Hazardous Chemicals in the Circular Economy (CE)

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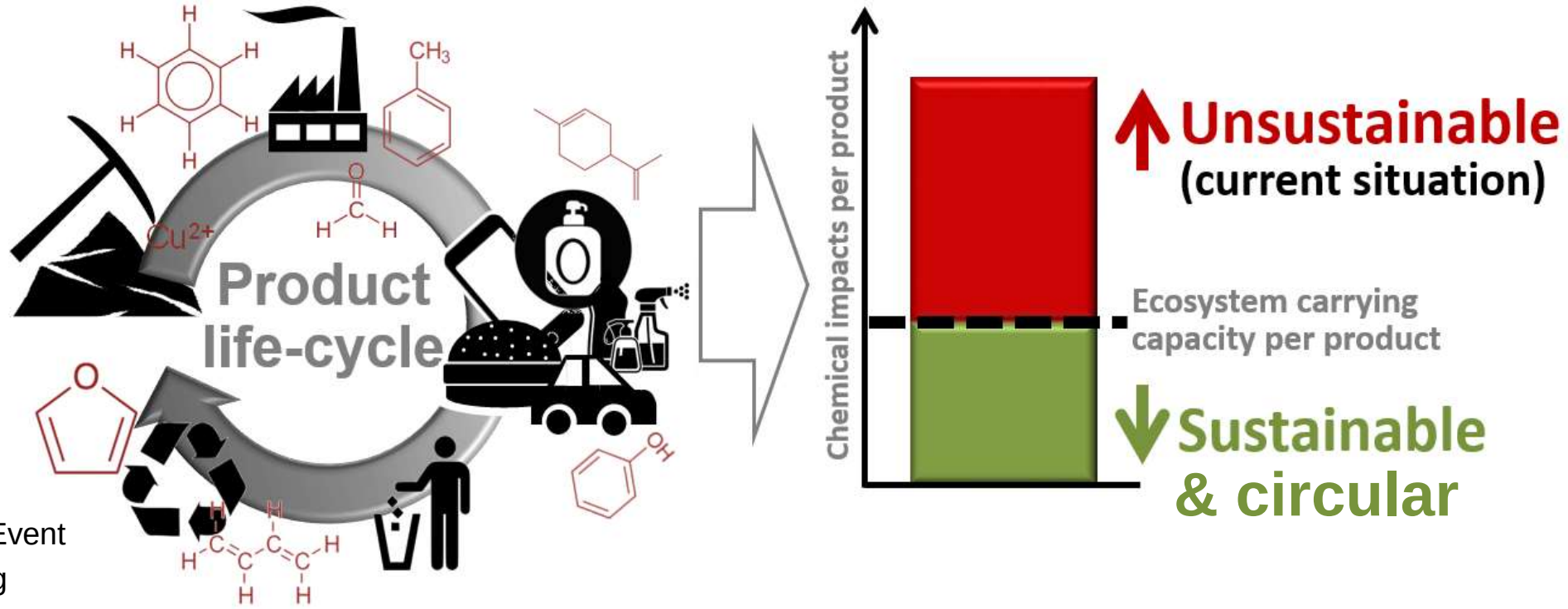


HCPP Project Final Event
12 Sep 19 | Göteborg

The ambition: Policy for a safe and sustainable future?

European regulations (in force as of 2019)

Occupational health

General & medical products

Classification & labelling

Detergents, toys, cosmetics

Air quality

Waste

Emissions & radiation

Food & food contact materials

Industrial chemicals

Construction products, medical devices

1990 — 1995 — 2000 — 2005 — 2010 — 2015 — 2020

Basel waste convention

POPs convention

UNEP SAICM

UN SDGs

International treaties & policy frameworks

Fantke et al. 2019 JESEE (accepted)

Known problems: Plastics in the Circular Economy

European Environment Agency 2016, adapted

- Plastics mainly derived from **fossil** resources
- Plastics largely designed for **short-lived, single-use** products
- When recycled, **cross-contamination** with additives
- **Leakage** to the environment, high persistence, hazardous substances
- Lack of **supply chain** knowledge, data, and suitable **assessment tools**
- Unclear/missing reduction **targets** for chemical and plastic pollution
- Few enabling **policies** to promote innovation in design, production, EoL
- Different management options for **marketed vs. new** products

Problem example: Plastic cross-contamination with PBDE

PBDE in flooring

DiGangi et al. 2011 OHC

PBDE in children toys

Chen et al. 2009, ES&T 43: 4200

PBDE in kitchen ware

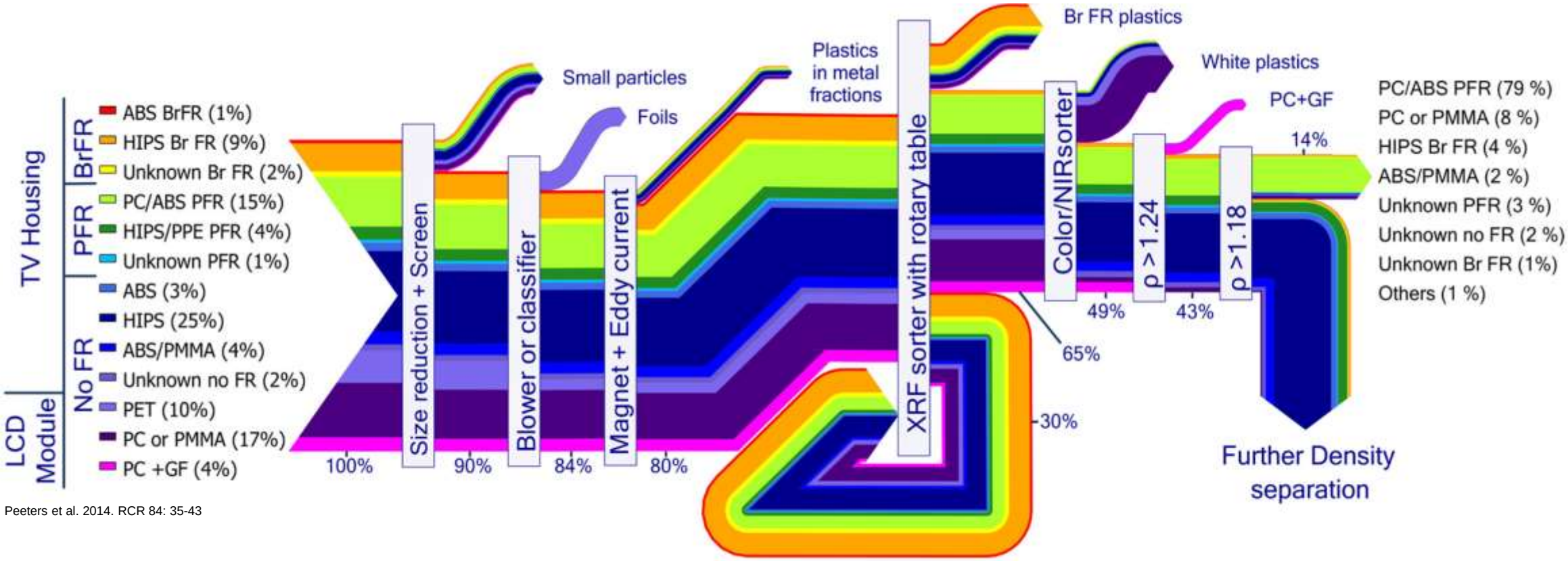
Samsonek & Puype 2013 FAC 30: 1976

High levels of PBDE & PBDD/F in recycled plastic in **sensitive uses**

Challenge to **control recycling** in developing & emerging economies

→ **For a circular economy, control materials along entire life cycles & identify safe alternatives**

Problem example: Complex wastes hamper management



Peeters et al. 2014. RCR 84: 35-43

E-waste plastic **complex input stream** of polymers and flame retardants (BFRs/PFRs) from TV housings and LCD modules

→ **For a circular economy, combine separation/recovery technologies**

Problem example: Missing market for plastic waste

PS, HIPS, PA, PP

PVC and PE

HIPS, ABS, with BFRs

PVC and PE

Some **recycling of plastic** has started in African countries, e.g. Ghana

Large share of plastic fractions (currently) does not have a **potential market**

Missing policies for enabling capacity to use plastic waste

→ For a circular economy, all major plastic fractions need to be addressed

SRI SUSTAINABLE RECYCLING INDUSTRIES

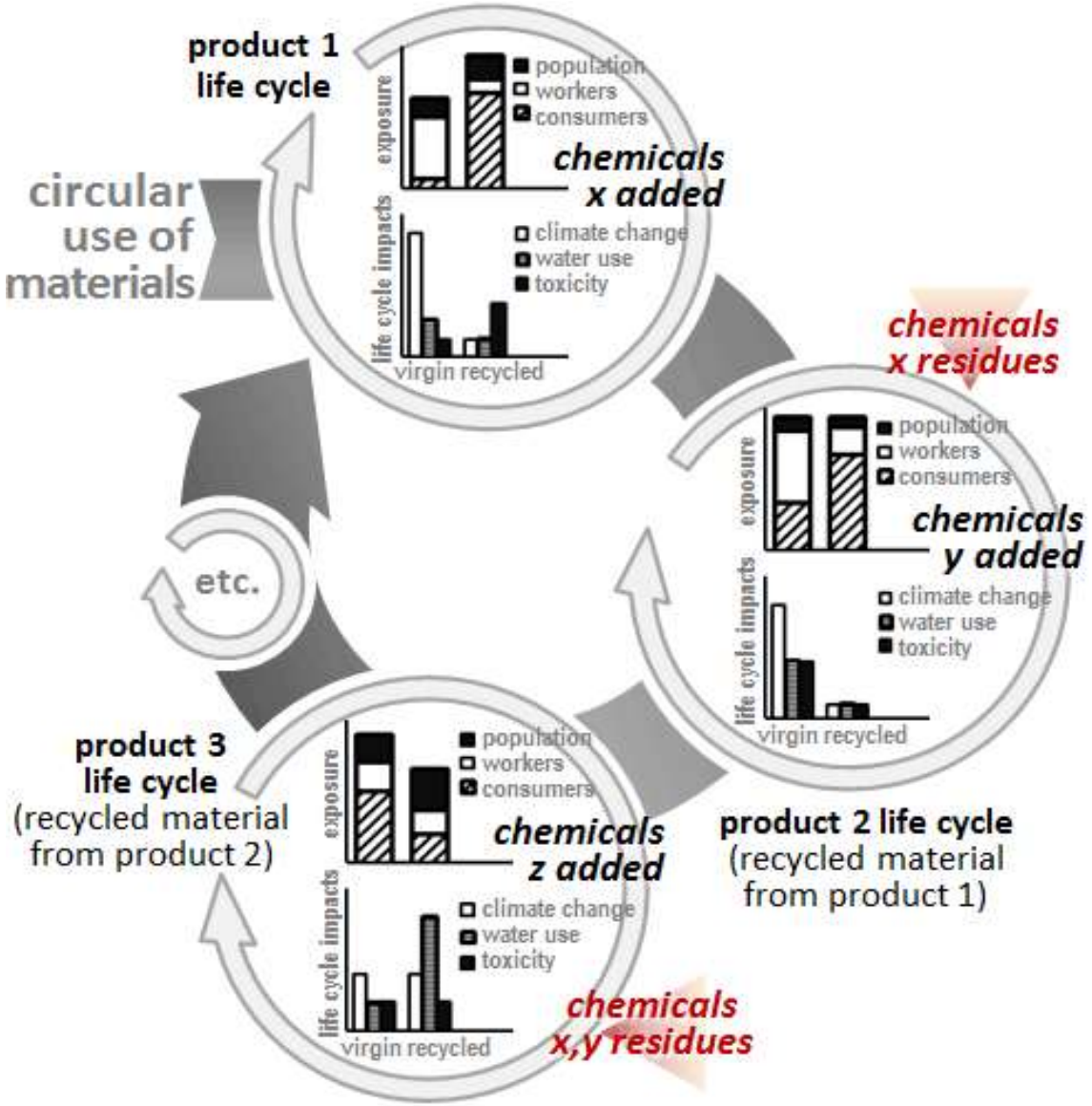
Solutions: Push substitution into product design processes

→ **Performance needs to be combined with environmental sustainability during design**

→ **Qualitative metrics need to be replaced by quantitative life cycle-based metrics**

→ **Relative improvement needs to be increased to meet targets for absolute sustainability**

Solutions: Focus on intersections between life cycles



Fantke & Illner 2019. Curr Opin Green Sustain Chem 15:91-97

Increase supply chain **transparency**

⇩

Start from **functional** basis for identification of suitable alternatives

⇩

Determine product **constituents**

⇩

Integrate workers, users, population

⇩

Incorporation into product design workflows → target **formulators**

⇩

Intersect chemical and material life cycles in a circular economy

Solutions: Defining science-based pollution targets

$$\mathbf{I} = \mathbf{P} \times \mathbf{A} \times \mathbf{T}$$

Impact = population × affluence × technology

$$[\text{persons}] \quad \left[\frac{\text{products}}{\text{person}}\right] \quad \left[\frac{\text{impact}}{\text{product}}\right]$$

Increased production volume

⇩

Increased emissions

⇩

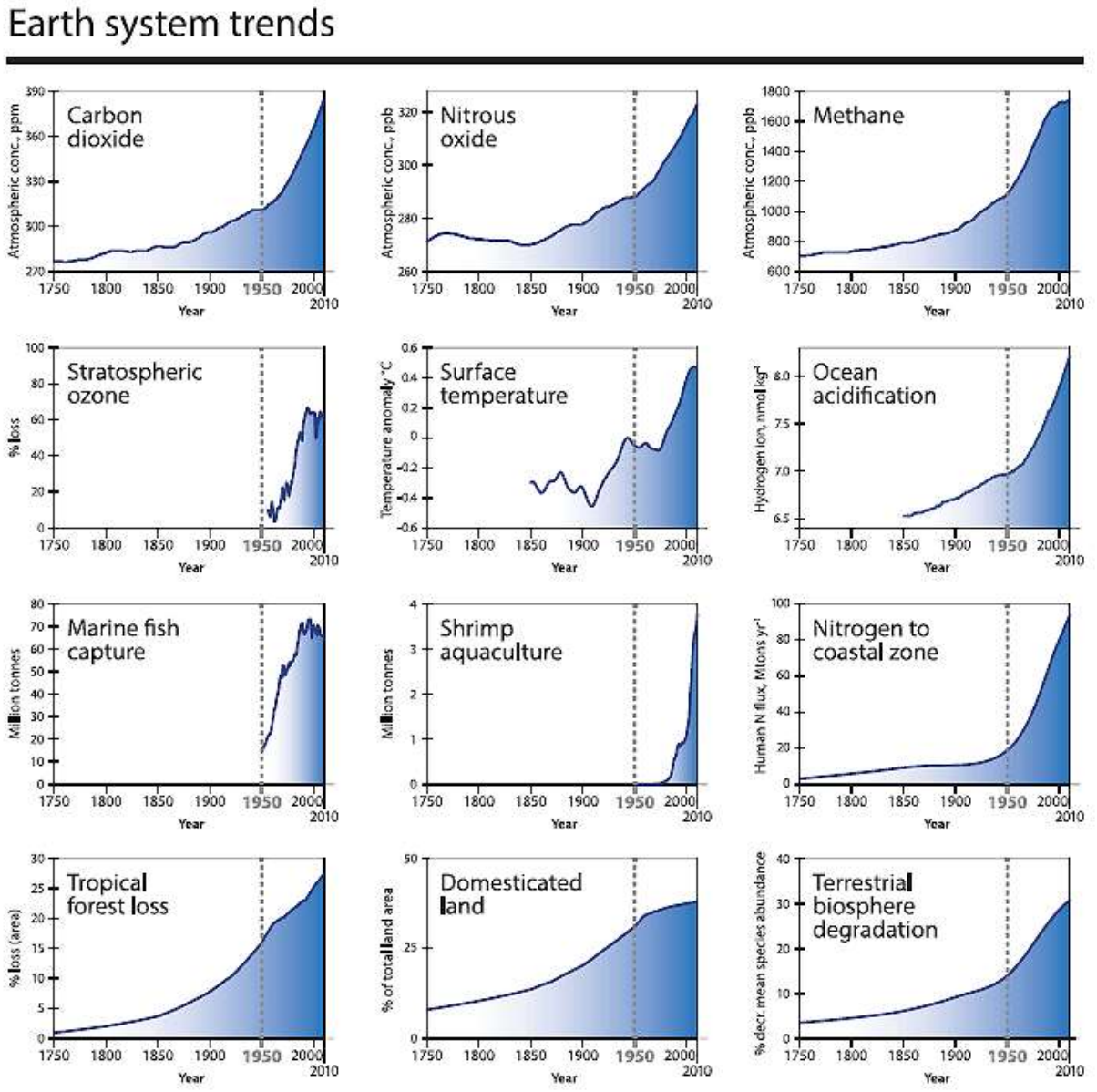
Increased environmental load

⇩

Reduction below ecological capacities

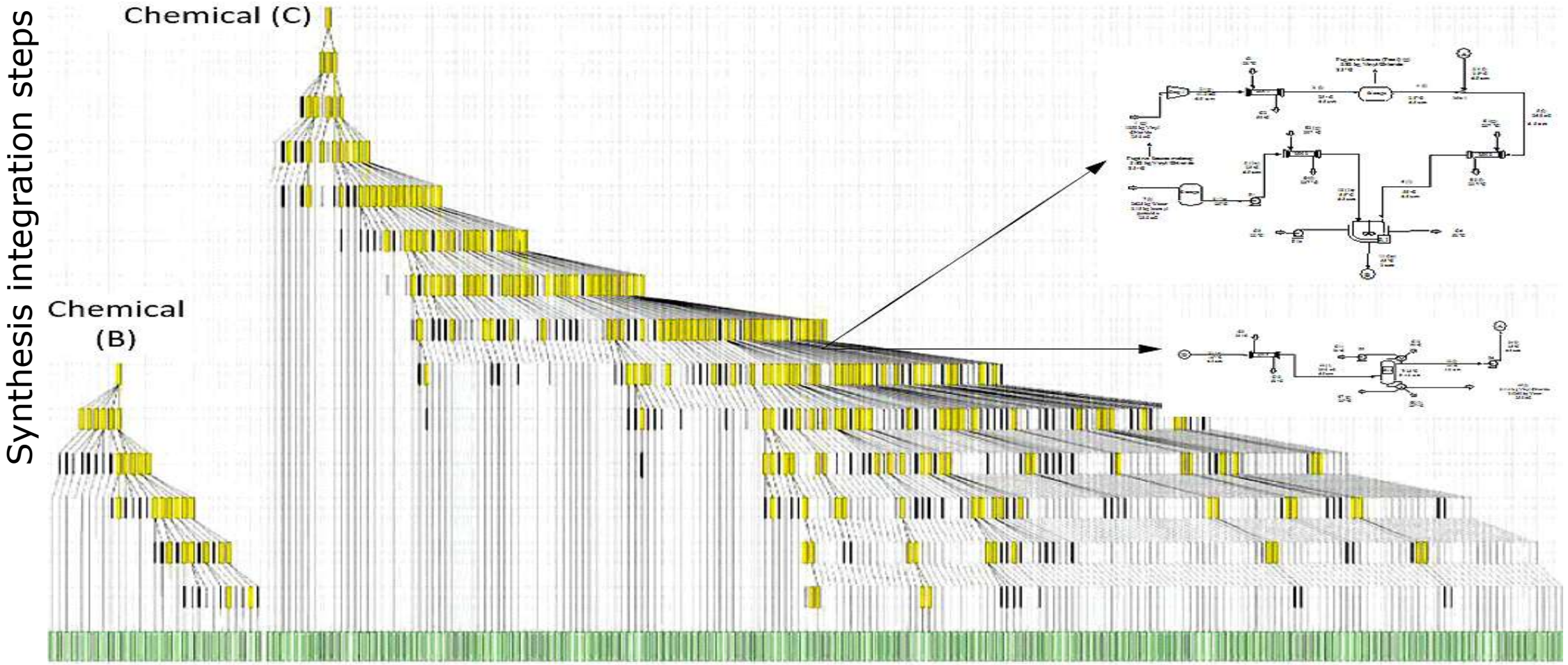
⇩

Develop science-based targets for chemical pollution & human exposure



Steffen et al. 2015. Anth Rev 2:81

Solutions: Full chemical supply chain information

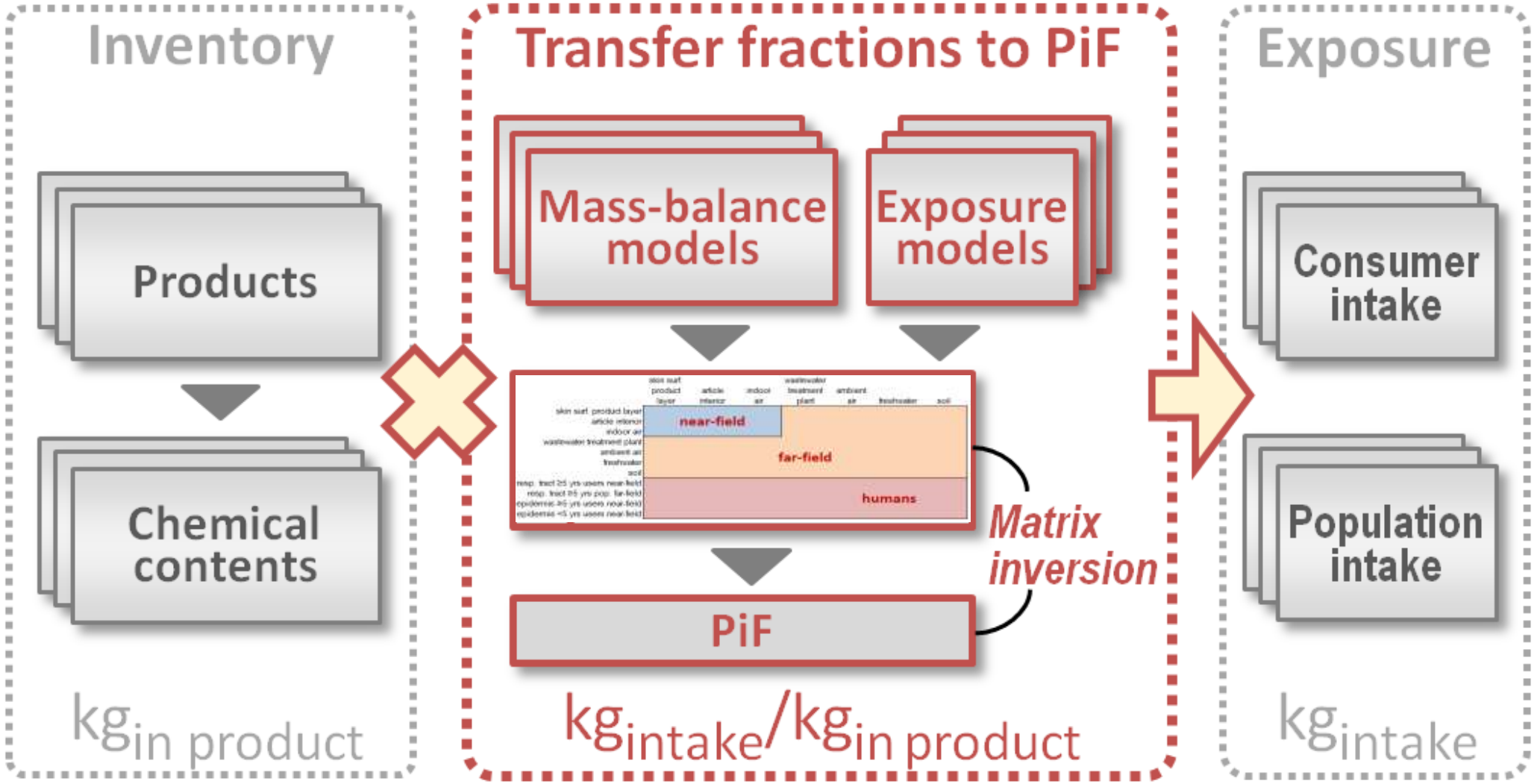


Overcash 2016. Green Chem 18: 3600-3606

Fully mass balance based, emission data from generic databases or spatial inventories

→ **Enables coupling to exposure models over full chemical life cycle**

Solutions: Integrating consumer, worker, population exposure

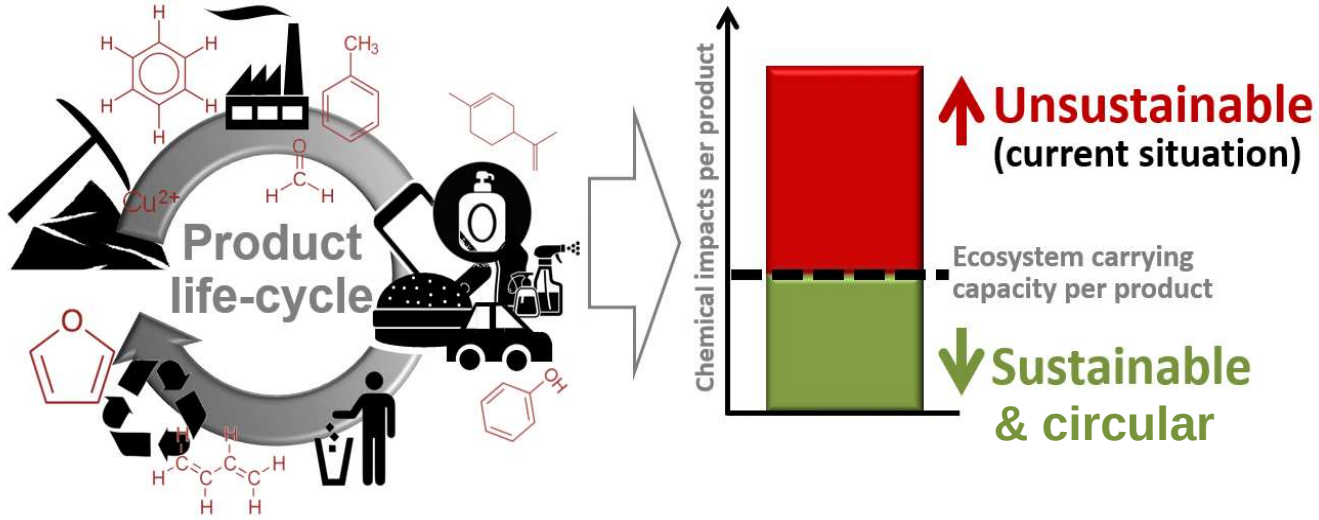


Fantke et al. 2016 Environ Int 94, 508-518

→ **Enables full life cycle based exposure and toxicity based substitution**

Take-home messages: Managing chemicals in CE

1. Push substitution into **design for reuse & recycling**
2. Manage supply chain and **life cycle information**
3. Consider **absolute sustainability targets**



Thank you!

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