Total Site Management

Program / work package: SGEM I / WP 2.3 Microgrids

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Abstract

The need for reliable, cost-efficient energy solutions applicable for bad- and off-grid locations is increasing in the telecommunication sector. This is due to the expanding base of radio base station sites in these types of areas and for example the rising trend of diesel fuel prices. The Green Energy Controller, an existing piece in Nokia Siemens Networks' energy solutions, provides the functionality to control and monitor the different power sources (e.g. diesel, solar, wind) on a site and also takes care of energy generation and consumption parameters as well as collecting alarms and measurements from the site. As the next step, studying and developing a potential ICT management solution to enable the controlling and monitoring to be done remotely was identified as an essential research topic. It was also seen that the management solution could be applied in the utility sector as well as in the telecommunication industry. The Total Site Management concept was researched and developed in the first phase of the SGEM program in the WP2.3 Microgrids. This report presents the research work done and the results of the project.

The methods used in the research project have included the Total Site Management solution development and piloting in some existing base station sites which are run by distributed energy solutions. The solution itself has been proven to work, for example the energy production figures in pilot sites were collected remotely. The controller unit manages the use of diesel fuel and the data collected can be utilized to further optimize the energy production and consumption. According to the financial calculations made, the controller solution on top of which the SW management solution has been built is able to decrease the diesel fuel costs by 250 000€ during the 15 years time-frame. The renewable energy solutions (solar PV, wind) bring approximately 4000 – 5000 € yearly savigs in operational costs if the renewable production can be increased by 4 kWh. Both the solar PV and diesel hybrid as well as the wind power and diesel hybrid solutions can achieve a pay-back time as short as six years with the electricity cost of 0,95 €/kWh and positive net present value. The critical infrastructure such as the radio base station requires the investment for a reliable electricity generation back-up solution (usually diesel generator) in addition to the renewable technologies. Renewable energy sources still have relatively high prices.

Even though the solution studied and developed in this research project works according to the expectations, there are many open issues to be studied further. The owner and operator of the equipment could vary according to the business model chosen. There are also many other factors as reliability requirements, technological development and cost pressure which impact the distributed generation both in one isolated site and in a microgrid. The results from this project and identified open issues have been seen as potential topics to be studied further in SGEM program phase two.

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1. Background

Nokia Siemens Networks has a large installed base of base stations around the world. As these are increasingly built in areas with frequent power outages (so called bad-grid sites) and with no grid at all (so called off-grid sites), the distributed energy generation solutions are essential to power the base station equipment. The solutions to manage and control these installations are increasingly important in the telecommunication sector as they bring energy efficiency and cost savings to the energy generation for the telecommunications operators. Due to their generic nature, the management and control solutions are believed to be potentially applied in the energy and utility sectors as well.

During the first year of SGEM program, the management and control solution related research has been conducted within the WP2.3 (Microgrids) in the Total Site Management (TSM) -project. The work package included the objectives to study the renewable energy generation in general, energy storage, management of micro grids and the financial payback calculations for distributed energy generation. Nokia Siemens Networks has installed the first field deployments within the first year of the program and has supplied the program with a set of base technologies and products for development of the concept.

The management and control concepts developed in the Total Site Management project, using a development platform called Open EMS Suite (OES), have been deployed to the rural radio base station sites in Lisbon, Portugal and Indonesian island of Sumatra. In addition, the management solution is installed in Noida, India, for test use. The first tests have shown that the concept provides the needed functionality for collecting the energy production and consumption data and thus it is validated that the solution works according to the expectations. The first version of the software was ready in June, 2010 and new releases have been developed regularly after that.

The first phase of the SGEM program has provided all participants a better understanding of the technical and financial challenges in microgrids. It should be noted that the concept developed in the first phase of the SGEM program is for a specific niche market and further studies are needed to apply the concept in a general energy and/or utility environment. Nokia Siemens Networks will be deploying the new solutions in the telecom market and will make the basic technologies available in the utility and energy sectors. The ability to manage a wide variety of energy sources in microgrids and working with multiple partners in the delivery of these are required in order to create a sustainable competitive advantage.

2. Scope and purpose

This report includes a description of the Total Site Management concept in general, the key financial calculations of the electricity generation with distributed energy solutions and their analysis. Then the key findings from the project are presented and the topics for further research are defined.

It should be noted at this stage that the Total Site Management concept was intended for the use in the telecom environment and it was assumed that all energy generated locally would also be consumed locally. Therefore the concept did not include a connection of the local generation and the micro grid to the electricity grid. The key parts of the research and the concept were related to the practicalities of managing multiple, geographically distributed generation sites and the financial payback calculations associated with this.

The purpose of this document is to provide the SGEM program participants the relevant information to be utilized both in their own work and in the forthcoming phase two of the SGEM program, especially in the work related to the WP6.6. task “Active Network Management and Microgrids”.

3. Total Site Management Concept

The distributed energy (like diesel or hybrid) powered sites need to be controlled and monitored in order to optimize the use of alternative energy sources, battery life time, to follow error situations (alarms) and different statistical data, like the fill level of diesel tank or energy consumed vs. produced by the different sources. The controlling system should have logic and control functionality for different power components such as solar, wind, diesel generator, and commercial grid power. The management solution provides the functionality for remote control, reporting and monitoring of remote base station sites with the controller solution.

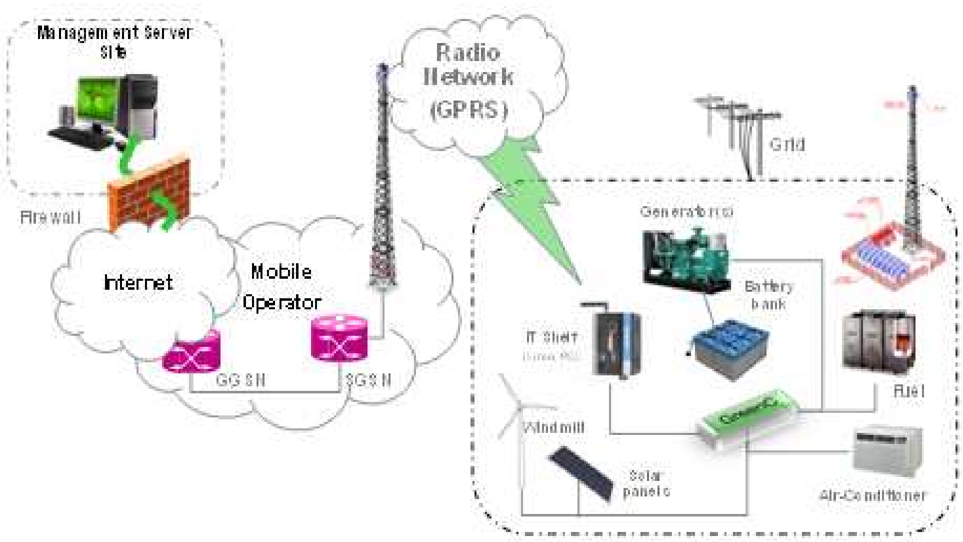

Figure 1. Overview of Green Energy Controller Management Solution domain

The Total Site Management concept integrates the Green Energy Controller installed in the base station site with the OES based management system for remote operations. The Green Energy Controller was an existing piece of technology at Nokia Siemens Networks prior to the starting of the research project. The particular development carried out in the research project was the centralized management software.

The main building blocks of the Total Site Management concept are:

- Green Energy Controller installed at the site
- Operation and Maintenance (O&M) agent with Modbus adaptor installed in IT shelf
- Centralized management server hosting management applications and related data

The controller unit has a programmable controller working as a heart of the system which is managing the demand of power and supply, providing for backup power and featuring monitoring and alarming functions for remote operation. The controller shall determine the energy source that is connected to the load. The essential items that the controller is responsible for are:

- Control and monitoring of the different power source(s)
- Control of the diesel generator(s)
- Measuring and alarming of site parameters such as energy generation/consumption

- Providing a communications interface to an external (remote) monitoring system
- Providing a local interface for basic monitoring and servicing requirements on site.

Green Energy Controller provides an Ethernet interface to be integrated to an IP Network. The controller provides Modbus application protocol interface over TCP to access the configuration data, alarming data and performance statistics from Green Energy Controller. These interfaces are used in this solution to integrate the controller with the remote management system.

Figure 2. NSN Green Energy Contoller.

The O&M Agent is a ready-made software component in an Open EMS Suite based management system that takes care of lower-level operation and maintenance (O&M) functions in the network elements. O&M Agent provides the required interfaces towards the management system for management data transfer. In this solution a SOAP interface is used to exchange data between O&M Agent and the management system.

The O&M agent software is located in an optional IT shelf unit, which is a small PC. For Green Energy Controller management purposes a Modbus adaptor application is used to retrieve information from the Modbus/TCP interface provided by the Green Energy Controller. The O&M agent also enables integration of other devices with management system, such as IP camera for local surveillance, if required. To establish the connectivity between the Management System and the IT shelf, built-in GPRS interface (or alternatively Ethernet interface) is used.

The centralized management server used in this solution was built on NSN Open EMS Suite platform and the applications used on top of the platform. Open EMS Suite provides out-of-the-box element management system functionality and an operation and maintenance (O&M) interface solution as general purpose SW development platform. The adaptation and integration into multi-vendor and multi-technology networks is supported by capability the of Open EMS Suite.

This solution makes use of the instant adaptation capabilities provided by the OES platform for adapting the Green Energy Controllers to the OES based management system. The basic applications for alarm monitoring (OES monitoring desktop) and performance statistics reporting (NetAct Basic Reporter) are used on top of OES platform. The SCADA application developed on the OES platform for this solution provides the support for real-time remote control view for the Green Energy Controller site from the OES based management system (this application was not available in first release of this solution but has since been delivered to customers).

The Advanced configurator application provides the storage and management interfaces for the configuration data from the network elements. It provides user applications for importing/exporting the plan information, for browsing and modifying the configuration management data etc. In the Green Energy Controller management solution Advanced Configurator applications are used to initialize the controller configurations, export/import the controller site configurations, modify the controller site configuration parameters etc.

4. Financial calculations

One key objective of the Total Site Management project has been to analyze the financial profitability of the distributed energy solutions. The controller solution is able to provide the exact figure of the electricity produced on a site. In this report, data collected during 15 days in December 2010 at a pilot site in Lisbon, Portugal is refered to. The energy solution in this site consists of the wind and solar hybrid solution. In addition, the site is connected to the main grid. Due to the relatively low real energy production figures and short time-frame the data was available from, the financial calculations in this report are based on scenarios of small, distributed power production. Also certain assumptions of the energy solution configurations and their prices have been made. The calculation based on different scenarios is assumed to give a more comprehensive picture of the potential of renewable energy used for electricity production than the calculations based on the exact production data only from a short time time during one month. The exact, measured figure of the energy production is refered to under each technology in this chapter (diesel, wind, solar).

When the solar panel system is representing the primary energy source and diesel generator is installed for back-up, the net cash flows with different energy production levels vary a lot. If the solar radiation is limited, the diesel generator needs to be run more. Thus the diesel consumption might be in a same level than in a full diesel powered site even though the investments to the solar panel system are also impacting the financial calculation.

In a case of the remote distributed energy generation (small power plant), some share of the total operational costs does result from the maintenance personnel travelling to and working on a site. On the other hand, the rural radio base station sites are visited regularly due to the maintenance needs of the telecommunication equipment. It can be assumed that the energy production equipment is maintained during those same visits and thus there is no need for separate visits. In general, the basic assumption is that the wind power equipment would need a maintenance once a month and solar power equipment twice a year.

In the calculations below, the decrease of -70% in diesel consumption is used when Green Energy Controller is installed on a site. This figure is based on data from some base station sites in the island of Sumatra in Indonesia where the controller solution is piloted. The decrease is in fact to some extent bigger than -70% but this figure was decided to be used as a baseline in these calculations.

Under each of the following sub-chapters, the sum of capital and operating cost of the technology is presented with and without the impact of the Green Energy Controller. In addition, in wind and solar solutions, the calculations were prepared for the production levels 1 kWh / day and 5 kWh / day from renewable source.

Diesel

Diesel powered radio base station sites are commonly used in bad-grid and off-grid environments. The capital expenses of the diesel solution are low but the continuous fuel consumption produces high operating costs. In addition, the continuing increase in the fuel price, the fuel being an attractive object for stealing in developing economies and the carbon dioxide emissions caused from burning the diesel fuel are some of the disadvantages of the diesel usage for electricity production[1].

The Chart 1 below presents the sum of capital and operating costs of the diesel solution both without and with the impact of Green Energy Controller. The capital costs included consist of two diesel generators (used in turns), battery unit and its cabinet as well as the controller unit. The operational costs include the fuel and its logistics as well as the maintenance cost. The price of 0,2 € / kWh has been used for the price for electricity in the diesel calculation.

Based on the calculation made (Chart 1 below), the Green Energy Controller solution is able to optimize the fuel consumption based on a need of the load and thus decrease the operating cost significantly. Within the used time frame in calculations (15 years), the total cumulative savings would be over 250 000€. For example, the duplicate diesel generator is not needed as the run-time of the generator decreases in significant level. The biggest saving is due to the decreased fuel consumtion and especially decreased need for its logistics. Another positive effect is that the CO_2 emissions are cut too.

[1] Community Power for Mobile. 2011. GSMA and International Finance Corporation. p. 21. http://www.gsmworld.com/documents/gpfm_community_power11_white_paper_lores(2).pdf [23.3.2011]

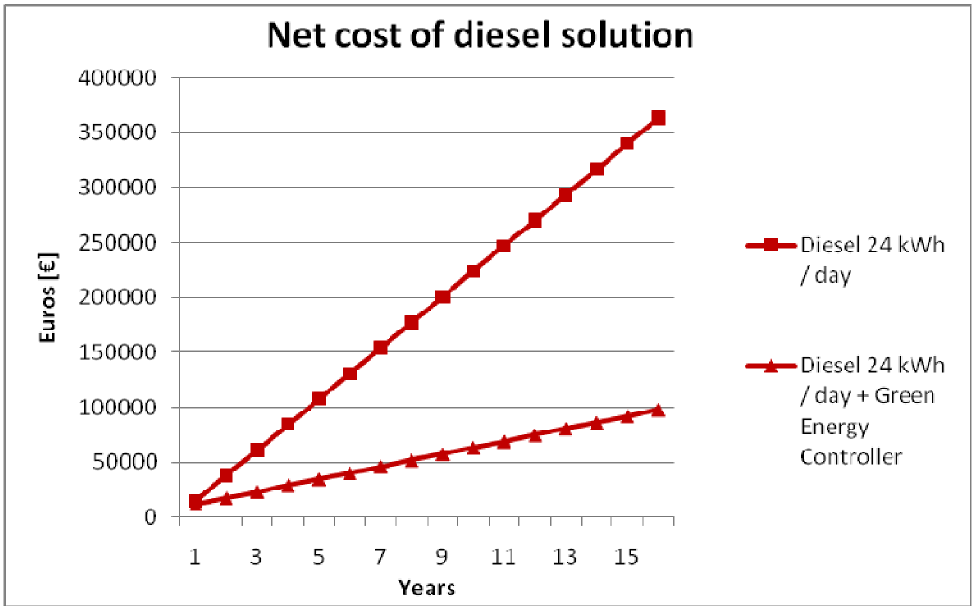

Chart 1. The sum of capital and operating costs of a site run with diesel power solution.

Wind

Based on the data in use, the average power generation from a wind power source in a pilot site in Lisbon was 2,7 kWh/day. This is a relatively low figure compared to the required amount of power for the radio base station which is approximately 24 kWh/day. The lowest daily generation of wind power was slightly over 1 kWh and the highest almost 6 kWh/day. With the power generation level this low, the usage of the wind power solution as the only source for energy does not seem to be sensible. However, the geographical location plays a very significant role when the viability of the renewable energy solution is evaluated. In general, the mountainous and coastal areas are favourable for the wind energy production. The time of a year (annual seasons) and local weather conditions naturally impact the realized power generation figures.

In the wind power related calculations, the windmill unit (2 kW), battery unit (including the cabinet) and two diesel generators were included to the capital costs. The controller was included also when the calculation on its effect was made. The operational cost includes the fuel for the generators, the fuel logistics and the maintenance expenses. The calculations have been made with the assumption that the price of electricity would be 0,40 € / kWh.

Based on the calculations conducted and results presented in Chart 2, the following, general remarks of the financial feasibility of wind and diesel hybrid can be made:

- The increase of 4 kWh / day in a renewable energy production decreases the yearly operational costs by app. 20% (approximately 4000 – 5000 € / year). This is due to the decreased need to produce electricity with the diesel generator. Thus each kWh produced by the wind solution brings significant monetary savings.
- According to this particular calculation, the total net savings when the controller solution is used is within 15 years time frame approximately 210 000€ (when 5 kWh is generated by the wind resource).

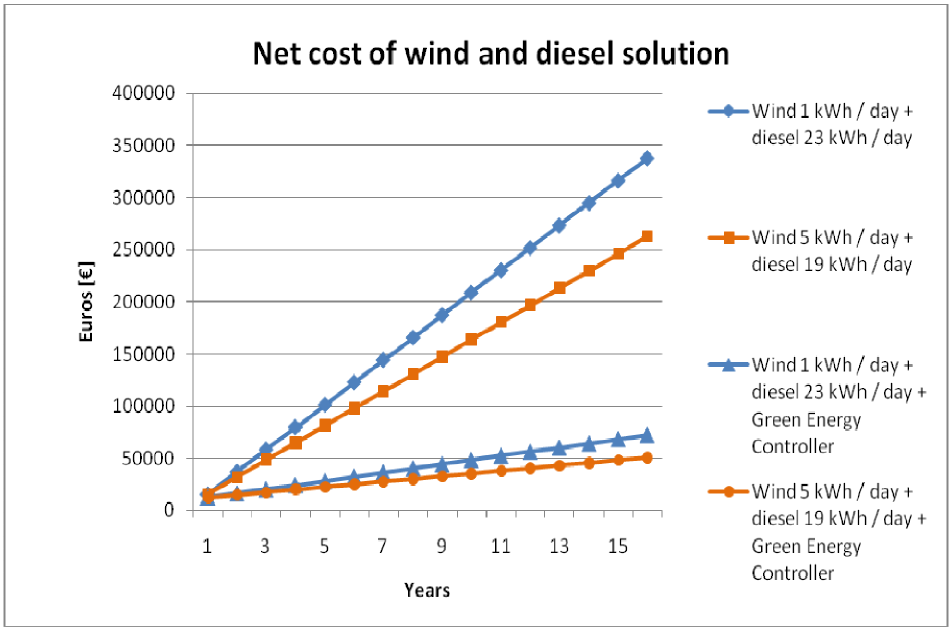

Chart 2. The sum of capital and operating costs of a site run with wind and diesel hybrid solution.

Solar PV

The actual power generation from the solar panel system in the pilot site was surprisingly low. The average production was only 0,7 kWh / day. Within the fifteen days of the reported data, there were three days with zero production. In addition, only during one day the generation exceeded 1,5 kWh / day and reached 3,4 kWh. It should be noted that December is the second weakest month in a year regarding the daily solar radiation in Lisbon area. While the highest amounts of radiation occur in the June and July (both having over 7,0 kWh / m^2 / day), in December the figure is only 2,1 kWh / m^2 / day.

In the solar power related calculations, the following items were taken into account: the solar panels (2 kW), battery unit and the cabinet, two diesel generators and rectifier. As the operating costs, the diesel fuel and its logistics as well as the needed maintenance were included. The price of the electricity was defined to be 0,40 € / kWh.

Based on the calculations, the following can be said of the financial feasibility of solar and diesel hybrid:

- Similarly as with the wind hybrid, the solar and diesel hybrid the decrease of 4 kWh / day produced by diesel would create approximately 4000 - 5000 € annual saving. The saving in total costs within the 15 years time is thus around 80 000€ / year and equals to 20% decrease.
- This calculation gave approximately 210 000 € savings within a 15 year timeframe when the Green Energy Controller solution is used (when 5 kWh is generated by the wind resource).

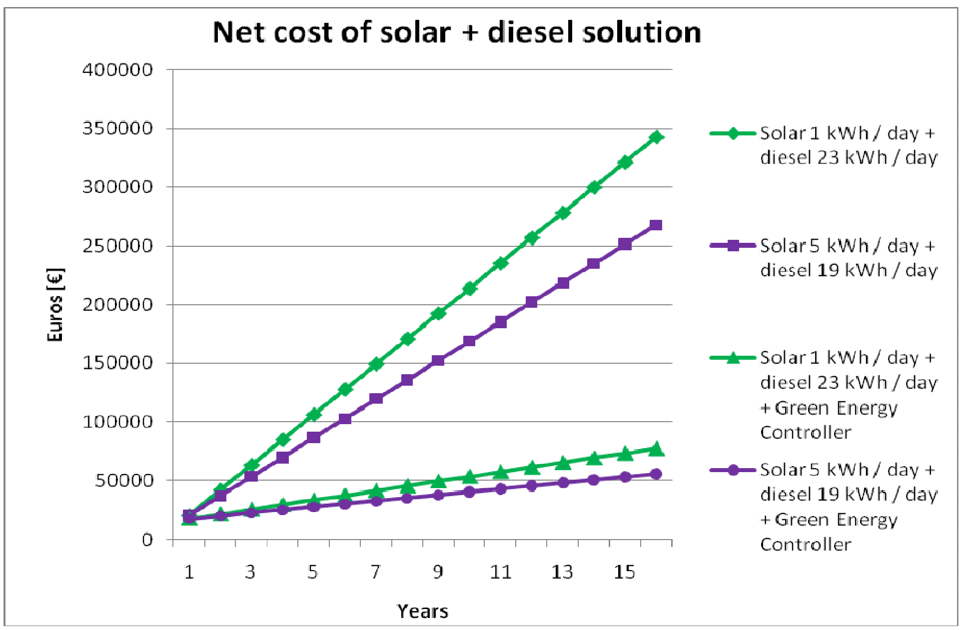

Chart 3. The sum of capital and operating costs of a site run with solar and diesel hybrid solution.

Total Site Management system benefits

The impact of the Green Energy Controller to the site energy management can be defined as following.

- The controller optimizes the energy generation activities between the power solutions installed on a site.
- It is assumed in the calculations that the diesel consumption could be decreased by 70% by using the Green Energy Controller solution.
- As the controller optimizes the energy production in a site, the back-up batteries can be charged and discharged based on a real need. Thus their life time extends.
- The operational costs decrease as less visits to the site are needed (to maintain the power equipment).

The benefits of using a centralized management system, on the other hand, are difficult to quantify, but the section below is intended to present general estimates of the savings and their impact on the calculations.

The collection of the consumption data enables further optimization of the available energy. The key issue to further improve the payback calculation is to minimize the diesel generator run-time (and thus minimise the cost of the fuel itself as well as the cost of the logistics of supplying the fuel to the sites).

The accuracy of the data is very important to identify further cost-saving possibilities. A full year's worth of data will give the operations staff much more accurate picture of the energy generation patterns. This is especially important for the renewable energy sources, but it is also important to identify the minimum, maximum and average duration of power cuts (in bad-grid locations) to optimise the size of the battery storage at the site. Typically these parameters are different at each site and need to be adjusted separately based on the available data.

The benefits for collecting the data into a centralised management system can be summarized as follows:

1) Better forecast of the generation quantity: Site-level information on how much energy is generated in a particular month or week
2) Better forecast for the energy consumption: Energy consumption patterns can be forecasted and further improve the use of energy on a per site basis
3) Optimized battery (or other energy storage) configuration: Minimise the diesel generation run-time when for example average duration of power cuts is known and batteries can cover it (no need to start the diesel generator)

4) Better and cost-efficient planning of maintenance activities (e.g. fuel delivery to the site): Maintenance activities can be combined for sites that are close to each other, need for visits can be forecasted accurately

In general, the renewable energy generation capacity and local storage need to cover as much of the energy needed as possible. Without access to accurate data on per-site basis it is impossible to optimize this. However, with a management system the calculations can be done easily and settings in the Green Energy Controllers can be done remotely (as often as needed). This optimization is assumed to further decrease the diesel runtime another 5-10 percentage points (-75-80% of the base scenario) in the short term and another 5 percentage points in the longer term (down to -80-85% of the base).

The Chart 4 (below) presents the case when the assumed level of 15% extra savings in diesel consumption due to the data utilization in power optimization is reached. The level of total monetary saving in this kind of case can be stated to be approximately 10 000€ within the assumed15 year timeframe.

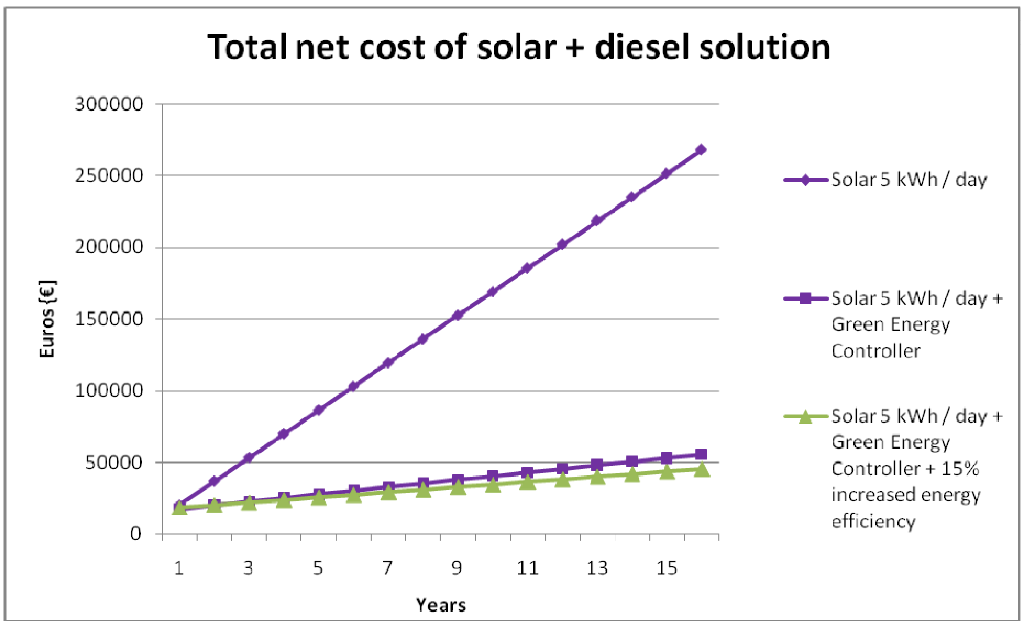

Chart 4. The sum of capital and operating costs of a site run with solar and diesel hybrid solution and the cost saving impact of increased energy efficiency

Pay-back time

In the calculations conducted, the net cash flow has been utilized to present the total costs over the 15 years time period for each of the distributed energy technologies (diesel, solar, wind). Now, in the pay-back time calculations, the importance of the positive net present value (NPV) is highlighted and e.g. the price of the electricity (revenue) is adjusted to enable this. Thus, the price of 0, 95 €/kWh both in solar and wind power cases gives a positive NPV which is an important factor for investors. The Chart 5 below presents that the Pay-back time sets around the sixth year after the investment made.

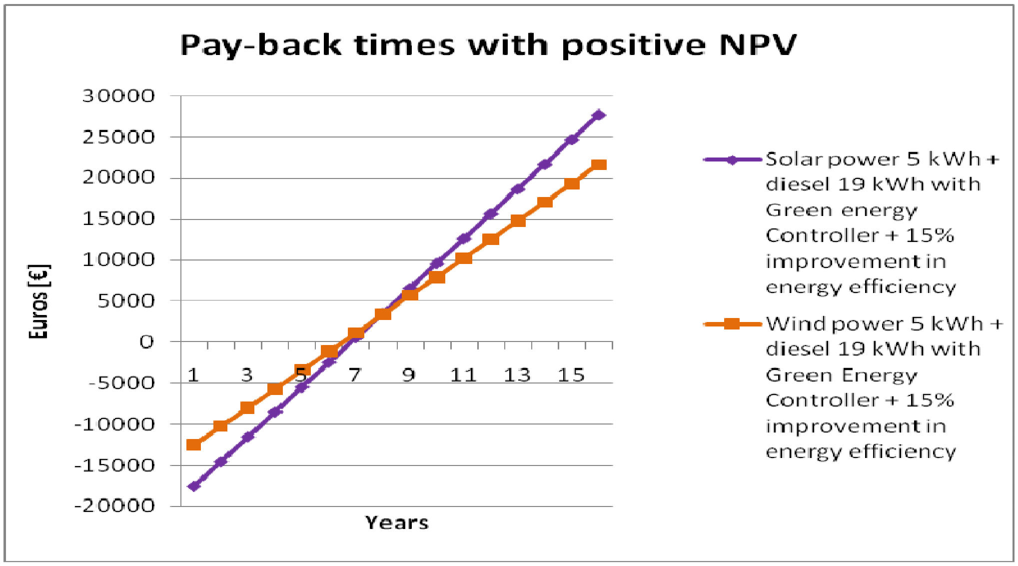

Chart 5. Pay-back times for solar and diesel as well as for wind and diesel hybrid solutions when positive Net Present Value (NPV) is reached

If the pay-back time is studied without the need to get a positive NPV, for example the solar and diesel hybrid solution could achieve the

- pay-back time of thirteen (13) years with the electricity price of 0,75 €/kWh
- pay-back time of 27 years with the electricity price of 0,68 €/kWh

The wind and diesel hybrid could reach the

- thirteen (13) years pay-back time with the electricity price of 0,80 €/kWh
- 28 years pay-back time with the electricity price of 0,74 €/kWh.

According to the calculations conducted, it can be said that a lower capital investment is needed in order to make it possible to reach the pay-back time with the electricity prices in level like 0,2 – 0,40 € / kWh. This is expected to happen when especially the prices of solar PV panels continue to decrease. Anyway, as the radio base site can be described as a critical infrastructure, back-up systems like diesel generators and large enough battery bank impact the cost structre significantly especially in off-grid locations.

5. Key findings

The Total Site Management concept has now been piloted to manage and control the energy generation and loads at radio base station sites. A site represents a specific type of distributed generation load with the infrastructure (telecommunication equipment) needing to be protected from electricity outages. Thus, the applicability to other sectors such as utilities is considered good because of the high importance of a reliable electricity feed.

The use of renewable sources is viable due to the reduction in energy generation cost and the lower ongoing operational costs. The use of wind seems to be very dependent on the choice of location. Thus, as a general energy source, wind does not seem to be suitable. Remote management of the energy generation is needed to optimize the use of the various energy sources in the microgrid. Additionally in the telecommunications domain, there are mechanisms available to minimize the energy consumption of the base station itself to further reduce the diesel consumption.

Remote management is foreseen to be needed in microgrid deployments to manage both the energy generation as well as energy consumption within the microgrid and/or island. In the telecom case the management of the consumption already exists, but in a general microgrid case the consumption management is needed. This links microgrid management to demand response as well as voltage and frequency management.

In Finland, trials of distributed generation in microgrid scale have been increasingly established in various locations. Some drivers for the utilization of the local energy resources are increasing interest in local, independent power generation and seeking both decreased energy costs (in terms of Total Cost of Ownership) and possibilities to produce energy in a sustainable way. The utilities are building distributed generation to utilize the local energy resources and involve their customers as producers also. The excess power sold by the prosumers to the grid broadens the product portfolio of the utility and increases the energy production reliability.

In Finland, based on the presentation of The Council of State[2], the wind power, biogas and wood based electricity production have received support in the form of a feed tariff. The

[2] Ministry of Employment and the Economy of Finland. Proposition from the Council of State od Finland for feed-in tariffs for renewable energy. 2010.

nominal power of wind power production approved by the system should be at minimum 500 kVa. The biogas plants and the utilization of forest converted chips as well as wood fuels should produce 100 kVa as minimum. [1]. The feed-in tariffs and CO_2 incentives provide potential possibilities to improve the business case attractiveness of the renewable energy solutions. The CO_2 emission trading provides a possibility for the producer of renewable energy to improve the profitability of the investment. The tariffs and related regulation differ country by country so they are not included to the financial calculatons in this report.

The research indicates that the renewable distributed energy generation is a viable alternative in the telecom sector. This is mainly due to the fact that energy generated with diesel generators is exceedingly expensive, especially if that is the only energy source at the base station site. Anyway, without more specific research, it cannot be concluded that the energy generation with a microgrid model would be viable within other sectors too.

6. Topics for further research

The work so far has proven that microgrid generation using the solar panels and wind power can provide a Return on Investment in the base station site energy generation as a hybrid together with diesel. The solar power has the advantage of being applicable in geographically wider areas as enough wind is usually available only in coastal and mountainous regions. The remote management of the equipment at the site is needed to allow the energy consumption to be optimized and to minimize the amount of site visits required to maintain the system in a working condition.

In the general case it is more difficult to provide an analysis of the viability. The open questions need more research. There are multiple factors that are different in the general case than in the telecom case, main differences being:

- Who owns the equipment? The equipment could be owned by multiple parties (e.g. PV equipment by the building owners, connection to the grid by the local distribution company)
- Who operates the equipment? The operational expenditures are fairly significant when the power is needed 24/7 and reliability needs to be at a reasonable level. E.g. diesel generators might be the only reliable source of power (as in the telecom case) and the fuel needs to be supplied when needed.

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http://www.tem.fi/index.phtml?101881_m=100414&s=4265 [In Finnish only. Access 13.2.2011]

- What is the earning logic for the people involved in building the micro generation? The earning logic may be driven by ROI calculations, but other factors may be relevant as well. Environmental factors, political pressure, improvement of reliability, backup power and other needs might make the investment in microgrids a real choice.
- In addition, revising of the financial calculation is seen as needed when the time series of the generated electricity figures representing several years and months are in use.

Further research is needed on tehcnology development for PV panels (especially production technology and expected cost development), replacements for diesel generators (e.g. hydrogen fuel cells) and business models for integrating microgrids into the grid. Protection schemes and management of microgrid power generation are additional topics for study.

7. Summary

The Total Site Management concept enables the optimization of the alternative power resources, battery life time and management of fault situations as well as effective utilization of statistical data (like energy consumed and produced source by source). The controller unit installed at the site enables the local control functionality for different power generation components. The management solution on the other hand provides the functionality for remote control, reporting and monitoring of remote sites.

As part of the research work, some basic financial calculations were conducted. Some data of the electricity produced in the pilot sites was used. The calculations themselves were conducted based on scenarios and assumptions made based on a broader set of information. The Green Energy Controller brings significant savings as the diesel fuel consumption is decreased through energy generation optimization on a site. In addition, the electricity generated from the renewable resources naturally decreases the fuel consumption of a site. Both the solar PV and diesel as well as wind power and diesel hybrid solutions can achieve a pay-back time under ten years but with significantly high electricity prices. With the current costs of the renewable energy technologies and the diesel fuel price, it is difficult to reach a sensible electricity price level as 0,20 € / kWh in the base station site type of case.

As a key finding it was stated that the Total Site Management concept is now piloted and it works according to the expectations. The remote monitoring and control activities can be conducted and reporting can be made (energy generation data is collected and stored). The benefits of the management system include better forecast of the energy generation and energy consumption quantities, possibility to improve battery optimization and improve the planning of better, cost-efficient maintenance activities. Regarding the renewable energy resources, it can be noted that the viability to use them, especially wind power, is much dependent on the location chosen.

The utilization of distributed generation to run radio base station sites and managing the energy production and consumption with an ICT solution represents the same fundamentals that are essential in microgrid concept as well. Isolated base station site with energy solutions has many similarities with the microgrid working in a islanding mode. The interest to modiify the management and control system from managing one site to manage a microgrid based on the current solution is of great interest and requires cooperation with energy industry partners. There are, however, some open questions which need more research. Those include, for example, the ownership of the equipment (energy solution itself, distribution etc), the operating parties and the chosen earning logic. The results and learnings from the Total Site Management project as well as the defined topics for further research are seen worth of further studies in SGEM phase II.

Terms and Abbreviations

CO_2	Carbon dioxide
ICT	Information and Communication Technology
NPV	Net Present Value
NSN	Nokia Siemens Networks
OES	Open EMS Suite
O&M	Operating and Maintenance
PV	Photovoltaics
ROI	Return on Investment
SCADA	Supervisory Control And Data Acquisition
SGEM	Smart Grids and Energy Markets program
SOAP	Simple Object Access Protocol
TCP	Transmission Control Protocol
TSM	Total Site Management
WP	Work Package