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Modeling Technology Wedges for the Transition to Low Energy and Low Carbon Energy Systems for the EU-27

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Smart Grids und *Distributed Generation*
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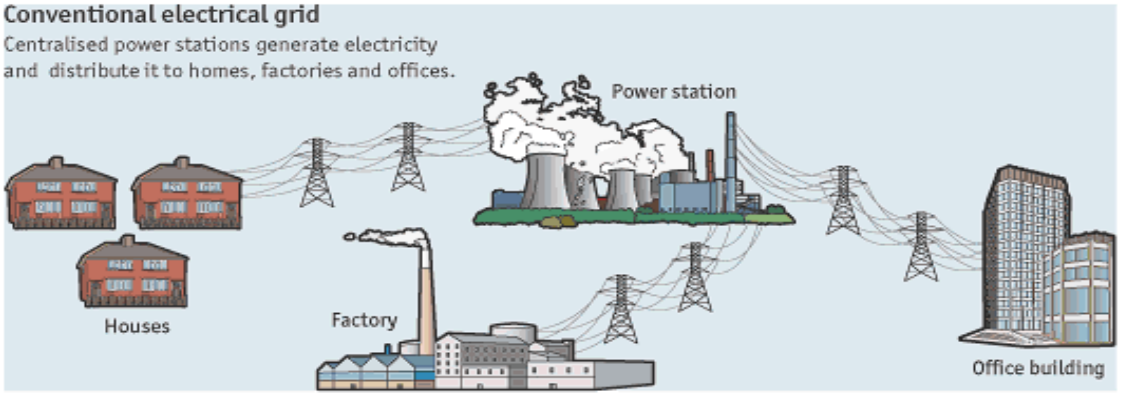
An Internet for electricity and heat

The shape of grids to come?

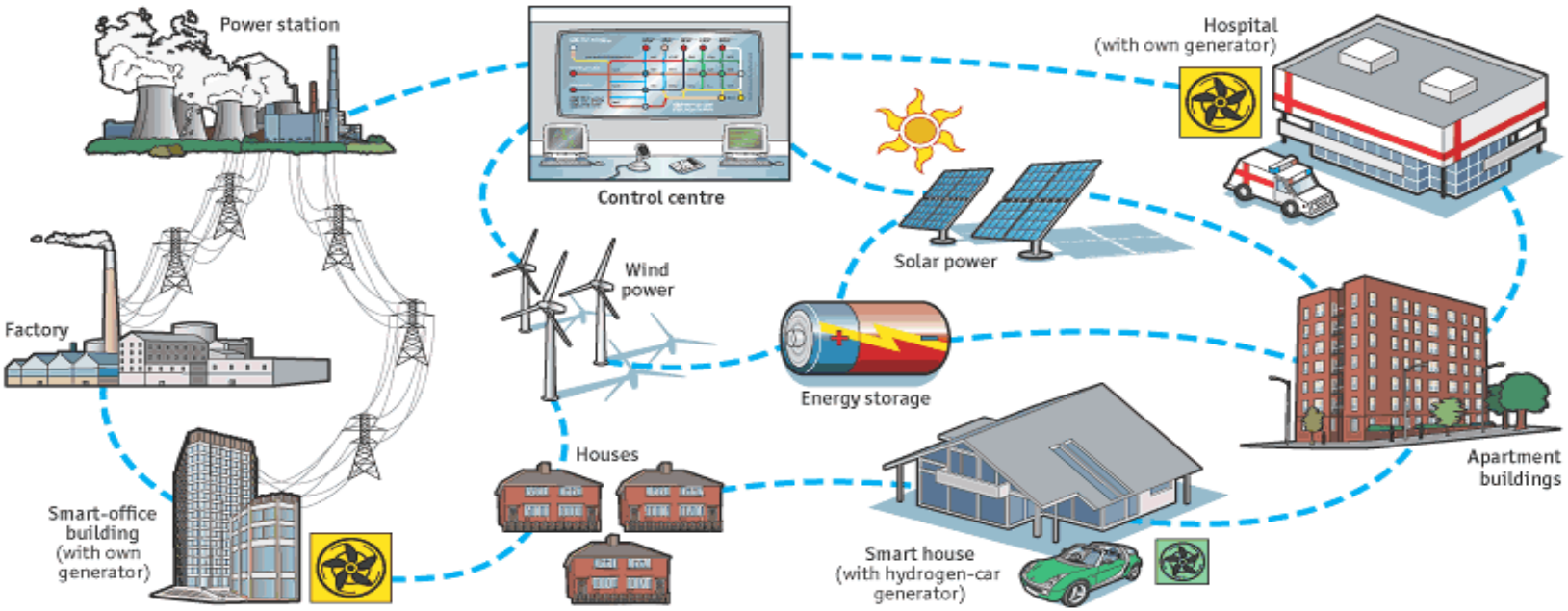


Energy internet

Many small generating facilities, including those based on alternative energy sources such as wind and solar power, are orchestrated using real-time monitoring and control systems.

Offices or hospitals generate their own power and sell the excess back to the grid. Hydrogen-powered cars can act as generators when not in use. Energy-storage technologies smooth out fluctuations in supply from wind and solar power.

Distributing power generation in this way reduces transmission losses, operating costs and the environmental impact of overhead power lines.



Sources: *The Economist*; ABB

TranSust.S

Agenda

- **Technology wedges approach to energy modeling**
  - **Implementation of Pacala & Socolow (2004)**
- **Simulation of low carbon and low energy policies for the EU-27**
  - **Effort sharing for 2020 targets**
- **Structural indicators of energy systems**
  - **Comparative analysis of energy systems**

Modeling Technology Wedges

The conceptual approach

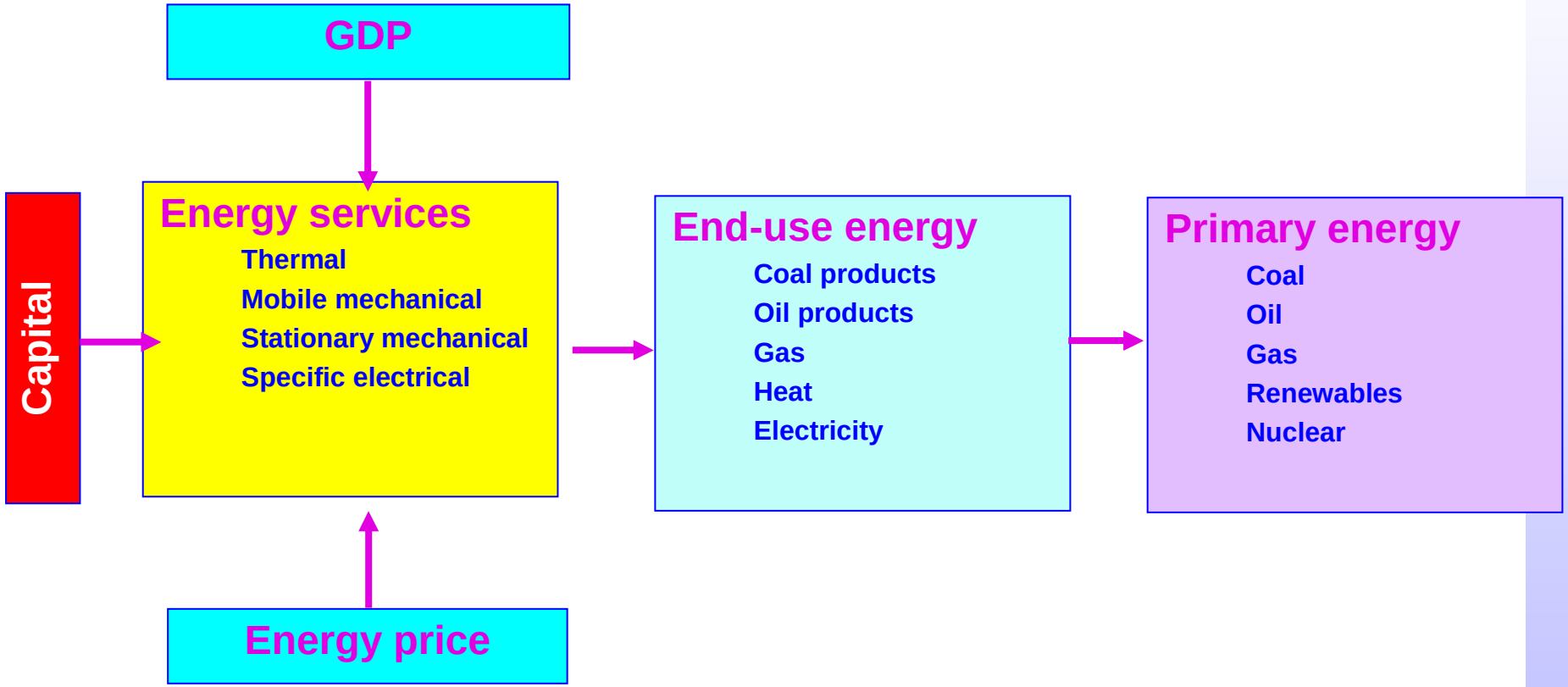
The Pacala-Socolow stabilization wedges

S. Pacala and R. Socolow
Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies
Science, Vol. 305, August 13, 2004.

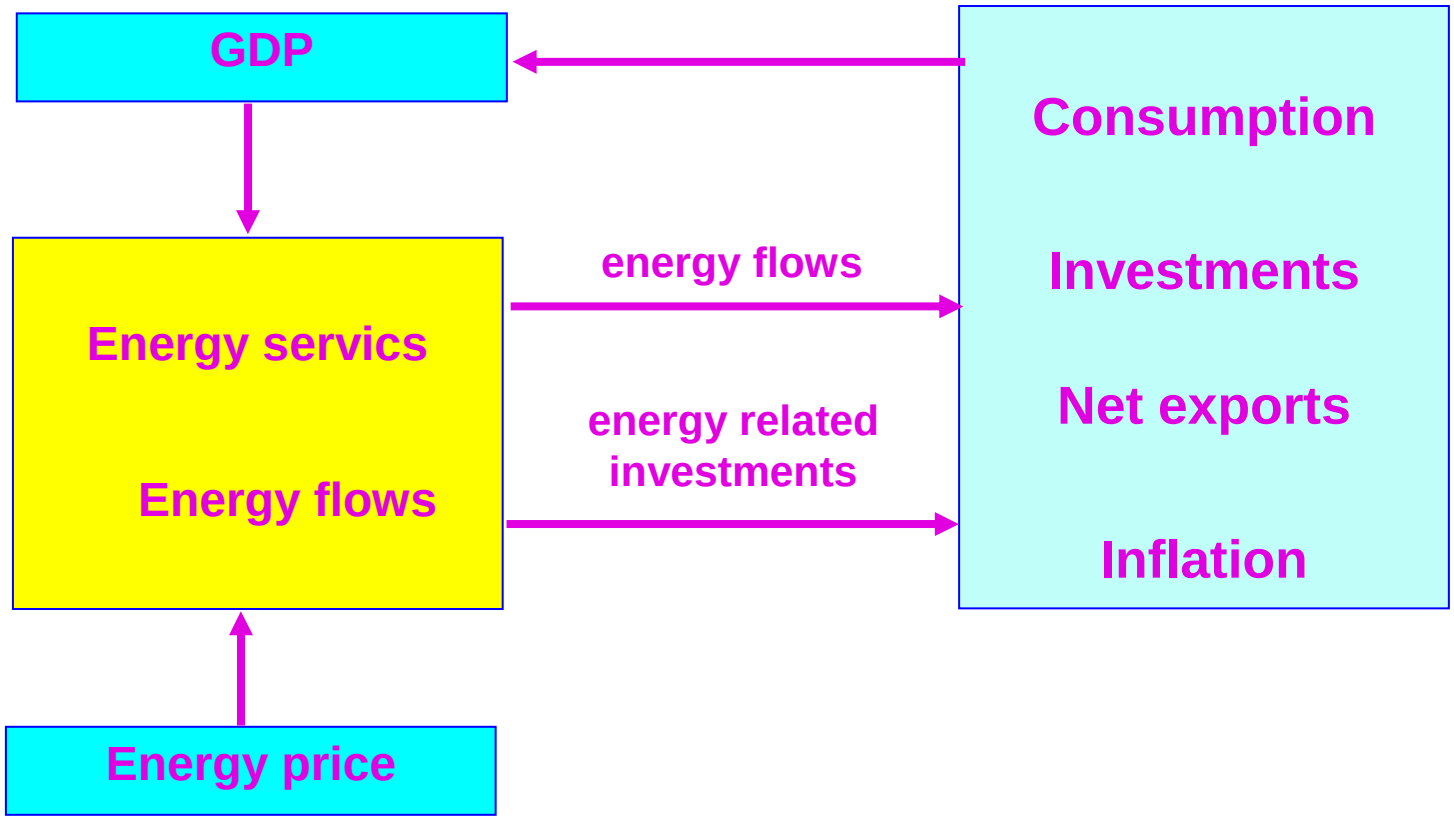
The implementation
GAIN modeling framework

- **Extended view of energy system**
  - **energy services**
  - **end-use energy**
  - **primary energy**
- **Impacts of technical change**
  - **on investment**
  - **on operating**
- **Integration into macro-economic framework**

The structural view of energy systems
From energy services to energy flows



The economic impacts
Macro economic linkages

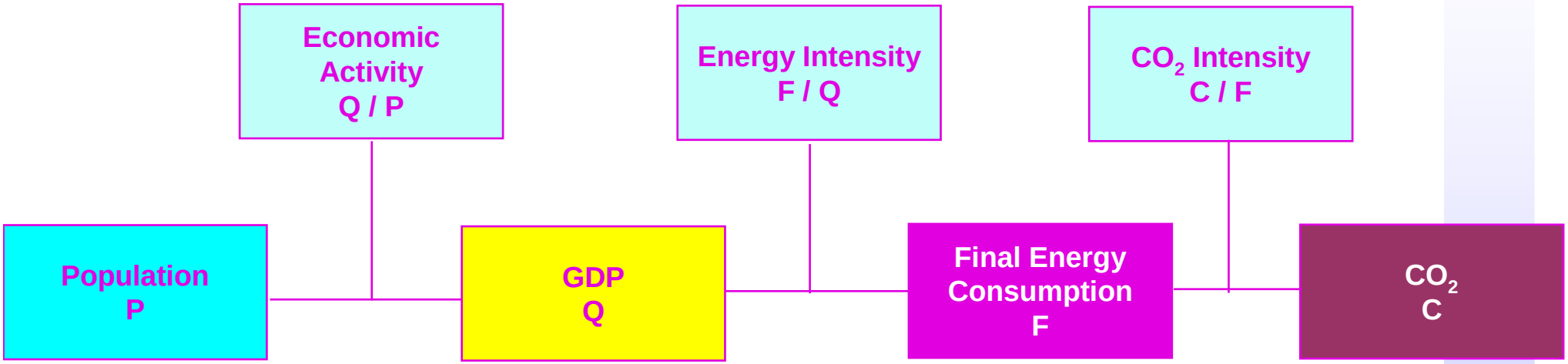


An example: Evaluating abatement efforts
Refurbishing buildings

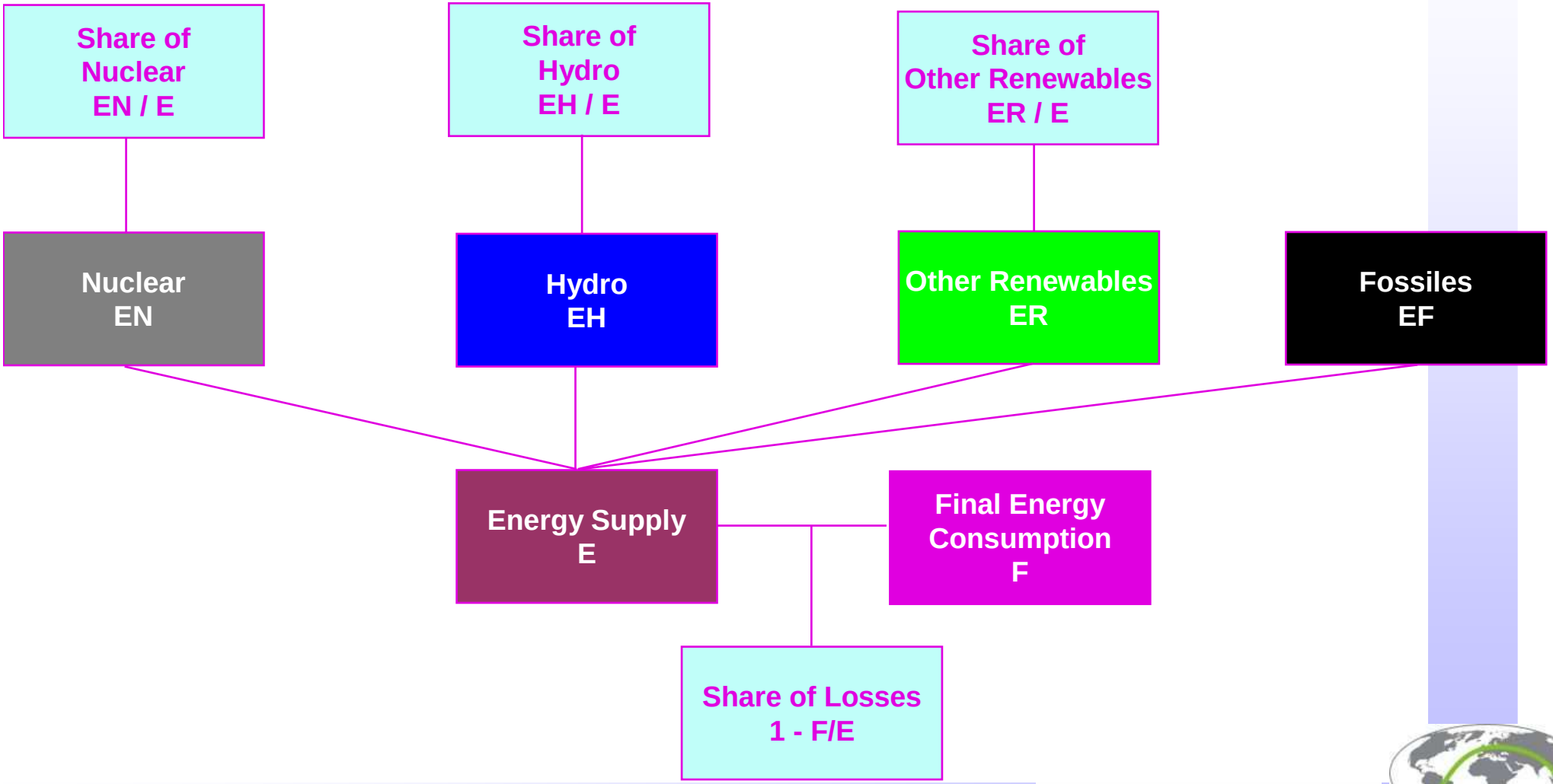
- **For each apartment**
  - **Investment costs of € 20.000**
  - **Reduction of energy by 60 percent**
- **Cost effects**
  - **User costs of capital of € 1.000 p.a.**
  - **Savings of energy costs much lower**

- **McKinsey Quarterly 07**
  - **Claims negative abatement costs of $ 60 for insulating buildings**

A structural model of the energy sector
Demand side



A structural model of the energy sector
Supply side



Simulating EU 2020 targets

EU Target Sharing 2020

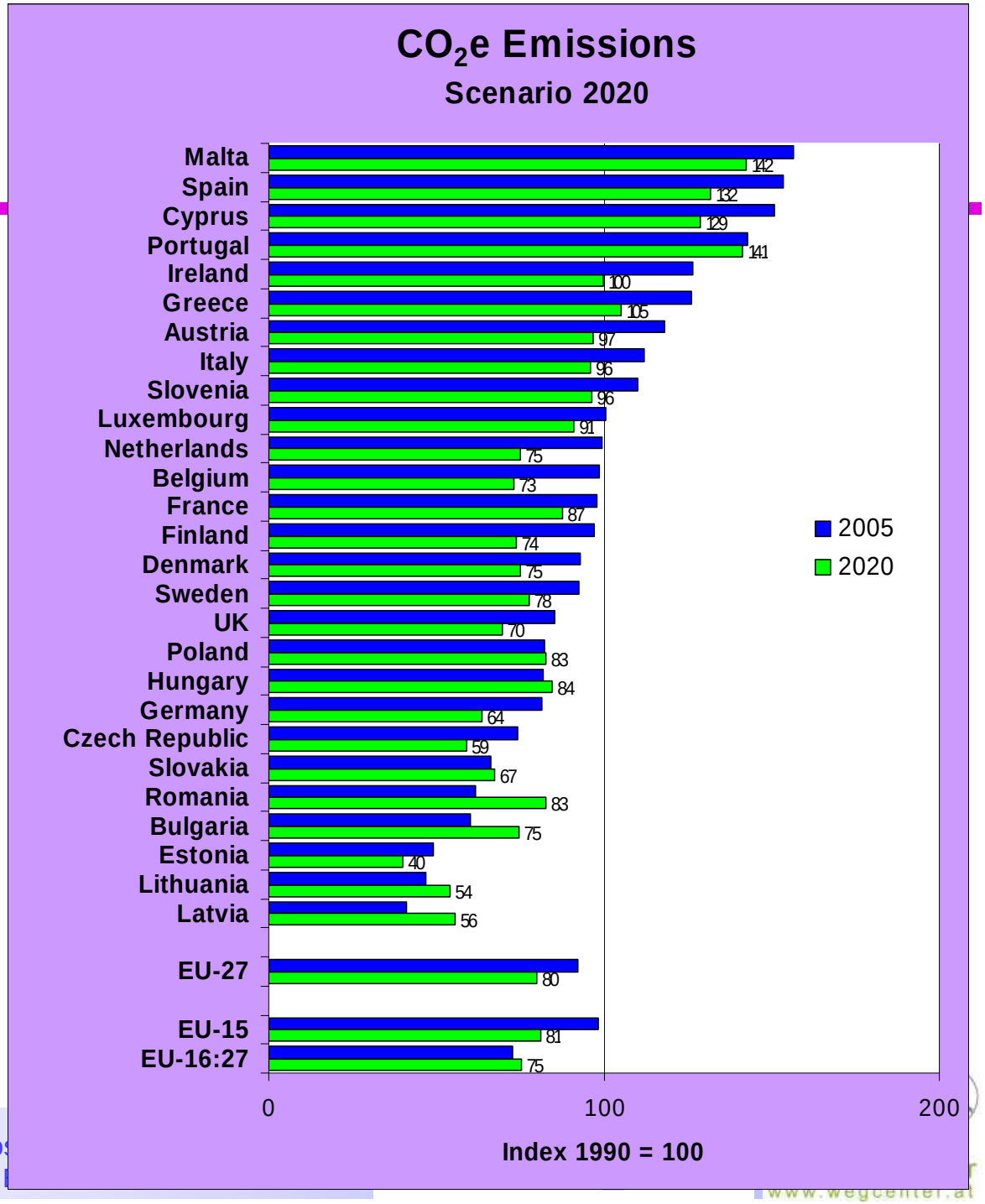
- **The ambitious EU Targets for 2020**
  - Minus 20 percent GHG emissions over 1990 - unilateral
  - Minus 30 percent GHG emissions over 1990 – multilateral
  - 20 percent increase of energy productivity – over BaU
  - 20 percent share of renewables
- **How to allocate these community targets to the Member States**
  - Target or effort sharing

Simulation of target sharing policies

- **Step 1: Specify Community targets**
  - **e.g. 20 percent share of renewables**
- **Step 2: Specify the extent of adjustment to this target**
  - **e.g. 50 percent of discrepancy to target**

CO_2e 2020

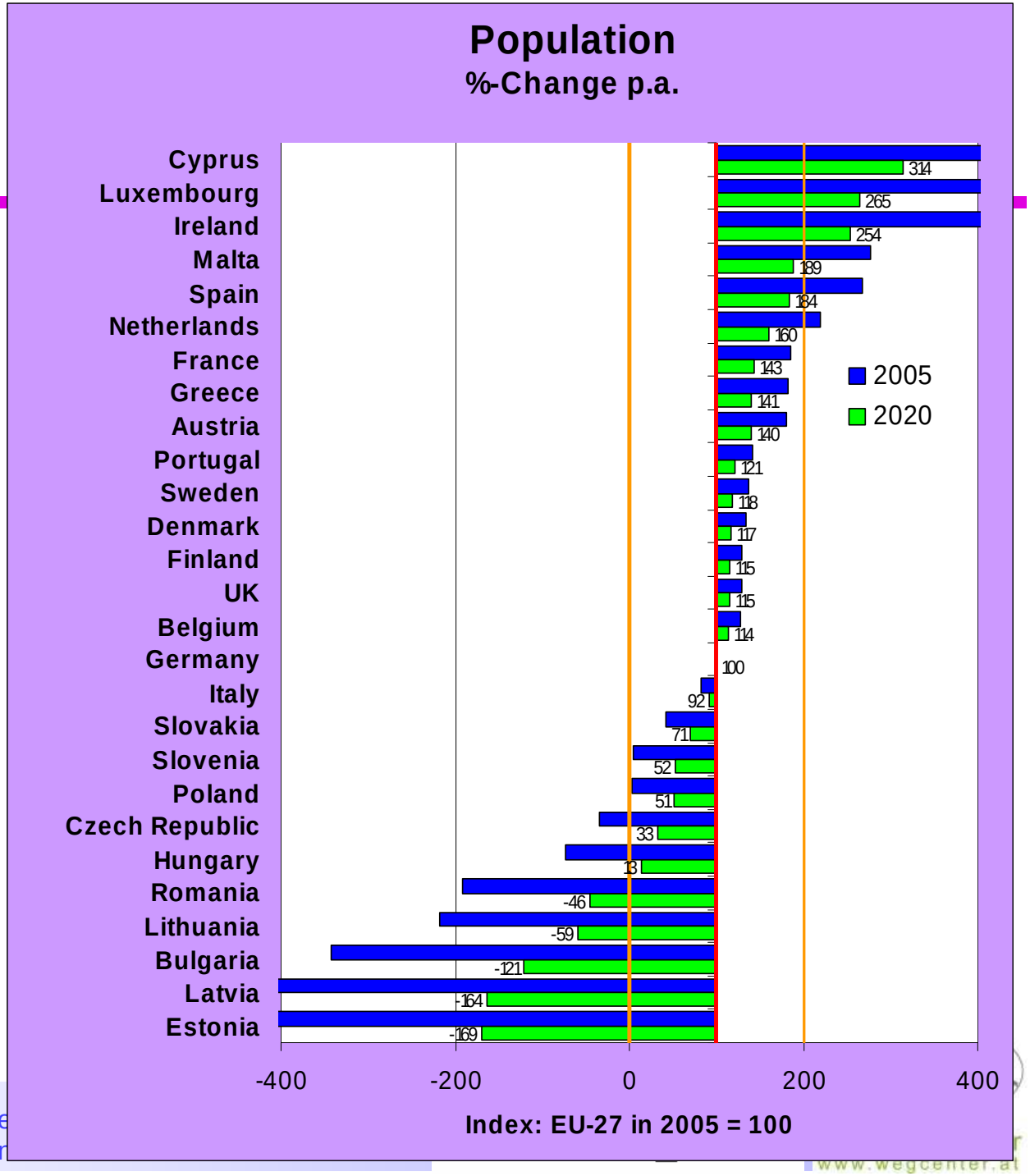
Reduction Scenario for 2020
-20 % CO_2e over 1990



Population

Scenario for 2020
-20 % CO_2e over 1990

Unchanged increase in EU-27 population 0,25 % p.a.



Economic activity

Scenario for 2020

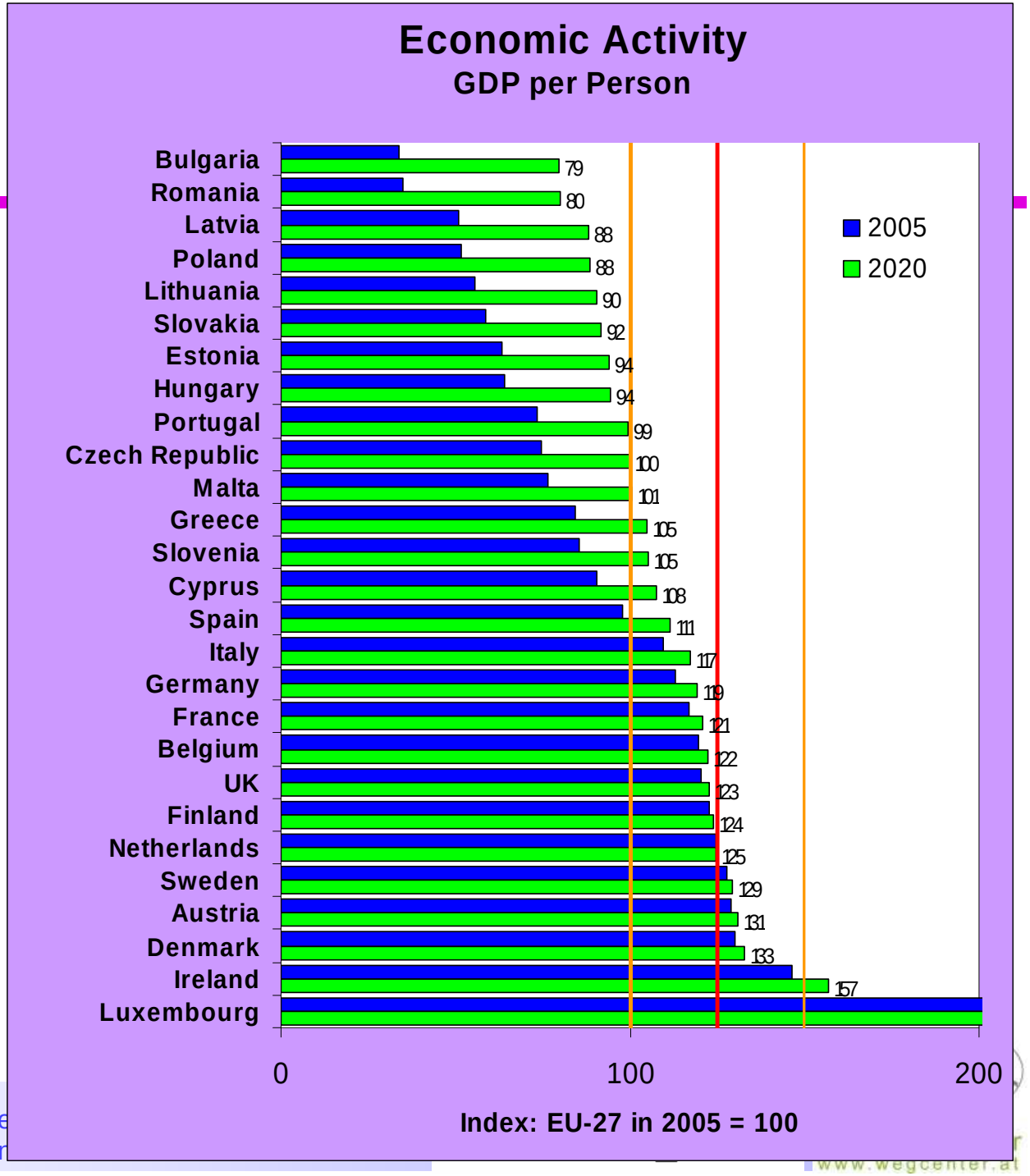
-20 % CO_2e over 1990

Target

+25 % real GDP ppp per capita

Convergence

50 %



Energy intensity

Scenario for 2020

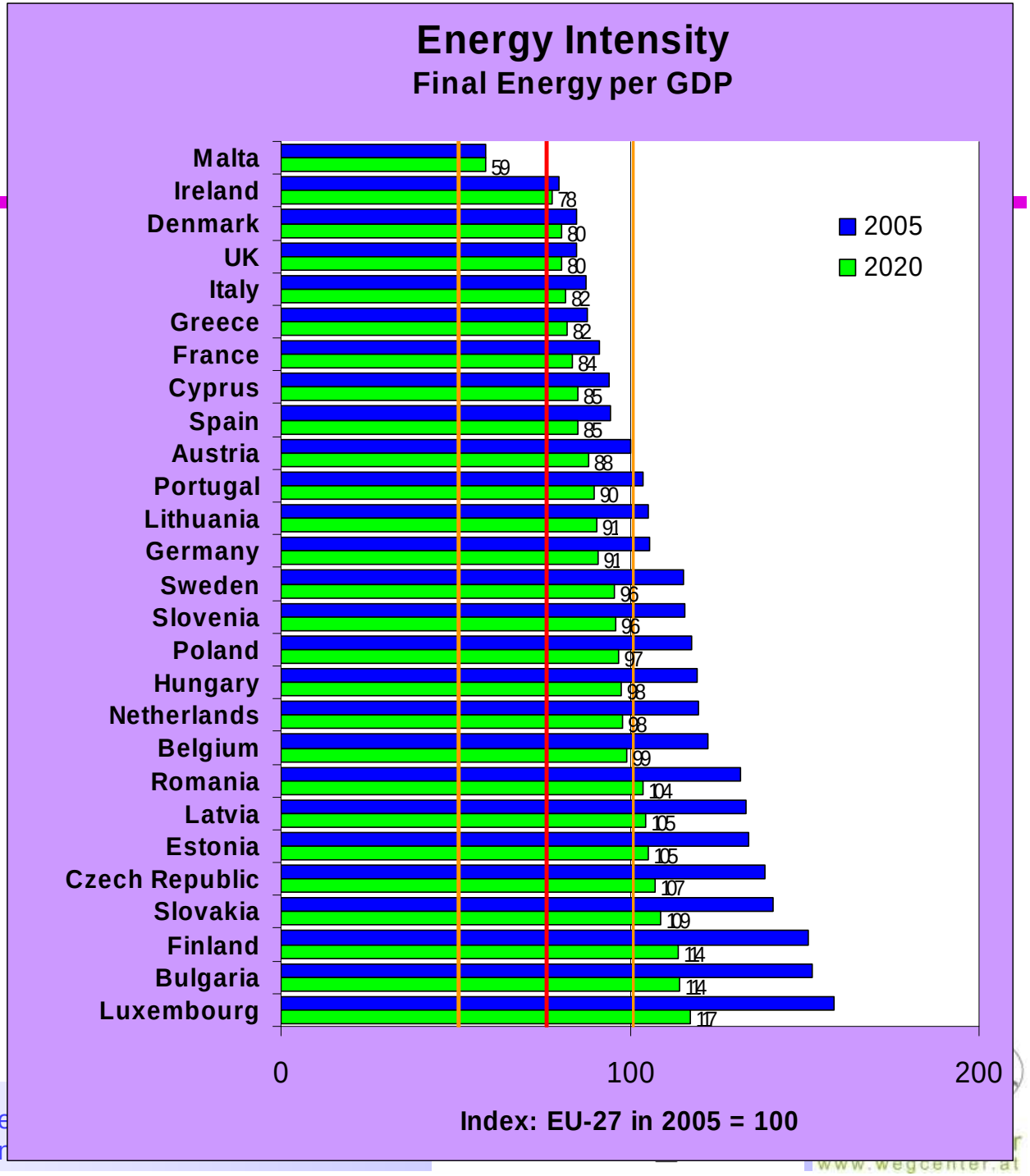
-20 % CO_2e over 1990

Target

-24 % FC energy per unit of real GDP ppp

Convergence

50 %

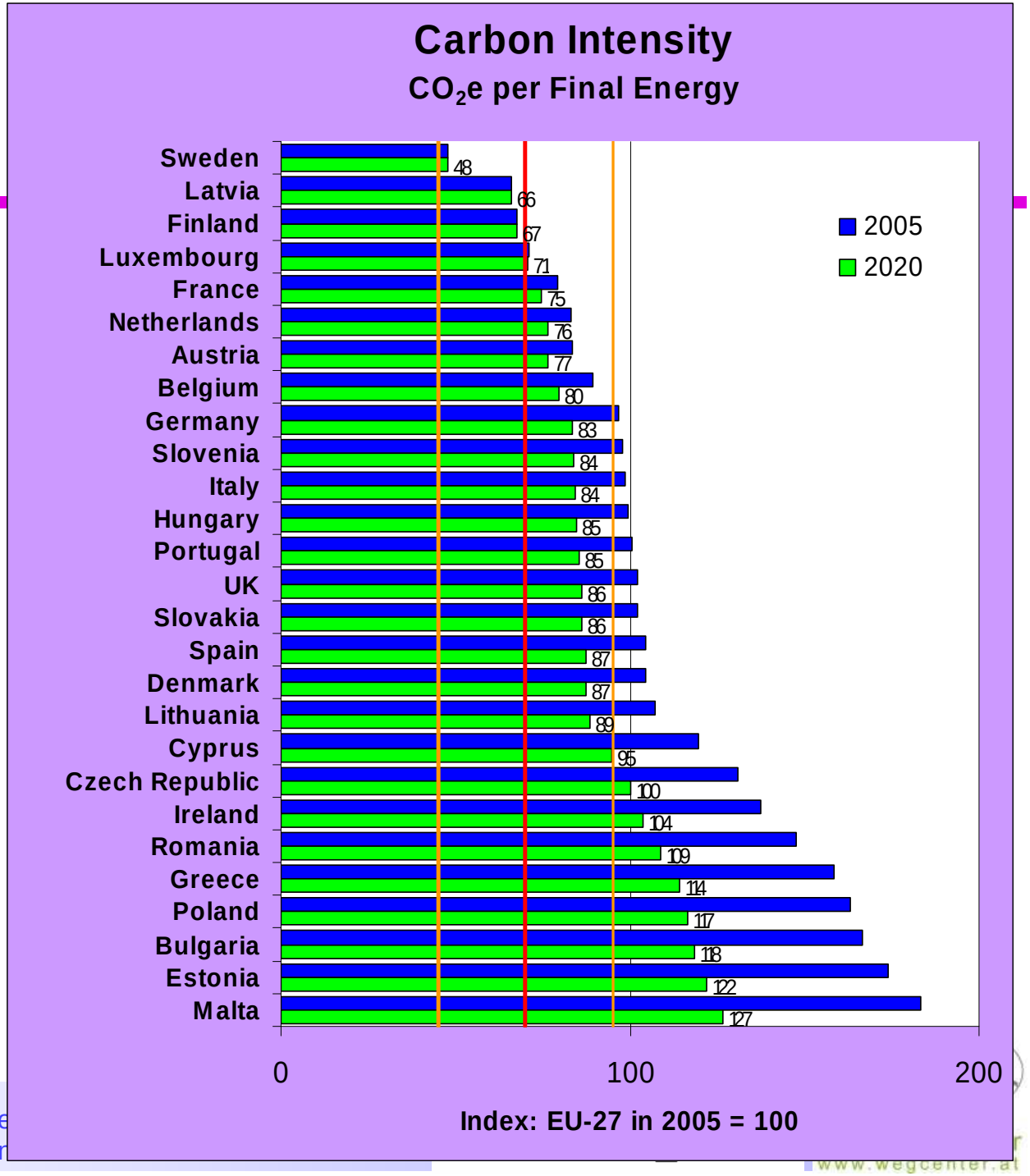


Carbon intensity

Scenario for 2020
-20 % CO_2e over 1990

Target
-30 % CO_2e
unit of FC energy

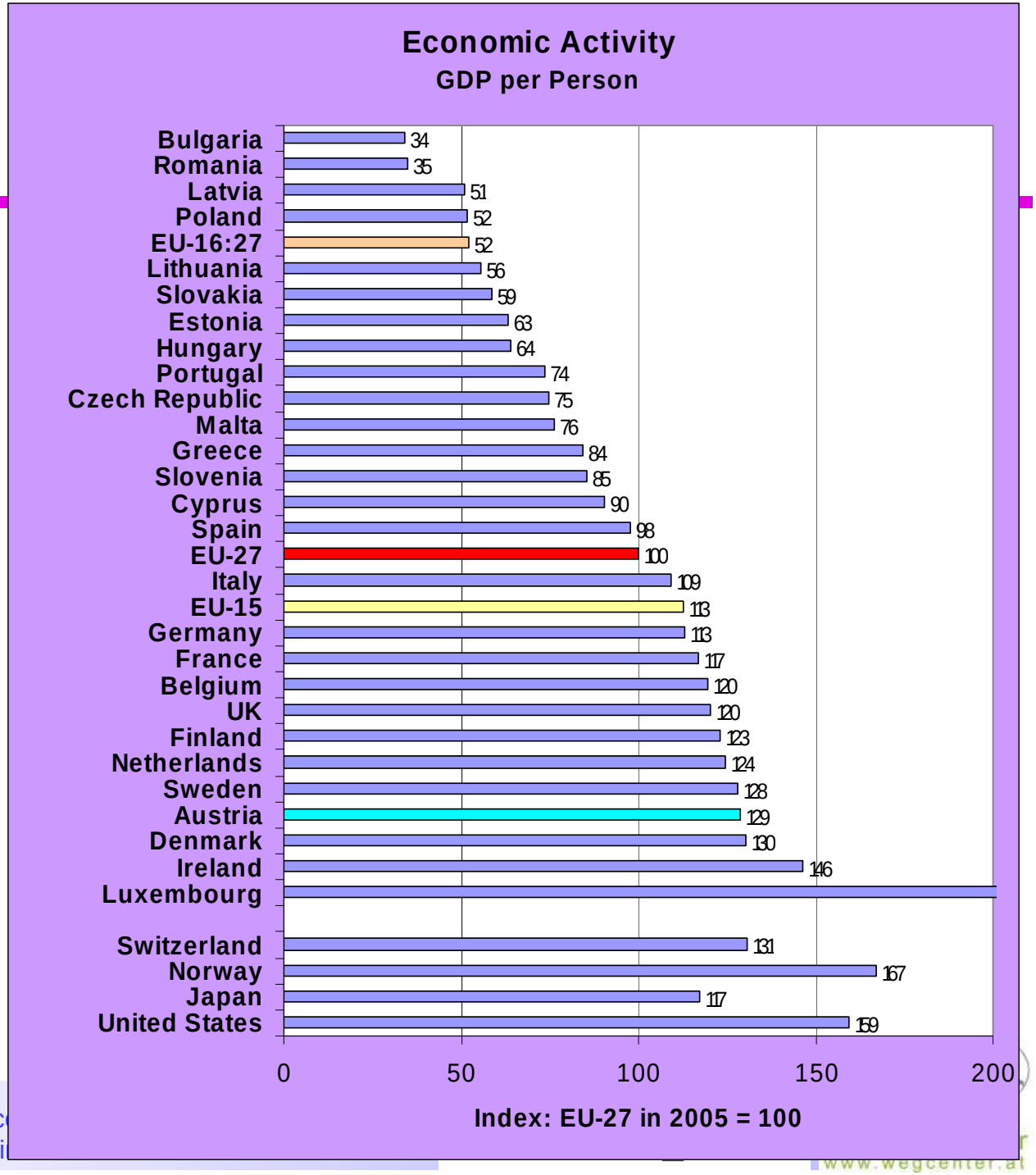
Convergence
50%



Structural Indicators

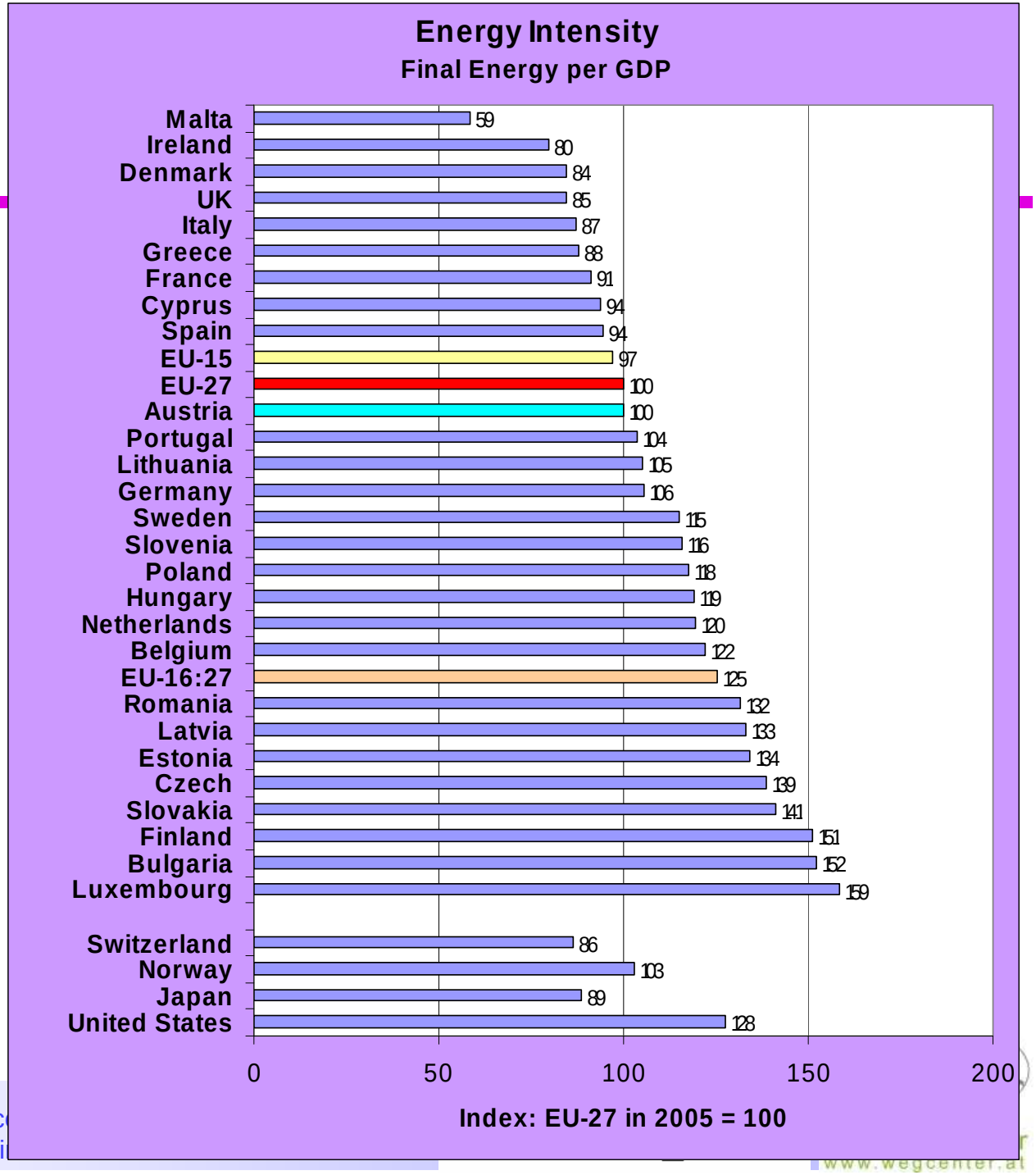
Structural indicator
Economic activity

GDP per Person



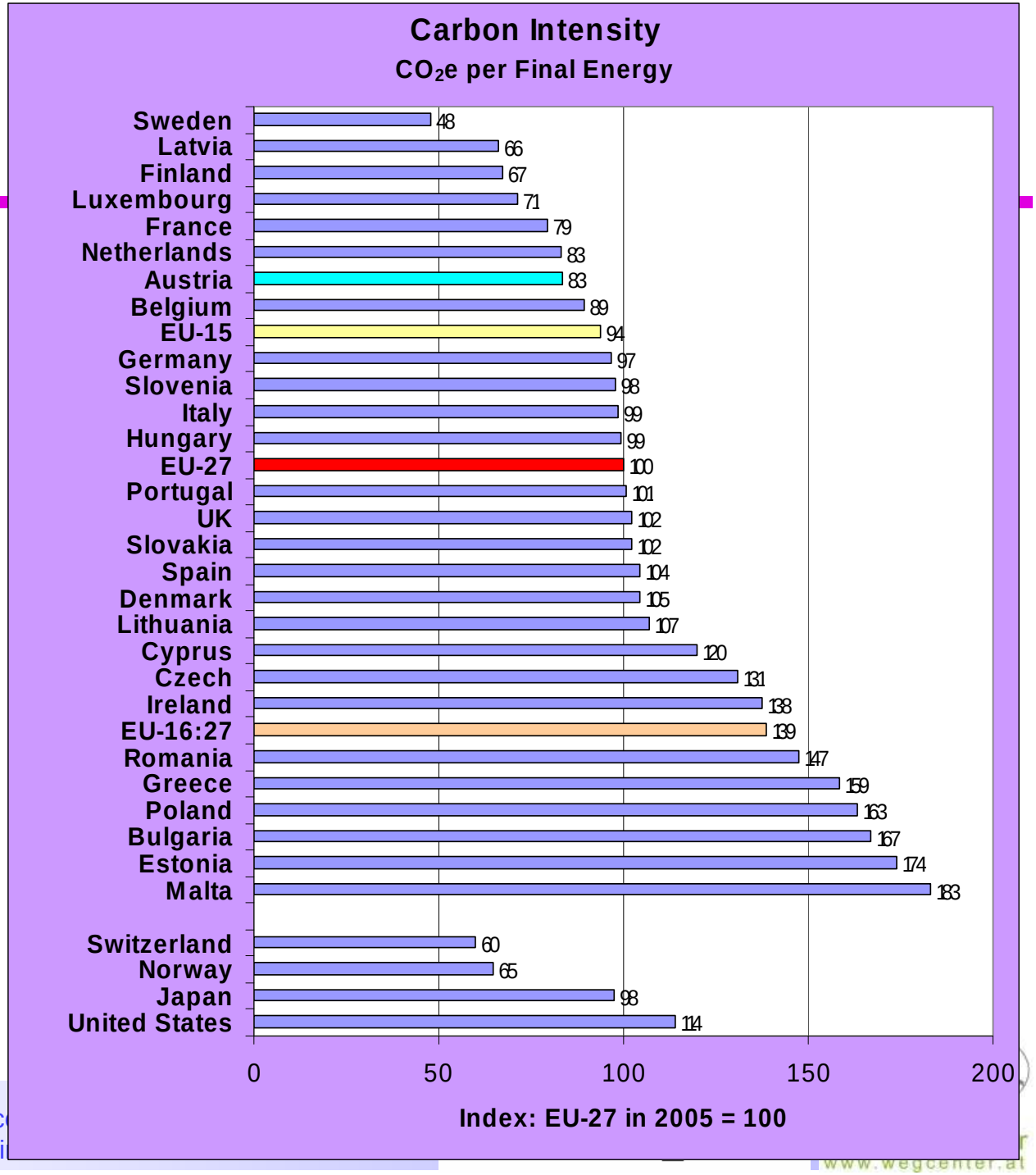
Structural indicator
Energy intensity

Final Energy per GDP



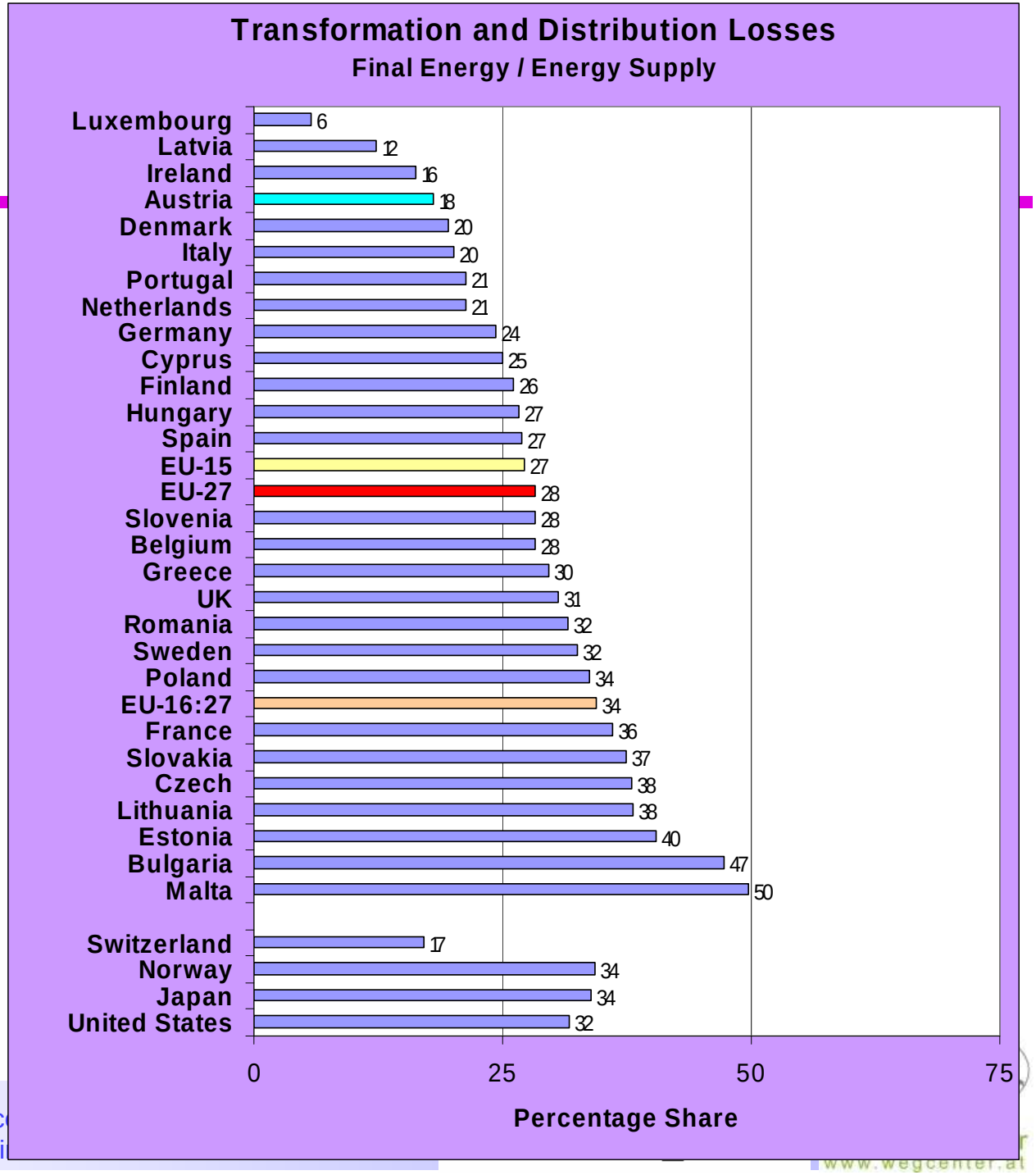
Structural indicator
Carbon intensity

CO2e per Final Energy



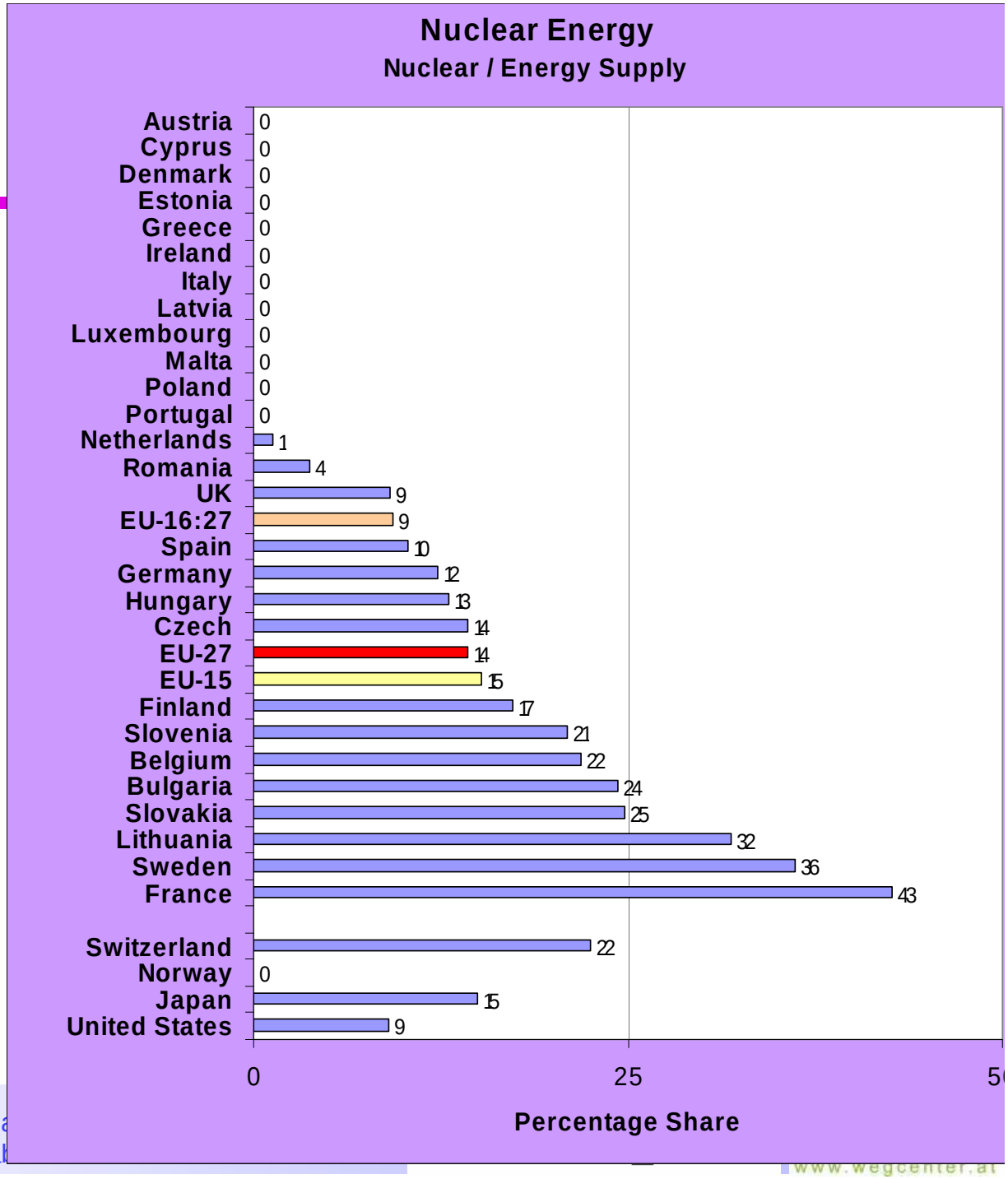
Structural indicator
Share of Losses

(Final Energy) /
(Energy Supply)
*** 100**



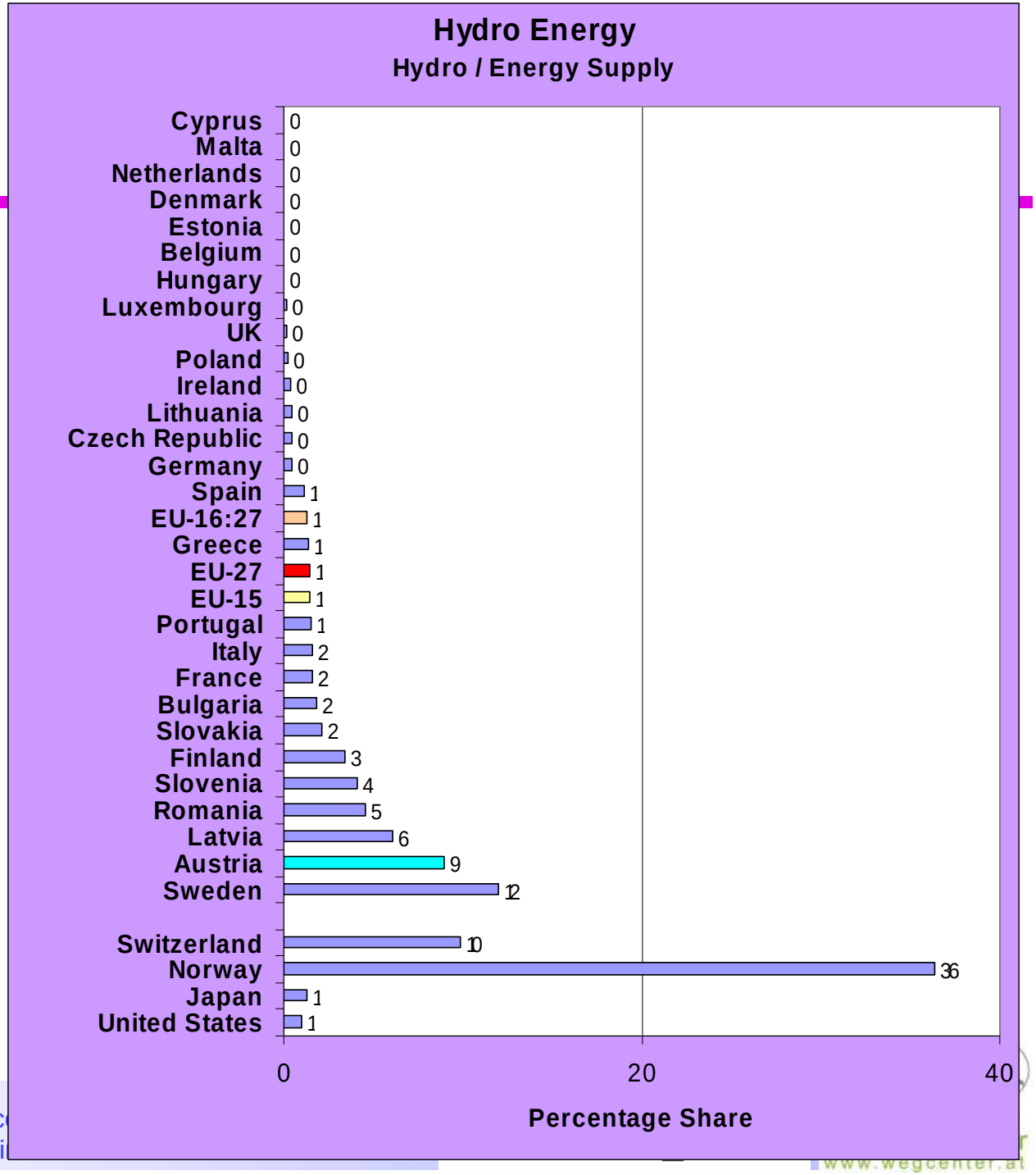
Structural indicator
Share of Nuclear

(Nuclear) /
(Energy Supply)
* 100



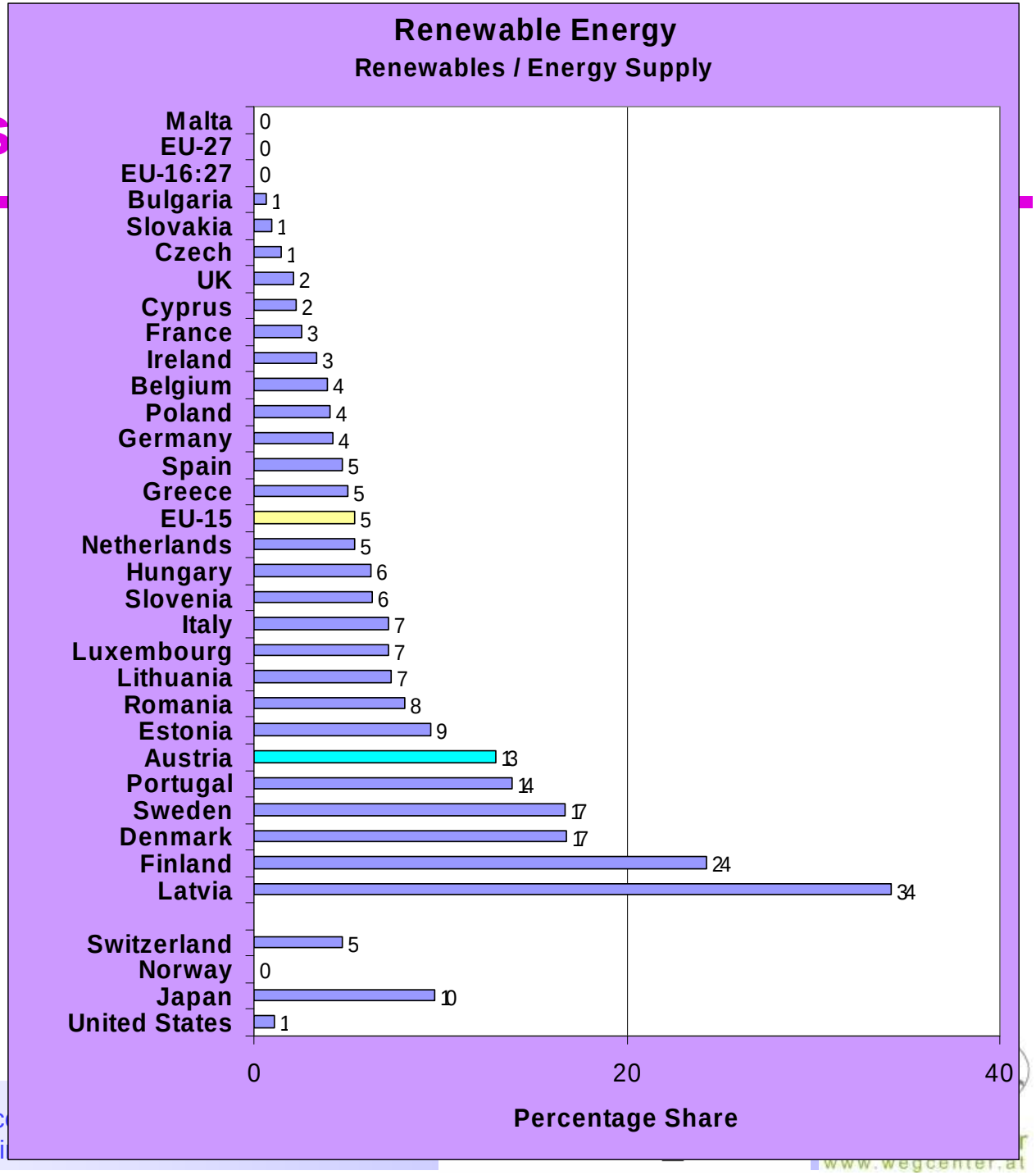
Structural indicator
Share of Hydro

(Hydro) /
(Energy Supply)
* 100



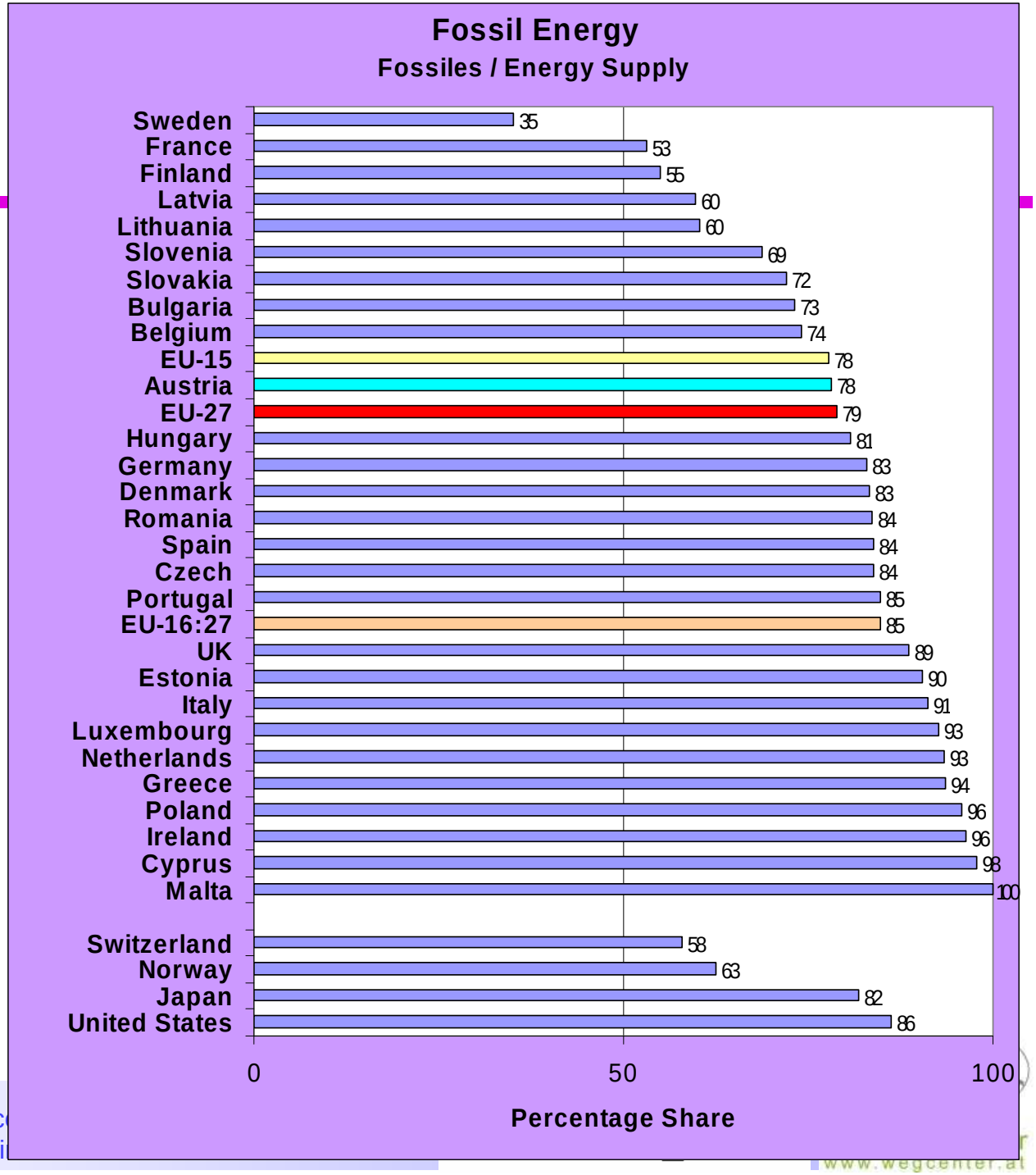
Structural indicator
Share of Renewables

(Renewables) /
(Energy Supply)
* 100



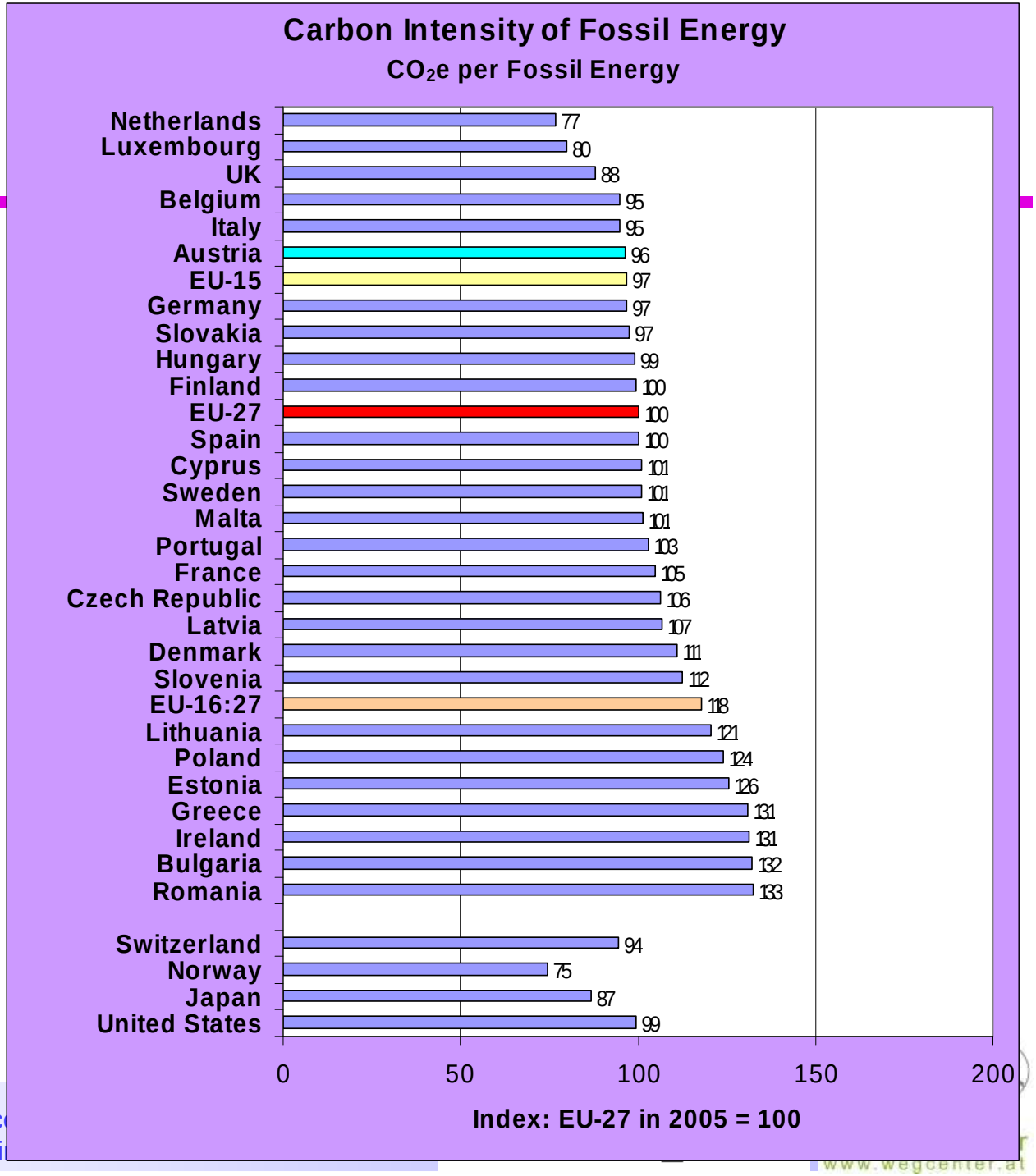
Residual
Share of Fossils

(Fossils) /
(Energy Supply)
* 100



Structural indicator
Carb. Intens. Fossils

(CO2) / (Fossils)



Conclusions

- **EU 2020 targets require a fundamental change of the structure of the energy systems of the Member States**

- **The key parameters**
  - **Economic activity**
  - **Application technologies**
  - **Transformation technologies**
  - **Renewables**

Thank you.