“Sustainable barriers?” – Obstacles for prosumers and micro-generation

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Keywords
microgeneration, solar energy, wind power, energy policy, prosumer

Abstract
This project was carried out at the Department of Energy Sciences at the faculty of engineering, Lund University. The aim was to investigate how an increased number of prosumers (customers who both produce and consume electricity, in residential and commercial buildings and small industry enterprises) affects the energy need and energy supply, and how this in turn affects our existing building stock and new-built buildings.

The objective was to analyse what barriers exist for prosumers and companies to build new buildings where electricity can be produced and to install micro electricity production devices on existing buildings. Moreover, suggestions on how to overcome these barriers were discussed. The project has been carried out by conducting interviews, creating a web survey and studying relevant literature. The results are mostly based on Swedish experience, not statistically significant, and should rather be seen as a first step towards mapping the barriers for household electricity production and how to overcome them. The comparison was also made with corresponding aspects of own micro-generation in other countries.

Conclusions for possible measures improving future energy policy, from Swedish perspective, were drawn. A number of factors constitute barriers for household micro electricity production. One of them is the design of the solar energy subsidy. Others are the lack of consideration of prosumers in the city planning, in the local plans and in the regulation of network concessions. A lack of knowledge dissemination, complex rules for private persons and economic factors are obstacles as well. Finally, the lack of consensus on definitions of energy efficient, electricity producing building also constitutes a barrier.

Introduction

BACKGROUND
The way we use, produce and distribute electricity is being changed. The trend towards smart grids and more distributed small-scale electricity generation, as well as lower prices for solar cells provide new opportunities for households to interact with the energy system. It provides better conditions for adapting the use of electricity to energy supply and to electricity prices, by controlling and reducing electricity consumption using smart services. It is possible to become a “prosumer” – i.e. to be a customer who both consume and produce electricity.

More individuals (in residential and commercial buildings and small industry enterprises) who produce their own electricity are an important component of the future smart grids and energy-efficient society. In light of this, it is significant with good prospects for individuals and for construction companies to build new houses with electricity generation facilities. A building may have a lifetime of 100 years or longer, which means that the decisions taken today will have consequences for a long time to come. Moreover, the amount of existing houses is much higher than the new ones so it is important that there are good conditions for installing and operating electricity producing systems on existing buildings.

With this in mind, it is interesting to make a summary of the aspects that influence the development of housing with opportunities for micro-generation of electricity and installation of power generation equipment in existing houses. What obstacles do various actors experience and what should be done to improve the situation?

OBJECTIVES

This work aims to provide an overview of the opportunities, barriers and aspirations of individuals and companies that build and, in some cases, administers housing to:

- Build new homes with the possibility of electricity production,
- Install power generation equipment in existing houses.

The work should be seen as a first step towards making such a statement and provide a comprehensive and broad picture of the situation for some players today. The study is focused on Swedish housing stock – single-family homes, apartment buildings, commercial buildings and small industry enterprises.

The main questions within this study are:

1. What further requirements for building design within the building codes are needed to promote the progress in development of houses with own electricity generation facilities connected to the smart grid?
2. What are the obstacles for individuals and companies to build such houses and/or to install small-scale power generation equipment in existing buildings?
3. What measures are needed to tackle barriers identified?

METHODS

A literature study has been made to explore the theory behind the issues and to highlight important topics.

Interviews have been held with representatives of the construction industry, utilities, experts at the University of Lund, representatives from municipalities and individuals who have built low-energy houses with electricity generation plants. A questionnaire was also sent to 24 building contractors. Based on this, conclusions were drawn about what is needed to promote the production of electricity in residential and commercial buildings.

The work is thus a compilation of available literature in the field and the experiences and views held by different actors – from construction companies to prosumers.

Own electricity production

There are different ways to produce own electricity. In 2012, the solar cells were the most common method in Sweden, but even small wind turbines, small hydro and small CHP plants, where biomass is converted into electricity and heat, occurred (Swedish Energy 2012). Also, fuel cells, wave and tidal power can be used for micro-production.

Some rules are valid in Sweden for those who want to connect their own power generation plant to the grid and sell the surplus to an electricity company. The production facility must be reported to and be approved by, the grid company. Grid companies are the ones who own the network and ensure that it keeps a good power quality. Therefore, the plant installed has to meet certain quality – avoid large voltage fluctuations on the net and harmonics should be kept below a certain level. There are also particular safety regulations.

Grid connection is charged depending on the capacity of the production plant (as a standing charge). Customers should also keep in mind that a qualified electrician must do the installation and that the products must be CE marked, according to the laws on health and safety (Scandinavian Heartland 2011).

For some plants building permit is needed. For example mini wind turbines (with a maximum of 3 meters rotor diameter and a total height of 20 meters) can be built on the ground but require a building permit if mounted on a building or roof (Vindlov 2012). Electricity supply company must be contacted regardless of whether the mini plant is connected to the grid or not (Swedish Energy Agency 2011). Permission required for solar panels varies from municipality to municipality. Solar panels mounted on a stand and not directly on the roof need building permit (Scandinavian Heartland 2011).

Finally, the customer must also have an electricity meter with hourly readings of both production and consumption. Such meter can be installed for free by the power company if the facility has a main fuse of a maximum of 100 Amps, an input power of up to 69 kW, and if the prosumers consume more electricity than they buy over a year (Energy Agency 2013b). If these requirements are met, the customer doesn't pay any network tariff for feeding electricity.

MICRO-GENERATION

Swedish customers can choose any retail company to sign a contract on selling electricity. Power companies have different definitions of what a micro-producer is. Some claim that the prosumer should be a "net consumer of electricity over a year" (Vattenfall, 2014, Skåne Energy, 2014). Other companies don't request this (E.ON, 2014, Värnamo Energy, 2014). A third definition is a "customer who is a micro-producer complementing electricity use from the power system with own electricity supplied in the same entry and exit point".

PRICING OF OWN ELECTRICITY PRODUCTION

The electricity price the Swedish customer pays for purchased electricity includes electricity fee, grid fee (both standing and variable component), energy tax, electricity certificate and VAT on the whole price. The price electricity companies pay for the electricity delivered by the prosumers includes the produced electricity and network performance. The company gets economic benefits of the locally generated electricity by avoiding grid losses (Scandinavian Heartland 2011).

The price for the delivered electricity prosumers get varies depending on if they are retail customers, where they live and how big the plants are. For example, some companies pay 1 SEK/kWh for customers, who are also retail electricity customers, whose facility has a maximum power of 10 kW. This means an immediate loss for the company of about 0.50–0.60 SEK/kWh. The price is set for marketing reasons and for future development reasons – to promote micro-generation. (1 SEK = 0.1 EUR.)

Net Billing

Billing with a net debit means that the electricity fed into the grid is balanced against the electricity that the customers buy, during a certain period of time. This period can be for example an hour, a month or a year. The customers pay thus only for net electricity consumption during the given period. This also means that they are not paying energy tax and VAT on all the electricity consumed during the billing period. But the Swedish government has made the clarification that this is incompatible with the VAT Directive from the EU, and the net debit will not be recommended to be introduced in Sweden.

Tax relief
Instead of net billing, the Swedish government proposed that micro-producers (or prosumers) should receive a tax reduction as compensation for the input electricity. This tax credit is considered to be compatible with the VAT Directive and should roughly equal the amount of money that a micro-producer would earn on the net debit. A bill was published in March 2014 with a proposal for legislation on tax reduction for micro-generation of renewable electricity. The law was proposed to be applied from July 1, 2014 for both individuals and companies. These may have a fuse of a maximum of 100 Amps, must feed in and out electricity in one single connection point and inform the grid owner that they supply the renewable electricity to the grid. The tax reduction amounts to 0.60 SEK/kWh and is given for at most 30,000 kWh per year per person and access point. Therefore, the amount tax credit can be at most 18,000 SEK per year. Tax credit is not given for all self-produced electricity, but only for the input electricity – that is, the excess electricity fed into the grid. A micro-producer may not get tax reduction for the electricity that exceeds annual electricity usage.

Feed-in tariff
A feed-in tariff means an agreement between electricity consumers and electricity companies, where energy customers are guaranteed a certain price for the produced electricity in a long term, usually 15–20 years. The electricity company is also obliged to accept electricity from the customer regardless of the electricity demand during this period (NREL 2010). There are many different ways to design feed-in tariffs and the compensation paid. Three basic versions are applicable: 1. the remuneration consists of a base amount plus a premium that depends on the price of electricity; 2. remuneration consists of a basic amount which extension has a minimum and maximum value, and 3. the compensation is fixed (Ragwitz et al 2012).

It is also common that the feed-in tariff value depends on the age of the actual plant; the older the plant, the lower the value. This should provide incentives for technological development and reduced construction costs. Feed-in tariffs are common within the EU to promote electricity from renewable energy sources. In 2012, 24 EU countries applied feed-in tariffs, an increase of 15 states since year 2000 (Ragwitz et al 2012). Sweden does not apply this system.

Electricity certificate
The electricity certificate is a way to support the production of renewable electricity. Producers of renewable electricity, including prosumers who use such as solar or wind power, can receive certificates (one certificate for 1 MWh produced electricity). Electric companies, power-intensive industries and certain electricity users are then commanded to purchase certificates at market prices (Swedish Energy Agency 2013). For prosumers who want to use the opportunity to sell certificates there is are a number of rules to consider.

In order to receive certificates requires an application submitted to the Swedish Energy Agency and an account with Swedish Net Operator needs to be created, for a certain fee (Swedish Energy Agency 2014). Electricity production must be measured every hour and reported to the Swedish Net Operator.

The electricity certificate system is not as common as feed-in tariffs. In 2012, six members of the EU applied certificates, including Sweden (Ragwitz et al 2012).

State and local government support for solar systems
Individuals, companies and organizations in Sweden can apply for state subsidies for the installation of solar energy systems – so called "solar energy support". This is given to grid-connected photovoltaic systems and solar electricity/solar hybrid systems (systems that can produce both electricity and heat). Solar energy support was introduced in 2009 and aims to increase the use of solar photovoltaic systems in Sweden and promote the transformation of the energy system. In 2013, the levels of support was updated and is now limited according as following:

- A maximum of 35 % of the cost of materials, labour and design is covered.
- The support is capped at 37,000 SEK/kW (excl. VAT) for photovoltaic systems and 90,000 SEK/kW (excl. VAT) for hybrid systems.
- Each system can have a maximum of 1.2 million SEK in compensation.
- The support is paid to systems that will be installed by December 31, 2016 or as long as the allocated money (210 million SEK) is enough.

Also at the municipal level, there are schemes to promote the installation of photovoltaic solutions. The municipalities that require a building permit for the installation of solar panels on existing buildings can choose to discount the cost of the building permit.

Obstacles for electricity generation in buildings
In the literature studies, interviews and surveys, different types of obstacles to install and operate power generation facilities in residential buildings were identified.

STRUCTURAL REQUIREMENTS
When residents go from solely being consumers of electricity to produce electricity and become prosumers, they become a part of the smart grid and need smart solutions and controls in their homes. This may require special technical design of buildings, materials, installations and energy performance.

The conclusion from this study is that the technical knowledge of how our buildings can be adapted to prosumers is already there and applied by those who build houses suitable for electricity generation. The experience with so called "smart solutions" gives numerous problems. However, knowledge of the construction of these more complex housing should be more widely disseminated to the various players in the construction industry; continuous training would probably be needed.

THE DESIGN OF THE BUILDING REGULATIONS

Market-based or regulatory requirements

Sweden's policy for energy efficiency in buildings can be seen as more market-driven than regulative. Since the 1970's, strict and detailed requirements for building energy use, requirements for specific building components and materials are applied. In the 1990's, some rules were replaced by more function-oriented and market-based requirements. The requirements were now at the system level rather than the level of detail and could be achieved in several ways. Some argue that this made that Sweden's demands on energy performance of buildings (since the 1990s) have not been ambitious enough and nowadays they are more as standards than the minimum requirements (Schade et al 2013).

Detailed and functional requirements

The interviews carried out within this study show that the construction industry companies mostly appreciate the functional requirements. More detailed requirements in the national building regulations, to encourage the growth of homes with electricity generation facilities, would not be well accepted. However, there is a support and need for a tightening of the requirements. On the other hand, more stringent requirements on the energy wouldn't have impacts on micro electricity production, as this is not included in the current building codes.

Credit for solar energy

Swedish building code (BFS 2011: 26) states that: "specific energy consumption of a building may be reduced by the energy from solar panels or solar cells placed on the main building, other building or ground, to the extent that balance the energy use of the building".

This means that only a portion of the produced solar energy can be credited to reduce the building's energy use. The definition can be interpreted that the generated electricity must be used instantaneously; the electricity produced on a sunny day cannot be used on a cloudy day. From an electricity production perspective, the next update of the Building Codes (2015) should take into account these uncertainties for the prosumers.

UNSAFE SITUATIONS FOR DEVELOPERS

Some different "unsafe situations" have been identified that prevent the construction of new housing units with self-generated electricity. To promote the construction of plus and nearly zero energy buildings, the state and municipalities should support the building developers and provide good conditions through careful planning and preparation. In the end, however, developers, property owners and individuals are those who must take the decision on investment; these decisions are based largely on economic aspects.

The problems that the developers meet are following:

- Unsure solar subsidies,
- Uncertain long-term goals and plans,
- Different definitions of nearly zero-energy buildings,
- Lack of solar power optimization in urban planning,
- Lack of dissemination of comprehensive knowledge to the companies and customers.

BARRIERS FOR ELECTRICITY GENERATION IN EXISTING BUILDINGS

Practical barriers

Several obstacles exist to install a power generation facility on an existing house. First, the existing building is not necessarily designed for such installation as, for example, solar cells. Usually building was not oriented between south-east and south-west. Other buildings and trees may shade the roof. Roof slope was chosen without regard to solar production. It is therefore easier to get a good solar potential for a newly built houses than for existing ones (Elforsk 2011).

Grid connection – Concession obligation

In Sweden, in order to build a power line, a permit is required – a concession. The concession obligation is governed by the Electricity Act and assessed by the Energy Market Inspectorate. The concession obligation for the electricity grid was introduced to prevent the construction of multiple parallel networks, as it is most efficient to transmit electricity on a single network, and to protect people, animals and nature. Anyone who has a concession in one area has a monopoly on building power lines and is bound to give, anyone who wants, an access to the grid. There are several exceptions. For example, a property owner can draw electric lines in the building and (usually) on the property, but is not allowed to draw it to another building, if it is used as a dwelling. It is possible to install a power generation facility on the property, next to the residential building but the concession obligation can prevent prosumers from taking advantage of the electricity surplus they produce, if they want to use it in another building or property. This leads to significantly declined profitability for the prosumers (Elforsk 2014).

Financial barriers

The number of installations of solar cells has increased in recent years as the price of solar panels has dropped, both internationally and in Sweden (Swedish Energy Agency 2014). The economic feasibility determines whether households would invest in a plant to produce own renewable electricity or not. However, several studies show that consumers do not always behave rationally from an economic perspective; an investment in an electricity generation plant may fall because of high investment costs, even though the system pays itself back in a reasonable time. This may be due to unawareness about the costs and benefits (Sauter & Watson, 2007), how individuals interpret information and because of personal priorities (Darby 2010).

High costs are often a major obstacle to electricity production in buildings, for both individuals and companies. Both the interviews and questionnaire revealed that net billing would have a great influence and is requested to increase the profitability of micro electricity generation. The net debit will not be introduced in Sweden, which means that other ways of achieving good profitability are much more important. For example how electrical utilities are pricing the electricity produced and delivered by prosumers. At the same time, good terms for the producers very often mean pure losses for the electric companies. In Germany, this has led to high electricity prices and the cost of electricity production has ended up on consumers' bills. Someone must be prepared to pay. An increase of Sweden's low electricity prices would of course favour the installation of private power generation. Improved ability to utilize excess electricity would also increase profitability. This can happen if the electricity storage becomes more affordable or concession obligation rules are to be reviewed.

International outlook

In comparison with the Swedish conditions and methods for micro electricity supply pricing, some examples from other countries are described.

AUSTRALIA

In Australia, feed-in tariffs are applicable. However, there is no national legislation. How the feed-in tariffs are designed varies between the different states and territories. Thus, the compensation the prosumers get depends on how many years the feed-in system has existed and on the requirements of the maximum power of the production units. In various parts of Australia it also varies how the produced and consumed electricity is measured, which created two types of feed-in tariffs (Energy Matters 2014). With the "gross feed-in tariffs" the prosumer is paid for the electricity produced, and pays for the electricity consumed. With the "net feed-in tariffs" the prosumer is paid for the net production of electricity, or pays for the net consumption (MEFL 2009). For both types of feed-in tariffs production and/or consumption is measured every half an hour (State Government of Victoria 2011). Feed-in tariffs based on net metering (net feed-in tariffs) have been criticized for actually being a net billing, despite the name (Metering 2008). However this system is the most common as it is applied by six of the eight states and mainland territories. One mainland territory has gross measurement, and one state is phasing out the gross measurement in favour of net metering, which means that they currently apply both systems (Energy Matters 2014).

In Australia, there are also two types of electricity certificates: one for large-scale facilities for renewable electricity and one for a small scale. The latter certificates are distributed to owners of small solar panels, wind turbines and hydroelectric power for each MWh of electricity generated. They are also given to owners of solar heating systems and heat pumps for each MWh of electricity their facility replaces. The certificates must then be bought mainly by electric utilities (Clean Energy Regulator 2013), like in Sweden.

DENMARK

Until the end of 2012, individuals who set up a plant for the production of renewable electricity, with a maximum power of 6 kW, were net charged on an annual basis (Iversen 2013). This caused excessive growth of solar installations and led to significant losses of tax revenues for Danish society. Hourly net metering was therefore implemented instead as a way to reduce subsidies for solar cells, something that the Danish market was mature for. For solar cells, the maximum power of 6 kW was raised to 400 kW (Iversen 2013) when it was considered that the previous limit only favoured single-family houses (Kebmin 2012). After the amendment, it was also possible to install a common electricity generation plant in larger residential buildings with the aim to cover individual apartment's electricity needs. Another change is that the feed-in tariff paid for excess electricity production expires after 10 years, and the prosumer will be paid the market price instead (Iversen 2013). Individuals who registered their plants to electricity grid companies and installed them by December 31, 2013 can still get yearly net debit (BEK No. 1032 of 26.08.2013, §16).

NETHERLANDS

To become a prosumer in the Netherlands needs no application, unlike Sweden. But prosumers must inform the network operator and electricity supplier that they, sometime in the future, will deliver renewable electricity to the grid. For installations with a maximum capacity of 3 × 80 Amps, net metering applies and the prosumers therefore only need to pay for their net consumption of electricity. Until January 1, 2014, a maximum of 5,000 kWh of electricity produced could be reduced from the purchased electricity every year. Prosumers who produced more electricity were paid for this. Nowadays, the limit is removed (Holland Solar 2014). The European Commission judges that the Netherlands' net metering is in conflict with the VAT Directive, while the Netherlands politicians mean that they do not look so formally on the issue. The Netherlands also applies feed-in tariffs, however, not for individual households but for companies and organizations. For example, a photovoltaic plant must have a capacity of more than 15 kW in order to have right to get feed-in tariff (NL Agency 2013).

NORWAY

Norway applies neither net metering, feed-in tariffs nor tax credit for self-generated renewable electricity (RES LEGAL 2013). The type of support that Norwegian prosumers can get for their electricity is an electricity certificate – something that is not adapted to small-scale electricity producers and is therefore not profitable (Sprenger 2013). To make it easier for individuals to supply electricity to the grid, exemptions from applicable regulations for "plus customers" were introduced in 2013. Net production and consumption is measured on an hourly basis (NVE 2013). Electricity supply companies in Norway are obliged to accept electricity from customers who want to enter the electricity grid (Sprenger 2013). The price the prosumer can get for electricity is determined by an agreement between the customer and the electricity grid company, but should follow market prices (NVE 2013). Changes are discussed to ensure "plus customers" remuneration for the input. First private individual plant selling electricity to the grid started in Norway 2011 (Sprenger 2013).

NEW ZEALAND

New Zealand provides no financial support for renewable, small-scale electricity and residents connected to the power grid are requested to not install their own grid connected power generation systems. The Government believes that it is rarely economically viable and does not carry such large environmental benefits. They claim that 77 % of the New Zealand's electricity production already comes from renewable energy sources. Moreover, new planned power generation facilities will also use renewables. This means that the advantages of small-scale renewable electricity in residential buildings are not as significant as in several other countries (EECA 2014). Electricity production for own use, with the surplus to the grid, is allowed, but there is no requirement that the energy companies have to purchase the electricity. It is therefore up to the power companies what they pay. Those who choose to feed electricity to the grid must, like in Sweden, get the plant approved by the grid company because of safety and power quality reasons (EECA 2010).

UNITED KINGDOM

Micro-production is an important method for the UK to achieve its long-term energy goals; including reducing greenhouse gas emissions and increase of energy security. Year 2050, micro-production based on renewable energy sources and energy with low fossil carbon content should meet 30–40 % of the UK's electricity needs (Allen et al 2008). Strategies to increase and support micro-production are formulated in the Government's Micro-Generation Strategy. Some proposed measures are given to tackle the non-economic barriers to micro-production. The idea is to better utilize the full available potential of the governmental financial support. The measures cover, among other things, information dissemination, education initiative in the industry, certification of installers and products, energy rating of buildings with regard to micro-production and the opportunities for groups to install micro-production together (DECC 2011a).

In 2010, the United Kingdom introduced feed-in tariffs. These replaced the previous investment support Low Carbon Buildings Programme for small-scale production (Hammond et al 2012). The support mechanism of renewable obligation certificates – an equivalent to certificates – is being phased out (DECC 2011b).

Britain's goal is that by 2016 all new housing will be "net zero carbon homes" meaning that the net carbon emissions from heating, cooling, ventilation, hot water and building electricity during one year shall be zero.

GERMANY

"Die energiewende" – energy transition – is a concept for Germany's ambitions to transform its energy system by replacing nuclear and coal power with renewable fuels (Graupner 2013). The goal is that 80 % of the electrical energy will be renewable by 2050 and electricity consumption will be reduced by at least 10 % by 2020 (Alpman 2012). The concept Energiewende has its roots in the German nuclear resistance in the 1970's and got a boost after the nuclear accident in Fukushima in 2011, when the government decided to phase out nuclear power by the year 2022. This led to major investments in renewable energy (Graupner 2013). One example of legislation to achieve the energy goals specified above is the "Renewable Energy Sources Act" with the German abbreviation EEC, which promotes renewable electricity production through feed-in tariffs. EEC has inspired several countries to similar legislation and is a further development of the German law on feed-in tariffs from 1991. Prosumers are guaranteed access to feed electricity to the grid and a fix income per kWh for 20 years (the Energy Transition 2014A).

The German feed-in tariffs have led to rapid and substantial expansion of facilities for renewable electricity generation. In 2012 over one million German houses had solar panels installed on the roof, a trend that has accelerated in recent years (Hansson 2012). The same year, 47 % of the installed capacity of renewable energy was owned by German households and cooperatives (Energy Transition 2014b). The economic support for renewable electricity generation, however, is put on household energy bills, which has led to the fact that Germany has the highest electricity prices in Europe. On the other hand, this sytem has a broad support among the inhabitants (Hansson 2012).

SPAIN

In 2012, the Spanish feed-in tariffs were abolished for economic reasons. A sharp increase in electricity demand between 2000 and 2008 led to an excessive expansion of mainly the renewable electricity production, resulting in a large surplus of electricity and economic problems for the energy companies and the society (Mir Artigues 2013). The economic problems occurred also mostly due to the fact that the cost of the substantial governmental support for renewable electricity production couldn't be covered by higher prices of electricity. A new maximum level of electricity price was set up every year. If it was exceeded, the Spanish Government had to pay the difference. The cost of this policy was very high (Morris, 2009).

Prosumers' own production of electricity was thus a loss for the retail and grid companies (Mir Artigues 2013). Instead of feed-in tariffs, the current legislation gives owners of electricity generation plants, with a capacity of less than 100 kW, possibility to be connected to the grid and sell electricity at market price (pv magazine 2014).

USA

In the USA, different states have different pricing systems for micro-generation (Sullivan et al 2014). In July 2013, forty-three states had net debit (DSIRE 2013a), with varying rules on the amount of compensation paid when the prosumer is a net producer, how much power that may be fed into the grid and what types of installations are eligible for that (Sullivan et al 2014). A smaller number of states, seven in May 2013 (EIA 2013), apply net debit and also feed-in tariffs, but this is not expected to be to a federal policy. A third way to provide financial assistance to individuals who produce their own electricity is the PACE program (Property Assessed Clean Energy) involving loans that the prosumers pay back on a monthly basis through a surcharge on property tax. The aim is that the monthly profits from its own electricity production will exceed the monthly extra cost of the loan (Sullivan et al 2014). Twenty-nine states were using the PACE program in April 2013 (DSIRE 2013b). In the USA, like in Sweden, permits are required for installation of micro-generation plants and even building permits may sometimes be needed (US Department of Energy, 2012a).

In some states, the prosumers should apply for a declaration that the neighbours will not be allowed to build any type of structure blocking own power plant to produce electricity (US Department of Energy 2013). Cost reductions, subsidies and tax incentives also exist as tools for increased profitability of renewable electricity generation plants (US Department of Energy 2012b).

Conclusions

The conclusions are based and refer to the Swedish case but can also be relevant for the other countries. The results from this research work have shown that:

- There is no need for the more specific requirements in building codes on how houses should be designed, built and connected to the smart grid, to promote micro electricity production. The existing functional requirements, which provide freedom of choice, are appreciated and effective enough.
- The knowledge how to build new houses and to adapt existing buildings to be prepared for electricity generation, and about smart solutions, already exists, although it should be spread out more actively to be successful.
- There are several obstacles for individuals and companies to build new houses with electricity generation facilities, or to install electricity generation plants in existing houses:
  - Economic barriers:
    - High investment costs (still relevant despite declining market prices for solar cells)
    - Inefficient and insecure financial support.
    - Unprofitable conditions to exploit the excessive production of electricity – concession obligation causes that the electricity must be sold instead of being distributed in a way that is most profitable for the owner of electricity generation plant.
    - Unprofitable conditions to sell excessive electricity due to the fact that net billing is not allowed.
  - Planning on the municipal level:
    - Lack of planning of micro electricity production areas blocks expansion of micro-generation both today and in the future.
  - Lack of knowledge and uncertainty because of that:
    - Individuals feel that electricity generation field is complicated and subject to complex rules; there are misconceptions about investment costs, production potential and profit.
  - Unclear definitions of energy-efficient electricity-generating building:
    - All the aspects of electricity production are not covered by a single definition; different players (national and international) prefer different definitions, which creates barriers for the building companies.

Three proposed measures are considered to have the greatest effect on electricity micro-generation in new and existing buildings:

- A restructuring of solar energy subsidies; applicants should know much earlier if the financial help is possible.
- An increased work on solar energy and micro-generation planning in municipalities.
- A review of the concession obligation rules; prosumers should benefit from the self-generated electricity instead of being obliged to sell it.

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Acknowledgements

The author would like to thank Master's student Sara Eriksson, who performed pre-study, surveys and interviews for this project, for her great input into this research work.

This project was financially supported by the Building Council (Byggrådet) in Sweden, an organisation aiming at supporting and promoting research on buildings in co-operation between Swedish universities and the industry.