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# CAMELIA – Concerted Action Multigeneration Energy (Deliverable)

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***"Concerted Action Multigeneration Energy Systems with Locally Integrated Applications"***

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WP6: "Techno-Economic impact & Socio-economic acceptance"

# DELIVERABLE D6.1

**Most suitable business models**
**for the introduction of polygeneration based on RES**
**and**
**methodologies for the evaluation of socio-economic acceptance**

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# Table of contents

# 1. Introduction

The aim of Workpackage 6 “Techno-Economic impact & Socio-economic acceptance“ is to identify and quantify the socio-economic evaluation methods and suitable examples for business models to realize a sustainable energy supply for the building sector using polygeneration.

The scope is seeking for models to investigate the effects of renewable energy sources (RES) generation – both feedstock production and energy conversion – as well as the effects of rational use of energy (RUE) in (eco)-buildings on the surrounding economic (financial, local industry creation, infrastructure development, regional value added, etc.), social (employment, education, health, etc.) and environmental climate.

Decision makers get an introduction to the importance of such analyses on non technical benefits[1] and barriers and a support in choosing the most appropriate models to evaluate the impacts of respective planned or existing projects. Comparisons can be made between separate bioenergy systems and support mechanisms to identify the optimal bioenergy production structures and eco-building facilities.

# 2. Basic definition business models

## 2.1 Energy businesses

If co- and poly-generation techniques are to penetrate an energy market, there has to be appealing local business models for local energy utility actors[2]. On a regulated energy market business models may be imposed by authorities more or less directly, where as on a deregulated energy market the authorities only can play a more indirect role in shaping the energy business on a local level. Further, the development of the European Union will have an impact on the development of regulatory means etc. both on a European and national level, and thus affect what solutions will be attractive on a local level. This is particularly well described in one of the reports from the Royal Swedish Academy of Engineering Sciences study “Energy foresight” from 2003 **Error! Reference source not found.**. In the report four scenarios are painted describing four slightly different directions of European Unions’ future development: scenarios where the development for instance will affect the size of the financial market(s) and the relative stability in these, as well as financial risk estimates; which in combination with other factors connected to the overall development in turn will stimulate the penetration of large scale solutions on the one hand and small scale solutions on the other, as well as how appealing what is perceived as new technologies (e.g. various forms of RES) seem to actors – what ever (local) energy market they are acting on.

The deregulation of several European energy markets (such as the Swedish) has lead to a reshaping of what is understood as an energy system. From mainly referring to an infrastructure carried value/process chain where the end use has been placed outside the systems boundary, the picture has become more varying and other notions of what makes out “the energy system” take a users perspective and thus come up with new descriptions and consequences. I.e. what make out an energy service business on the new deregulated energy markets are varying and the development of IT and its penetration into the

[1] Categorised by social aspects, macro level, supply side and demand side. See: J. Domac, K. Richards, Final Results from IEA Bioenergy Task 29: Socio-economic Aspects of Bioenergy Systems, IEA Bioenergy, 2003
[2] Even though these *local actors* may be national or even multinational energy utility companies, they act on a local *utility market* in some sense.

energy utility and service businesses gives new possibilities and enables still new perspectives. This is something that has been described and elaborated upon in e.g. Fredrik Lagergren's doctoral thesis "Rethinking energy systems" from 2004 **Error! Reference source not found.**.

The level of experience of co- and poly-generation technologies may be varying between the European countries as well as within. In some countries co-generation is normal everyday business, and in others its not. In the Scandinavian countries it is what is normal. With large heating demands over a large part of the year and traditions of large energy utility companies (often city or state owned) that until a few years ago operated in more or less local monopoly situations, implementation of district heating has had large market penetration. When space and process cooling in densely populated areas became an issue many of them put district cooling into their "product portfolio". The roll out of the district cooling grids has been very systematic and target minded in general, in contrast to the development of the Les Halles area in Paris, which has developed more as an organically growing network.

## 2.2 Business models

A business model may describe how a business and its values are brought to market, and to what customers etc. Varying building stock and historical structure of the present energy companies together with local prerequisites will render in unique solutions to technology, combinations and sizes, and thus attract different utility companies and operators, with different product packaging as a consequence.

## 2.3 Drivers

The possibility to integrate a poly-generation (poly-utility) solution in a local situation is dependent on a series of aspects, drivers

### 2.3.1 Energy usage

Indiscriminately of whether it is the question of implementing larger scale (city size situation) infrastructural district distribution of heat, power and possibly cooling, or smaller scale building size situation adopted tri-gen plants, the energy usage situation is detrimental to if and how interesting poly-generation is and how it may be implemented. Cf. **Error! Reference source not found.**. Historically the electricity usage and heating demand has followed each other over the year, setting a market for heat and power production and heat distribution via district heating and the electricity grid. Over the years the requests for spatial cooling has increased. Typically the spatial cooling demand is present during summer, and in many cases this may not be enough to make district cooling an interesting option: Especially not in the average small scale implementation. However, on a large scale the base load for cooling is usually around 30% (process cooling, e.g. servers etc) of the peak load, making district cooling more interesting. I.e. on a small scale local basis the usage of various energy utilities may be complementing each other over the year, from a user's perspective, and thus making implementation of small scale poly-generation much more complex. There are however examples where this has been done successfully such as the McCormack exhibition and conference complex in Chicago.

### 2.3.2 Energy market

The shape of the local energy market is an important driving factor. The presence of large infrastructure energy utility companies can create a market where utilities are bundled and packaged into consumer interesting services providing heating, cooling and electricity bundled into one "product". It is even possible for them to market energy utilities in the form of "pleasant indoor climate and lighting" and charge their customers for that instead of "energy" (kWh). With the entrance of facility management companies as utility providers to end customers this is something that may be further emphasised.

The (local) financial situation (banks as well as internally in larger corporations) may of course either endorse or suppress the implementation of large infrastructural energy services, and the risk involved in small scale situation adapted poly-generation solutions may likewise act endorsing or suppressing on these. Not necessarily in the same way.

### 2.3.3 New fuels and sources

New technologies such as gasification of biomass in small to large scale plants will create a larger potential for solid biomass as fuel in small scale highly efficient co-generation plants, and increase their potential in more densely populated areas. The presence of free cooling sources in some localities may reduce the operations cost for district cooling for instance (cf. the Stockholm district cooling grid with a significant amount of free cooling in it, as compared to the Helsinki grid which is operated by mainly absorption liquid chillers). Etc.

### 2.3.4 Redundancy

Resent events in Europe and other parts of the world have illustrated the vulnerability of the modern large scale energy infrastructure. If not before, redundancy in energy systems has become an ever increasingly important issue. The benefit of, especially, small scale co- and poly-generation in terms of redundancy is a large potential market, primarily in less dense populated areas. As it is today, RES solutions will stop if there is no power in the grid. The development of domestic heat pumps with internal redundant power generation is but one example.

### 2.3.5 Other drivers

There are however other, sometimes local, drivers to implement co- and poly-generation solutions on either large or small scale. The development of IT-solutions enables operation of geographically distributed energy services plants on and as a large scale operation. Etc.

# 3. Business models

If co- and poly-generation techniques are to penetrate an energy market, there has to be appealing local business models for local energy utility actors. On a regulated energy market business models may be imposed by authorities more or less directly, where as on a de-regulated energy market the authorities only can play a more indirect role in shaping the energy business on a local level. Further, the development of the European Union will have an impact on the development of regulatory means etc. both on a European and national level, and thus affect what solutions will be attractive on a local level. This is particularly well de-scribed in one of the reports from the Royal Swedish Academy of Engineering Sciences study “Energy foresight” from 2003 [3]. In the report four scenarios are painted describing four slightly different directions of European Unions’ future development: scenarios where the development for instance will affect the size of the financial market(s) and the relative stability in these, as well as financial risk estimates; which in combination with other factors connected to the overall development in turn will stimulate the penetration of large scale solutions on the one hand and small scale solutions on the other, as well as how appealing what is perceived as new technologies (e.g. various forms of RES) seem to actors – what ever (local) energy market they are acting on.

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The level of experience of co- and poly-generation technologies may be varying between the European countries as well as within. In some countries co-generation is normal everyday business, and in others its not. In the Scandinavian countries it is what is normal. With large heating demands over a large part of the year and traditions of large energy utility companies (often city or state owned) that until a few years ago operated in more or less local monopoly situations, implementation of district heating has had large market penetration. When space and process cooling in densely populated areas became an issue many of them put district cooling into their “product portfolio”. The roll out of the district cooling grids has been very systematic and target minded in general, in contrast to the development of the Les Halles area in Paris, which has developed more as an organically growing network.

What is not normal is small to medium scale highly situation adapted poly-generation.

## 3.1 Business logics

To achieve co-and poly-generation RES in any size, business models attractive to all involved actors are required. Business models with incentives for all actors: Every stake holder in the setup has to be able to gain a profit (economic, political etc.) or no action will be taken. The idea of what makes out *the good deal* is essential and what makes out *a good deal* for one company may not be perceived as *a good deal* at all for another seemingly similar company. As the general trend is moving towards more and more specialised companies, the importance of alliances between different companies is imminent [2]. The key question is thus what type of companies are interesting in a particular case – with a specific technical prerequisite and setup – and what impact has the relative size on this to the palette of actors and stake holders.

### 3.1.1 The anatomy of the good deal

Who then are the subjects of a deal – preferably a *good deal*? What roles have to be filled? Professor Eric Giertz points out that one has to start looking at the core business of the concept and then consider the actors presumably involved. Who are really needed? [2]
The trend moves to ever more specialized companies, and on a new market (which co-/poly-generation RES may be though as – especially if a small or medium plant scale is considered) one has to find the appropriate technology and a good segment of clients/customers. It is not absolutely certain that a coordinating actor is required, if the profitability for all actors is evident the business will probably appear anyway, or at least unintentionally by some stake holder or another, but it is very likely that some form of coordinating actor has to be present to "carry" the value chain. The value chain in these cases may be described as networks of value chains or intertwined value chains.
Remarkably, quite often the wrong coordinating actor is chosen: The one that has the most to loose, in this case large energy companies [2]. Establishing new perhaps smaller scale co- or poly-generation plants driven by e.g. renewable energy sources with surplus electricity output, is in direct competition with the existing plants operated by the large (often pan-European) energy companies, and will in the long run (possibly) reduce the price of electricity as less coal and oil fired power plants has to be taken into operation, and even the price for district heating in CHP-driven networks. Consequently the margins (and profits) of the large energy companies will be reduced[3]. Therefore it is necessary for some type of new actor to niche it self into the market – a perhaps unexpected actor breaks this ground more easily [2]. Plausible examples of companies of this type would be control or facility management companies such as TAC, Siemens or Dalkia, or even a company only coordinating these – a company outsourcing just about everything but the site adoption of technology, and coordination of the business. If a coordinating company can carry not only the nested value chains of the various actors involved, but also a main part of the risk, and provide operations and management of the physical facilities and plants, the deal will quite possibly be considered good by end-users as well as the rest of the actors in the business setup. To an end-user simplicity and ease of use is likely desirable, and only having to cope with one business counter part is quite likely the key.

### 3.1.2 Generalising the model for a small to medium scale RES situation

A powerful tool to examine and describe *Human Activity Systems* (HAS) is what is known as *Soft Systems Modelling* (SSM)[4] [3, 4], and will be used in the following section to describe a generalised business model. In a generalised case where a small or medium scale RES (co-, tri- or poly-generation) would be attractive the *actors* (A) described below are required – actors each representing one *Weltanschauung* (W). Each of these actors may represent more than one *Weltanschauung*. [3, 4] Each *W* results in one *root definition* (RD) describing the *HAS* (business model or setup in this case) from that particular *W*'s point of view. *RD*'s are described using a certain set of model elements:

*Customer* (C): "Victim" of the system's activities

*Actors* (A): Unit or person who carries out activities in the system

*Transformations* (T): Conversion of some input to some form of output

*Weltanschauung* (W): Indisputable image of the world which makes the particular system meaningful to study – in what perspective does it have a purpose. In a business setup built on alliances etc. between companies and other

[3] All this assumes a relatively large penetration on the market for smaller scale co- and poly-generation technology.
[4] It is also referred to as *Soft Systems Analysis* and *Soft Systems Methodology* (cp. [3] and [4]). Henceforth in the current work it will be referred to as *Soft Systems Modelling* or SSM.

actors, there will be several W's, $W_1$, $W_2$, $W_3$…, each describing the business from an individual perspective For each *W* a *RD* has to be set.

*Owner* (O): Who is the owner of the system? Who has the power to alter the contents of the system? [5]

*Environment* (E): Imposition which the system takes as given: e.g. corporate environmental policy, the aims and purpose of core business, legislation, local regulations and policies etc.

**Root definitions**

In a small to medium scale poly-generation business setup the following actors representing one (or more) *W* are required in some form or another:

1. User of electric power/heating/cooling in its business (EUU)[5]
2. Business coordinator/concept carrier (CCC)
3. Supplier of financing – bank (BANK)
4. Supplier(s) of hardware and machinery (may include procurement and installation), plant operation and maintenance services, and perhaps of fuel. (SPS)
5. Trader/buyer of surplus electric power/heating/cooling (SCM)

<u>Buyer/user of electric power/heating/cooling-services in its core business (EUU):</u>

C – The core business and its operations at a certain (set of) location(s)
A – Concept coordinator and carrier (CCC), i.e. the organization or company who carries the agreement to supply "our" core business with the agreed upon quality energy utilities.
T – To provide the core business with energy utilities at an appropriate quality[6]
W – Supply energy (utility) services to enable our core business to carry out its operation
O – Owner or lease contract holder of the particular poly-generation plant (CCC)
E – Corporate environmental policy and share holder expectance of financial and other output.

Root definition for the business model (system) according to EUU:

*A CCC owned system to provide our (EUU) core business with energy utility services at the right quality using a situation adopted RES poly-generation solution arranged and operated by CCC, so that we (EUU) may carry out our own business and its operations in accordance with our environmental policy and our share holders expectances of financial and other outputs.*

<u>Concept coordinator and carrier (CCC):</u>

C – Energy utility users (EUU), suppliers of products and services necessary to accomplish the appropriate plant design, its realisation and operation, and the surplus capacity manager (SCM) of potential surplus energy (electric power, heating, cooling).
A – CCC, EUU, suppliers of financing, products and services
T – Coordination of activities to enable the most efficient (cost and environmental) transformation of the RES in question, to the desired energy utilities at the desired quality

[5] This may represent a company or a private home owner, and even though the latter is probably less likely it is quite possible in certain scenarios.
[6] Quality in the sense of e.g. availability, temperature levels and/or required indoor climate, price and environmental impact.

W – Minimising risk for involved actors while enabling marketing of small and medium scale situation adapted RES driven poly-generation technologies to provide for required energy utilities.
O – CCC
E – Green energy services with ease of use and minimised risk for all involved actors.

Root definition for business model (system) according to CCC:

*A CCC owned system to realise an optimal RES poly-generation solution to provide EUU with energy utility services by CCC's coordination of SPS', SCM's and BANK's activities to minimise risk while maximising ease of use and simplicity for all involved actors in the setup including EUU.*

<u>Supplier of financing (BANK):</u>

C – CCC
A – BANK and CCC
T – Taking from BANK's funds to provide capital to concept realisation and there by generate profits in core business
W – Generation of BANK's profits at an accepted risk and in accordance with BANK's (environmental) policies
O – BANK
E – BANK's environmental policies and share holder expectance of financial and other output from BANK's activities

Root definition for business model (system) according to BANK:

*A CCC owned system to realise an optimal RES poly-generation solution to provide EUU with energy utility services by CCC's coordination of SPS', SCM's and BANK's activities to minimise risk while maximising ease of use and simplicity for all involved actors in the setup including EUU.*

<u>Supplier of products and/or services to accomplish over all concept activities (SPS)</u>

C – CCC
A – SPS and CCC
T – Making SPS' products (e.g. machinery or bio fuel) or services (e.g. O&M) available for the RES poly-generation plant in question
W – Sticking to SPS' core business
O – CCC
E – CCC's ideas of appropriate plant design and setup, and what is currently technically achievable with the financial limitations in question etc.

Root definition for business model (system) according to SPS:

*A CCC owned system to realise a poly-generation plant solution that makes use of products and/or services to provide an energy utility service under CCC's coordination fulfilling their (CCC) demands on energetic and economic efficiency.*

<u>Surplus capacity management (SCM):</u>

C – CCC and third party base capacity owner or operator with whom SCM has a bilateral counter regulation contract
A – CCC, SCM and third party actors who may control the possibilities to dispose surplus capacity (at a certain moment in time) to common grid (electric and district heating or cooling).
T – Transfer (buying?) of surplus capacity (and possibly sell back at times of inadequate local energy production capacity[7]) by the aid of counter regulation of common or contracted base capacity (e.g. hydro power) to allow for the disposal or "storage" of surplus energy from CCC.
W – Small scale RES may remove some peak load and demand problems. RES is in accordance with SCM corporate policies. ETC
O – SCM and possible third party actors who may interfere with counter regulation in certain cases[8]

[7] "Inadequate" as in too little local production capacity or at significantly higher operations cost.

E – Limitations in counter regulation at the site in question, environmental policies and share holder expectances of financial and other output from SCM

Root definition for business model (system) according to SCM:

*A SCM owned system to trade and counter regulate CCC's momentary surplus energy/power capacity or demand for extra ditto as efficiently as possible and according to SCM's bilateral agreements with any relevant third party actor, from one or a series of CCC's smaller scale RES-production plants, in accordance with SCM's corporate environmental and business policy as well as share holder expectations on financial and other output from SCM.*

'Consensus by accommodation' primary task of general business model

The primary task of the business model may, after deducing an accommodated root definition, be described as [3]:

*A CCC coordinated (owned) activity to realise a RES poly-generation plant to provide energy utility services to EUU and if necessary handle surplus capacity or capacity deficit using counter regulation in SCM's regime, while minimising risk and maximising ease of use and simplicity for all involved actors in the setup.*

Obviously this root definition does not really describe all necessary activities to achieve the desired business setup even in general terms; it is by far too imprecise. But it is likely undisputed by all involved actors, even though there is generally quite little overlap by the SPS' and BANK's perspective vis-à-vis SCM for instance.

### 3.1.3 Example: A working business model, Ekosol

One descriptive existing business with very small scale RES-utilisation is the Ekosol concept [6-10]. Its possible success is not built on particularly fancy technology, but on a business model that apparently works in this specific case.

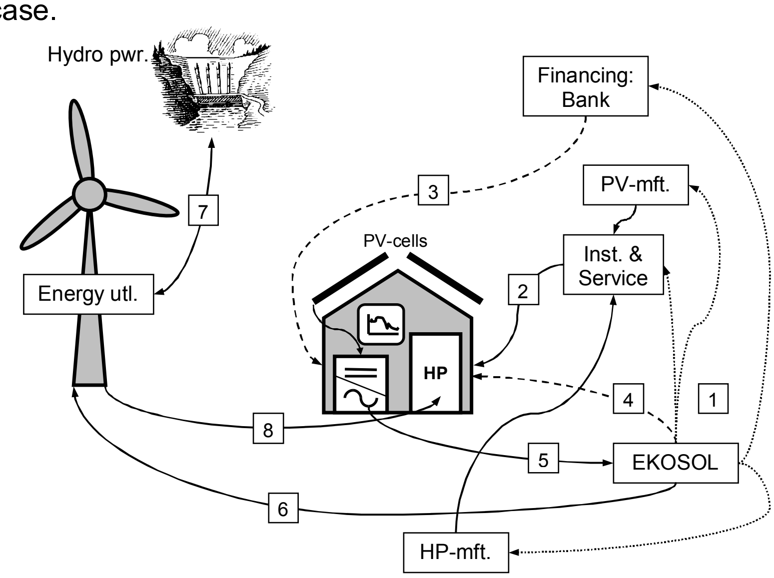



**Figure 1 Schematic of the Ekosol single family PV setup.**

Ekosol (CCC) coordinates procurement of the required equipment as well as arrangements for the necessary authorization from local authorities together with a house manufacturer ($SPS_1$) for family A (EUU) (1). (2) Ekosol has a contract with an installation and service contractor ($SPS_2$) to install photo-voltaic solar panels (from $SPS_3$) on the roof of the building, a ground coupled heat pump (from $SPS_4$) and

[8] There may be several reasons for this: small scale power supply to regional grid seen as a problem due to technical aspects, competition with "our own production" etc.

DC/AC-converter equipment (from $SPS_5$) [9], etc. (3) The bank (BANK) with whom Ekosol has an agreement, lends money to family A to finance the house, and provide them with an interest free loan on the installation (hardware and work) of the energy system. (4) Ekosol rents the pv-panels solar panels from family A, and (5) get the electricity generated from these. As most of the electricity (approximately 5MWh/year) is produced during the warm season, this electricity has to be taken care of by some means and in some sense stored to a time when it is needed. (6) This is handled by a contract between Ekosol and a municipality owned power company (SCM) with a corporate policy to produce "green" power. (7) As the SCM already has its power production in the form of wind turbines it has a bilateral agreement that enables it to counter regulate the (unpredictable) wind- and solar-energy production with hydropower. Family A (preferably but not necessary) buys back its power needs (to run the heat pump) from SCM (8). [6]

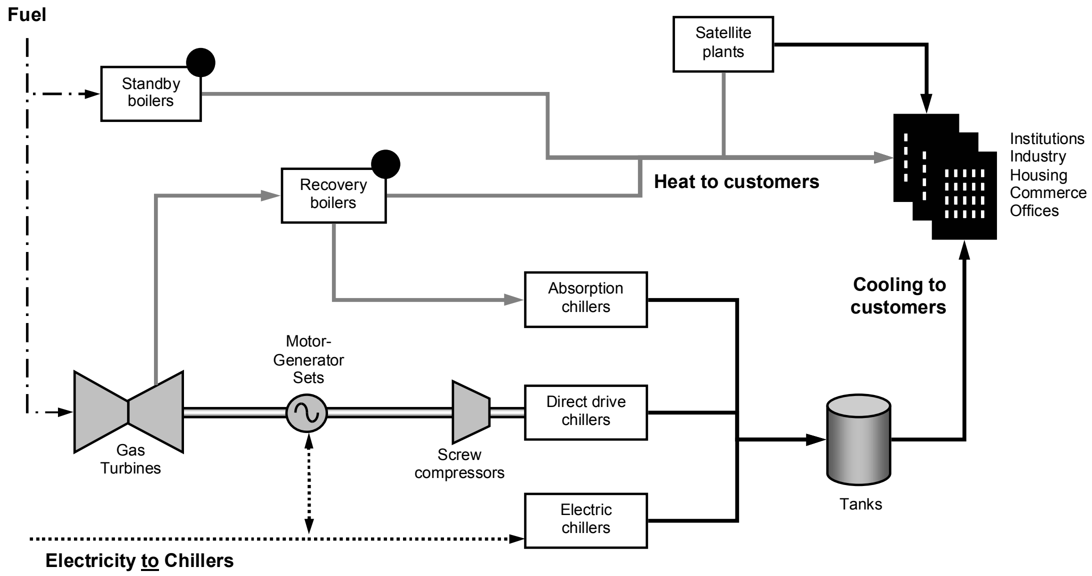
The economic efficiency of this business model is hampered by the cost for connecting an electric production unit to the grid in Sweden– currently approximately 300€/year. [6]
In this particular example there are two (at least) issues that makes this business interesting for the actors in the cluster/alliance: Firstly, the bank has founded its decision to give an interest free loan for the energy installation with the motivation that a low operating cost reduce the risk for the bank as well as being in line with its environmental policy [11]. Generally, real estate investors do not consider energy demand a big issue, or that it has an impact on the risk of the deal, but in the case of a single family house the operational costs may have a large impact on the margin for the home owner [11]. Secondly, it illustrates the importance of a system to handle surplus capacity or a capacity-demand mismatch. Unless some governmental regulation (local/regional/national/EU) is applied, the provider of capacity to the grid gets a price significantly lower than what may be the market price, quite likely in the range of the production price of the cheapest alternative production type in the grid[10], often less than, say 10 % of the market price of electricity [12]. In the Ekosol case, they are paid approximately 0,2€/kWh [6]. So, unless there is a bilateral agreement or legislation rendering in a significantly increased sell-price, the power produced in a small scale plant will have a higher value when used internally than when sold to the "grid" – when used internally it has the same value as the market price on the grid with taxes, tariffs etc, and when sold it has the value of grid price without taxes and tariffs. In practice it might have no practical value at all if no such bilateral agreement is present[11].

### 3.1.4 Example: Regulated market – grid input and management regulations

In the event that a local market does not allow for automatic permission to distribute surplus capacity to a common electric grid and there is no bilateral agreement with a grid owner to put this surplus power to the market there is a need to match production of power, heating and cooling very accurately to the user demand, which (i) may increase the price of equipment and (ii) decrease the possible profits and in the long run make the investment a poor deal to some key actor. One example of this is the Tri-Gen operation at the McCormick congress and exhibition complex in Chicago, Illinois (cf. figure 2) [13].
The prime energy source of the Tri-Gen operation is natural gas. The utilities supplied to the McCormick exhibition and congress centre were air conditioning (spatial heating and cooling through a district heating and cooling grid), process cooling (servers, restaurant kitchens etc) and on site electricity. As the main energy utility was air conditioning the production focus was positioned on that. As a consequence of this a substantial part of the energy (capacity) needed to operate the electric chillers at certain times (warm days) had to be bought from the state grid at market price. (cf. figure 2). [13]

[9] This enables Ekosol to arrange for the house to have very low energy utility operations costs.
[10] In the Swedish case hydropower.
[11] In some sense a legislation increasing the sell-to-grid price of the power may be considered a bilateral agreement, though not voluntary from the buyer's point of view.

Had the electricity market at the time been deregulated, and/or a contract for counter regulation been present, it is quite possible that the gas turbine and generator sets had been larger and that surplus power had benefited to the economy of the operation.




- **Primary energy: Gas**
- **Utilities: Electricity for internal use, Waste heat**
- **Waste Heat used for recovery boiling and absorption chillers**
- **Chilled water storage to shift loads**

**Figure 2 The systems schematic at the Tri-Gen operation at McCormick Centre in Chicago**

## 3.2 Larger scale plants and businesses

It is likely that a large scale energy company at one time or another may consider cogeneration in the form of district heating (on a city level) with electric production, or even tri-generation with district cooling on a city scale added. In this case it is much more coherent with what commonly is their core business; usually operating large scale plants (several hundred megawatts output) for energy production. Running these on renewables or not is essentially a question of handling the profitability of choosing one fuel instead of another. I.e. in the large (or even very large) scale plants, the business is more likely to be handled within one single actor than what is required for establishing small scale operations as the ones above. The relation to the customers is essentially the same independent of whether they are buying electric power, district heating or cooling. Further, the energy company takes care of the whole value chain. This type of large scale operation enables the large company to keep the control of their production plant/operations mix: they can decide how to match their production over a series of plants to match customer demands and market prices of electric power[12]. In the event that some form of biomass is chosen as fuel in a CHP plant, a similar infrastructure for the biomass as for e.g. oil or coal has to be present. There are to day companies profiling them as providers of e.g. pellets much similar to oil and coal suppliers, creating the same type of infrastructure. [16]

[12] There are currently no district heating system where there is not a local monopoly in a given district heating or cooling grid, as compared to the situation on a deregulated electric power market with accompanying electric power exchange market such as *Nordpool* in Scandinavia. District heating and cooling networks are usually considered as natural monopolies. Cp. [14] and [15]

So in this case, the structure remains but the importance of the different actors/perspectives is reshaped. The “large” energy utility company takes up a majority of the roles in the setup: CCC, BANK and SCM and in some cases even SPS.

## 3.3 Scenarios – future shape of Energy Europe and its impact on small scale business

[13]In 2002 the Royal Swedish academy of engineering sciences published a series reports from a scenario program called *Energiframsyn Sverige i Europa* (Energy foresight Sweden in Europe). (Cp. e.g. [17-19]). During 2002 more than a hundred individuals from both the private and public industry, and research, participated in four expert panels. Especially the report from the structural foresight panel – *Kan framtiden påverkas? – Framtidsbilder för Energieuropa* (Can the future be influenced? – Future scenarios for Energy Europe) – is interesting in the sense that it describes prerequisites that will have a great impact on the conditions for e.g. implementation of co- and poly-generation businesses in Europe. The objective for this panel, consisting of 12 experts with extensive experience from energy companies, finance, customers, research, authorities and politics, was to understand how energy structures might change during the next 20 years. [19]
The report from the panel for structural foresight treats the structures of the energy system and how these may change during the next twenty years or so. The panel considered three structures particularly interesting to study: the institutional structures, the (energy) industrial structures and the technical structures. Since these structures are affected by other larger contexts the panel choose to study two different paths of development. One concerns the development of the European Union (EU), and the other development and importance of information technology (IT).

### 3.3.1 Structures of importance

Early on the panel found that there is a considerable inertia suppressing changes in the technical structures of the energy system, which implies that no radical changes are likely to occur within it in the next twenty years. There are also conserving forces that counteract changes, e.g. difficulties acquiring new locations for power production. I.e. it is thus very likely that new facilities will end up adjacent to already existing sites which will contribute to conservation of the current large scale geographical and technical structures. The panel argues that even though the already existing technical energy infrastructures are not likely to change, other technical infrastructures may have an increasing importance and effect in the energy business as well, e.g. the development of IT. The question is what effect?

[13] The following section is essentially a summary of the report from structural panel in *Energy foresight Sweden in Europe* [17-19]

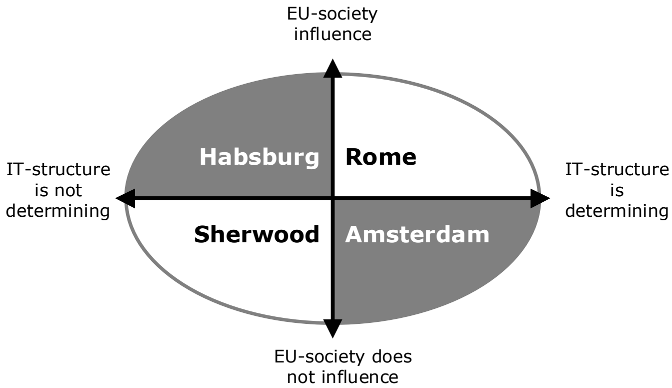



**Figure 3 In the report from the structural panel four scenarios are pictured. Source [19].**

### 3.3.2 Four scenarios

As an attempt to understand how the three central structures might evolve, two fundamental driving forces were identified: *the common evolution of Europe* and *the importance of IT in society.* Combinations of these two prime movers resulted in four scenarios, each depicting a 20-year foresight perspective. Each scenario has its own setting, and the names that have been given to them indicate their historic episodes: Habsburg, Amsterdam, Rome, and Sherwood. [19]

### 3.3.3 The common development of Europe

If the EU develops towards a truly common market with a common ground in the energy field, the large players will benefit since bigger corporations have greater possibilities to make use of a more substantial market. Capital cost will also decrease which benefits large-scale operations. This development is described in the Habsburg and Rome scenarios.
If the EU evolves in a way that decreases the amount of common rules and regulations for the energy corporations, the ones that best make use of the local conditions in different regions or countries will be favoured. Even businesses that are capable of working on a global arena could be favoured, but the ones depending on a pan-European market will face a tougher time leveraging upon their position. This development is described in the Sherwood and Amsterdam scenarios.

### 3.3.4 The importance of IT in society

Corporate conditions will change if the IT infrastructures become widely implemented by a majority of people and for a multitude of purposes. Increasing amounts of free and available information will consequently increase insight and transparency, also in corporations. It puts pressure on the corporations to change and simultaneously offers new possibilities. Corporations may split into smaller entities but also create new business based on networks and IT. This development takes place in the Rome and Amsterdam scenarios.
If the IT infrastructures do not change society, then businesses that can harvest from the existing structures will be favoured. The European energy market becomes an oligopolistic market.

Flexibility continues to be of utmost importance for the energy companies. Cooperative efforts, investments, or other decisions which render the energy companies great flexibility, benefit from higher capital expenditure and lesser prospects of risk spreading. Such situations generally arise if the markets are well-defined and strongly dependent on politics. This is the case in the Sherwood scenario.

### 3.3.5 Industrial structures

During the 1990's, the energy industry experienced a series of quick changes. The most outstanding is probably the corporate response to the electricity and gas market deregulations. There are however, several other circumstances also worth mentioning:

- the IT implementation for administration, operation, trade, and so on
- increased use of external entrepreneurs offering diversified services
- outsourcing of (earlier) internal operations

**Driving forces**

The panel found three driving forces for changes that are especially important to the energy field in general and to the electric power area in particular:

- capital availability and capital expenditure
- new technology throughput
- changed rules of play, i.e. regulations, and so on

These driving forces are in essence external, and affect the companies' business "from the outside." To these we can add driving forces, such as changing business trends or political considerations, both with great influence.

There are of course also "internal" driving forces that affect every private company, for example the owners' goals, the board's goals, and the management's goals. The owners' goals have been unclear and sometimes even nonexistent, typically within many municipalities (but not all) that "inherited" energy businesses without specifying a pronounced objective.

There can also be unpronounced goals which pull the company in different directions, such as when there are discrepancies between board goals and management goals. In addition, groups within the companies might have their own, more professional, missions. The ownership of the central and "historical" investments could become an end in itself within many engineering-prone companies, whereas an over-confidence in financial key figures could create short-term and failed business in other companies.

Nevertheless, the internal driving forces are strongly dependent on the situation, and therefore we will have to suffice with viewing the external driving forces that at least share some resemblance in all companies.

**Division of power companies according to capital expenditure**

If risks throughout the different energy businesses are viewed through a financial perspective they will stand out as capital expenditure variations. This could in turn lead to business differentiation, meaning that certain capital requirements are drawn to certain business types. Hence, the demands of the capital markets do influence the business structures. This is already a fact for companies with capital intensive operations, such as the aviation business which transfers the airline fleets to other owners and instead leases the airplanes. However, tax regulations in different countries vary greatly, and this complicates the separation.

Internal tensions could similarly emerge between different business units that individually have to fulfil different demands on investments and corporate grants. One difficulty that affects corporate strategy is the different time perspectives on yield evaluations within the business units. This can be handled by

placing different yield requirements on the internal units, but also through the selling of certain parts to other owners with other yield demands and risk profiles.
When structuring a company there are of course other considerations than the pure financial. Market strategic, technical, and institutional factors are also of imminent importance.

**New technology changes the rules of play**
It is not just the availability of capital and yield requirements which decide the development of the corporations. The implementation of new technology can have large implications since it has the power to radically change certain business conditions. But new technology does not immediately lead to changes. Rather, considerable amounts of time usually pass between technology acknowledgement, often at the prototype stage, and commercial availability. After that it takes even longer to implement it into business operations sufficiently enough to impact the industrial structure.
A modern example is the implementation of computerized operations within power plants or real estate. Thanks to a combination of automatic control systems and computer networks, the technical staffing at plants and properties can be decreased, thus allowing more sub-contracting. The sub-contractors thus become an integrated part of the business. This is a new way of working, a new industrial structure.

**Establishment obstacles**
If entry obstacles are low then new players will be established. Many operations within the power supply sector are much alike other businesses and it is an easy task for an all-encompassing financial company to also begin trading on the electricity market.
Some parts of the energy business have higher entry obstacles, for example power lines and nuclear power plants. There are also competence availability obstacles. The costs to overcome these obstacles can be substantial – but they are relative, meaning that a high cost of entry only blocks out some players. Other players with lots of inexpensive capital could perhaps get through the obstacles.

### 3.3.6 Technological structures

The technological structures available in 2020 can be split into two categories: existing structures of 2002 which are deemed to remain in practice in 2020, and new technological structures which may have been realized in 2020. The first category holds structures that have taken a long time to build up and that are regarded as worthwhile, for example power lanes and power plant sites. The other category could contain various telecommunications solutions, such as different broadband and wireless communication structures.

**Existing networks and production sites**
Geographical circumstances also affect the development of technological structures. The value of a power company is partly based upon its “site value”, i.e. the expectation that a certain location will continue to generate yield even in the future. This assumption is based on technical estimations that future energy technology and power plants will require the same kind of locations and have the same geographical structure. In addition, the environmental code limits or precludes new sites for power plants and distribution. The geographical structure given by the current sites of energy related operations can thus be regarded as continually important.

**Communicative structures and techniques**

The extensive build-out of various digital communications networks open possibilities to create new energy systems which can only be linked through monitoring and control structures. Already today there are numerous automation systems for indoor climate control and power consumption in buildings. This has opened new control and monitoring possibilities, and has also brought with it new educational processes.

Older energy systems linked different buildings together through a mutual district heating network or through the electricity supply network. Therefore it became natural to use geographical demarcations when discussing the energy system. Tomorrow might see the communications structure linking different buildings or other types of users, and in such a situation it might be the *behavioural pattern* of energy use that becomes the focal point. This is a fact since similar behavioural patterns of energy use will result in similar monitoring and control requirements.

When adding the price fluctuations of power, both customers and suppliers can get financial incentives towards a more precise power consumption control, and in the extension we could possibly also anticipate a limited automated electricity trade.

An increased use of communicative structures combined with a widespread use of distributed small scale power plants could be a stepping stone for new concepts, such as “virtual power plants” or “home electricity” (electricity actually produced in the home) or entirely new combinations of local energy transfer and power consumption.

**Small scale distributed power and heating plants**

Back when the power supply system was built it consisted of small plants located in the vicinity of the user. Even after it became possible to transmit electricity far and away, many small local networks were constructed. However, thereafter the production plants grew considerably and finally culminated with huge plants such as the EDF nuclear power plant BP174 in Givet (FR) or “The Three Valleys” in China.

Lately, another development path has drawn much attention – small scale, power generating machines, which come in sizes ranging from one or two kilowatts to a few megawatts.

Combined small scale power and heating plant production is already available in roughly a thousand installations. Natural gas is normally used as fuel source, and this, in turn, disqualifies most countries without a well developed natural gas network. There are several different fundamental technologies: gas turbines, combustion engines, and fuel cells. The first two are most commercialised.

The thought is to place these units close to the consumer, for example in the basement of a large building. The building’s power and heat requirements will be produced right there. These units will most likely be connected to the electricity supply network in order to compensate and level out the shifting electricity load.

Sometimes they are purely viewed as a power source, which is erroneous since one of their large benefits is that they also generate heating (co-generation) and sometimes also cooling (tri-generation). They thus cover several different energy needs within the same unit or with additional modules, the report states.

The existing power supply network is geared towards centralized power generation. That is, where power is generated at a few network locations and then distributed in a unidirectional flow. Is it technically possible to hook up a large number of local electricity producers in an urban area such as London, Hamburg or Paris?

**Technical competence**

A prerequisite for the breakthrough and spreading of a certain technology in a society is that some sort of competence or susceptibility exists within the new technology. The opposite should also be a fact, where a certain type of societal competence gives a certain technology an advantage when compared to another technology. However, the question is where to find such competence?

### 3.3.7 Summary of each of the four scenarios characteristics

**Habsburg**
The Habsburg era symbolizes the European time period which ended with the outbreak of World War 1. The Austrian dual monarchy was a great empire, but finally got stuck in its own mould. The rulers did not want to “shift the balance” but instead keep it for as long as possible.
The upper left corner of the scenario matrix combines the driving forces “The EU develops strongly” and “IT as usual.” Habsburg is characterized by a strongly coherent EU, but the increased use of IT has not lead to any revolutionizing changes.

**Amsterdam**
Amsterdam illustrates the mercantile idea. In the 17$^{th}$ century the merchant ships of the East India Company brought home goods from all corners of the world, and the city became a hub where merchandise were traded and shipped onwards throughout Europe. The scenario replaces this physical trading arena with others of electronic nature.
The lower right quadrant of the matrix combines the driving forces “The importance of the EU decreases” and “An online world.” If both of these dominate the development, the whole idea of a European Union might become obsolete even before it has been fully shaped.

**Rome**
The historical Rome had standardized measurements and weights, a common legislation, and a common market. The empire was in many ways an early EU but with a smaller central administration and a considerable delegation of power to the provincial governors, and so on. Rome used the republic as the form of government, and there is currently a discussion on whether or not Europe should become “The United States of Europe.”
The upper right quadrant of the matrix combines the driving forces “The EU develops strongly”, and “An online world.” In this scenario, the EU administration manages to handle and incorporate the new possibilities brought about by the comprehensive societal IT acceptance. The EU reforms its administration and manages to create widespread public EU acceptance.

**Sherwood**
In Nottingham there was law and order, but only as far as the sheriff’s power reached. Just outside was the wild Sherwood Forest, with a different set of rules. Some people could live well by using the regional differences in rules. Robin Hood lived to take from the rich and give to the poor, whereas the sheriff of Nottingham rather used the opposite principle. What will this idea look like in an energy scenario? Who is the “energy rich” in 20 years?
The lower right corner of the matrix combines the driving forces “The importance of the EU decreases” and “IT as usual.” Sherwood is characterized by a close to symbolical European Union, at the same time as the increased IT use has not led to any significant structural change.

*The scenarios may be summarised as in the table below.*

| | HABSBURG | AMSTERDAM | ROME | SHERWOOD |
|---|---|---|---|---|
| Development of Europe | The EU grows in size and importance | The EU idea begins to wither | The EU is reformed and grows in strength | The EU diminishes in importance |
| Common values | Common European values are rooted | Global movements spread different value systems | European pragmatism characterizes everyday life | Regional safeguarding and the nation grows stronger |
| International crisis management | Common European face outwards, disunity inwards | Ad hoc constellations by countries and corporations | Europe often seen as a neutral part in international conflicts | International ad hoc constellations in cooperation |
| Taxes and regulations | Gradual tax and regulation convergence, frame agreements important tool | Tax convergence avoided. Taxes are regulated in detail | Swift rule and regulation convergence. Tax neutrality important | Rule and regulative convergence is avoided. Taxes are used as a means of competition |
| Market structures | Extensive internal European trade with common rules | Global trade with divergent rules | Large European home market with substantial international trade influx | Global and local trade. Regional and national rule and regulation diversity |
| Industrial organization | Mega-corporations with integrated value chains | Multilocal network companies with global connections | Specialization and large-scaleness. Divided value chains | Locally based companies with coherent value chains |
| Capital markets | Large capital market and stable systems render low risk and low capital expenditure | Large capital market but with varying stability renders high risk, but also risk-spreading possibilities | Large capital market with some stability renders low risk and good risk-spreading possibilities | Small high-risk capital markets render large capital cost, but with possibility to handle it through cooperation |
| Infrastructure investments | Large projects consolidating the European sub-systems | Locally adapted projects. The need for investments are brought to surface thanks to better systems knowledge | Large projects with little EU involvement. The EU sets the agenda | Locally designed projects in cooperation between the government and the industry |
| New energy technology | Predominantly large-scale technology, developed through cooperation between the EU and the industry | Technology is developed for a global market. Plug-and-play concepts common. Communications functions important | Both small and large-scale technology develops through the market conditions. Communications render new knowledge | New technology is locally adapted. Often integrated with industries and nearby communities |
| Carbon dioxide issue | Common EU systems with internal negotiations | Different priorities in different countries. Trade systems common | The companies assume own responsibility. The EU monitors | Different in different countries. Local environmental opinions render local measures |

**Table 1 The four scenarios of the structural report depicted in ten categories. Source [19].**

## 3.4 What if..?

All of the scenarios painted in the *Energy Foresight* study exist in Europe today, but in various regions and countries. Which business setup is likely in which scenario?

### 3.4.1 Habsburg

Small scale localised poly-generation production will have severe difficulties to establish them selves unless they can be operated cost effectively without the need for capacity-demand mismatch management through counter regulation (SCM)[14]. The industrial structure is depicted with mega-corporations with large integrated value chains. As already can be seen today in some extent, these large corporations focus on operating large scale production plants, leaving the ownership and operation of district heating and cooling networks in cities of less than 100 000 inhabitants to other smaller, often local actors. It is however possible that these local (publicly owned) companies could establish them selves in a slightly larger scale operation where the one or a few locally dominant industries have various kinds of energy demands and perhaps large amounts of waste process heat. In this case a local (public?) utility company could establish itself in a role of concept coordinator, financer etc.[15]

### 3.4.2 Amsterdam

In a market structure with relative large multi-local actors, the role of situation adopted RES poly-generation in small and medium scale will be potentially strong. Regionally deregulated energy markets will make capacity-demand mismatch management through counter regulation easier, even as it is possible that certain countries will inhibit strong regulations stating that e.g. power produced using RES has to be bought at, say market price by the local net owner, and not at the price of the cheapest energy source (usually hydro or nuclear power). I.e. that it must be bought with the price of $CO_2$-generating source power (oil, natural gas or coal). The strong Pan-European acting multi-local companies could then co-operate a series of plants on a national or regional level. It is very likely that the coordinating companies will be attracted to this European market, mainly as a mean to commence their core business, which really may be production and logistics of bio-fuels such as wood pellets. [16]

### 3.4.3 Rome

The relative low cost of capital and a strong European market with common rules and large scale energy companies opens up for a more strongly bonded European power grid. The penetration of IT-solutions will enable these companies to operate not only large scale plants (city scale or larger) but also distributed small scale production operated (i) on a large scale and (ii) as a mean to break in on other large competing companies home turf, providing air-conditioning and power to local customers (hospitals, exhibition centres, malls etc) while using the power produced in a larger more Pan-European operation.

[14] Cf. McCormick in Chicago [13]

[15] Cf. Sundsvalls or Borlänge municipality, where the local energy company's activities is integrated with the energy system of the large paper mill energy usage.

That is, if a deregulated Pan-European power market is created. Further, it enables very, much specialised, today small operators to spread their business to other parts of EU. It is very likely that the coordinating companies will be attracted to this European market, mainly as a mean to commence their core business, which really may be production and logistics of bio-fuels such as wood pellets, but in this case they would either not be in the electric power production business at all, or rely on common European regulations concerning power trade and bilateral agreements with a very small number of electric utility companies (one or two). [16]

### 3.4.4 Sherwood

The Sherwood scenario local initiatives will enable very locally adapted operations. Operations with a strong local integration where municipality owned public utility companies act as coordinators. IT may be used for remote operations and management, but then again it may not: it will not be determining to the operation in the same way as local industry needs etc. The projects will have more local politics as drivers than anything else. Fuels will be chosen more to serve local industry and producers, and local political ambitions, than higher national or Pan-European goals[16]. It may be much more complicated for small scale operations to get contracts allowing for counter regulation on a national or European level, leading to either local *combinates*[17] or avoidance to enter local electric production if that is not the main purpose of the operation. Hence poly-generation on a smaller scale will have much more difficulties establishing it self as a common technology.

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[16] Cp. Sala-Heby Energi, a publicly owned utility company that operates a bio-fueled district heating grid, and distribute the same wood pellets to single family houses in slightly more remote areas for in-house local heat production, and charge these customers for district heating – not pellets.
[17] Cp. The Sovjet Union

[8] STEM, *SolEl-programmet*, in *Swedish Energy Agency Website*, (http://www.stem.se/WEB/STEMEx01Swe.nsf/F_PreGen01?ReadForm&MenuSelect=928E28FE0CAD26FCC1256DBA005C8231), Accessed: 2006-04-09.

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[19] IVA, *Kan framtiden påverkas? - Framtidsbilder för Energieuropa*, *IVA-M 340* in *Energiframsyn Sverige i Europa*, A. Narvinger, Editor. 2002, Kungliga Ingenjörsvetenskapsakademien: Stockholm.

# 4. Basic definitions socio-economic acceptance

## 4.1 Benefits

Energy supply in buildings concerns many people. Only few people live on an island, where it does not matter, how their neighbours will be affected by a certain measure. Providing energy will create noise, traffic and emissions. Business partners will supply and assist, municipalities will plan, governments will set the rules, and local enterprises and building owners will decide, which energy services they will access. Doing that, they will make profits, create jobs and incomes, improve their quality of life and get re-elected – or the opposite. Supplying buildings with energy and especially renewable energy will affect farmers, tourists, tenants, owners, technology providers and politicians. It is to their interest, that they should check the acceptance of their activities beforehand.

Benefits of such an acceptance driven approach will be:

- To develop and improve regionally accepted integrated applications of polygeneration in buildings,
- To find new clients, suppliers and partners for a local implementation and build up confidence and trust,
- To build up identification with the idea of renewable energy use in buildings and positively influence public opinion.

## 4.2 Evaluation of socio-economic acceptance

Acceptance is the positive attitude of a client towards a product or service. Acceptance is on hand when needs are met, conflicts are sorted out, interests are balanced – and people get informed about this. The whole system must be considered. What does a local supply mean for the region, the municipality, the specific site? How does it affect existing and future supply chains? How will a farmer benefit maintaining his farm and upgrading his family income, when selling biogas? Which new and competitive projects could an eco-village create, a local mayor or a regional manager could add to his references? Will a house-wife or a hotel technician be satisfied with the convenience of a sophisticated passive house architecture? Acceptance of polygeneration would not only mean to not oppose a new energy supply system, but to know it, to trust it, to desire it and to actively promote its dissemination. Kari Thunshelle, Norwegian partner within a European project bringing retrofit innovation to application in public buildings[18], therefore found it necessary to enter the mind of the decision maker when or before the decisions are made, to give him/her the information needed to understand the technologies and give arguments for why this is a good idea, to show that the solutions are possible and to give ideas and guidance on how to make it economically possible.[19]

Acceptance within the target group is one of the main preconditions to make a product idea successful. Research on acceptance contributes scientific tools to find out influence factors and barriers to acceptance. Acceptance evaluations aim at identification of those product features that influence predominantly clients' opinions and purchase patterns. As a consequence, a product or service may be

[18] Experience and results from EU FP6 Brita-in-PuBs project – Bringing retrofit innovation to application in public buildings. WP1: Real project planning and decision barriers, project needs and financial strategies.
[19] Kari Thunshelle: Eco-buildings in the context of socio-economic evaluation tools – or how to make people go to America? CAMELIA Symposium "Sustainable Energy Supply for Buildings – Ecological Potental and Socio-economic Acceptance" of EU-Coordination Action, Profactor, Steyr, 17/18 April 2006.

further developed towards an optimal fit to clients' demands. The scope of an acceptance evaluation will focus on the customers' needs as well as on improvements the producer could introduce; improvements both to the product as well as to its setting. Results of such acceptance evaluation may be introduced directly into a better service and communication, and therefore yield additional sales.

That is a main reason, why acceptance evaluations have become wide-spread in the past few years. In fact, acceptance is an old sociological dimension, a classical topic in market research. New is, that acceptance now is not only attached to commercial products, but also to public goods, societal infrastructures and policy shifts. There are three main drivers behind that. First, the public becomes more aware about public services and their performance. The civil society claims to participate in decisions about its concerns. People are ever better educated, they put pressure on the efficiency and flexibility in local and regional administration. Second, we are witnessing a major shift in technologies. Major technologies do not diffuse steadily, but cumulate and break through in long-term waves. According to the German technology researcher Leo Nefiodow[20], these shifts are called basic innovations, and they bring forward technologies in clusters, finally occupying large shares of world gross value added and economic growth. The upcoming basic innovation cluster comprises biotechnology as well as nanotechnology, renewable energy[21], and human technologies like networking and psycho-social health promotion. These technologies would replace many old institutions, industries and behavioural patterns (e.g. the shift from trains to automobiles in one of the last technology waves), and need huge investments – their acceptance becomes a societal issue. Thirdly, industry is infiltrating national and European policies more and more. The notion of acceptance would serve as an instrument to support lobbies and pressure groups and to justify provincial governments' decisions accordingly. Exactly that hidden ambition is the crucial point of "acceptance of acceptance studies".

The acceptance of technology integration in a certain location is linked both to socio-economic technology impacts as to the communication about them. An assessment of acceptance will have to take into account not only real impacts, but also presumed impacts, expectations, subjective aspiration and apprehension.

In general terms, evaluations target at measuring the impact of an intervention, a project or policy. When that project or policy will be implemented, certain results will be achieved. The question is, whether these results are a consequence of the intervention, or whether the results would also have occurred, when the project or policy would not have been implemented. "The fundamental tenet of impact assessment is the need to compare the observed situation with the intervention to *what would have been* had there been no intervention at all." The difference in resulting outcomes between these two states constitutes the impact of the intervention – but it cannot be observed directly and thus needs deciding on assumptions and making judgements.[22]

Their appropriateness will constitute the quality of the evaluation. In natural science and engineering this issue is appropriately dealt with in experimental designs, changing single parameters and thus attaching effects to causes. In societal development such an experimental design generally is not available. The counterfactual is not observable. We could compare the situation before and after, but that may be influenced by other factors, conditions, laws, actors. We could compare locations with and without the technology, and the same argument applies. We could survey people's opinions whether they verify the impacts, and interview experts – and we assume that they would know the impact and were willing to respond honestly. From a cognition point of view there is no way to get the real socio-economic impact of a technology implementation in a certain location in non-experimental designs.

As a consequence it is wise to allow a contextual approach to evaluations, as it is promoted e.g. in the discussion on evaluating employment development. Evaluation would be part of a learning system, making a region capable of self-correction, especially self-introduction of renewable energies. Socio-

[20] Leo A. Nefiodow (2001): Der sechste Kondratieff, St.Augustin.
[21] See e.g. the study on acceptance of hydrogen in vehicles, promoted by the BMW company: Gundi Dinse (2003): Akzeptanz von wasserstoffbetriebenen Fahrzeugen – eine Studie über die Verwendung eines neuen und ungewohnten Kraftstoffes, Institut für Mobilitätsforschung (IFMO), Berlin, 4. Aufl. 2003
[22] Eric Oldsman: Evaluating Business Assistance Programmes. Symposium "Evaluating local economic and employment development", OECD (LEED) Programme, EC DG Employment and Social Affairs, BMWA Wien, 20–21 Nov 2002

economic acceptance evaluation would not just make judgments, account for criteria and standards, but also be formative in improving implementation and empower people for regional energy business development. Having that goal in mind, it will be advantageous to get in touch with the stakeholder beforehand and agree on the evaluation method to be applied. Documenting these assumptions transparently, will definitely support the acceptance of a socio-economic evaluation. When evaluating acceptance, it must be assured, that information derived by that process is re-fed into societal communication. An acceptance study collecting individual opinions and entrepreneurial demands is a sort of communication, and will be a very powerful progress measure, when it is not a one-way communication but integrated in a process of regional, political and inter-sectoral bargaining and conflict resolution.

Evaluation of socio-economic acceptance would need methods that are both sensible to various stakeholder demands and are capable of contributing to a regional participation and mobilisation process. Criteria for selection of evaluation methods should comprise as well specific contents (e.g. does the method account for CO2 reduced) as well as the methods' discoursivity i.e. its participatory potential.

## 4.3 Criteria

A literature research has been carried out in order to find out dimensions that are relevant to integration of polygeneration into buildings[23]. The result has been a list of 33 such dimensions, some of them addressing economic, ecologic, political or social targets. Those dimensions build up a basic content framework of intended outcomes. It should be notified, that there is no one set of dimensions that will fit all locally integrated projects for polygeneration in buildings. With that caution in mind, certain dimensions may be selected from the list being more relevant than others for a specific project. Other dimensions should be added to the set of relevant dimensions, covering the local contexts of an installation. Whether the list is comprehensive, finally will depend on a specific project and its regional context.

A survey instrument has been constructed, to support regional decision makers in finding out which demands are most important, and which polygeneration systems are most interesting to their region. The scope of experts' questionnaire is to regional needs, to find out solutions for polygeneration integration. Regional decision makers find out which technologies would be preferred in their region

The survey instrument (see appendix) comprised 23 item groups, 17 of them categorized. It has been pre-tested within the CAMELIA team. Some of the results are documented in the next chapter. The following list describes the criteria, and gives some test results (in italics) pointing out, which of them have been regarded as important (within a test region), which of them might have been fulfilled (by preferred technologies). Applying the survey in real cases certainly will yield other preferences, and therefore other evaluation demands.

### 4.3.1 Business and economy criteria

The economy is an adaptive system designed for efficiently matching human needs. Economic criteria therefore account for benefits to enterprises and sectors, helping them to better fulfil demands. When such benefits exceed the scope of individual enterprises, i.e. when they affect sectors, regions, networks, they also become a political (or public) issue.

- **Regional Key Projects and Technologies**. Some regions are specialized in certain technologies. Introducing multigeneration energy systems could become an application of such technologies, further develop them or attract them as a key project. For example the

[23] See e.g. R. Madlehner, H. Myles, Modelling Socio-Economic Aspects of Bioenergy Systems: A survey prepared for IEA Bioenergy Task 29, IEA Bioenergy, 2000

Burgenland municipality Güssing introduced thermal gasification of biomass and feeds CHP heat into a local area heating network. A multigeneration application that would further support this key project and technology would rank high with respect to that indicator.
***Test demand:*** **HIGH*, fulfilment:* HIGH**

- **Support of Related Industries and Sectors**. Some regions focus on specific sectors. Introducing multigeneration energy systems could support these industries and sectors by fostering their infrastructure, or allowing these sectors to locally supply multigeneration energy systems. An example of this is agriculture, which could be stabilized when not only producing food but also energy crops.
***Test demand:*** **HIGH*, fulfilment:* HIGH**

- **Regional Trade Balance / Independent from Imports**. Using own resources for producing energy will decrease import necessities. Areas with a negative trade balance could even deal with some of their deficits. Independence from imports has shown up to become a motivating factor in periods of increasing oil prices and uncertainties in foreign relations.
***Test demand:*** **HIGH*, fulfilment:* HIGH**

- **Security of Supply / Risk Diversification**. Diversifying energy systems will also lower the risk of supply slumps and increase security of supply. It is obvious that such insurance services are available only at a price and a reasonable charge on electricity (or heat, cooling …) prices could be acceptable as customers are also used to pay for insurances. This indicator marks the trade-off between efficiency and stability of energy supply.
***Test demand:*** **HIGH*, fulfilment:* HIGH**

- **Establishment of a Regional Knowledge Base**. Knowledge is a key factor for the modern economy. Re-integrating the chain of energy supply into a region will increase its knowledge base. When implementing heat pumps, photo voltaic or heat storage, regional specialists and experts must be qualified to maintain and further develop that systems. The end-user will become an actor in energy supply, not just delegating decisions.
***Test demand:*** **HIGH*, fulfilment:* HIGH**

- **Regional Growth**. Multigeneration energy systems could contribute to regional growth, when they increase outputs and productivity, lower costs, attract incomes, enterprises and labour. Investment in building insulation e.g. would increase employment in the construction sector, and – later on – lower heating expenditures.
***Test demand:*** **HIGH*, fulfilment:* MEDIUM**

- **Export Potential**. A region with low own demands and high renewable resources could increase its export potentials. That is valid e.g. for sparsely populated or uninhabited areas with extensive forestry or agricultural land use, for wind exposed locations or sunny Mediterranean sites. Export potentials will depend also on transport feasibility, energy densities, energy storage. In many cases, proximity of energy supply and demand is inevitable, reducing export potentials and even leading to social conflicts on site.
***Test demand:*** **HIGH*, fulfilment:* MEDIUM**

- **Enhanced Competitiveness of Enterprises**. This effect characterizes the supply side and relates to changes in productivity, investment in resources, employees' qualification and flexibility, inward and outward co-operation and networking. A multigeneration project

including many suppliers of energy crops could increase competitiveness, when co-operation structures are established that would generate also other incomes, e.g. in farmers' direct food marketing.
***Test demand:*** **HIGH*, fulfilment:* MEDIUM**

- **Improved Infrastructure**. Creating infrastructures like a local area heating or cooling network could increase the efficiency of individual energy supply in buildings.
  ***Test demand:*** **HIGH*, fulfilment:* MEDIUM**

- **Diversification**. Introducing new technologies in energy supply to buildings will diversify regional services, e.g. plumbers will qualify to install heat-pumps, ventilation, solar panels; architects will specialize on solar and climate optimization; building owners will demand new services in construction and energy consultancy.
  ***Test demand:*** **HIGH*, fulfilment:* MEDIUM**

- **Income Creation**. When using local resources, incomes will be created within the chain from resources to final services. These incomes include enterprises' returns as well as employees' earnings. Incomes correspond to value added and as well to induced employment. The primary sector profits, when agricultural or forestry resources are used; services and industry will increase their incomes, when new cooling, heating or power generation is integrated into buildings.
  ***Test demand:*** **HIGH*, fulfilment:* MEDIUM**

- **Increased Productivity**. Productivity reflects the additional value generated through the use of capital, labour, material and other factors of production. Heating networks e.g. may increase their productivity, when more households connect to the grid; municipal waste water treatment plants may do so, when they could sell sewage gas, or even better heat and power. Measurements of productivity are often restricted to output per employee, an indicator not reflecting increased outsourcing, but being relative simply to obtain necessary data.
  ***Test demand:*** **HIGH*, fulfilment:* MEDIUM**

- **Induced Investment**. Investment is induced on the one hand by establishing multigeneration systems, on the other hand also by the supply chain; e.g. the hotel will invest in an absorption air conditioning system, and the technical firm will invest in repairing equipment.
  ***Test demand:*** **MEDIUM*, fulfilment:* MEDIUM**

### 4.3.2 Ecological and environmental criteria

Even from an anthropocentric perspective, the preservation of ecology and environmental capital may be a beneficiary: as a future resource for up-following generations, and as a resource for human recreation and health. Thus, ecology and environmental criteria bear many social and economic aspects.

- **Sustainable Use of Renewable Resources**. A sustainable use of renewable resources would mean a design dimensioned for long-term feasibility. Multigeneration systems could make use of renewable resources (like wood-chips) in a sustainable way, when gathering not more wood from forests than will grow again.
  ***Test demand:*** **HIGH*, fulfilment:* HIGH**

- **Air Quality**. An outcome of using renewable resources and preservation of non-renewables is the reduction of CO2-emissions, a major issue of air pollution. Air quality is an issue that also comprises reduction of other contaminants, and thus is not a single indicator but more a set of them. Wood, wood chips and pellets e.g. could be renewable resources that even increase dust emissions. Bad odour in the near surroundings of a biogas plant reduces air quality.
  ***Test demand:*** **HIGH*, fulfilment:* HIGH**

- **Noise Reduction**. Offices, dwelling areas, recreational areas like tourist resorts or hospitals must avoid noise emissions. Exchanging a gas motor by a stationary fuel cell for a power back-up system in a hospital would reduce noise emissions. Traffic induced by material transport to a CHP plant on the other hand would increase noise at the spot and possibly cause neighbour protests.
  ***Test demand:*** **HIGH*, fulfilment:* MEDIUM**

- **Landscape Amenities**. Local integration of polygeneration applications need decentralised installation and construction. Whether a CHP plant beautifies a landscape or not, will depend on the architect as well as individual taste. On the other hand wind turbines may not appeal to the tastes of many, and even defy the architects, when not re-designing traditional Dutch windmills. Micro wind turbines on houses, as proposed and already provided by a UK entrepreneur[24], would therefore cause a thorough bargaining with municipal public authorities, when applied in dense settled areas.
  ***Test demand:*** **HIGH*, fulfilment:* LOW**

- **Transport and Traffic Reduced**. When changing the energy supply system, traffic flows will change as a consequence. A local integration could reduce traffic under a global perspective, but increase it locally. This could result in a mixed blessing, when the global advantage could not subjectively outweigh the local inconvenience.
  ***Test demand:*** **HIGH*, fulfilment:* LOW**

- **Preservation of Non-Renewable Resources**. Non-renewable resources will be preserved either by abstaining from them or by substitution with renewable ones. Multigeneration systems could make use of renewable resources (like biogas) as well as non-renewables (like natural gas).

[24] Tony Gordon, Building Integrated Wind, Windsave Ltd., Presentation at CAMELIA Symposium, University of Ulster, Belfast, 13. Jan. 2006.

***Test demand:*** **MEDIUM*, fulfilment:*** **HIGH**

- **Biodiversity.** Biodiversity is often attached to a diversity in land use. Thus, a wood based multigeneration for buildings in forestry intense areas would contribute to biodiversity, when aisles and glades would create a mix in forestry monocultures.
  ***Test demand:*** **MEDIUM*, fulfilment:*** **HIGH**

- **Water Quality**. A clean industrial production as well as a sustainable agriculture and waste treatments are crucial to water quality.
  ***Test demand:*** **MEDIUM*, fulfilment:*** **MEDIUM**

- **Preservation of Soil Quality**. A sustainable land use, especially in farming, is crucial to soil quality. E.g. fertilising land with manure from animal husbandry would take care of soil quality, when the manure had been fermented previously by processing it through an anaerobe digestion.
  ***Test demand:*** **MEDIUM*, fulfilment:*** **MEDIUM**

### 4.3.3 Social and immaterial criteria

Social and immaterial criteria affect and characterize the area of human life. Individual and collective life styles, preferences and values, are the driving forces in this area. The needs for social relations and acceptance, self realisation, security and basic supplies constitute that area, even when some of their fulfilments are released to the economy and the political system.

- **Increased Employment and Job Supply**. Employment lets people participate in the economy, giving them access to goods and services. When using local resources, employment will be created within the chain from resources to final services. Employment corresponds to gross production and as well to value added. The primary sector profits, when agricultural or forestry resources are used, even more than services and industry, as the productivity in the primary production in general is lower than in the secondary or tertiary sector.
  ***Test demand:*** **HIGH*, fulfilment:*** **MEDIUM**

- **Health promotion**. A sound environment and standards of living will promote individual health. With respect to use of resources, many of the arguments for “ecology and environment” also apply for human health. For applications of multigeneration in buildings, the functions and features of buildings will especially affect human well-being – and maybe conflicting with energy saving issues, e.g. being allowed to open windows in passive houses.
  ***Test demand:*** **HIGH*, fulfilment:*** **MEDIUM**

- **Support of Regional Pioneers**. Implementation of local applications of polygeneration will need regional first movers, acting as pioneers of application and promotion.
  ***Test demand:*** **HIGH*, fulfilment:*** **MEDIUM**

- **Education and Qualification**. Knowledge and know-how constitute main factors for self-esteem and flexibility, individual education and qualification generally correlates with wage levels.

***Test demand:*** **HIGH*, fulfilment:*** **MEDIUM**

- **Preservation of Building Substance and Ambience**. They constitute factors for an increased standard of living.
  ***Test demand:*** **HIGH*, fulfilment:*** **MEDIUM**

- **Integration and Employment of Weak Target Groups**. Energy policies may interrelate with employment policies. The supply chain from local resources to energy services may include not only high qualified, but also less qualified jobs (e.g. in agriculture).
  ***Test demand:*** **HIGH*, fulfilment:*** **LOW**

- **Feel comfortably**. Providing the most individual benefit can be an achievement of a multigeneration system.
  ***Test demand:*** **MEDIUM*, fulfilment:*** **HIGH**

- **Conformity with Regional Development Vision**. This factor attaches the individual priorities for their region and their conformity with polygeneration. When goals towards sustainable energy use harmonize, difficulties in realization may be overcome more easily.
  ***Test demand:*** **MEDIUM*, fulfilment:*** **HIGH**

- **Development of a Culture of Cooperation & Participation**. As polygeneration may attach many actors, sectors and industries in a region, a culture of participation is a promoting factor. And vice-versa: a specific polygeneration project can be used as an occasion to further improve and give substance to networks and co-operations.
  ***Test demand:*** **MEDIUM*, fulfilment:*** **MEDIUM**

- **Mitigating Rural Depopulation and Over-Ageing**. A regional balanced development is a target of social cohesion and stability. Tying energy supply to local multigeneration will decentralise economic activities and rise opportunities for weak regions.
  ***Test demand:*** **MEDIUM*, fulfilment:*** **MEDIUM**

- **Less Poverty**. Energy policies may interrelate with social policies. The supply chain from local resources to energy services may create jobs and incomes accessible for the poor and unqualified.
  ***Test demand:*** **MEDIUM*, fulfilment:*** **LOW**

## 4.4 Example: Pre-testing the expert's survey

A survey has been carried out, targeting energy experts, sampling CAMELIA project partners, supplemented by technical students of the University of Aachen in Germany. 13 questionnaires suitable for evaluation have been remitted. The questionnaires were in paper form, being personally delivered and collected, by fax and via e-mail. The survey was carried out in July and August 2005. Most of the respondents had a background in engineering, only two of them in business, economy, financial services or public authorities. 62 % have been working in the field of bio-energy for up to five years, 38 % for even more. The sample is strongly gender biased: only 1 respondent has been female – a typical quota for engineering samples.

The respondents were asked to choose a region, well-known to them, where they would suggest to apply and to integrate multi-generation energy systems. Within that region they ought to fix a place of a special application, e.g. a district of a city. The respondents chose urban areas as well as rural. Most of the sites were European, some of them in southern, others in central Europe. Due to the structure of the sample, 5 have been in Germany.

These regions were the location of a specific scenario. Two alternative scenarios were available:

SCENARIO 1: In the year 2020 *energy for buildings will be provided 25 % by Renewable local resources.*

SCENARIO 2: In the year 2020 *energy consumption in buildings will be dropped by 50 % per square meter and year.*

For most of the respondents these scenarios have been ambitious and courageous as well as attractive and desirable, at least to some extent. But these scenarios sometimes do not describe a realistic and attainable future state. For SCENARIO 1 only 23 % believe in its attainability, for SCENARIO 2 these are 46 %. 62 % believed totally, that SCENARIO 2 would be attractive and desirable. Nevertheless, asked to choose one of the scenarios above for further consideration, the majority of two thirds chose SCENARIO 1: providing buildings 25 % by Renewable local resources.

### 4.4.1 Scenarios

| **Please consider the following scenarios for your region. SCENARIO 1: In the year 2020 energy for buildings will be provided 25% by Renewable local resources.** | | | | | | |
|---|---|---|---|---|---|---|
| Do you think this scenario is ... | no answer | Yes, totally | Yes, to some extent | probably not | Definitely no | score |
| ambitious and courageous | *15 %* | *38 %* | *46 %* | *0 %* | *0 %* | *82* |
| attractive and desirable | *15 %* | *46 %* | *31 %* | *8 %* | *0 %* | *82* |
| realistic and describes an attainable future state | *0 %* | *23 %* | *0 %* | *62 %* | *15 %* | *44* |
| **SCENARIO 2: In the year 2020 energy consumption in buildings will be dropped by 50% per square meter and year.** Do you think this scenario is **...** | | | | | | |
| attractive and desirable | *23 %* | *62 %* | *15 %* | *0 %* | *0 %* | *93* |
| ambitious and courageous | *15 %* | *31 %* | *46 %* | *8 %* | *0 %* | *76* |
| realistic and describes an attainable future state | *15 %* | *8 %* | *38 %* | *23 %* | *15 %* | *48* |

CAMELIA-experts' questionnaire, pre-test sample n=13

Tangible building types had to be considered for the issue of implementation. For most of the respondents, these buildings were schools, universities or one-family-houses. For one third of the respondents, buildings with 20 and more dwelling units and tourism, recreational resorts, swimming-baths as well were building types they wanted to consider. A fourth of the respondents also would propose supermarkets, shopping centres, storehouses, or bureaus, private or public administration. It is interesting that high density and industrial sites were not chosen frequently, only a few respondents proposed buildings with up to 20 dwelling units, old city centres, urban high density residential quarters, urban business quarters, hospitals – none at all claimed for industrial production buildings.

### 4.4.2 Building types

| **Which of the following building types would you consider to be most appropriate for realizing** |
|---|

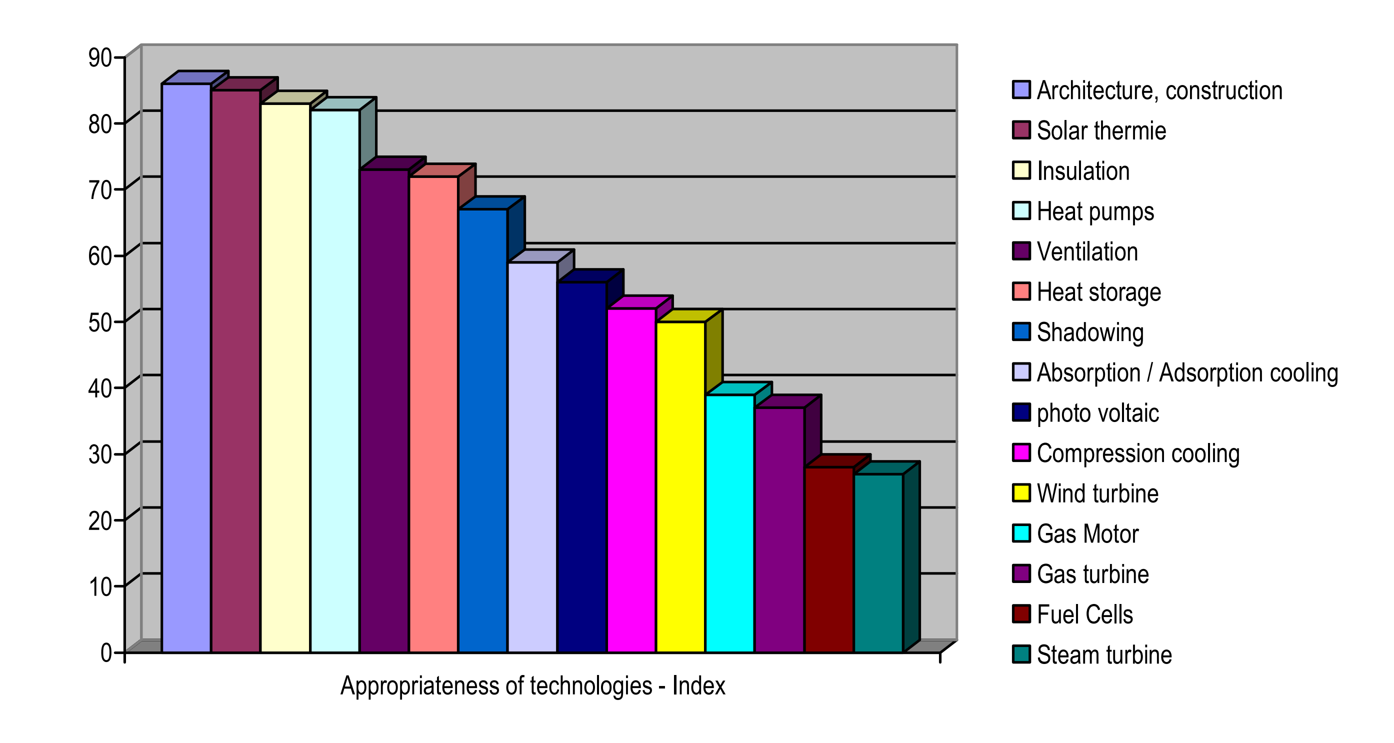
| **that scenario?** | | | |
|---|---|---|---|
| schools, universities | *62 %* | buildings with up to 20 dwelling units | *15 %* |
| one-family houses | *54 %* | old city centres | *15 %* |
| buildings with 20 and more dwelling units | *31 %* | urban high density residential quarters | *15 %* |
| tourism, recreational resorts, swimming-baths | *31 %* | urban business quarters | *8 %* |
| supermarkets, shopping centres, storehouses | *23 %* | Other : Hospitals | *8 %* |
| bureaus, private or public administration | *23 %* | industrial production buildings | *0 %* |

CAMELIA-experts' questionnaire, pre-test sample n=13

The main local renewable resources will be solar: Half of the respondents totally agree with this statement, and another half would regard this true to some extent. The second favourite is wind. Wood (chips and pellets) and agricultural biogas range ex aequo at the third place. To some extent straw, peat, bark or other organic wastes, landfill or sewage gas, and geothermie will be an efficient and extensive local source, but reformed gas, pyrolysis gas, hydropower and waves will seldom be a feasible option.

Quite a range of technologies seem to be most appropriate for achieving this scenario. Highest feasibility is achieved by solar and climate optimized architecture and construction, as well as related passive technologies like insulation and shadowing, as well as logistics like ventilation, heat storage and specific distribution technology. – When it comes to specific sources of energy the favourites are installation of solar panels, heat pumps and absorption / adsorption cooling. Photo voltaic, compression cooling, wind turbines would be considered sometimes, but gas motors and turbines as well as fuel cells and steam turbines would frequently be not an appropriate option.

### 4.4.3 Favourite technologies



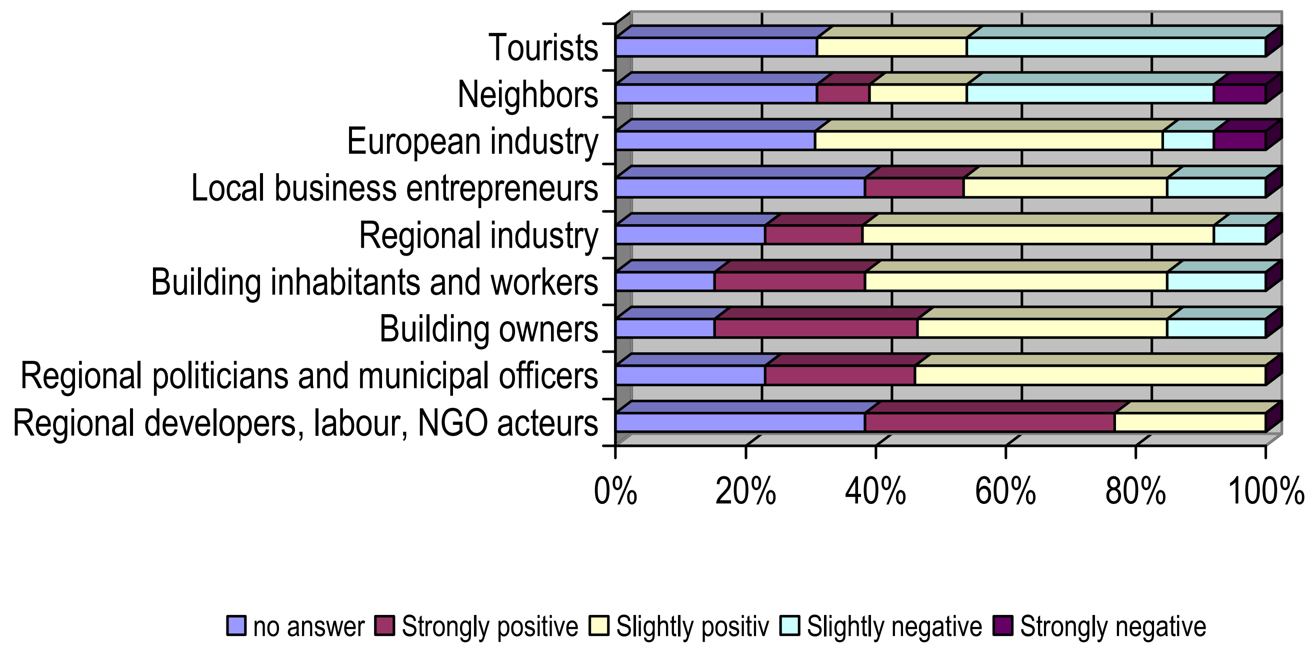

CAMELIA-experts' questionnaire, pre-test sample n=13

Technologies need persons who promote them. It has been important to know, which persons, person groups and organizations are affected by the scenarios and the most favourite technologies. The opinion of people affected will be most crucial to acceptance or non-acceptance of a technology. Both, positive and negative issues have to be regarded.

Analysing different target groups, most of the scenario effects are considered to be positive. Purely positively affected will be the group of regional developers, labour, environment NGO actors as well as regional politicians and municipal officers. They therefore should be most efficient in promoting local renewable energies and related technologies. Building owners and building inhabitants and workers will also be affected positively, but some slightly negative effects will also have to be considered. The same applies to regional and European industry and local business entrepreneurs: they will belong to the winners of that technology shift too. A crucial factor may be neighbours and tourists. The respondents do not expect any strong effects, neither positive nor negative ones. As slightly negative effects will outweigh the others, it will necessary to consider special measures in order to let them participate from benefits joined with the proposed technology shifts.

It is expected that most sectors will have added value effects or occupational effects. Clear winners will be technical equipment and service providers, plant engineering and construction. The technology shift will support definitely also the building sector, financial intermediaries, banks, investors as well as teachers, researchers, consultants; transportation and storage provider and agriculture, forestry, fishing. – For municipal services: sewage and refuse disposal, real estate and renting, electricity, gas and water suppliers there will be both advantages and disadvantages.

#### 4.4.4 Stakeholders affected




CAMELIA-experts' questionnaire, pre-test sample n=13

One of the results of the preparatory study has been a set of dimensions, and a ranking of these dimensions according to their regional relevance and technology fulfilment.

There are some effects that will very clearly be promoted from the scenario and the related technologies. 33 effects have been studied. The most virulent effects ranked in their order of predominance are (1) Sustainable Use of Renewable, (2) Preservation of Non-Renewable Resources, (3) Air Quality, (4) Establishment of a Regional Knowledge Base, (5) Regional Key Projects and Technologies,

A sustainable use of renewable energy sources and preservation of non-renewable resources will certainly establish a high value for many users. Sustainability values may be high, but they might become discounted as it often occurs, when future benefits are paid present-day. The third issue, air quality, could carry the idea of sustainability more touchable. The fourth and the fifth benefit both start off from a non-material base: knowledge and know-how that is the base for technology and their integration. A regional key project will surely use these immaterial factors to create jobs and incomes, but the question arises, if this relationship is transparent to the customer.

More generally, we will have to ask whether these fulfilments will meet regional demands. With all the 33 aspects, we posed the question, which kind of effects is important to the respondent's region. That question resulted in a score of regional demands. The most important effects, a region will demand, ranked in their order of predominance are: (1) Air Quality, (2) Education and Qualification, (3) Support of

Related Industries and Sectors, (4) Sustainable Use of Renewable Resources, (5) Increased Employment and Job Supply.

We notice that items 1 and 4 already show up in the list of most dominant technology effects. Technology seems to fulfil these customer demands with respect to sustainability – yet a more detailed analysis will have to survey regional stakeholder and key target groups other than technology experts to guarantee an appropriate view of regional demands. Item 2 attaches again a non-material value: education and qualification. Items 3 and 5 show very clear, that a region will highly prioritise its own industries and sectors and the employment created therein.

Here, technology features do not correspond very much with regional demands. Within a test, covering various regions and technologies, this does not surprise. The scores of technology fulfilments and regional demands correlate only r=0.173 (n=33). The effects appear as a cloud in the two-dimensional space of demands and fulfilments. If technology would be adjusted to demands, this picture would present us a straight line, or at least an up-bound ellipse, containing most of the points. In a real case application, that correlation should increase much, in order to guarantee a high customer satisfaction.

# 5. Methods of socio-economic evaluation

As it has been depicted out, the evaluation should be integrated into a participatory decision making process. Well accepted evaluation standards, presented by the German Evaluation Society[25] or the US-American "Joint Committee on Standards for Educational Evaluation", argue e.g. to (1) identify stakeholders so that their interests can be clarified and taken into consideration when designing the evaluation, (b) to clarify the purposes of the evaluation so that stakeholders can provide relevant comments, (c) disclosure findings to the extent possible.

Evaluation should – most important – consider those dimensions that are relevant. The experts' questionnaire above delivers a tool to acquire a ranking of these dimensions in each individual case. The decision, which dimensions to consider and how to weigh them, will be eased, when stakeholders are involved in prioritising them. Which dimensions could be relevant, has been described above. The method should be comprehensive with regard to the dimensions needed. Other, inbound features are, that methods should take into account indicators that are valid, reliable and practical.

- **Relevance**. Measures selected for the evaluation need to be adequate and important to the particular polygeneration system being studied.

- **Comprehensiveness.** The system of indicators should be comprehensive, comprising all relevant dimensions, and should balance them according to their relevance. An indicator for comprehensiveness has been built counting the number of criteria the method evaluates

- **Discoursivity**. Results of the evaluation should be integratable into a learning process. Stakeholders (and not only the evaluators) are involved in specifying criteria and indicators as well as evaluative judgements.

- **Validity.** Measures need to provide an accurate reflection of the underlying feature that is supposed to be measured.

- **Reliability**. Measures should be subject to as little measurement error as possible.

- **Practicability**. Data needed to calculate measures must be available, procedures transparent and cost-efficient. The relationship between cost and benefit of the evaluation should be appropriate.

[25] english summary (pp 47–50) in: Deutsche Gesellschaft für Evaluation (DeGEval), Standards für Evaluation, Köln 2002, ISBN 3-00-009022-3.

## 5.1 Evaluation demands

Within CAMELIA project partnership, evaluation methods for socio-economic acceptance have been discussed. It was generally agreed that projects and measures should be evaluated in order to control scenario realization. They should be evaluated ex ante, before starting a project, in order to be able to adapt them to regional demands. Furthermore, an ex post evaluation after five years of operation seems very important to the majority of the respondents of the experts' questionnaire. To most of the respondents, quantitative methods and especially life cycle analysis of environmental effects are important.

Generally, other methods of evaluation seem to be rather unknown. This applies e.g. to input-output analysis calculating value added and employment effects, as well as to qualitative methods, contingent valuation of subjective readiness to pay or the hedonic price method. With respect to economic effects, cost-benefit and opportunity cost analysis had some priority. These methods are also capable for comparing with competitive investments and for making intangible effects visible. We therefore suggest, to support politicians as well technicians in access to such methods. Another consequence, directly related to the scope of CAMELIA, suggests choosing evaluation tools depending on customer demands, using the created experts' questionnaire in specific case studies (WP 7).

## 5.2 Evaluation tools - overview

Within CAMELIA there was a survey of a set of 11 evaluation tools, addressing socio-economic acceptance and capable for applications concerning polygeneration (Questionnaire see: Appendix).

### 5.2.1 Evaluation tools and socio-economic acceptance criteria - overview

| Method | Criteria | Material flow analysis | Balance of exergy | Balance of energy | Interviews and questionnaire | Life cycle assessment | Externalities | Quality Function Deployment | P.E.S.T. Analysis | Regionalized Input-Output Analysis | General Equilibrium Model | Development Impact Analysis | SUM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Business and economy impacts | Establish a Regional Knowledge Base | | | | x | | | x | x | | | | 2 |
| | Regional Key Projects and Technologies | | | | (x) | | x | x | x | x | | | 4 |
| | Support of Related Industries and Sectors | | | | | | | x | x | x | x | | 3 |
| | Regional Trade Balance / Indep. from Import | | | | | x | | x | x | x | | | 3 |
| | Security of Supply / Risk Diversification | | | | (x) | | | x | x | | | x | 3 |
| | Regional Growth | | | | x | | | x | x | x | | x | 4 |
| | Export Potential | | | | | | | x | x | | x | | 2 |
| | Enhanced Competitiveness of Enterprises | | | | | | | x | x | | x | | 2 |
| | Improved Infrastructure | | | | | | | x | x | x | | x | 3 |
| | Diversification | | | | | | x | x | x | x | x | | 4 |
| | Pay-back time, return on investments | | | | | x | | x | x | | | | 2 |
| | Income Creation | | | | x | | | x | x | x | x | x | 5 |
| | Increased Productivity | | | x | | x | | x | x | | | | 3 |
| | Induced Investment | | | | | | | x | x | x | x | | 3 |
| Ecology and environmental impacts | Sustainable Use of Renewable Resources | | x | x | x | x | | x | x | | | x | 6 |
| | Air Quality | x | | | x | x | x | x | x | | | x | 6 |
| | Noise Reduction / Protection | | | | x | | x | x | x | | | x | 4 |
| | Climatic Change | x | | | x | x | x | x | x | | | x | 6 |
| | Landscape Amenities | | | | | | | x | x | | | x | 2 |
| | Transport and Traffic Reduced | | | | x | | x | x | x | | | x | 4 |
| | Preservation of Non-Renewable Resources | | x | | x | | | x | x | | | x | 4 |
| | Land usage and housing availability | | | | (x) | | | x | x | | | x | 3 |
| | Biodiversity | | | | | | x | x | x | | | x | 3 |
| | Water Quality | x | | | | | x | x | x | | | x | 4 |
| | Preservation of Soil Quality | | | | | | x | x | x | | | x | 3 |
| Social and immaterial impacts | Increased Employment and Job Supply | | | | x | | x | x | x | | | x | 4 |
| | Health promotion | | | | x | x | x | x | x | | | x | 5 |
| | Support of Regional Pioneers | | | | x | x | x | x | x | | | | 4 |
| | Education and Qualification | | | | (x) | | | x | x | | | x | 3 |
| | Preserve Building Substance and ambiente | | | | | x | x | x | x | | | x | 4 |
| | Integrate / Employ Weak Target Groups | | | | x | x | x | x | x | x | | x | 6 |
| | Feel comfortably, Quality of Life | | | | x | x | x | x | x | | | x | 5 |
| | Conform with Regional Development Vision | x | | | x | x | x | x | x | x | | x | 7 |
| | Culture of Cooperation and Participation | | | | x | x | | x | x | | | x | 4 |
| | Mitigating Rural Depopulation / Over-Ageing | | | | x | | | x | x | | | x | 3 |
| | Less Poverty | | | | | | | x | x | | | x | 2 |
| COMPRE-HENSIVENESS | number of criteria evaluable | 4 | 2 | 2 | 21 | 13 | 16 | 36 | 36 | 10 | 6 | 25 | |
| DISCOURS-IVITY | participatory potential | 1 | 1 | 1 | 4 | 2 | 2 | 3 | 1 | 3 | 1 | 1 | |

### 5.2.2 Material flow analysis

| Name of the method | **Material flow analysis** | | |
|---|---|---|---|
| Focus | Ecology and environmental impacts | | |
| Technical description | | | |
| Using Material Flow Analysis (MFA), engineers and planners can determine the main sources, flows, stocks, and emissions of man-made and natural materials. Assessment of materials and energy related environmental impacts based on systems analysis; derivation of indicators for sustainability e.g. of materials intensity per service unit (MIPS), | | | |
| Criteria addressed | | | |
| Business and economy impacts | Ecology and environmental impacts | Social and immaterial impacts | |
| | Air Quality, Climatic Change, Water Quality | Conform with Regional Development Vision | |
| Applicability | Ex ante: yes | Ex post: yes | |
| References | | | |
| Energy crops: http://www.biogasakzeptanz.at<br>General: http://www.wupperinst.org | | | |
| Strengths | Weaknesses | | |
| Attaches energy supply to regional potentials<br>Capable to find out bottlenecks in regional supplies of renewable resources (availability) | Indicators like materials intensity per service unit (MIPS) did not really become accepted | | |

### 5.2.3 Balance of exergy

| Name of the method | **Balance of exergy** | | |
|---|---|---|---|
| Focus | Ecology and environmental impacts | | |
| Technical description | | | |
| The balance of exergy relates to the second. fundamental theorem of thermo-dynamics: Closed systems will increase their disorder (entropy), when converting energy. Entropy never decreases. Thermal energy reflects low entropy. When providing energy services, they should contribute as less as possible to entropy creation. Using industrial waste heat as an input e.g. would be preferable to an oil-fired building central heating | | | |
| Criteria addressed | | | |
| Business and economy impacts | Ecology and environmental impacts | Social and immaterial impacts | |
| | Sustainable Use of Renewable Resources, Preservation of Non-Renewable Resources | | |
| Applicability | Ex ante: Yes, preferred | Ex post: Yes | |
| References | | | |
| | | | |
| Strengths | Weaknesses | | |
| Differentiates the quality of conversion and value of fuel; characterizes sustainability | In practice, it must be supplemented by other indicators<br>Lack of demonstrativeness to non-technicians | | |

### 5.2.4 Balance of energy

| Name of the method | **Balance of energy** | | | |
|---|---|---|---|---|
| Focus | Ecology and environmental impacts | | | |
| Technical description | | | | |
| The balance of energy compares energy inputs to energy outcomes, and reflects productivity. The balance answers the question, how much energy must be put in in order to achieve the benefit expected. The concept behind relates to the first fundamental theorem of thermo-dynamics, stating that energy will prevail in a closed system. | | | | |
| Criteria addressed | | | | |
| Business and economy impacts | Ecology and environmental impacts | | Social and immaterial impacts | |
| Increased Productivity | Sustainable Use of Renewable Resources | | | |
| Applicability | Ex ante | Yes, preferred | Ex post | yes |
| References | | | | |
| | | | | |
| Strengths | | Weaknesses | | |
| A basic, relevant and practical indicator, transparent in communication | | In practice, it must be supplemented by other indicators | | |

### 5.2.5 Interviews and questionnaires

| Name of the method | **Interviews and questionnaires** | | | |
|---|---|---|---|---|
| Focus | Social and immaterial impacts | | | |
| Technical description | | | | |
| Socio-economic effects can best be evaluated by means of interviews and questionnaires | | | | |
| Criteria addressed | | | | |
| Business and economy impacts | Ecology and environmental impacts | | Social and immaterial impacts | |
| Establish a Regional Knowledge Base, Regional Key Projects and Technologies, Security of Supply / Risk Diversification, Regional Growth, Income Creation | Sustainable Use of Renewable Resources, Air Quality, Noise Reduction / Protection, Climatic Change, Transport and Traffic Reduced, Preservation of Non-Renewable Resources, Land usage and housing availability | | Increased Employment and Job Supply, Health promotion, Support of Regional Pioneers, Education and Qualification, Integrate / Employ Weak Target Groups, Feel comfortably, Quality of Life, Conform with Regional Development Vision, Culture of Cooperation and Participation, Mitigating Rural Depopulation / Over-Ageing | |
| Applicability | Ex ante | yes | Ex post | yes |
| References | | | | |
| BIOPROM, CAMELIA<br>http://www.biogasakzeptanz.at | | | | |
| Strengths | | Weaknesses | | |
| Capable to assess multiple effects on acceptance and motivation of stakeholders<br>Capable to cover a holistic approach<br>Integrating stakeholders from the very beginning | | Experts' interviews are time and resources consuming, especially when conducted face-to-face<br>Strengths of causal inference and complexity capability are low<br>Susceptible to subjective rating and strategic answering | | |

### 5.2.6 Life cycle assessment

| Name of the method | **Life cycle assessment** | | | |
|---|---|---|---|---|
| Focus | Ecology and environmental impacts | | | |
| Technical description | | | | |
| Life Cycle Assessment (LCA) is a tool used to evaluate the potential environmental impact of a product, process or activity throughout its entire life cycle by quantifying the use of resources ("inputs" such as energy, raw materials, water) and environmental emissions ("outputs" to air, water and soil) associated with the system that is being evaluated. | | | | |
| Criteria addressed | | | | |
| Business and economy impacts | Ecology and environmental impacts | | Social and immaterial impacts | |
| Regional Trade Balance / Indep. from Import, Pay-back time, return on investments, Increased Productivity | Sustainable Use of Renewable Resources, Air Quality, Climatic Change | | Health promotion, Support of Regional Pioneers, Preserve Building Substance and ambience, Integrate / Employ Weak Target Groups, Feel comfortably, Quality of Life, Conform with Regional Development Vision, Culture of Cooperation and Participation | |
| Applicability | Ex ante | yes | Ex post | yes |
| References | | | | |
| BALANCE (IER), GEMIS, Öko-Institut | | | | |
| Strengths | | Weaknesses | | |
| Life Cycle Assessment is an appropriate means to assess environmental effects; GEMIS includes already a lot of process chains<br>LCA provides a common and transparent data base. | | Generally, a lot of work and resources are needed. | | |

### 5.2.7 Externalities – Software EcoSense

| Name of the method | **Externalities Software EcoSense** | | | |
|---|---|---|---|---|
| Focus | Social and immaterial impacts | | | |
| Technical description | | | | |
| Externality analysis tool EcoSense is an instrument to assess external environmental effects and the impacts on environment, health and social aspects | | | | |
| Criteria addressed | | | | |
| Business and economy impacts | Ecology and environmental impacts | | Social and immaterial impacts | |
| Regional Key Projects and Technologies, Diversification | Air Quality, Noise Reduction / Protection, Climatic Change, Transport and Traffic Reduced, Biodiversity, Water Quality, Preservation of Soil Quality | | Increased Employment and Job Supply, Health promotion, Support of Regional Pioneers, Preserve Building Substance and ambience, Integrate / Employ Weak Target Groups, Feel comfortably, Quality of Life, Conform with Regional Development Vision | |
| Applicability | Ex ante | yes | Ex post | yes |
| References | | | | |
| http://www.ier.uni-stuttgart.de/forschung/projekt_de.php?pid=270 | | | | |
| Strengths | | Weaknesses | | |
| EcoSense provides a common and transparent data base. | | A lot of work and human and computing resources are needed. | | |

### 5.2.8 Quality Function Deployment

| | | | | | |
|---|---|---|---|---|---|
| Name of the method | **Quality Function Deployment** | | | | |
| Focus | Comprehensive | | | | |
| Technical description | | | | | |
| QFD is a comprehensive method for quality design. It surveys customer needs from observations, uncovers quality features from a customer perspective, translates these into designs characteristics and deliverable actions, and builds and delivers a quality product or service by focusing the various business functions toward achieving customer satisfaction | | | | | |
| Criteria addressed | | | | | |
| Business and economy impacts | Ecology and environmental impacts | | Social and immaterial impacts | | |
| Potentially all | Potentially all | | Potentially all | | |
| Applicability | Ex ante | yes | Ex post | In part | |
| References | | | | | |
| Locating optimal sites for biogas plants EU FP4 HOORAY<br>Biogas in stationary fuel cells: EU FP5 EFFECTIVE (http://www.biomatnet.org/secure/FP5/S1565.htm)<br>Baaske, Trogisch (ed.): Biogas Powered Fuel Cells, Trauner, Linz, 2005, ISBN 3-85487-626-2<br>In general: http://www.qfdi.org | | | | | |
| Strengths | | | Weaknesses | | |
| Orients integration of technologies, product and service development to an optimal matching with customer and stakeholder demands | | | Is not a measurement by itself but an aggregate – needs supplementary data, questionnaires, interviews, site visits | | |

### 5.2.9 P.E.S.T. Analysis

| | | | | |
|---|---|---|---|---|
| Name of the method | **P.E.S.T. Analysis** | | | |
| Focus | Comprehensive | | | |
| Technical description | | | | |
| The method considers, what environmental influences have been particularly important in the past, and the extent to which there are changes occurring which may make any of these more or less significant in the future. It provides an analytical framework with a checklist of important environmental forces. These forces are divided into political, economic, social and technological factors (P.E.S.T.) which shape the business environment of the emerging industry. | | | | |
| Criteria addressed | | | | |
| Business and economy impacts | Ecology and environmental impacts | | Social and immaterial impacts | |
| POTENTIALLY: Establish a Regional Knowledge Base, Regional Key Projects and Technologies, Support of Related Industries and Sectors, Regional Trade Balance / Indep. from Import, Security of Supply / Risk Diversification, Regional Growth, Export Potential, Enhanced Competitiveness of Enterprises, Improved Infrastructure, Diversification, Pay-back time, ROI, Income Creation, Increased Productivity, Induced Investment | POTENTIALLY: Sustainable Use of Renewable Resources, Air Quality, Noise Reduction / Protection, Climatic Change, Landscape Amenities, Transport and Traffic Reduced, Preservation of Non-Renewable Resources, Land usage and housing availability, Biodiversity, Water Quality, Preservation of Soil Quality | | POTENTIALLY: Increased Employment and Job Supply, Health promotion, Support of Regional Pioneers, Education and Qualification, Preserve Building Substance and ambience, Integrate / Employ Weak Target Groups, Feel comfortably, Quality of Life, Conform with Regional Development Vision, Culture of Cooperation and Participation, Mitigating Rural Depopulation / Over-Ageing, Less Poverty | |
| Applicability | Ex ante | yes | Ex post | yes |
| References | | | | |
| Volker Jaensch, Marketability analysis for an innovative fuel cell / biogas technology in Spain, South bank university, London, 2000. | | | | |
| Strengths | | | Weaknesses | |
| Holistic approach, national economy oriented | | | A qualitative method needing supplementing interviews & reasoning, not feasible to single sites | |

### 5.2.10 Regionalized Input Output Analysis

| Name of the method | **Regionalized Input-Output Analysis** | | |
|---|---|---|---|
| Focus | Business and economy impacts | | |
| Technical description | | | |
| Input-output analysis is one of a set of related methods which show how the parts of a system are affected by a change in one part of that system. Input-output analysis specifically shows how industries are linked together through supplying inputs for the output of an economy. Output refers to gross production, or total sales. One of the main problems with calculating regional input-output tables in this way is the overestimation of local economic activity. | | | |
| Criteria addressed | | | |
| Business and economy impacts | Ecology and environmental impacts | Social and immaterial impacts | |
| Regional Key Projects and Technologies, Support of Related Industries and Sectors, Regional Trade Balance / Indep. from Import, Regional Growth, Improved Infrastructure, Diversification, Income Creation, Induced Investment | | Integrate / Employ Weak Target Groups, Conform with Regional Development Vision | |
| Applicability | Ex ante: yes | Ex post: yes | |
| References | | | |
| Renewable Energy Studies: Greisberger, Hasenhüttl, Beschäftigung und Erneuerbare Energieträger, BMVIT, Wien 2002.<br>Regionalisation techniques: http://www.owp.nl | | | |
| Strengths | Weaknesses | | |
| Well known method<br>Wide-spread applicated for energy technologies<br>Yields demonstrative figures for employment and incomes<br>Efforts may be low | Assuming fixed economic relationships<br>Static in nature<br>Limited to the economy, provides no tools for an interaction between population and economic changes | | |

### 5.2.11 General Equilibrum Model

| Name of the method | **General Equilibrium Model** | | |
|---|---|---|---|
| Focus | Business and economy impacts | | |
| Technical description | | | |
| Dynamic economic model for prognosis of effects of a technology integration | | | |
| Criteria addressed | | | |
| Business and economy impacts | Ecology and environmental impacts | Social and immaterial impacts | |
| Support of Related Industries and Sectors, Export Potential, Enhanced Competitiveness of Enterprises, Diversification, Income Creation, Induced Investment | | | |
| Applicability | Ex ante: yes | Ex post: yes | |
| References | | | |
| WIFO Wirtschaftsforschungsinstitut | | | |
| Strengths | Weaknesses | | |
| Capable to integrate price shifts in course of a technology dissemination<br>More realistic than Input-Output-Model | Very labour extensive<br>Non-transparent<br>Difficult to regionalize | | |

### 5.2.12 Development Impact Analysis

| Name of the method | **Development Impact Analysis** | | | | |
|---|---|---|---|---|---|
| Focus | Evaluation of consequences of development on a community | | | | |
| Technical description | | | | | |
| Cumulative effects assessment, documentation of the anticipated economic, fiscal, environmental, social and transportation-related impacts of a particular development on a community | | | | | |
| Criteria addressed | | | | | |
| Business and economy impacts | Ecology and environmental impacts | | Social and immaterial impacts | | |
| Identification of the deficiencies or tradeoffs between possible development alternatives or courses of action and the environmental impacts associated with each alternative | Identification of valuable environmental resources in the community and surrounding area that may be affected by a proposed development | | Determination which groups and to which extend in the community may be directly or indirectly affected by the project or action | | |
| Applicability | Ex ante | yes | Ex post | (yes) | |
| References | | | | | |
| United States, National Environmental Policy Act (NEPA) | | | | | |
| Strengths | | | Weaknesses | | |
| Focus on environment and community<br>Figuring out a well balanced decision report<br>Well structured methodology | | | Weighting of impact factors not well defined<br>Business and economy hardly considered | | |

# 6. Workshop WP6

The workshop was held on  and 17th and 18th of May 2006 in Steyr/Austria organized by Profactor with the support of the relevant project partners together with the workshop of WP5 “Environmental Impact”. It was an open symposium with the participation of 16 external persons, in total there were 35 people including the speakers and the project partners.
Title: “Sustainable Energy Supply for Buildings – Ecological Potential and socio-economic Acceptance”. A proceeding in hardcopy was prepared. On the Symposium webpage all presentations are available for downloading: www.camelia-symposium.com

## 6.1 Program

**Wednesday, 17th May 2006**

**SOCIO-ECONOMIC ACCEPTANCE**

Opening Session:

Chair: Johann Bergmair (Profactor)

| | | |
|---|---|---|
| 12.30 – 12.45 | Welcome and introduction | Friedrich Mader (A)<br>*Profactor Produktionsforschungs GmbH* |
| 12.45 – 13.15 | Introduction to the coordination action CAMELIA | Francis Meunier (F)<br>*CNAM Conservatoire National des Arts et Métier* |
| 13.15 – 14.00 | Socio-economic effects – the drivers of successful bio-energy supply of buildings | Karin Stieldorf (A)<br>*Institut für Hochbau, TU Wien* |

Session 1: **"Methods for integral Implementation of Energy Projects"**

Chair: Ludger Eltrop (Uni Stuttgart)

| | | |
|---|---|---|
| 14.30 – 15.00 | Socio-economic approaches to development of bio-energy | Erik Ling (S)<br>*Sveaskog* |
| 15.00 – 15.30 | Methods – eco-buildings in the context of socio-economic evaluation tools | Kari Thunshelle (N)<br>*SINTEF Building Research Institute* |

Session 2: **"Successful regional and international Examples"**

Chair: Francis Meunier (Cnam)

| | | |
|---|---|---|
| 16.00 – 16.30 | Non technical hampering factors of bio-energy projects in urban areas | Ludger Eltrop (D)<br>*Universität Stuttgart* |
| 16.30 – 17.00 | Sustainable energy and urban planning: a review on Zaragoza experiences | José A. Turégano (E)<br>*Fundación Ecología y Desarrollo* |
| 17.00 – 17.30 | Acceptance of regional biogas implementation | Wolfgang Baaske (A)<br>*STUDIA* |
| 17.30 – 17.45 | Further Discussion | Francis Meunier |

**Thursday, 18th May 2006**

## ENVIRONMENTAL IMPACT

Opening Session:

Chair: Francis Meunier (Cnam)

| | | |
|---|---|---|
| 08.45 – 09.00 | Welcome and introduction | Isabel Kuperjans (D)<br>*RWTH Aachen* |
| 09.00 – 09:30 | LCA-Method | Gerfried Jungmeier (A)<br>*Joanneum Research* |

Session 1: **"Environmental impact of energy consumption in buildings"**

Chair: Claude Bouvy (RWTH Aachen)

| | | |
|---|---|---|
| 09:30 – 10.00 | Regenerative Energy Supply and Tri-Generation (LCA for buildings) | Gerfried Jungmeier (A)<br>*Joanneum Research* |
| 10.00 – 10.30 | Modelling and Optimisation of complex energy systems -<br>Efficient Tri-Generation System at Munich Airport | Matthias Rzepka (D)<br>*e.square GmbH* |

Session 2: **"Carbon Management, Emissions trading and flexible mechanisms of the Kyoto Protocol"**

Chair: Christian Schweigler (ZAE Bayern)

| | | |
|---|---|---|
| 11.00 – 11.30 | Overview | Sonja Frenzel (D)<br>*FutureCamp GmbH* |
| 11.30 – 12.00 | Process validation, verification and certification | Werner Betzenbichler (D)<br>*TÜV SÜD Industrie Service* |
| 12.00 – 12.30 | Examples:<br>Building Projects and Industrial Energy Systems | Sonja Frenzel (D)<br>*FutureCamp GmbH* |
| 12.30 – 12.45 | Further Discussion | Christian Schweigler |

## 6.2 Summary

The introduction to the topic “Socio-economic effects – the drivers of successful bio-energy supply of buildings” by Karin Stieldorf opened a worldwide variety of integrative housing. The adaptation to the local society, behaviour of people and climate situation to the architecture of the building leads to a good basis for comfort of living and sustainability regarding low energy consumption.

The following block of methodologies for socio-economic evaluation was opened by Eric Ling with “Socio-economic approaches to development of bio-energy”. The focus was more on the energy supply with RES. Three models were analyzed: scenario model, institutional model and participatory model. Each leads to some good results, but a mixture of strategies would lead to the best solutions like profitable business opportunity, structural development and appropriate assessment results.

Putting the focus more on the building side Kari Thunshelle held the presentation “Methods – eco buildings in the context of socio-economic evaluation tools – or how to make people go to America?”. Following the analysis done in the EU-project BRITA in PuBs the barriers of implementing low energy solutions in RES are the starting point for a successful project. The way to find solutions for the main problems: information, economy and organisation as well as to bring the solutions to the relevant decision makers is described in guidelines on the webpage of the project.

The block “Successful regional and international examples” showed some experience and some limits of demonstration sites. Ludger Eltrop pointed out the “Non technical hampering factors of bio-energy projects in urban areas”. Specific conditions in urban areas, like high density of energy demand, etc. on the one side and sensitive environmental or traffic situation, etc. need a well balanced planning phase and an appropriate ex ante analysis of hampering factors. Within the EU-project BioProm several European regions were analysed using the questionnaire method and a situation inventory. Economy and information deficits are the most important barriers. Different situations led to quite similar results.

A second example was given by José A. Turrégano by “Sustainable energy and urban planning: w review on Zaragoza experiences”. Low energy consumption especially for heating can be realised easily following a few strategies in the planning of buildings. E.g. direct solar radiation can safe up to 60% of heat demand. Secondly the end-user behaviour influences the energy saving. Especially this key issue will be investigated in the EU-project Renaissance expecting correlations between social research and energy consumption.

The third example regarding application of socio-economic support to regional bio-energy projects was presented by Wolfgang Baaske entitled “Acceptance of regional biogas implementation”. The tree pillars of a successful implementation of a biogas production are feasibility, availability and acceptance. A set of dimensions regarding the acceptance, like awareness, expectations, risks, knowledge, etc are to be evaluated in an adapted questionnaire. The positive effects were shown in a specific biogas plant project with the result, that communication of all stakeholders and neighbours, information about regional energy production etc. lead to good acceptance. In the Austrian national founded project Biogasakzeptanz a web page is available (only in German language) with evaluation tools for regional info, acceptance analyses, economic feasibility, eco balance, energy crops for evaluation of biogas projects.

# 7. Related EU-projects and web pages


[1] BRITA in PuBs (Bringing Retrofit Innovation to Application in Public Buildings): Socio-economic Analysis on Barriers and Needs, Deliverable no. 5
www.brita-in-pubs.eu

[2] IEA Bioenergy, Task 29: Socio-economic drivers in implementing bioenergy projects
www.iea-bioenergy-task29.hr

[3] BioProm (Overcoming non-technical barriers of project-implementation for bioenergy in condensed urban areas)
www.bioprom.net

[4] Renaissance (Renewable ENergy Acting in SuStainable And Novel Community Enterprises)
www.renaissance-energy.net

[5] POLYCITY (Polygeneration and regional energy management in…)
www.polycity.net

[6] Biogasakzeptanz – Interactive web page for socio economic acceptance of biogas plants
www.biogasakzeptanz.at

# 8. Working Team and Authors

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# 9. Appendix

## 9.1 Methods' questionnaire

## 9.2 Experts' questionnaire

# Evaluate Projects for "Building supply with local renewables"

## concerning environmental impact and socio-economic effects

*Please, answer due to your personal opinion! Use separate sheets for each method.*

**Which method do you consider?**

.........................................................................................................................................................

**Please give a short description:**

.........................................................................................................................................................

.........................................................................................................................................................

## *Effects*

**1. Which kind of environmental impacts is the method capable to evaluate? Please tick all impacts that apply**

- ☐ Sustainable Use of Renewable Resources
- ☐ Air Quality
- ☐ Preservation of Non-Renewable Resources
- ☐ Biodiversity
- ☐ Water Quality
- ☐ Preservation of Soil Quality
- ☐ Landscape Amenities
- ☐ Transport and Traffic Reduced
- ☐ Climatic Change
- ☐ Noise Reduction / Protection

**2. Which kind of socio-economic effects is the method capable to evaluate? Please tick as many as apply**

- ☐ Support of Related Industries and Sectors
- ☐ Enhanced Competitiveness of Enterprises
- ☐ Export Potential
- ☐ Induced Investment
- ☐ Regional Key Projects and Technologies
- ☐ Conform with Regional Development Vision
- ☐ Diversification
- ☐ Preserve Building Substance and ambiente
- ☐ Increased Employment and Job Supply
- ☐ Health promotion
- ☐ Income Creation
- ☐ Mitigating Rural Depopulation / Over-Ageing
- ☐ Pay-back time, return on investments
- ☐ Regional Trade Balance / Indep. from Import
- ☐ Regional Growth
- ☐ Increased Productivity
- ☐ Establish a Regional Knowledge Base
- ☐ Security of Supply / Risk Diversification
- ☐ Improved Infrastructure
- ☐ Support of Regional Pioneers
- ☐ Culture of Cooperation and Participation
- ☐ Feel comfortably, Quality of Life
- ☐ Education and Qualification
- ☐ Integrate / Employ Weak Target Groups
- ☐ Less Poverty
- ☐ Land usage and housing availability

**3. Other? ……………………………………………**

## *Application*

**4. When should the method be applied?**

☐ Ex ante ☐ Ex post ☐ both possible

**5. To which building types could the method be applied within appropriate time and effort?** *Please choose all appropriate categories*

☐ single family houses ☐ hotels, hospitals ☐ small villages ☐ regions of 100.000 inhabitants or more

**6. What are the specific advantages the method provides, or disadvantages to cope with?**

advantages or benefits: disadvantages:

................................................................................ ................................................................................

................................................................................ ................................................................................

**7. Please indicate references to supporting software or application projects**

www........................................................................ ................................................................................

www........................................................................ ................................................................................

www........................................................................ ................................................................................

***PLEASE SEND TO: Wolfgang Baaske, ST UDIA, Panoramaweg 1, 4553 Schlierbach, Austria, Fax +43 7582 81981 94***

P.S.: THANK YOU FOR YOUR CONTRIBUTION!

## Supporting measures

**9. What measures can be attractive and effective in your area to support the realization of your vision?** *Qualitative description:*

.............................................................................................................................................

.............................................................................................................................................

**10. Which reasons may persons have to refuse local renewables in buildings and what are the main constraints?** *Qualitative description:*

.............................................................................................................................................

.............................................................................................................................................

**11. How can hampering factors be overcome?** *Qualitative description:*

.............................................................................................................................................

.............................................................................................................................................

## Evaluation

**12. What kind of effects should be evaluated, in order to improve renewable energy projects and increase the acceptance?** *Qualitative description:*

.............................................................................................................................................

.............................................................................................................................................

## Some personnel information

**13. What is your role within the regional energy system?** *Please, tick all appropriate categories*

☐ Producer / farmer forestry
☐ Waste management
☐ Public Authority
☐ Advisor / consultant
☐ Engineering technical Planner / design
☐ Environment / Ecology Association
☐ Economy / Financial
☐ Private citizen
☐ Scientist / Student
☐ Others ................................

**Your gender** ☐ male ☐ female

***PLEASE SEND TO: Wolfgang Baaske, ST UDIA, Panoramaweg 1, 4553 Schlierbach, Austria, Fax +43 7582 81981 94***

THANK YOU FOR YOUR CONTRIBUTION!



# Building supply with local renewables

*Local renewable energy sources may provide buildings with heat, cooling and power – and this could solve many regional and global problems. The following questionnaire wants to find out which kind of solution would fit to your region. Please, answer all questions due to your personal opinion!*

## Your region

**1. Which region do you consider for supply with renewable energy?**

**Region** i.e. Tyrol, Île de France, Sicilia, Devon, Düsseldorf ……………………

**Place** of a special application, i.e. 3ieme district de Paris, university campus ……………………

## Your vision

**2. Which of the following scenarios would you prefer as an attractive vision for your region?** *Please choose one*

☐ Scenario 1
*In the year 2020 energy for buildings will be provided 25% by Renewable local resources*

**OR**

☐ Scenario 2
*In the year 2020 energy consumption in buildings will be dropped by 50% per square meter and year*

## Buildings

**3. Which of the following building types would you consider to be most appropriate for realizing your vision?**

*Please choose maximum 3 building types.*

☐ buildings with 20 and more dwelling units
☐ buildings with up to 20 dwelling units
☐ one-family houses
☐ supermarkets, shopping centres, storehouses
☐ industrial production buildings
☐ tourism, recreational resorts, swimming-baths
☐ bureaus, private or public administration
☐ schools, universities
☐ old city centres
☐ urban business quarters
☐ urban high density residential quarters
☐ Other ...................................

## *Technologies*

**4. Which of the following technologies would you consider to be most appropriate for realizing the vision for your region?**

*Please choose / tick* *maximum 3 categories*

| | |
|---|---|
| ☐ installation of solar thermie | ☐ Heat storage |
| ☐ photo voltaic | ☐ Fuel Cells |
| ☐ Wind turbine | ☐ Compression cooling |
| ☐ Heat pumps | ☐ Insulation |
| ☐ Gas turbine, gas motor | ☐ Ventilation |
| ☐ Steam turbine | ☐ Shadowing |
| ☐ Solar / climate optimized architecture / construction | ☐ Others ................................. |

**5. Local renewable energy sources to be used to feed the system:**

*Please choose / tick* *maximum 3 categories*

| | |
|---|---|
| ☐ Solar | ☐ Wood / wood chips / pellets |
| ☐ Wind | ☐ Agricultural biogas |
| ☐ Waves | ☐ Landfill or sewage gas |
| ☐ Hydropower | ☐ Reformed gas, pyrolysis gas |
| ☐ Geothermie | |
| ☐ Straw, peat, bark, other organic wastes | ☐ Others ................................. |

**6. Please, describe your most favourite application technology in words!**

*Qualitative description:*

.............................................................................................................................................

.............................................................................................................................................

## *Winners and loosers*

**7. Who will be affected by this scenario positively (+) or negatively (–)?**

| *Please click each line – your personal opinion!* | ++ | + | – | – – |
|---|---|---|---|---|
| Building owners | | | | |
| Building inhabitants and workers | | | | |
| Neighbors | | | | |
| Tourists | | | | |
| Local business entrepreneurs | | | | |
| Regional industry | | | | |
| European industry | | | | |
| Regional developers, labour, environment NGO acteurs | | | | |
| Regional politicians and municipal officers | | | | |

**8. Which development goals do you think are important to your region? And which impact of local renewables in buildings might be introduced in your region, applying the technologies you described above?**

*Please tick appropriate left hand AND / OR right hand columns!*

| It is important to my region | GOAL /IMPACT | I expect it as an effect |
|---|---|---|
| | Health promotion | |
| | Feel comfortably | |
| | Air Quality | |
| | Water Quality | |
| | Preservation of Soil Quality | |
| | Preservation of Non-Renewable Resources | |
| | Biodiversity | |
| | Noise Reduction | |
| | Transport and Traffic Reduced | |
| | Landscape Amenities | |
| | Preservation of Building Substance and ambiente | |
| | Education and Qualification | |
| | Development of a Culture of Cooperation and Participation | |
| | Mitigating Rural Depopulation and Over-Ageing | |
| | Diversification | |
| | Less Poverty | |
| | Integration and Employment of Weak Target Groups | |
| | Support of Regional Pioneers | |
| | Conformity with Regional Development Vision | |
| | Security of Supply / Risk Diversification | |
| | Regional Growth | |
| | Export Potential | |
| | Regional Trade Balance / Independent from Imports | |
| | Sustainable Use of Renewable Resources | |
| | Regional Key Projects and Technologies | |
| | Establishment of a Regional Knowledge Base | |
| | Increased Productivity | |
| | Enhanced Competitiveness of Enterprises | |
| | Support of Related Industries and Sectors | |
| | Improved Infrastructure | |
| | Increased Employment and Job Supply | |
| | Income Creation | |
| | Induced Investment | |
| | Others (please describe) | |

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