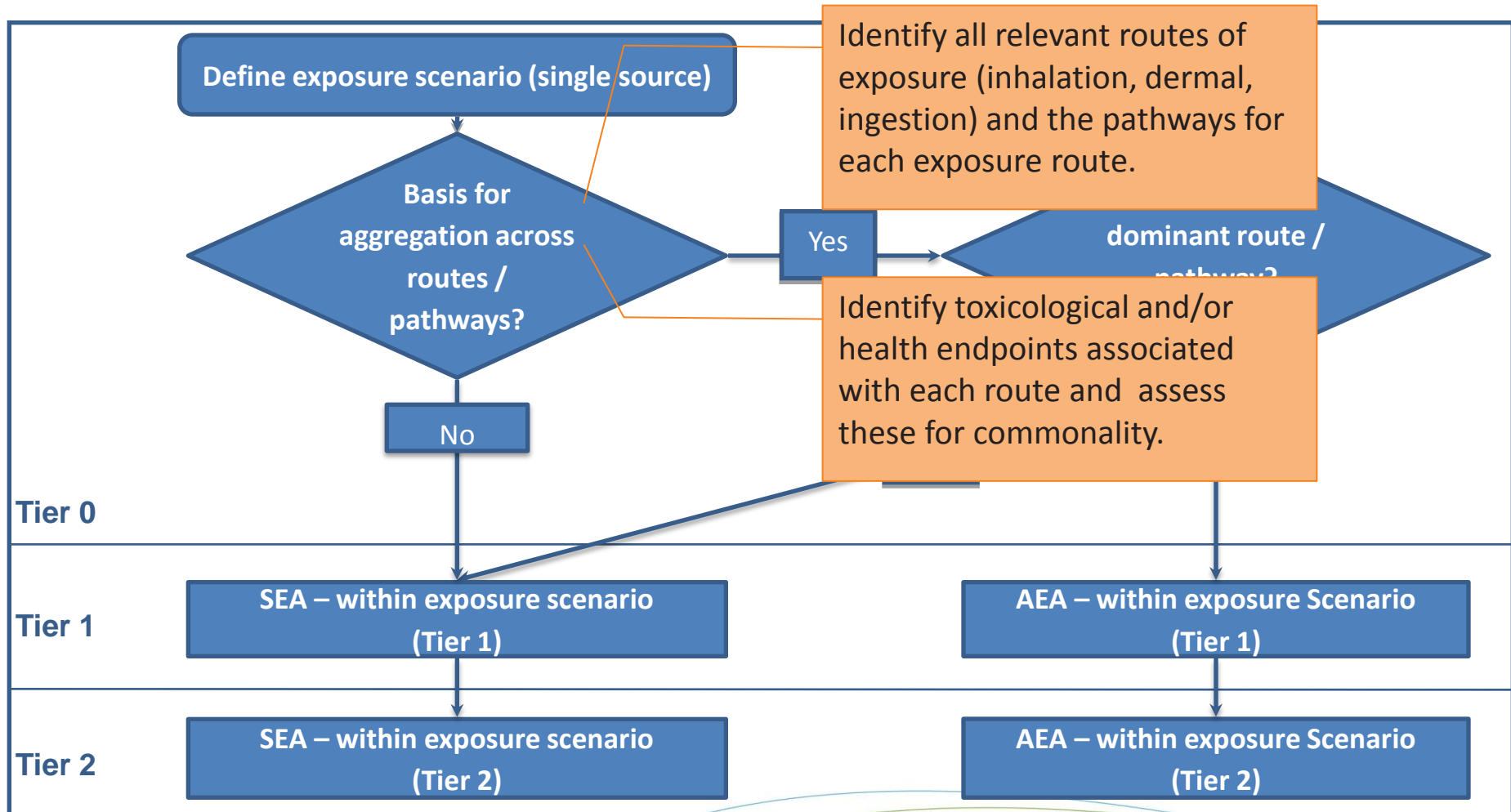
# Challenges

- » Quantifying all possible sources, pathways and routes of exposure can become a very complex task in terms of data collection, data assessment, exposure modelling and – not least – verification.
  - » TAGS to provide a ‘decision structure’
  - » When to go to higher tiers
- » Partial or incomplete tools to evaluate a full AEA
  - » ECETOC-TRA
  - » Full chain modelling tools (INTERA)
- » Inconsistent ways to evaluate adequacy of models and data
  - » Verification strategy in TAGS

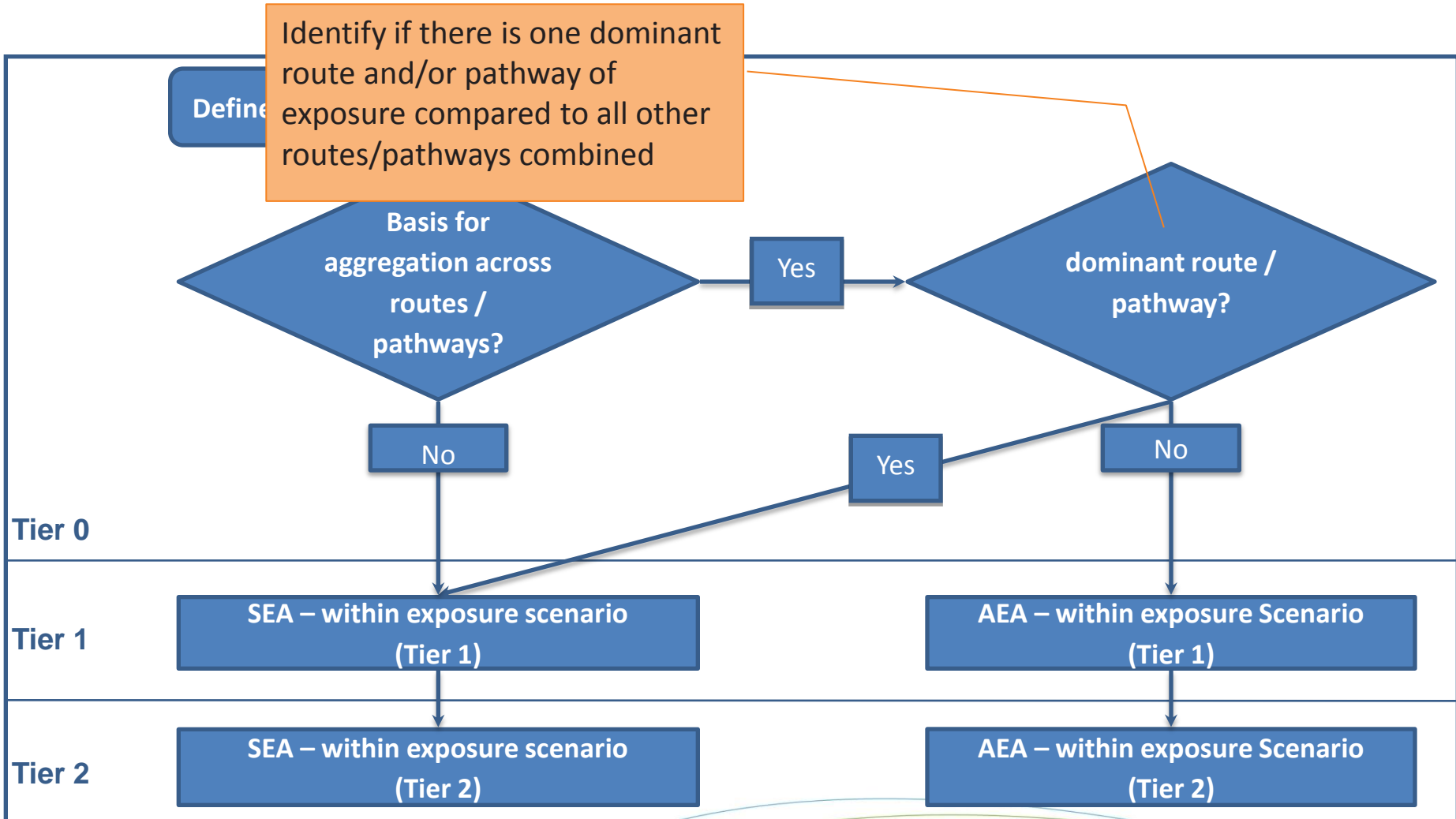
# The Tiered Aggregate Approach (TAGs) - **within** Exposure Scenario



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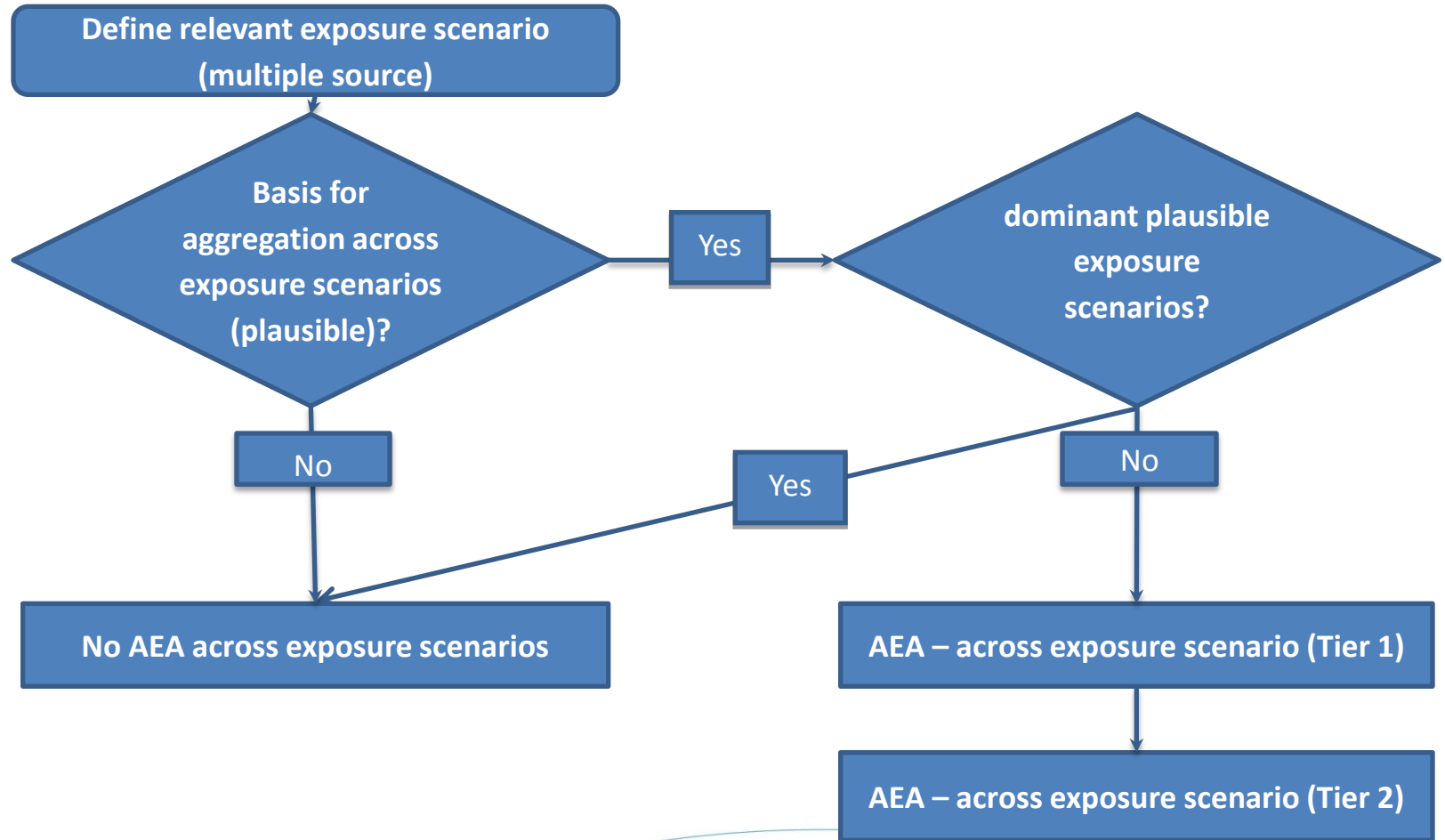


# The Tiered Aggregate Approach (TAGs) - within Exposure Scenario

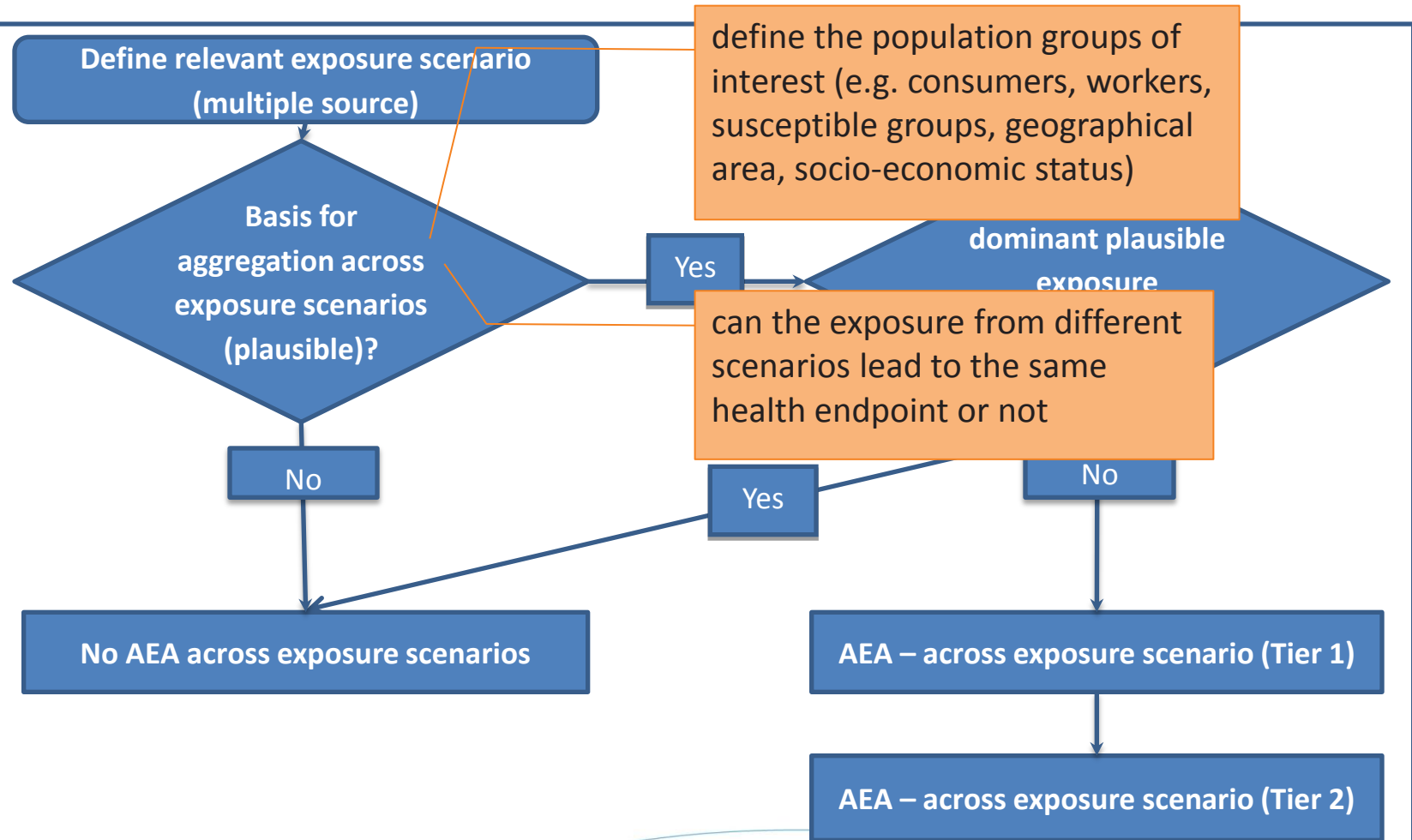




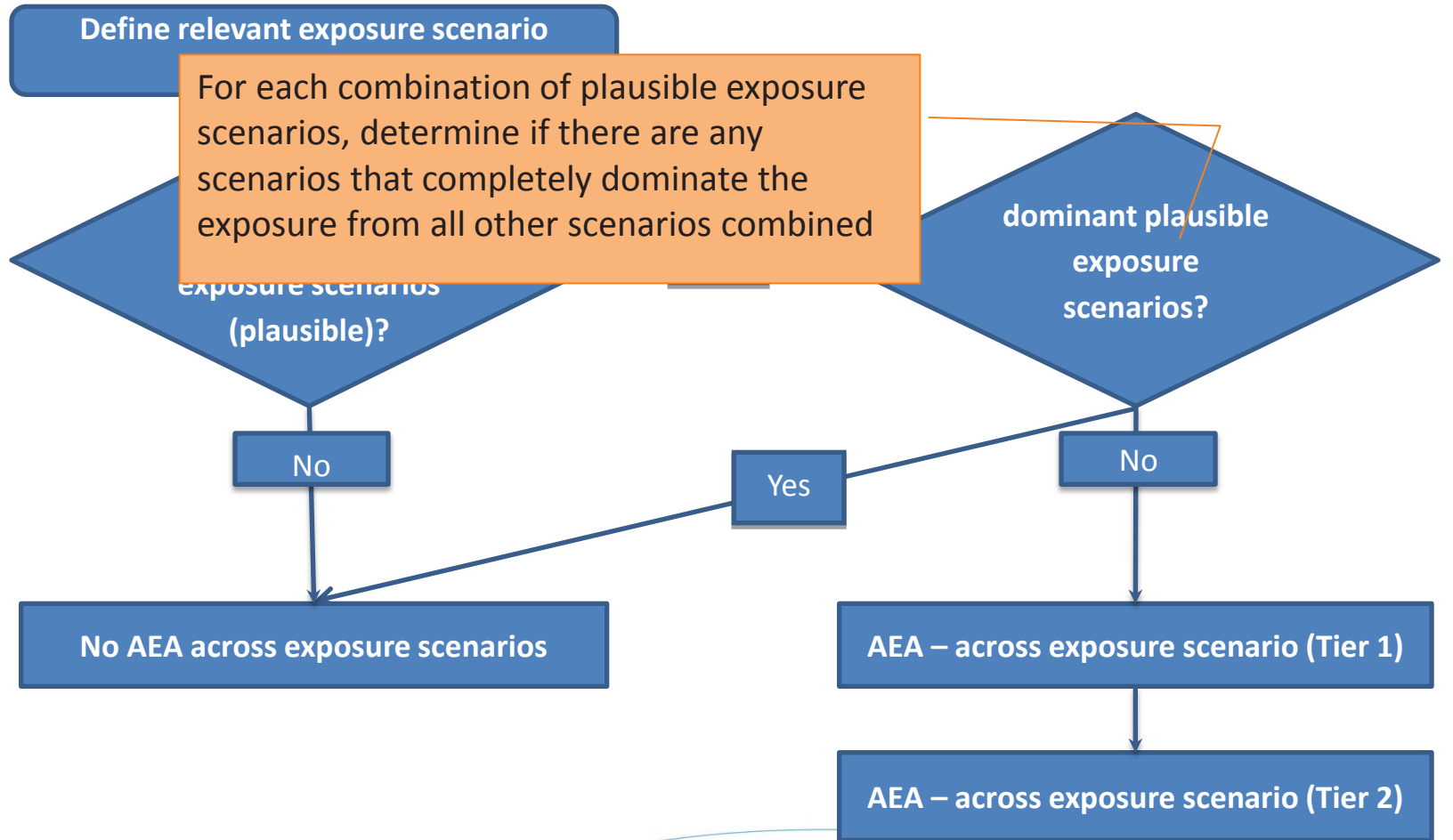
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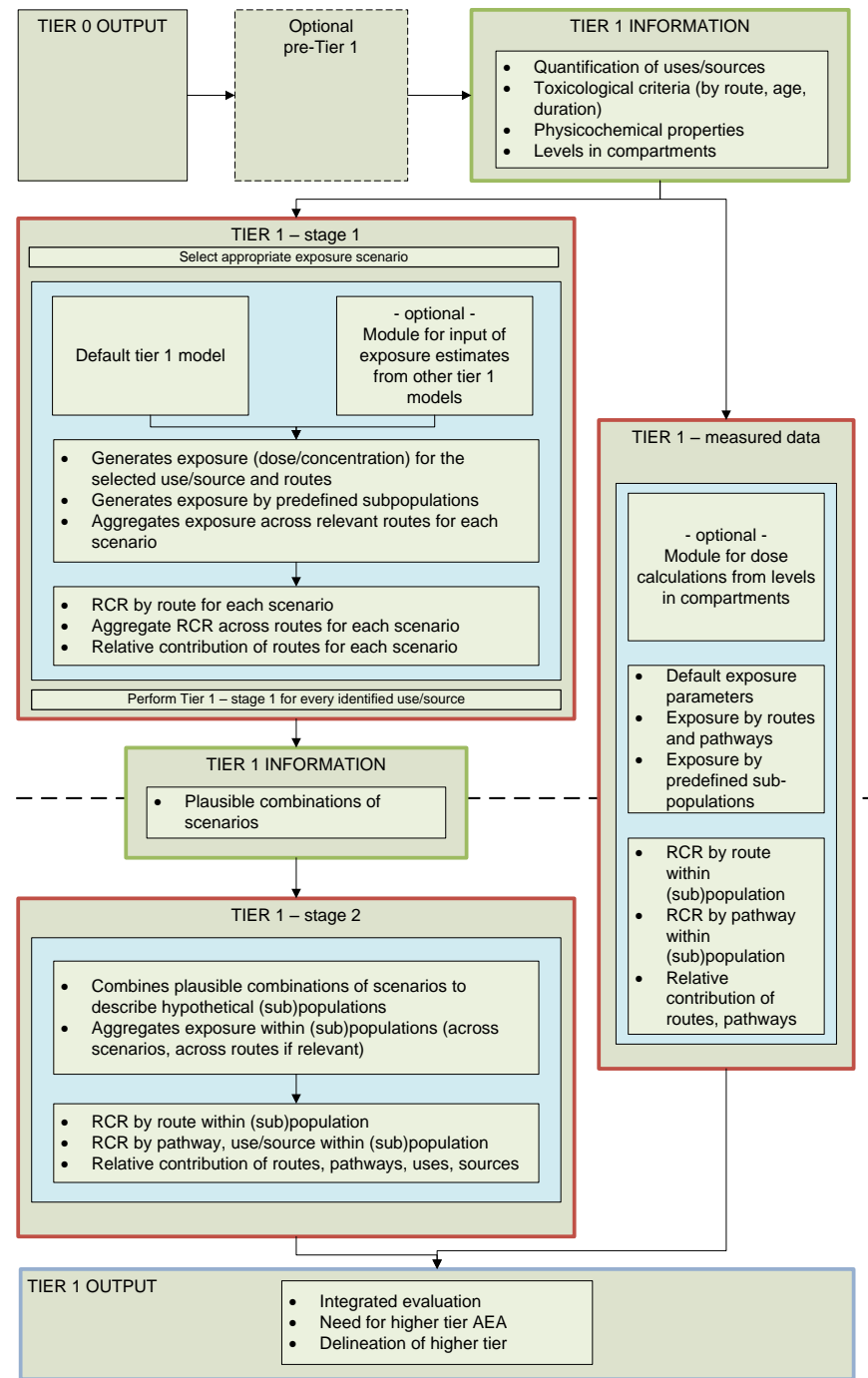


# The Tiered Aggregate Approach (TAGs) - across Exposure Scenarios

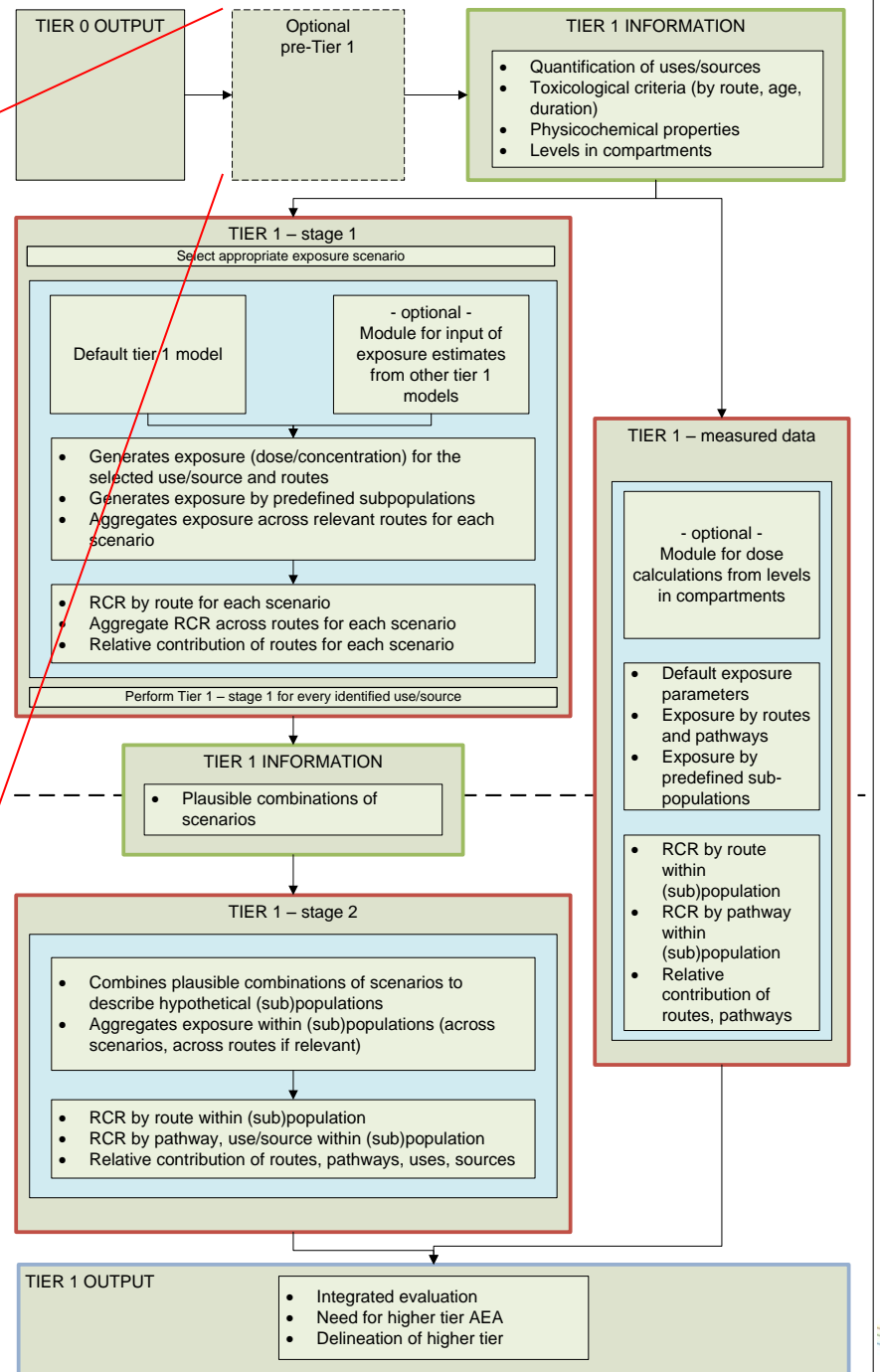
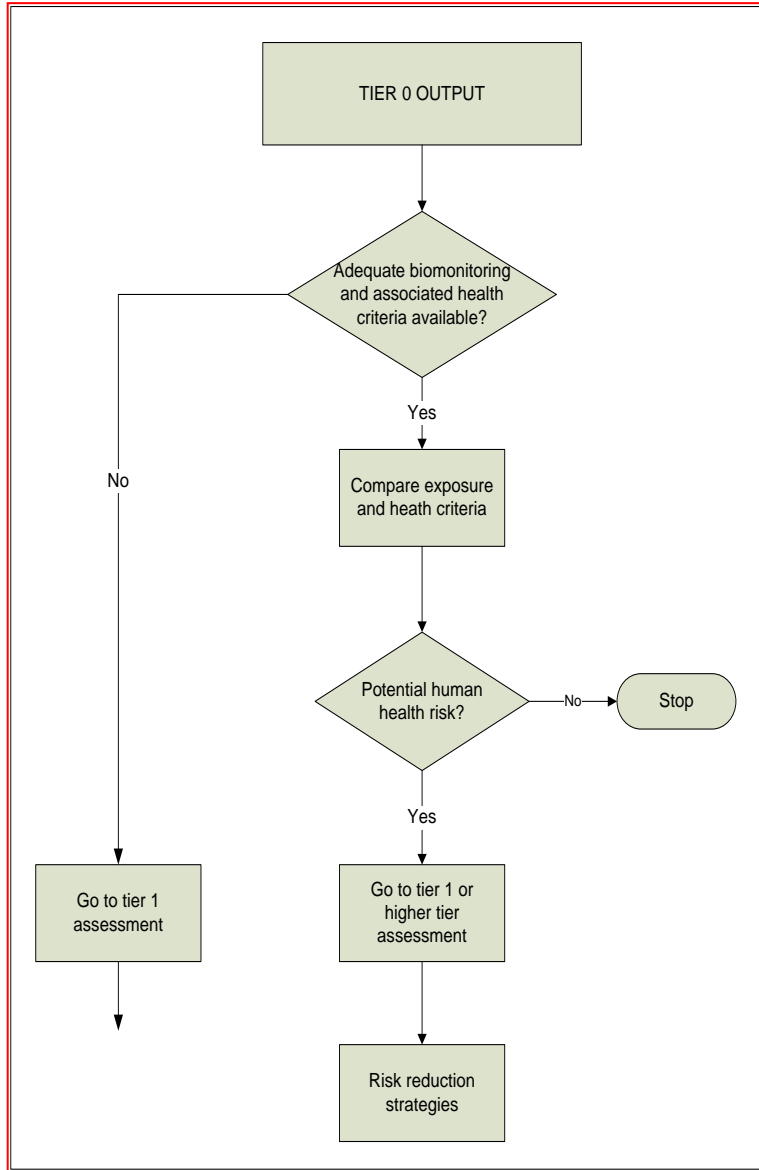


# Tiered approach : next steps

- » Steps to go from TIER 0, via pre-TIER 1 to TIER 1 and further



# Tiered approach : next steps



# Tools for AEA

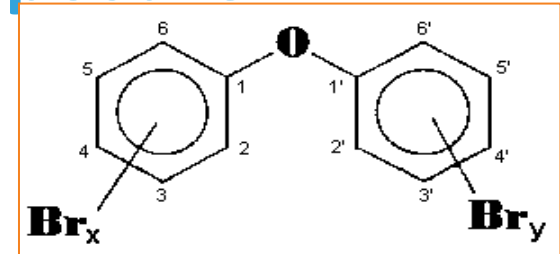
- » The current, non-aggregated version of the ECETOC TRA tool forms a good basis for the further development of a Tier 1 tool for AEA.
- » The structure and the current formulas and spreadsheets of the ECETOC TRA tool allow fairly easily the modifications to turn the tool into a more complete AEA tool.
- » In TAGS we suggest modifications to account for:
  - » adult and children exposure separately in the consumer module ;
  - » adult and children exposure separately in the environment module ;
  - » aggregate exposure across routes (within scenario);
  - » aggregate exposure across scenarios (and across routes).

# Verification strategy

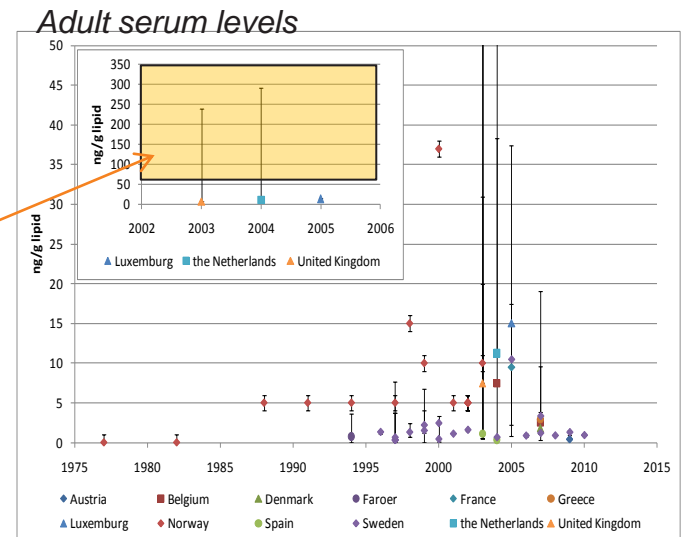
- » To strengthen the plausibility of the assessment.
- A. verification of the applicability domain of substances and spatial and temporal resolution;
- B. verification of the conceptual model;
- C. verification of the applicability domain of databases and parameters;
- D. verification of model software implementation;
- E. verification of model predictions (assessment verification):
  - » E1. verification of intermediate steps along the source to receptor chain, and
  - » E2. verification of by means of biomonitoring data.

	validity of conceptual model	validity of implementation	availability of existing data for verification	verification data supporting assessment
assessment A	major source missing			
assessment B	OK	not OK	-	-
assessment C	OK	OK	-	-
assessment D	OK	OK	limited data	data inappropriate for verification
assessment E	OK	OK	OK	limited support due to inappropriate data
assessment E	OK	OK	OK	verification data support assessment

# Illustration of Tiered Aggregate exposure: TAGS BDE 209 case study



- » TIER 0 : need for aggregation?
  - » Yes : systemic health effects: neurodevelopmental, liver, thyroid and possible contribution from different pathways and routes
- » Pre-TIER 1: Indication of low risk, however:
  - » data for children; lower brominated congeners
- » TIER 1:
  - » ECETOC TRA v2 overconservative
  - » Assessment based on measured levels:
    - » Highly exposed subpopulations
    - » Lacks direct contact with articles
  - » Generation of lower brominated congeners not accounted for
- » TIER 2:
  - » Low to no health risk
  - » Need to account for children in all tiers
  - » Evaluate EFSA dietary methodology and data versus ECETOC TRA dietary data





# Summary

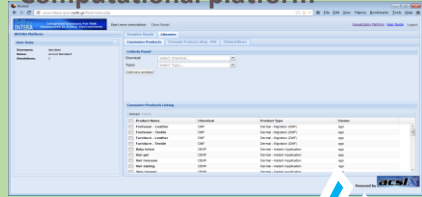
- » The TAGS project developed a tiered approach to (non-occupational) aggregate exposure assessment, distinguishing three tiers with increasing levels of data needs and complexity.
- » A methodology and process for verification of aggregate exposure assessments is available.
- » A tiered approach guiding the user towards the relevant aspects of aggregation helps to optimize and reduce efforts.
- » Suggestions to improve the ECETOC TRA with TAGS findings
- » Full chain modelling tool has been developed for indoor exposures  
=INTERA

# Integrated Exposure for Risk Assessment in Indoor Environments (INTERA)

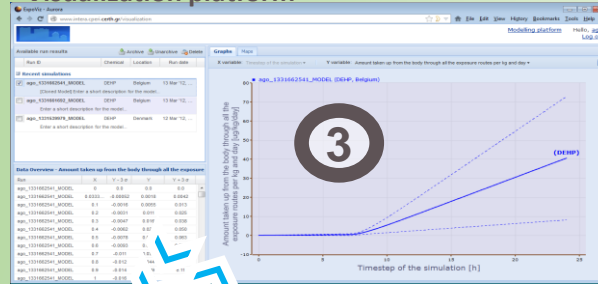
- » The INTERA project (<http://www.intera-home.eu/>) developed and applied a full chain mechanistic modelling approach that includes:
  - » The relations among the sources of contamination (outdoor and indoor), and the levels of indoor contamination.
  - » The modelling of actual exposure to indoor contamination, from source to dose, including internal dose modelling (Physiology Based Toxicokinetic (PBTK) modeling)
- » Available at <http://www.intera.cperi.certh.gr>
- » As part of INTERA a Knowledge Management System has been developed:
  - » Incorporating appropriate databases of quality assured source data;
  - » Making available and applying suitable models and statistical methodologies for the characterization and treatment of such data;
  - » With the ability to display exposure predictions in a number of formats.
- » Available at <http://en.opasnet.org/w/Intera>

# Client side (browser)

## Computational platform



# Visualization platform



1

# Server side

Available run results

Run ID	Chemical	Location	Run date
debrouwk_1331818687_MODEL	DIDP	Belgium	15 Mar '12, 14...
debrouwk_1331728642_MODEL	DEHP	Belgium	14 Mar '12, 13...
debrouwk_1331728185_MODEL	DEHP	Belgium	14 Mar '12, 13...
debrouwk_1331727574_MODEL	DEHP	Belgium	14 Mar '12, 13...
debrouwk_1331726613_MODEL	DEHP	Belgium	14 Mar '12, 13...
debrouwk_1331583680_MODEL	DEHP	Italy	12 Mar '12, 21...
debrouwk_1331563133_MODEL	DEHP	germany 2	

Archived

Data Overview - Concentration in urine of metabo

Location	Y
	x
	x
	x

Graphs Maps

X variable: Geolocation Y variable: Concentration in urine of metabolite 1

Map type: Central measure: P50/avg 1,5884962 9,999999999999999



# To conclude and continue

- » Better and **more integrated tools** for tiered aggregate exposure assessment are needed to overcome the current difficulties when using different models for part of the aggregate exposure modelling.
- » **More data is needed** in many cases, for instance for model parameterization and verifying the aggregate exposure assessment.
- » Try developing research to differentiate the exposure assessment between **children and adults**.
- » In the longer term all knowledge and tools, including aggregate exposure tools, should **be integrated in an overall framework** to characterize the exposome.

# Thank you



Arja Asikainen, Katleen DeBrouwere, Emma Doust, Karen Galea, Alberto Gotti, Einari Happonen, Araceli Sanchez Jimenez, Anastasios Karabelas, Spyros Karakitsios, Periklis Kontoroupi, Eelco Kuipers, Elias Mplatsis, Spyridoula Nikolaki, Denis Sarigiannis, Sean Semple, Arnout Standaert, Rudi Torfs, Matti Jantunen, Martie van Tongeren, John Cherrie, Christa Cornelis, Carole Garden, Sally Spankie