Europese Commissie

Methodology development for Comprehensive Assessment

Mindaugas Jakubcionis

Johan Carlsson

www.jrc.ec.europa.eu

Serving society
Stimulating innovation
Supporting legislation

Joint Research Centre

Scope

Europese Commissie

- Comprehensive Assessment (CA) according Art 14(3) of EED should establish the most cost-effective and beneficial heating and cooling option for a given geographical area for the purpose of heat planning using a Cost Benefit Analysis (CBA).

- It should be performed by all MS by the 31st Dec 2015.

- JRC is developing technical background studies on possible best practices for the Commission to support implementation

- The Commission will consult Member States and stakeholders on the technical background studies

Contents

Europese Commissie

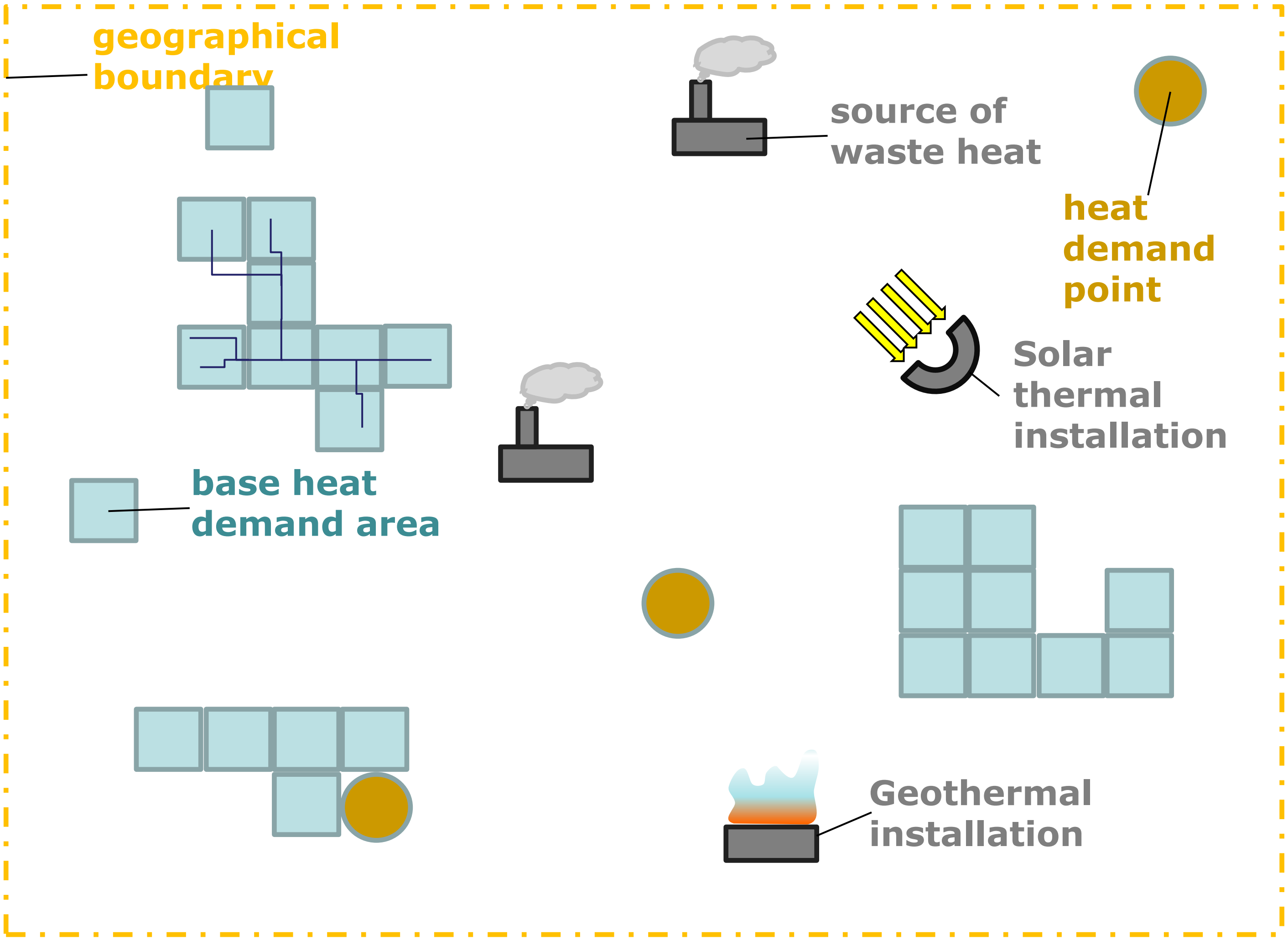
1. Data collection on heating and cooling demand.
2. Data collection on climatic conditions.
3. Forecast of heating and cooling demand.
4. Collection of data on energy generation installations and energy supply sources
5. Collection of data on district heating and cooling infrastructure.
6. Creating heat demand areas.
7. **Preparation of heat maps.**
8. **Setting of system boundaries.**
9. Setting the baseline scenario.
10. Setting alternative scenarios.
11. **Inventory of effects.**
12. **Valuation of economic costs/benefits.**
13. **Valuation of environmental costs/benefits.**
14. **Net present value calculations.**

Data collection

Data to be collected on:

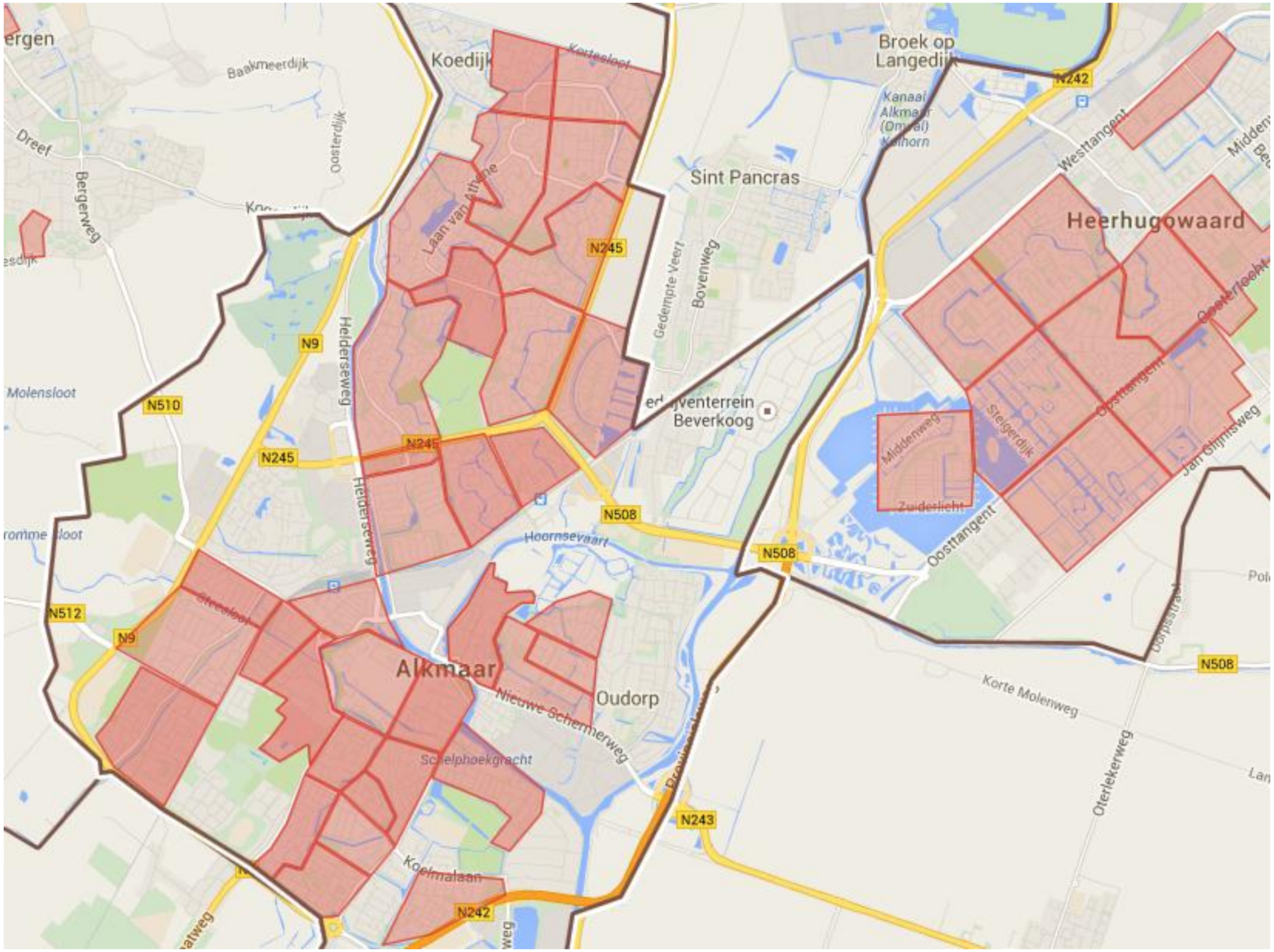
1. Energy consumption, represented by areas (residential and service sector) and points (industrial zones).
2. Energy supply and distribution pipelines and other infrastructure.
3. Energy generation, including:
   a) electricity generators;
   b) waste incinerators;
   c) CHP (both existing and planned);
   d) district heating installations;
   e) renewables.

Making a heat map



Base heat demand areas

Europese Commissie

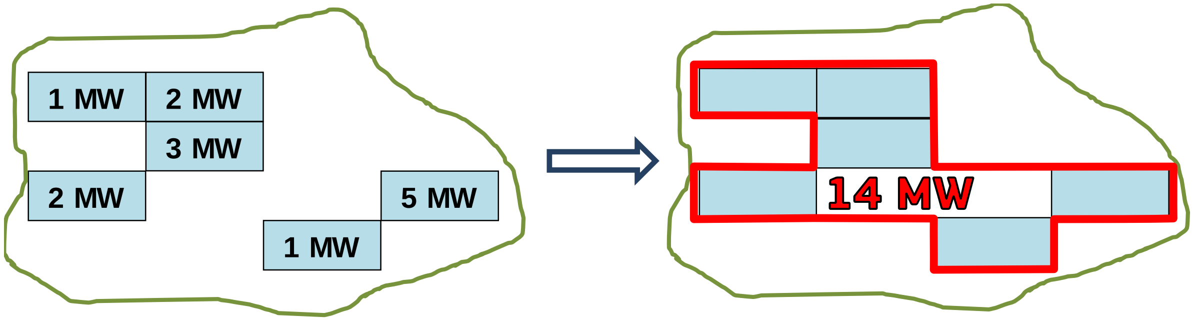


Joint Research Centre

Creating greater heat demand areas

Europese Commissie

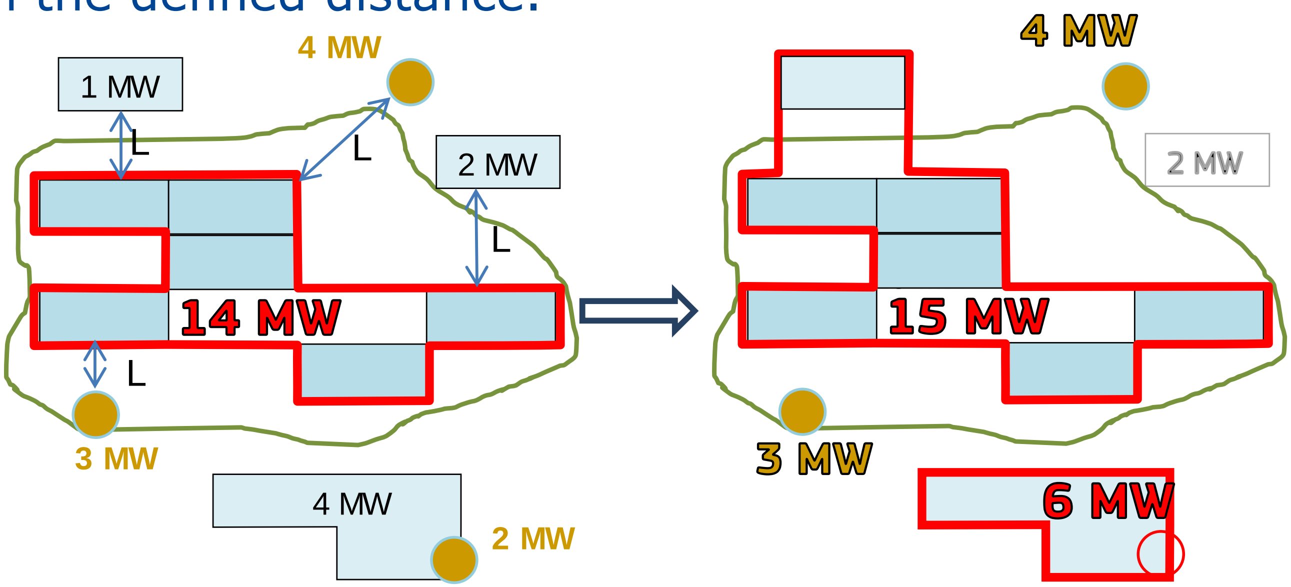
- Combine previously identified *base heat demand areas* into larger units - *greater heat demand areas*.



- A greater heat demand area may consist of one or more base heat demand areas.
- The limits for this step might coincide with the administrative boundaries of a city or other settlement. Very large cities can be divided into districts or parts.
- All previously identified base heat demand areas inside these limits would be treated as a part of single greater energy demand area.

Creating greater heat demand areas

- Adjoining base heat demand areas (for instance suburbs) can be added to some greater heat demand areas if they are too small to be evaluated as separate heat demand areas and if they are within the defined distance.

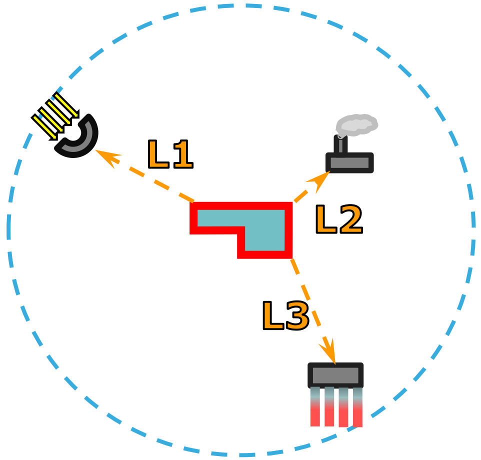


- Industrial zones (point consumers) can also be added to greater heat demand area if they are within the defined distance and if they require similar heat temperatures as residential consumers.

Threshold distance

Europese Commissie

- Now the process of linking demand areas/points with potential sources of waste or renewable heat can be started, thus setting system boundaries.
- The first step is to set a technical threshold distance from heat demand areas/points, within which potential sources of waste or renewable heat will be identified. It would primarily depend on amount heat supplied, price of heat, capacity factor of heat line, climatic conditions and discount rate.
- After deciding on the threshold distance, all possible links of heat demand areas/points and waste heat and renewable heat should be identified.

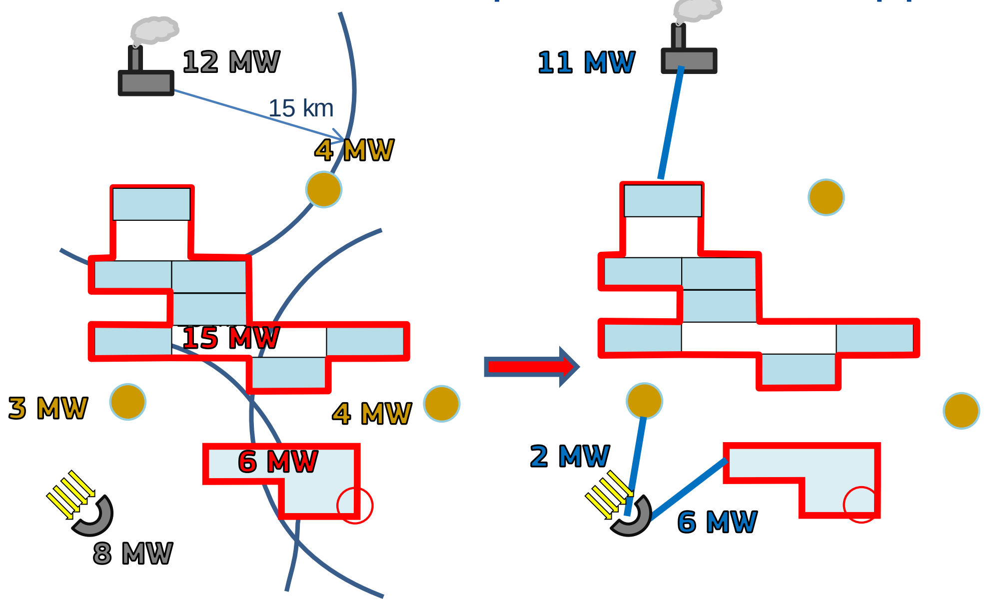


Heat linking process

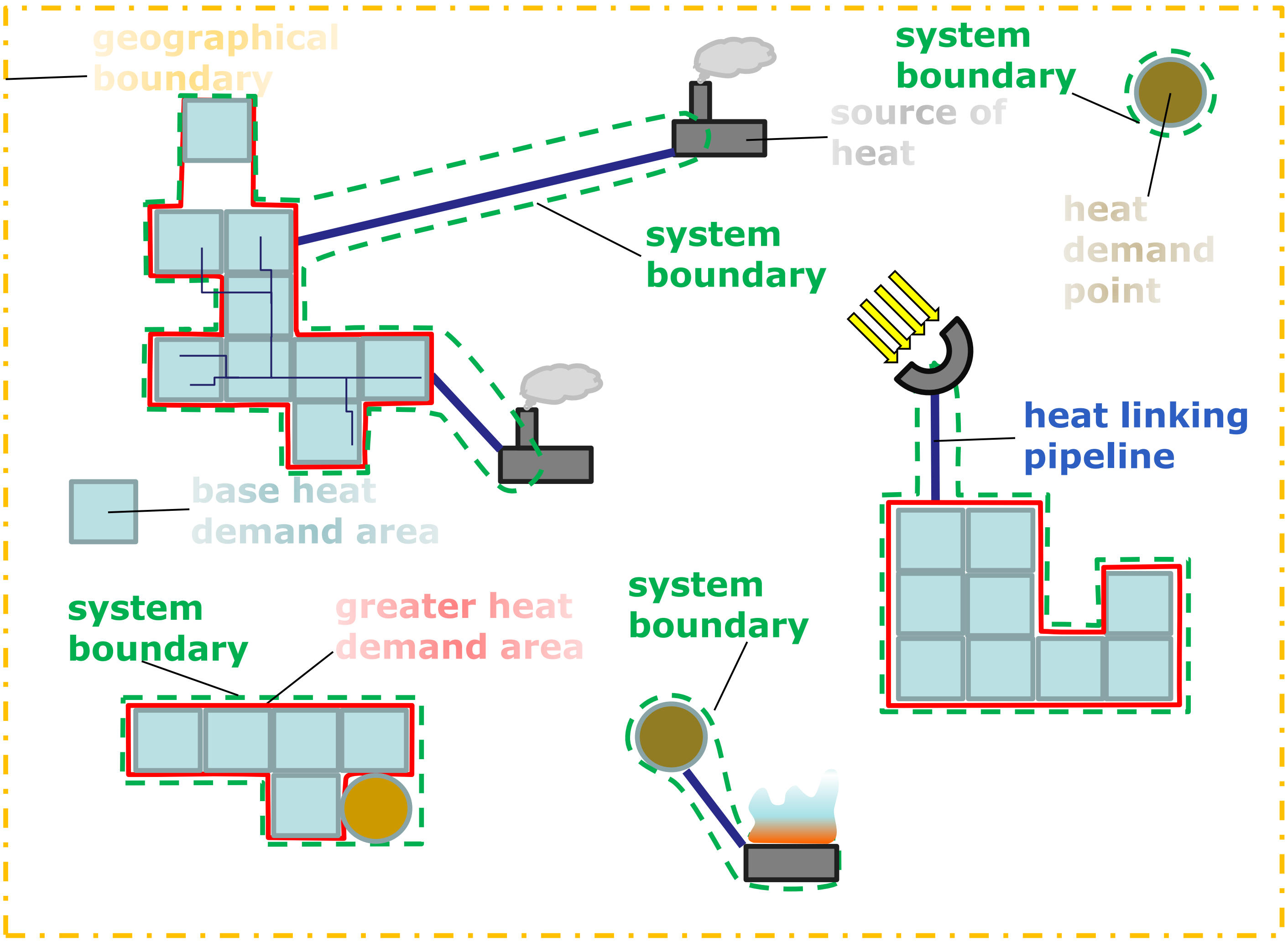
- Linking of heat consumers and suppliers can be accomplished using following empirical equation:

$$\mathbf{k} = P_D / \left(\mathrm{L} \cdot \sqrt{P_D / P_S} \right)$$

- P_S – heat, which can be supplied by particular supplier, MW;
- P_D – heat demand of particular consumption area/point, MW;
- L – distance from demand area/point to heat supplier, m.



Setting of system boundaries



Contents

Europese Commissie

1. Data collection on heating and cooling demand.
2. Data collection on climatic conditions.
3. Forecast of heating and cooling demand.
4. Collection of data on energy generation installations and energy supply sources
5. Collection of data on district heating and cooling infrastructure.
6. Creating heat demand areas.
7. **Preparation of heat maps.**
8. **Setting of system boundaries.**
9. Setting the baseline scenario.
10. Setting alternative scenarios.
11. **Inventory of effects.**
12. **Valuation of economic costs/benefits.**
13. **Valuation of environmental costs/benefits.**
14. **Net present value calculations.**

Cost benefit analysis (CBA)

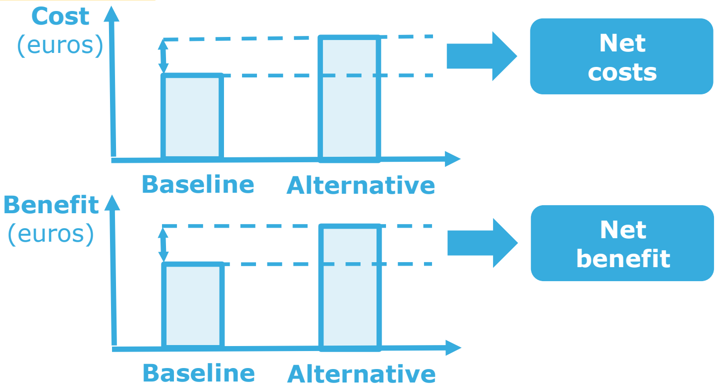
Europese Commissie

- **CBA** is an analytical tool for **appraising investment decisions** by assessing **welfare changes** attributable to them.
- Conducting a CBA implies assessing the **changes in costs and benefits between baseline and alternative scenario:**

$$Cost_t = [Cost_t]_{Altern.} - [Cost_t]_{Basel}$$

$$Benef_t = [Benef_t]_{Altern.} - [Benef_t]_{Basel}$$

Examples



- Costs and benefits that remain constant in both scenarios *do not have to be accounted* because when assessing its change, they become null. This is the case of the **heat production**: its value is not accounted in the CBA as a *benefit* because its value is the same in both scenarios.
- **Time horizon** should represent the lifetime of the longest living asset.

Financial & economic analysis

Europese Commissie

- The CSWD of EDD sets out that MSs must ensure that the country level CBA has both an **economic and financial analysis** included.
- The **financial analysis** tackles the analysis **from an investor's perspective** using the conventional discounted cash flow approach.
- The **economic analysis** tackles the analysis from the **point of view of the society.** Changes in welfare of the society has to be assessed.
- Once the financial analysis has been done, some adjustments have to be introduced in the analysis to reflect a social perspective.

Financial analysis: inventory of effects

Europese Commissie

COSTS

- **Capital cost of heating/cooling**
  - ✓ Resources devoted to assets acquisition
  - ✓ Take place when adding additional capacity
  - ✓ Data: technical modules, Annexes A-H
- **O&M costs** (excluding fuel)
  - ✓ Associated to the consumption of materials; maintenance; administration; labour, etc.
- **Fuel and electricity costs**
  - ✓ Forecasts of energy prices are required
  - ✓ Data can be find in '*EU Energy, transport and GHG emissions trends to 2050*'
- **CO_2 costs**
  - ✓ For units that fall under the ETS
  - ✓ Long-term estimates on CO_2 prices of ETS can be find in '*EU Energy… trends to 2050*'
- **Loss of revenues from electricity**
  - ✓ For PP converted to CHP maintaining fuel
  - ✓ Wholesale prices of electricity are used

BENEFITS

- **Revenues from electricity**
  - ✓ For PP converted to CHP and new CHP.
  - ✓ Wholesale prices of electricity are used.
- **Residual value**
  - ✓ For those assets whose lifetime is shorter than the time horizon.
  - ✓ These assets are replaced and at the end of the time horizon, their value should be taken into account.
  - ✓ This task implies appraising net revenues that those assets can generate beyond time horizon.

Economic analysis: inventory of effects

Europese Commissie

COSTS

- **Capital cost of heating/cooling**
  - ✓ The same as in the financial analysis but net of direct taxes.
- **O&M costs** (excluding fuel)
  - ✓ The same as in the financial analysis but net of direct taxes.
- **Fuel and electricity costs**
  - ✓ The same as in the financial analysis but net of direct taxes.
- **Loss of revenues from electricity**
  - ✓ The same as in the financial analysis

NEW

- **Environmental and health externalities**
  - ✓ From pollutant emissions associated to fuel combustion on energy production life cycle.
  - ✓ By using *damage factors* derived from the Impact Pathway Approach [*EUR/MWh*].

NEW

- **Impact on energy dependency**
  - ✓ Impact on the economy caused by increases on imported fuel prices.

BENEFITS

- **Revenues from electricity**
  - ✓ The same as in the financial analysis
- **Residual value**
  - ✓ The same as in the financial analysis but net of direct taxes.

NEW

Macroeconomic impact

- ✓ Including effects from:
  - i. Capital and O&M expenditures on heating and cooling solutions
  - ii. Reductions on the energy bill.
- ✓ Methodological approaches:
  - i. Input-Output methodology or
  - ii. Macro-economic models (i.e, CGEM)

NEW

Reliability of the system operation

- ✓ Contribution to avoid/reduce the power outages (by support local voltage levels; diversifying power supply; etc).
- ✓ Approach consist on estimating the avoided costs derived from outages

Environmental and health externalities

Europese Commissie

- A relevant externality is the damage to health and environment from **pollutants** emitted during fuel combustion within energy life cycle.
- Pollution cause **damages** on health, yield changes for crops, soiling of buildings, ecosystem damages, global warming, etc.
- Methodological approach: ***Impact pathway approach***, by assessing: emissions → changes in concentration → impacts → damages.
- Databases offer **damage factors** from Impact Pathway Approach. They inform about damages produced by, i.e., an additional unit of energy.
- Damage factors can be used to assess environmental and health externalities in each scenario:

$$[Environmental\ Impact_{y,t}]_{Scen.} = [Energy_{y,t}]_{Scen.} \cdot Damage\ Factor_y$$

- Report on '*Subsidies and costs of EU energy*' provides damage factors per unit of energy for different heat and electricity technologies.

Net Present Value, NPV

Europese Commissie

- As mentioned, conducting a CBA implies assessing the **changes in costs and benefits between baseline and alternative** scenario:

$$Cost_{i,t} = [Cost_{i,t}]_{Altern.} - [Cost_{i,t}]_{Basel}$$

$$Benef_{i,t} = [Benef_{i,t}]_{Altern.} - [Benef_{i,t}]_{Basel}$$

- The **total cost and total benefits** of each year is the result of summing the value of all categories of costs and benefits:

$$Cost_t = \sum_{i=1}^{n} Cost_{i,t}$$

$$Benefit_t = \sum_{i=1}^{n} Benefit_{i,t}$$

- Finally, the **NPV integrates in a unique estimate the expected benefits minus the costs**, both suitably discounted:

$$NPV = \frac{Benefit_t - Costs_t}{(1+r)^t}$$

Discount rate

- NPV estimation requires the use of a 'discount rate'. This parameter reflects the value of future cost & benefits compared to present ones.
- Using the discount rate, future costs and benefits are converted into their present value allowing comparison between costs and benefits that happen in different moments of time.
- The financial analysis uses a *financial discount rate*, while the economic analysis uses a *social discount rate*.
- The **financial discount rate** reflects the opportunity cost of capital. The EC recommends a 4 % financial discount rate in real terms.
- The **social discount rate** reflects the social view on how future benefits and costs should be valued against present ones. The EC suggests using: 5 % for the Cohesion countries and 3 % for the rest.

Interpretation and sensitivity analysis

- When there are several scenarios, the selection depends on their compatibility:
  - ✓ *Mutually exclusive* scenarios → choose the one with the highest NPV.
  - ✓ *Not exclusive* → ranking scenarios from higher NPV to lower NPV.
- Conducting the financial and economic CBA provides two indicators:
  - ✓ *Financial rate of return,* FNPV
  - ✓ *Economic rate of return,* ENPV

Interpretation

$$When \begin{cases} FNPV < 0 \\ ENPV > 0 \end{cases} \Rightarrow Eligible, support\ required$$

- Finally, a sensitivity analysis has to be done to assess the impact on results associated to changes in relevant factors.
  - ✓ *Possible approach*: assess changes on NPV by using realistic ranges in key parameters. Observe potential changes in final ranking of alternatives.
  - ✓ *Paramaters*: discount rates; CAPEX; OPEX; fuel and CO_2 prices; damage factors…