

1 Scenarios

Europe's DG power generation in the year 2020

In the following, four scenarios will be given to illustrate possible futures of DG within the EU's electricity supply in the year 2020. The scenarios will serve as a basis for a robustness check of the policy recommendations derived in the DECENT project. It is not the aim of the scenarios to describe desirable futures nor will it be analysed which steps have to be taken in order to reach any of the scenarios. The time horizon for the scenarios is 2020. It was chosen so that the scenarios coincident with the time when new policies developed from the DECENT recommendations (2010) would show their effects. The technical input for the scenarios was drawn from the future survey. The scenarios were developed along two key drivers – environmental concern and technological development - which have substantial impact on Europe's future power market. The scenarios have an illustrative nature in order to portray the findings of the future survey and to sketch possible future trends in the electricity business:

- Scenario I – Green Power and Nuclear Ecology
- Scenario II – Huge Fossiles
- Scenario III – Widespread Economic Niches
- Scenario IV – Hip Ecology

Development of scenarios

The major impact factors upon the development of the electricity market and decentralised generation which have been identified in the DECENT project were structured and evaluated in a workshop by the DECENT research team [Berlin meeting December 3rd & 4th 2001]. Two drivers:

1. Extent of greenhouse effect on the agenda
2. Degree of technological development of decentralised generation technologies

were selected to form the orthogonal axes of a matrix with four quadrants – the later scenarios (see Figure 1-1 below).

The chosen set of drivers was preferred against other discussed sets since they are not under direct control of EU-policy in contrast to e.g. the liberalisation of the energy market. Although measures taken up by the commission do have an impact on the drivers their relation is uncertain. Furthermore the drivers are to a great extend logically independent from each other and both of them are independent from policy strategies concerning the liberalisation process. Therefore they were considered to be especially suitable for a “robustness check” of the policy implications derived in the DECENT project. In this respect it has to be mentioned that policy regulations on EU and on member state level concerning the regulation and

liberalisation of the energy market may have a stronger impact on the future of electricity generation in Europe than the selected drivers.

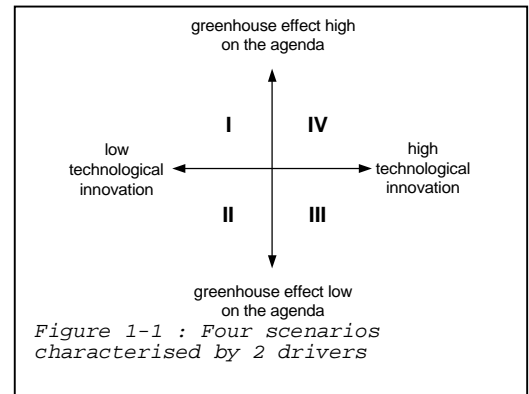
The drivers are specified as follows:

1. Greenhouse effect on the agenda

The driver measures general public opinion on how harmful the greenhouse effect is to humankind and the importance this issue has upon political and economic decisions.

However, the reason why the greenhouse effect is high or low on the agenda may be various: The impact of CO₂ emissions on climate change are not as drastic as anticipated today. The impacts are very drastic and first effects become visual. Other issues

(economic or social crises) push environmental concerns off the agenda. However those possible reasons for a change in environmental concern will not be analysed further. The “zero” level would be today’s awareness of public opinion and the willingness of decision makers to take them into account. It is assumed that the development of the environmental concern from today up to the year 2020 has been rather linear – either towards a stronger or a lesser concern.



2. Technological innovation

This driver measures the technological innovation that DG technologies have undergone. The focus lies less on the “in principle feasible” but rather on the “in practice applied” technologies. Thus the level of technological innovation corresponds directly to the initial costs of electricity from renewables and CHP in the various scenarios. Influential factors for this driver may be progress in basic research as well as economies of scale (in unit production). The different public opinion on how important it is to achieve CO₂ emission reductions (represented by driver 1) may have an impact on the efforts undertaken to foster the development of certain technologies. It is assumed however that the resulting initial cost are on the same (high) level in scenarios I and II. Respectively, they are equally low in scenarios IV and III.

Today’s state of the art would represent the lowest level on the axis of this driver. Drawbacks beneath this level seem only to be realistic when industrial branches collapse. For the scenarios minor drawbacks due to reduced production rates are included. However, “wild cards” like catastrophes are not considered.

The four scenarios were built to illustrate a set of possible futures. They were developed by combining the two drivers as indicated in Figure 1-1. As a first skeleton the “facts” of the state of the various decentralised generation technologies (efficiency of technologies, achieved cost reductions, share of technology in EU’s gross power generation, etc.) were derived from the results of the future survey. It was assumed that the relation between drivers and the constraints (used as variables for the questionnaire statements) is as follows:

The higher the greenhouse effect is on the agenda the less crucial is the constraint by:

- Lack of support mechanisms
- Lack of public information
- Spatial planning provision and procedures

Analogous, if technological innovation is high the following constraints lose impact:

- Lack of R&D funding
- Insufficient education / skill base
- Inadequate standardisation

For each statement a mean time of occurrence was calculated from the expert responses. The time of occurrence was altered in the four scenarios according to the influence of the drivers upon the constraints which were rated as important by the experts for the occurrence of the statement.

Example:

Statement 2: “10% of Europe’s electricity comes from wind power” depends mainly on spatial planning procedures (76% of experts), support mechanisms (54%) and public information (28%). The need for R&D was rated very low (24%) and so were the need for standardisation (9%) and education / skills (7%). The expected time of occurrence was 2017. So in scenario IV this share of windpower should well be reached. If you compared scenario I and III, the share of windpower should be higher in scenario I, being close to the 10% landmark. It has little importance in scenario II.

Based upon those “facts”, a general vision of the social, political and market situation of electricity related issues was sketched. Major actors were identified. The most significant actor was picked to describe the situation from their perspective. However it has to be stressed that “most significant” does not mean highest market penetration. The described actors are significant in terms of being unique for the particular scenario.

Review of scenarios

The scenarios were reviewed by five European energy experts:

- Ms. Daniela Velte, Prospektiker, Spain
- Ms. Cynthia Horn, RISOE, Denmark
- Mr. Mads Borup, RISOE, Denmark
- Mr. Reinhard Grünwald, Office for Technology Assessment at the German Parliament (TAB), Germany
- Mr. Lutz Mez, Freie Universität Berlin, Germany

The reviewers considered the scenarios to be self-consistent and in line with the results of the DECENT future survey. However, it was noted by one reviewer that the stated experts' opinions seemed to be very prudent and that the degree of technological innovation in scenarios I and II was unrealistically low.

The chosen set of drivers was generally considered to be suitable for the aim of the scenarios. In this respect however, it was stressed by one of the reviewers that the implementation of EU-liberalization policies on Member-state level may have a stronger impact than the two chosen drivers on the shape of future power generation with respect to decentralized versus centralized solutions. Thus, when performing the robustness check it has to be considered that there can be a great degree of variation within one scenario due to different policies.

Some of the reviewers' comments concerning the scenarios actually pointed towards the scope of the DECENT survey as such. Two major technologies are not mentioned: geothermal power as well as tidal and wave power. Furthermore there are basically no assumptions on the consumer side made, therefore substitution and synergy effects are neglected (wind power for desalination, electricity for heating, growing demand for cooling and air conditioning). In this respect it was noted that the perspective taken did not adequately include the situation in southern Europe.

1.1 Scenario I – Green Power and Nuclear Ecology

There has been no substantial progress in the technological development of renewable energy technologies or combined heat and power production. The achieved cost reductions are minimal. On the other hand, the greenhouse effect is considered to be a very urgent issue. Therefore enhanced support schemes to promote CO₂ emission reductions are in place. Private companies promote and use renewables for image reasons. The willingness of consumers to pay more for ecology is quite high. Green power is an established product. However, since most renewable energy sources are still quite expensive, there is a shift towards promoting energy saving and higher energy efficiency. In some countries nuclear power is becoming more important again.

The electricity business is split between the mainstream, which is dominated by big utilities and the green power market with a large share of small idealistic companies trying to push renewable generation technologies.

On March 9th 2020, euroNews, Europe's leading virtual magazine published an interview with Mr. Alfred Pfeiffer (54), technical manager of Unit[e], one of the leading green power companies in the EU:

euroNews: Mr. Pfeiffer, Unit[e] has just had its twenty fifth company anniversary. You are one of the first generation power companies specialised on green power. After some ups and downs your company has established itself as one of the major players in the European green power market. Are you confident with where you are now?

Pfeiffer: Sure we are! Unit[e]'s **Eco-Power**[®] has a market share of more than 20% of the national green power (see inbox) market in Germany and that accounts for less than one half of our turnover. We are active throughout all of Europe doing both production, trade and retail of electricity from renewable sources. Today there is – finally – some continuity in the power business again: The claims have been marked out - and we turned out to be one of the bigger ones of Europe's green power retailers. However green power is still just the smaller fraction in the electricity market. The big shares are still held by the big players and now with the

Green power basically comprises electricity generated with low or none CO₂ emissions. In most cases one refers to electricity which has been labelled by the CO₂CUT initiative. The label was invented in 2007 and is the only green power label acknowledged Europe-wide. Electricity from large hydro power plants does generally not account to the share of green power although it causes no CO₂ emissions. It has not been labelled by CO₂CUT since a further support of large hydro power plants has not been considered to be necessary.

restrengthening of nuclear power in some countries the former monopoly companies will still gain ground. So we can be confident of where we are today.

euroNews: Looking back, to when it all started in 1998. What about your visions? Did things turn out like you expected after the liberalization of the power markets?

Pfeiffer: As I said, we started as a small independent power company specialised on green power. Looking at our ideals, I guess the spirit hasn't changed much. We want to push renewables because it is an ecological necessity. But we want to do it on a sound economic basis. Even if you look at the technical part of it, things haven't changed all that much. To be honest the technological development of renewable energy technologies has not turned out to be what people expected it to at the turn of the millennium.

euroNews: In which respect?

Pfeiffer: Well, look at windpower for instance. There have been plans to build vast offshore windparks. Few of them have been realised. Most of them were downsized and in terms of rentability most of them failed...

euroNews: why that?

Pfeiffer: Offshore windfarms have huge maintenance costs. There were – and still are – corrosion problems with some vital parts, the erection of the towers is quite troublesome and costly. There are quite few technical problems, all of which can be solved but drive the costs up. Still wind power – onshore and offshore – accounts for 7% of the total electricity production in the EU and one fourth of it comes from medium sized offshore parks. (...) Onshore we have reached a limit I believe. Even I as an ecologist who takes the greenhouse effect very serious wouldn't want to push it any further. Offshore Unit[e] is developing its fifth wind farm, despite all difficulties.

euroNews: And what about other renewable energy resources? When are we going to enter the solar age?

Pfeiffer: Haven't we yet? (laughs) No, seriously, in the photovoltaic market we seem not to have moved to much. Technologically speaking, most so called "new materials" have not proven to be successful. Our company also lost quite a bit of money which we had put into PV technologies where a "major breakthrough is just ahead". Basically today it comes down to various well established silicon cells. The cost reductions have not been what you would have anticipated 20 years ago, but I personally believe there still is a big future in photovoltaics. We just put the one hundred thousandth PV plant under contract. A 3.5 kW_p system on a small patio near Siena, Italy. I saw pictures of it – they used PV roof tiles with five different shades of red – it looks fantastic. It's a pity that the company producing them never really reached what you could really call mass production. The owner of the house, by the way, is a German

woman, who in fact is one of our first contractors. She owns another system in Freiburg, Germany, which was put up some 20 years ago.

euroNews: Is that a typical scheme: a small PV system owned by...

Pfeiffer: ... someone who is environmentally engaged? Yes! You see, quite a few effective support mechanisms have been implemented to push renewables. However we are still lagging behind in what should be done to counter the greenhouse effect. Most people think so and many of them are willing to pay their share in order to protect the environment. The producers which we have under contract – private companies and individuals – do not look so much to the interest they earn with their system, as long as they break even. And our costumers are willing to pay more, because they can see what it is for.

euroNews: Do you also have combined heat and power plants under contract?

Pfeiffer: Yes, we do, but just a minor share. CHP is well supported by all kinds of programmes. For an environmentally aware home owner CHP is a must anyhow. And with the established support schemes they are cost effective. But Unit[e] has been trying to get biomass plants under contract and we have managed to accompany some very interesting projects. Most of them are individually tailored though. Biomass fuel is still expensive compared to natural gas or oil. Collection and distribution of residues demand high logistics. And since the growth of most energy crops is highly energy consuming itself you are limited to very few crops which can be grown ecologically with a sophisticating output. I guess that's what hinders biomass from becoming the major fuel for power production. Basically, new plants are put up wherever there is some support scheme for regional development. Especially in structurally weak regions, many farmers supplement their income with green power production.

euroNews: Looking into the future, what do think are the greatest problems in reaching further CO₂ reductions?

Pfeiffer: Well speaking for the electricity sector, I think power management still is a big problem. There are attempts to put up load management systems and some of the consumers would be willing to accept quite some inconveniences. If you even want to call that inconvenience – I personally don't care *when* my refrigerator works, as long as my food is cooled. But we are still lacking smart systems which control household appliances depending on high or low electricity prices. That would give us great opportunities to further the share of renewable energy in Europe's power generation. But in contrast to that, new nuclear power plants are set up with the good intentions of cutting CO₂ down ... well I don't want to open that discussion up again, but the points is, if you don't have the right framework – economically and technically – you are giving renewables a hard time.

1.2 Scenario II – Huge Fossiles

There has been no substantial progress in the technological development of renewable energy technologies or combined heat and power production. The achieved cost reductions are minimal. The greenhouse effect is not very present in the general discussion. Most decision makers do not consider it to be an urgent issue.

The European power market is dominated by several transnational power companies holding a market share of more than 90%. Large power plants using fossil fuels and nuclear power are predominant in the electricity production. Public funding and support schemes for renewable energy technologies and small CHP applications have gradually been brought down. Decentralised generation consequently plays a minor part in the electricity supply. Further developments are only carried out under the aspects security of supply and regional development.

On March 9th 2020, euroNews, Europe's leading virtual magazine published an interview with Ms. Françoise Lacroix (45), public relations manager at EEE Power Inc.:

euroNews: Madame Lacroix, EEE is the largest European Power Company today. Does in consequence EEE have a special responsibility to promote a sustainable development in the electricity business?

Lacroix: Most definitely! Sustainable development is one of our main targets and our economic success is based on it. For the economy of Europe the security of the energy supply is absolutely vital and a reliable electricity supply is the heart of it. In producing electricity EEE is very prudent concerning the demands of future generations – we are using the existing resources with maximum efficiency. The improvements in energy efficiency we have achieved within the last thirty years have been tremendous. Large scale plants provide both heat and power at low costs using minimal resources.

euroNews: Nevertheless you are relying upon fossil fuels for more than 60% of your power production. The majority of those fuels, namely natural gas and oil, are imported. Is that not something that endangers security of supply in the long run?

Lacroix: Well, you see, we are living in a globalised world and imports are not bad intrinsically. So far no political crisis has been severe enough to really endanger Europe's energy supply. But you are right it would be false to rely on only one source of energy. EEE has taken all efforts to diversify its power production as much as possible. We use a sound mix of gas, oil, coal, hydro and nuclear power.

euroNews: Concerning hydro power – being the only sustainable energy source you have named – what have been the achievements to build up a higher capacity?

Lacroix: Hydro power is the only renewable energy source that is available 24 hours a day. It is highly reliable and well suited to satisfy the demands. Therefore the potential of hydro power has been exploited wherever it was economically feasible. With large hydro power plants the potential has been tapped for many years. The major growth has been in small power plants. Here the capacity in Europe has risen by 20% compared to the year 2000.

euroNews: How about wind energy? That seemed to be a big issue?

Lacroix: We don't own any windfarms ourselves, but we are buying electricity produced by wind turbines. Most of them were erected about 10 years ago. I don't know if you have followed the trends in the wind business. After the high production rates at the beginning of the millennium, there was almost a collapse in the turbine manufacturing business in recent years. Onshore the expansion of sites is limited due to protest from neighbours of wind farms. Offshore applications are just not feasible. Some very rural areas still profit from the erection of wind farms. They became power producers, thus drawing a little money into the region. I believe that's a good thing as long as the prices are reasonable.

euroNews: Do you see a prospective for solar energy?

Lacroix: If you look at photovoltaics, the cost reduction in the last thirty years has been so small, that I don't see a breakthrough in the near future. There are specialised applications, especially in third world countries, where there is no existing grid. In Europe, it's not only the cells, it's also the power management. The wind turbines are giving us enough trouble as it is. Sure there is a technical solution for everything, but why increase the prices for no reason?

euroNews: And what do you think the future will bring?

Lacroix: Well, in the long run, say over a period of fifty years or more, fossil fuels will diminish and other sources of energy supply will gain importance. May that be nuclear fusion or large thermal solar or geothermal, may be tidal and wave power plants or any other - I don't know. New energy sources is one issue we will have to be thinking about in the far future. But in the meantime, we at EEE make sure to use fossil fuels as efficiently as possible so that there won't be anything to worry about today.

1.3 Scenario III – Wide spread economic niches

There has been an innovative push on renewable energy technologies. Great cost reductions have been achieved for both renewables and combined heat and power production. The greenhouse effect is not very present in the general discussion. Most decision makers do not consider it to be an urgent issue.

Public support schemes for CO₂ emission reductions have gradually been brought down. Decentralised generation is used wherever economically lucrative. Least cost management approaches are applied frequently. Due to computer aided power management systems it is easy to integrate decentralised power generation technologies into the existing supply concepts.

Actors in the electricity business are mainly big utilities offering multi-utility services together with highly specialised, profit oriented service companies. Small businesses (green power producers, manufacturers of generation technologies, service companies) have grown or been bought up.

On March 9th 2020, euroNews, Europe's leading virtual magazine published an interview with Ms. Mette Grønberg (37), key account manager at Northstar, one of the biggest European utilities.

euroNews: Ms. Grønberg, Northstar is the biggest power company in the Nordic countries but electricity is not all you are offering.

Grønberg: That's true. I mean, it used to be easy at those times when you just sold electricity or gas or ... whatever. But to me it seems that most of our customers buy energy solutions. Sure, Northstar owns the biggest share of generation capacity in the Nordic countries, but what is it that our costumers get to see from us? Look at *alwaysenergetic* a 100% daughter of Northstar. It is a highly specialised, relatively small company. Its target is to provide highly reliable energy schemes for customers who have extraordinary demands on security of supply, for example hospitals, IT companies and the like. A power loss for them is not tolerable. They have demanding needs concerning temperature and purity standards of the air. For them quality matters the most. Still they want to cut down their costs – that's why they give our experts the job: *alwaysenergetic*.

euroNews: What would you supply to a medium sized Internet provider who starts a new office with a fairly big server?

Grønberg: First we would develop an energy concept together with the client. That may include a CHP scheme both for heating and cooling. This might e.g. be a Stirling engine or a micro turbine. However, we now mostly apply fuel cells

powered by natural gas. When we have all the parts together we arrange the technical set up. We also offer to manage the maintenance, the sales of excess electricity production, literally everything. The customer can choose from different financing schemes according to their needs.

euroNews: Is that typical? Don't most of your customers buy the cheapest standard solution?

Grønberg: Yes, in a way you are right. But standard solutions only match standard customers. I guess it started with the introduction of the new price schemes for electricity. Formerly we used to have high peak loads and at other times didn't know where to go with all the power we had at hand. Real-time metering opened the way to share this burden with the customer. Those who were a little bit flexible in their electricity demand dashed for the cheaper real-time tariffs. A whole market of demand side management tools emerged. Appliances are doing what you want from them, according to your individual needs, but they try to pick the cheapest tariff whenever possible.

Or look at single houses in remote areas. We have quite a few of them outside the urban clusters. For Northstar the maintenance of the electricity grid or even grid extensions are expensive. Least cost planning management schemes have been applied to all of our working fields. So for those customers far off we offer special energy saving contracts and financing schemes for individual power supply. You know, tremendous technical achievements have been made with fuel cells and new storage concepts. The costs for stand alone solutions are going down. We even have started some pilot projects where we took some areas off the grid again.

euroNews: Do you also use photovoltaics in such cases?

Grønberg: Scarcely! Solar cells were promoted due to environmental concerns at the beginning of the millennium. The former support schemes for most renewable energies have either been reduced drastically or done away with completely within the last decade. Due to technological improvements costs for PV were cut down to one half over the last 20 years. Still PV power is expensive. Depending on the circumstances solar cells are an economic alternative to supply standalone appliances in a power range of say up to some 100 Watts. With improved storage that might grow even further, but I guess we never reach the point where a significant number of households in Europe relies on PV. Most of the PV production is exported to southern countries.

euroNews: And wind energy?

Grønberg: Literally speaking, wind energy has become a *big* business. Most lucrative are the large offshore windparks. Technically they have proven to be feasible and the large units help cutting the costs. But to compete with other means of

power production you are limited to regions with high and reliable wind speeds.

euroNews: What will be the greatest challenges Northstar faces in the future?

Grønberg: I believe the greatest challenge will be to keep up the pace of innovation in which we were striving forward in the past. Technologically, but also in terms of coming up with solutions that fit our costumers and which stand on a sound economic basis.

1.4 Scenario IV – Hip ecology

There has been a strong development in the fields of renewable energy technologies, fuel cells and other CHP technologies. Great cost reductions have been achieved for decentralised generation technologies. The greenhouse effect is considered to be an urgent issue. Consequently support scheme to reduce CO₂ emissions are in place. Their focus is on renewable energies, CHP and energy saving.

Due to innovative technological developments and a strong environmental awareness in the public certain renewable energy technologies have gained an importance as status symbols for customers. They are used by private companies for image reasons. Their “necessity”, whether for fashion or design is not questioned.

The profile of actors in the energy business has broadened. Although a large share of electricity is produced, distributed and sold by big transnational companies a wide variety of small and medium sized companies have entered the market.

On March 9th 2020, euroNews, Europe’s leading virtual magazine published an interview with Mr. Massimo Prato (47), Prato Energy Investments.

euroNews: Mr. Prato, your company is the major investor in the newly build ecovillage of Montepulciano, the biggest energy independent settlement in northern Italy...

Prato: ... yes! Have you been there? It is a beautiful place! And no electricity wire around it for more than three miles. I personally think the architecture fits in splendid with the landscape! And yet everything is very functional. (...)

euroNews: Who are the people who will be living there? The rich who do not care about the costs or hardcore ecologists who want to prove that they can live without being hook up to the electricity grid?

Prato: Neither one! Remember the leaps technology has made lately! The cost for solar power dropped to one fourth compared to the year 2000. In Montepulciano we used standard PV roof tiles as an economic solution and still they have a really great design. We also applied a totally new integrated demand side management system. With that we were able to push the need for energy storage to a minimum. And still it is not like the inhabitants have to suffer major inconveniences. The few limitations you have with regards to the maximum power available are totally bearable.

I believe, the people who will be living in Montepulciano are people who are very aware of the ecological situation of the world. They know that a lot is done by the government to counter the greenhouse effect, but they also know, that this is not enough by far. They want to demonstrate that more can be done.

euroNews: Which is the main energy source you use in Montepulciano?

Prato: Well, basically in this case we used a biogas CHP plant as the main source of power. We thought about fuel cells. The developments made for fuel cells in cars really gave stationary applications a push lately. Now you see hydrogen supply networks emerging everywhere. But in the case of Montepulciano we sought a solution together with the local farmers. Most of them complement their income with energy crops anyhow.

euroNews: If you look back, say over the last two decades. What has been the major development in the energy business from your point of view?

Prato: To me, most significant and most fascinating to watch was the upcoming of all those “plug and generate” components. In solar and CHP, it became so easy for the consumers to become power producers. Just like that. Buy it, sign a contract, plug it in and some smart chip is concerned with power management and billing – you yourself don’t have to worry. That opened up the way for quite a few newcomers in the energy market who “run” virtual power plants without having to come up with the investment themselves.

euroNews: Is Prato Energy Investments also engaged in wind farms?

Prato: We used to, when we started the business 20 years ago. But wind energy has become the business of the big investors, like the big power companies. The wind industry really has boomed. The standard turbine size has passed the 10 MW line a couple of years ago already. Shortly 15% of Europe’s electricity demand will be covered by wind energy. The onshore sites are all exhausted by now, even taken into account that most people are very tolerant towards wind turbines – well they just see the necessity. And to build large offshore wind farms, as I said, you really need a lot of money. But it still is an interesting business. And with the growing hydrogen market I believe that wind driven offshore hydrogen production plants have a great future. It used to be natural gas we were drilling for in the north sea now we are going to produce hydrogen – with no CO₂ emissions at all!

euroNews: One final question Mr. Prato – what is the secret of your success?

Prato: If it was a secret we wouldn’t be successful!
In the energy business, trust is the most important thing! Of course, everybody loves solar cells: the architects play around with fancy colours, every new company building has integrated PV-facades for image reasons, there is no portable home appliance you wouldn’t also get with flexible power cells and so on. But in the end most people do buy electricity from the grid. And if you care about CO₂ emissions you want to make sure the green power you buy is really green! Technically there are no problems with virtual power plants – you can integrate which ever mix of renewables you want, or if you come the other way: select the right sources so that you hit a certain price level. It has to work, sure, if you are not reliable it becomes expensive. But the most important thing

for me is the customer. If someone wants green investments they know Prato is green not grey!