Topmotors training program "IEO" - Sino-Swiss (China): knowledge transfer and cooperation

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Abstract

Topmotors is the national information program of the Swiss Federal Office of Energy (SFOE) for efficient electric motor systems in Switzerland. One of the important and innovative outputs of Topmotors is the practical continuing education program, which consists of theoretical knowledge training, and also practical motor system simulation for operation. By working with research institutes and universities, the pump and fan system demonstrators have been designed and built for the training courses in Industrial Energy Optimization (IEO). Compared with traditional training programs in which theoretical training from text books still takes mainstream, the practical and operable training with demonstrators have better effectiveness, which has been proven in various Swiss trainings since 2016. Another unique thing of IEO is the high practical share and the training on demonstrators specially developed for the course.

Renergy in China in cooperation with Topmotors from 2016 tries to transfer the technical design of the pump demonstrator. With the R&D funding support from Science and Technology Bureau of Zhenjiang city, both parties agreed to transfer the Swiss design for the Chinese training program. From 2019, the Swiss Agency for Development and Cooperation (SDC) has made financial resources available to prepare the training material for English language use so that they can be used internationally, in which the Chinese expertise will be integrated as well. Switzerland and China started a collaboration, to transfer Swiss public funded technology, design and knowledge to China, and China invests in R&D fund for localization, piloting and promotion. It is not only a good practice in combined technology and experienced knowledge transfer, but also finances are invested from both countries. This training transfer experience and best practice training can later also be used in other developing countries. It has the potential to be a good example of “North” supported South-South cooperation.

The project started in February 2019 and the goal is to develop a full package of "Topmotors China and International" training program including courses, materials and the pump demonstrator. In fall 2019 will be the first pilot course with up to 100 oversea students and trainees from Jiangsu University in Zhenjiang, China. Afterwards, the program will regularly train Chinese experts specifically in the field of energy efficiency of electric motor systems.

Figure 1: Pump demonstrator developed by HEIG-VD, Switzerland

Background

Motor systems consume more than 50% of global total electricity and more than 70% of global industrial electricity [1]. The total energy saving potential from motor system is huge by implementing various policy and technical measures. According to the study from Conrad U. Brunner and Paul Waide in 2011, the largest saving comes from total motor system optimization of application, transmission, gears and motors [2].

To tap the full saving potential, an efficiency improvement project including motor system general audit, saving potential assessment and identification, system diagnosis and testing, system retrofit and saving monitoring is needed to be conducted either by the factory itself or with the support of external companies. The share of the consulting and engineering in the total cost is essential for the project payback time.

The energy performance contracting business model has played an important role in promoting the optimization of large motor systems. The third-party efficiency professionals take all work from the factory audit, system diagnosis, system retrofit and even the project financial support. This business model has an advantage for larger motor systems because the share of consulting and engineering in total project cost is reasonable and profitable.

When the scenario comes to the medium and small motor systems, which has a large number of systems and small absolute savings potential for each system, the share of the consulting and engineering in total project cost increases significantly to a level, that the payback time becomes too high to be economic reasonable for commercial energy service companies. The traditional model of outsourcing all work to external energy service companies will not be economic reasonable for medium and small motors. The motor system optimization diagnosis and engineering cost should be shared by the factory management and engineers with the external professional support.

The experiences from Sino-Swiss Zhenjiang Topmotors pilot project show, that the in-house capacity from factory management and engineers will motivate internal efficiency improvement projects [3]. The in-house capacity building also has the advantage of designing and implementing a continuous improvement program. The most cost-effective way to build the in-house capacity is the motor system managing and technical training.

Over the past 10 years, within the framework of the Swiss information program "Topmotors" [4], the need for specialist knowledge in the field of "electric motor efficiency" has been repeatedly expressed.

For this reason, a special training program for professionals was set up in Switzerland: "IEO - Industrial Energy Optimization".

The Swiss Federal Office of Energy (SFOE) has provided financial support for the preparation of training documents and the development of special demonstrators [5].

Between 2016 and 2019, a total of 9 courses took place at 3 different Universities all over Switzerland.

Goal

The goal of this program is to transfer the created knowledge and proven methodology from Switzerland to China and to establish a network of national IEO classes. Based on experiences of the 9 courses and the feedback of the participants at the end of every course, the training documents were constantly developed further. The latest version is now basis for the translation into English, to be used in China.

Methodology

The concept of the course is unique. During 6 days (always Friday and Saturday), the participants are trained in several energy relevant technologies, in order to be able to carry out efficiency improvement measures on electric motor systems independently. A basic technical education as prior knowledge is an important requirement for the participation in IEO.

IEO D5-2019		1	2		3	4		5	6
		friday	saturday		friday	saturday		friday	saturday
		10 may 2019	11 may 2019		24 may 2019	25 may 2019		28 june 2019	29 june 2019
09:15	10:00	welcome, introduction	modul 1: motors, lesson	personal analysis	modul 3: Fans, lesson and experiments	lesson: compressed air systems	personal analysis	Modul 5: energie-management and communication	final exam
10:15	11:00	swiss energy Law, MEPS							presentation: personal analysi
11:15	12:00	Motor-Systems-Check Method	modul 2: VFD, lesson			modul 4: pumps, lesson			
12:15	13:00								
13:15	14:00	Lunch			Lunch			Lunch	
14:15	15:00	Motor-Systems-Check Tools	modul 1&2: Motors & VFD, experiments		modul 3: Fans, experiments	modul 4: pumps, experiments		Modul 6: cooling systems, lesson & experiments	presentation: personal analysi
15:15	16:00								
16:15	17:00								feedback
17:15	18:00	personal analysis Q&A	personal analysis Q&A		personal analysis Q&A	personal analysis Q&A			closing

Figure 2: Timetable of lessons "IEO D5-2019"

For all modules and lessons, there is a set of slides shown during the course. Every participant gets a printed folder with all slides and an USB stick with all documents and software tools.

All modules are supported by practical experiments in the laboratories of the universities. Special demonstrators have been developed for some modules, which further strengthen the experience and the learning effect (e.g. **Figure 1**).

The 6 key training modules are (Figure 2**):**

1. Electric motors
2. VFDs
3. Fans
4. Pumps
5. Energy management and communication
6. Cooling systems

Also, the series of Software Tools [7] for the Motor-Systems-Check are provided and included in the training program. It is expected that with the Standard Test Report (STR), the trainee will be capable to analyze and quantify an existing electric motor driven system and estimate its eventual electricity savings.

In addition to theoretical knowledge transfer, all participants also have a practical task to perform. The practical part of the training includes a detailed analysis of a motor driven system in their own company with the knowledge and software tools taught in IEO. The time required for such an analysis in addition to the 6 training days is approx. 60 to 80 hours.

On the last day of IEO, there is a final exam for all participants. The first part of the exam is a written 1-hour test with questions on all topics covered. The second part of the test is the presentation of the personal analysis of each participant's motor driven system. If both proofs of performance are successfully completed, a certificate is handed out in addition to the course confirmation and the graduates receive two ECTS credit points.

International Intellectual Property Transfer

The training experiences in Switzerland can not only be used to Swiss industrial energy efficiency improvement, but also in other countries. Top10 China started to work with Impact Energy (program leader of Topmotors) from 2014 to promote motor system efficiency programs in China by introducing the Topmotors methodology. Both institutes jointly implemented the Sino-Swiss Zhenjiang Topmotors pilot project, which is supported by Zhenjiang Economic and Information Commission from 2015 to 2017. More than 100 factories have been assessed by the Topmotors methodology. The initial assessment confirms the European experience, that there are huge untapped electric energy saving potentials in Zhenjiang factories. However, the human resources from the project team are quite limited, which means that the consecutive implementation is not sufficiently facilitated. The conclusion by the team is that to stimulate the internal motivation and building up knowhow is the first priority. It is decided to import the Swiss Topmotors training program including the demonstrators and training material to China.

The intellectual property of Topmotors Switzerland IEO training material are widely distributed at all partners including universities, technical institutes and individual consultants. If the IEO training material will be transferred to Chinese stakeholders, the Chinese technology transferees have to contact the IP owner to negotiate, which takes a long time and effort and is not efficient. The Chinese transferees (Renergy and Scinergy) and the Swiss partner (Impact Energy) reached an agreement to pay the Sino-Swiss Topmotors IP transferring hub at each side. The IP to be transferred to China will firstly be authorized to Impact Energy at Switzerland from the original owners, then Impact Energy negotiates with Renergy how to make the international transfer. By taking this more complex but unified model, the Swiss pump demonstrator developed by Christophe Besson was successfully transferred to Scinergy to China for free. An agreement line from HEIG-Impact Energy-Scinergy has been well established. This work model shows the importance of respecting of IP. By taking this smooth international IP transfer, Scinergy has successfully applied for the R&D funding to localize the pump demonstrator in China.

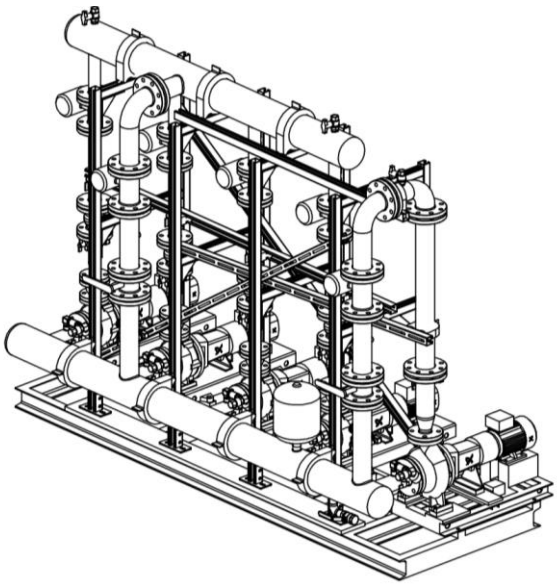

Figure 3: Design of pump demonstrator, Chinese version

Based on this successful technology transfer, the Swiss Agency of Development Cooperation decided to support the further transfer of Swiss energy efficiency know-how to China, which is the full training material. They are currently available in German, French but not yet in English.

Promotion in China

The IEO training program targets on management and technical staff from factories and energy service professionals in Switzerland. The Ministry of Industry and Information Technology (MIIT) in China highlights the importance of industrial energy efficiency diagnosis service in China. A new policy named “Industrial Energy Efficiency Diagnosis Service Action Plan” was implemented from 23rd May 2019 [6]. The article 4 of the action plan states to improve the capacity building of diagnosis service, which means to support the capacity building of energy service companies in energy efficiency diagnosis and promote the trainings not only for energy service companies but also the management and engineers from factories. The scope of the action plan widely covers all industrial energy efficiency, in which Topmotors IEO training material can play a better role in future China public training.

There is a professional public institute “Energy Conservation Center” in each municipal and provincial government. Energy conservation centers play the supervision role of implementation of the energy conservation policies in the city or province including the energy conservation issues of commercial, industrial and public institutes. Supported by local public funds, energy conservation centers also provide management and technical trainings for companies, which is a very good promotion entry for the IEO training program. By conducting the pilot trainings for factories directly at the beginning to improve the training package, to "train the trainers" will be the main promotion strategy. The trainers from energy conservation centers will be equipped with the demonstrators and training material and integrate the IEO training into their existing energy efficiency training programs for factories.

China is now one of the important destinations for international students, especially from other development countries from Asia and Africa. The negotiation with the Oversee Education College (OEC) of Jiangsu University in Zhenjiang has been started, which aims at conducting pilot trainings for international and domestic students in relevant fields in Topmotors starter training and even integrate industrial energy efficiency training into existing education plans. A formal optional course in industrial energy efficiency has been proposed to OEC and is currently under internal discussion. The OEC of Jiangsu University has almost 3,000 annual international students from more than 110 countries. The awareness raising and initial managing and technical training for students might support the long-term payback of efficiency improvement globally and raises awareness.

Promotion internationally

The Topmotors IEO training material has been shown to policy makers and experts in ASEAN countries in a series of networking meeting in ASEAN countries by Renergy. An initial interest has been stimulated and they are looking forward to when the international version is available.

Conclusions

1. In-depth managing and technical training can balance the diagnosis cost in motor system energy efficiency improvement projects between factory in-house and external support. It is the most cost-effective measure to stimulate the efficiency improvement within the company. It lends itself best for continuous energy efficiency improvement programs in factories.

2. Topmotors IEO training in Switzerland has demonstrated the effectiveness in a number of courses and subsequent project work of the trainees.

3. The formal and good planning of international intellectual property transfer has been conducted in IEO training, which not only satisfies the owner of the IP, but also supports the transferee to get external financial and technical support.

4. The transferred technology has the necessity and potential to be localized and improved. The original version might not satisfy the full demands for the targeting market due to the different education and background of the trainees. The Chinese IEO training package targets not only the management and engineers at factory, but also the students in universities from home and abroad. The difference in background requires the training package to be adapted to the new situation.

5. Due to the rapid development and deployment of the information technology especially the IoT technology, new training material in this field is needed to be developed to support the acceleration of the motor system IoT process. The demonstrators including pump and fan should also include the new features of IoT, which will show the trainee not only the instant meter numbers but also the whole process of system configuration, adjustment and optimization.

6. Training the trainer promotion plan can amplify the effectiveness of the Topmotors training.

7. The Topmotors IEO training has the huge potential to be spread to other developing countries with existing education system and other international initiatives.

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