STORK ASSET MANAGEMENT TECHNOLOGY

COSTS ESTIMATIONS ON BEHALF OF ENSURING COMPLIANCE WITH ENERGY EFFICIENCY DIRECTIVE

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Content area

- Legislative Scope
- Decision Model generics
- Requirements for costs model
- Way of working for costs estimation
  - Contents of DACE Costs Handbook
- Way of working for decision model
- End Result – and way forward within WCM – PEIBI initiative

01

LEGISLATIVE SCOPE

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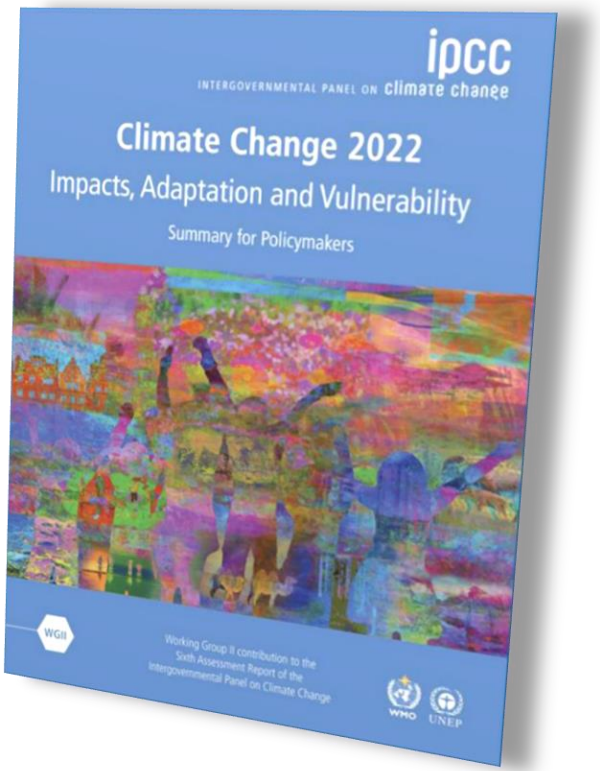
Energy Efficiency Duty & Investigating Duty:

Requirements resulting from the “Activity decision” (“Activiteitenbesluit”), which specifies which large industries are subjected to requirements in order to reduce the total CO_2 footprint of the activities.

This as follow up- of the Climate agreement with its dedicated measures on European level.

Subdivision is made as per size of activity:

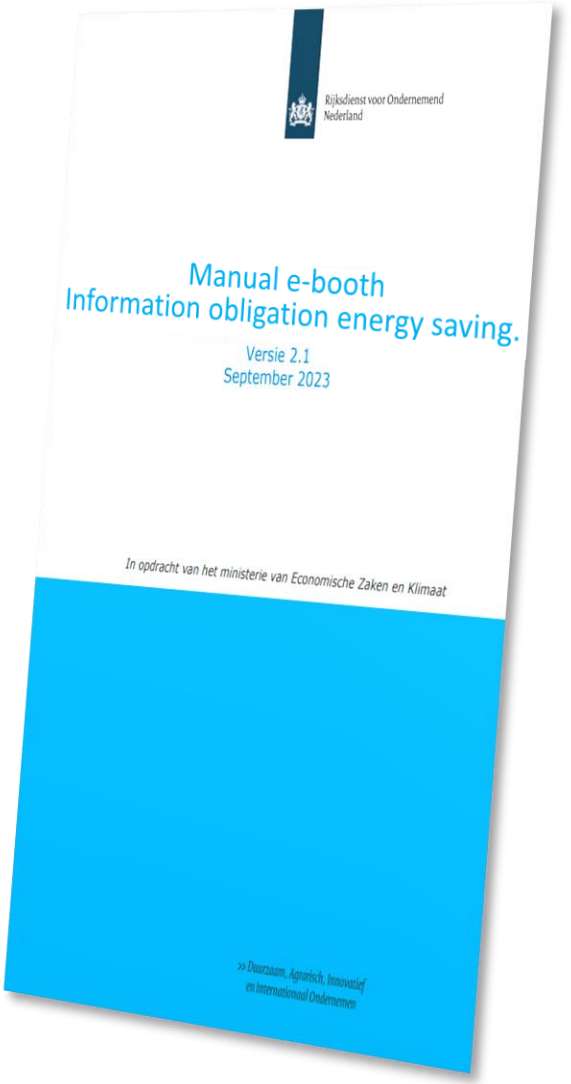
- Investigation duty: > 10 M KWh or 170 k m³ gas
  Factor: 200 ↕ 7 ↕
- Information duty: > 50 K KWh or 25 k m³ gas.



LEGISLATIVE SCOPE

Steps in investigating duty:

1. Description of Business Environment
2. Analysis of Energy use
3. Analysis of process equipment and installations.
4. Inventory of costs-effective CO_2 reducing measures.
5. QA/QC with respect to plan of execution
6. Scope of execution based on energy loss acceptance criteria



BILFINGER

02

DECISION MODEL GENERICS

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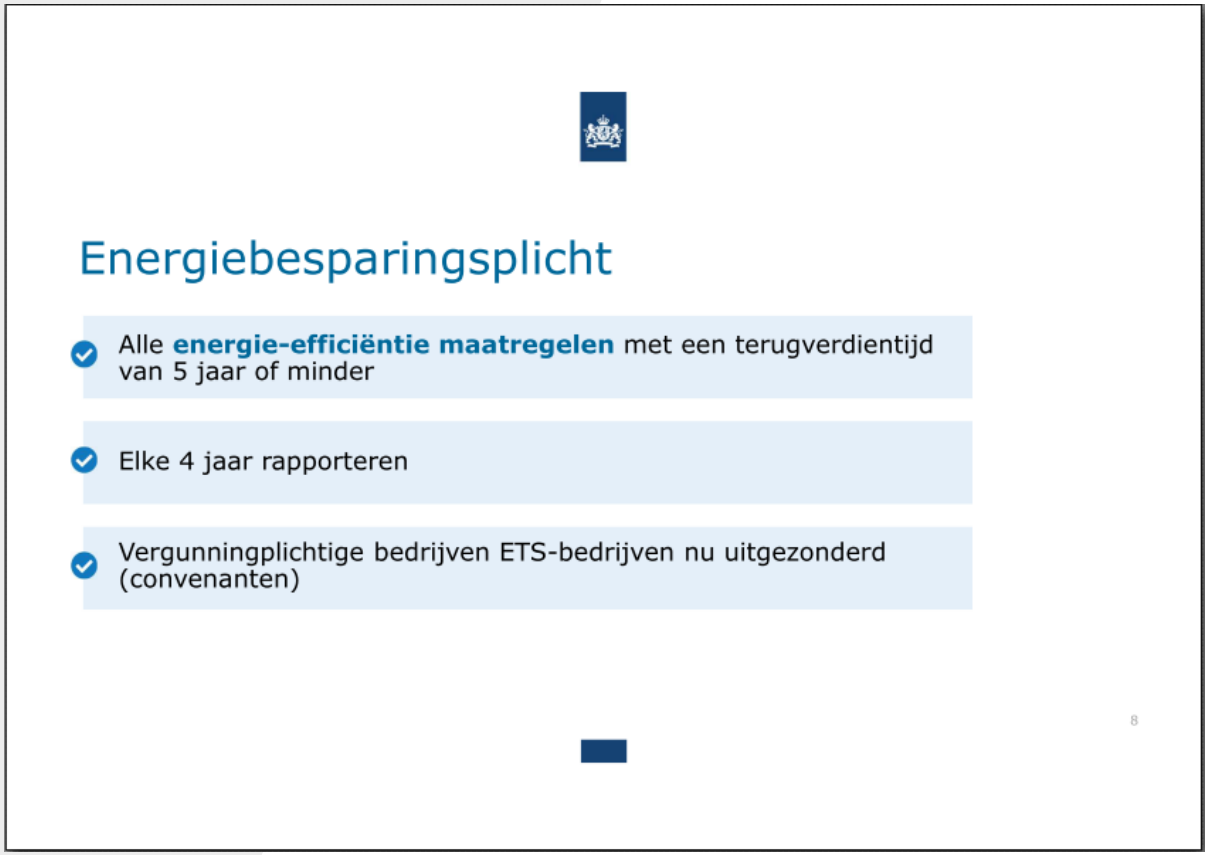
Requirements related to Energy saving duty:

- Obligatory implementation in case of a return of investment which is less than 5 yrs (expected to be upgraded to 7 yrs in 2027).
- Report on a 4 years cycle to be provided.
- Currently applied to companies with energy use exceeding 50.000 kWh/yr or 25.000 m³/yr gas.



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REQUIREMENTS FOR COSTS MODEL

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Requirements:	Criterion:
▪ Pay-out interval needs to be resulting of calculation	▪ Basis for legislation

▪ Therefore way of working with uncertainties needs to be clarified. Assumptions:
  ▪ assume obligatory approach (so proof of pay-out needs to be reasonable certain)
  ▪ Deal with uncertainties by (a) specifying these (b) showing how these are dealt with
	▪ Fines can only be applied in case proof is “beyond reasonable doubt”.

▪ For a feasibility study, in general estimation level ± 50% is sufficient.
  ▪ For this, generalized estimations will AACE Class 4 (L: -15% to -30%; H: 20% to 50%) will be appropriate
  ▪ In case costs models are used, these need to be calibrated on traceable sources.
	▪ Each Δ < 50% ; Sum of Δ’s < 50%.
	▪ Publicly available –up to date- sources required.

▪ Impact of additional costs (scaffolding, blasting, painting etc) needs to be made explicit.	

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WAY OF WORKING FOR COSTS MODEL

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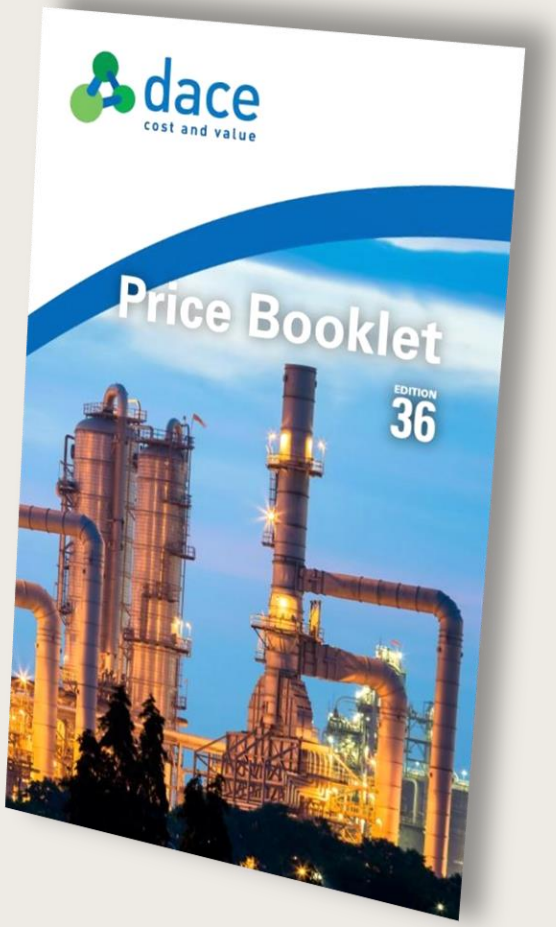
TRACEABLE REFERENCE FOR COSTS INPUT DATA.
(DACE Price Booklet, Ed.36; 2023)

DETERMINE MAIN PARAMETERS AND SELECTION OPTIONS
Determine behavior using curve fitting process.

OPTIMISATION PROCESS
End goal: ± 50% Max. deviation. Average < 25%

USE OF COSTS MODEL FOR DECISION PURPOSE

BILFINGER



WAY OF WORKING FOR INSULATION COSTS MODEL

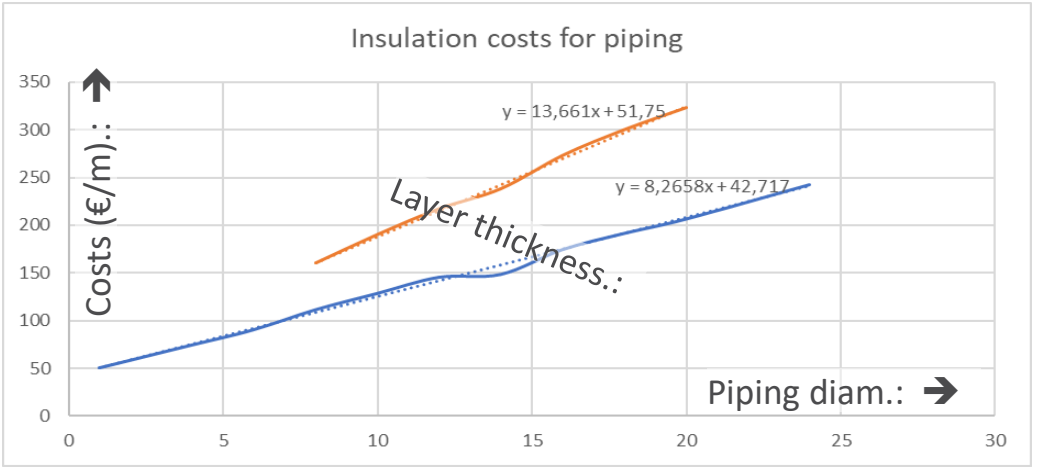
MAIN INPUT PARAMETERS

- Piping diameter
- Insulation thickness

Thickness:		100 mm	Max: 2,4%
Diam (in)	**Price**	**Formula:**	**Error:**
8	160	161,4 €/m	0,87%
10	190	188,8 €/m	-0,63%
12	217	216,2 €/m	-0,37%
14	238	243,6 €/m	2,35%
16	273	271,0 €/m	-0,73%
18	300	298,4 €/m	-0,53%
20	323	325,8 €/m	0,87%
14	149	158,6 €/m	6,43%
16	175	175,1 €/m	0,07%
18	192	191,7 €/m	-0,18%
20	207	208,2 €/m	0,58%
24	243	241,3 €/m	-0,71%

OUTPUT PARAMETRISATION

- Costs as output.
- In this case: Linear model: Costs = [A]*Diam. + [B] (Excel curve fit to diam.)



- Par. [A] and [B]: a function of Insulation Thickness. ➔ 2nd fit to thickness.
- Result: [Insulation Costs] = Form([Piping Diameter]; [Insulation Thickness].

WAY OF WORKING FOR INSULATION COSTS MODEL

OTHER COSTS MODELS INVOLVED

- Blasting (€/m2)
- Painting (€/m2)
  - Primer Y/N
  - Intermediate coating Y/N
  - Top coating Y/N
- Scaffolding

- This for:
  - Vessels, tanks and heat exchangers
  - Flat parts, walls, channels and tank roofs
- Note: Specific parts costs multiplier 1,5-3

➢ Result: [Insulation Costs] = Form([Blasting]; [Painting-option]; [Insulation Thickness]).

WAY OF APPLICATION

- Conversion towards applicable dimensions

Spherical top, bottom or front.	**3**
Segment cap, ring cap, conical piece or point cap	**2,5**
Transition piece, conical piece, point cap	**2**
Flat head, cap, lid or end piece whether or not removable	**1,5**
Cabinets or doors	**2**

WAY OF WORKING FOR ENERGY LOSS COSTS MODEL

PARAMETERS INVOLVED

- Surface temperature
- Ambient temperature
- (Speed of wind)
- Energy price (seasonal effect)

HEAT LOSS DETERMINATION

A:
- Empirical values, based on references, to be used.
- Radiation: 5 W/m².K ; Convection – outside – average: 20 W/m².K.; ➔ 25 W/m².K.
- Straightforward formula using MEASURED skin temperature.

B:
- Theoretical loss, using design values, to be calculated.
- Based on material properties, thickness and design temperature.
- Design loss (as determined by design choices; assuming +15% related to Quality)

C:
- Gap ((Design) – (Actual)) in €/jr assuming hr. loss times 24*7*300.

- Note: sensitivity to 1°C. temperature measuring uncertainty – linear loss.

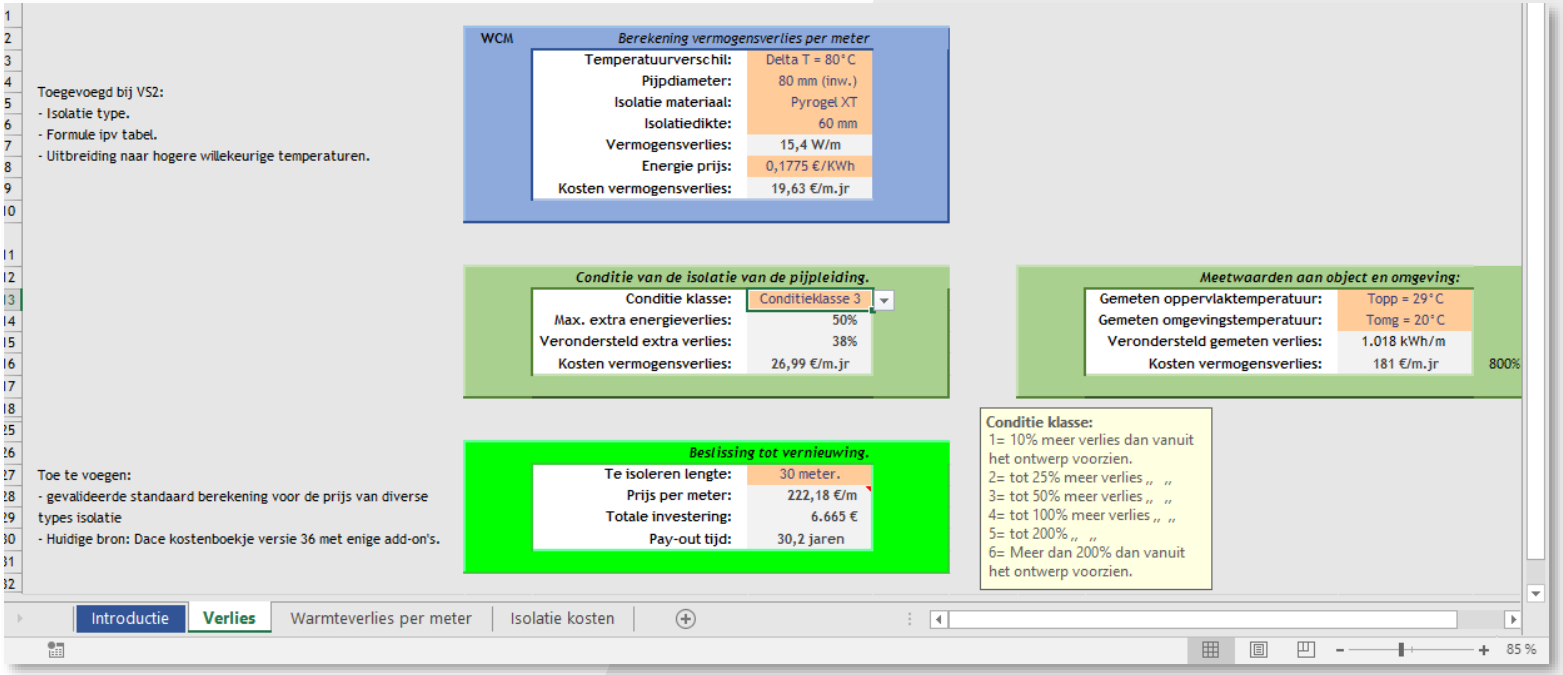
BILFINGER

05

WAY OF WORKING FOR DECISION MODEL

WAY OF WORKING FOR DECISION MODEL.

- Should be in applicable as simple Excel tool.
- Base decision on sampling by referencing on extremes encountered.
- More detail depending on risk related to decision error
- End result in terms of **Pay-out time**.



WAY OF WORKING FOR DECISION MODEL.

- Condition assessment using % loss of insulating capacity, to be developed and calibrated on proof from practise
- With this, tables to be generated providing costs of energy loss related to condition decrease, yielding capability to prioritize on main costs (loss) drivers.

- Example: calculation done with 100% functioning insulation, condition class 1, against the investment costs, for a piping system with the next features (check thickness guidance.):
  - Actual process temperature: 50° C; Skin temp. assumed)
  - Ambient temperature: 20° C. Costs: 0,1775 €/kWh.
  - "Budget insulation" as per reference; Calcium silicate.
  - No painting nor scaffolding involved.
- Example reveals: a very limited temperature drop over the insulation already suggests to go for the thicker materials.
- Of course different costs factors and inclusion of painting and scaffolding result in "less Scope"
- Update with deterioration as per condition and including additional costs for scaffolding & painting foreseen.

Bron:	RVO; Best Practise Isolatie (Juni 2015).							
0,06 W/k.m	lambda isolatiefactor (W/mK)					Ln natuurlijke logaritme		
Delta T = 30°C	Qv warmteverlies (W/m)					D leiding-buitendiameter met isolatie (mm)		
Isol.dikte: 40 mm.						d leiding-buitendiameter zonder isolatie (mm)		
Pijp diam.: 50 mm.	Isolatiedikte							
11,84 W/m	10	20	30	40	50	60	75	100
10	10,29	7,03	5,81	5,15	4,72	4,41	4,08	3,71
15	13,35	8,70	7,03	6,13	5,55	5,15	4,72	4,25
20	16,32	10,29	8,16	7,03	6,31	5,81	5,28	4,72
32	23,29	13,95	10,71	9,03	7,98	7,26	6,51	5,71
40	27,89	16,32	12,34	10,29	9,03	8,16	7,26	6,31
50	33,61	19,24	14,34	11,84	10,29	9,24	8,16	7,03
60	39,31	22,14	16,32	13,35	11,53	10,29	9,03	7,71
80	50,68	27,89	20,21	16,32	13,95	12,34	10,71	9,03
100	62,03	33,61	24,06	19,24	16,32	14,34	12,34	10,29
200	118,66	62,03	43,11	33,61	27,89	24,06	20,21	16,32

Delta T = 30°C		Comparison of new-built insulation, having temperature difference.							
Criterion:	5 Yr.	Isolation thickness.							
Insulation costs (ø):		10	20	30	40	50	60	75	100
43 €.	10 ø mm.	5 jr.	8 jr.	9 jr.	11 jr.	12 jr.	13 jr.	14 jr.	15 jr.
45 €.	15 ø mm.	4 jr.	7 jr.	8 jr.	9 jr.	10 jr.	11 jr.	12 jr.	13 jr.
46 €.	20 ø mm.	4 jr.	6 jr.	7 jr.	8 jr.	9 jr.	10 jr.	11 jr.	12 jr.
49 €.	32 ø mm.	3 jr.	5 jr.	6 jr.	7 jr.	8 jr.	9 jr.	10 jr.	11 jr.
52 €.	40 ø mm.	2 jr.	4 jr.	5 jr.	6 jr.	7 jr.	8 jr.	9 jr.	10 jr.
55 €.	50 ø mm.	2 jr.	4 jr.	5 jr.	6 jr.	7 jr.	8 jr.	9 jr.	10 jr.
57 €.	60 ø mm.	2 jr.	3 jr.	4 jr.	5 jr.	6 jr.	7 jr.	8 jr.	10 jr.
63 €.	80 ø mm.	2 jr.	3 jr.	4 jr.	5 jr.	6 jr.	7 jr.	8 jr.	9 jr.
69 €.	100 ø mm.	1 jr.	3 jr.	4 jr.	5 jr.	5 jr.	6 jr.	7 jr.	9 jr.
97 €.	200 ø mm.	1 jr.	2 jr.	3 jr.	4 jr.	4 jr.	5 jr.	6 jr.	8 jr.
Piping diam.↑									

06

END RESULT – AND WAY FORWARD FOR WCM PEIBI INITIATIVE

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- World Class Maintenance: a joint industry initiative
- PEIBI: "Platform voor Effectief Isolatie Beheer voor de Industrie"

  Platform for **E**ffective **I**nsulation **M**anagement for the Industry.

Corrosion under Insulation

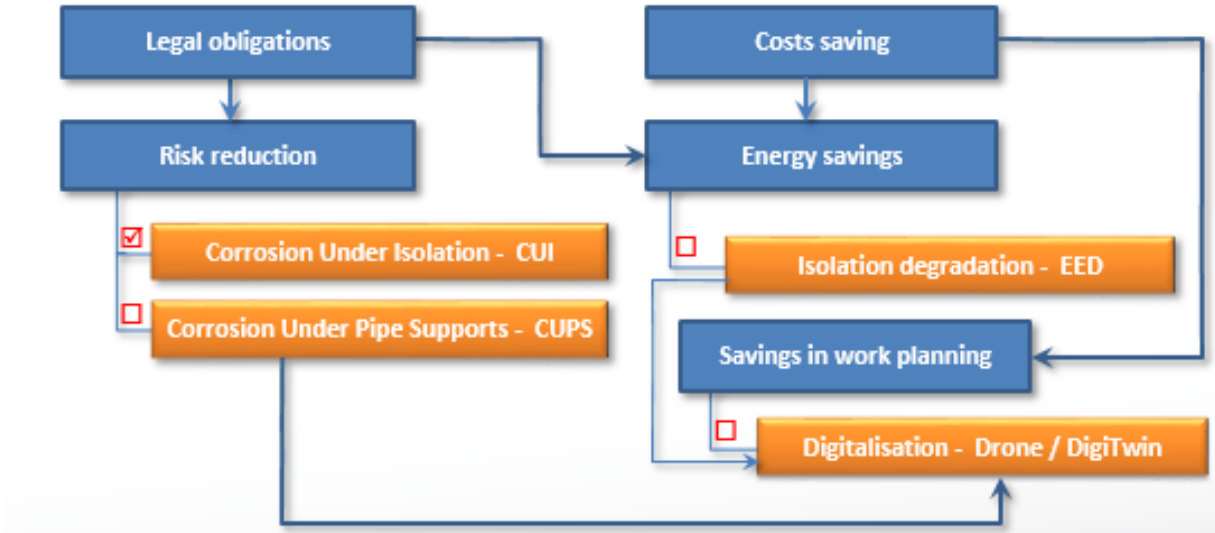

Figure 1: Connections between obligations, wishes, costs and benefits

PEIBI

Platform for
B (dutch) Effective
Insulation Management in the
Industry

WORLD CLASS MAINTENANCE

END RESULT – AND WAY FORWARD FOR WCM PEIBI INITIATIVE

- Tooling being developed supporting required reporting format.
- Results to be uploaded towards RVO Portal as part of legislative requirements.
- Results to be stored for comparison and evaluation, based on updated info and overall energy loss calculations.
- Experiences obtained, to be shared amongst PEIBI members, thereby reducing required effort in order to achieve an effective, proven and costs-efficient way of working.

Thank you for your attention.

Contact us

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References:
Dealing with uncertainty: Investment predictability of conventional and innovative projects; Abstract ICEC 2022 Jun 14th, Rotterdam.