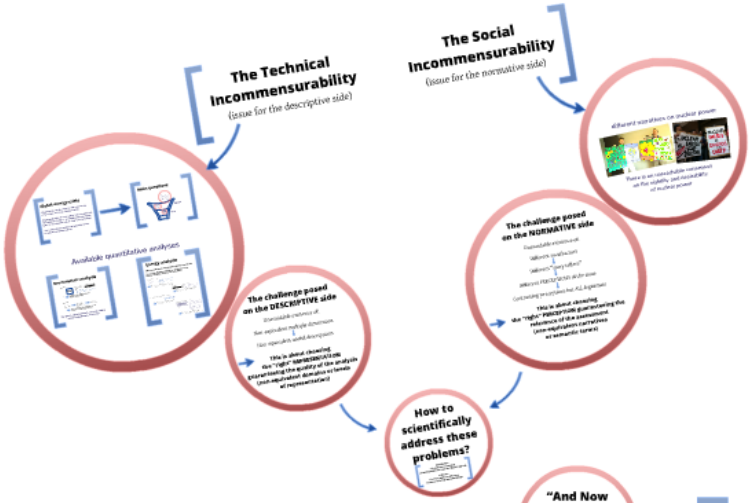
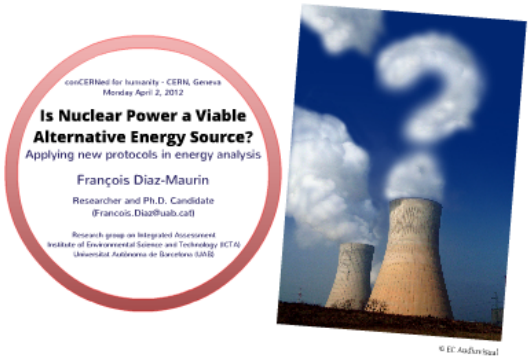
Thank you for your attention!

François Diaz-Maurin

(Francois.Diaz@uab.cat)





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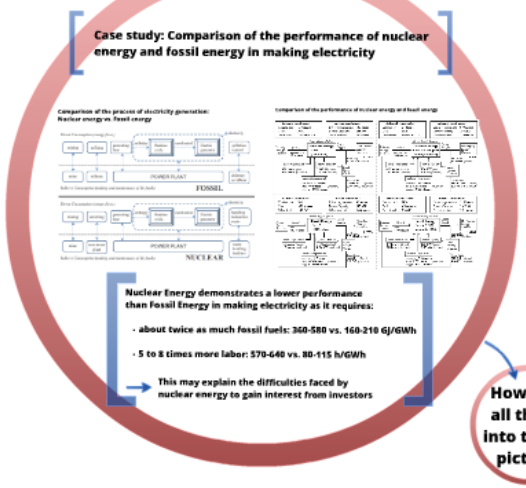
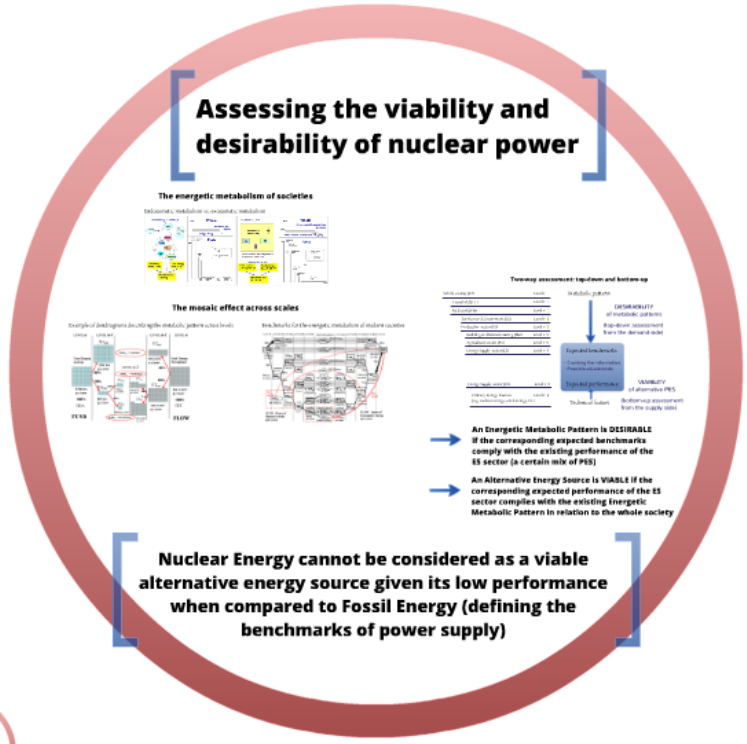
"And Now for Something Completely Different..."



How does all this fit into the big picture?



conCERNed for humanity - CERN, Geneva
Monday April 2, 2012

Is Nuclear Power a Viable Alternative Energy Source?

Applying new protocols in energy analysis

François Diaz-Maurin

Researcher and Ph.D. Candidate
(Francois.Diaz@uab.cat)

Research group on Integrated Assessment
Institute of Environmental Science and Technology (ICTA)
Universitat Autònoma de Barcelona (UAB)

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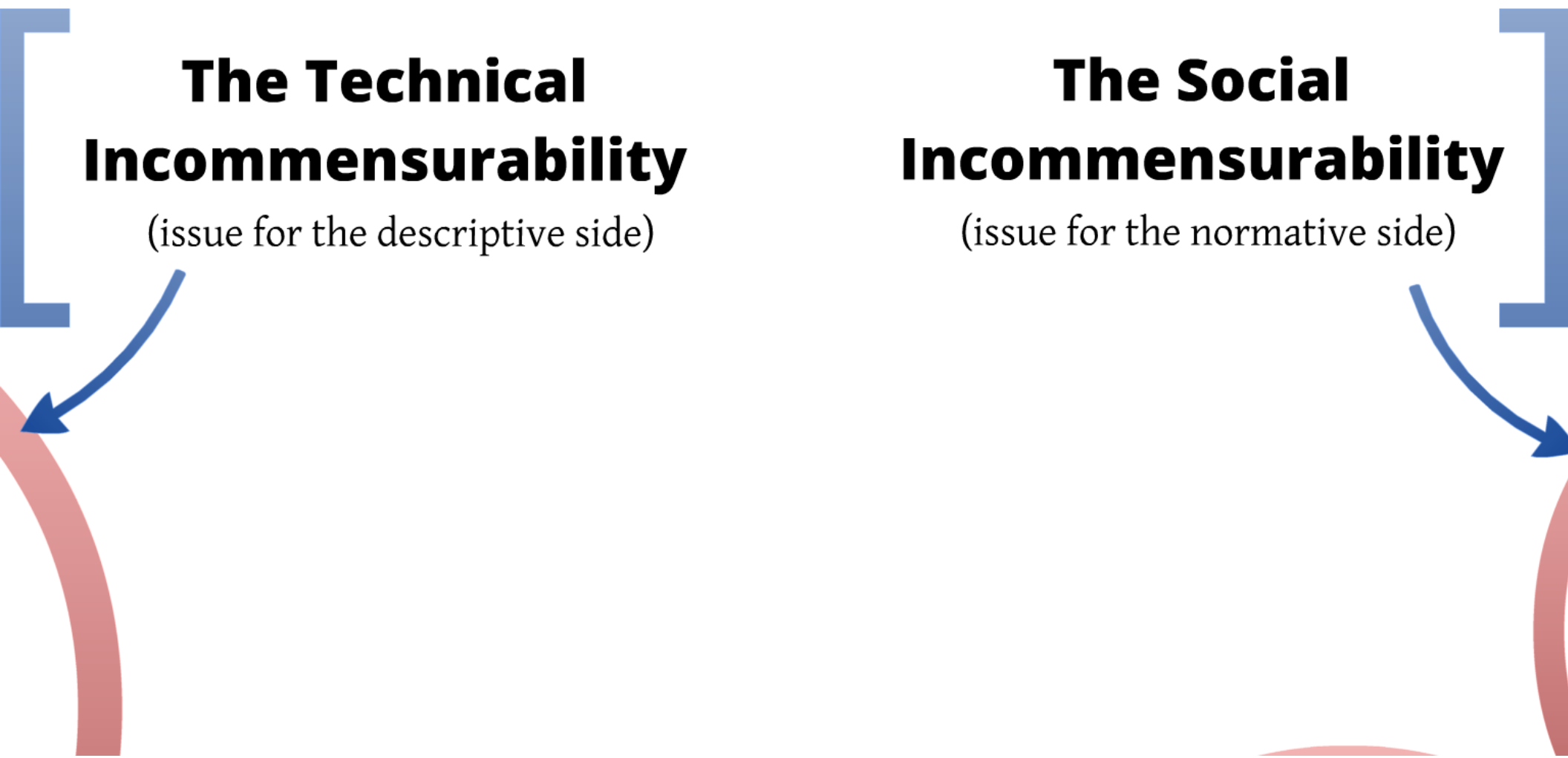
The Technical Incommensurability

(issue for the descriptive side)

The Social Incommensurability

(issue for the normative side)



The Technical Incommensurability

(issue for the descriptive side)

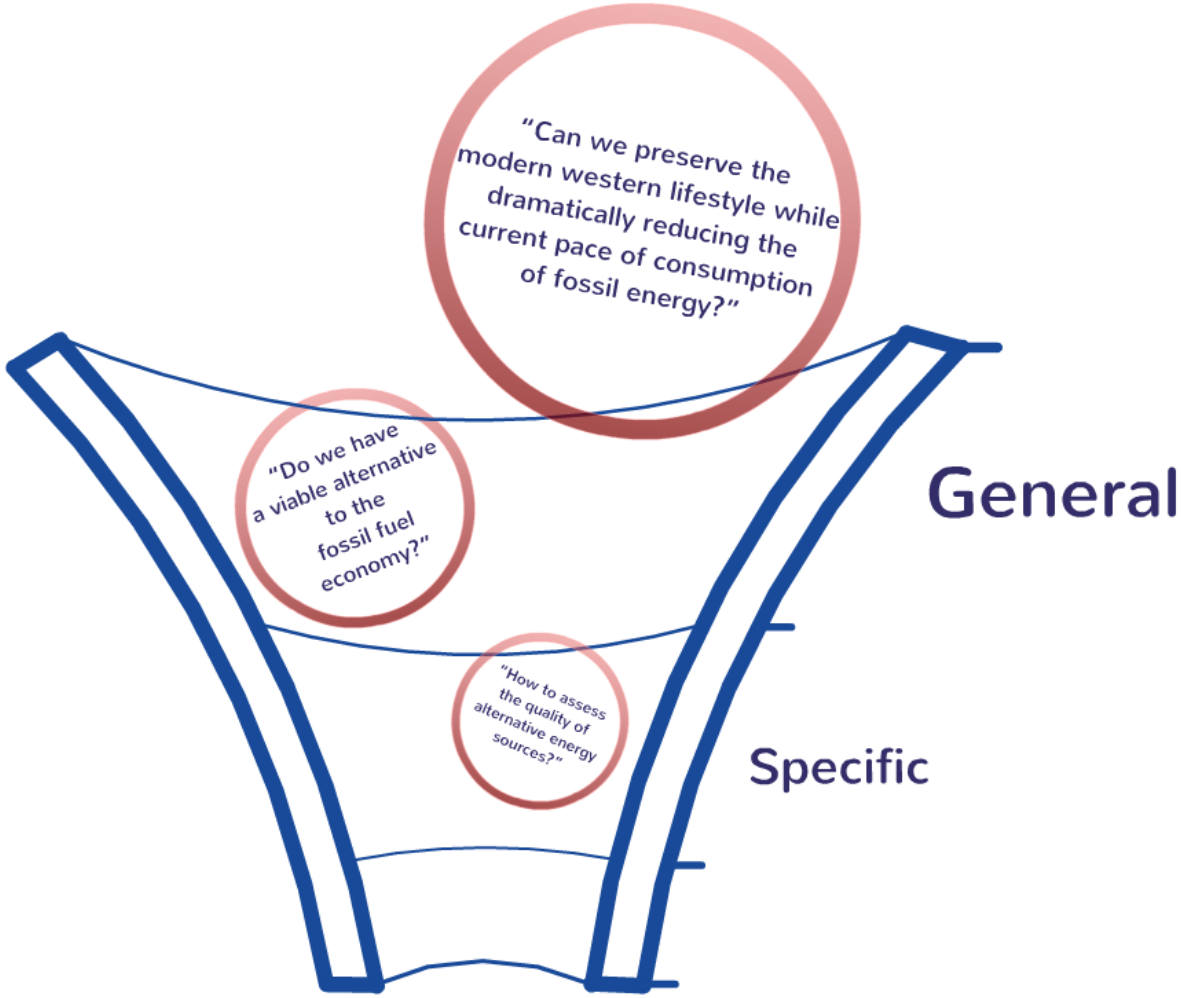
Global energy crisis

Modern global society based on the massive use of fossil fuels as Primary Energy Sources

Ongoing depletion of fossil energy stocks implies that this Metabolic Pattern will change in the near future (peak of oil production and of other fossil resources)

This is the rationale behind the desperate search for alternative energy sources

Main questions



"Can we preserve the modern western lifestyle while dramatically reducing the current pace of consumption of fossil energy?"

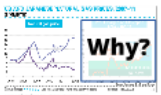
"Do we have a viable alternative to the fossil fuel economy?"

"How to assess the quality of alternative energy sources?"

Available quantitative analyses

Econometric analysis

Problem #1



Direct economic cost of energy (price) = **dollars to buy energy / GDP**

- Historically below 4% of GDP (OECD countries)
- Major economic recessions in the last five decades when passed 6% of GDP

→ **High degree of freedom on energy prices (subsidies, tax discount...)**

Problem #2

increase in the price of oil → **depreciation of the US$ and other currencies** → **increase in the price of oil**

→ **The price affects the depreciation of the currency used to assess the price! (impredicativity)**

We need to define the quality of primary energy sources independently from prices

Energy analysis

Different methods based on thermodynamics reading (e.g. exergy analysis)

However, mono-dimensional and mono-scale methods entail several problems when dealing with the issue of "energy quality":

Problem #1: Truncation problem

- Energy systems operate simultaneously on multiple scales
- Unavoidable existence of non-equivalent descriptions

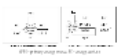
→ **Any quantitative energy analysis must integrate the existence of non-equivalent descriptions (e.g. different energy forms)**

Problem #2: Joint production problem (reductionism)

- Different INPUTS entering the system
- Different OUTPUTS exiting the system
- "Apples" must not be summed with "Oranges"

→ **We have to use more than a single quantitative variable to characterize the performance of energy systems**

Problem #3: Complexity of energy transformations in society



- Autocatalytic loop of energy conversions:
  EF → PES → EC → EF → PES → EC

→ **Any quantitative energy analysis must deal with impredicativity and at times non-linearity**

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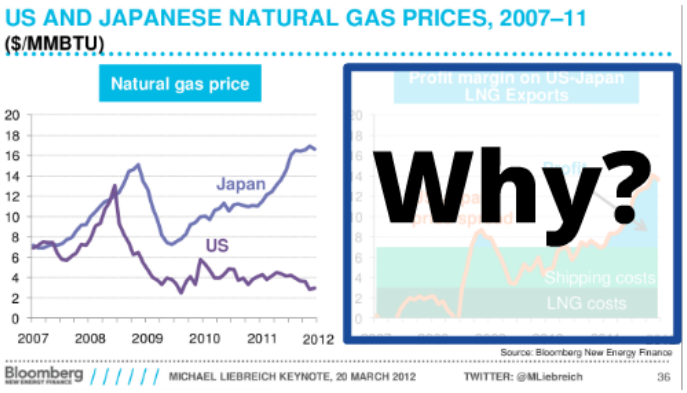

source: Bloomberg New Energy Finance, 2012

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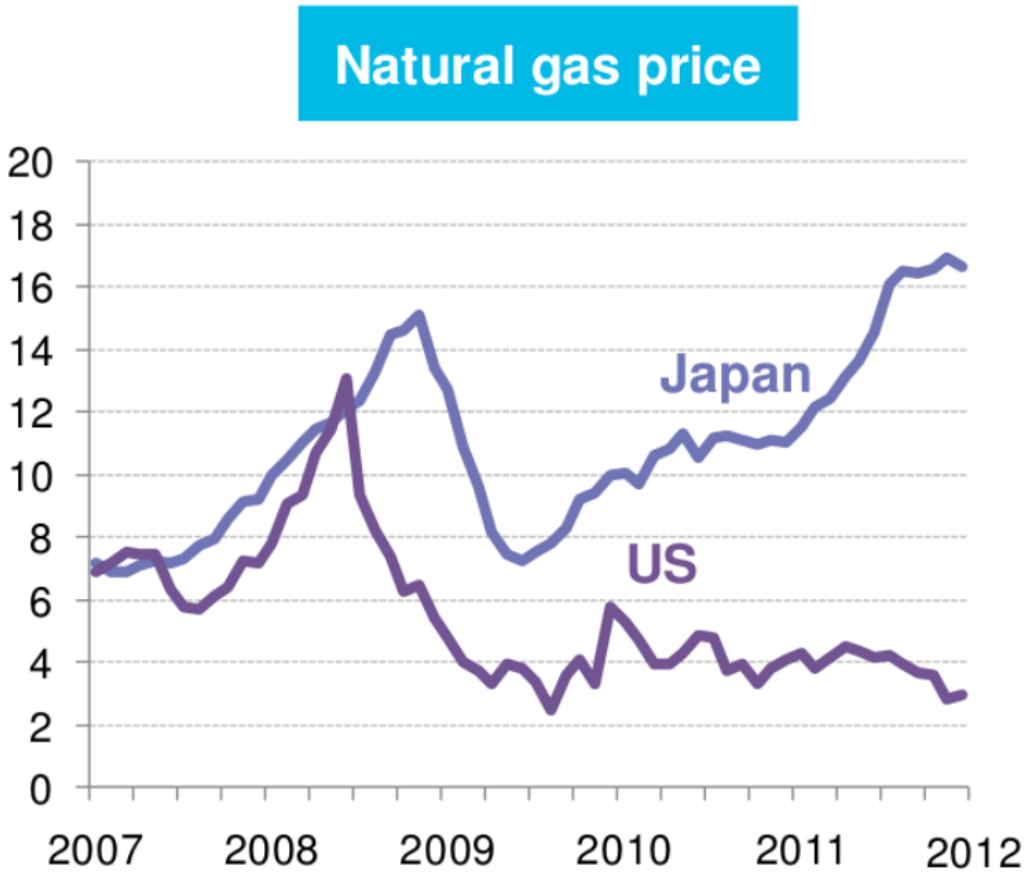
US AND JAPANESE NATURAL GAS PRICES, 2007–11

($/MMBTU)



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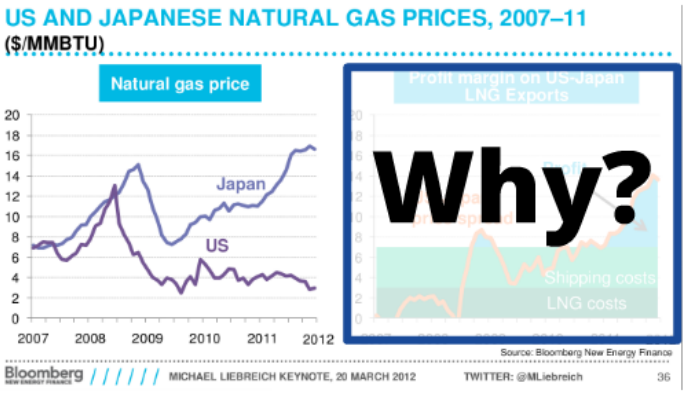

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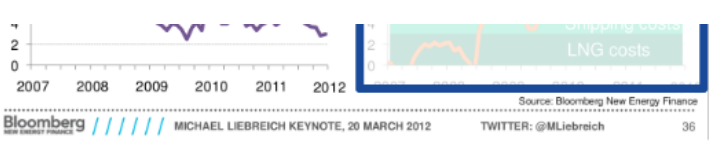

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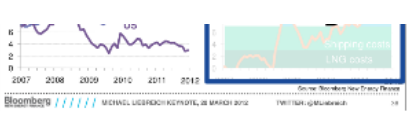

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However, mono-dimensional and mono-scale methods entail several problems when dealing with the issue of "energy quality":

Problem #1: Truncation problem

Example: flow of energy embodied in 1 hour of labour

- Rigorous scientific assessments found in literature vary from 0.2MJ to more than 20GJ (a factor of 100,000!).
- An energy input required for a given process (or an energy output) in reality depends on the choice made when defining the boundary of that process.

- **Energy systems operate simultaneously on multiple scales**
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→ **Any quantitative energy analysis must integrate the existence of non-equivalent descriptions (e.g. different energy forms)**

Problem #2: Joint production problem (reductionism)

Example the Energy Return On Investment (EROI):

$$EROI = \frac{\text{energy output}}{\text{energy input}} = \frac{\text{electricity}}{\text{electricity + fossil fuels + coal + gas + ...}} = \frac{\text{kWh}}{???}$$

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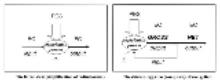

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We cannot "make" energy (thermodynamic principles), so we can only exploit PRIMARY ENERGY SOURCES by investing available ENERGY CARRIERS and other PRODUCTION FACTORS for producing a NET SUPPLY of ENERGY CARRIERS.

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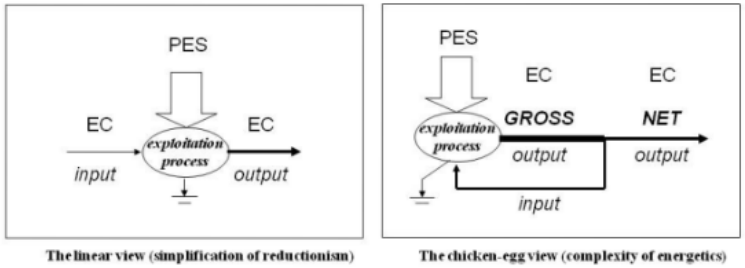

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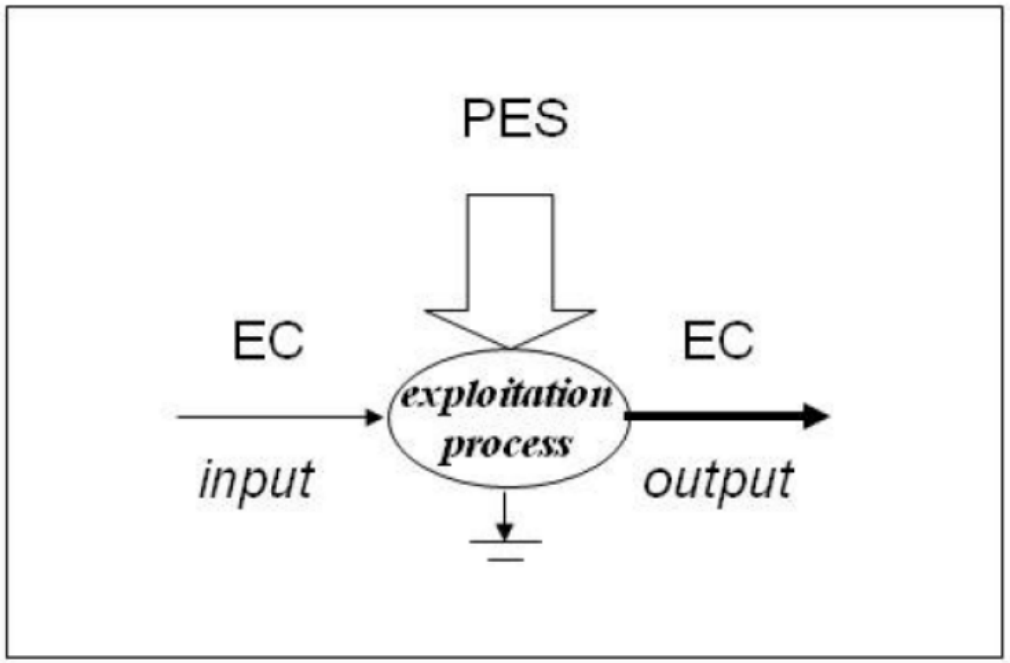

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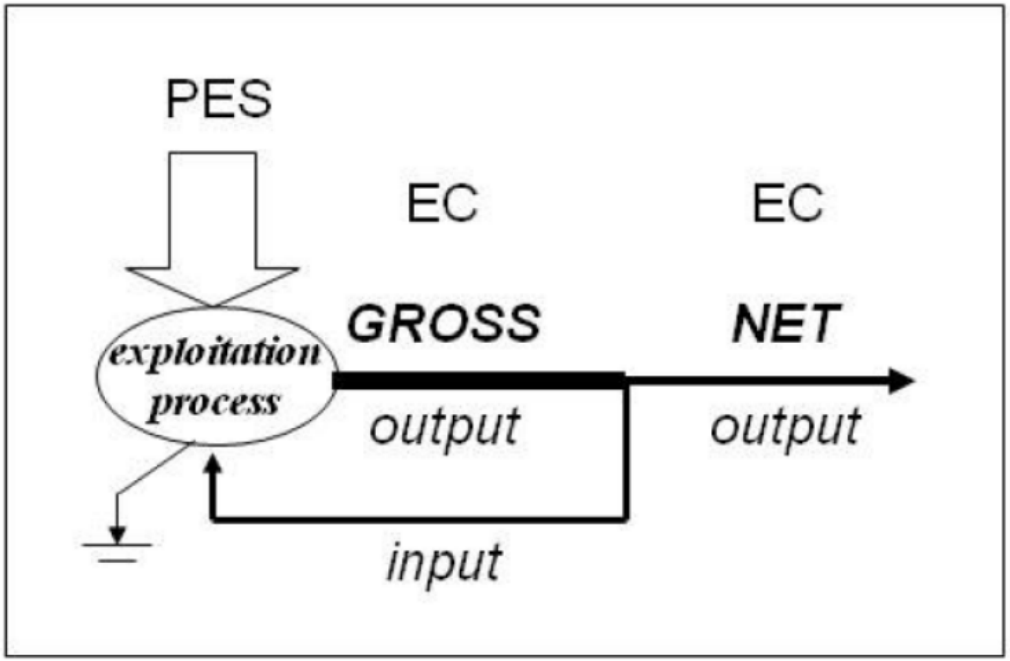

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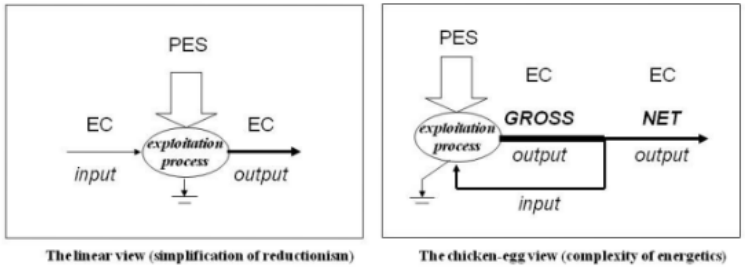

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Example: the different protocols used
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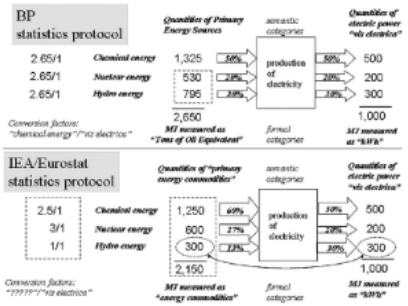

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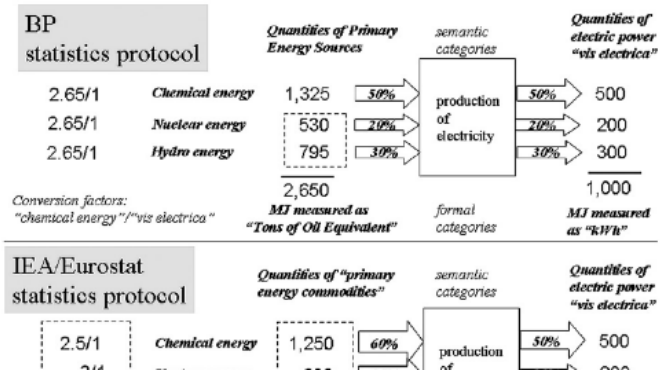

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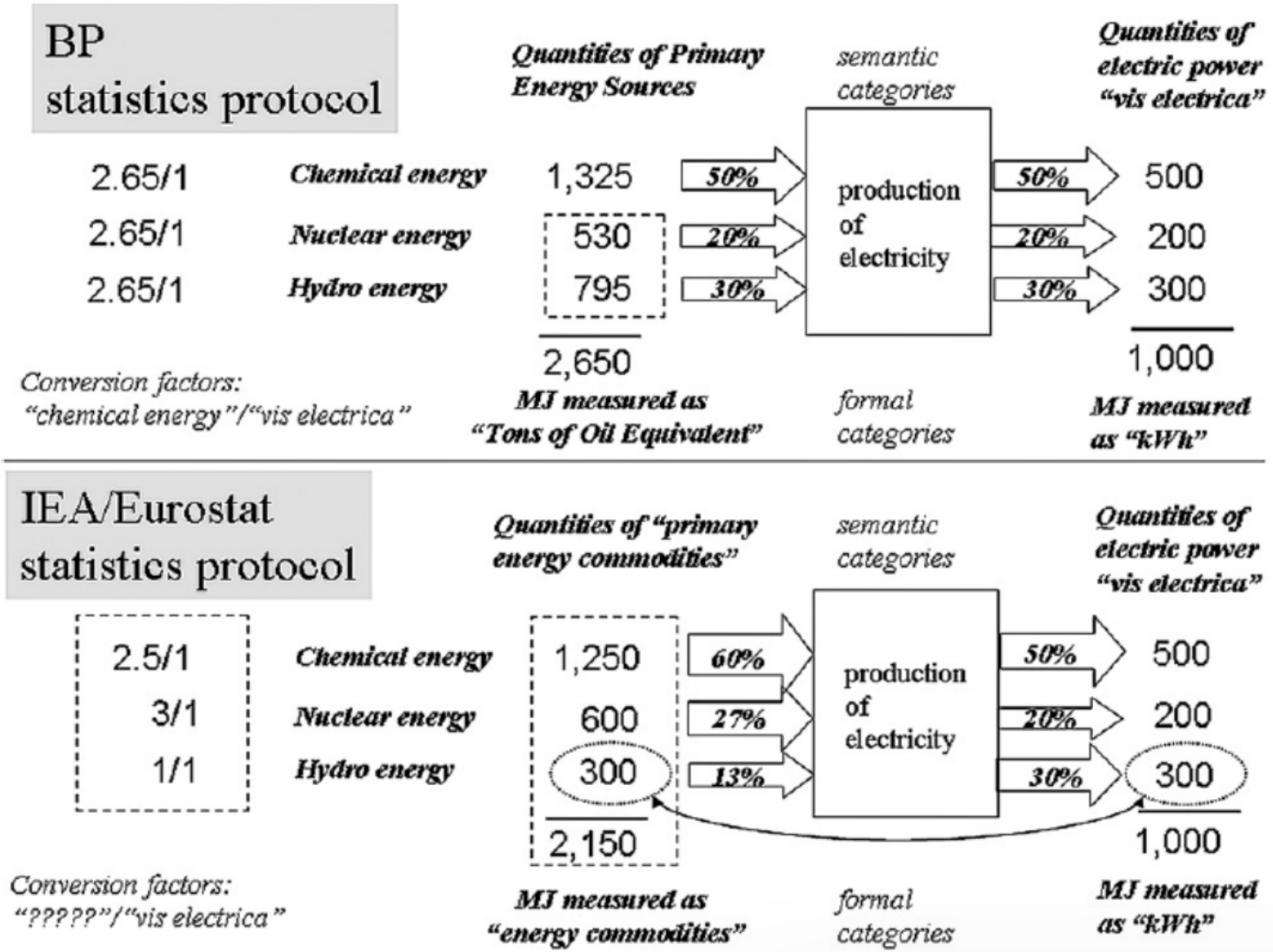

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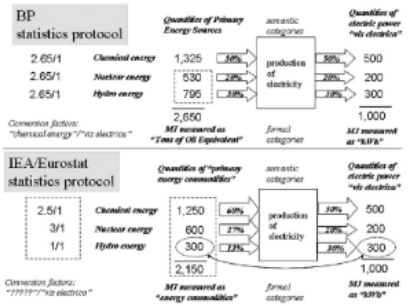

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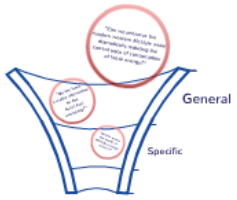

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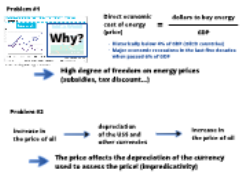

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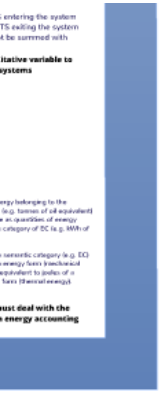

The challenge posed on the DESCRIPTIVE side

Unavoidable existence of:

Non-equivalent multiple dimensions

↓

Non-equivalent useful descriptions

→ **This is about choosing the "right" REPRESENTATION guaranteeing the quality of the analysis (non-equivalent domains or levels of representation)**

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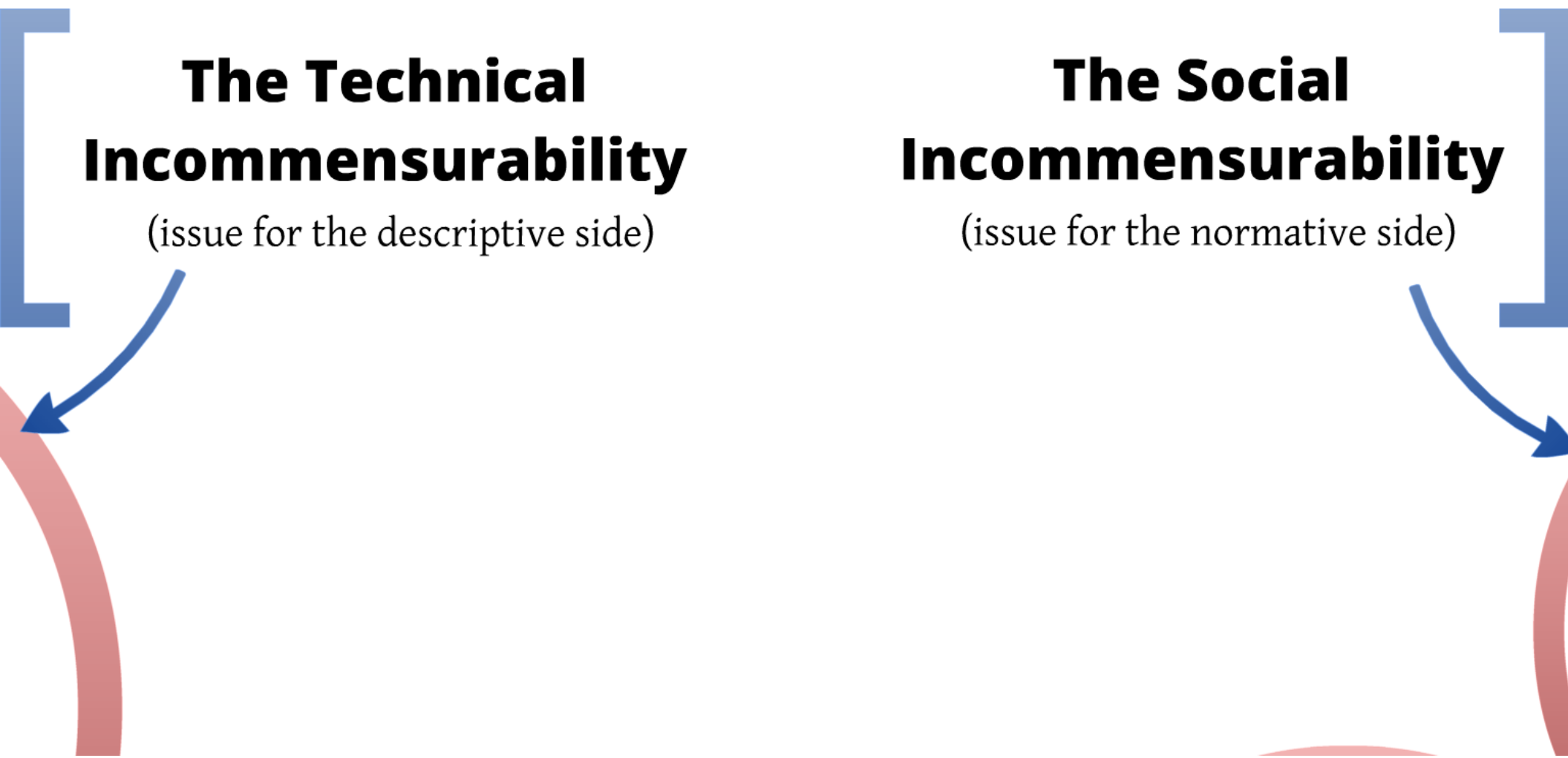

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(issue for the normative side)

different narratives on nuclear power

There is an unreachable consensus
on the viability and desirability
of nuclear power

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Unavoidable existence of:

Different social actors

↓

Different "story tellers"

↓

Different PERCEPTIONS of the issue

↓

Contrasting perceptions but ALL legitimate

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↓

Non-equivalent useful descriptions

This is about choosing the "right" REPRESENTATION guaranteeing the quality of the analysis (non-equivalent domains or levels of representation)

The challenge posed on the NORMATIVE side

Unavoidable existence of:

Different social actors

↓

Different "story tellers"

↓

Different PERCEPTIONS of the issue

↓

Contrasting perceptions but ALL legitimate

This is about choosing the "right" PERCEPTION guaranteeing the relevance of the assessment (non-equivalent narratives or semantic terms)

How to scientifically address these problems?

DIAGNOSTIC:
We must keep separated the DESCRIPTIVE side from the NORMATIVE side

THERAPY:
We must make the difference between ANALYSIS and ASSESSMENT

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"And Now for S

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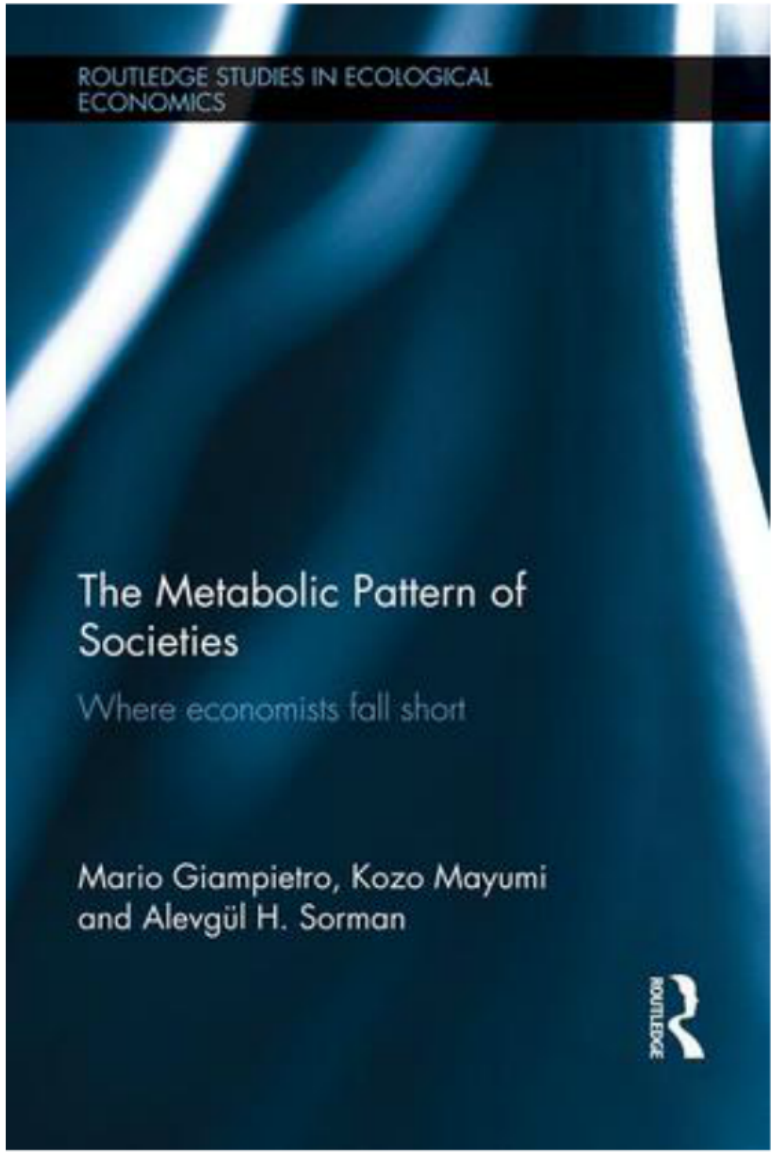
“And Now for Something Completely Different…”

(Monty Python's Flying Circus, 1971)



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Energy Analysis for a Sustainable Future

Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism

Mario Giampietro, Kozo Mayumi and Alevgül H. Sorman

To Be Published 30th August 2012 by Routledge

New protocols for assessing the performance of energy systems

Integrated assessment of the whole process of production of energy carriers based on the concept of "grammar"

F. Diaz-Maurin and M. Giampietro, A "Grammar" for Assessing the Performance of Power-Supply Systems, submitted to Energy (under review)

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Rule #1: Making the distinction between ANALYSIS and ASSESSMENT

integrated analysis

a given REPRESENTATION based on proxy variables, models and data.
This representation has been chosen in the step of "issue definition"
whose semantics is assumed to be "valid" (for whom? for how long?)

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This representation has been chosen in the step of "issue definition"
whose semantics is assumed to be "valid" (for whom? for how long?)

integrated assessment

a process guaranteeing a quality check on both:
(i) the chosen REPRESENTATION; and
(ii) the pre-analytical choice of a USEFUL PERCEPTION of the issue to be dealt with.
These choices are not “substantive”, therefore they have to be negotiated among social actors.

Rule #2: Choosing the "right" perception of the problem (using a "GRAMMAR")

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"Any quantification depends on a pre-analytical
(arbitrary) choice of a narrative (what to perceive)"

(Rosen's modeling relation theory)

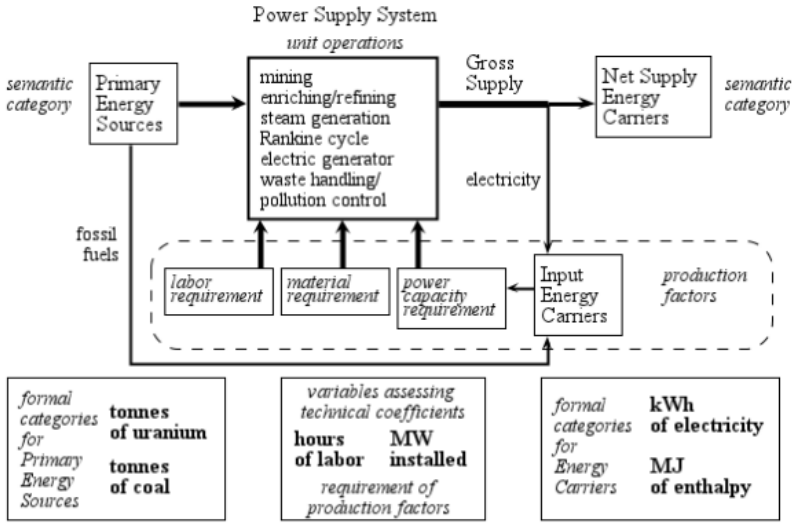
A "grammar" consists in a set of expected relations linking:

SEMANTIC categories and FORMAL categories

(the different energy forms used in the process)

(the relative quantification)

Example: Semantic and formal categories for characterizing the performance of a power supply system



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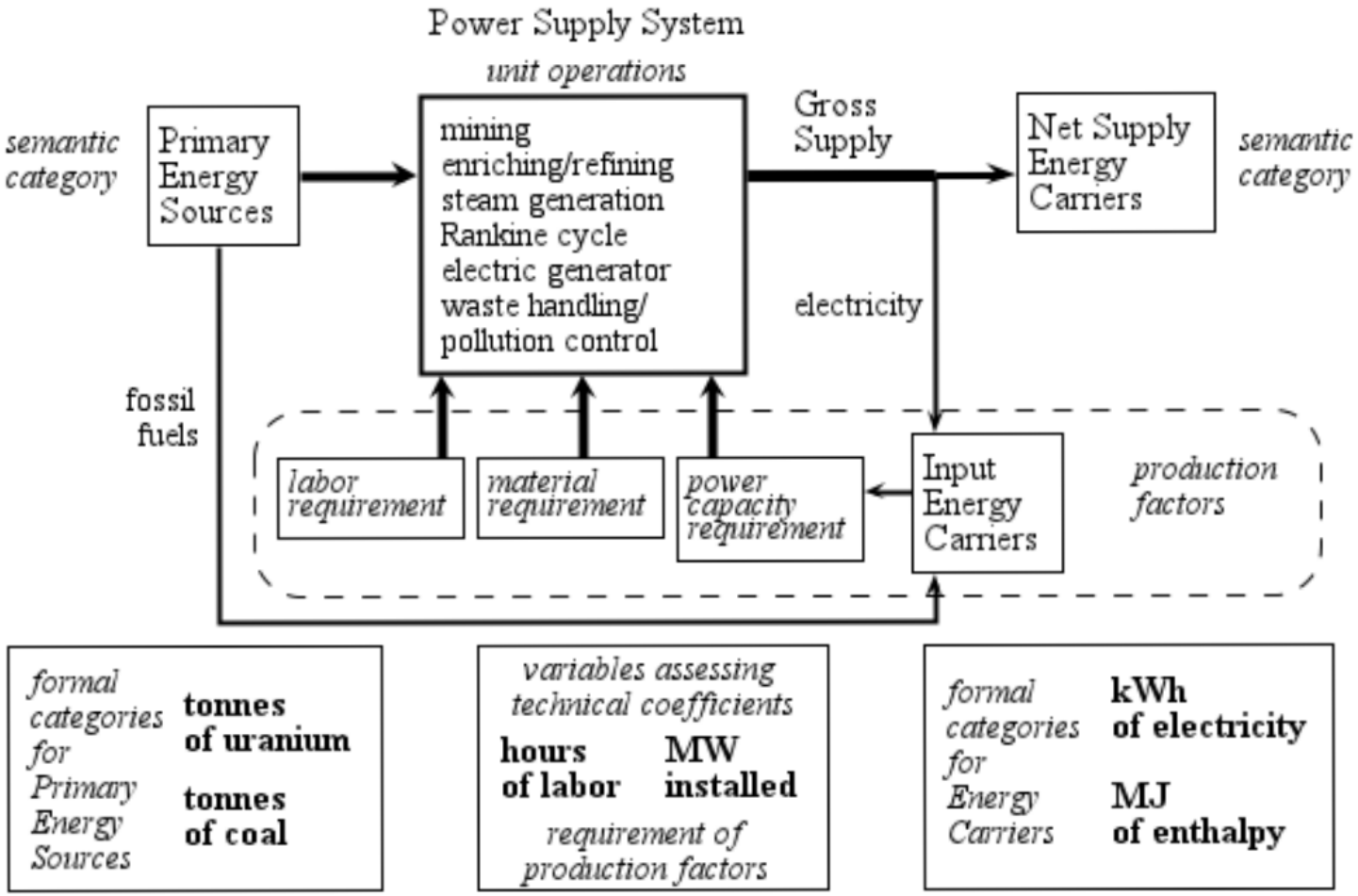
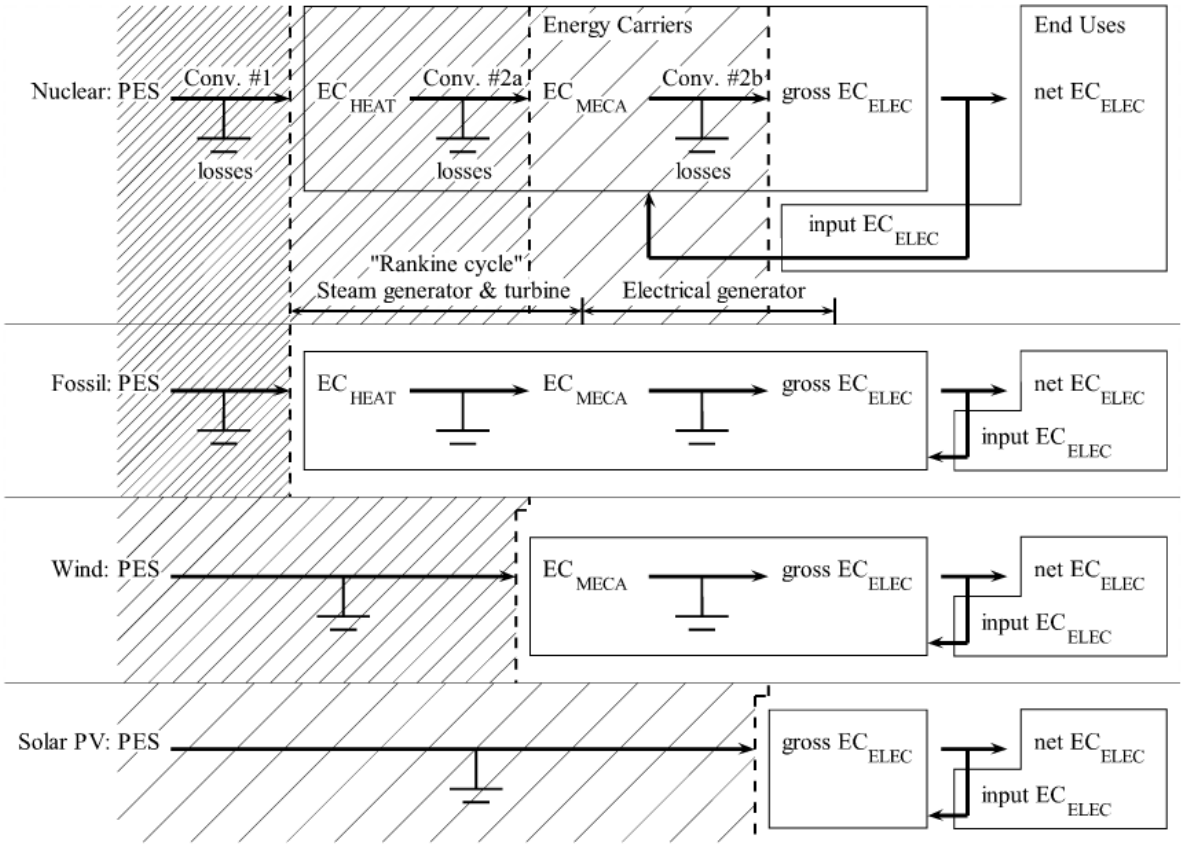


Rule #3: Handling the ambiguity associated with energy accounting

A "grammar" is capable of handling the inherent ambiguity associated with energy

Examples of grammar for power-supply systems



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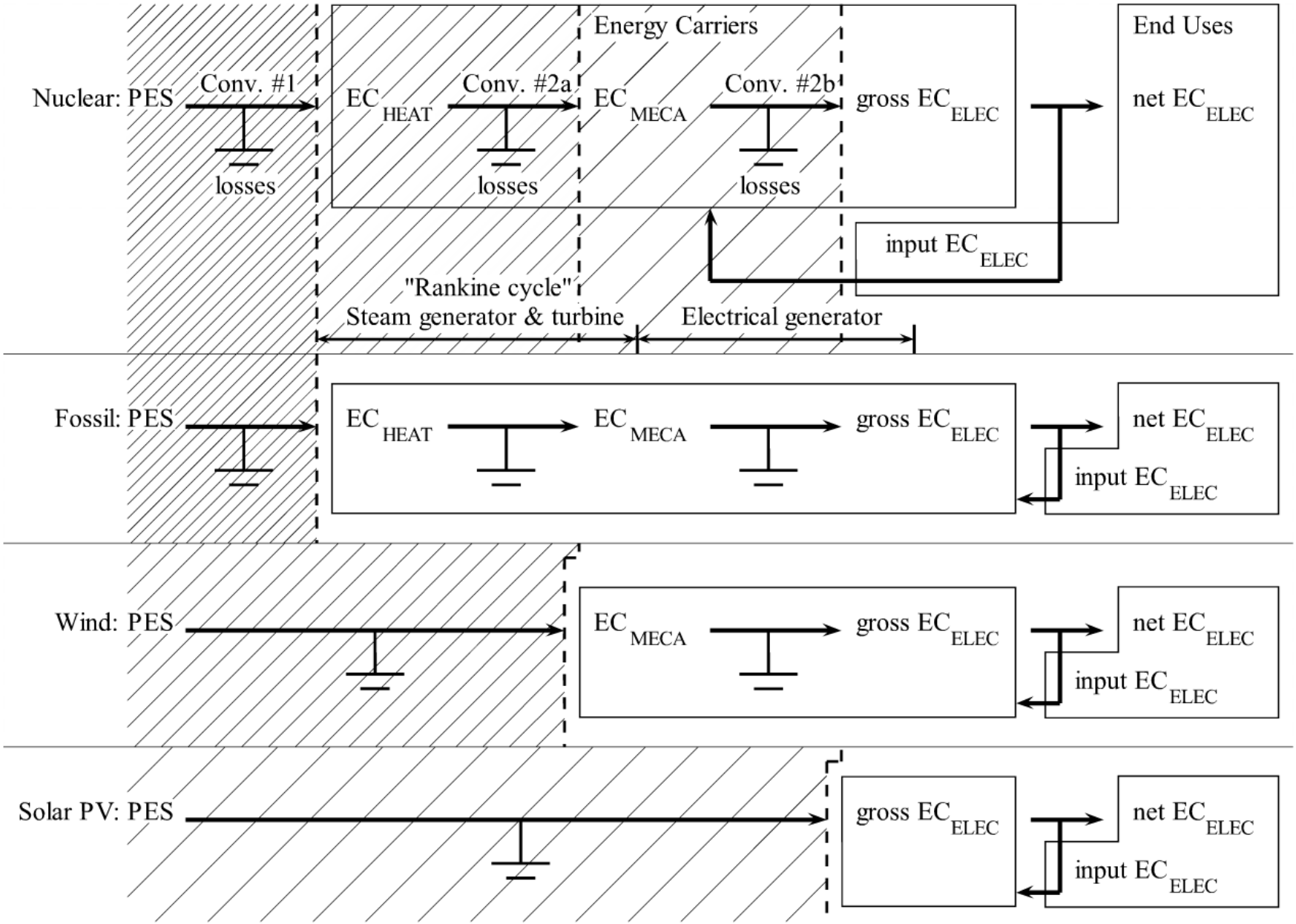

Case study: Comparison of the performance of nuclear energy and fossil energy in making electricity

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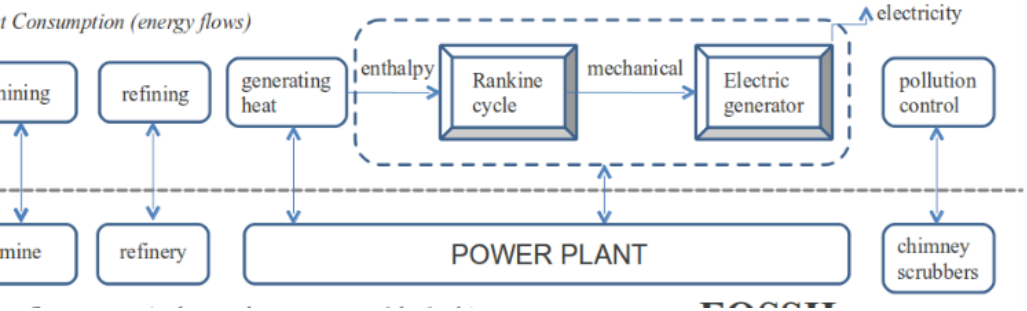
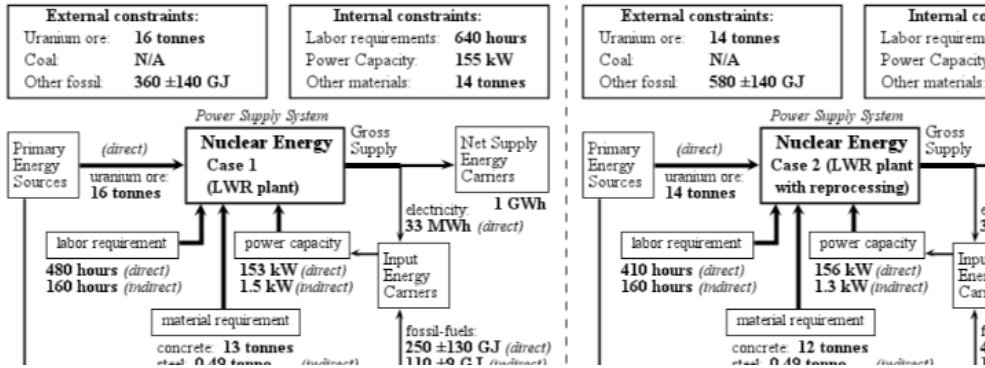
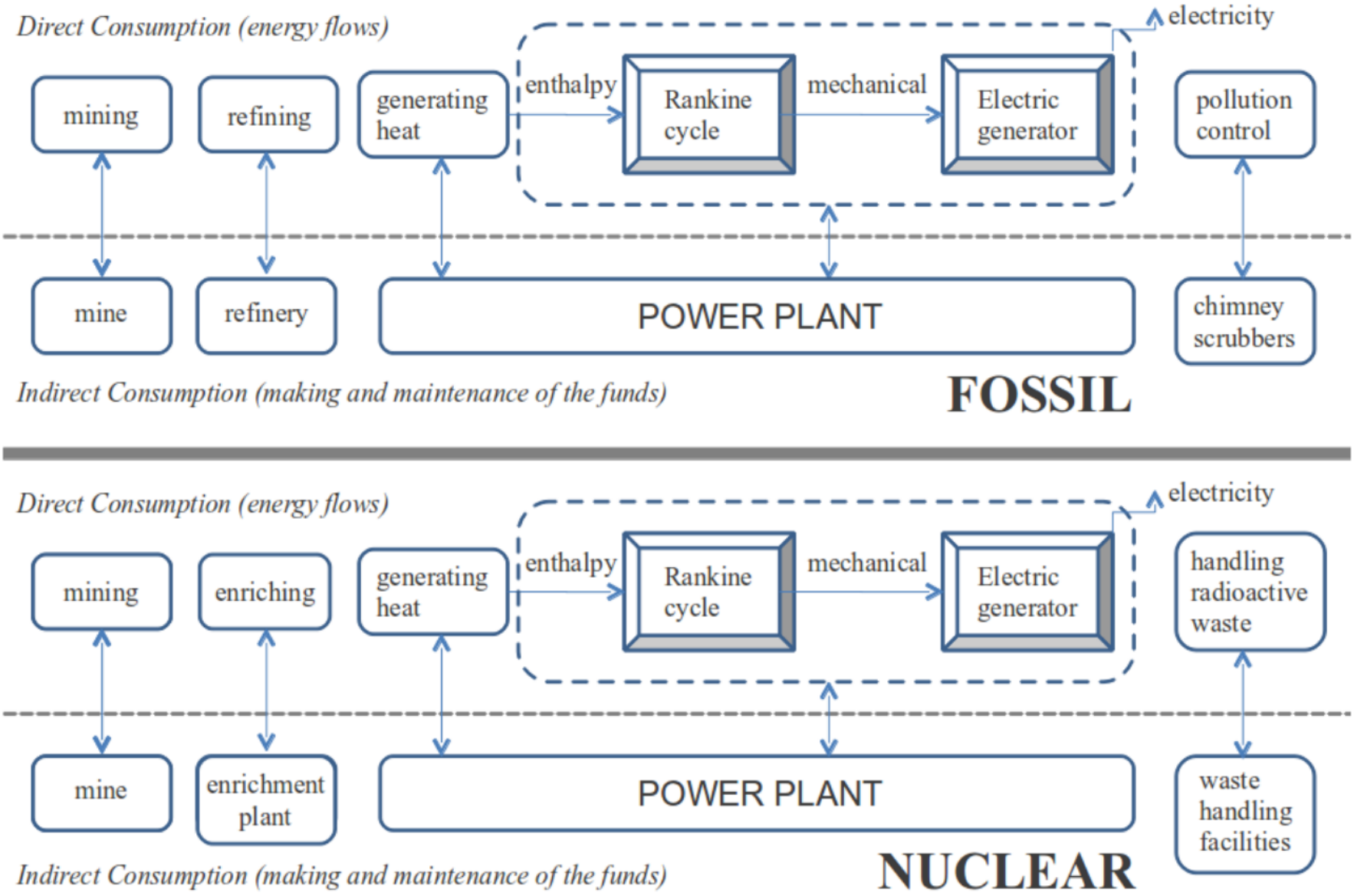


Comparison of the performance of nuclear energy and fossil energy



Comparison of the process of electricity generation: Nuclear energy vs. Fossil energy



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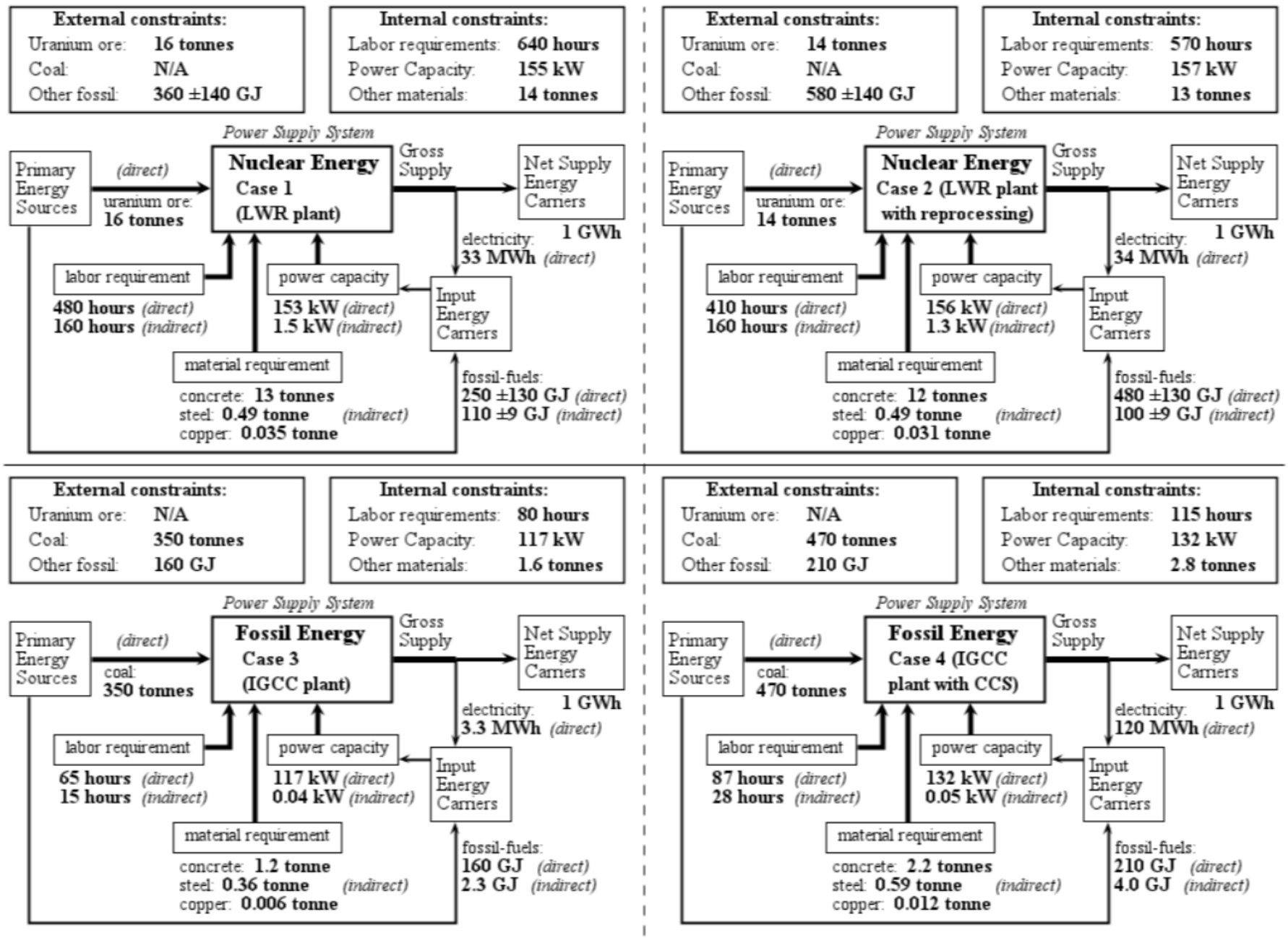

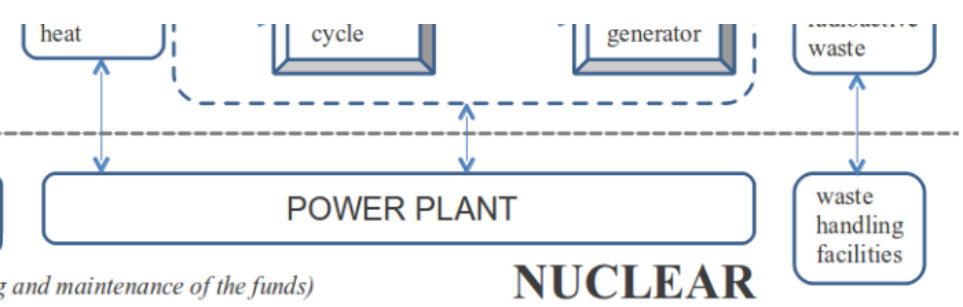

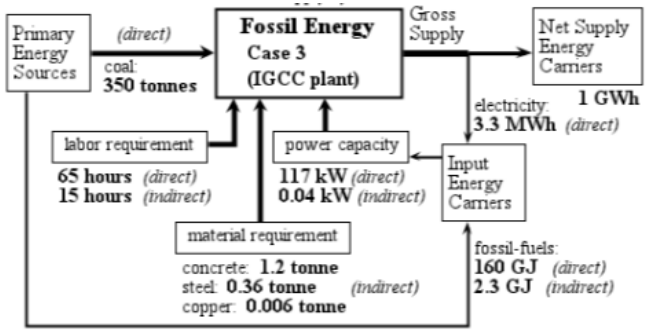

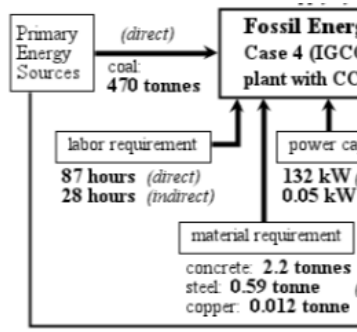

Nuclear Energy demonstrates a lower performance than Fossil Energy in making electricity as it requires:

- **about twice as much fossil fuels: 360-580 vs. 160-210 GJ/GWh**
- **5 to 8 times more labor: 570-640 vs. 80-115 h/GWh**

→ **This may explain the difficulties faced by nuclear energy to gain interest from investors**

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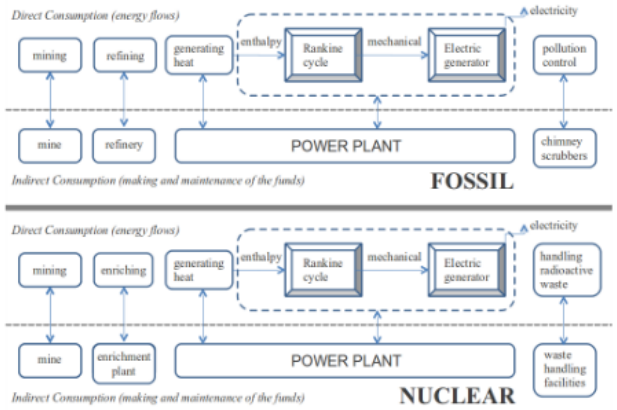

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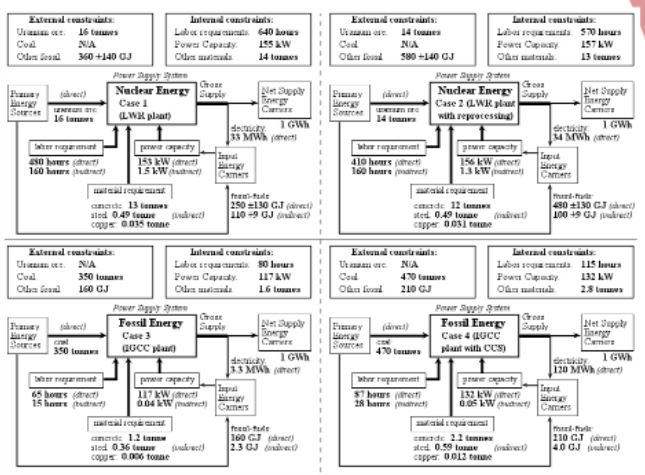

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How does all this fit into the big picture?

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Assessing the viability and desirability of nuclear power

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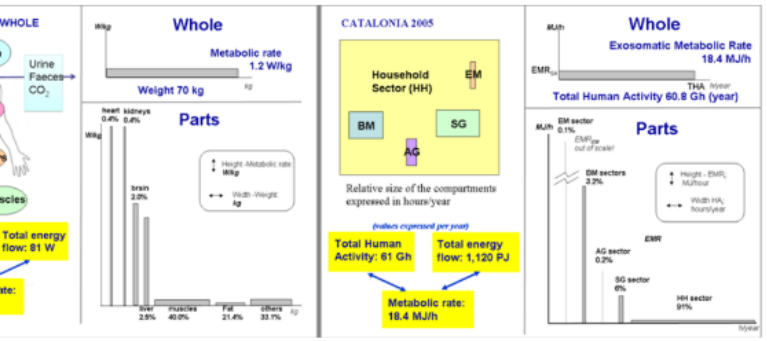
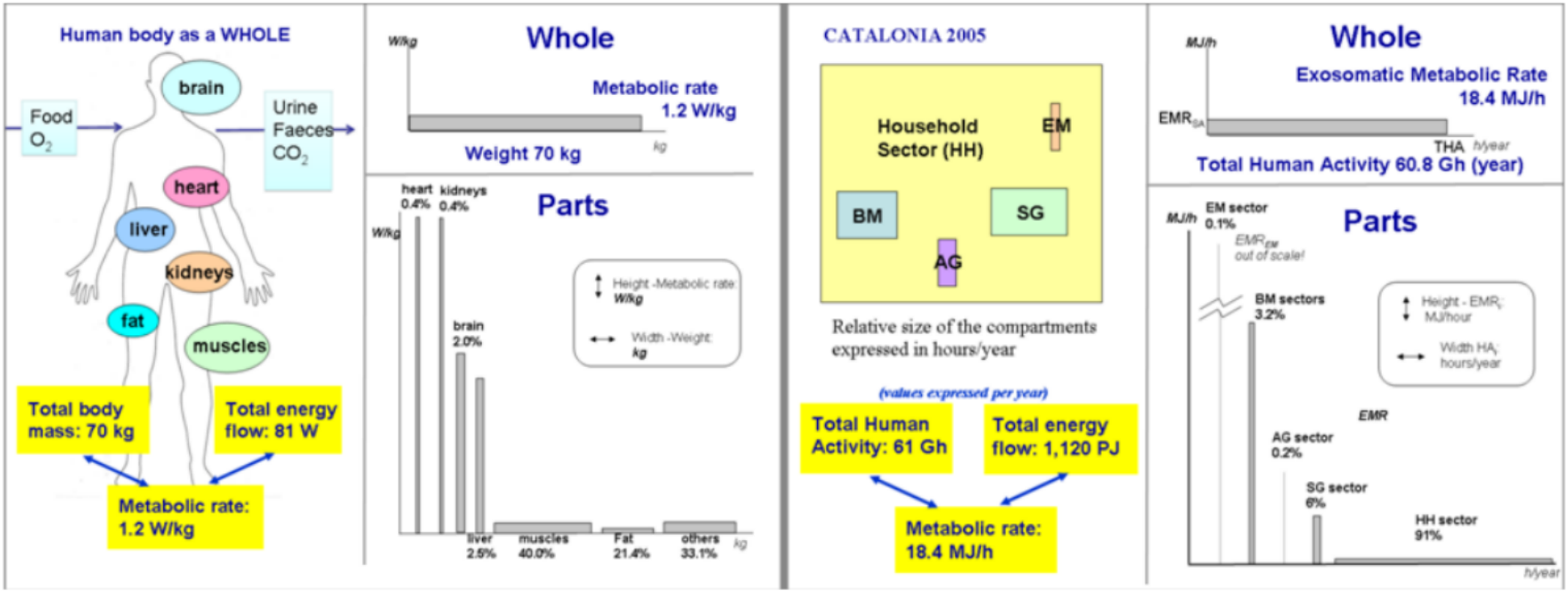


Two-way assessment: top-down a

The energetic metabolism of societies

Endosomatic metabolism vs. exosomatic metabolism



The mosaic effect across scales

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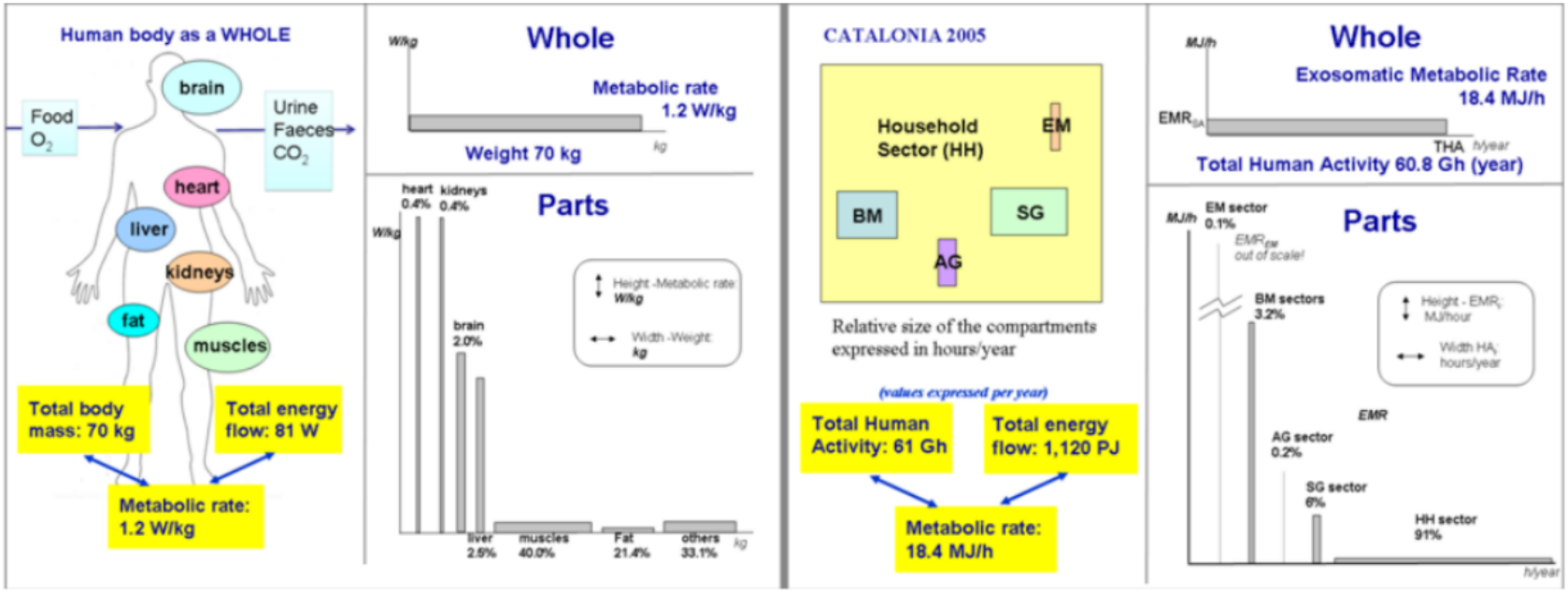
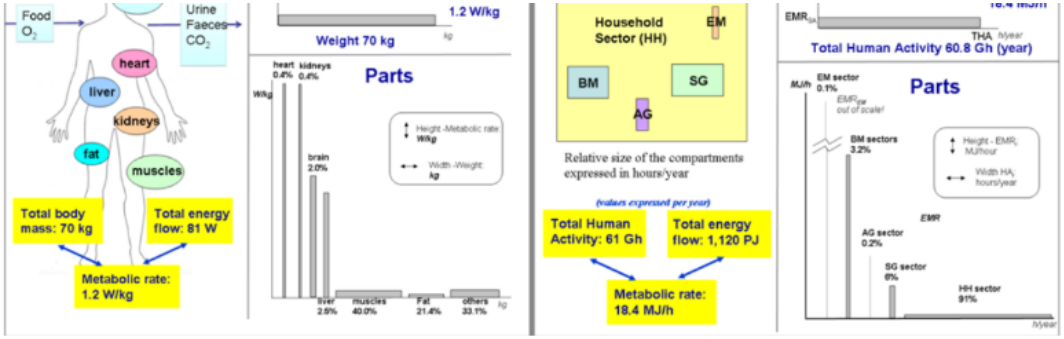


The mosaic effect across scales

s describing the metabolic pattern across levels

Benchmarks for the energetic metabolism



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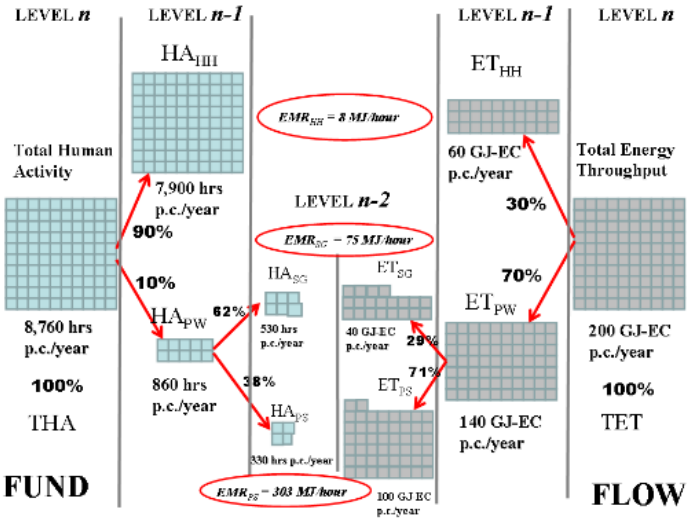
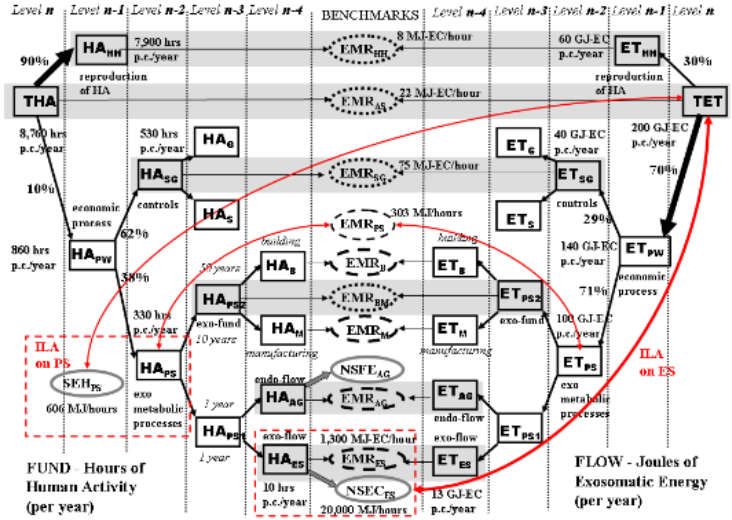
Example of dendrograms describing the metabolic pattern across levels



Benchmarks for the energetic metabolism of modern societies



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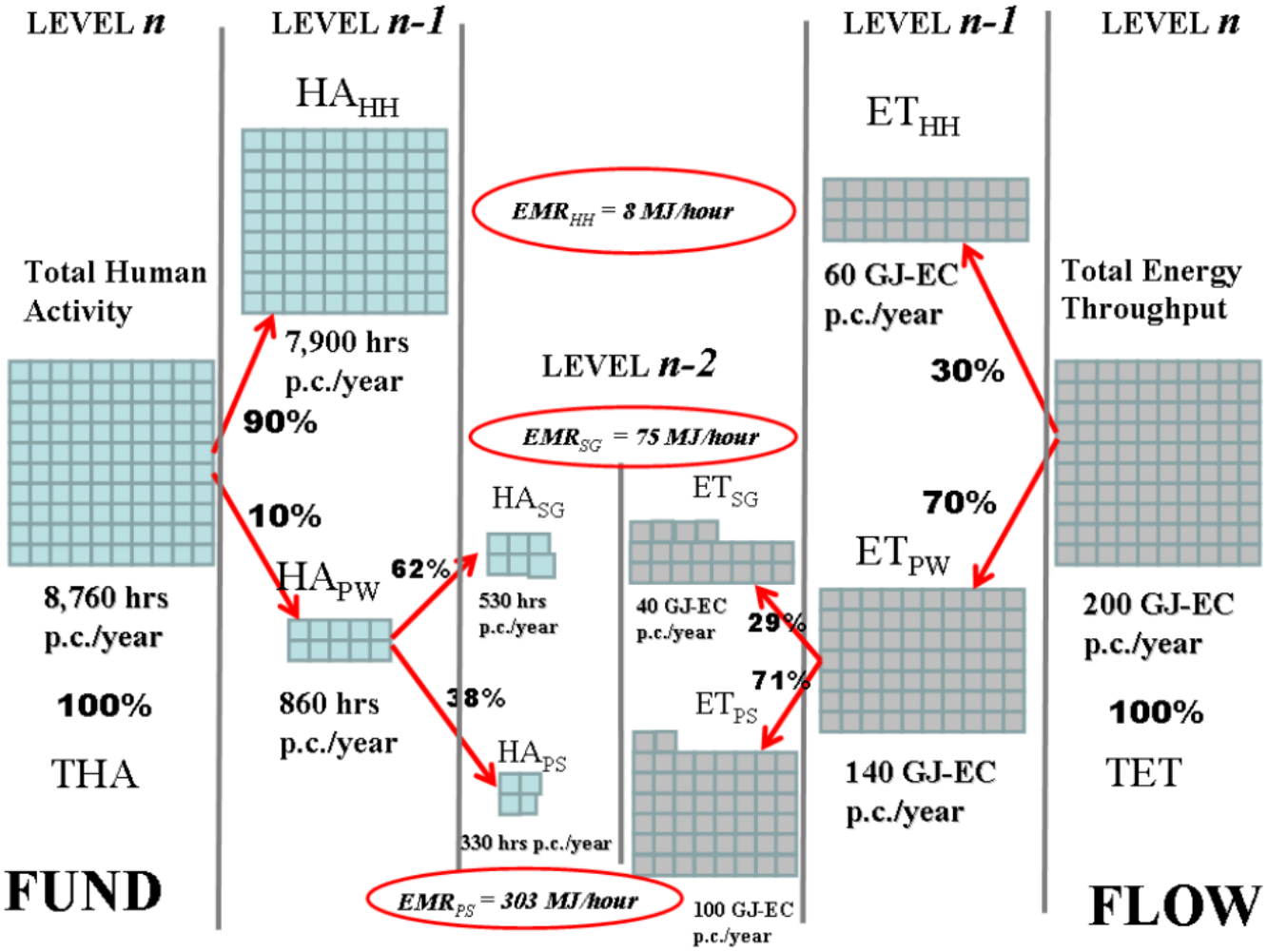

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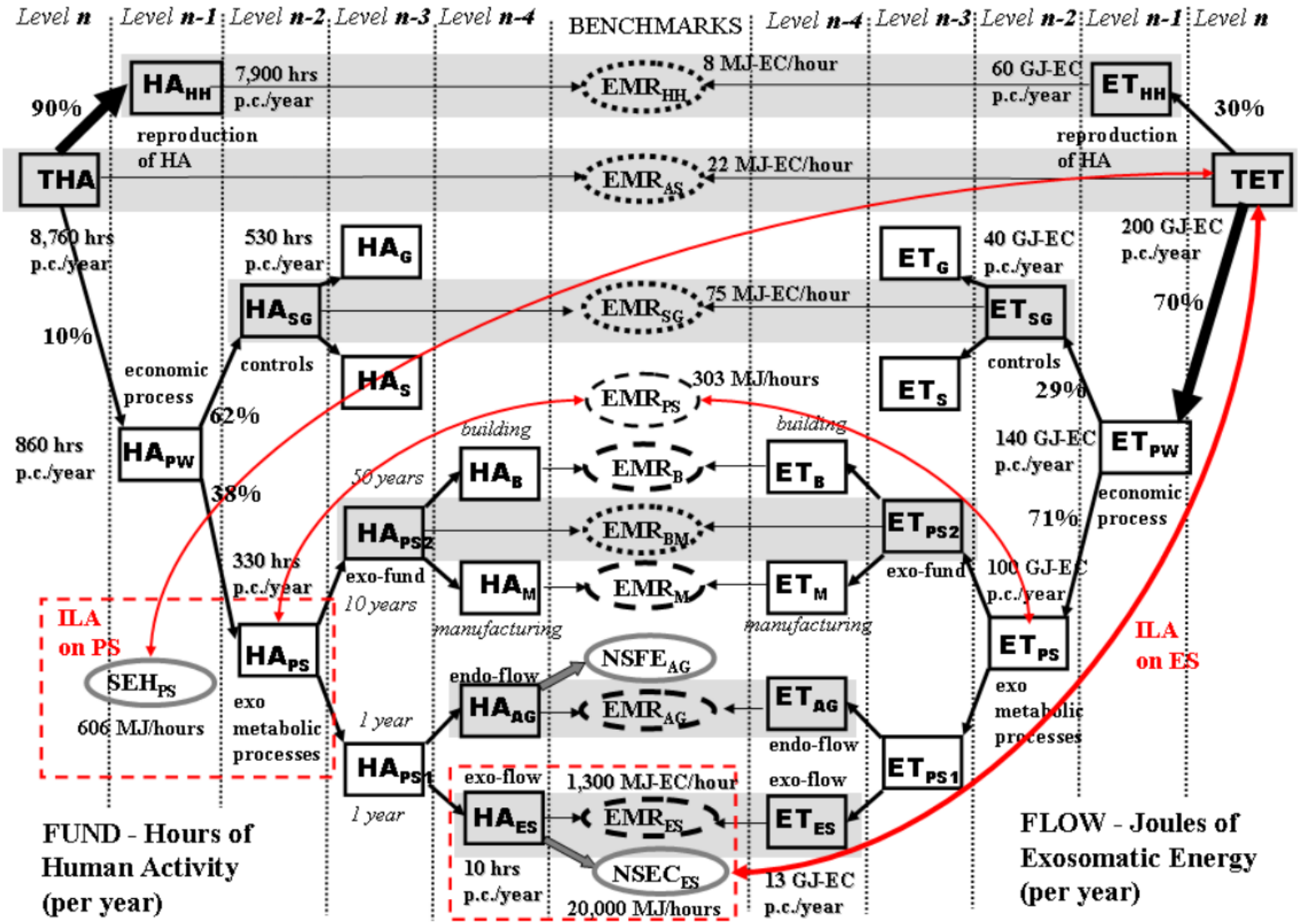


Two-way assessment: top-down and bottom-up

Whole society (SA)	Level n
Household (HH)	Level n-1
Paid work (PW)	Level n-1
Services and Government (SG)	Level n-2
Production sector (PS)	Level n-2
Building and Manufacturing (BM)	Level n-3
Agriculture sector (PS)	Level n-3
Energy Supply sector (ES)	Level n-3

Energy Supply sector (ES)	Level n-3
Primary Energy Sources (e.g. nuclear energy, wind energy, PV)	Level n-4

Metabolic pattern

DESIRABILITY
of metabolic patterns

(top-down assessment from the demand side)

Expected benchmarks

- Crossing the information
- Possible adjustments

Expected performance

Technical factors

VIABILITY
of alternative PES

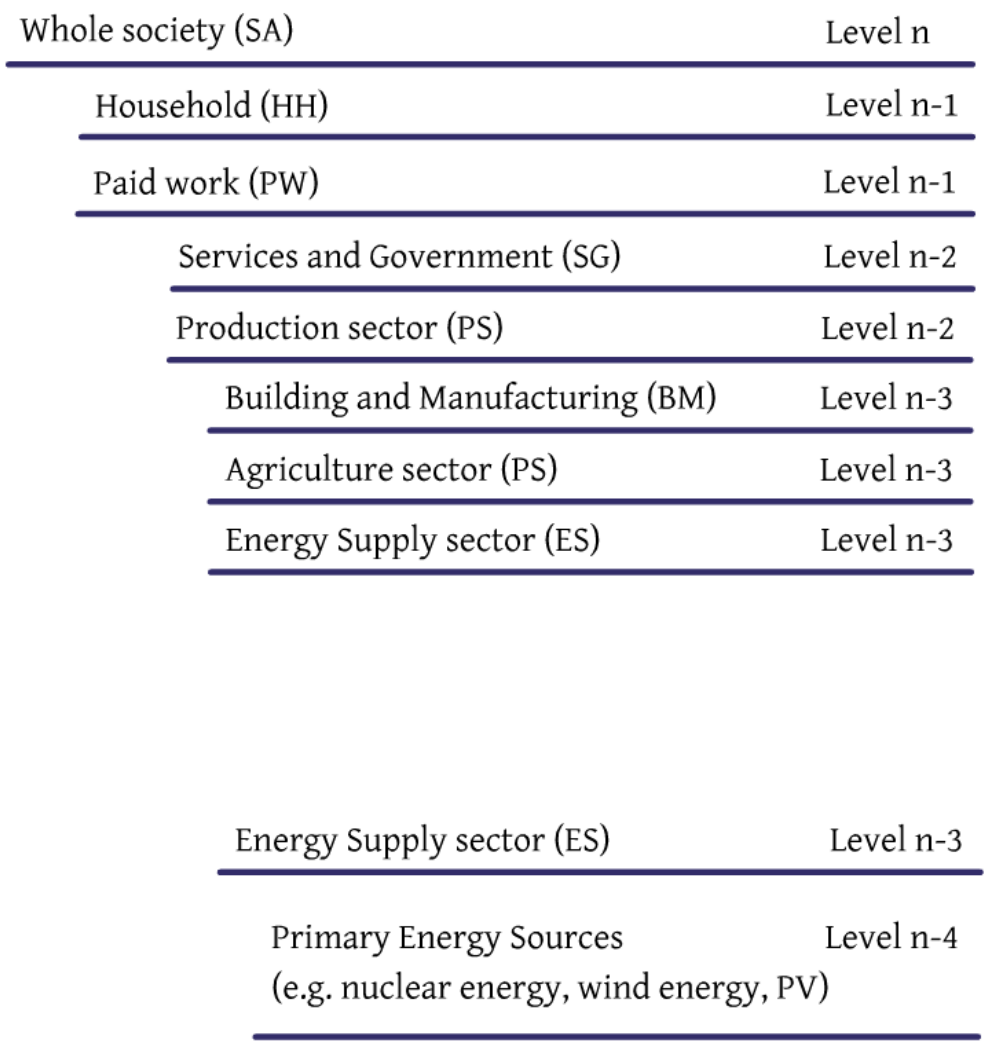
(bottom-up assessment from the supply side)

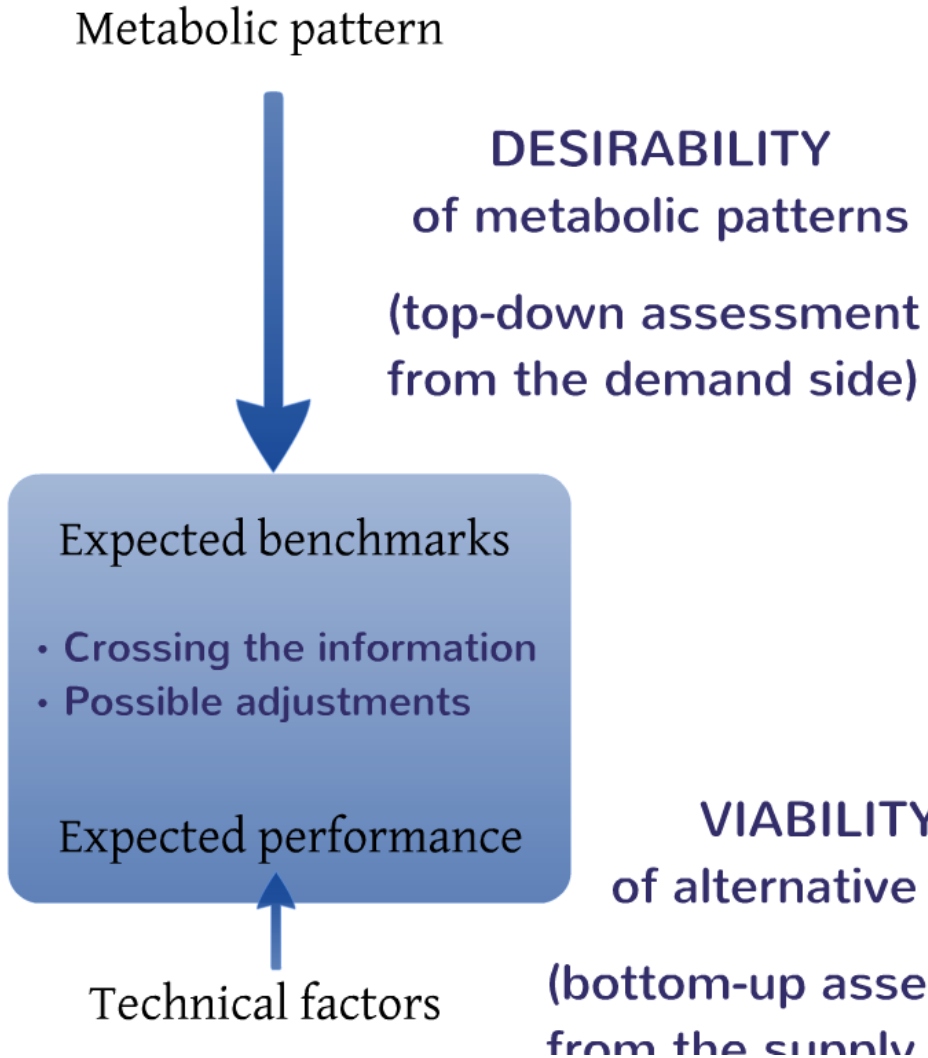
modern societies

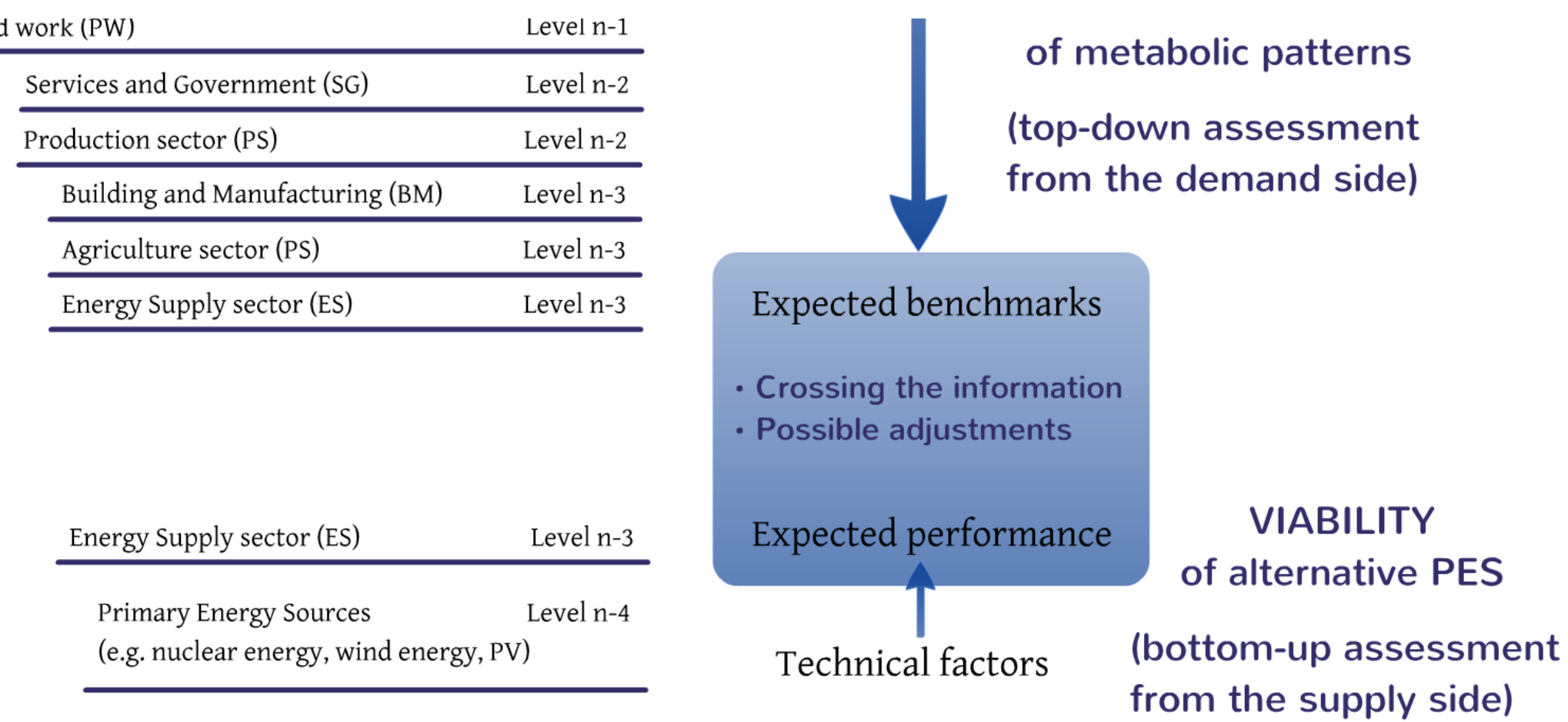
An Energetic Metabolic Pattern is DESIRABLE if the corresponding expected benchmarks comply with the existing performance of the ES sector (a certain mix of PES)

An Alternative Energy Source is VIABLE if the corresponding expected performance of the ES sector complies with the existing Energetic Metabolic Pattern in relation to the whole society

Two-way assessment: top-down and bottom-up







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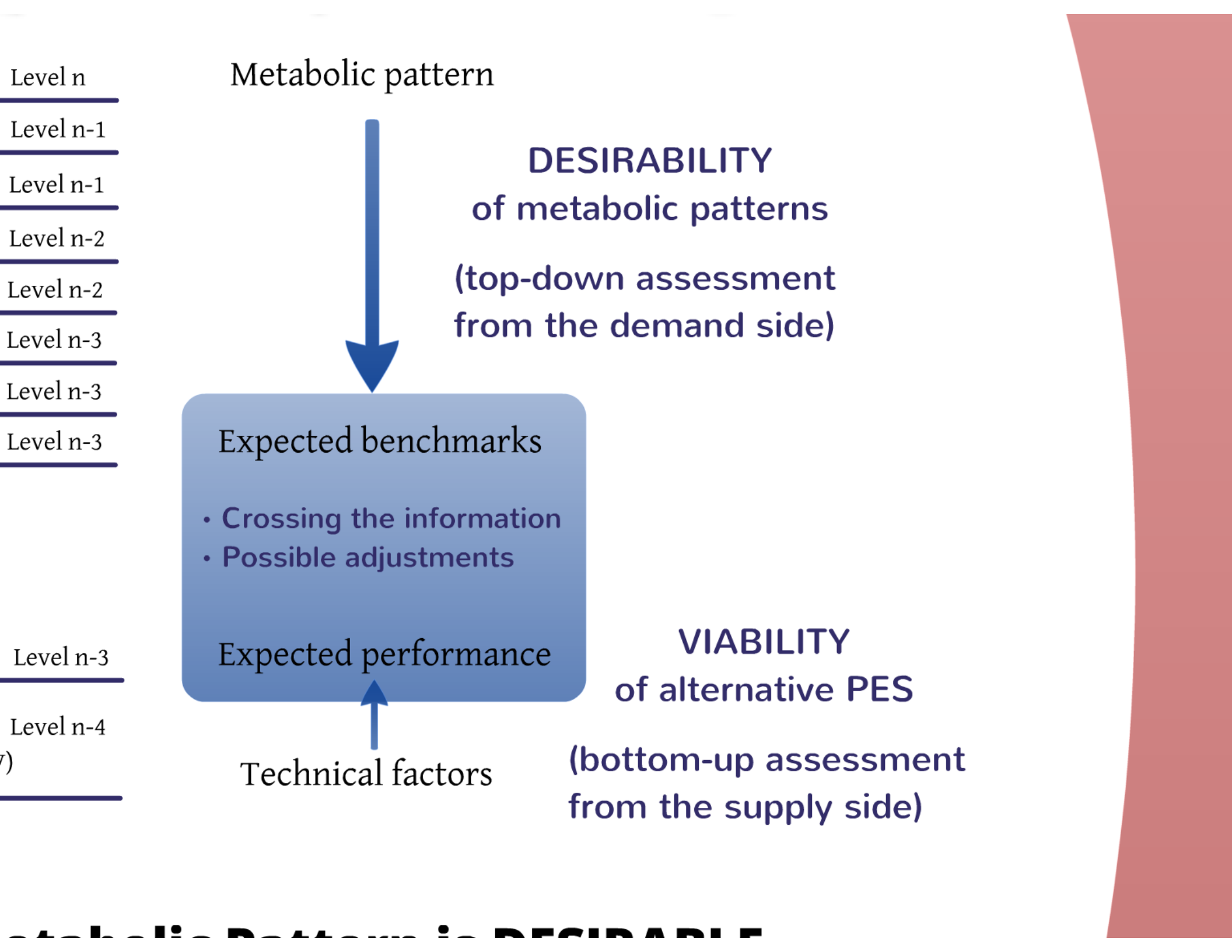
Level n
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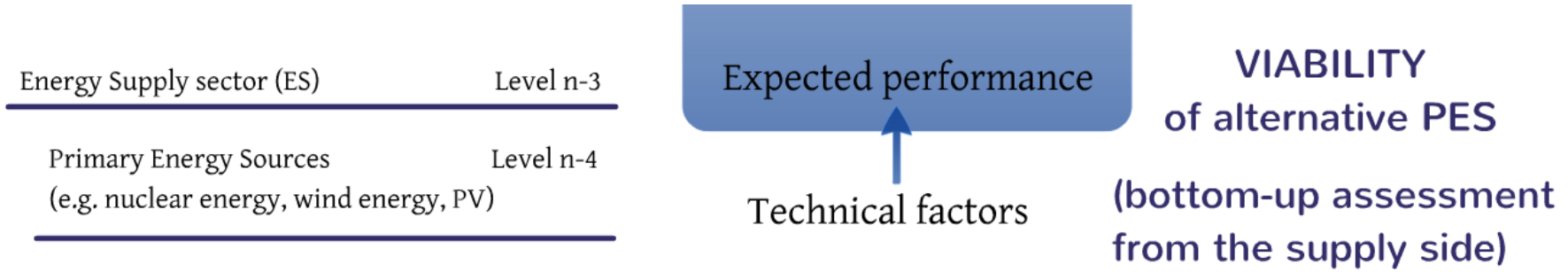

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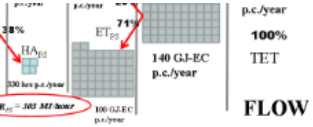

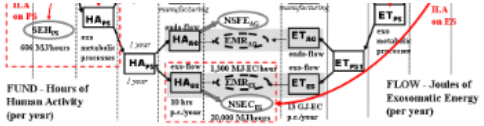

Primary Energy Sources Level n-4
(e.g. nuclear energy, wind energy, PV)

Technical factors

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from th

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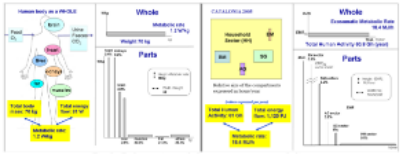

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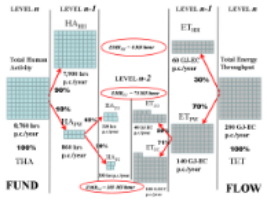

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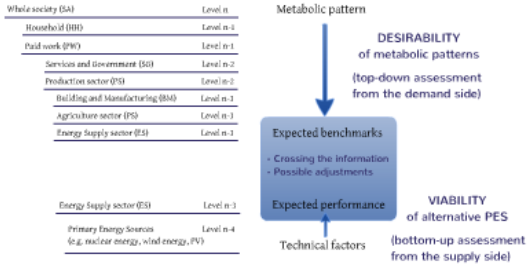

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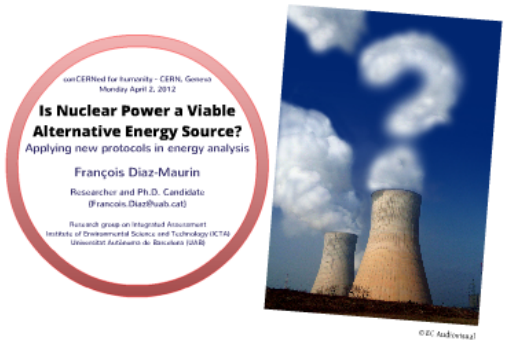
How does

Thank you for your attention!

François Diaz-Maurin

(Francois.Diaz@uab.cat)



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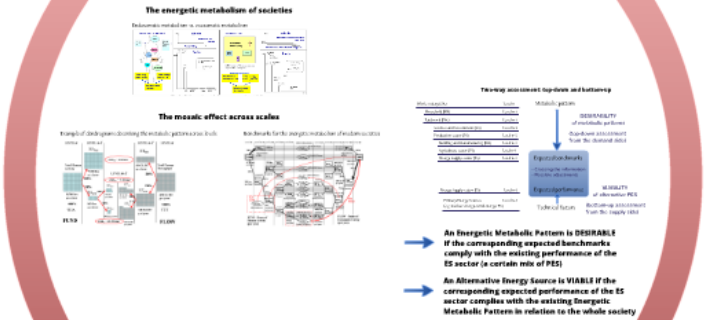

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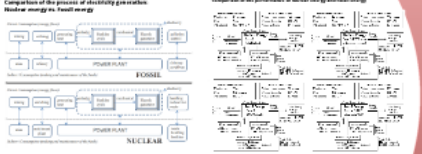

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