

# DSM Spotlight

The Newsletter of the International Energy Agency Demand-Side Management Programme October 2010



## task XVI

### Comprehensive Refurbishment through Energy Performance Contracting – Experiences and Conclusions

*This article highlights some key results from the publication, "Comprehensive Refurbishment of Buildings through Energy Performance Contracting: A Guide for Building Owners and ESCos including Good Practice Examples", produced by DSM Task XVI, Competitive Energy Services.*

Residential and commercial buildings are major consumers of final energy - and waste it at an alarming rate. Building's generate 21% of global greenhouse gas emissions or 8.2 Giga tons of CO<sub>2</sub> equivalent per year – this figure does not include construction and disposal of the buildings.<sup>1</sup> And, they consume 53% of the world's total electricity consumption.<sup>2</sup> While new building construction rates range between less than 1% in an average city to over 10% in booming regions, only some new buildings benefit from model energy performance. The majority of saving potential will be realized in the vast and already existing building stock.

The economic saving potential is high for energy efficiency refurbishment measures in buildings. According to Vattenfall and McKinsey, the greenhouse gas abatement potential in the building sector is 3.7 Giga tons of CO<sub>2</sub> equivalent per year by 2030 or 45% across all building types applying measures, such as "improved building insulation, better heating and cooling efficiency, energy efficiency in lighting and appliances". And, what might it cost? Quoting the same source, the "marginal abatement

cost curve is negative (-160€/t CO<sub>2</sub>)", which means that implementation of the saving measures will result in a net positive cash flow over of 25 years.<sup>3</sup>

Standard **Energy Performance Contracting** (EPC) projects apply demand reduction measures that typically comprise building technologies (heating, ventilation, air-conditioning (HVAC), lighting, electrical applications, control systems). In most cases, building construction measures<sup>4</sup> such as, renovation and insulation of facades, replacement of windows and the roof, and passive solar shading measures are excluded. A **Comprehensive Refurbishment** (CR) approach to buildings - examining and treating all energy sensitive aspects – taps these added saving potentials now and not some 30 years later, when the next building refurbishment cycle comes.

In this article, we describe good practice examples that integrate building construction refurbishment measures into EPC projects in order to achieve the comprehensive refurbishment of buildings. We propose to call these **Comprehensive Refurbishment EPC** (CR-EPC) models – *General Contractor* (GC CR-EPC), *General Planner* (GP CR-EPC) and *Refurbishment 'Light'* (CR 'Light' EPC). These three basic models were described in the June 2010 issue of the DSM Spotlight, Issue 37.

<sup>3</sup> See footnote 1

<sup>4</sup> By building construction measures we understand measures like refurbishment of facades, windows or passive shading, whereas standard Energy-Contracting measures are building technologies like HVAC, lighting or controls

#### PARTICIPATING COUNTRIES

Australia  
Austria  
Belgium  
Canada  
Denmark  
Finland  
France  
Greece  
India  
Italy  
Japan  
South Korea  
Netherlands  
New Zealand  
Norway  
Spain  
Sweden  
Switzerland  
United Kingdom  
United States

<sup>1</sup> Vattenfall 2007, Global Mapping of Green House Gas Abatement Opportunities up to 2030

<sup>2</sup> IEA World Energy Outlook 2006

## PUTTING THEORY TO PRACTICE

### Three Multi-Storey Residential Buildings in Graz, Austria

#### Initial situation

- Constructed in 1959, 150 residential units
- High heating energy consumption 120 kWh/m<sup>2</sup>
- Units heated by single stoves
- Hot water heating decentral in each unit
- Building facades are not insulated and damaged

#### Objectives

- Comprehensive refurbishment to improve living quality and quality of building structure.
- Reduction of energy consumption and greenhouse gases.
- Highest quality benchmarks for construction and economic criteria.

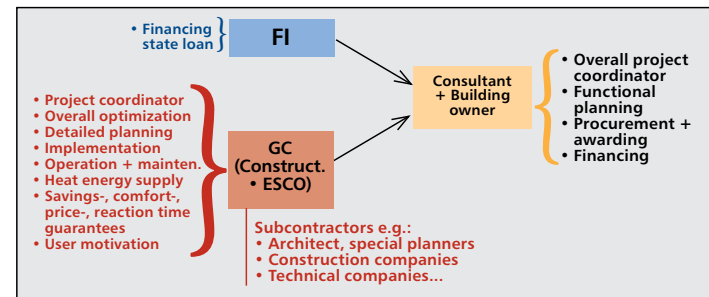
#### Measures

- Thermal insulation of building envelope and exchange of windows
- Gas fired central heating and hot water supply with integrated solar thermal system for water heating
- Energy management and control system
- Lift installation and replacement of electronic installations (e.g., lighting system)
- O&M of ESCo and user motivation actions (e.g., education and awareness raising)

#### Business Model

- A General Contractor can afford this comprehensive refurbishment guarantee model.
  - All measures tendered as one package (from planning to O&M)
- Guaranteed investment sum €2.18 million.
  - Financing through state loan and savings
- Guaranteed savings.
  - 24,500€/a heating costs (-45%)
  - 474 MWh/a heating energy (-45%)
  - 405 tCO<sub>2</sub>/a
- Project and contract duration of 15 years.

#### Contracts and Cash Flows



Implementation model.

#### Conclusions

- Risk transfer to General Contractor – complete service package.
- Sustainability of measures with living quality and building construction improvement.
- Most applicable are larger residential buildings (transaction costs).
- Adequate procurement process is important → partly functional specifications with performance specifications.
- Guaranteed reaction time for technical breakdowns and comfort standards.
- Tenants benefit from favourable financing conditions → running costs remain at same level.

For more information on this project contact Jan W. Bleyl-Androschin, [bleyl@grazer-ea.at](mailto:bleyl@grazer-ea.at), and Daniel Schinnerl, [schinnerl@grazer-ea.at](mailto:schinnerl@grazer-ea.at), of Graz Energy Agency.



Residential Building in Graz, Austria. Before refurbishment.



After refurbishment.

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## Utility Based ESCO: Ground-Coupled Heat Pump Technology for Residential Consumers – Integrated Energy Contracting in Spain

### Objective

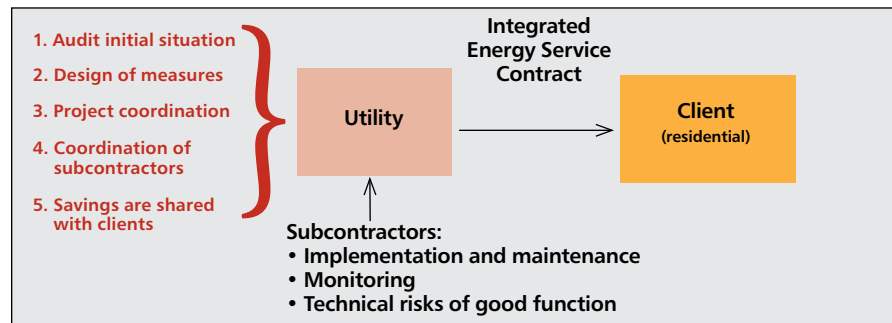
Ground-coupled heat pump technology is efficient for both heating and cooling. It can produce ratios up to 4 kW of thermal energy per kW of electrical energy. Until recently, this technology has hardly been used in Spain.

The objective of this project is to analyze if ESCO services for residential ground-coupled heat pumps are a viable solution for mass implementation in the mid-term.

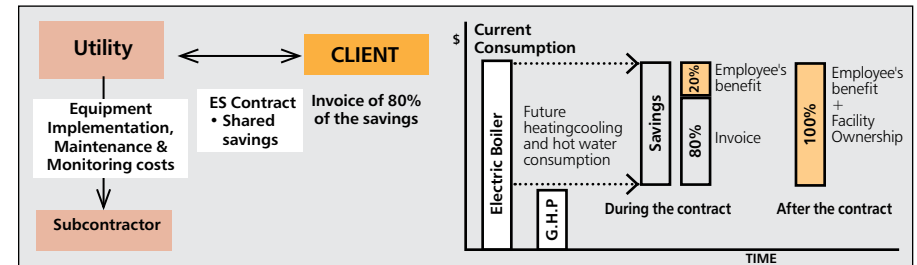
### Business Model

- Select 30 houses.
- Conduct a detailed energy audit to identify the viable candidates. (Of the 30 houses, 12 qualified. Non-qualifying candidates were rejected mainly due to the inability to perform the necessary drilling).
- Subcontract the monitoring.
- Sign an integrated (performance + supply) contract with the employee.
- Install the systems.
- Active equipment: ground-coupled heat pump (10.7 thermal KW/~2.4 electric kW; COP ~4.2). The systems' efficiency is constantly monitored (both COP Coefficient of Performance and SPF Seasonal Performance Factor) and guaranteed during the duration of the contact. Heating appliances were replaced if they did not operate with water. Absorption machines were included for cooling where needed.
- Passive measures (refurbishment): measures mainly consisted of replacing windows and sealing window and doorframes.

### Contracts and Cash Flows



### Integrated Energy Contracting Heat Pumps – Contractual Relationships



### Integrated Energy Contracting Heat Pumps – Cash Flows

- The utility takes care of all the installation (grants, license, etc) and owns the facility during the contact term.
- The client pays from electric savings, assuming the client has an electric boiler.
- The client pays the electric company for his electricity consumption (as before the ESCO project).
- The ESCO charges 80% of the savings achieved for the installation, maintenance and monitoring. The client is not charged for consumption by the ESCO (that is paid to the electric company), but for the savings achieved.

### Conclusions

- Facilities are under construction or in operation.
- No information has been provided about how the installations will be financed. Utility's assets can surely back the investment.
- Utility needs to develop an easy to understand service package for residential consumers.
- Utility requires stable statutory regulations and needs to invest in high quality training for its employees.

This project is being tested in the houses of the ESCO's employees through Integrated Energy Contracting, which will provide reliable performance indicators in the different Spanish regions. The ESCO is currently analyzing and preparing a solution for residential customers for possible mass implementation in Spain.

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 Red Eléctrica

*This example was reported by Andrés L. Sainz Arroyo, [asainz@ree.es](mailto:asainz@ree.es), of Red Eléctrica de España, Spain. For more information, please get in contact.*

## Comprehensive Refurbishment of Low Income Residences, Netherlands

The ECOLISH-Pilotproject Vrieheide consists of six housing blocks.

### Measures

- Insulation of roof, bottom floor façade, bottom floor rear
- Isolation gables and rear wall surfaces
- High Efficiency glazing of the rear doors in the living rooms and bedrooms
- Self-adjusting ventilation

### Business Model

- Essent, as a general contractor, can afford this comprehensive refurbishment investment sum of €114,000, including VAT.
- Funding possibilities:
  - Mortgage: total funding from VVE, interest 5%, value of the house as deposit, reducible from tax
  - Revolving fund: cooperation with municipal government, interest 2%

### Conclusions

- Project can only be done collectively.
- Funding from savings of 63,000.
- Owner's contribution an average of €8,500 per dwelling on an investment of €19,000.
- Integration of subsidies and revenues from energy savings are advantageous for owners.
- Energy savings calculated by using normal behavior. More savings could be achieved by efficient behavior, so additional benefit.
- Eliminate overdue maintenance works.
- Next step. Municipal government establish a revolving fund.

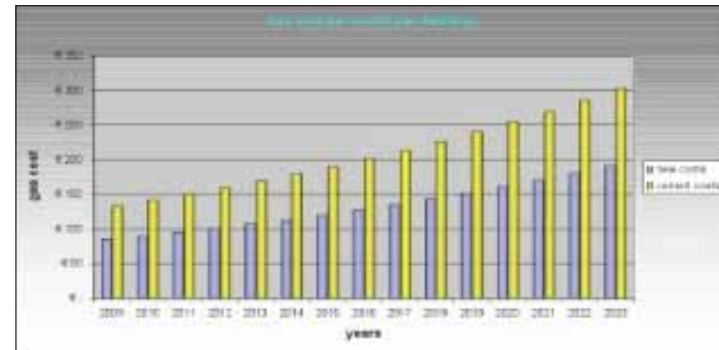
This project in the residential area of Vrieheide was developed under the European ECOLISH program. Vrieheide is located within the municipality of Heerlen, which also participates in the program. The Association of Owners welcomes the project. Currently, however, the project is on hold because the municipality of Heerlen is analysing the demolition and rebuilding of the houses.

GER KEMPEN  
Essent Energy Services

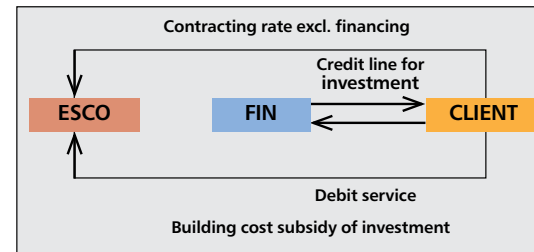
*This example was reported by Ger Kempen, [ger.kempen@essent.nl](mailto:ger.kempen@essent.nl), of Essent Energy Services in the Netherlands, please get in contact for more information.*



Vrieheide low income residences after renovation.



Energy cost forecast for Vrieheide buildings.



Comprehensive Refurbishment of pilot project Vrieheide – Cash Flows

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# task XVI

## Energy Performance Contracting—Conclusions & Recommendations

Based on the findings of **DSM Task XVI** and the experiences gleaned from the good practice examples, the following conclusions and recommendations can be given:

- ▶ The proposed CR-EPC models can facilitate customized packages of building construction and building technology measures in combination with the known guarantees of standard EPC models and outsourcing of technical and commercial risks to ESCOs.
- ▶ Generally, any building design approach should first focus on all the possible demand reduction potentials (including the building envelope). Only as a second step should the remaining demand be supplied as efficiently as possible.
- ▶ An integrated energy efficient planning process is especially necessary if renewable energy sources are to be applied, for example, solar cooling will hardly be feasible with high cooling loads of more than 40 W/m<sup>2</sup>.
- ▶ We propose three different models for the implementation of comprehensive refurbishment through Energy-Contracting 1) General Contractor, 2) General Planner, and 3) CR “Light“-EPC model. All three CR-EPC models allow combining (comprehensive) refurbishment measures in buildings with the advantages and long- term guarantees of Energy-Contracting models.
- ▶ The choice of the implementation model (especially for public sector building owners) depends mainly on three factors:
  - The share of building construction vs. building technology measures in relation to the total project volume over the contract period. This has implications mainly on the procurement law (if applicable).
  - Whether functional or detailed specifications for the contracting of the energy efficiency measures are desired and applicable from a procurement law perspective.
- Who the building owner wants to entrust with the detailed planning, overall optimization and supervision of the project: a general planner or a general contractor.
- ▶ All three models proposed can be applied both in the public and the private sector.
- ▶ Energy-Contracting models cannot decrease pay-back times of energy efficiency investments. At current energy prices, the typical guaranteed energy cost savings of a CR-EPC contract cannot repay comprehensive building measures like a complete building envelope refurbishment within 10 years. The building owner has to co-finance the investment with a building cost allowance (or a residual value payment at the end of the contract). Another option is a longer contract term of 20- 25 years, as is common for Public-Private-Partnership contracts.
- ▶ Financing must be individually arranged from a combination of CR-EPC savings guarantee, investment cost allowance by the building owner, third party financing from a financing institute (or ESCO) and subsidy programmes. We recommend differentiating between financing and energy services. ESCO’s are experts in technical, economic, and organisational matters of Energy-Contracting, which is what they should be commissioned for. Financing is not necessarily their core business. ESCO’s can be considered as a vehicle and facilitator for financing. In many cases including a financing institution as a third party to take over financing matters and risks makes good sense.
- ▶ Comprehensive refurbishment (CR) of buildings is a demanding task in terms of integrating and optimizing all the building construction measures and building technologies. It requires experienced partners and an integrated planning process that balances the effects of the different EE-measures. A good example for this approach is the reduction of all electrical and thermal cooling loads including solar shading options before assessing an air conditioning unit.
- ▶ The necessity for quality assurance at the construction site is not related to the contracting model. Quality requires controlling and depends on the motivation of the construction company to deliver long-term quality. Energy-Contracting models offer an instrument to provide incentives to optimise life- or project cycle performance, including the operation phase of the building, because the ESCO is not only responsible for the construction but also for the operation and maintenance of the building. Thus, the ESCO has an inherent interest to take care of quality assurance at the construction site and perform proper maintenance.
- ▶ In many cases EE is not the driving force behind comprehensive refurbishment of buildings. Nevertheless, minimum performance standards for any thermal refurbishment and guarantees for maximum energy consumption should be written into the terms of reference. CR-EPC models, as promoted here, are a good means to secure these goals and are also applicable to Public-Private Partnership models such as, sale and lease back projects.

*This article was contributed by the Task XVI Operating Agent, Jan W. Bleyl-Androschin ([bleyl@grazer-ea.at](mailto:bleyl@grazer-ea.at)) of Graz Energy Agency. These findings are considered a work in progress due to the limited number of practical experiences collected to date. Feedback and inquiries are welcome.*

# taskXIX

## Work Concludes on Micro Demand Response and Energy Saving

*Households and Small and Medium Enterprises (SMEs) consume about 50% of electricity in developed countries. By encouraging these sectors to modify their energy consumption, it is possible to make a significant impact on overall energy use. The experts of the IEA DSM Task on Micro Demand Response and Energy Saving have spent the last year and a half determining how best to deliver demand response and energy saving products to residential and SME markets, using energy saving service providers, demand aggregator businesses or both.*

Interest in the potential for Demand Side Management (DSM) to create more reliable and sustainable energy systems has increased significantly over recent years, largely driven by international commitments to reduce greenhouse gas emissions. Greater participation from the demand side is seen as an important mechanism for addressing the issues of improving overall system balancing, reducing the reliance on inefficient fossil fuel generation, particularly at peak times, and increasing the utilisation of renewable energy sources with variable output.

Households and Small and Medium Enterprises (SMEs) consume up to around 50% of electricity in developed countries. Therefore, encouraging these sectors to modify their energy consumption has the potential to make a significant impact on overall energy use. However, the participation of households and SMEs, which individually consume relatively small amounts of energy, requires that several thousand of 'micro loads' are influenced and coordinated to ensure that the desired outcome is achieved. Approaching consumers in order to integrate their energy use in this way is complex. Ensuring that consumers can take advantage of all available opportunities in order to ensure that

the potential value of modifying consumer behaviour is maximized is critical.

### IEA DSM Work

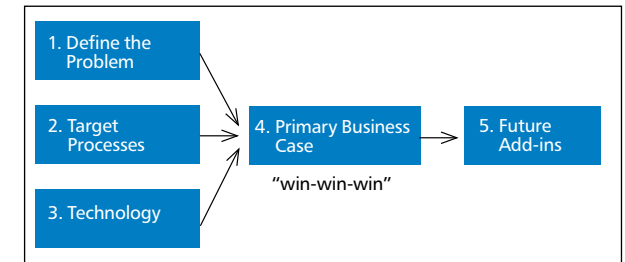
DSM Task XIX was established to define demand response and energy saving products and to determine how they can be delivered into the residential and/or SME markets on a commercial basis, using energy saving service providers and/or demand aggregator businesses.

Task experts looked at the factors that influence the development of demand response and energy saving products, including:

- The impact of the prevailing market structure on the way that electricity is traded and the way that market participants interact with one another;
- The demand response requirements of different market players in terms of the amount of aggregated response required, the preferred profile shape, the notification period provided to customers, and the duration over which the demand response should be delivered;
- An assessment of the energy end uses and its applicability for demand response and energy saving products;
- The identification of a range of different delivery mechanisms that can be used for energy saving and demand response products, including consideration of different approaches to aggregate small consumers; and
- The technical architecture components required for each category of demand response and energy saving products.

New demand response and energy are a key element in the transition from a supply driven electricity

system, to one that involves all participants, including the end-users themselves. However, there is no 'one size fits all' approach that can be adopted to ensure that new products are targeted to suit the capabilities of end-users as well as the requirements of the ultimate 'buyer' of the service. Tailored solutions need to be identified and assessed within the specific context of where they will be applied. As such, a step-by-step methodology was developed for assessing the cost effectiveness of new products and services, and applied to five country specific case studies. The step-by-step methodology is outlined below.



### Step 1 | The Problem

The first step in the implementation of demand response or energy saving programs requires the definition of the 'problem' to be solved. This definition should include the identification of the 'buyer' i.e. the organisation with a specific problem to be solved. The buyer is the organisation to whom an aggregator will sell the demand response or energy saving services. In certain cases, the aggregator will be the buyer.

### Step 2 | The Target Process

The target process is the specific end use of electricity that is able to deliver the demand response or energy

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## Task XIX from page 6

savings required to solve the problem identified in Step 1. Here, the 'provider' is defined as the organisation with the target process, and within the scope of this project includes households and SMEs.

### Step 3 | The Control, Monitoring and Communications Technology

Once the problem and the target process have been identified, it is possible to define the control, monitoring and communications technologies required.

The control, monitoring and communications technologies are likely to be specific to the particular requirements of each individual demand response or energy saving product.

### Step 4 | The Business Case

For a demand response or energy saving product or service to become successful it must:

- Make savings for the 'buyer'
- Produce a net income for the 'provider'
- Make money for the aggregator

The Business Case explores the costs and benefits to each of the participants (or stakeholders), with the aim of demonstrating a win – win – win situation. For example, in the case of peak price avoidance through households avoiding use at peak times:

- The 'buyer' must make a saving compared to the alternatives of either buying high priced energy or investing in more capacity;
- The 'provider' (e.g. the householders) must benefit through lower bills or improved service; and

- The 'aggregator' must generate a new, positive, income stream.

### Step 5 | Future Add-ins

Often the installation of improved control, monitoring and communication equipment will open up other possible income streams for the aggregator, thereby providing additional benefits to the 'providers'. Exploring all of the possible products and services (and all possible 'buyers'), arising from a single initiative, may turn a marginal Business Case into a highly viable one, either now or in the future.

For example, the installation of a Building Monitoring System (BMS) to provide energy savings (cost savings to the host SME, energy purchase cost savings to the Energy Supplier), may facilitate the provision of, say, Reserve Services for the Transmission System Operator (TSO).

This step-by-step approach outlined above has been applied to five country specific case studies:

**Finland** - Dynamic control of electric heater loads for demand management

**France** - Dynamic response of residential heating loads

**Greece** - Energy efficient air-conditioning equipment

**India** - Mass installation of energy efficient lighting

**UK** - Direct load control of commercial air conditioning

*The final Task reports will be available on the DSM website <http://www.ieadsm.org/ViewTask.aspx?ID=16&Task=19&Sort=0> in March 2011. This article was contributed by Linda Hull, [linda.hull@eatechnology.com](mailto:linda.hull@eatechnology.com), of EA Technology, United Kingdom.*

## NOTE FROM THE CHAIRMAN

### It is time for an IEA DSM University?

Isn't it amazing that a decade into the 21st century we are still arguing about the necessity to make better use of the world's resources by capitalizing on energy efficiency's full potential?! And, that we still have to discuss if it is worth the pain to save the energy and the load, which have "negative costs" ( i.e., adds cash to the wallet?)

OK, energy efficiency is not easy. It is actually quite complicated. And, it might require some further education to understand, manage and sell. So let's start delivering these skills, and how about at a DSM university.

The design and operation of energy systems are still dominated by planning and management ideas that were formed in the days when systems relied on centralized generation and deliveries from monopolized supply companies. This has resulted in a situation where energy efficiency is a resource that is rarely used to its full capacity.

Application of DSM in real life is not homogenous and depends very much on local circumstances in countries and regions. Even if the technical solutions and opportunities were very similar, the institutional settings dictate how the business cases can be developed.

### DSM Programme Assets

The IEA DSM Programme has produced a wealth of material that relates to different aspects of how energy efficiency can be managed and more broadly applied. Much of this written material is relevant even if produced some time ago – the development of management techniques is not happening that fast. These reports, however, may be found to be too technical for readers who do not fully comprehend the background of the work.

The Programme also has a vast network of participants, institutions and experts; this is an asset in itself, but one that could be further developed.

### DSM University

Based on the above observations of the needs and assets, there is a case to further develop and disseminate DSM materials. One means for achieving this goal would be to form a "DSM University" that could:

- Reformat existing DSM published material to reach out to new users and thereby improve dissemination and application.
- Offer courses on demand or a specific set of topics.
- Provide training from our pool of experts.
- Set up a system for expert and institution networking, services, partnering, etc.
- Link with other organisations that have a specific need of expertise.

**Hans Nilsson**  
IEA DSM Chairman

# case study

## Paradip Port Substitution of Cooking Fuel Project - India

This is the sixth article in a series highlighting the case studies of **DSM Task XV, Network Driven DSM**. This Task demonstrated that DSM can be successfully used to support electricity networks in two main ways 1) by relieving constraints on distribution and/or transmission networks at lower costs than building 'poles and wires' solutions, and 2) by providing services for electricity network system operators, achieving peak load reductions with various response times for network operational support.

### Introduction

The *Paradip Port Substitution of Cooking Fuel Project* was initiated and funded by the Paradip Port Trust. The Trust was set up by the Government of India to administer the port of Paradip, an autonomous body under the Major Port Trusts Act, 1963. The Trust purchases electricity in bulk from the Grid Corporation of Orissa Limited (GRIDCO) and then supplies electricity directly to its employees for household use. The Trust supplied electricity to its employees at a subsidised average flat rate of 132 Indian rupees per month and had to bear an annual loss of around 31 million rupees.

The objective of the *Paradip Port Substitution of Cooking Fuel Project* was to reduce system peak demand by introducing LPG as a domestic cooking fuel and replacing the electric stoves used by Trust employees. The project was targeted at the residential sector because cooking used approximately 60% of the electricity in each household. And, almost 90% of the 3,592 households in the Trust's service area used electric stoves for cooking, adding 3 to 4 MW to the electricity demand.

The maximum contract demand of Paradip Port under its supply contract with GRIDCO was 7.5 MVA, but peak demand often reached 9 to 10 MVA, resulting in penalty charges. The industrial load did not exceed 4 MVA at any point in time, but the domestic load exceeded the contract quantity by 2 to 3 MVA during peak periods. Because electric stoves were the largest contributors to the peak demand, replacing these with LPG cooking stoves would result in considerable electricity and cost savings.

### Description of Project

The replacement package offered by the Paradip Port Trust included stoves and LPG cylinders. An LPG cylinder bottling plant, with assured gas supplies from Paradip Port, was established in the area to ensure an adequate supply of LPG cylinders.

The Trust offered its employees the following incentives to move from electric stoves to LPG stoves:

- 100% subsidy on purchase and installation of an LPG stove;
- 100% reimbursement of the cost of the LPG cylinder;
- Reduction in the flat rate electricity tariff from 132 rupees to 80 rupees per month; and
- A limit on electricity consumption under the flat rate tariff fixed at 108 kilowatt-hours per month; consumption above this limit to be charged at the full price of 3.37 rupees per kilowatt-hour.

As the two-part tariff was introduced, meters were installed to monitor the electricity consumption in individual households and to enable accurate charging for electricity consumption.



Paradip Port, on the Bay of Bengal in Orissa, India.



The Paradip Port Trust was the main stakeholder responsible for the financing, procurement, implementation and monitoring of the project.

The housing department of the Trust was responsible for the entire project. The major investment in the project was the procurement and installation of the LPG stoves and electric meters in individual households. The entire cost was born by the Trust and was recovered through electricity and cost savings.

The end-users in this project were employees of the Trust and thus directly connected to the project implementer. Therefore, it was relatively easy for the

*continued on page 9*

Trust to create awareness and to market and control the project. The Trust motivated the end-users in the stove replacement project through various awareness programs.

### Results

The Paradip Port Trust replaced a total of 2,874 electric cooking stoves with LPG stoves. The morning peak was reduced by 2.3 MW and the evening peak by 3.2 MW. The project resulted in ongoing annual savings to the Trust of 15 million rupees.

The total implementation cost for the Paradip Port Substitution of Cooking Fuel Project was 19.7 million rupees. The additional cost of running the project was identified as 200,000 rupees per year. The entire cost was born by the Trust and was recovered through electricity and cost savings. A detailed breakdown of the implementation cost is shown in Table 1.

Table 1. Implementation Costs for the Paradip Port Substitution of Cooking Fuel Project	
Expenditure Item	Cost (INR)
LPG gas stoves for 2,874 houses	3.4 million
Enrolment fees for 2,874 houses	2.9 million
Fire resistant panels in huts	1.3 million
Fire extinguishers for huts	1.0 million
Security cages and pipes for LPG cylinders	1.0 million
Electricity meters for 2,874 houses	9.0 million
Publicity and safety training	1.1 million
Total implementation cost	19.7 million

*This article was contributed by David Crossley of Energy Future Australia Pty. Ltd. For more information on this case study and others, visit Task XV, Network Driven DSM at <http://www.ieadsm.org/ViewTask.aspx?ID=17&Task=15&Sort=1>.*

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