

Development of Energy Consulting Competence by Solving Dilemma Situations with Structure Formation Techniques

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Abstract

Rising energy prices and stricter energy laws have dramatically increased the need for energy consulting services in Germany. The energy consulting market lacks uniform standards, and craftspeople working in this area of work find it difficult to transfer their high skill level in their original jobs into energy consulting services.

Energy consulting is characterised by uncertainty. Based on a specialized competence model, and adhering to the didactical concept of moderate constructivism, open-ended dilemma exercises were designed, i.e. concrete energy consulting scenarios in which learning energy consultants deal with various sources of uncertainty. These exercises are implemented with the help of the Heidelberg structure formation technique. By dealing with uncertainties in real life situations, the competence of energy consultants should be developed.

Workshops were designed in which groups of energy consultants deal with trilemma exercises in this open, constructivist environment. In each exercise, the participants use various approaches, resulting in a wide variety of solution networks. Development of competence was achieved on multiple levels. Most importantly, energy consulting was seen as an area with paradoxical requirements, so they developed open, holistic thought patterns rather than linear reproductions of rote solutions. In addition, most participants embrace an innovative reflection mode, further improving their competence. The workshops for development of competence were carried out successfully and will be refined in the future.

1 Introduction

Rising energy prices and the new German Energy Saving Ordinance (EnEV), which includes the now-compulsory energy certificate and which was published in accordance to the EU Directive on the Energy Performance of Buildings (EPBD), have dramatically increased the demand for energy consulting services in Germany. Energy consulting is characterised by a high level of uncertainty on multiple levels, caused by the complexity of the domain, paradoxical requirements and perspectives, dynamic of the interaction and others.

To develop competence in such an open environment, a linear, unidirectional approach, in which a teacher thinks in terms of “true and false”, is not useful.

This objectivist approach requires a low level of uncertainty, which is not applicable in energy consulting. Achievement of competence development in an open field like energy consulting is enforced by a didactical principle which uses the uncertainty to its advantage. To combine competence development with the uncertainty of energy consulting, constructivism offers a viable didactical approach. A comparison of traditional didactical concepts and open constructivist concepts is given below (see Table 1). It becomes evident that purely objectivist positions are not sufficient to provide energy consultants with vocational and further training, but a subjectivist approach is preferable.

Table 1: Comparison of traditional and constructivist didactical concepts [Reich 2002]

Traditional didactics	Constructivist didactics
Learning by dividing material into small separate units	Learning by discussion of complex, real-life problems
Teaching in terms of “right and wrong”	Teaching in terms of “find your own way”
There is only one single correct answer	There are several correct answers
Short-term learning Contents quickly forgotten after exam	Long-term learning “Learning for life”

A specialized competence model was defined, and adhering to the didactical principles of moderate constructivism, open-ended dilemma exercises were designed, i.e. concrete energy consulting scenarios in which energy consultants deal with various sources of uncertainty, especially paradoxical requirements. These tasks require a construction of a subjective theory (i.e. individual line of thought used to handle a particular problem), which can be documented using the Heidelberg structure formation technique. This technique includes the construction of a card/arrow-network, thus allowing easy visualization of the subjective theories designed to handle the same trilemma exercise. Therefore, it provides a fertile means to encourage discussion among the participants.

By dealing with uncertainties in real life situations, the competence of energy consultants is developed. Following this line of thought, workshops were organised. The methodology, the results and the significance for further research are highlighted in the following text.

2 Theoretical model for energy consulting

To provide a theoretical foundation for measurement of competence, the existing energy consulting competence model of Lüneberger and Frenz [2009] was adapted and refined. The new theoretical model contains three dimensions: fields of activity in energy consulting, areas of competence, and levels of reflection (see Fig. 1). In the following sections, these concepts are described in further detail.

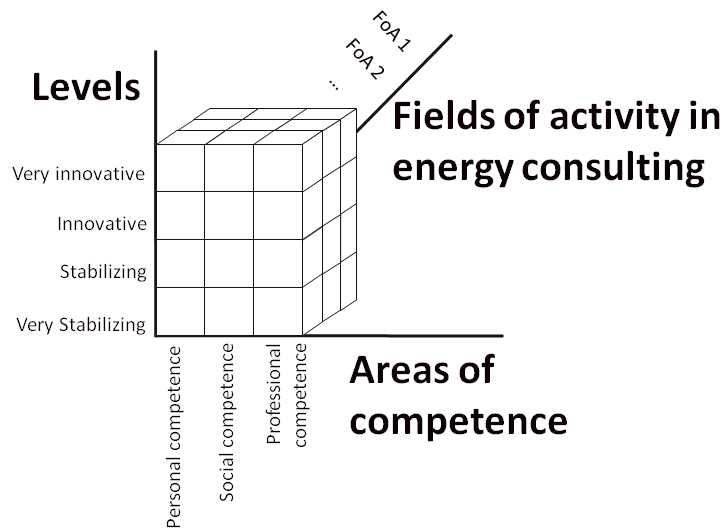


Figure 1: Competence model of energy consulting

[adapted from Lüneberger and Frenz 2009]

2.1 Validated fields of activity in energy consulting

After conducting workshops with energy consultants, Heinen et al [in proceedings] defined a validated curriculum for energy consulting, which contains ten fields of activity (FoA) along the chain of economic value added (see Fig. 2).

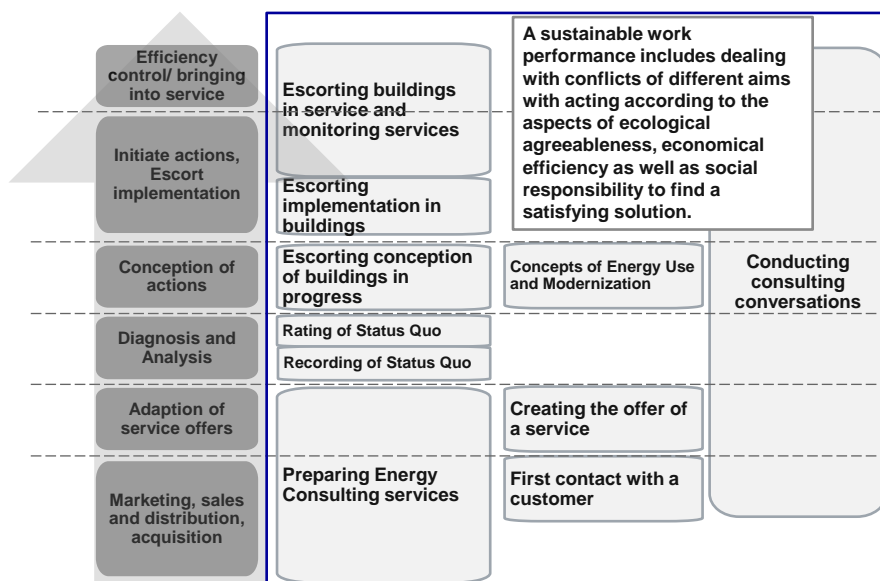


Figure 2: Validated fields of activity in energy consulting [Heinen et al, in proceedings]

Expert workshops have shown energy consultants are far more often confronted with paradoxical and conflicting situations than in the fields of activity of their original jobs, e.g. chimney sweeper, carpenter or draftsman. There are several reasons for these conflicts.

Firstly, energy consultants should comply with the UNESCO definition of sustainability and with the principles of Education for Sustainable Development (ESD): an individual must recognize,

understand and evaluate the mutual dependencies (triple dilemma, or “trilemma”) between social, ecological and economic demands (see Fig. 3) [UNESCO 2010]. In practice, the balancing of this “trilemma” often leads to paradoxical situations.

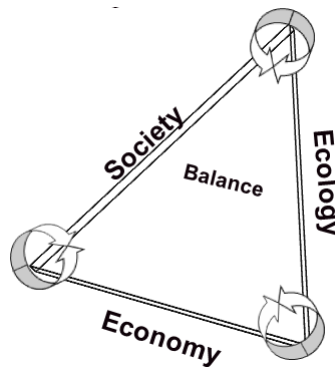


Figure 3: Triangle of sustainability [UNESCO 2010]

Secondly, energy consulting is a form of consulting, i.e. means recognizing and balancing goals and interests of all stakeholders. These dynamic interactions lead to a low level of foreseeability regarding the choice of a concrete acting strategy and the result of the interaction.

Thirdly, the technical aspects of energy consulting also cause conflicts. An energy concept e.g. which is optimized to minimize CO₂ emission, stipulates the implementation of a wood pellet boiler, which produces undesired high levels of dust. If the concept is designed to minimize the emission of further gases (esp. dust, nitrogen oxides, sulfur oxides), a gas fired condensing boiler with solar warm water support should be proposed.

2.2 Areas of competence

Competence is defined as an cognitive asset used to solve problems, and there is a further differentiation between personal, social and professional competence [Erpenbeck and von Rosenstiel 2003]. Because energy consultants should act sustainably, they have to balance economical, ecological and social demands. This not only leads to complex paradoxical situations and open-ended conflicts, but also requires an especially high level of professional competence.

2.3 Level of reflection and professional behaviour

To evaluate the conscious handling of the above mentioned conflict situations, the level of reflection and of professional behaviour have to be measured. Professional behaviour is defined as the conscious interaction with paradoxical situations to achieve an acceptable compromise. Energy consultants act sustainably, e. g. they balance economic, ecological and social demands. These constraints frequently lead to paradoxical situations, and energy consultants require professional behavior to handle these paradoxical situations [Schütze 1996].

For assessment of professional behaviour, the theoretical model for energy consulting includes the reflection mode [Tiefel 2004], which observes how an individual reflects on a certain problem. Tiefel defines four reflection modes, namely “very innovative”, “innovative”, “stabilizing” and “very stabilizing”. In an innovative reflection mode, an individual reflects on a particular problem by broadening the problem scope and by trying to create something new. In a stabilizing reflection mode, an individual reflects on a particular problem by reducing its complexity and by attempting to implement tried-and-proven solutions. An innovative approach is preferable for small and medium scale problems, in which creative problem solving is needed, and a stabilizing

approach is desirable for large scale problems with a large scope and many stakeholders, in which it is vital to define and adhere to clear-cut goals.

3 Workshop concepts for development of energy consulting competence

On multiple levels, the above defined theoretical model reflects uncertainty and the non existence of clear cut solutions. For development of competence in such an open environment, a linear, unidirectional approach, in which a teacher claims to know the absolute truth about a certain topic, and transfers his knowledge to his pupils in terms of right and wrong, is not useful. This approach requires a low level of uncertainty, which is not applicable in energy consulting. To achieve competence development in an open field like energy consulting, a didactical principle has to be enforced which uses the uncertainty to its advantage.

3.1 Theoretical foundation: Constructivism

To combine competence development with the uncertainty of energy consulting, constructivism offers a viable didactical approach. Constructivist teaching follows seven principles [Dubs 1995]:

1. Orientation towards complex, real-life problem areas which require an integrated point of view, rather than simplified problems whose complexity can be easily reduced. This requires a holistic approach instead of a linear concatenation of stock solutions, which in turn requires a teaching environment in which open-ended group discussions are encouraged
2. Interpretation of learning as an active process based on context and subjective experience
3. Emphasis on collective learning
4. Conscious correction of mistakes and errors is vital for the acquisition of knowledge
5. Emphasis on connecting areas of learning with the experience and the interests of the group members
6. Learning is not only cognitive, but also has social aspects, because both rational and emotional skills are needed to solve problems
7. Evaluation of learning success not in terms of “right and wrong”, but rather on “how much was learned”, emphasizing the importance of self-evaluation

Energy consulting has been identified as an area of work with uncertainties on several levels, where holistic, open-ended learning in groups is helpful. Therefore, to develop competence in this area of work, the principles of constructivist teaching were implemented.

Constructivism is subdivided into two directions, namely radical constructivism and moderate constructivism (see Fig. 4). Both rely on group discussion and apply, evaluate and transfer knowledge in multiple contexts and from multiple perspectives. Radical constructivist learning is exclusively self-controlled group work, in which all knowledge is seen as purely subjective, whereas moderate constructivism acknowledges the existence of objective knowledge and leaves open whether the group discussion should be moderated or not.

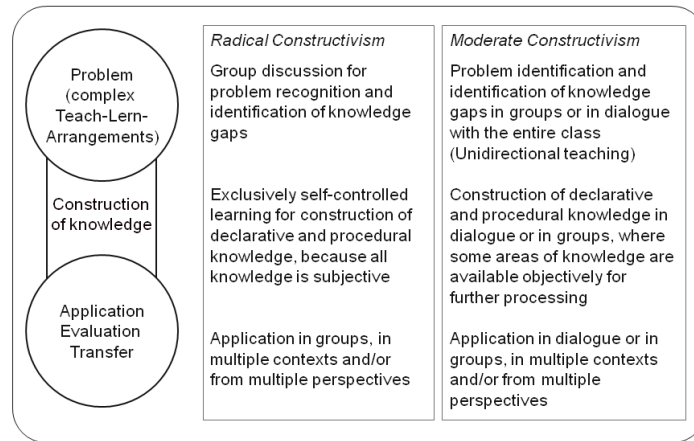


Figure 4: Constructivism from a teaching perspective [Dubs 1995]

Constructivist learning is especially helpful in fields where the required areas of knowledge and the required abilities are highly non-procedural, complex tasks with more than one valid answer are dealt with, and an incomplete availability of information exists (see Fig. 5, columns #1-3). The more those three points apply, the less direct teaching is useful, and the more an indirect teaching approach (learning by consulting) becomes important.

Energy consulting is a field in which there are various levels of uncertainty, complex tasks and an often incomplete availability of information. Competence development in this field of activity requires a learning environment which adheres to the principles of constructivism. Because energy consulting contains objective data (e.g. norms, laws, mathematical formula), a moderate constructivist approach is chosen.

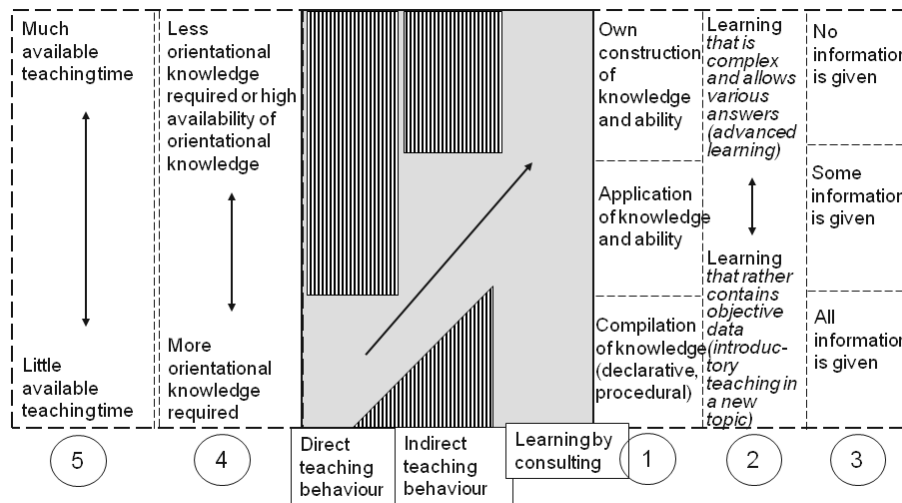


Figure 5: Constructivist teaching and learning principles

3.2 Situational orientation: Trilemma exercises

In the previous section, the use of a moderately constructivist teaching environment was explained. Applying this principle as well as the theoretical model of energy consulting competence, a concept for the competence development of novice energy consultants was developed. Emphasis was laid on a high level of orientation on typical work tasks. The exercises focus on dealing with real life energy consulting situations and uncertainty, especially paradoxical

requirements of sustainability (i.e. simultaneous fulfillment of economic, ecological and social requirements).

Exemplarily, the field of activity “concepts of energy use and modernization” (see Fig. 2) often contains paradoxical requirements, especially regarding dimensions of sustainability (i.e. simultaneous fulfillment of economic, ecological and social requirements), which in turn require high levels of professional competence and an innovative reflection mode. This observation also applies for other fields of activity in energy consulting, so results derived from research in this area can be reasonably generalized.

Following this line of thought, “trilemma exercises of sustainability” were designed by expert energy consultants. In these exercises, energy consultants orally deal with a concrete energy consulting situation, in which they have to work out and present a technically viable and sustainable solution to a fictional customer. In this case, the tasks respectively focus on creation of modernization and energy concepts, professional expertise and innovative reflection mode. An example of a trilemma exercise (excerpt of the “Aachen anti-pollution zone” exercise):

“A one family house (built in 1986, 200m² area, gas boiler from 1986) in the inner city of Aachen -- a city which attracts many tourists from nearby Netherlands and Belgium and where an anti-pollution zone is being proposed – is to be energetically optimised. Develop a heating concept that is economically, ecologically and socially viable.”

Expert energy consultants developed reference solutions and worked out three basic, technically viable solutions, each with a drawback:

- A gas fired condensing boiler is inexpensive, but uses fossil fuel and is plagued by high emissions (especially CO₂), which barely fit the requirements to avoid an anti-pollution zone.
- A wood pellet boiler is also inexpensive, uses natural resources (wood) and is low in CO₂ emission, but dust emissions are 3000% above anti-pollution zone levels. Such a zone would effectively cut off motorised traffic into the inner city, so tourism (a big social factor) would take a big hit.
- A heat pump is cheap, but requires well insulated walls to work efficiently. In this case, the walls (built in 1986) are too old, and replacing them would be too expensive.

They concluded that a gas fired boiler with 60% solar warm water support would be probably the solution which best combines technical viability and adherence to sustainability. They also pointed out that sustainability depends on the interpretation and the scope of the question (e.g. is nuclear energy sustainable?), and that a “perfect solution” was ruled out by definition. As a consequence, techniques have to be designed to reflect these lines of thought. Mastering this challenge of “think globally, act locally” according to EDS is vital for the development of energy consultant competence.

3.3 Practical implementation of energy competence development workshops

Workshops were organised in which novice energy consultants worked with two trilemma exercises to develop their competences. Most important goal of those workshops was to find out how the participants construct their respective subjective theories (i.e. the individual knowledge applied to solve this particular task), therefore the Heidelberg structure formation technique was used. This technique includes the visualisation of thought constructs by card/arrow-networks. Because visualisation of subjective theories (a form of thought constructs) is essential for the development of competence in energy consulting, the construction process of these networks forms an important part of the workshops.

In detail, the Heidelberg structure formation technique includes three parts. Firstly, the interviewer conducts a semi-structured interview, in which the participant presents his approaches, thoughts and beliefs, i.e. his subjective theory, regarding a specific question (e.g. how to solve a trilemma exercise). The relevant thoughts are written down on cards, which the participant connects with arrows, expressing goal/means-, cause/effect- or other relationships, thus forming a structure formation network. After finishing this task, he gets the opportunity to reflect on his solution and to make last minute changes. Using this technique, the subjective theory can be visualised, creating a holistic view of the thought structures of the participant [Scheele and Groeben 1988].

With the help of the Heidelberg structure formation technique, workshops for the development of energy consulting competence were organised with novice energy consultants. To enforce the principles of moderate constructivism, the participants were clustered together in groups of 2-4 members, encouraging discussion and thinking from multiple perspectives, and the interviewers were rather counselors than teachers, underlining the openness of the trilemma exercise and highlighting the notion that there was a high level of uncertainty and therefore no perfect solutions. Also, the "think globally, act locally" motto regarding sustainability was repeated. In detail, the workshop included following parts:

1. Introduction: the interviewers present a trilemma exercise to the novice energy consultants and gives them 45 minutes time to individually work out solution approaches.
2. Development of a common solution: the members of the group present their results in a 10-minute oral presentation, in which they can also use a flipchart. After that, the members pool the best solutions together and create a "best of" of their solutions, each containing the respective line of thought. This includes both technical and non-technical aspects.
3. Production of structure formation cards: the relevant thoughts from step 2 are written down on structure formation cards by the interviewer. In addition, about 30 optional cards containing indicators from the education for sustainable development were provided by the interviewer.
4. Construction of a structure formation network: the cards were pinned to a cardboard wall and connected with goal/means-, cause/effect- or other arrows, forming a network of nodes and edges. The participants were encouraged to highlight nodes or edges which they found especially economic / ecological / socially relevant, important or paradoxical.
5. Feedback and reflection: after finishing the network, the interviewer allowed the group members to take a 15-minute break to clear their minds. They were given the opportunity to look at their solution with fresh eyes and consciously reflect on their result, especially regarding their approaches dealing with the complexity, sustainability and validity of their solution.
6. Presentation of the finished networks by the respective groups in front of all participants, with emphasis on explaining the line of thought and the subjective theories used to deal with the trilemma problem.
7. Reflection of the results: open discussion of the presented networks by all participants and conscious evaluation of each network, thus also conscious evaluation of the subjective theories. By analysing the different approaches, each energy consultant can reflect on his own subjective theory.

4 Results

Applying the methods described in previous section, we conducted six workshops. Groups of energy consultants dealt with a trilemma exercise. In sessions which usually lasted four hours, they first worked out and discussed their individual approaches under the supervision of an interviewer from our research team, who wrote down every relevant thought on a card. While the group compiled a "best of" list of ideas, these cards were pinned on a cardboard. Using the "best of" list and the cards, the participants constructed their respective group networks.

From our researchers' point of view, it was highly interesting to see how the different groups worked, especially regarding the implementation of the "think globally, act locally" motto. Some subjective theories emphasised the financial aspect ("the customer chooses the cheapest offer, so our solution must not cost much"), whereas others focused more on the social and/or ecological points of view. Also, the trilemmas of sustainability were interpreted differently: some saw the core of the trilemma on a small scale, technical scope, while others on a large scale, global level. This resulted in various different solution networks, which could not be evaluated in terms of "right" or "wrong", rather in terms of "probably socially viable" or "probably not socially viable". A totally coherent standard solution does not exist.

In terms of development of energy consulting competence, the workshops had positive effects on the participants. Previously, most energy consultants had seen energy consulting as a linear process with perfect solutions, and did not see the often paradoxical requirements of sustainable energy consulting. For the first time, many participants became conscious of this trilemma, and expressed the strong sentiment that this was a "big positive effect" for them. This was a great positive development of energy competence.

In addition, dealing with trilemmas of sustainability and discussing alternative solution networks generally resulted in an innovative reflection mode. Most participants realised that a rote solution to these complex problems does not provide satisfactory results, so they were motivated to think creatively and construct new solutions. This conforms to an innovative reflection mode, and the majority of the participants recalled that they rarely had experienced this "open thinking" in their area of activity. This also was a positive development of competence.

Furthermore, the participants experienced the advantages of a open discussion with a holistic approach to problem solving. The Heidelberg structure formation technique struck some as a bit counter-intuitive (i.e. they expected to express their thoughts in a written text), but the benefits of this technique (concise visualisation of the line of thought, easy addition of relations, low text redundancy etc.) were duly acknowledged. Also, it was the first time for many to work with this technique, so further competence development took place.

Finally, the participants also improved their professional expertise. The trilemma exercises were regarded as tough, but fair, and required an elevated level of energy consulting competence to deal with them. Additionally, because the participants had to learn / refresh their knowledge about the most recent version of relevant German energy laws, and refine their approach according to them.

The workshops showed there is no all-satisfying optimal solution for trilemma problems, and that the main line of thought ("think globally, act locally") produces many socially viable solutions. Several participants were disappointed for not being provided with a "perfect network", but the majority of the novices felt sensitised for the necessity of consciously handling trilemmas of sustainability.

5 Conclusion

From a didactical point of view, the workshop for development of energy consulting competence was a success. By consciously handling uncertainty and open ended trilemma exercises in a group, the energy consultants were sensitised in handling paradoxical requirements, especially regarding dimensions of sustainability. This was described as the main point of improvement of energy consulting competence. In addition, technical expertise, the handling of structure formation techniques and the ability to work out solutions in a group discussion were improved.

From the standpoint of moderate constructivism, many goals were achieved. With the help of the open environment, the energy consultants acknowledged and handled uncertainties in their field of activity and in the end thought less in terms of "right and wrong", and rather in terms of "how well did we solve and have balanced the particular problem".

The development of reflection is currently achieved by open discussion of the presented networks, resulting in a conscious evaluation of each approach. By analysing the different approaches, each energy consultant can reflect on his own subjective theory. In the workshops, this generally led to a more innovative reflection mode. A next step would be the quantification of this aspect of competence development by defining and validating indicators of innovative and stabilising reflection mode.

Future workshops are planned with more trilemma exercises, possibly focusing on different competences in different validated fields of activity and will be refined regarding the improvement of reflection.

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