E4 Training Week: Where to start: Energy efficiency indicators in the industrial sector and data needs

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Scenario exercise

Your manager has asked you for a report on what are the expected results of a planned energy efficiency program.

• What kind of data do you need and where do you find it?
Key elements of an industrial energy efficiency program

1. Prioritization of industrial subsectors, end uses, and technologies for targeting
2. Selection of indicators for quantifying industrial energy efficiency
3. Design of data strategies for assessing and communicating progress over time
1. Prioritization of industrial subsectors, end uses, and technologies

Some key questions:

- Which industrial subsectors account for the most energy use, and where are they headed?
Historical trends – where to get the data?

U.S. manufacturing consumption of energy as a fuel, 2002-2010

- Primary Metals
  - 2002: 1,655 trillion btu
  - 2006: 1,744 trillion btu
  - 2010: 2,123 trillion btu

- Chemicals
  - 2002: 3,222 trillion btu
  - 2006: 3,195 trillion btu
  - 2010: 3,769 trillion btu

- Petroleum and Coal Products
  - 2002: 3,319 trillion btu
  - 2006: 3,396 trillion btu
  - 2010: 3,202 trillion btu

- Paper
  - 2002: 2,361 trillion btu
  - 2006: 2,354 trillion btu
  - 2010: 3,110 trillion btu

- Food
  - 2002: 1,116 trillion btu
  - 2006: 1,186 trillion btu
  - 2010: 1,158 trillion btu

- All Other Manufacturing
  - 2002: 2,764 trillion btu
  - 2006: 3,782 trillion btu
  - 2010: 3,705 trillion btu

Projections – where to get the data?

Final energy consumption by energy source in the Indian cement sector (2DS)

1. Prioritization of industrial subsectors, end uses, and technologies

Some key questions:

- Which industrial subsectors account for the most energy use, and where are they headed?
- What are the most important end uses of energy?
Energy use by end use – where to get the data?

U.S. Manufacturing Sector Total Process Energy (TBtu), 2010

Energy use by end use – where to get the data?

U.S. Manufacturing Sector Total Nonprocess Energy (TBtu), 2010

1. Prioritization of industrial subsectors, end uses, and technologies

Some key questions:

• Which industrial subsectors account for the most energy use, and where are they headed?
• What are the most important end uses of energy?
• Are there strategic synergies or co-benefits to consider?
Multiple benefits of energy efficiency

2. Selection of indicators for quantifying industrial energy efficiency

What are energy efficiency indicators?

• Indicators are tools for analysing interactions between activities and energy consumption
• These allow policymakers to understand the impact of energy efficiency as well as the potential for future improvements
• Indicators can help to track progress over time
• An energy efficiency indicator is calculated as a ratio of energy consumption to an activity variable (physical or monetary).
2. Indicators pyramid

Level 1: Aggregate indicators
Level 2: Industry sub-sector level indicators
Level 3: Product-/process-/technology-specific indicators

2. Indicators pyramid

- At which levels of the indicators pyramid do the following indicators belong?
- Which level is best???

<table>
<thead>
<tr>
<th>Level 1</th>
<th>National industrial energy intensity ([GJ/unit of value added])</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 2</td>
<td>Energy intensity of crude steel ([GJ/t crude steel])</td>
</tr>
<tr>
<td>Level 3</td>
<td>Thermal energy intensity of clinker ([GJ/t clinker])</td>
</tr>
<tr>
<td>Level 3</td>
<td>Specific electricity consumption in primary aluminium ([kWh/t Al])</td>
</tr>
<tr>
<td>Level 3</td>
<td>Energy intensity of paper and paperboard ([GJ/t paper &amp; paperboard product])</td>
</tr>
</tbody>
</table>
2. Developing indicators - data required

- Energy use
  - Total energy use by fuel and by sub-sector/product/process
  - Greatest possible level of disaggregation to capture differences in carbon content and calorific value – include different types of coal and oil, for example
  - Should be expressed in energy units (J, toe, tce, etc. of final or primary energy) rather than in physical units (kg, l, etc.) to allow for standardised comparisons
2. Developing indicators - data required

- Physical production
  - Quantities of physical production at the product, technology, or process route level
  - For example:
    - Product: Methanol, ammonia & BTX; Paperboard, coated paper, newsprint, etc. $[\text{Mt}]$
    - Process route: Primary and secondary aluminium; crude steel from EAF, BOF, and OHF routes $[\text{Mt}]$
    - Product/technology: Mechanical wood pulp, chemical wood pulp, other pulp $[\text{Mt}]$
2. Developing indicators - data required

- **Economic output**
  - Units of economic value-added by sector, sub-sector, or product for a given country or region
  - Should be expressed in constant monetary units to allow for time series comparisons
2. Developing indicators - data required

- Other relevant data
  - Depending on the sub-sector and process, other data can also be relevant. For example:
    - In the cement industry, average clinker ratios, types and shares of waste co-processed
    - In the iron & steel industry, scrap steel use, recycling rates
    - In many sub-sectors, waste heat recovered, average carbon and calorific content of waste materials/alternative fuels
3. Design of data strategies

- Who is responsible for calculating energy efficiency industry energy efficiency indicators?

- From where do you collect the data for industry energy efficiency indicators?

- How are the indicators disseminated?
Level 1 indicator – example

Energy intensity per unit of value added by region, 2000-2012

- Can provide a picture of the evolution within a country’s industry sector
- Should not be used for cross-country comparison, though it seems comparable
Where do you get the data?

Level 1: Aggregate indicators
Typically available from IEA national energy balances, national statistical offices, national governments

Level 2: Industry sub-sector level indicators

Level 3: Product-/process-/technology-specific indicators
## Description of Level 1 indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Data required</th>
<th>Purpose</th>
<th>Limitations</th>
</tr>
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</table>
| Total energy consumption by unit of industrial value-added                | • Total industrial energy consumption  
• Total industrial value-added (in constant currency)                                                     | • Reflects trends in overall energy consumption relative to value-added                               | • Does not directly measure energy efficiency developments  
• Changes over time can be influenced by factors not necessarily related to energy efficiency  
• Cannot be used for cross-country comparison                                                                 |
Energy intensity per tonne of crude steel, 2000-2012

Source: IEA Energy Balance and IEA analysis.

Note: Energy consumption derived from IEA Energy Balance and therefore may include some energy used for non-core processes, such as some energy for captive heat/CHP.
Where do you get the data?

Level 1: Aggregate indicators
Typically available from IEA national energy balances, IOs from national statistical offices, national governments

Level 2: Industry sub-sector level indicators
Typically available from national governments through industry surveys, and/or emissions trading schemes and industry associations

Level 3: Product-/process-/technology-specific indicators

Data requirement
Level of aggregation
## Description of Level 2 indicators

<table>
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</table>
| Sub-sector energy consumption by unit of value-added | • Energy consumption by sub-sector  
• Corresponding value-added (in constant currency) | • Indicates the relationship of energy consumption to economic output in a particular sub-sector | • May hide important structural shifts in a sub-sector  
• Value-added is influenced by a range of pricing effects unrelated to physical production or energy efficiency |
| Sub-sector energy consumption by unit of physical production (specific or unit energy consumption) | • Energy consumption by sub-sector  
• Corresponding physical production | • Indicates the relationship of energy consumption to physical production | • Not possible to compare across sub-sectors because of differences in process and units  
• Cannot provide an aggregate picture of efficiency in industry  
• May hide important structural shifts in a sub-sector  
• Difficult to apply for industrial sectors where a wide range of products exist and energy consumption cannot be allocated to a specific product |
Thermal energy intensity per tonne of clinker


Note: Covers 30% of global capacity, and may not have equal coverage in each region.
## Description of Level 3 indicators

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</tr>
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</table>
| Product or process level energy consumption by unit of physical production (specific or unit energy consumption) | • Energy consumption by product or process  
• Corresponding physical production | • Indicates the relationship of energy consumption to physical production  
• Indicates energy efficiency improvements within a process or product | • Not possible to compare across sub-sectors because of differences in process and in units  
• Cannot provide an aggregate picture of efficiency in industry  
• Use care when interpreting to ensure consistent boundaries and definitions  
• Can be influenced by changes in process technology |
Where do you get the data?

Level 1
Aggregate indicators

Typically available from IEA national energy balances, IOs from national statistical offices, national governments

Level 2
Industry sub-sector level indicators

Typically available from national governments through industry surveys, and/or emissions trading schemes and industry associations

Level 3
Product-/process-/technology specific indicators

Typically collected by industry associations, but not always publicly available

Level of aggregation

Data requirement
Data collaboration initiatives: Global

- **World Steel energy and CO₂ performance database**
  - Voluntary reporting by members (about 85% of global production)
  - Anonymous site- and process-level data available to World Steel members only for benchmarking purposes

- **Cement Sustainability Initiative (CSI) – Getting the Numbers Right (GNR) Database**
  - Mandatory reporting by 24 members in 100 countries and covering 30% of global capacity
  - Publicly available country-level data and indicators for some countries, more detailed data available to members only

- **World Aluminium statistics**
  - Voluntary reporting by member and non-member companies
  - Publicly available data and indicators at regional level
  - Estimates used to fill data gaps
  - Data also available from member associations
Data collaboration initiatives: Regional

- Aluminium Federation of South Africa
  - Physical production (tonnes) of semi-fabricated products, primary metal, secondary metal and reprocessed metal on website up to 2002

- Australian Aluminium Council
  - Aggregated CO₂ emissions (direct & indirect) and emissions intensity of alumina and aluminium manufacturing for its members, 1996-2011 reported on website

- The Aluminum Association (North America)
  - Monthly physical production data for 100+ companies surveyed in US and Canada available on website for 1998-2014, more detail for members
Thank you
Data challenges

Boundary issues

- Definitions and boundaries of products, processes, and sectors should be defined clearly to allow for standardised data and easily comparable indicators
- IEA approach based on UN Statistics’ International Standard Industrial Classification (ISIC) definitions
Data challenges

- Quality of input resources
  - Some input materials, such as ores and fuels, can vary significantly in terms of quality and energy content, and can have a large impact on overall indicators.
  - Ensure that factors used accurately reflect the local context, and that data is collected on a standardised basis. Waste fuels, in particular, can have widely varying calorific values.
Data challenges

- Allocation of co-generation and on-site generation data

- These should be accounted for at the site level to ensure accurate accounting of energy efficiency and emissions. However, boundaries (particularly for surplus heat and electricity sold) should be clearly defined.