Integrating energy efficiency into industrial strategy – a case study from the European aerospace sector

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Abstract

The many examples of energy efficiency initiatives in the literature are limited to “what” not “how”. A gap exists on how organisations translate energy efficiency objectives into strategy. The available literature is either generic on strategy deployment or lacks empirical support. This research explores how a European aerospace manufacturer developed its strategy in order to meet its energy efficiency objectives. The research documents four years of observation covering: an energy efficiency initiative in one manufacturing plant; the launch of a central strategy across plants; inter-plant integration and coordination; completed improvement projects. A narrative of these activities is presented and critically reviewed against the literature and is validated using commentary from key actors within the organisation and document analysis. The paper provides practical insights for other manufacturers embarking on their journeys. The challenges encountered are documented and used to present issues for further research.

1. Introduction

There is growing evidence that industry is starting to see the value of operating in a sustainable way [1]. Although the focus for many companies still tends to be on solely environmental issues there are also stories of companies realizing benefits across the triple bottom line [2][3]. Nowhere is this more evident than in large OEMs. And nowhere is this more evident than in the topic of energy efficiency [4].

Energy efficiency is an important short to medium term step for companies embarking on their sustainability journey. Energy is unique as an environmental aspect in that it has an increasing direct cost associated with every unit used and is linked directly with another environmental aspect, CO₂. Thus companies who reduce energy also reduce CO₂ impact and recurring cost. This cost saving serves to demonstrate the value of working in an environmentally responsible way generating future buy-in and is also a potential funding source for future projects.

Along with pressure from customers, policy makers and lobby groups these immediate financial benefits are important drivers for moving the sustainability agenda away from just a communication exercise to a corporate strategy.

For the aerospace sector, corporate social responsibility has been high on the agenda for some time (see section 3.2). The public perception of air travel as a significant contributor to climate change has led to OEMs developing a clearly defined and well publicized environmental strategy [5]. The focus has generally been on reducing the in-service emission of aircraft, although more recently the impact of manufacturing operations has also been targeted (see section 3.2).

But how do such approaches cascade from the boardroom to the shop floor? There are many examples of corporate objectives towards energy efficiency as well as examples of successful energy efficiency projects. However there is little
evidence which demonstrates how these corporate objectives drive the improvement projects.

This paper presents a longitudinal case study from one of the large aerospace manufacturing companies, Airbus, showing the emergence of an industrial strategy towards energy efficiency. In the context of this paper, “industrial strategy” means any strategy which drives activities within a manufacturing operations perimeter.

This paper contributes to knowledge by providing insight into practice through the presentation of an industrial case study. It further contributes by analysing that study to provide practical insights both to other manufacturers wishing to develop industrial strategy for energy efficiency and also to researchers with an interest in how industrial strategy can be effectively cascaded across an organization to improve eco-efficiency.

2. Approach

This work explores how a company developed its energy efficiency strategy. In particular it seeks to understand how the company developed the strategy across many sites rather than what it implemented in isolation. The paradigm of this research is therefore phenomenological to capture how changes to processes occur over time.

The method is case based. The cases are drawn from multiple sites of a single corporate entity. Data collected is both quantitative and qualitative to capture the impact of changes as well as the processes that led to them. The research is longitudinal, capturing repetitive implementations of an improvement approach. The work therefore passes through multiple iterations of description, explanation and testing. It should be noted that for the purposes of brevity of reporting the iterations will not be reported explicitly.

The method of data collection is observation from one of the authors using observation journal, interview and document collection. The implementation of the change projects are by multiple groups of employees of the corporation, some of which are led by one of the authors. The unit of analysis is an individual change project and all available change projects are included in the analysis.

Deductive reasoning is used for the case analysis. The within-case analysis and cross-case analysis was carried out with the latter being reported here. The outcomes are validated by multiple actors within the company, some of whom are directly involved in the change programme, others are independent of it.

3. Case Study

The following case study is presented in four parts. The first part describes how a manufacturing site implemented an initiative locally in response to the corporate vision. The second part describes how the corporate vision was broken down into an industrial strategy and how internal good practice was identified and embodied in the strategy. The third part describes how the industrial strategy was deployed through a company-wide network. The fourth part describes how this industrial strategy led to improvement projects which delivered savings in line with the corporate objectives. The interaction between these different parts is shown in Figure 1 below which contains references to the relevant subsections.

![Fig. 1. Overview of the case study](image)

3.1. Local Plant Initiative

In 2009, a team working at Airbus’ plant in Broughton, UK, saw there was an opportunity for improving the environmental performance of the plant by first looking at improving the performance of the manufacturing system in order to reduce the energy consumed by manufacturing processes. Until this point most energy improvements had been focused on building performance. By looking at both buildings and the manufacturing system in tandem the team theorized that significant savings could be made and so led a consortium in a 3-year research project funded by the UK government to look at how this could be modelled called THERM [6]. As a result, the team uncovered best practice externally based on lean principles [7]. This was then modified for use in the Broughton plant and implemented in a pilot [8]. Further modifications were made to create a methodology which was rolled out across a number of manufacturing processes in the plant.

The methodology makes use of classic lean tools [9] with an emphasis on continuous improvement through “plan-do-check-act” and the identification and elimination of non-value add use of energy. A key part of the approach is the way in which improvements are prioritised according to an interpretation of the waste hierarchy applied to energy. These prioritising steps are stop, remove, repair, reduce, trade and change. The resulting acronym STRE3TCH is the name by which the approach became known. More information on this approach can be found in [8].
3.2. Central Initiative

Airbus established a corporate vision for environmental performance in 2006 known as Vision 2020. This vision related to an improvement across five key environmental aspects by 2020 compared to 2006 levels. (These aspects were energy consumption, CO₂ emission, waste production, volatile organic compound (VOC) emission and water consumption and industrial discharge). An environmental management plan (EMP) was put in place describing the corporate approach for environmental improvement, externally validated in 2007, leading to Airbus becoming the first aerospace enterprise to be ISO14001 certified for all its sites and products.

In 2009 a multi-functional team (MFT) was set up to support work towards the energy objective known as the Energy MFT. This was led by the facility management function and as such improvements focused on areas such as building performance and energy generation. Manufacturing was not deemed outside scope but there was limited engagement with the manufacturing community.

In order to further drive the corporate objectives into manufacturing and to develop an industrial strategy for the environment, in 2011 an initiative was launched led by the communications team called Blue5 (after the five environmental aspects in the corporate objectives). It was soon found that a communications initiative alone would not drive the behaviours and projects required to meet the objectives and so the Blue5 team went in search of demonstrated good practice across Airbus through engagement with environment managers at each manufacturing site. The environment manager at Broughton highlighted the impact the STRE3TCH initiative had had at the site and, after investigating the savings claimed, the approach was adopted as part of the industrial strategy.

3.3. Cross-Plant Integration

In 2012, in order to implement the strategy a roadmap was created based on three key areas of activity in industrial energy efficiency. The first of these areas was the lean approach outlined in the STRE3TCH initiative in Broughton. The second was to ensure that any new processes were designed in such a way to be as energy efficient as possible, in effect implementing STRE3TCH in the design phase of a system. The third was to put energy efficiency on the research agenda within the organization so that energy is considered when new technologies are being developed. Through the whole strategy the idea of continuous improvement is key.

Up to this point initiatives had been centrally focused with engagement within manufacturing plants limited to raising awareness. It was agreed that in order to replicate the improvements in Broughton across the plants a process of cross-plant coordination needed to be performed. Airbus had previously done this when seeking to harmonise its manufacturing processes through the use of what it calls Airbus Process Technology Leaders (APTLs) within the manufacturing engineering function. This approach consists of each plant nominating a representative with one representative taking the lead and coordinating activities

Thus the same approach was applied to the creation of an industrial energy efficiency network. The process was coordinated by the manufacturing engineering function which both has some responsibility for environmental performance in an industrial perimeter and also has the experience of cross-plant coordination as described above.

In the second half of 2012, each plant was asked to nominate a representative. Notably in this case the representatives on the network were not all from the same function but were from the following mix of functions: industrial maintenance (5), manufacturing engineering (3), lean operations (1), health & safety (1), facility management (1). This network extended across all the manufacturing plants within Airbus across Europe: UK (2), France (3), Germany (3), Spain (3). Each representative was asked to identify and launch a number of projects at their respective sites in 2013 based on the lean approach from 3.1. Based on these projects individual targets were set at each plant, added to the overall objectives of each plant manager and tracked centrally in a reporting tool. The targets were annual and based on savings measured in absolute terms in megawatt hours (MWh). A coordination processes was agreed where all the plants meet together for two days once every three months to discuss their projects and to share good practice identified locally.

3.4. Results After One Year

Table 1 below shows the savings achieved by the different plants in the first year of implementation. Figures have been normalized against the savings target of Plant A.

Table 1. Energy savings per plant during the first year of improvement

| Site Reference | Savings Target | Actual Savings | Savings cf. target |
|----------------|----------------|----------------|--------------------|
| Plant A        | 1.000          | 1.712          | 171%               |
| Plant B        | 0.001          | 0.006          | 500%               |
| Plant C        | -              | -              | -                  |
| Plant D        | 0.375          | 0.083          | 22%                |
| Plant E        | 0.125          | 0.122          | 97%                |
| Plant F        | 0.208          | 0.208          | 100%               |
| Plant G        | 0.167          | 0.392          | 235%               |
| Plant H        | 0.286          | 0.224          | 78%                |
| Plant I        | 0.108          | 0.108          | 100%               |
| Plant J        | -              | -              | -                  |
| Plant K        | 2.917          | 4.167          | 143%               |

Plant C did not set a target because it did not have any resource for carrying out projects in 2013. A lack of resource was also an issue in plants D and H where the savings were less than planned. This shortfall was because some planned projects could not be carried out due to the lack of resource. Plant J initiated a project in 2013 but is due to deliver in 2014 and so had no target or savings for 2013. The other plants either achieved their target within a few percent or far exceeded their target due to additional projects being complete outside of the original forecast.
Examples of projects include control system optimisation, compressed air leak repair, cycle time reduction and machine refurbishment.

Note that during this period revenues grew by 7% thus the improvement in efficiency is not associated with any economic downturn. Since the savings are not normalised against production this too is not a factor.

4. Analysis and Discussion

Based on the results achieved after one year the approach outlined in the case study above appears to lead to positive results. Only facility management-led projects recorded savings prior to 2013 (with the exception of the Broughton initiative), thus it could be inferred that these savings would not have taken place without the industrial strategy in place. However what cannot be determined is whether a different strategy would have led to greater or lesser savings. Also, the sustainability of any savings, or rate of savings, cannot be determined after only one year. The following analysis and discussion will therefore focus on critically assessing the means by which the corporate objective for energy efficiency was integrated into an industrial strategy and the features of this strategy rather than critically assessing the impact of the strategy.

4.1. Underpinning improvement methodology

A key feature of the strategy is that it is underpinned by an improvement methodology which influences all aspects of the strategy. As the methodology is based on lean manufacturing principles this is perhaps not surprising. Lean tools are well documented (e.g. [9]) and are used by many manufacturing organisations. However the biggest gains are to be made when lean philosophy becomes integral to the corporate strategy [10].

Some authors [11]-[13] have shown how lean approaches can naturally lead to increased energy efficiency; production efficiency results in less wasted resources including energy. However there are few documented cases of lean approaches being specifically tailored for energy reduction. Hope [14] is the first to show a unique approach to energy in lean and indeed it is this approach which was adapted and used in the case above in 3.1.

It is perhaps this uniqueness which raised the profile of the initiative in Broughton to such a degree that it was adopted as the industrial strategy for energy efficiency. The fact that the methodology had also been proven elsewhere [15] is also significant. The barriers to implementing energy efficiency are well documented (e.g. [16]-[18]) with the fear of implementing something which will not work featuring prominently. However, pointing to successful implementation in a similar environment can certainly reduce the impact of barriers associated with this fear of failure. The initiative in the Broughton plant therefore made extensive reference to the approach as “coming from Toyota” (i.e. in [14]) to generate buy in and avoid this barrier [18]. Equally, once proven in Broughton it was therefore much easier to integrate the approach across the different manufacturing plants. The Energy MFT refer to the industrial strategy in its entirety as “the lean approach”.

4.2. Organisation to support the strategy

An improvement methodology needs actors to carry out the improvements, thus having a good structure through which these actors can act and interact is important.

A variety of organizational structures are described in the case. The organization described in 3.1 is very locally focused, responding to the needs and pressures of the plant. Although it is working towards the corporate vision (described in 3.2) its focus is on improving local environmental performance. In order to do this external partnerships are forged and it is through benchmarking against another company outside Airbus that good practice is brought in. The process through which this good practice is applied is also interesting in that it is first piloted before being deployed more widely, which is itself an embodiment of the lean way of working present in the good practice. (That is, plan-do-check-act is applied, as described in [9].)

This local organization is very different from the organisation of the corporate headquarters described in 3.2. The central organization is very strategic in nature with a global view across the whole organization. A clear vision for environmental performance is set for the company which is then broken down into its constituent parts based on the key aspects of that vision. For example, the objective for energy reduction is described as part of the global vision but the strategy for that aspect is managed by a dedicated team made up of representatives from across the company and led by the function which can have the biggest impact on achieving the objective. This underlying organizational structure to support the strategy is not immediate following the vision and takes time to develop, as can be seen from the timings given in 3.2 between each level of breakdown of the vision.

The organizational structure described in 3.3 is somewhere between the other two. There is a local focus with each plant acting as described in 3.1 – and there is also a good link to the existing central organization (the Energy MFT and Blue5) which is fostered through the network across all the plants. This network ensures the cascade of information across the organization – horizontally, with good practice being shared between the plants, and vertically, with objectives being cascaded down from the central functions and savings being reported upwards.

Not long into the first year of implementation it was found that the industrial maintenance function was ideally suited to supporting this kind of activity because they had both the technical understanding of the manufacturing processes and also the ability to effect change through their existing perimeter of control. In future years the strategy could be adapted to have a point of contact from industrial maintenance in each plant. As important as industrial maintenance is, the diversity of the representatives is still seen as a strength of the network as each member brings different expertise and experience. For example, one representative from the manufacturing engineering function was able to bring
significant expertise on painting processes which became a sub-strategy deployed across all the plants.

It is important to note that all plants are considered as equal in the network, irrespective of the size of the plant or the projects being carried out. It is also important to note that the variety of functions represented within the network means that there is a breadth of knowledge available to each representative. During the first year of implementation a representative from one plant was observed to provide assistance to a representative from another plant on numerous occasions.

4.3. Setting appropriate targets

Having people in place with a methodology to follow does not necessarily mean that improvements will take place; those people need to have a target.

The change management literature (e.g. [19]) states that an appropriate vision and a sense of urgency are required to motivate people towards change. The overall vision is provided by the corporate vision for energy efficiency (see 3.2 above). However for many people this vision is hard to relate to, if indeed they are aware of it at all, and so it certainly does not provide the sense of urgency.

In the case above this sense of urgency was provided by asking the plant representatives to set an objective for their plant in the form of an energy savings target to be realized within one year and by making the representative responsible for achieving that savings target. This annual timeframe adds more urgency than the targets due by 2020 described in 3.1 above, but also allows some flexibility so that the representatives are still free to work on day-to-day objectives unrelated to energy (i.e. their “day jobs”). These targets became part of each individual’s performance review which is linked to annual remuneration appraisals. Further importance was given to each target by also including it (to a lesser degree) in the plant manager’s performance review.

As can be seen from Table 1, there is a large range of targets set for each plant, which exposes an obvious flaw in allowing the representatives to set their own targets. The targets are not based on savings potential relative to overall site consumption but are based on expected savings from improvement projects. This means that although the plants are working towards the corporate objectives, by asking them to set their own targets there is no hard link to the corporate objectives.

The main reason given for this is to maintain the engagement of the plants. Since the industrial strategy is new the engagement was deemed to be too fragile to risk plants simply dismissing the targets as unobtainable.

An additional consideration is that it is the plant representatives who are in the best position to decide what is achievable or not and so are the only ones who can set meaningful objectives; it is better to save some energy than none at all.

It is also clear that the existing energy efficiency of each plant will be different and so some plants will have more opportunities than others. An analogue of this is the improvement of another key resource: water. One plant has already achieved a reduction in line with the corporate objectives due to compliance with legislation whereas some other plants have demonstrated an increase. It would therefore be unfair to expect all plants to have the same annual water reduction target – and it could mean that some plants would never actually meet their commitment.

The success of the industrial strategy for energy efficiency in the first year of implementation means that engagement is now high and it has been possible for the representatives to be encouraged to set more challenging targets for the second year more closely aligned with the corporate objectives. Indeed some plants have already linked their target with the corporate objectives. In order to have true integration however the industrial strategy will need to provide a stronger link between the activities of the plants and corporate objectives.

5. Conclusions

Energy efficiency has been integrated into the industrial strategy for Airbus and has led to savings after one year of implementation. The key factors for enabling integration of energy efficiency into the industrial strategy are:

- Defining the strategy through an improvement methodology which actors across the organisation could identify with and use;
- Allowing the implementation of the strategy to be run from the industrial plants rather than from corporate headquarters;
- Setting industrial-specific targets which the industrial plants are accountable for.

Further work is required to understand how effective the strategy is at saving energy and whether it is transferable to other organisations and sectors. The industrial strategy could also be further improved by creating a clear link between the corporate vision and the plant objectives.

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References

[1] M. Despeisse, F. Mbaye, P. Ball, and A. Levers, “The emergence of sustainable manufacturing practices,” IUPCC, pp. 1–29, Dec. 2010.
[2] J. Elkington, Cannibals with forks: The triple bottom line of 21st-century business, 1st ed. Oxford, UK: Capstone, 1997.
[3] P. M. Senge, B. Smith, and N. Kunschiz, The Necessary Revolution: How Individuals and Organisations Are Working Together to Create a Sustainable World, 1st ed. London, UK: Nicholas Brealey Publishing, 2010.
[4] P. Ball, S. Roberts, A. Davé, and H. Pimenta, “16.1 Towards a factory eco-efficiency improvement methodology,” presented at the 11th Global Conference on Sustainable Manufacturing, Berlin, 2013, pp. 542–547.
[5] ATAG, “Aviation Industry Commitment to Action on Climate
Change,” presented at the 3rd Aviation & Environment Summit, Geneva, 2008, pp. 1–1.

[6] P. Ball, M. Despeisse, S. Evans, R. Greenough, S. Hope, R. Kerrigan, A. Levers, P. Lunt, M. Oates, R. Quincey, L. Shao, T. Walmsley, C. Wheatley, and A. Wright, “Modeling buildings, facilities and manufacturing operations to reduce energy consumption,” POMS, Apr. 2011.

[7] M. Despeisse, M. R. Oates, and P. D. Ball, “Sustainable manufacturing tactics and cross-functional factory modelling,” Journal of Cleaner Production, vol. 42, pp. 31–41, 2013.

[8] P. Lunt and A. Levers, “Reducing Energy Use in Aircraft Component Manufacture - Applying Best Practice in Sustainable Manufacturing,” presented at the SAE AeroTech Congress 2011, Warrendale, PA, 2011, 1st ed.

[9] J. Bicheno, The New Lean Toolbox. Picse Books, 2004.

[10] T. Ōno, Toyota Production System: Productivity Press, 1988.

[11] K. Kissock and J. Seryak, “Lean Energy Analysis: Identifying, Discovering and Tracking Energy Savings Potential,” presented at the Proc. SME, Livonia, MI, USA, 2004, no. October, pp. 1–11.

[12] K. Kissock and C. Eger, “Measuring industrial energy savings,” Applied Energy, vol. 85, no. 5, pp. 347–361, May 2008.

[13] J. Seryak and G. Epstein, “Quantifying Energy Savings from Lean Manufacturing Productivity Increases,” presented at the Proceedings of the 28th Industrial Energy Technology Conference, New Orleans, LA, USA, 2006.

[14] S. Hope, “Sustainability in Manufacturing - towards zero emissions,” tv.theiet.org, 10-Nov-2011. [Online]. Available: http://tv.theiet.org/technology/manu/12068.cfm. [Accessed: 22-May-2014].

[15] S. Evans, M. N. Bergendahl, M. Gregory, and C. Ryan, Towards a Sustainable Industrial System. University of Cambridge, 2009.

[16] S. Sorrell, J. Schleich, S. Scott, E. O'Malley, F. Trace, U. Boede, K. Ostertag, and P. Radgen, “Reducing barriers to energy efficiency in public and private organizations,” SPRU, Jun. 2000.

[17] P. Rohdin and P. Thollander, “Barriers to and driving forces for energy efficiency in the non-energy intensive manufacturing industry in Sweden,” Energy, vol. 31, no. 12, pp. 1836–1844, Sep. 2006.

[18] P. Lunt and P. Ball, “Barriers to energy reduction in manufacturing,” presented at the Proceedings of the 10th International Conference on Manufacturing Research, Aston, 2012, vol. 2, pp. 699–704.

[19] J. Kotter, Leading Change, 1st ed. Boston, MA, USA: Harvard Business School Press, 1996.