INOGATE Meeting 2015-12-17
Energy optimization
AGENDA

- THE OPTIMIZATION METHOD
- A CASE STUDY –LYNGBY PORT
TOTAL CONCEPT

A method for reduction of energy consumption in existing non-residential buildings.

Goal: achieve max saving in a cost efficient way

Mere info: www.totalconcept.info
**TOTAL CONCEPT – 3 STEPS**

**Trin 1** – audit and action package

**Trin 2** – carrying out the measurements

**Trin 3** – follow up

**STEP 1**
- Creating the action package
  - Information gathering and compiling data
  - Energy calculations
  - Investment cost estimations
  - Profitability calculations and the creation of an action package
  - Reporting and presentation of proposals

**STEP 2**
- Carrying out the measures
  - Designing the measures
  - Construction work and installations
  - Functional performance checks

**STEP 3**
- Following up
  - Measuring energy use after renovation
  - Checking profitability results
TOTAL CONCEPT
HOW TO CREATE AN “ACTION PACKAGE”?

Internal rate of return diagram

Annual savings k€/a

Internal rate of return $r_i$

Calculation period
20 years

Investment k€
TOTAL CONCEPT
HOW TO CREATE AN “ACTION PACKAGE”?

Internal rate of return diagram

Annual savings $\text{k€/a}$

- $r = 25\%$
- $r = 20\%$
- $r = 15\%$
- $r = 12\%$
- $r = 10\%$
- $r = 8\%$
- $r = 6\%$
- $r = 4\%$

Calculation period 20 years

Investment $\text{k€}$
TOTAL CONCEPT
HOW TO CREATE AN “ACTION PACKAGE”?

Annual savings k€/a

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$ r = 25\% $  
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TOTAL CONCEPT
HOW TO CREATE AN “ACTION PACKAGE”?

Annual savings
k€/a

Investment k€

Internal rate of return $r_i$

Profitability

Demand 5%

7% - 2% = 5%
CASE STUDY - LYNGBÝ PORT

CASE STUDY - LYNGBY PORT IES AS A MODELLING TOOL
CASE STUDY - LYNGBY PORTIES AS A MODELLING TOOL
CASE STUDY - LYNGBY PORT
MEASURED ENERGY CONSUMPTION

<table>
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<tr>
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<th>Energy use 2014</th>
<th>Energy certification 2010</th>
<th>Energy use 2013</th>
<th>Simulations</th>
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<td>0</td>
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<td>EI (common, incl. ventilation and cooling)</td>
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CASE STUDY - LYNGBY PORT
CASE 0, CALCULATION RESULTS
• Heating constitutes for 66% of energy consumption but only for 44% of energy cost. 34% of electricity consumption generates 56% of energy costs. Electricity consumption includes also estimated tenancy energy consumption for lighting and equipment. **125kr/m²**

• Heating cost: 0,65DKK/kWh

• Electricity cost: 1,65DKK/kWh
CASE STUDY - LYNGBY PORT

DEFINITION OF BASE CASE

Ambition level:
- Indoor climate
- Standard renovation (overworn elements)
- Extra requirements (e.g., 20% more working places, better daylight)

CASE "0"
(existing building)

Indoor climate class A
20% more work stations

Indoor climate class B
0% more work stations

Indoor climate class C
Standard renovation: windows
15% more work stations
CASE STUDY - LYNGBY PORT
SELECTION OF BASE CASE

CASE 0 (1,1/1,4mio kr)

BASELINE (1,1/1,9mio kr)

BASELINE 17 (1,0/1,8mio kr)
LYNGBY PORT
MEASURE B1 – DISTRICT HEATING

• Conversion of natural gas boilers to district heating.
• Calculation using factors, given by Lyngby-Taarbæk municipality

• Price: 150.000kr
• Improvements: price (0,65kr/kWh -> 0,55kr/kWh); efficiency 84%->95%
• Annual saving: 390MWh
LYNGBY PORT
MEASURE B2 – PHOTOVOLTAIC

- Price: 1.750.000kr
- 1090 m2
- Improvements: production of electricity
- Annual saving: 281MWh
MEASURE B3 – NEW COOLING MACHINE

- Price: 2,200,000kr
- Improvements: COP 2,5 → 4,1
- Annual saving: 81MWh
MEASURE B4 – NEW VENTILATORS

- Price: 570,000 kr
- Improvements: Reduction of pressure 200-250 Pa because of removing high velocity in outlier. Better efficiencies, more rotations
- Annual saving: 301 MWh
MEASURE B5 – PIR SENSORS IN TOILETS

- Price: 70,500kr (47 toilet cores)
- Improvements: 15% reduction in energy consumption for toilet lighting
- Annual saving: 3MWh
MEASURE B6 – NEW BMS SYSTEM

- New central BMS panel and controls: kr. 250,000
- BMS for existing ventilation units: kr. 250,000
- Office rooms (5 setpoints per room, 68 A-rooms): kr. 1,750,000
- **Total**: kr. 2,250,000.

- Annual saving: 161MWh heating + 116MWh common el
# MEASURE B7 – NEW WINDOWS

**Existing:**

- $U_w = 2.5 \text{ W/m}^2\text{K}$
- $g_g = 0.7$
- $LT = 0.71$

### Table

<table>
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<tr>
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<th>Type</th>
<th>$A_{ntal}$</th>
<th>$A_w$</th>
<th>$A$</th>
<th>$U_w$</th>
<th>$F_r^*$</th>
<th>$g_g^*$</th>
<th>$L_T^*$</th>
<th>$B_w^{**}$</th>
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</table>

**Total:**

- $1034$ $\text{m}^2$
- $1331.59$ $\text{m}^2$
- $0.87$ **

- **Price:** 14,3 mio kr
- **Improvements:** Better U-value, lower g-value
- **Annual saving:** 370MWh
Internal rate of return diagram

- Conversion to district heating
- New ventilators
- Insulating ventilation ducts in shafts
- Optimization of BMS system
- New cooling system
- PIR sensors in toilets
- New windows

Annual savings [kdkk]

Investment [kdkk]
The energy saving for the package that fulfills the owner internal rate of return is 20% for heating and 23% for electricity. For the package with 8 measures it is respectively 44 and 23%.