Bottom up –method 20:
Energy Audits, Industry and Tertiary sector

Original slides for the method 20 by Wuppertal Institute.
Method 20 developed and original slides modified by Motiva.

Harmonised bottom-up evaluation methods:

Elements of Calculation: Four steps for calculation

- **step 1**: **unitary gross annual energy savings**
  (per end-use action)

  (+) no. of participants or units

- **step 2**: **total gross annual energy savings**
  (of a facilitating measure)

  (+) double counting, multiplier effect, free rider effect?

- **step 3**: **total ESD annual energy savings**
  (of packages of EEI measures)

  (+) timing and lifetime of end-use action within ESD period and performance degradation

- **step 4**: **total ESD energy savings for year "i"** **(i=2010 or 2016)§**

Harmonised bottom-up evaluation methods:

Elements of Calculation: Three levels of evaluation efforts

	Data scale	Main data sources	Data processing and documenting
Level **1**	**European default values**	**existing/available** European regulation, studies and statistics	**security factor** according to the level of **reliability** of the default value
Level **2**	**National** representative **values**	**up-to-date** national statistics, surveys, samples, registries	requirements = **minimum set of information and justifications** to be reported
Level **3**	**Program- or Participant-specific**	**specific** monitoring systems, registries, surveys, measurements	requirements to report on the specific data and justifications **in detail** (standard report at least available)

➔ an evaluation method may combine different levels of efforts, as several parameters are needed in the calculations

Harmonised bottom-up evaluation methods:

Example 2: Energy audits in industry and tertiary sector

- a method dealing with a type of facilitating measures
- the unit is a participant (one energy audit)

(method developed by Motiva , Finland)

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What end-use actions are considered?

- all kind of end-use (EEI) actions (improvement actions) proposed as a result of an energy audit including e.g.
  - investments in energy efficient technologies or
  - better operation and maintenance due to improved information

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Calculation process

- **Step 1.1: Basic calculation formula for the unitary savings**

  Annual energy savings of one participant = the participant's electricity energy savings + the participant's (heat + fuel) energy savings through the implemented improvement actions identified in the audit

→ *+ distinction between energy carriers: electricity on one hand, (heat + fuels) on the other hand*

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Calculation process

- **Step 1.2: General baseline**

→ Average baseline values cannot be formulated for energy audits

→ In practice energy consumption before and after each improvement action is usually calculated by the auditors - this difference represents the savings achieved in each improvement action

→ Do to the character of energy audits, a different approach is followed

→The approach conforms to the ESD definitions of calculating energy savings. According to this definition: "… an amount of saved energy determined by measuring and/or estimating consumption before and after implementation of one or more energy efficiency improvement measures, whilst ensuring normalisation for external conditions that affect energy consumption."

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Calculation process

- **Step 1.3: Normalisation factors (e.g., weather conditions, occupancy levels, plant throughput, opening or operating hours, plant throughput)**

→ normalisation factors are not used when total savings by energy audit programmes are calculated.

→ some of normalisation factors can be taken into account by the auditor in calculations made within an individual energy audit for the individual baselines of the energy consumption for the equipment analysed or the whole building or facility.

→Several factors can be taken into account when calculating the savings by individual improvement actions e.g. equipment operating times are an important source of potential savings when improvement actions are proposed. Also temperature corrections are usually made for the total heat consumption (excluding the use of hot water) of the audited facility but not used for the calculation of the savings in this method.

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Calculation process

- **Step 1.4: Four possible options to calculate unitary annual energy savings (abbrev. as *[savings]*, see also step 1.1)**

A) [savings] are estimated **from the annual consumption** of a participant audited, using a **EU default % for savings (Level 1)**

*[savings] = [% of savings (EU) * Annual Consumption (GWh/a)]*

B) [savings] are estimated **from the total energy savings potential** reported **in the audits,** using a **EU default % for realised savings (Level 3&1)**

*[savings] = [% for realised savings (EU) * Total Savings Potential (GWh/a)]*

C) [savings] are collected **directly through surveys,** ex post, for past but recent energy audit schemes, if option B or D not possible **(Level 2)**

D) [savings] are calculated **from the total savings potential** reported in the audit and the average **degree of implementation** in energy audits **(Level 3)**

*[savings] = [% Degree of Implementation * Total Savings Potential (GWh/a)]*

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Calculation process – Option A

- **Step 1.4: Option A) = Level 1 (not recommended)**

*[savings] = [% of savings (EU) * Annual Consumption (AC) (GWh/a)]*

- *distinction between energy carriers to be used: electricity on one hand, (heat + fuels) on the other hand*

Data needed:

- **EU default values for savings (% of AC in energy audits in industrial, municipal or private service sector)**
- **AC (annual energy consumption) of the audited facilities**
  - tertiary sector: AC possible to calculate via **average specific consumption** (per m^2 or m^3) **by building type and by energy type** (electricity and heat) AND **audited building volumes** (m^2 or m^3) **by building type**

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Default values Option A

- **Proposed EU default value** for **option A, Level 1:**

  [% of savings (EU)] (average energy savings achieved by energy audits)

Sector	Savings as % of annual consumption	
	Electricity	**Heat and fuels**
Buildings in the **municipal** services sector (residential buildings not included)	2%	3%
Buildings in the **private** services sector (residential buildings not included)	1.5%	4%
Industry (energy-intensive process industry not included)	1%	2%

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Calculation process – Option B

- **Step 1.4: Option B) = Level 1 and 3 combined**

*[savings] = [% for realised savings (EU) * Total Savings Potential (TSP) (GWh/a)]*

- *distinction between energy carriers to be used: electricity on one hand, (heat + fuels) on the other hand*

Data needed:

- **EU default value % for realised savings of the TSP reported in energy audits by sector (Level 1)**
- **TSP (total savings potential) for the audited facilities by sector from audit database (Level 3)**

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Default values Option B

- **Proposed default value** for **option B, level 1:**
  [% for realised savings] ***(% for realised savings out of potential savings)***

Sector	**Proportion of realised savings** (%, compared to the Total Potential Savings assessed by the audit)	
	Percentages to be used as default value in option B calculations	
	Electricity	Heat and fuels
Buildings in the **municipal** services sector (residential buildings not included)	25%	25%
Buildings in the **private** services sector (residential buildings not included)	25%	25%
Industry (energy-intensive process industry not included)	20%	15%

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Calculation process – Option C

- **Step 1.4: Option C) = Level 2**
- **Proposal:** Only to be allowed for past but recent energy audit schemes, if option B or D not possible, i.e., no database of energy savings potentials identified in audits exists;
- Resource-intensive, expensive and rather unreliable

Data needed:

- **Each participants' ex-post achieved annual energy savings due to actions implemented as a consequence of the audit, from a national survey**

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Calculation process – Option D

- **Step 1.4: Option D) = Level 3 (recommended)**
- *[savings] = [% degree of implementation (DI) * Total Annual Savings Potential (TSP) (GWh/a)]*

*[degree of implementation DI [%]] = [Implemented actions (%) + actions Decided to be implemented (%) + a * actions under Consideration (%)]*

(default value for a=0,05 for actions in industry and a=0,3 for actions in tertiary sector)

Data needed:

- **Ex-post follow up data (for remarkable share of audited facilities) for I, D and C to calculate the DI [%] in different sectors**
- **TSP (total savings potential) defined in the audit**
- default values or national average for a in different sectors

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Calculation process

- **Step 2.1: calculation formula for the <u>total gross</u> savings**

→ summing up the savings per participants, making a distinction between industry and tertiary

total gross annual energy savings =

$$\sum_{i=1}^{n} [\text{annual energy savings of } \underline{\text{industrial}} \text{ participant } i]$$

$$+ \sum_{j=1}^{m} [\text{annual energy savings of } \underline{\text{tertiary}} \text{ participant } j]$$

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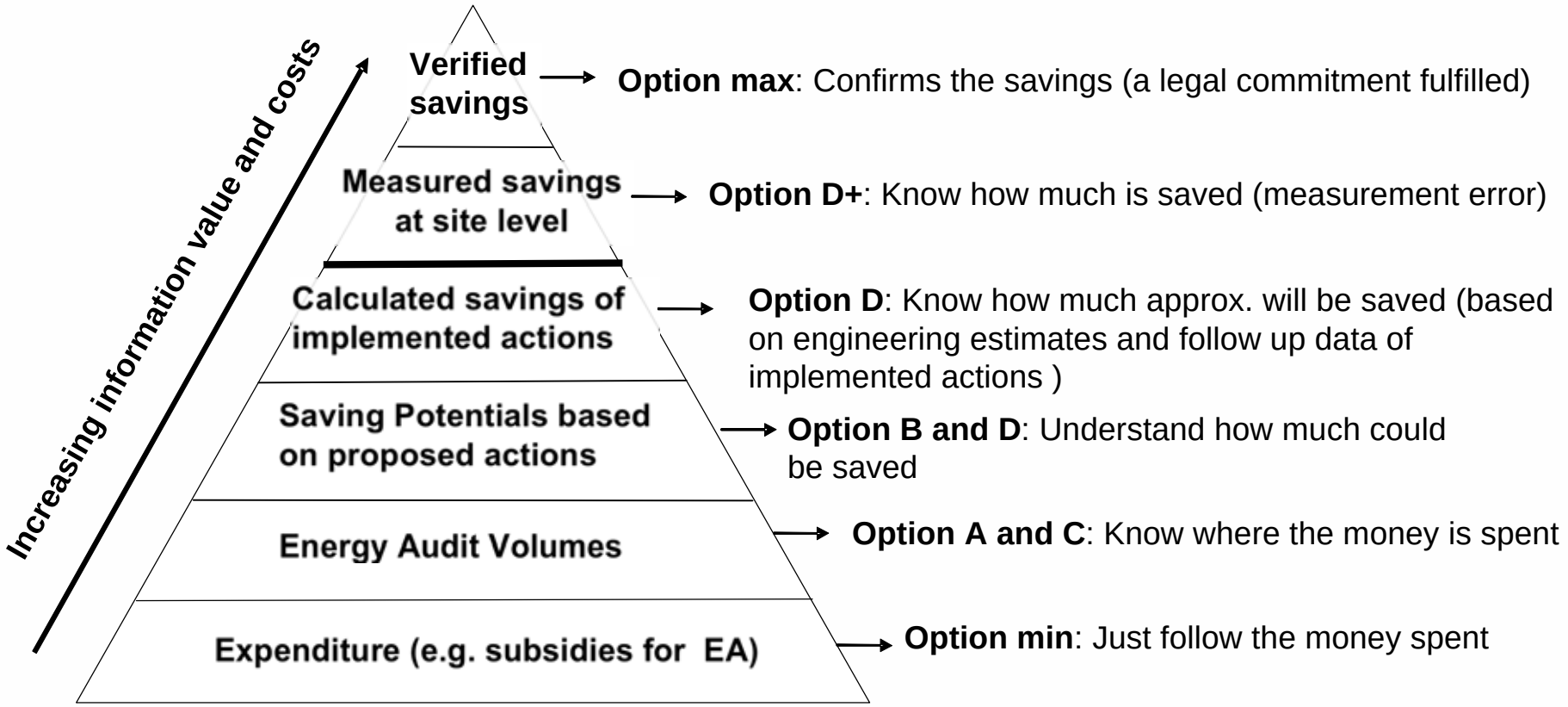
Monitoring

- **Step 2.2 Possible monitoring systems**



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Corresponding monitoring technique and costs (1)

Options	Coverage	Complexity	Rough cost estimates		Information gained from
			< 100 audits/year	> 100 audits/year	
MIN Expenditure	All audits	Easily achieved	No extra costs	No extra costs	Application
A and C Energy audit volumes	All audits	Easily achieved	Negligible extra costs	Minor extra costs – 0.25 man-months/year	Application
B and D Saving potentials	All audits	More complex. Tool necessary , i.e. database	Minor extra costs. Need spreadsheet – 0.5 man-month	Development costs: 6 man-months/year Operation costs: 1 man-months/year	Audit report
D Calculated savings of implemented end-use actions	All audits/ samples	More complex. Need tool (database) and feedback from clients.	Operating costs in the range of 2 man-months/year	Operating costs in the range of 4 man-months/year	Questionnaire/ site visits

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Corresponding monitoring technique and costs (2)

Options	Coverage	Complexity	Rough cost estimates		Information gained from
			< 100 audits/year	> 100 audits/year	
D+ Measured savings at site level	All audits/ samples	Complex. Need tool, feedback from clients and analytical expertise.	Costs in the range of 4 man-months/year	Costs in the range of 1 man-year	Questionnaire (annually)
MAX Verified results	Samples	Complex. Need tool, feedback from clients and analytical expertise.	Costs in the range of 6 man-months/year (based on representative samples)	Costs in the range of 1 man-year (based on representative samples)	Monitoring on-site level

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Calculation process

- **Choice of the evaluation efforts and the calculation option**

  - depends on the share of the audit programmes for the national ESD target; a **threshold of 10%** is proposed, above which **at least level 2** values are **required (i.e., option A excluded, C?)**

  - depends also on the **data availability** (and hence on the monitoring system used)

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Calculation process

- **Step 3.1: formula for the <u>total ESD</u> savings**

total ESD annual energy savings =

total gross annual energy savings **- *double counting*** *estimate*
- technical ***interactions*** *(?) +* ***multiplier*** *energy savings* **- *free-rider*** *savings(?)*

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Calculation process

- **Step 3.2: double counting**
  - possible crossing with other facilitating measures (e.g. subsidies, voluntary agreements, etc.)
  - can't be estimated as a coefficient factor, should be estimated in absolute terms
  - recommendation: exchanging information between the monitoring systems for the different facilitating measures or even an integrated monitoring and evaluation process
  - the decision how to allocate the possible double counting is always up to the Members State
- **Step 3.3: technical interactions**
  - best addressed during audit when estimating the savings potential by ranking the proposed actions by priority order, and then using as baseline consumption for the next lower ranked action the consumption taking account of the higher ranked actions

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Calculation process

- **Step 3.4: multiplier effect**
  - no significant evidence from existing studies
  - studies to quantify this effect are costly → recommended to consider this only when multiplier effect is strongly expected (e.g. for identical small facilities like a chain of small supermarkets)

- **Step 3.5: free-rider effect**
  - a Finnish study assessed it to be 10-15% of the realised actions
  - compensation with multiplier effect in some extent

  →may be assumed to be rather limited for energy audits (especially if conservative values are used for savings lifetime)

  →free riders (not mentioned in ESD) need not to be taken into account

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Calculation process

- **Step 4: savings lifetime**

Level 1	Default values: **6 years** for tertiary and **8 years** for industry (6 years for all, if no sector distinction can be made from monitored data)
Level 2	Proven **national average** per type of participant
Level 3	Lifetime value **per type of improvement actions** (or group of actions) if: - the Member State can present justifying information - values per type of actions are proven (national values) or agreed among Member-States (default EU values)

- **Early actions**
  - in principal all energy savings raised from energy audits (improvement actions) since 1995 can be taken into account if Member State is able to show the savings still exist in 2010 or 2016.

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Quality assurance / uncertainties

- uncertainties can be reduced significantly by **quality assurance** of the audits → if no quality assurance is done, calculations particularly at level 1 are void

- when estimated savings exceed a **certain proportion of national** total ESD energy savings **target**, a national **quality assurance** program is **necessary**. It is proposed to set the **threshold** at **5%**.

  There are **two factors** to consider:
  1) the **competence of the auditors;**
  2) the **quality of the audit reports**.

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Uncertainties

- **Possibilities to report uncertainties**

Level 1	Identify and report **sources of uncertainties**.
Level 2	Identify and report sources of uncertainties + estimate **range of magnitude** for each parameter used (min-max)
Level 3	Identify and report sources of uncertainties + conduct a **sensitivity analysis** with pessimistic/optimistic scenarios or quantify uncertainties (confidence intervals)

Discussions

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