



National Institute for
Economic Research
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**The flow-fund model of *Georgescu-Roegen*:
how to avoid epistemological flaws in sustainability science**



Institute of Environmental
Science and Technology • UAB
Research Group on Integrated Assessment

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Content of the talk

1. Are we using good indicators in economic analysis?
The Economic Energy Intensity of the economy
2. Fixing the problem using the flow-fund model of Georgescu-Roegen: the metabolic pattern of EU15 in the last 20 years
3. **The light . . .** when looking for indicators we have to combine information about “fund elements” (extensive) and “flow/fund ratios” (intensive). **DO NOT TRUST** information about “flow elements”!

1. Are we using good indicators in economic analysis?
The Economic Energy Intensity of the economy

How useful is the indicator Economic Energy Intensity of the economy?

The indicator **Economic Energy Intensity (EEI)** is obtained by dividing the **Total Energy Throughput (TET)** of the economy of a country (the energy used) in a year by the **Gross Domestic Product (GDP)** of that country in that year

$EEI = TET/GDP$ - It is measured in MJ/US\$

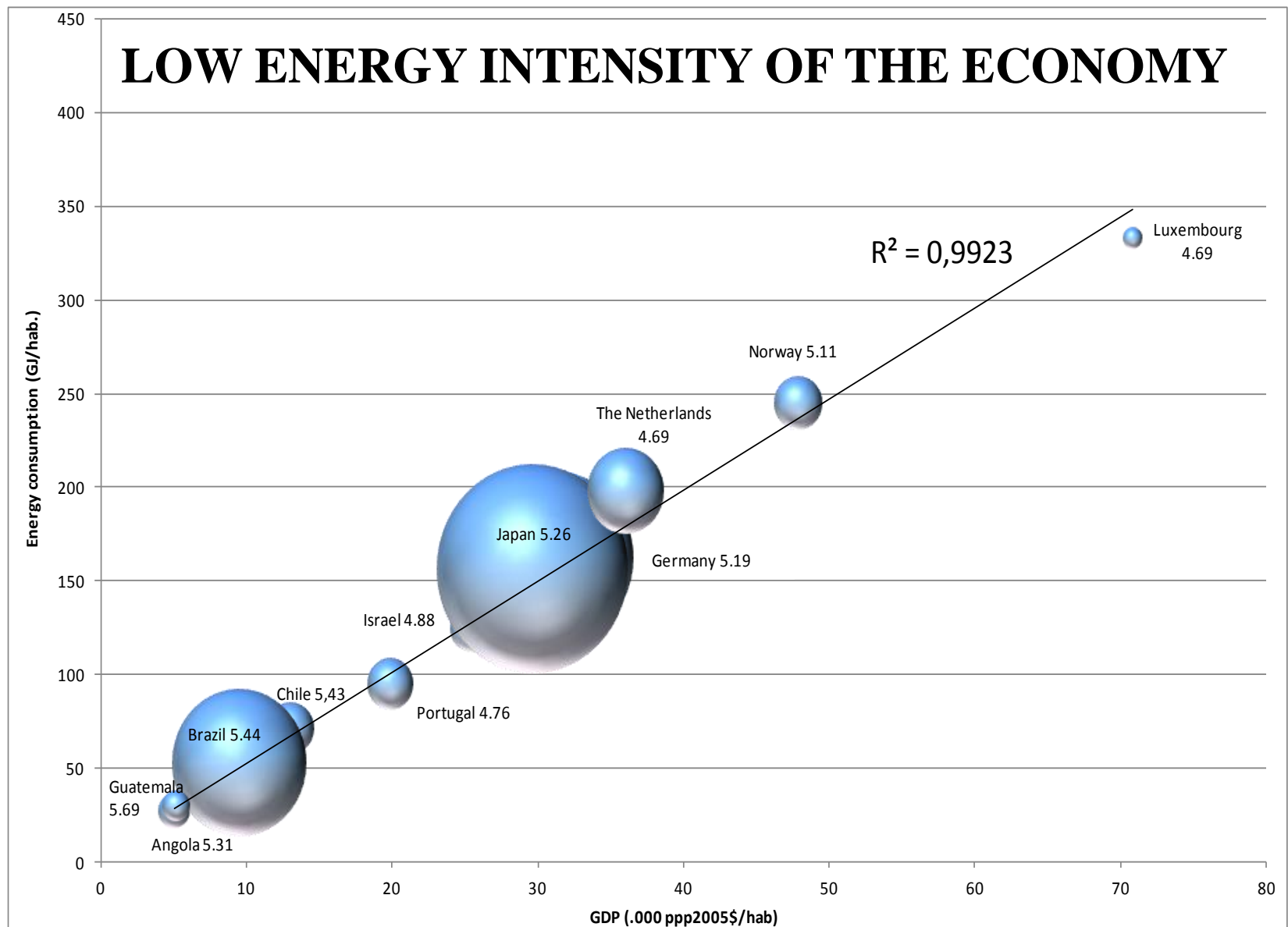
1 MJ = unit of measurement of energy = MegaJoules

The indicator **Economic Energy Intensity** (EEI) is not particularly good at characterizing typologies of countries . . .

As a matter of fact, if we look at clusters of countries with similar values of EEI we find groups of countries with extremely different typologies of economies!

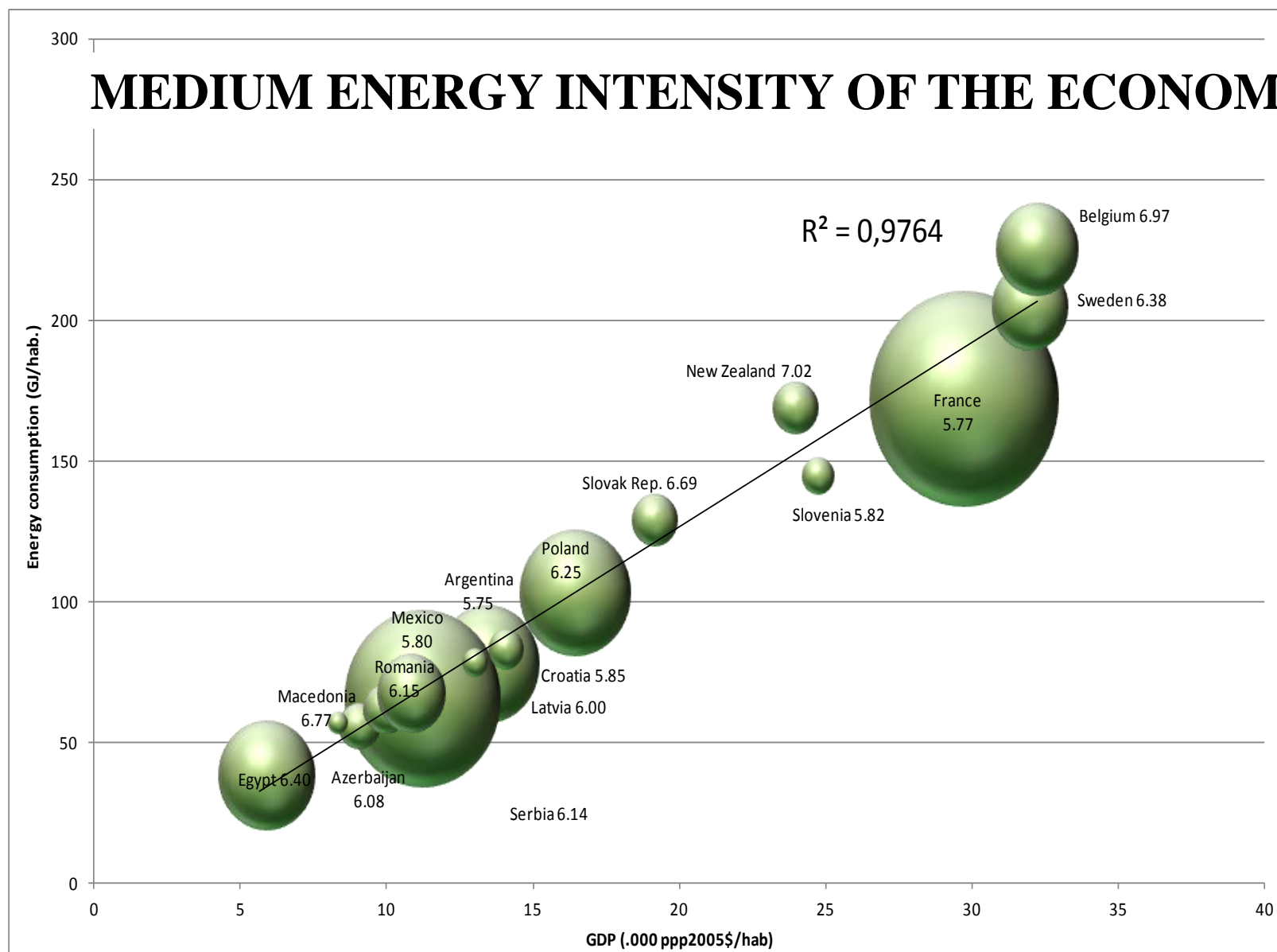
The following data are from:

Fiorito G. 2013 Can we use the energy intensity indicator to study “decoupling” in modern economies? *Journal of Cleaner Production* Vol. 47: 465-473



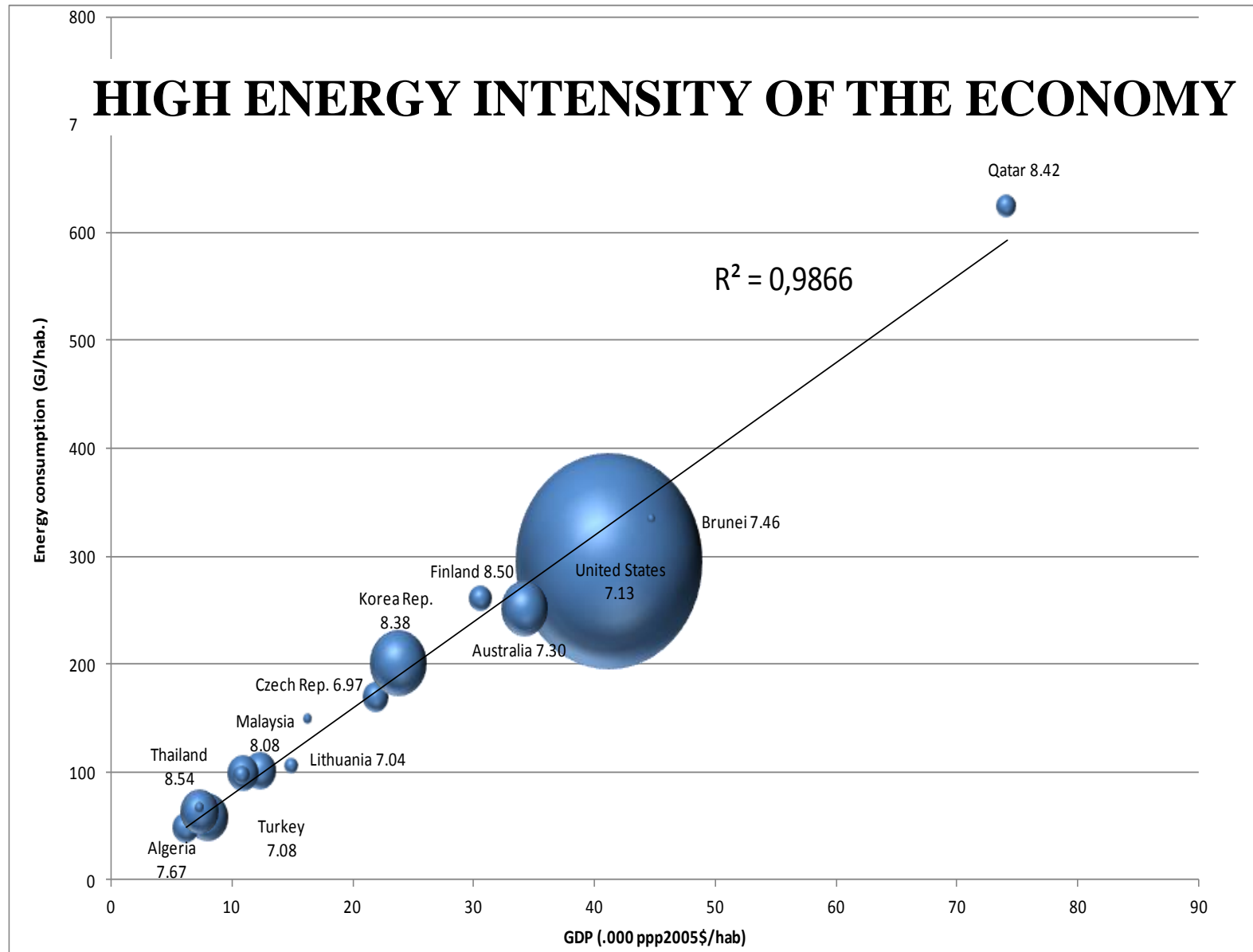
Guatemala, Germany, The Netherlands, Angola, Norway, Chile

MEDIUM ENERGY INTENSITY OF THE ECONOMY



Macedonia, Sweden, Azerbaijan, France, Egypt, Sweden, Argentina

HIGH ENERGY INTENSITY OF THE ECONOMY



Thailand, Australia, Algeria, Finland, United States, Malaysia, Turkey

The explanation of this fact is quite easy:

the indicator EEI is the ratio over two flows – TET/GDP

- (i) TET is associated with a flow of energy; and
- (ii) GDP is associated with a monetary flow

In turn these two flows depend on two Flow/Fund ratios

$\text{GDP (the flow)} = \text{GDP p.c. (flow/fund)} \times \text{population (fund)}$

$\text{TET (the flow)} = \text{EMR}^* \text{ (flow/fund)} \times \text{population (fund)}$

$\text{EMR}^* = \text{Energy Metabolic Rate} = \text{energy use per capita per year}$

the flow/fund ratios – GDP and Energy Use per capita per year
can also be expressed as flows per hour of human activity

Total Human Activity = population x 8,760 (hours in a year)

By doing so we can write the flow/fund ratios as follows:

$$\text{GDP per hour} = \text{GDP/THA}$$

$$\text{EMR per hour} = \text{TET/THA}$$

Now we can finally explain why the Economic Energy Indicators
should not be used . . .

Year 1997

Finland = 12.6 MJ/\$

MJ

\$

TET
GDP

=

$$\frac{\text{TET}}{\text{THA}} = \frac{\text{GDP}}{\text{THA}}$$

El Salvador = 12.6 MJ/\$

Finland = 29.73 MJ/h

El Salvador = 2.92 MJ/h

**12.6 MJ/\$ is a ratio
semantically void
NO EXTERNAL
REFERENT**

**Finland = 2.35 \$/h
(20,600 \$/year p.c)**

**El Salvador = 0.23 \$/h
(2,020 \$/year p.c)**

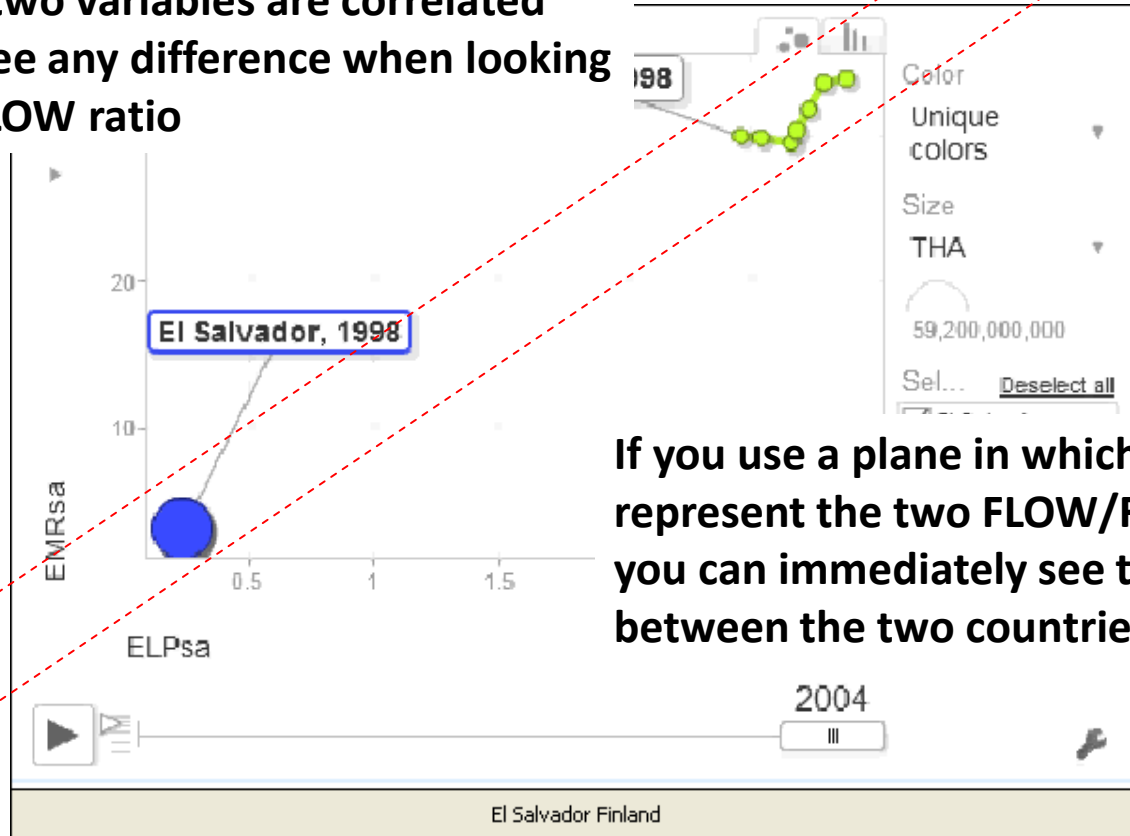
PACE OF ENERGY PER HOUR



because the two variables are correlated
you cannot see any difference when looking
at a FLOW/FLOW ratio

$\frac{TET}{THA}$

MJ/hour



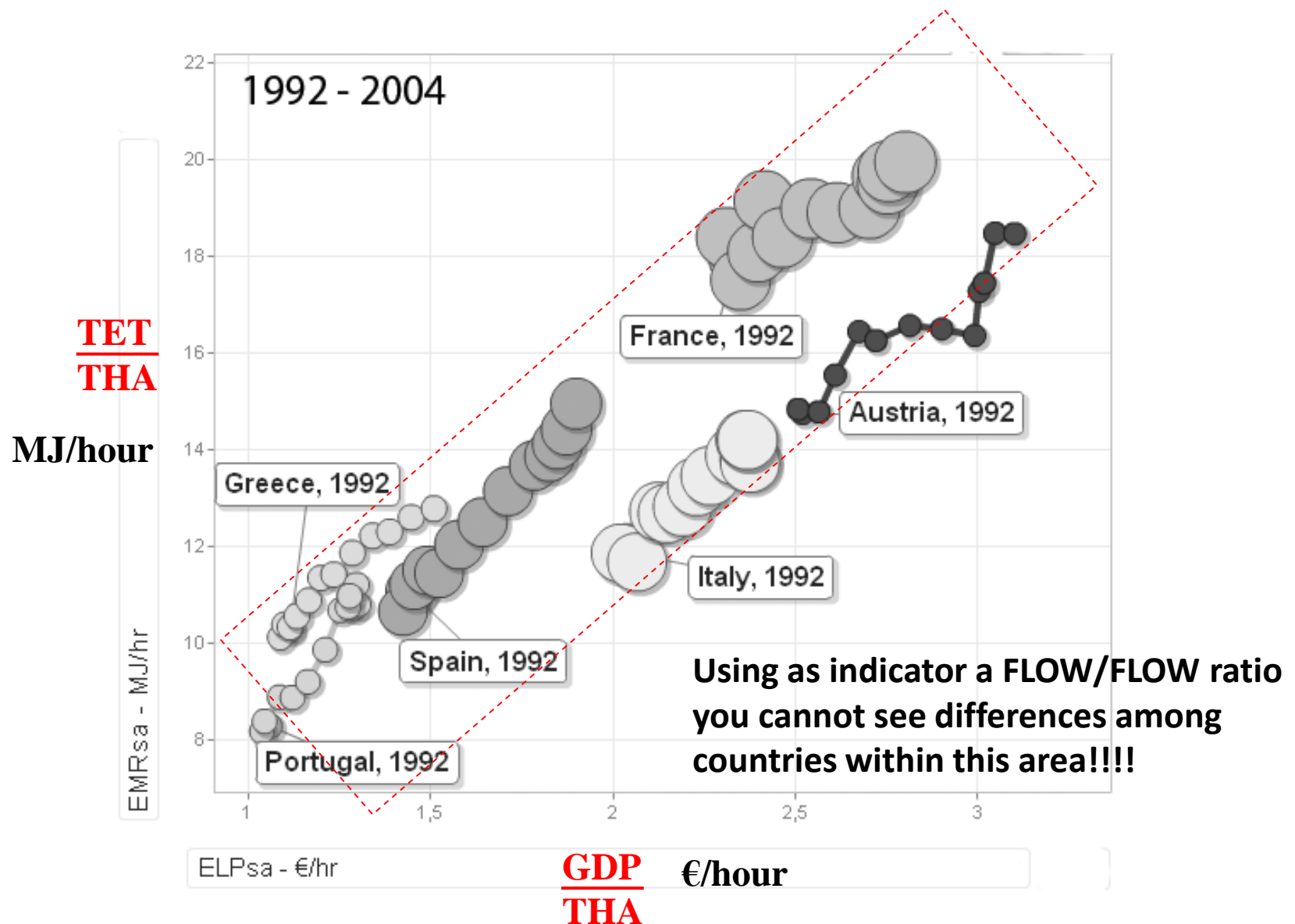
If you use a plane in which you can
represent the two FLOW/FUND ratios
you can immediately see the differences
between the two countries!!!!

€/hour

$\frac{GDP}{THA}$

PACE OF ADDED VALUE
PER HOUR

At the level n – the whole society



2. Fixing the problem using the flow-fund model of Georgescu-Roegen: the metabolic pattern of EU15 in the last 20 years



***The distinction between funds and flows
(proposed by Georgescu-Roegen) to be used
to choose useful accounting protocols . . .***

FORMAL DEFINITION

- * a FUND-element is what remains “the same” in the chosen analytical representation in the duration (time horizon) of the analysis
- * a FLOW-element is what appears (or disappears) in the chosen analytical representation in the duration (time horizon) of the analysis

SEMANTIC DEFINITION

- * FUND-elements = what the system is “made of” = *what the system is*
- * FLOW-elements = how the system interacts with its context
= *what the system does*

By making this distinction one can realize that **BIOECONOMICS** requires identifying first of all the identity of the fund elements
= what category of **fund element** are we talking about?)

After specifying the typology of fund element
the relative flow/fund ratio can be used as benchmark

For example, we can calculate flow/fund ratios for a fund element that is:

- * **THE WHOLE COUNTRY**

 - **SPAIN**

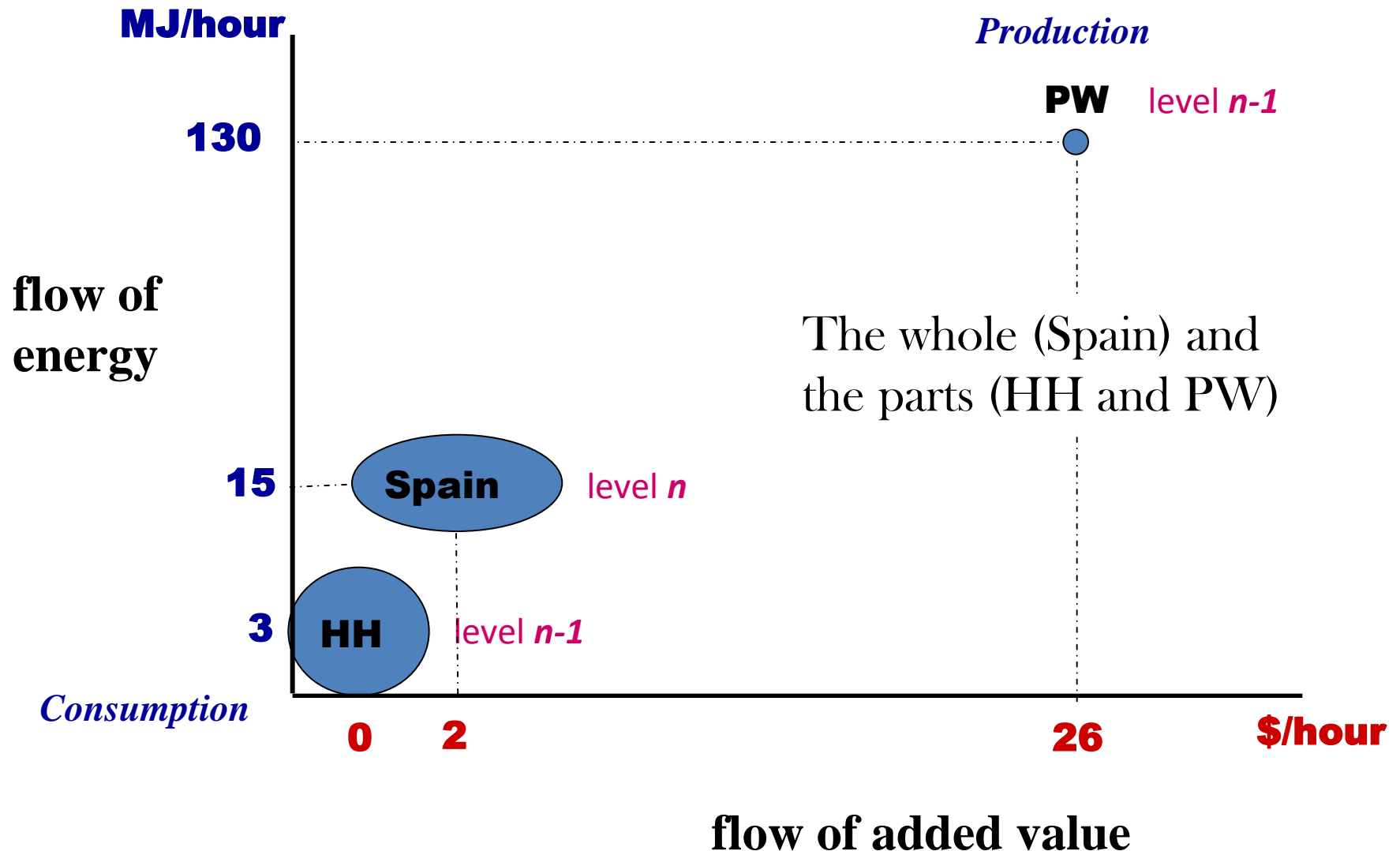
- * **PARTS OF THE SOCIO-ECONOMIC SYSTEM**

 - Household Sector (HH) vs Paid Work (PW)

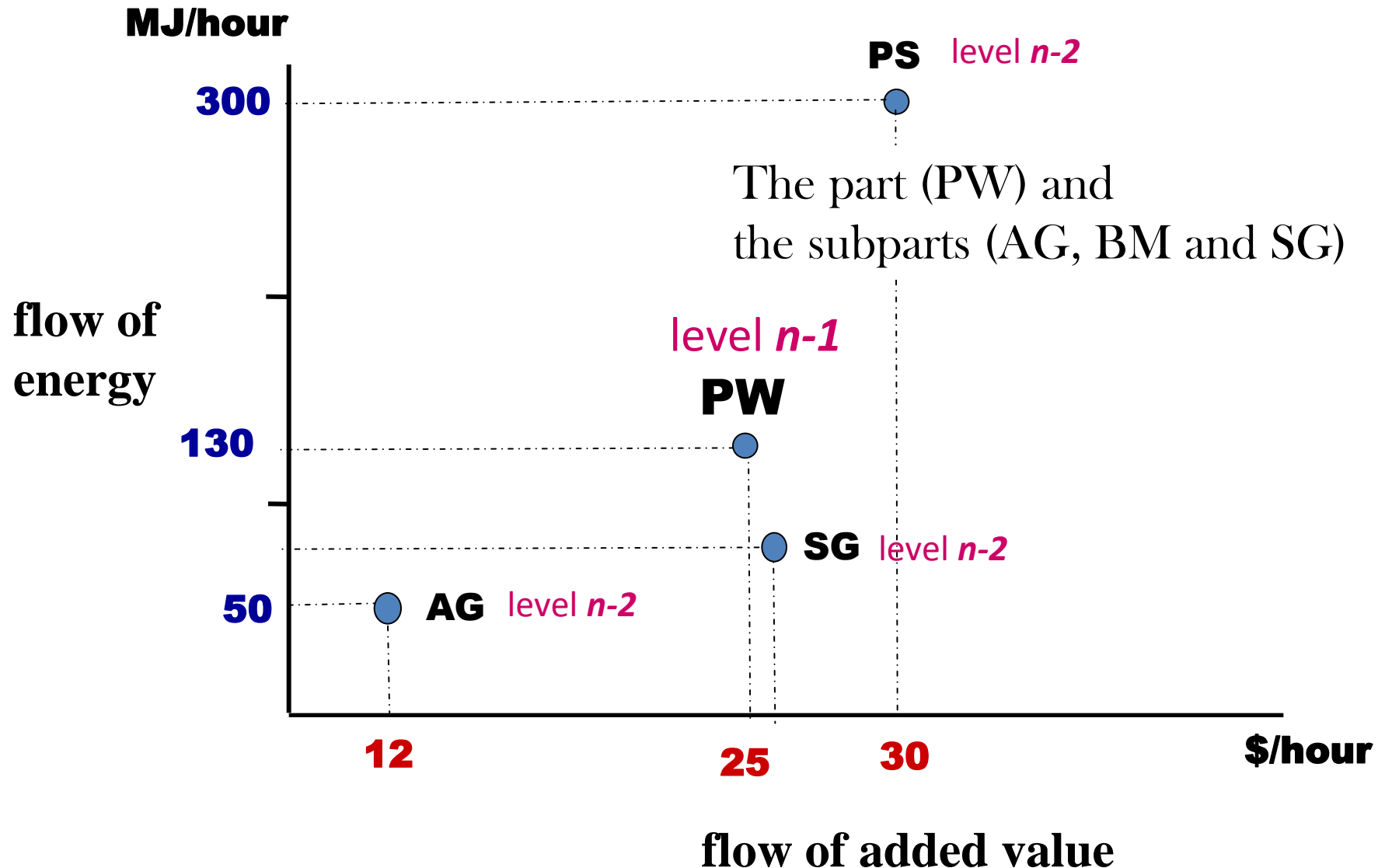
- * **SUBPARTS OF THE PARTS - *defined within PW***

 - Agriculture (AG); Building&Manufacturing (BM); Service&Government (SG)

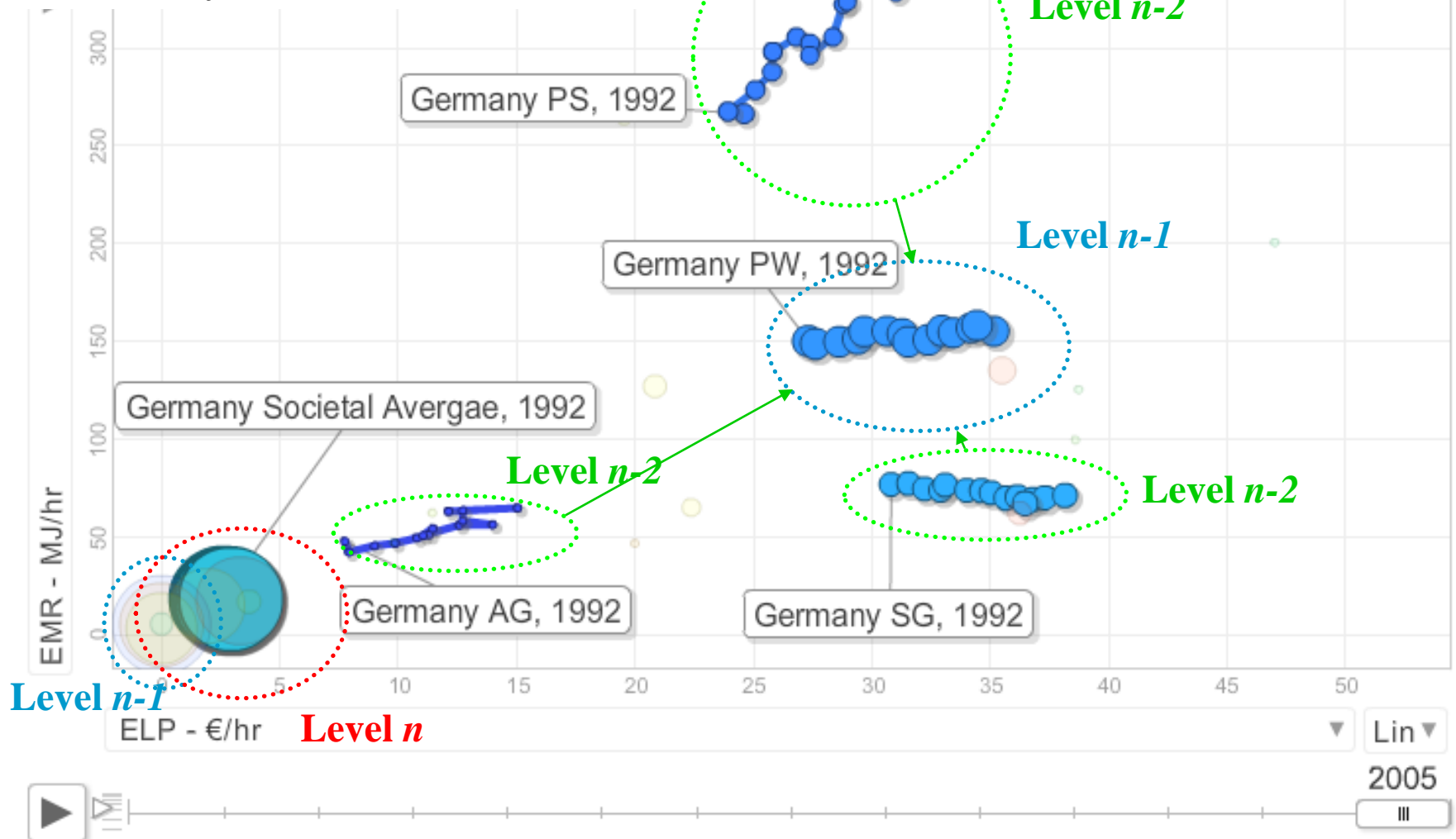
A multi-level analysis of the energy intensity of a modern society:
moving from level $n \rightarrow$ level $n-1 \rightarrow$ level $n-2$ (using flow/fund ratios)



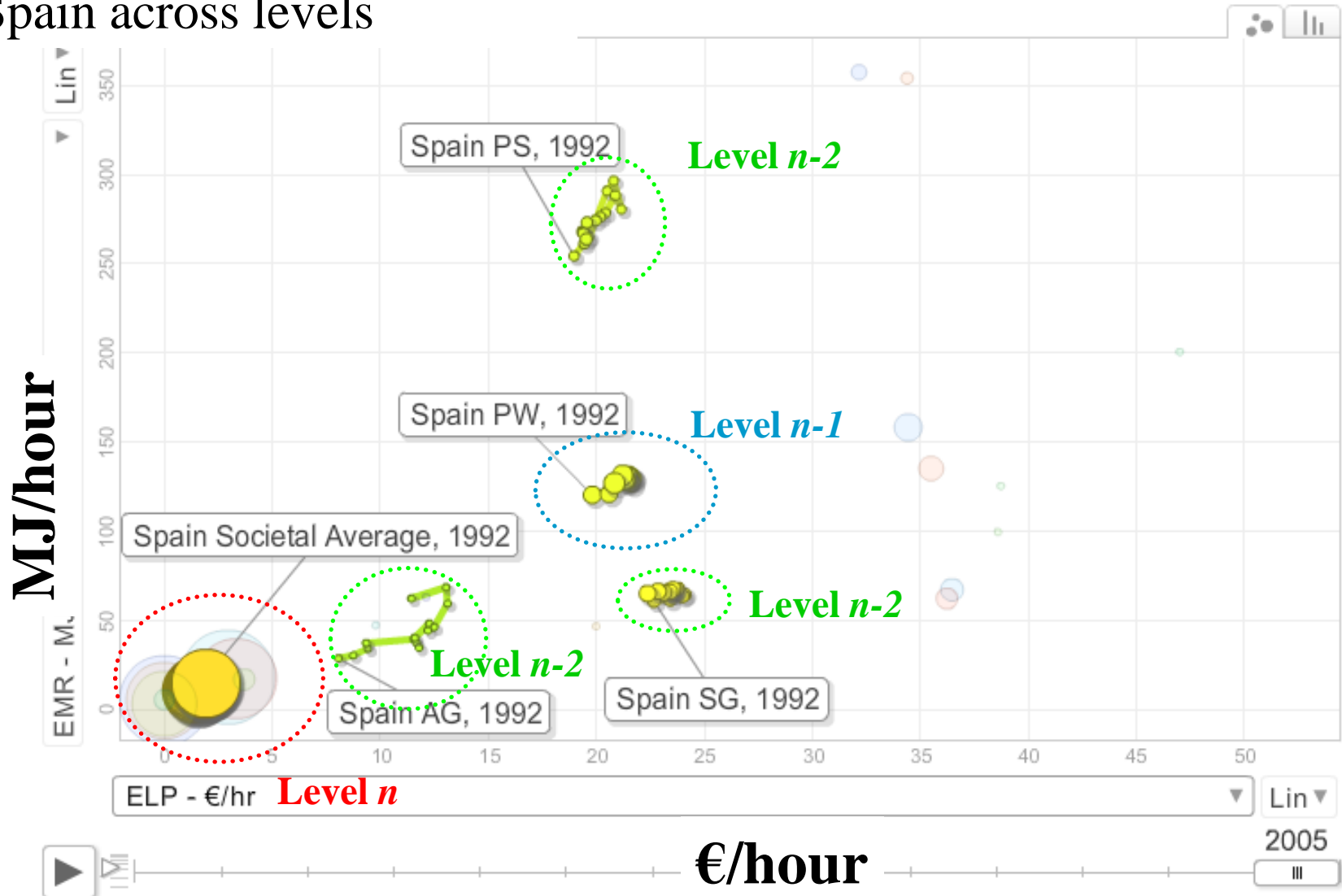
A multi-level analysis of the energy intensity of a modern society:
moving from level $n \rightarrow$ level $n-1 \rightarrow$ level $n-2$ (using flow/fund ratios)



The metabolic pattern of Germany across levels

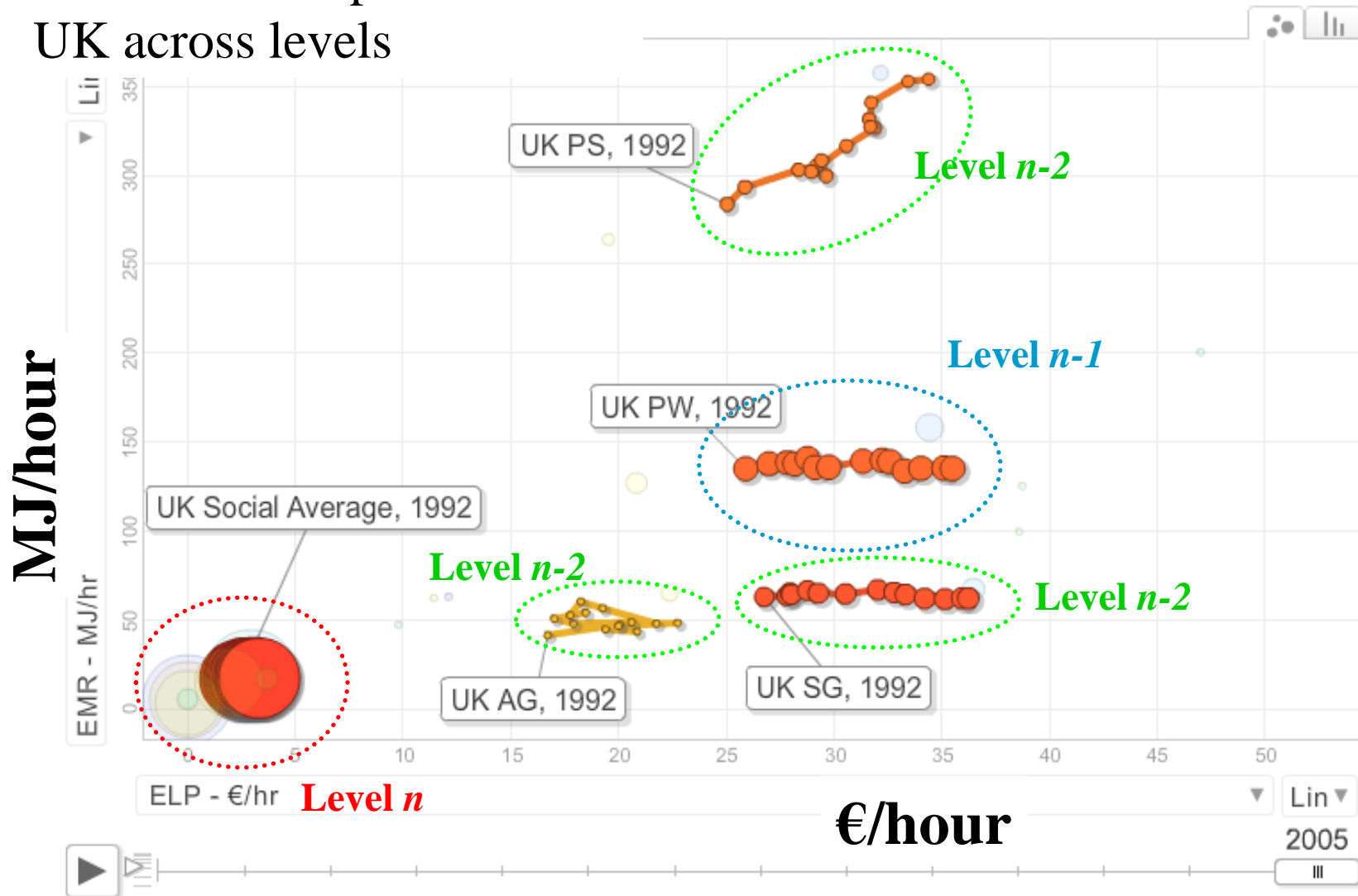


The metabolic pattern of Spain across levels

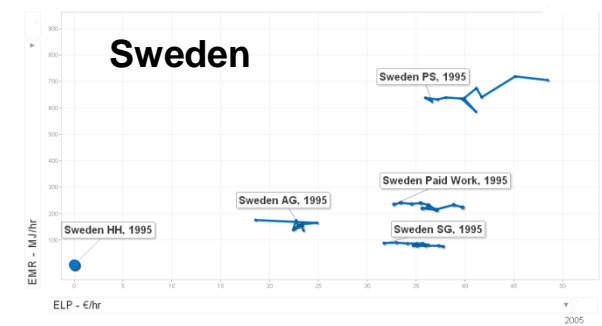
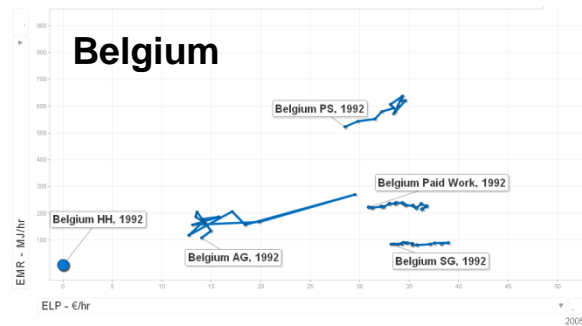
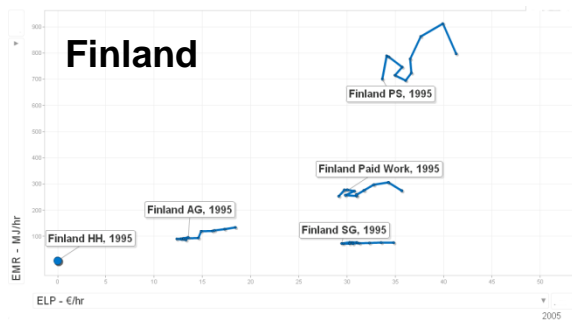


Using a plane to describe the economy at different levels

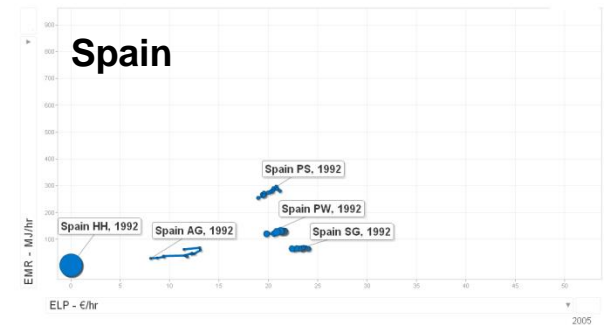
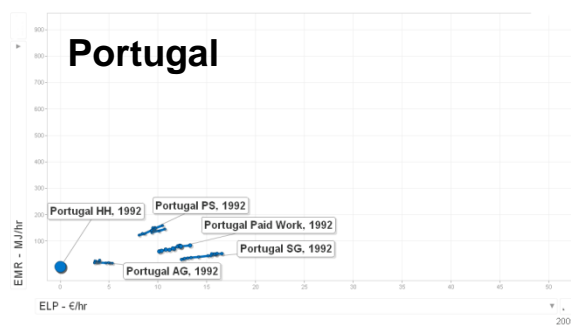
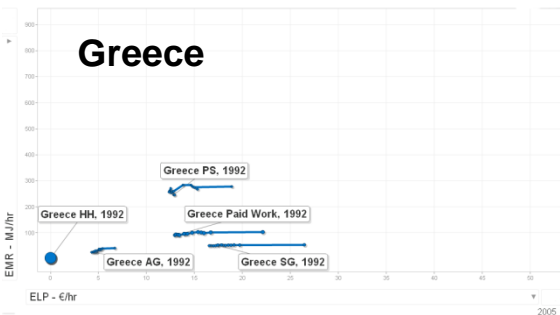
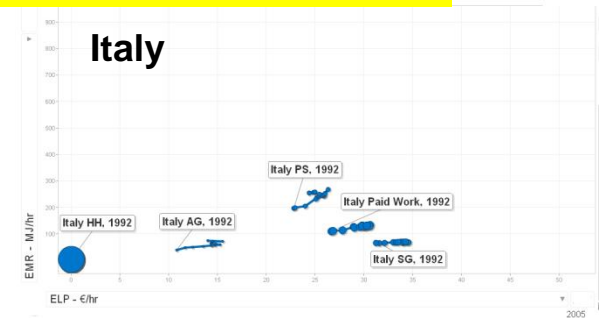
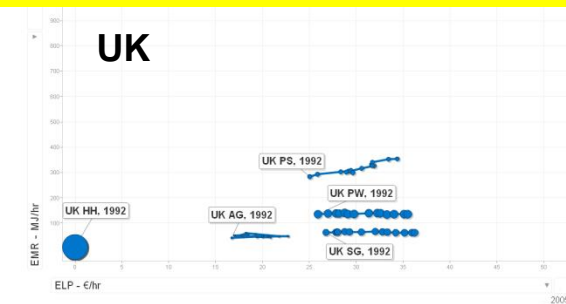
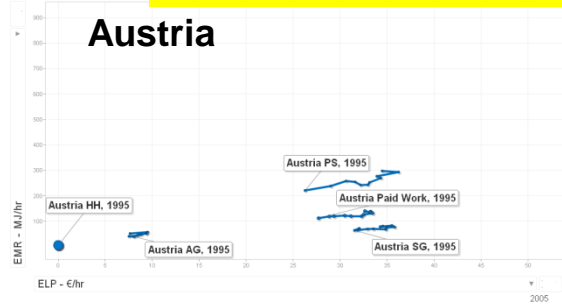
The metabolic pattern of UK across levels



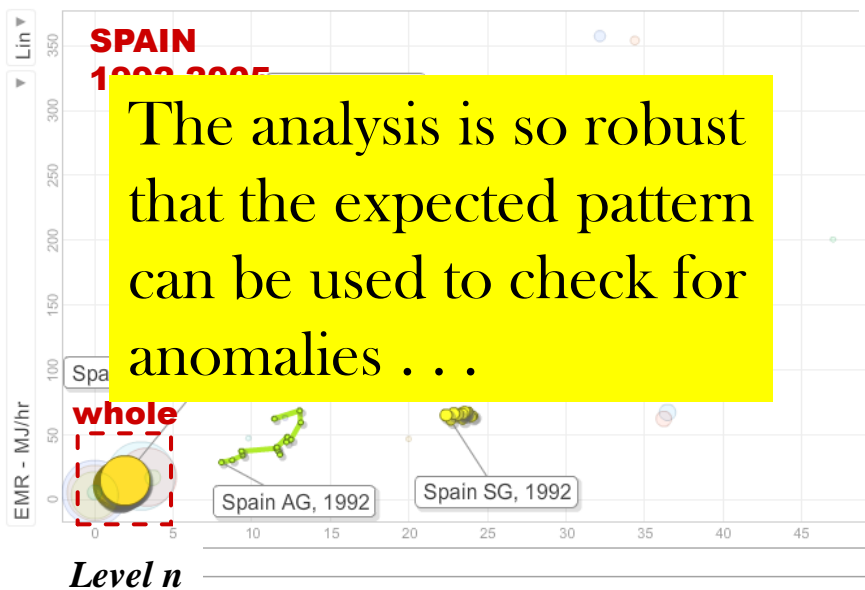
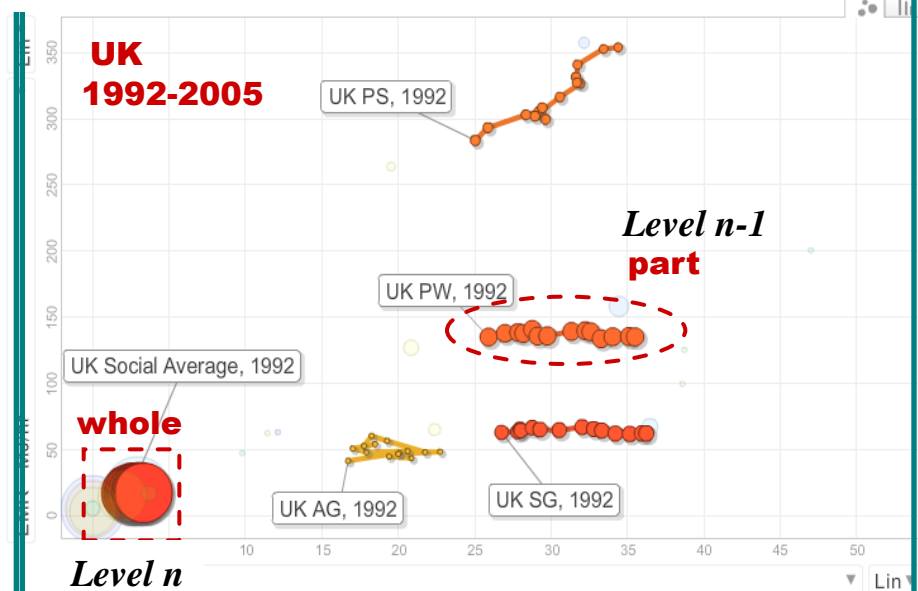
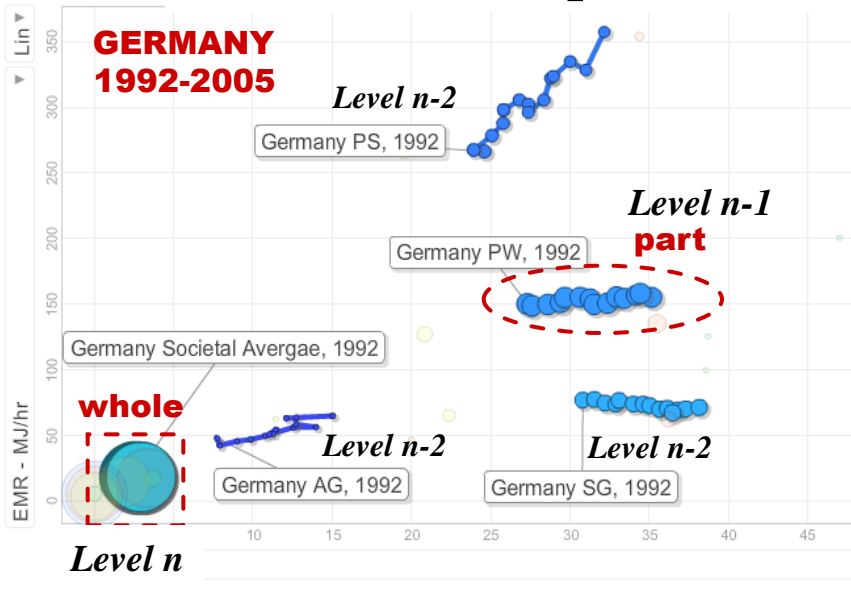
Using a plane to describe the economy at different levels



Netherlands When observing the right categories of fund elements you can finally study patterns in which “apples” are compared to “apples” and “oranges” are compared with “oranges”! Then the metabolic pattern of EU15 is quite clear in terms of expected values of flow/fund ratios and in terms of relative size of fund elements within the economy



The metabolic pattern of EU countries across levels





CONCLUSION - THE LIGHT!



The wisdom of Nicholas Georgescu-Roegen . . .

you will never understand anything if you do not make a proper distinction between “funds”, “flows” and “stocks”. The economic process is about reproducing funds and it is not about producing and consuming flows! This is the secret of metabolic analysis ...

**THE ECONOMY IS NOT ABOUT PRODUCING
“GOODS AND SERVICES” (FLOW ELEMENTS)**

**THE ECONOMY IS ABOUT REPRODUCING
THE PROCESSES REQUIRED TO
“PRODUCE AND CONSUME GOODS AND SERVICES”!**

THEREFORE WHAT WE HAVE TO STUDY ARE:

- (i) FLOW-FUND RATIOS (intensive variables);**
- (ii) RELATIONS OVER FUNDS (extensive variables)**

THE LIGHT

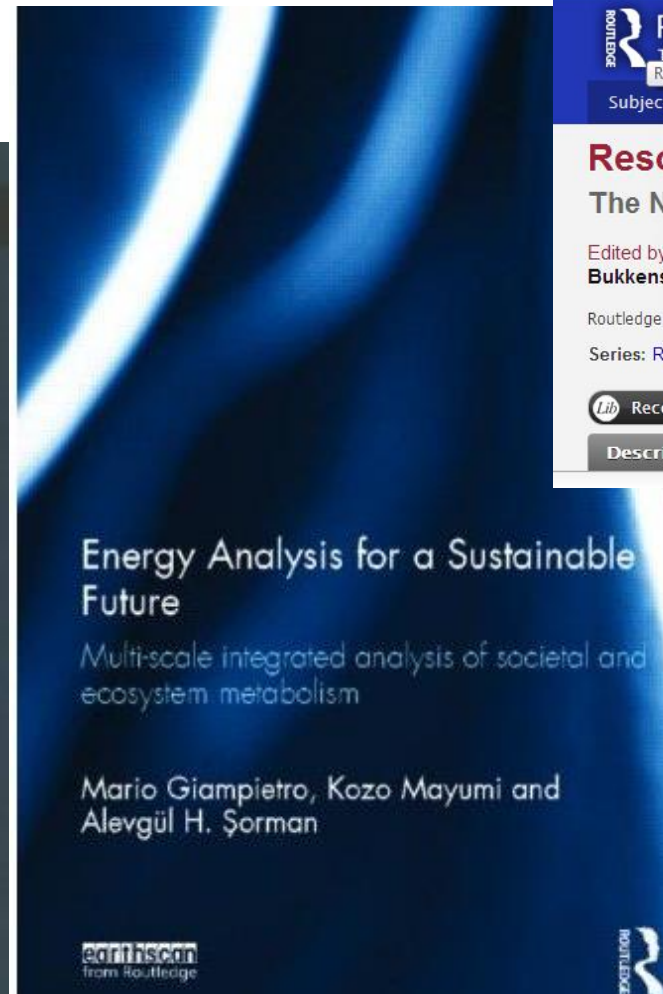
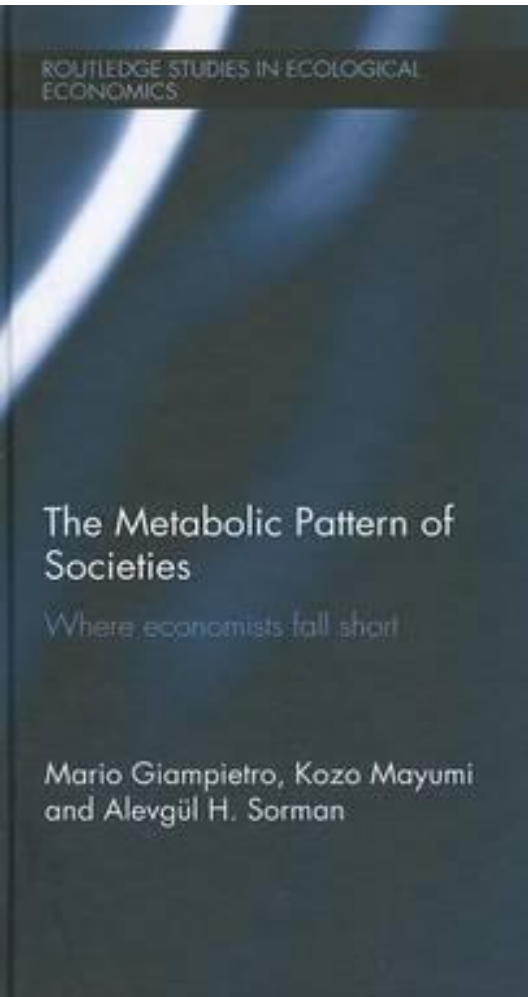
FLOWS
output

FLOWS
input

	food	energy	water	money
food	double	N/A	N/A	es
energy				
water				
money	price	price	price	interest rate

This information is completely useless if it is used outside the context provided by the analysis of the flow/fund ratios and the relative size of fund elements

The books behind this presentation



thank you for
your attention

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