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ENVIRONMENTAL PERFORMANCE INDICATORS AND THEIR RELATION WITH ECONOMIC FACTORS IN TEXTILE BAT IMPLEMENTATION

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Ministério do Ambiente e do Ordenamento do Território

OUTLINES

1) Project Context and Aims

2) Methodology for *BAT and EPIs* Selection. Results of EPIs collected during BAT implementation

3) Methodology for Economic and Environmental assessment, benefits, externalities quantification/ monetarization

4) A BAT case study: model for heat-insulation pipe and stenters. Simulations using previous data collected from stenters exhaust

5) First results of the Web Decision Support Tool

Project Context and Aims

Textile → Finishing Process → Intensive energy and resources consumption

(2375 SMEs in Portugal)

↓

EPI
(EMS) monitoring

Benefits ↑

IPPC → BREF EU (BAT) textile → Cleaner Production application

Costs ↑

- ***Establish the relevant EPI in the Cost-Benefit analysis***
- ***Determine the suitable emissions factor***
- ***Contribute for benchmarking and improve environment friendly techniques***

IPPC - Integrated Pollution Prevention Control

SME – Small and Medium Enterprises

EPI – Environmental performance Indicators

EMS – Environmental management system

BREF – Best Reference document for BAT

BAT- Best available technique

Companies and BAT selection (Methodology)

1. Group of Companies selected:
   - IPPC criteria (10 tonnes of treatment capacity)
   - Resources and time to deal with the project aim
   - Production Process with relevant information

   Totalizing 8 companies with IPPC criteria and 1 without (lower than 10 tonnes capacity) that is planning to meet IPPC.

2. Criteria of BAT selected:
   - Broadest (applied, or potentially applicable, in most companies)
   - Embody the specificity of each company process
   - Possibility of obtaining or monitoring technical data
   - Wide coverage of the whole environment subject
   - Easily implemented with low investment cost

Models and variables (Data collection Form)

1) Mathematic Models,

2) Basic BAT variables (technical, economic and environmental),

3) Environmental Performance Indicator,

Form to collect data

Example:

1) Pipe Heat losses (thermal): convective and conductive heat transfer through cylindrical surfaces in steady state. Economic (losses and cost of energy).
2) Basic Variables: Diameter, surface temperature, environment temperature, pipe thickness, emissivity (pipe material or insulation), air speed, fuel consumption, efficiency of heat system, maintenance and operation cost, investment cost.
3) EPI related: specific energy consumption, air emissions.
4) Form to collect the data (take into account the companies).

EPI (Environmental Performance Indicators) - phases

Map EPI references for the textile sector (scientific literature and ISO 14000)

EU regulations – operational environmental license

EU priorities – GHG reduction, energy minimization (recovery). (Measure and Monitoring)

EPIs collected from companies selected – First results

Values	Environmental Performance Indicators						
	Energy	Water	Wastewater				Waste
	Specific energy consumption (tep/t)	Specific water consumption (m^3/t)	Specific wastewater generated (m^3/t)	COD (kg/t)	BOD_5 (kg/t)	TSS (kg/t)	Specific waste gererated (t/t)
Maximum	3.19	213.62	184.31	98.34	31.30	10.02	0.28
Medium	1.68	138.27	116.57	64.92	19.60	5.99	0.12
Minimum	0.64	55.62	46.35	35.36	9.47	2.94	0.04

Values fit the expected, according to international benchmark results (Kawase T ., 2007) (Alanya et al., 2008)

Values (ratio)	Environmental Performance Indicators comparision						
	Energy	Water	Wastewater				Waste
	Specific energy consumption	Specific water consumption	Specific wastewater generated	COD	BOD_5	TSS	Specific waste generated
Minimum/ Maximum	**5**	4	4	3	3	3	**7**

➢ ***The ratio between maximum and minimum emphasizes the difficulty to establish the suitable emission factor mainly for energy and waste.***

➢ **The fabric (textile) passes more than once through finishing processes evidenced by the specific energy consumption, but high energy consumption does not necessarily represent problems in production. This EPI should be considered together with GVA/ production (Global Value Added).**

Economic cost involves:

(a) Investment cost, (b) operation and maintenance cost, *(c) revenue, (d) benefit and avoided cost.*

Net present value can be calculated from:

$$NPV = -(\text{investment expenditure}) + \sum_{t=0}^{n}\left(\frac{\text{net revenues}_t}{(1+r)^t}\right)$$

Where:

t = year 0 to year **n**
n = the project lifetime
r = the discount (interest) rate.

Economics and Cross-Media Effects – European Commission - IPPC

(d) Benefits and Avoided cost => Economic Benefit (Production/Environment)

Reduce the resources consumption (i.e. less gas consumed)

Reduce cost production, emissions (CO_2) and treatment (wastewater) - improve of efficiency

(c) Revenue – gain represented by sales (byproduct/waste with market value)

(a/b) Investment expenditure - assessed by user. Preliminary quote with manufacturer and installer

- **Establish the ratio (Cost Effectiveness): *(cost)/(reduction of emission) and Benefit-to-Cost (B/C)***
- **Assessment of EPIs related.**

If investment expenditure (cost) is unknown/unavailable => the output will display the maximum investment which will return

NPV = 0

Default variables values: (In case the user does not detain further information)

- Operational time during the year;
- Interest rate;
- Project lifetime;

Stenters Thermal Heat losses – Economic Insulation

•Goal (Stenter): calculate heat losses through wall chambers (in loco) and compare with hypothetical situation (installing insulation).

•Condition: Plain plate + Unidirectional Flows + Forced convection

•Application: Insulate wall chambers avoiding heat losses (old/second hand equipment)

Condition	Wall temperature (°C)	Operation temperature (°C)	Ambient Temperature (°C)	Chambers Dimension (m)	Heat loss (kWh/year)	Additional Insulation (mm)	Heat loss (kWh/year)	Avoided cost from energy lost (€/year)	Environmental benefit -CO2- (kgCO2/year)
Forced air flow	50	145	25	1.5 l 3 w 1.7 h	2239	50	1671.41	25.06	114.63

•Calculus allows to check **heat losses** and compare **avoided costs** with **insulation costs,** considering:

Data: efficiency heat systems = 80%, energy cost = 9.81€/GJ, CO_2 cost = 12.57 €/ton.

*Air flow = 0.1m/s // l = length, w = width, h = height

Pipe Thermal Heat losses

•*Goal* (pipe): calculate heat losses per meter of pipe, with and without insulation.

•*Condition*: Radial system (cylindrical) + Steady state + Unidirectional Flows + Forced or Natural convection

•*Application*: exhaust air from outlet chamber - used as hot source in heat exchanger (air or water)

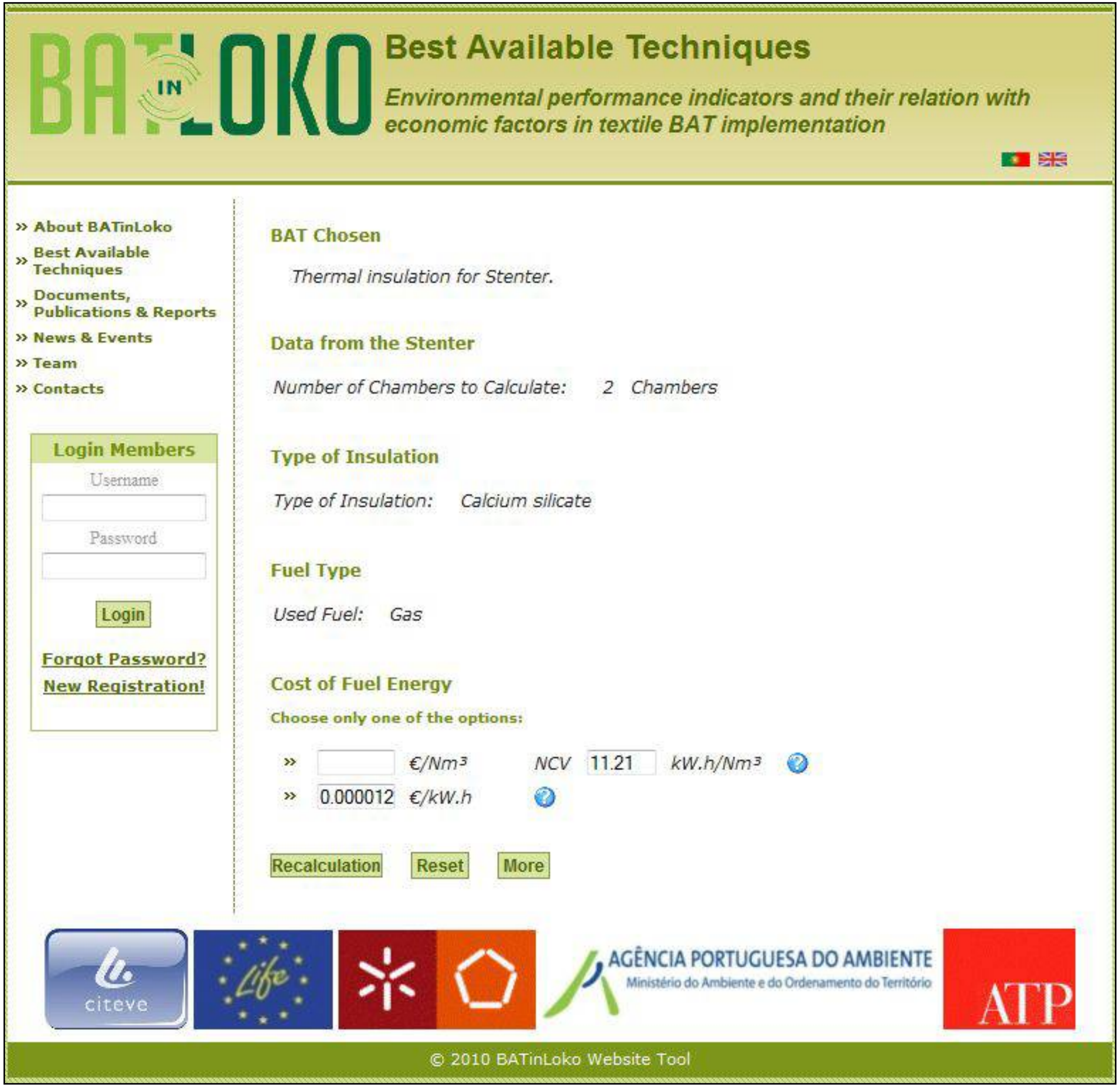
Condition	Pipe Temperature** (°C)	Pipe Diameter (mm)	Insulation Thickness (mm)	Ambient Temperature (°C)	Heat loss insulated (W/m²)	Heat loss uninsulated (W/m²)	Difference annual (kWh/m)	Cost of energy lost (€/m.year)	Environmental benefit -CO_2 (kgCO_2/m.year)
Forced air flow	122	710	50	35	125.2	635.99	2553.95	112.75	515.80

Data: efficiency heat systems = 80%, energy cost = 9.81€/GJ, CO2 cost = 12.57 €/ton.

To simplify measures and avoid costly measurement instruments, calculus are developed considering *external pipe temperature*, focusing on convection heat transfer, so that it doesn't' depend on internal fluid.

*Air flow = 0.1m/s

**pipe temperature ≈ fluid temperature (in the beginning of the flow)


BATINLOKO
Best Available Techniques
Environmental performance indicators and their relation with economic factors in textile BAT implementation
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Login Members
Username
Password
Login
Forgot Password?
New Registration!
BAT Chosen
Thermal insulation for Stenter.
Data from the Stenter
Number of Chambers to Calculate: 2 Chambers
Type of Insulation
Type of Insulation: Calcium silicate
Fuel Type
Used Fuel: Gas
Cost of Fuel Energy
Choose only one of the options:
» €/Nm³ NCV 11.21 kW.h/Nm³
» 0.000012 €/kW.h
Recalculation
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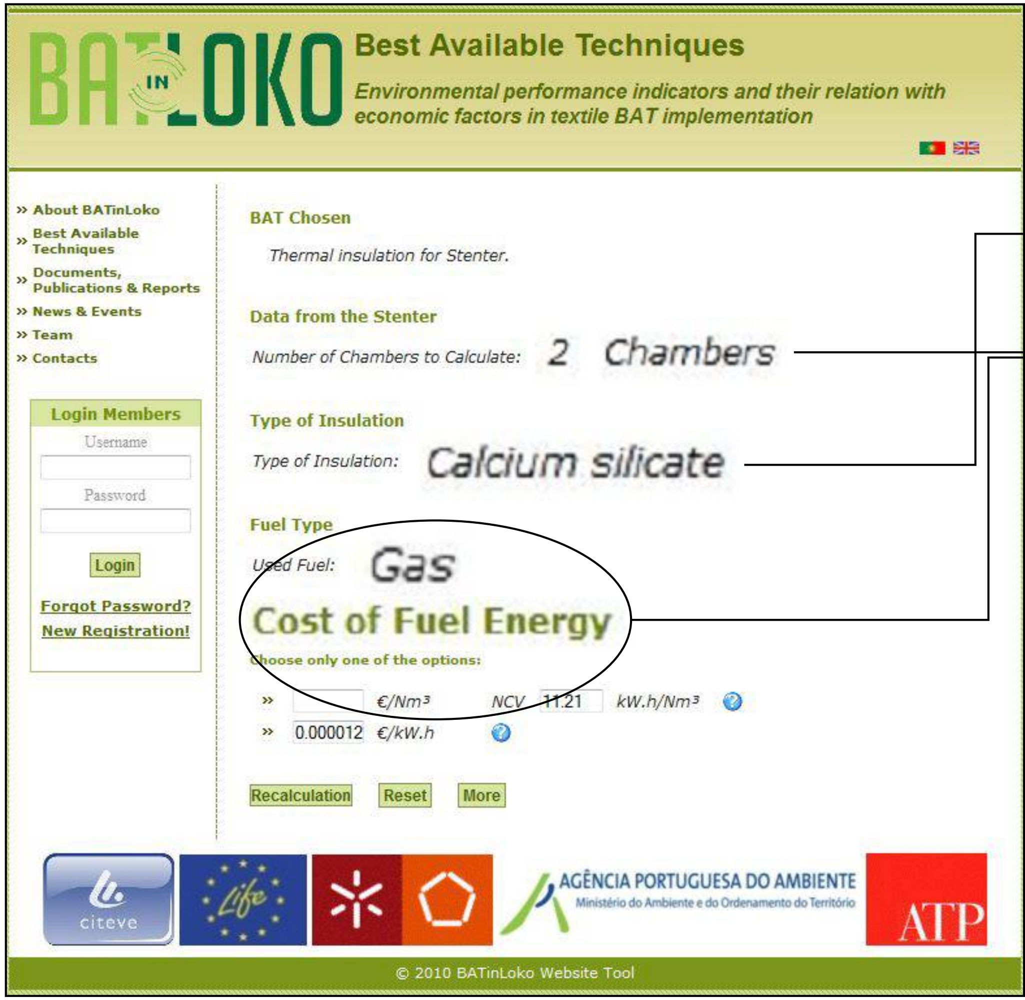
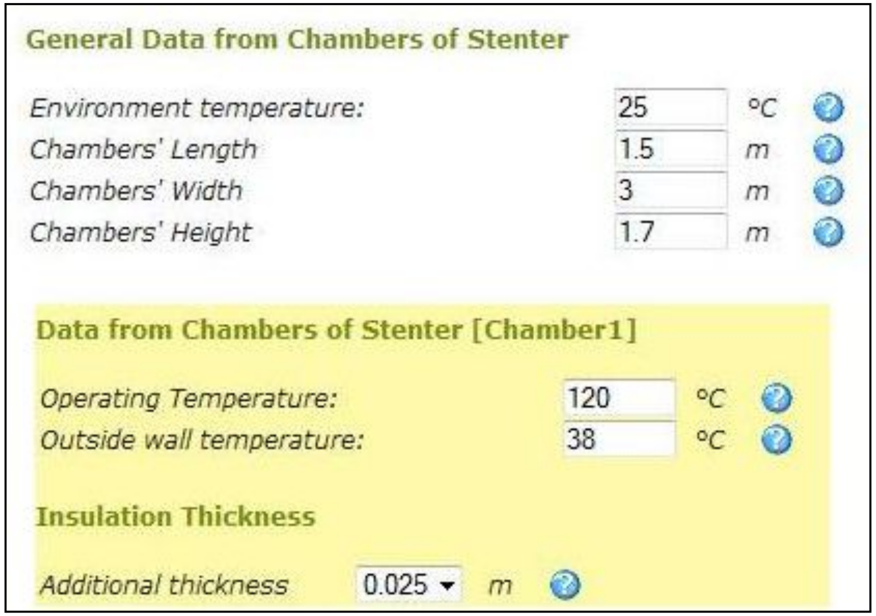
How it works ? – Chamber of Stenter



Number of Chambers in the Stenter - can be selected

Type of insulation

Type of fuel and cost



 5) Web Decision Support Tool

Calculated Results for Avoided Cost

Heat loss with insulation inloco:	*4705.24*	*KWh/year*
Heat loss with insulation after simulation:	*4154.57*	*KWh/year*
Discounted cost of energy saved:	*47.38*	*€*

Calculation of Economic Benefits

Gain	*500*	*€/year*
Investment	*350*	*€*
Percent of Investiment for Cost of Operation and Maintenance	*2*	*%*

Economic Benefits *493.01* *€*

Calculation of Environmental Benefits

Annual Emission Factor:	*56.1*	*kg CO_2/GJ*
CO_2 Price:	*12.58*	*€*

Environmental Benefits *1.40* *€*

Net Present Value

Net Present Value *2131.31* *€*

Recalculation Report

Recalculation Report

- [x] *Economic Benefits*
- [x] *Environmental Benefits*

Continue

Type of output

For this example all data was detailed including GAIN, INVESTMENT and OPERATIONAL & MAINTENANCE

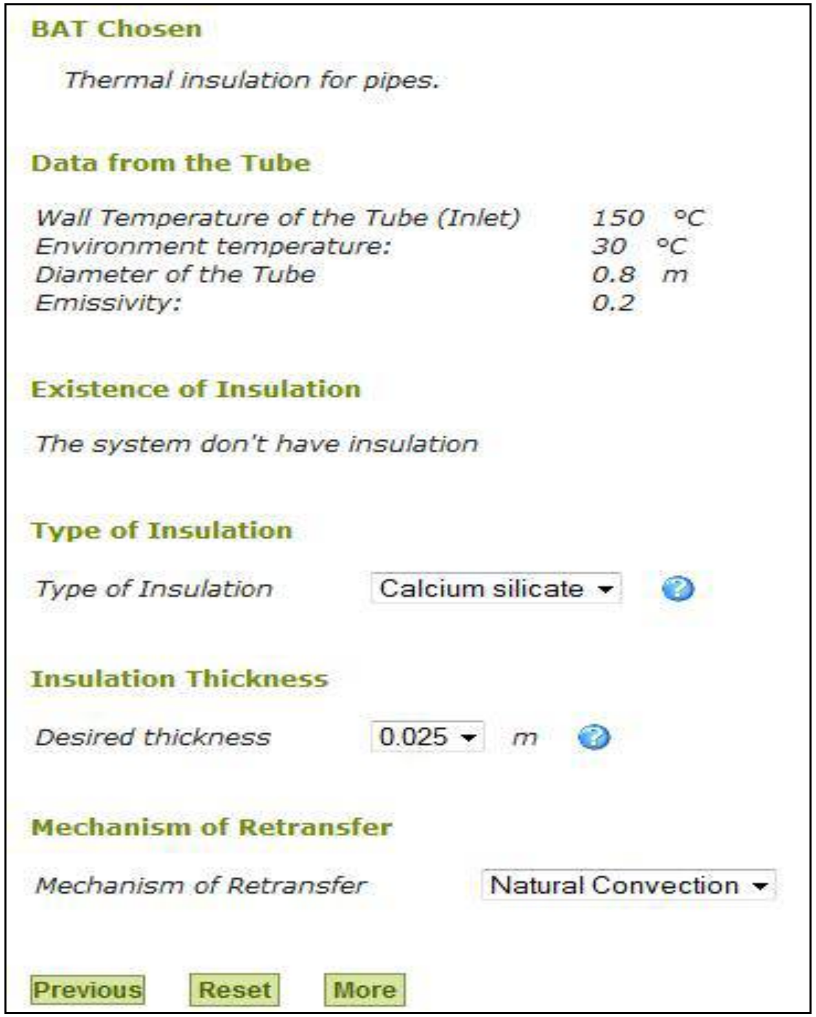
Operation and maintenance:

Number of hours operation in the year:	8250	*h/year*
Efficience Heat System:	70	*%*
Project Lifetime:	10	*years*
Discount (Interest) Rate:	15	*%*
Cost of Energy (Fuel):	*0.000012*	*€/kW.h*

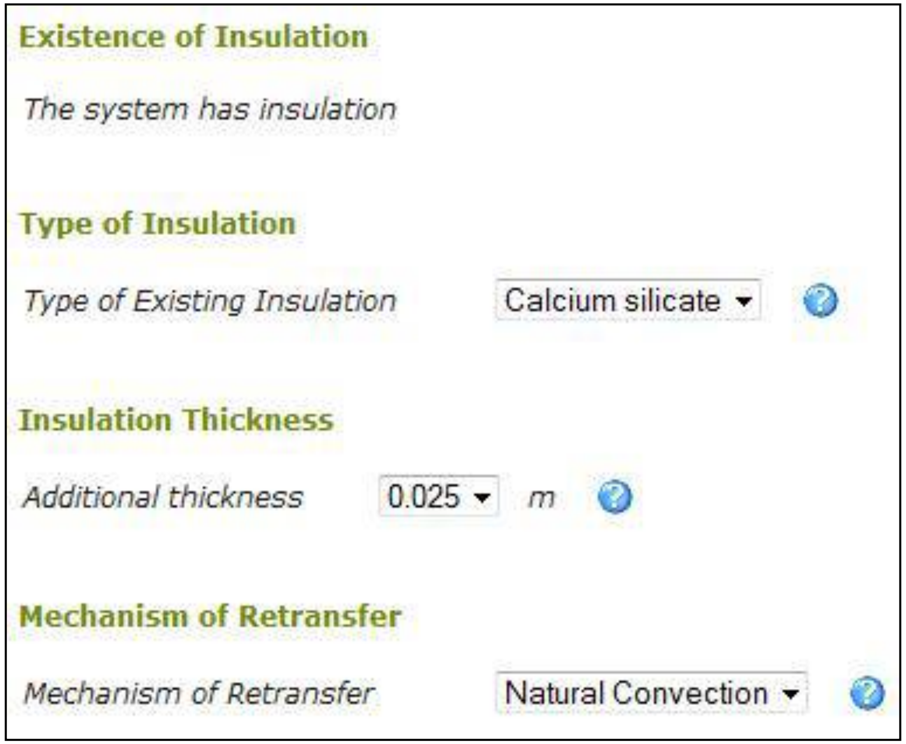
Recalculation Reset Calculate Avoided Costs

Variables (O&M, Economic, Design)

How it works ? – Pipes



The output (ongoing) can provide heat loss from pipe, valves and support.



Insulated pipe – simulation for better insulation

CONCLUSION

•Although EPIs' values are acceptable (Kawase T ., 2007; Alanya et al., 2008), significant variation between maximum and minimum value was found, which extends (widens) the range of values. This may require dynamic (yearly) monitoring and regulations/standardization linked to range of values and/or other EPIs.

•The algorithms developed helped to created a friendly/helpful tool that enables to estimate the economic and environmental benefits for BAT incorporation. In this perspective, it can assist the companies and encourage the improvement of environment friendly technique.

•The Web tool can serve the EU companies (deliverable of this project) .

ACKNOWLEDGMENTS

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