EUA-EPUE
European Platform of Universities in Energy Research & Education

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EUA-EPUE Response to SET-Plan Consultation

Key Action No. 6: Continue efforts to make EU industry less energy intensive and more competitive

BACKGROUND

This "Input Paper" provides the perspective of the European Platform of Universities in Energy Research & Education (EUA-EPUE) to the consultative process on the European Strategic Energy Technology Plan (SET Plan) - Key Action No. 6 - Continue efforts to make EU industry less energy intensive and more competitive.

EUA-EPUE responds to the consultation from the perspective of the universities' role in society. Universities constitute a significant part of the research capacity in Europe. At the same time, they educate the highly skilled work force of our societies. We consider therefore that setting up the SET Plan projects with ensured integration of innovative research with education, including industrial partners, will provide a high pay-off towards achieving the energy system transition that is the objective of the SET Plan.

RESPONSE

Proposed targets in energy efficiency in industry

For the main expected outcome: To make specific recommendations on the priorities/targets proposed in the issues paper(s)

- Do you agree with the targets set in the issue paper?
- Do you think that the level of ambition is correct?
- Are there any standing issue(s) in the way to reaching the proposed targets/priorities?

It may be useful to understand the broader context in which these targets/priorities need to be achieved. If possible, we suggest that the following is addressed as well:

- *What are your specific recommendations on prioritising R&I activities on these issues (and building where appropriate on relevant existing initiatives)?*
- *Who are the best placed actors to implement the targets/priorities (Industry, EU, Member States, regions, groups of countries/organisations/etc.)?*

The Issues Paper No. 6 provides a good synopsis of the current situation with respect to energy efficiency in industry in Europe. It helps to structure the discourse about reducing the energy intensity of Europe's industry in line with the overall goal of the SET Plan. There are however issues that should be mentioned in the background description (Section 2) in order to provide the basis for comprehensive action. These are:

- *The relative position and importance of the Industrial Sector*
    - While Buildings and Transport involve hundreds of millions "elements" (houses and cars), the Industrial Sector consists of relatively few but very large consumers of energy, which means that a few actions can make significant energy savings.
    - In addition, the "time constant" for pure efficiency measures is larger in transport (10-20 years) and much larger in Buildings (50-100 years) compared to Industry. Thorough technology changes requiring strategic infrastructure decisions however have time constants

between those of the transport and building sector (e.g. innovative technologies for steel production).

- *The role of power in industrial energy use*
  - While it is rightly stated that about 63% of the total industrial energy is for process heating and cooling, the considerable remainder is mostly power. Given the European power generation mix which is still (and will be to a considerable part in future) based on thermal power generation, the primary energy demand induced by industry will be almost evenly distributed among heating/cooling and power.
  - Applications of power in industry are primarily compression of gases, pumping and use of electricity for electrolysis in the metal industry. Especially compression and pumping offers considerable potential for energy efficiency increase in industry and must not be neglected.

- ***Do you agree with the targets set in the issue paper?***

Some initial comments on the priorities as listed under Section 6. Targets:

a. Targets should focus on specific energy consumption (i.e. per ton produced) wherever possible.
b. Exergy is often a much better measure to describe the energy utilisation in industry, since energies of different qualities are involved, and the exergy concept (i.e. maximum ability to perform work) allows a unified treatment of different energy forms. Targets should therefore be based on their potential to minimise exergy loss in processes rather than just looking at energy loss.
c. For sector-specific R&I, the priorities should be to focus on the sectors that combine the following issues in the best possible way: Where is the largest energy consumption? Where is the largest potential to save energy? Where is energy consumption most important for the competitiveness? Where are the largest “single” energy consumers? What are the most promising sector-overarching impacts that industry has on a comprehensive energy efficiency improvement of European society?
d. Based on the first four statement, it is easy to agree in the selection of sectors that are given priority in the issue paper (Petroleum refineries, Chemical and Pharmaceutical, and Iron and Steel).
e. Following the last statement, the omission of the food sector is problematic. While it is true that this sector by itself is not particularly energy intensive, wastes and by-products of this sector may provide valuable resources for energy (e.g. bio-fuels). Looking at the potential of 100 Mio t/y of waste and by products[1] along the value chain to the consumer of which a roughly a third is within the responsibility of the food & beverage industry (post-harvesting to processing to distribution), this sector may contribute considerably to the overall efficiency of European society. On top of that it would firmly link the SET-Plan with other European policies, notably the quest for a European Bio-Economy.[2]

- *30 % increase in the economical (PB < 5 years) energy saving potential by 2030*

a. A Payback time of 5 years is normally not acceptable for industrial companies unless governmental measures are used to promote such projects.
b. Given the use of 5 year PB, the target of 30% seems adequate.

[1] Based on FAO data, http://www.fao.org/save-food/resources/keyfindings/en/
[2] See: Innovating for Sustainable Growth: A Bio-economy for Europe COM(2012) 60 final, Brussels

- *1/3 of the promising emerging technologies are becoming commercially available by 2030*
  a. This depends largely on the definition of "emerging technologies". Without a clear definition of what constitutes these technologies this goal is more guesswork than analytic estimation and not helpful.
- *Develop and demonstrate waste heat recovery solutions by 2025*
  a. Waste heat recovery can follow three main avenues; direct use, upgrading the heat, by heat pumping and heat to power conversion. Several technologies exist today; the main issue is not to demonstrate, but to make these economically viable.
  b. The large amounts and the low temperature of many sources of waste heat are the main obstacles for its utilisation. In many cases, utilising this potential within processes generating this waste heat will not be possible. It requires therefore cooperation with other actors (e.g. within industrial parks, with residential settlements, etc.) to put this huge potential to use. The target therefore should focus on **inter-sectoral use** of industrial waste heat more than on **recovery**. Merging this target with the target for reduction of energy consumption by process optimisation is recommended.
- *15 % increased energy performance of components by 2025*
  a. This target is dependent on the definition of "component". A general average over very diverse components (reactors, distillation columns, heat exchangers, compressors, pumps, turbines, etc.) regarding an increase of their energy performance by 15% is not helpful!
  b. For most components, energy input is less dependent on component efficiency than on system/process efficiency. As an example, around 90 % of pumps run far from their optimal operation range[3]. The reason for this is design uncertainty, leading to over dimensioned pumps, squandering energy in considerable amounts. It is extremely inefficient to improve the performance of pumps (or any other component) at high cost when the real efficiency problem lays with design and operation. We recommend reformulating the target to a higher value (minimum 20 %) and including design and operation: "20 % reduction of industrial process energy demand by increasing energy efficiency, improving system integration and optimal design and intelligent operation of components".
- *15 % reduced energy consumption through process optimisation by 2020*
  a. The target described above in fact covers the ICT/control aspect of this target.
  b. This target therefore must focus on modelling, optimisation, process integration; this has to be made clear in the title. This is an approach separate from using ICT and control systems, as a methodological tool geared towards design and retro-fitting of industrial plants.
  c. There is a clear link between this target and the target on waste heat recovery. Optimisation must not stop at the factory gate and must be expanded to "total site optimisation", including all possible energy providers and consumers at or close to the industrial site. For this the target should be laid on primary energy utilisation at a site, limiting the allowable energy loss (e.g. to 30 % primary energy not put to any use at the total site).
  d. Besides that, the terms process integration and intensification also apply to physical integration and intensification of industrial processes. This approach (which is again separate from ICT and

[3] http://www.chemieundmore.com/archive/431696/Energieverbrauch,-Energieersparnis-und-Energieverschwendung-in-Pumpen-und-Systemen.html

control and modelling as well) in itself provides large energy efficiency potential and requires R&D efforts. We propose to include this approach under the "emerging technologies" list.

- ***Do you think that the level of ambition is correct?***

The level of ambition seems to be in line with the EU Energy Strategy as stated in 2015, where it is said that energy efficiency in industry should increase by 27% by 2030. The targets dealing with efficiency increases regarding component design, integration and operation as well as total site optimisation should be reconsidered as their focus may change.

- ***What are your specific recommendations on prioritising R&I activities on these issues (and building where appropriate on relevant existing initiatives)?***

The following bullet points highlight efforts on which prioritising R&I efforts can either build or that provide good starting points for achieving the goals described above.

a. There exists a number of road maps regarding emerging technologies[4] that already provide insight into prioritising R&D efforts. As experts in the respective fields have assembled them, they can act as basis for prioritising R&D efforts.

b. The introduction of White Certificates has certainly been a strong driver for energy efficiency. The impact of this tool has been relevant particularly for industry (79% of certificates issued in 2014 in Italy). Of these certificates, 50% concern the generation and recovery of heat and cooling, while 41% concern the energy optimization of industrial processes and plant layout.

c. The compulsory energy audit of large industrial users and of high-energy intensive industrial plants, enforced in 2015 following the Energy Efficiency Directive (EED), has definitely promoted awareness of the energy problem among industrial operators. The local administrations should launch programs to promote energy audits of companies, such as PMI, for which the EED audit process was not required.

d. Transparent application of the evaluation criteria in the White Certificate awarding process is highly desired by industry

e. The application of ISO 50001 Energy Management schemes should be promoted, for example by means of fiscal incentives or more favourable investment amortization periods.

Proposed targets in energy efficiency in industry

1. **Sector specific R&I**: Increasing the energy efficiency of our most energy consuming industries by increasing the cost effectiveness of **existing technologies**.
   Target: By 2030, the energy saving potential related to economically viable technologies (i.e. payback not longer than 5 years) is increased by 30% compared to the potential identified in 2015.
   Indicators: Economic energy savings potential (payback not longer than 5 years)

a. In order to tap the potential of the food & beverages sector to reduce bio-resource loss along the bio-value chain from post-harvest to distribution, a mapping of all relevant waste and by-product flows from this sector is necessary. Specific targets for increasing the efficiency along

[4] See e.g. the CEPI Two Team effort for pulp & paper industry: http://www.cepi.org/system/files/public/documents/publications/innovation/2013/finaltwoteamprojectreport_website.pdf

this value chain have to be set, in accordance with the targets for energy loss prevention proposed here under the cross cutting technologies section above.

b. Building on existing methodologies[5], optimal technology networks to utilise these resources and transform them to useful products (e.g. bio-fuels) and energy services must be generated.

c. Implementation of these measures requires **cooperation between academia** (improving value-chain-optimisation methods), **industry** (both as by-product and waste generator and as utiliser of these secondary resources), **agriculture and regional authorities** (as the use of many of these secondary resources must be de-central as they have disadvantageous logistical properties). Development of innovative business models along the bio-value chain are necessary.

Proposed targets in energy efficiency in industry

2. **Sector specific R&I**: Increasing the energy efficiency of our most energy consuming industries by progressing **emerging technologies**.
   Target: By 2030, 1/3 of the currently promising emerging technologies are becoming commercially available.
   Indicators: R&I Maturity progress (lab, pilot, demonstration).

a. Emerging technologies, including process intensification and physical integration of process steps still require successful transformation from basic research to pilot scale and finally industrial application. This calls for **intensive collaboration between industry and academic researchers**. Particular emphasise must be laid fostering collaboration for the step from lab to pilot scale and from pilot scale to industrial demonstration. This requires the development of strong networks of pilot plant installations, jointly operated by industry and academic research institutions.

Proposed targets in energy efficiency in industry

3. **Cross-cutting R&I**: maximising the economic returns of **waste heat recovery**.
   Target: By 2025, develop and demonstrate waste heat recovery solutions (heat exchanger, storage, distribution, and industrial symbiosis).
   Indicators: Evolution of BAT for heat recovery (IED), monitoring of industrial excess heat

a. In addition to existing technologies, emphasis should be on R&I for new technologies that can utilise some of the 750 TWh of waste heat in Europe. Electrical energy production from waste heat using ORC plants is a fairly well established technology in selected industrial sectors (e.g. steel, glass, and cement manufacturing). There is a need for R&I concerning the optimal reuse of lower grade waste heat. Stirling motors are potentially an alternative solution for electrical production from waste heat.

b. There is a definite R&I requirement to improve thermal storage and energy conversion technologies for the heat recovery from batch processes.

c. Further development and **dissemination from academia** to industry of proper analysis techniques for industrial energy systems optimisation is necessary. One example is the application of Pinch Analysis to optimise heat exchangers networks in complex industrial plants / processes. This technique may be applied both to heat recovery inside a given manufacturing process, and to the use of waste heat to produce different energy carriers. R&I efforts are

[5] E.g. methods generated within the BioEnergyTrain project, see: http://www.bioenergytrain.eu/

necessary to enlarge the range of application of such methods, e.g. to Work and Heat Exchange Networks (WHENs), where the traditional heat recovery problem is extended to include power recovery as well as to utilise the heating of compression and the cooling of expansion.

d. Many industrial plants have excess heat production in the warm / hot season. In presence of a significant and simultaneous demand of cooling energy (for process uses or space air conditioning), opportunities arise to use the waste heat as energy input for absorption refrigeration equipment. The same concept applies to CHP, yielding to tri-generation. **Cooperation on R&I between industry and research institutions to improve technologies and analytical methods to optimally integrate these technologies is necessary.**

e. Ventilation is usually one of the main terms of the thermal energy budget of a factory. Regenerative heat recovery from exhaust air or fume hoods (pre-heating of ventilation outdoor air) using either "passive" heat recovery with heat exchangers / heat-moisture exchangers, or "active" heat recovery with heat pumps have a high potential of development.

f. The cold chain determines high demands of refrigeration energy in the successive phases of food manufacturing, storage, distribution and retail. Recovery of condensation heat from refrigeration cycles represents a very interesting energy saving opportunity, for example in supermarkets. **Integration between food refrigeration and air conditioning should also be considered and assessed.**

g. Wherever possible combustion (with enormous exergy losses) should be replaced by compression and expansion. In this respect, adiabatic compression and research into compressors that are able to operate at high temperatures is a promising field for R&I activities.

h. If combustion has to be used opportunities exist for a more widespread application of economisers and recovery heat exchangers on exhaust fumes. R&I activities for burners should aim at both pollutant emission reduction and increased combustion efficiency.

i. Optimisation of energy management in industries has to follow a "total site" approach, **including all energy providers and consumers** in the vicinity of industrial plants. **This requires close cooperation with academic research institutions** (to provide progress in the methodological approaches for total site integration and optimisation) **and communities** (as possible consumers of excess industrial heat).

j. Progress on approaches in "industrial ecology" to integrate different industrial processes in industrial parks are necessary to improve the overall energy efficiency of the industrial sector. **This requires innovative cooperation between academia and industry to improve methodological approaches and implement them in industrial practice**.

Proposed targets in energy efficiency in industry

4. **Cross-cutting R&I:** maximising the economic returns of **high-efficiency components**.
   Target: By 2025, improve energy performance of components by 15%
   Indicators: Minimum energy performance standards for relevant industrial products (EcoDesign Directive) / evolution of BAT (IED)

a. Optimal design, system integration and operation of components offer energy efficiency potentials that usually dwarf those of technological innovation to improve the performance of components themselves. This requires cooperation between academic training and industry to improve, disseminate and implement innovative approaches to the design of fluid transport, pneumatic and heat transfer systems within industrial processes.

b. R&I efforts are necessary to improve materials and heat exchanger geometries/configurations to reduce fouling.

c. High efficiency lighting has been one of the most widely applied areas of intervention in industry (as well as in public outdoor areas). The development of reliable and affordable LED technologies, already established in the past years, will drive further results in this area.

d. The strong diffusion of variable speed drives, coupled with high efficiency AC electric motors (e.g. reluctance motors) has been the other key technology in the area of high-efficiency components.

e. Compressed air is one of the main energy users in several manufacturing sectors. The management optimization of multiple compressors systems, coupled with diagnostic tools aimed at air leakage detection, are very promising areas of improvement. Work recovery in compressed air pressure reduction processes, as an alternative to dissipative expansion, should also be considered.

f. Small size CHP system, based on IC engines, turbines or fuel cells, still have a limited application in industry. There is definitely a potential for a wider application of such technologies.

Proposed targets in energy efficiency in industry

5. **Cross-cutting R&I:** Enhancing operational improvements with **ICT** and intelligent operating systems
   Target: Enhancing operational improvements with ICT and intelligent operating systems
   Indicators: % of savings related to operational improvements

As already stated in the critique of the targets, there is a clear link between this target and target 3 (waste heat recovery). Process optimisation and (methodological) integration must apply a “total site” approach and the issues raised under target 3 apply therefore to this target, too. Merging the targets under a stringent target limiting primary energy loss is recommended.

CONTACT

Dr. Lidia Borrell-Damian
Lidia.borrell-damian@eua.be
Director, Research & Innovation
European University Association

Lennart Stoy
Lennart.stoy@eua.be
Project Manager, Research & Innovation
European University Association