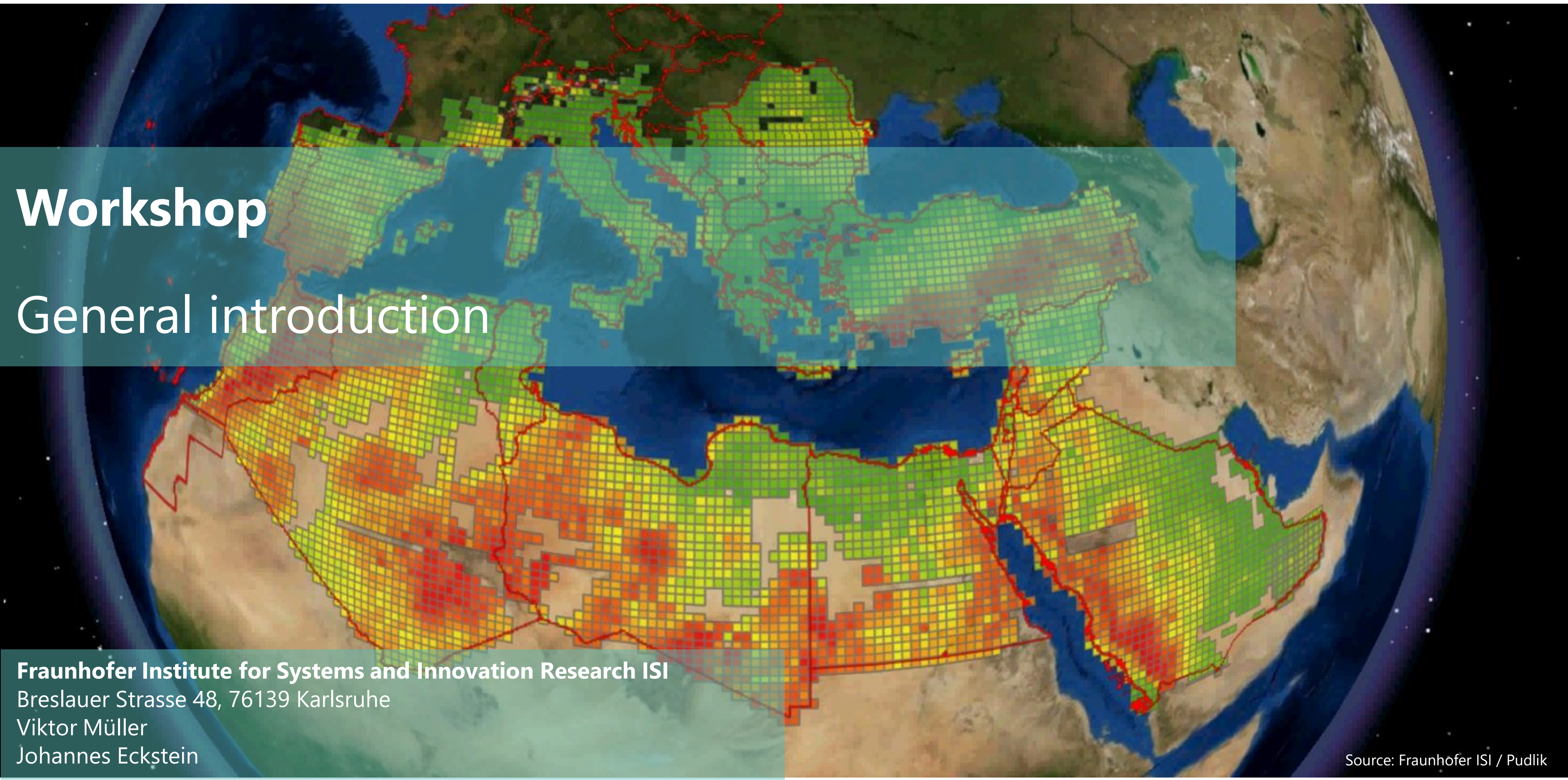
LEAP USER GROUP WORKSHOP AS PART OF THE REGIONAL EXCHANGE OF MODELLING EXPERTS IN THE WB6



Workshop

General introduction

Fraunhofer Institute for Systems and Innovation Research ISI
Breslauer Strasse 48, 76139 Karlsruhe
Viktor Müller
Johannes Eckstein

Source: Fraunhofer ISI / Pudlik

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WORKSHOP PROGRAM

- 24.02: Selecting and programming indicators
- 03.03: Integrating non-energy sectors and emissions in LEAP
- 10.03: Structuring your LEAP model to reflect policies
- 17.03: Supply-side optimization with LEAP

BUSINESS UNIT: CLIMATE POLICY

- Questions regarding climate policy developments (part. gas markets, hydrogen) and innovation support policies (EU Innovation Fund, CCfDs)
- Questions related to emission trading systems (EU and other ETS)
- Climate change mitigation strategies and their assessment

- **Johannes Eckstein** is senior researcher in the business unit Climate Policy in the Competence Center Energy Policy and Energy Markets
- Work focus:
  - energy and climate policy development and evaluation
  - focus on industrial applications and policies
  - scenario-based energy system modelling

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BUSINESS UNIT: GLOBAL SUSTAINABLE ENERGY TRANSITIONS

- **Support of planning and implementation of sustainable energy and development strategies in emerging and developing countries.**
  - assessment of potentials and possible diffusion pathways for renewable energy technologies
  - model-based analyses of energy systems
  - evaluation of local value creation potentials for energy technologies
  - development of policy instruments and strategies supporting sustainable energy transitions.

- **Viktor Müller** is junior researcher in the business unit Global Sustainable Energy Transitions in the Competence Center Energy Policy and Energy Markets
- Work focus:
  - promotion strategies for renewables energies
  - hydrogen technologies and synthetic fuels
  - modelling of energy systems

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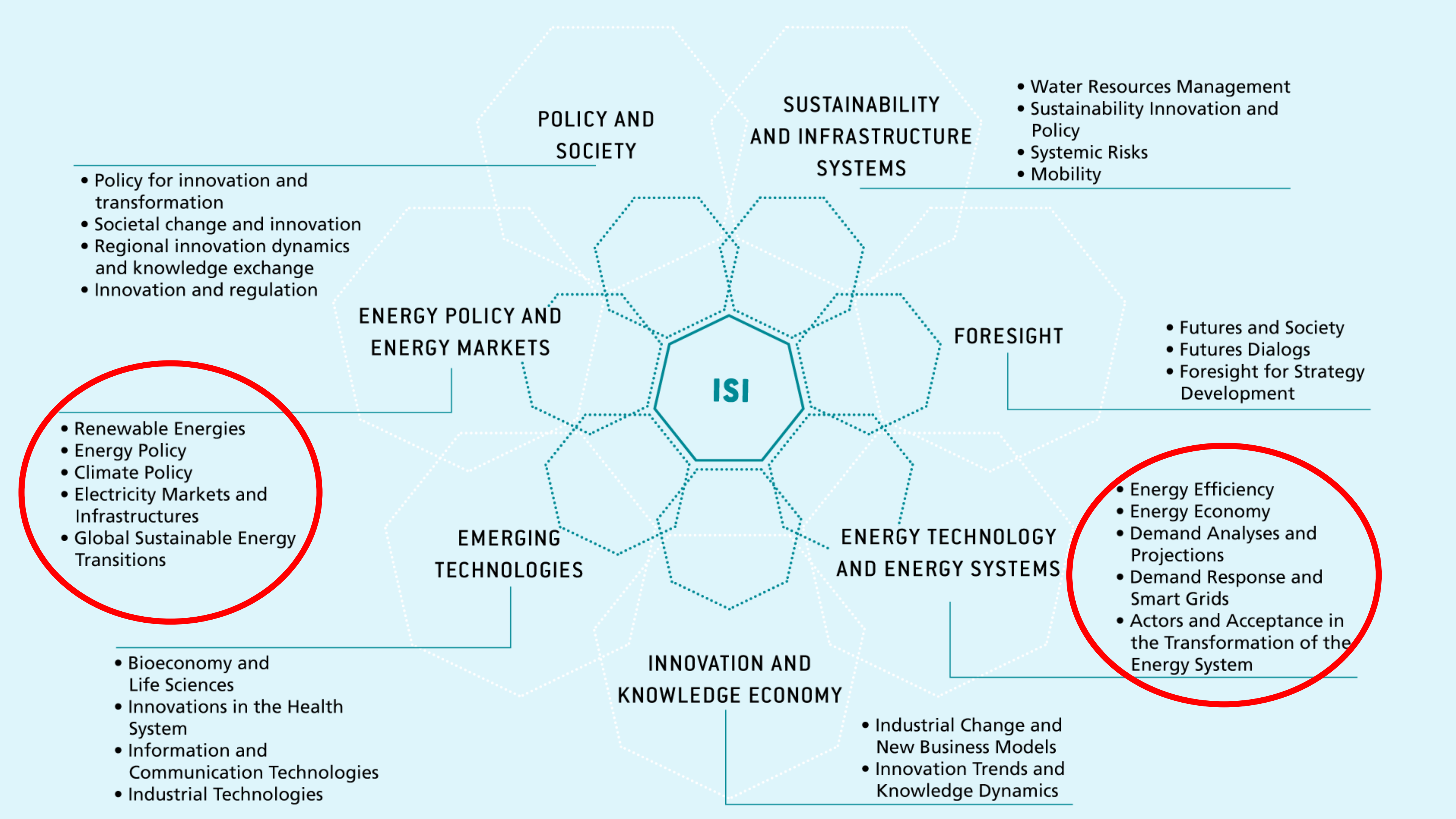

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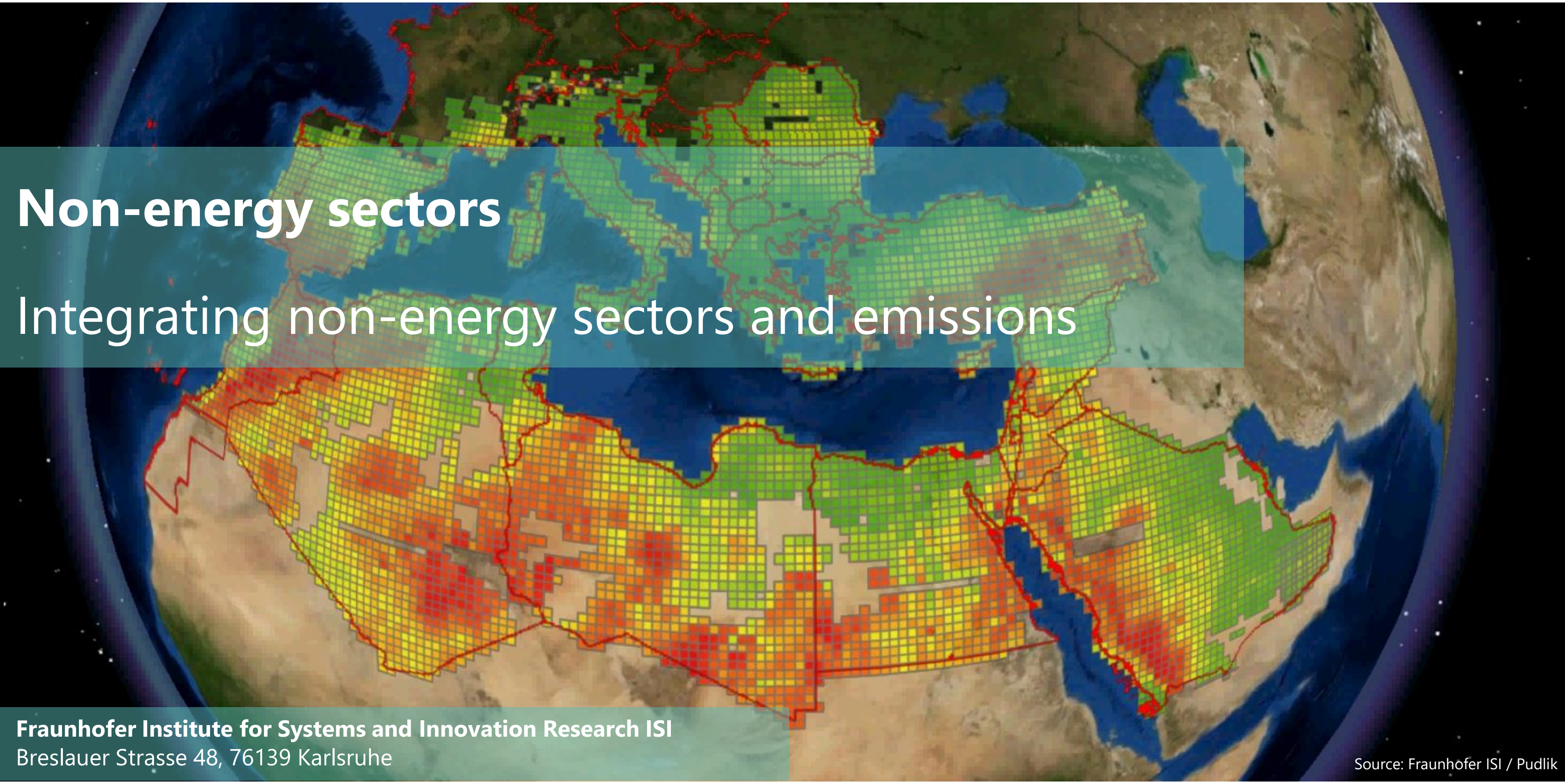

Non-energy sectors

Integrating non-energy sectors and emissions

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INTEGRATING NON-ENERGY SECTORS AND EMISSIONS IN LEAP

- Where do you currently estimate non-energy emissions?
- How to program these in LEAP for one consistent model
- Simple linear examples and steps towards a dynamic waste sector!

NON-ENERGY SECTORS

- To cover the full system and all sources of emissions, non-energy sectors are important
  - source of emissions, particularly non-CO2 constituents, which can be long-lived gases of high GWP
  - sink for emissions in LULUCF sector

  - covers activities in four sectors:
    - IPPU: industrial products and product use
    - Agriculture
    - LULUCF
    - Waste

NON-ENERGY SECTORS

- To learn more about these sectors and how they lead to emissions, the IPCC handbooks are an excellent source of information

➢ https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html

NON-ENERGY SECTORS

- To learn more about these sectors and how they lead to emissions, the IPCC handbooks are an excellent source of information
  - gives a detailed account on the physical background
  - detailed instructions on how to describe the emission sources
  - contains default data you need to implement the sectors

  - The methods also underly the IPCC software for GHG inventories

  - The material is supplied in several volumes
    - IPPU, AFOLU, Waste
    - (and volumes for energy)

Model design:
Describing non-energy emissions in LEAP

For non-energy emissions, an activity is directly linked with emissions:

Activity variable	x	Emissions
decomposing waste		CH4 emissions
is often a function of many variables		often non-CO2 effects
this is where complexity resides		LEAP knows default emission factors

NON-ENERGY SECTORS

- The IPCC methodology covers all sectors in three tiers, from least to highest complexity:
  - **Tier 1:** uses little local activity data and default factors, which gives you a good estimate but few control points in the model
  - **Tier 2:** uses more local acitivity data and a choice of factors as well as more complex equations, which gives you more control points in the model
  - **Tier 3:** uses only local activity data and factors, sometimes using using the same equation as tier 2 or more complex

IPPU: MAIN CONCEPTS

- Production leads to emissions of GHG, mostly linear functions (Tier 1)

EQUATION 4.4
CO_2 EMISSIONS FROM IRON AND STEEL PRODUCTION (TIER 1)

$$\text{Iron \& Steel: } E_{CO2,\, non-energy} = BOF \bullet EF_{BOF} + EAF \bullet EF_{EAF} + OHF \bullet EF_{OHF}$$

- But it can become more complex if you have more data (Tier 2 or 3)

EQUATION 4.21
CO_2 EMISSIONS FROM PREBAKED ANODE CONSUMPTION (TIER 2 AND TIER 3 METHODS)

$$E_{CO2} = NAC \bullet MP \bullet \frac{100 - S_a - Ash_a}{100} \bullet \frac{44}{12}$$

Where:

E_{CO2} = CO_2 emissions from prebaked anode consumption, tonnes CO_2

MP = total metal production, tonnes Al

NAC = net prebaked anode consumption per tonne of aluminium, tonnes C/ tonne Al

S_a = sulphur content in baked anodes, wt %

Ash_a = ash content in baked anodes, wt %

44/12 = CO_2 molecular mass: carbon atomic mass ratio, dimensionless

EQUATION 4.26
PFC EMISSIONS BY SLOPE METHOD (TIER 2 AND TIER 3 METHODS)

$$E_{CF4} = S_{CF4} \bullet AEM \bullet MP$$

and

$$E_{C2F6} = E_{CF4} \bullet F_{C2F6/CF4}$$

Where:

E_{CF4} = emissions of CF_4 from aluminium production, kg CF_4

E_{C2F6} = emissions of C_2F_6 from aluminium production, kg C_2F_6

S_{CF4} = slope coefficient for CF_4, (kg CF_4/tonne Al)/(AE-Mins/cell-day)

AEM = anode effect minutes per cell-day, AE-Mins/cell-day

MP = metal production, tonnes Al

$F_{C2F6/CF4}$ = weight fraction of C_2F_6/CF_4, kg C_2F_6/kg CF_4

AGRICULTURE: MAIN CONCEPTS

- Important input variables are
  - livestock numbers
  - manure management systems in the country
  - fertilization amounts applied

- Leads to emissions of CO_2, CH_4, N_2O from enteric fermentation, manure management, etc.
- At this level, it is not complicated, but you need the input data
- Can become more complex if you need to consider soil dynamics

LULUCF: MAIN CONCEPTS

- At full (and common) complexity, it is difficult to implement in LEAP
  - Considers: above and below ground biomass, dead wood, litter and soils
  - in forest, cropland, grassland, wetlands, settlements, other land
  - for 'category remaining category' and 'category converted to other category‘
- All the dynamics of exchange should be covered by a model
- LEAP provides little support – you would need to work with key assumptions only

  ➢ We have implemented this in a more simple approach by using existing data of emissions

LET'S GO TO LEAP

Source: LEAP Handbook

WASTE: MAIN CONCEPTS

- Waste sector emissions are special
  - Emissions in one year do not come from the activity in that one year, but from the complete history
  - E.g.: Unmanaged landfills emit CH4 continously for approx. 50 years! (IPCC methodology recommendation)

- So the model needs to consider the historic deposition of waste

EQUATION 3.4
DDOCm ACCUMULATED IN THE SWDS AT THE END OF YEAR T

$$DDOCma_T = DDOCmd_T + \left(DDOCma_{T-1} \bullet e^{-k}\right)$$

EQUATION 3.5
DDOCm DECOMPOSED AT THE END OF YEAR T

$$DDOCm\ decomp_T = DDOCma_{T-1} \bullet \left(1 - e^{-k}\right)$$

Where:

T = inventory year

$DDOCma_T$ = DDOCm accumulated in the SWDS at the end of year T, Gg

$DDOCma_{T-1}$ = DDOCm accumulated in the SWDS at the end of year (T-1), Gg

$DDOCmd_T$ = DDOCm deposited into the SWDS in year T, Gg

$DDOCm\ decomp_T$ = DDOCm decomposed in the SWDS in year T, Gg

k = reaction constant, $k = \ln(2)/t_{1/2}$ (y^{-1})

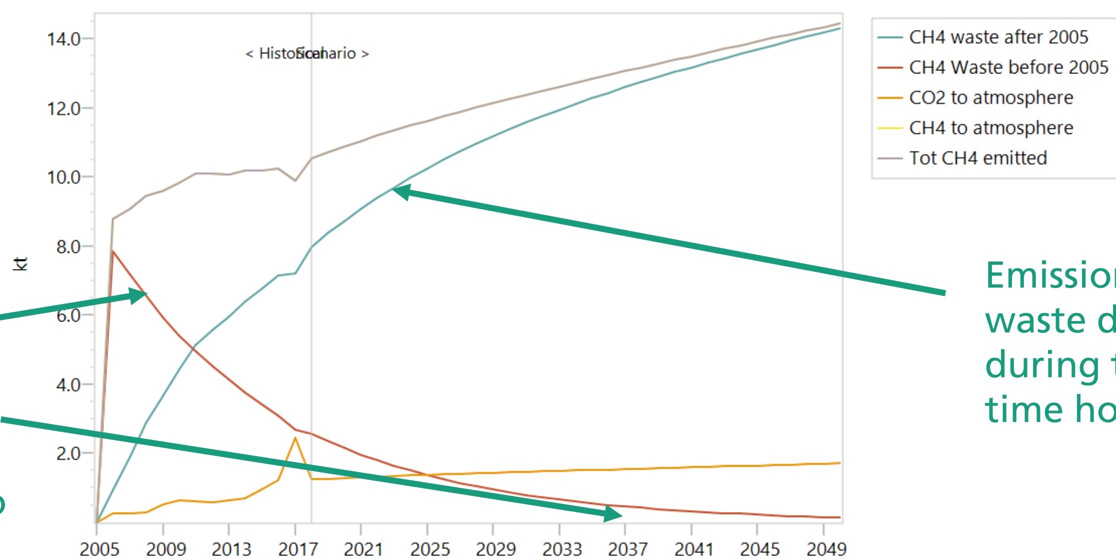
$t_{1/2}$ = half-life time (y)

WASTE: MAIN CONCEPTS

- It is tricky to implement in LEAP, but can be done
  - Use PrevYearValue function

IPCC waste model: Activity Level (kt)

Scenario: With existing measures autonomous, Region: Region 1



Emissions from waste deposited before the model history – tuned to a different data source

Emissions from waste deposited during the model time horizon

Emissions even here from before 2005!

LET'S GO TO LEAP

Source: LEAP Handbook

LEAP NON-ENERGY SECTORS

Questions, comments?

Your own experience?

How to make use of the fact you are all

- *working with the same tool*
- *in similar projects ?*

⇨ *Does everything need to be developed again and again in each CP?*

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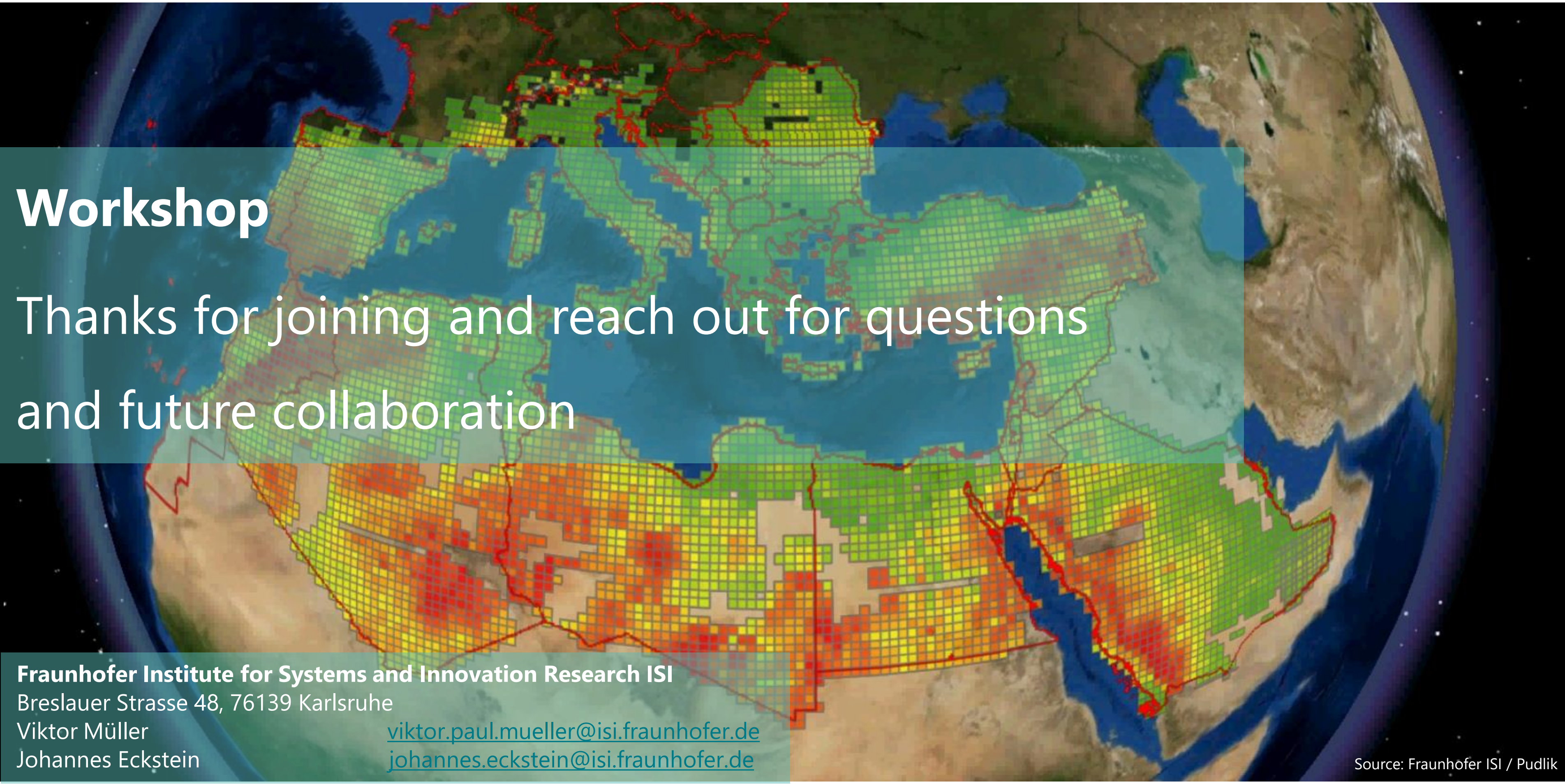

Workshop

Thanks for joining and reach out for questions

and future collaboration

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