EUSUSTEL

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Workpackage 2

Anticipation of future energy demand

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How to forecast energy demand

There are essentially three ways to make predictions about the future demand for energy (and for electricity in particular):

1. The extrapolation of present trends with some provision for the possibility of major changes
2. A top-down approach, which considers an exogenous forecast of economic development, assumes an overall energy intensity of GDP (variable with time), and a "reasonable" curve of electricity penetration with time
3. A bottom-up approach, which again assumes some exogenous variables like GDP, population and international fuel prices, and starts from the evolution of the demand for energy <u>services</u>, applying predicted technology evolution that gradually improves energy efficiency.

A combination of top-down and bottom-up approaches

The extrapolation approach, while generally very useful for short to medium term predictions, fails to predict any non-linear trend and becomes utterly unreliable for long period of times (like the 25+ years we are considering here). Therefore it will not be taken into consideration here.

Both the top-down and the bottom-up approaches have their merits and their limitations.

The approach that is suggested here is to use both methods, compare the results and try to sort out the reasons for possible discrepancies.

The top-down approach

- The curve connecting the energy intensity of GDP with the per capita GDP has been extensively studied for various countries, sectors and periods. The EU is certainly well into the descending part of the curve, and it can reasonably be predicted that the trend will continue in the future.
- Some caution must be applied to the case of the new-comers into the EU, especially those that used to belong to the Centrally Planned Economies. In that case, the far from optimum energy efficiency that prevailed in the past, and the economic crisis that has accompanied the transition to a market economy, will require a specific treatment for which expertise from those countries should be exploited.

Demand elasticity

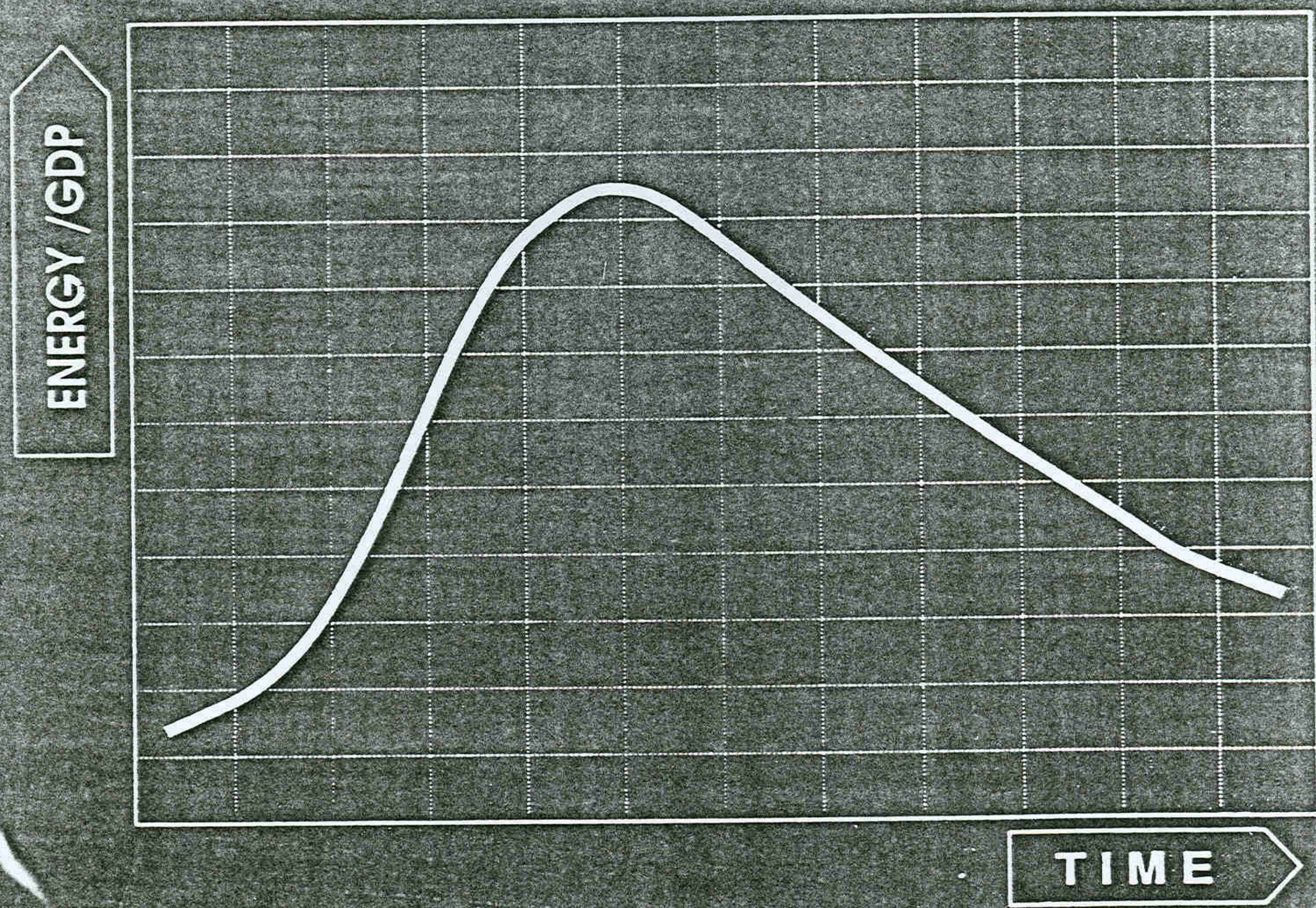
- The demand for energy will be affected to some degree by the prices of energy. This can be taken into account at the macro level by introducing an elasticity of demand to price.
- A single value for the elasticity of (electricity) demand is probably too rough an approximation. It is suggested to take three different values for:
- The industrial sector
- The household sector
- The commercial and service sector

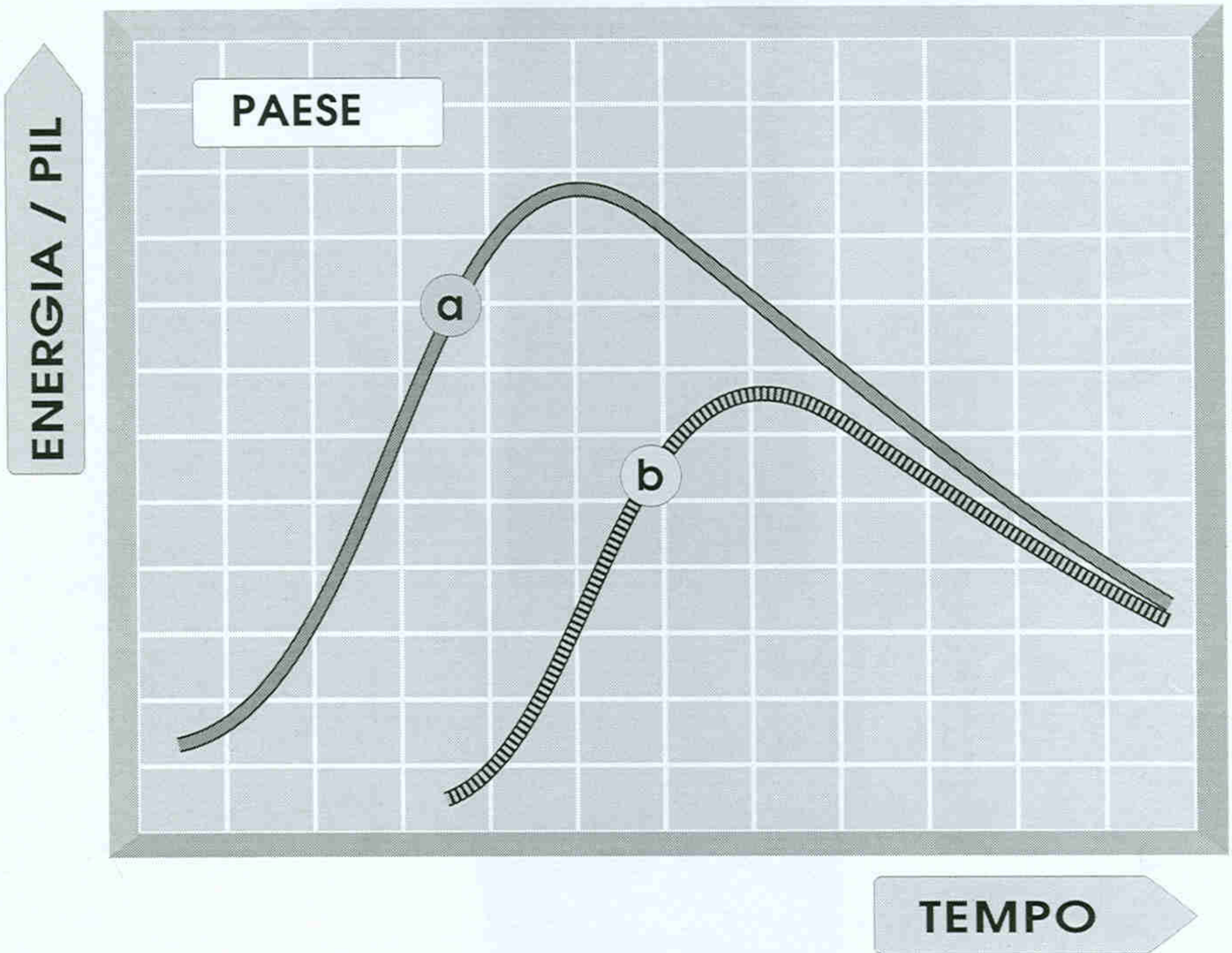
(typical values may be 0.3, 0.15 and 0.4 respectively)

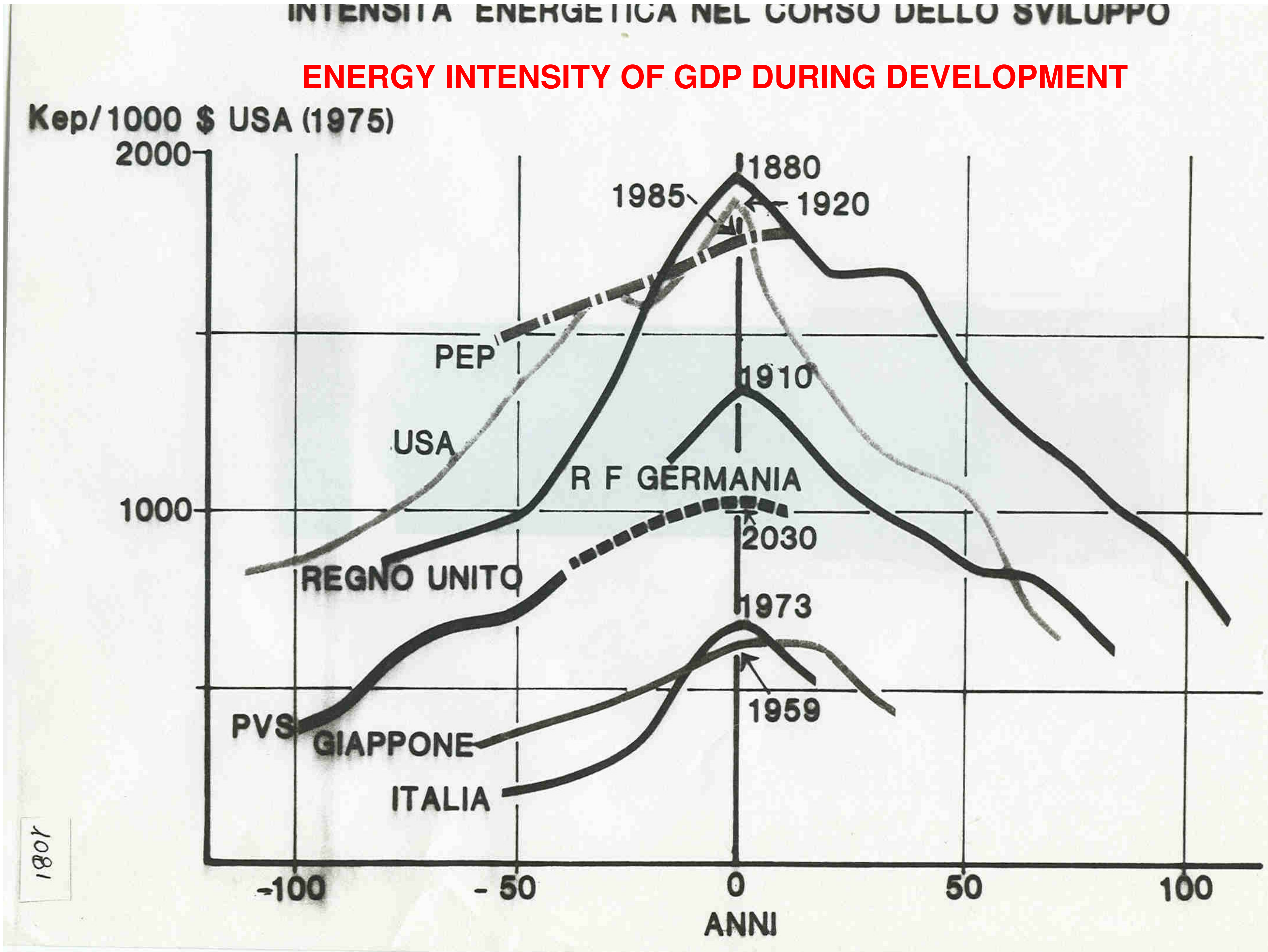
(the transport sector does not seem to be relevant for electricity demand, unless one makes very optimistic assumptions on battery cars)

OF GDP THROUGHOUT THE ECONOMIC
DEVELOPMENT OF A COUNTRY

ENERGY INTENSITY OF GDP THROUGHOUT THE ECONOMIC DEVELOPMENT OF A COUNTRY




ENERGIA / PIL
PAESE
a
b
TEMPO


INTENSITA' ENERGETICA NEL CORSO DELLO SVILUPPO
ENERGY INTENSITY OF GDP DURING DEVELOPMENT
Kep/1000 $ USA (1975)
2000
1000
1880
1985
1920
PEP
1910
USA
R F GERMANIA
2030
REGNO UNITO
1973
1959
PVS
GIAPPONE
ITALIA
-100
- 50
0
50
100
ANNI
1801

The bottom-up approach

- The bottom-up approach starts with the break-down of the energy demand into sectors, and for each sector into specific energy services (e.g. for the domestic sector the energy services required will include space heating and cooling, lighting, cooking, food refrigeration and freezing, dish and laundry washing, entertainment etc.)
- The demand for each service can be linked to an exogenous driver: population; GDP per capita; age distribution; family size etc.
- The first step is therefore the identification of these drivers, their links with demand for specific energy services, their evolution with time.
- Once one has the projection of the demand for energy services, one can look into the best way (from the point of view of the market) to satisfy this demand: by which energy carrier and by which end-use technology (either already on the market or supposed to come to the market as time goes by)

Representing the electricity demand

- The total demand for electricity can be represented by the following function:
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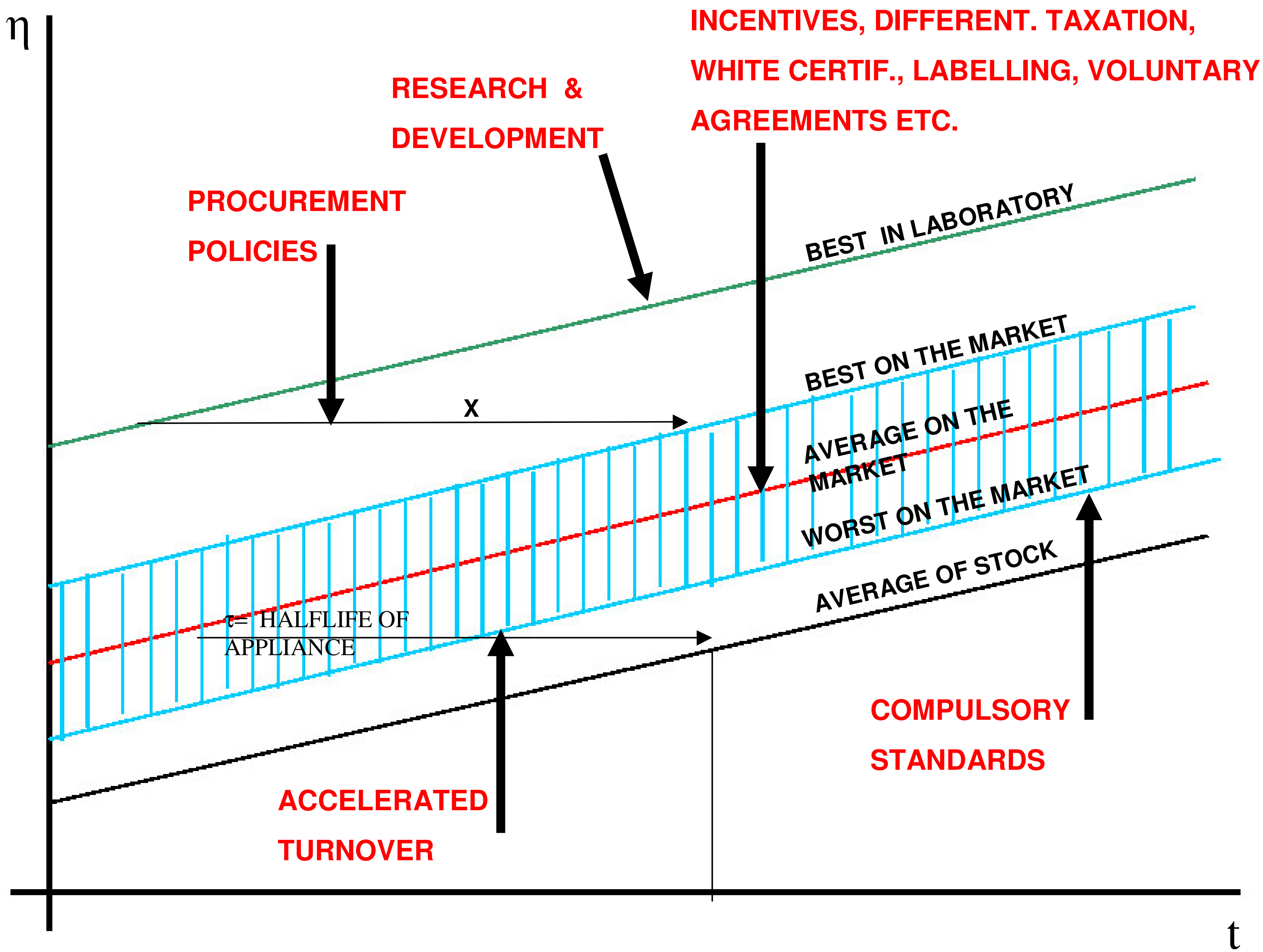
- $\mathbf{D = \Sigma\, d_{serv.} * f_{behav} * \eta_{ave.stock}}$

where the sum is extended over all energy services, $\mathbf{d_{serv.}}$ is the demand for the final service required (eg m^3 of space to be heated, kg of cloths to wash etc.); $\mathbf{f_{behav}}$ is a factor representing the behaviour of the final user, which can be more or less waste-oriented (lights on when no one is present, overheating of buildings etc.); $\mathbf{\eta_{ave.stock}}$ represents the average efficiency of the stock of plants or appliances supplying each service (how many kWh needed on average for washing 1 kg of laundry etc.)

Energy efficiency policies

Of course energy demand should not be taken as an exogenous variable: energy policies can act on the demand for energy even without reducing the demand for energy services by:

1. Reducing the behavioural coefficient (i. e. reducing wastes) by means of information campaigns, diffusion of automatic controls like thermostats or time switches etc)
2. Increasing the average efficiency of supplying each energy service, by encouraging the diffusion of more efficient equipment and technology, by developing and bringing more rapidly to the market new efficient technology, by encouraging the replacement of obsolete, energy-wasting appliances etc.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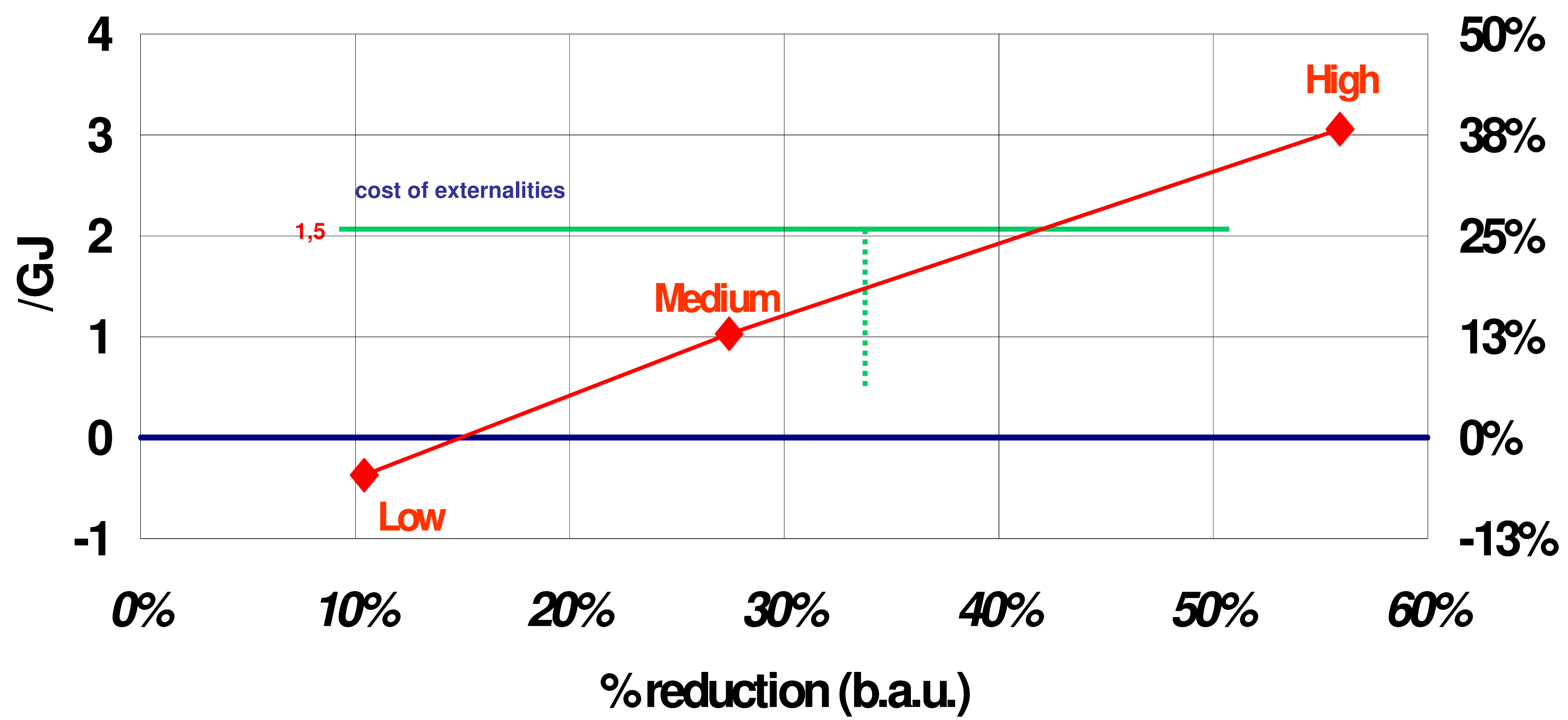
INCENTIVES, DIFFERENT. TAXATION,
WHITE CERTIF., LABELLING, VOLUNTARY
AGREEMENTS ETC.
RESEARCH &
DEVELOPMENT
PROCUREMENT
POLICIES
BEST IN LABORATORY
BEST ON THE MARKET
X
AVERAGE ON THE MARKET
WORST ON THE MARKET
AVERAGE OF STOCK
τ= HALFLIFE OF APPLIANCE
COMPULSORY
STANDARDS
ACCELERATED
TURNOVER
t

WEU Markal model - White Certificates Scenarios
Residential and Commercial Sector

Trade-off curve:
total (R&C) final energy saved in 2020 (% of b.a.u. scenario) vs. average energy system cost increase (/GJ and %) in 2020



The “rebound” effect

The result of an energy efficiency policy may be lower than expected because of the “rebound effect”: more energy efficiency brings to less cost for the energy service, leading to more demand for services and thus less energy saved.

Actually, the rebound effect may come from 2 sources:

1. Direct: since the cost for a given service is lower, the demand for that service will increase (elasticity)
2. Indirect: the lower cost frees up some money which is spent for something else, which will have some energy demand implication.

The direct effect may reduce the expected savings by a maximum of 40%, but many services are rather inelastic (e.g. “white goods”, or home appliances). 20% seems a reasonable assumption on the average. The indirect effect is more difficult to evaluate, but it is unlikely to be higher than 10%

A MARKAL-MACRO calculation for Italy has shown a 27% total rebound effect for a specific case.