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The Good Fairy and the Bad Raisin Pickers:

The Dilemma of Renewable Energy

Gregor Berz[*] and Manfred J. Holler[**]

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Abstract: This paper discusses the possibility of an efficient arrangement of production of electricity by means of renewable energy, i.e., wind and sunshine. In order to support a stable provision of electricity, a combination with traditional power stations is necessary to overcome the storage problem. A simple model of a natural monopoly is used to demonstrate that such a combination is not sustainable if market entry is free and electricity is traded on the spot market. Alternative public policy instruments are discussed (taxes, subsidies, and entry regulations) which might be applied to overcome this problem and guarantee an efficient provision of electricity.

JEL Codes: L1, L5, Q2

Keywords: Renewable energy, storage capacity and storage technology, power-to-gas, market entry, contestable market, spot market, regulation.

1. Introduction

The paper will start with the story of the baker and the fairy. However, what looks like a fairytale can be, rather directly, applied to the issue of the renewable energy and the inherent storage problem. This will be demonstrated in section 3. The conclusion of this exercise will be that we need a joint arrangement combining the providers of renewable energy and the more traditional power stations working with gas and steam. The latter serve as storage

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[*] Institut für Angewandtes Mechanismus Design (IFAMD) and Institute of SocioEconomics (ISE), Munich, gregor.berz@ifamd.de

[**] University of Hamburg, Center of Conflict Resolution (CCR), and Institute of SocioEconomics (ISE), Munich, holler@econ.uni-hamburg.de.

capacity and buffer. Section 4 proposes a cooperative solution of the two parties. The model in section 5 however demonstrates that, despite its efficiency, such a cooperative solution may invite raisin picking as the market arrangement is (perhaps) not sustainable. In section 6, we discuss the closing down of the spot market and other policy measures (taxes, subsidies, and entry regulations) that support an efficient solution.

2. The Baker and the Fairy: a Fairytale?

In *Sustain*, a small rather isolated village behind the mountains, each villager buys a bun for 1 Euro every day. So he or she spends 30 Euros in a month of 30 days (which are the months we look at). To produce a bun, the baker spends 40 Cents for the flour, milk, water, energy, etc.: these are his costs for an additional bun, i.e., his marginal costs. But there are also fixed costs: he has to pay rent for the bakery and a salary for the young helper. There are fixed expenditures for the electricity, the water and the cleaning material, and imputed costs for the depreciation of the equipment. Given this fixed costs and the number of villagers the baker faces fixed costs of 10 Euros for each costumer. Therefore, each costumer causes 22 Euros of costs to the baker. However, each costumer has a willingness to pay 30 Euros, and thus the baker earns a surplus of 8 Euros per costumer.

Costumers and baker were happy. However, some day a beneficent fairy came to visit the village and offered a bun to each costumer for free. She repeated her visit every day when there was sunshine and distributed the buns to the villagers for free. It seemed there was quite often sunshine – in fact, the probability of sunshine was 50 per cent, but the sunny days were not foreseeable. In the beginning the villagers were quite happy about this present because they saved 15 Euros per month on buns. However, then they experienced that the baker closed down his bakery, cancelled the rental agreement of his house, sold his machines and the rest of the flour he had in his storage room. To cover the remaining demand of 15 buns per villager during the month caused 6 Euros of variable costs and 10 Euros of (quasi-) fixed costs.[1] There is a deficit of 1 Euro per villager for the baker which is, at least in the longer run, disastrous to his economic performance. In the end, the villagers will be quite unhappy because they do not get a bun when the sun is hiding, although their willingness to pay is 1 Euro for it – every day.

It could well be that the fairy feels the unhappiness of the villagers and learns about complaints and even accusations and therefore will stop visiting the village behind the

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[1] The story assumes that fixed costs were zero when the baker does not produce at all, i.e., they are not sunk, but quasi-fixed.

mountains even when there is sunshine. The villagers will be without buns at all, and, despite their willingness to pay of 30 Euros each, no baker will come and settle down because all bakers have heard that there is this beneficent fairy that comes to the village and offers buns for free if the sun is shining, and there are too many sunshine days to allow for gaining surpluses.

It seems that trouble is due to the fact that fairies do not have to cover costs and can give their buns for free, but not all the time. The fairy could have arranged with the baker not deliver the buns for free, but charge 1 Euro – or deliver the buns to the baker and let him charge 1 Euro. When there is no sunshine, the baker will deliver the buns for the same price, however, costs will accrue to him. Because of the 50 per cent of sunshine the baker's costs will be 16 Euros again, but total revenues are 30 Euros as, concurring with the willingness to pay, each villager will get every day a bun at a price of 1 Euro. As a result there will be a surplus of 14 Euros for the baker and the fairy. The two can share this surplus and be happy. The fairy may even insist that the price of the bun will be lowered to let the villagers participate in this happy cooperation. This concludes the fairytale. But there is at least one real-world example to it.

3. The Dilemma of the Renewable Energy

The production of renewable energy, when it is based on making use of sunshine or wind, is characterized by negligible marginal costs, on the one hand, and the instability (i.e., "randomness") of provision of the natural resource, on the other. Of course, in general, there are substantial fixed costs, but they are sunk and thus no longer relevant for decision making. The baker in the above story could sell his machinery, but most of the fixed costs of e.g. a coal-based electric power station is in the construction of the plant and can hardly be recovered. But who wants to buy a wind power station at a price that covers a substantial share of the costs of its installment? The new owner will have similar costs, perhaps even lower ones, because it is easier to install a new wind turbine than a used one.

However, fixed costs are not the problem – to the consumers. In our "village behind the mountains" the sun does not shine every day, and rain and wind are even more unreliable. Either the villagers rely on electric energy that travels from far away, with heavy technical and social costs implied[2] – e.g., overhead transmission lines are not very popular to the neighborhood and may trigger outrage – , or they risk to be out of electricity every other day

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[2] Of course, depending on the distance, up to thirty percent of the energy will be lost on its way from A to B.

as the large-scale storage of electricity is still an unsolved problem. Of course, in the good days of sufficient sun and wind, surplus electricity can be used to pump water into higher level reservoirs. However, there are trade-offs that limit the use of such technologies of energy storage substantially. River regulation is also meant to protect the neighborhood from floods or even allow for shipping. In addition, there are the demands for protecting the nature and, e.g., for sustaining a beaver-friendly environment. Reservoir dams and pumped storage hydro power stations are hardly acceptable, often highly disgraced and meet heavy resistance from ecological activists and their political organizations. In fact, today, large sums are spent by the public to re-naturalize rivers which, in fact, tends to destabilize water provision.[3] Most likely, the various trade-offs and the ecological concerns are the reasons if hydro power stations are not considered as clean technology (see, e.g., Mazzucato, 2014).

In general, there are environmental, ecological and political limitations to the building of new and larger basins. The energies of sun and wind are not storable at all and the energy of water is of rather limited storability. In order to guarantee a daily sufficient supply of electricity, it seems necessary either to import energy "from far away" or to return to traditional energy providers that do not rely on renewable inputs, like coal, oil and gas (COG) power stations. However, these inputs are much more costly than sun, water, and wind, and depending on the output. This also holds for imported electricity which is not always produced by renewable inputs. In both cases, the corresponding variable (and, to some extent, also marginal) cost are not negligible.

Table 1: Capacity utilization of various technologies – Germany, 2012

	Installed Capacity		**Actual Production**		**Utilization**
Uranium	12,70 GW	6,89%	11,32 GWa	15,79%	89,18%
Coal	54,04 GW	29,31%	31,55 GWa	44,00%	58,38%
Gas	26,38 GW	14,31%	8,70 GWa	12,14%	33,00%
Wind	31,30 GW	16,98%	5,77 GWa	8,05%	18,43%
Sun	32,64 GW	17,70%	3,00 GWa	4,19%	9,20%
Water	10,36 GW	5,62%	3,12 GWa	4,35%	30,13%
Bio	6,16 GW	3,34%	4,52 GWa	6,30%	73,36%
others	10,81 GW	5,86%	3,72 GWa	5,18%	34,39%
Sum	**184,37 GW**		**71,70 GWa**		

Source: BMWi, 2012

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[3] This happened to the Isar river in Munich and its vicinity – with some disastrous effects to its banks when there was high-water in 2013 and the upstream Sylvenstein reservoir could not take in more water without risking the damage of the blocking dam. Note this is just one interpretation of what happened, there are alternative ones, more supportive to the re-naturalization policy.

The storage problem of renewable energy based on wind or sunshine is also reflected in the low degree of capacity utilization illustrated in Table 1. It seems obvious that the production of electricity by means of wind and sun is driven by their availability, i.e., by the supply constraints, while the production of nuclear power stations and COG power station is determined by the demand for electricity and its variation of the days, the week, and the seasons. It is interesting to note that the installed capacity of 63,94 GW covered by wind and sun power stations comes close to the total production (and "consumption") of 71,70 GW in the year 2012. If we add the 10,36 GW of the installed capacity of water, then there seems to exist even a surplus capacity of renewable energy. However, given the volatility of wind and sun, it needed an installed capacity of close to 63,94 GW to achieve an actual production of 8,77 GW. The capacity was (almost always) fully used when activation was possible, but if there is no wind then the turbine remains idle.

In order to guarantee a satisfactory provision of electricity, the relevant question is whether the traditional power station will exist, if we can expect that the sun will shine fifteen days per months only (as in our fairytale above). In sunshine days, the renewable energy power stations (REPS) can offer their supply at much lower prices than the traditional suppliers, and they will do so because most likely there is a throat-cutting competition between the REPS because of over-capacities and the zero marginal costs that bring about the over-capacities. COG power stations can create revenues only, if the production of the REPS is not large enough to cover demand, e.g., due to a less generous provision of renewable energy. But in these days of shortage, will the energy prices be high enough to cover the costs of the COG power stations? Not only are their variable costs non-negligible, there are substantial fixed costs. The larger part of these fixed costs are sunk, and not relevant for the decisions of the existing COG power stations, although they decide of whether there are new investments in modern technology and keeping the old one working. However, these fixed costs and the volatility of the sales are major factors that determine of whether new COG are going to be built. This question is highly relevant if demand for electricity increases or if today's COG do no longer produce efficiently from a technical point of view because of aging – or are no longer acceptable from an environmental point of view. The latter is exemplified by a political decision to close the nuclear power stations (as valid for Germany). In competition to the REPS and without any regulation or public subsidies, investments in COG power stations are likely to be very small – too small to guarantee satisfying total demand at a "manageable" price. Of course, even in this situation, a spot-market equilibrium can be achieved for very high prices but with negative consequences for the industries and consumers that depend on the daily provision of electricity. These negative consequences will carry over to the whole economy: Exports will become more expensive, employment will be reduced, or adjusted to the fluctuation of the energy prices, etc.

4. The Cooperative Solution

If prices are high on the days of shortage, REPS will be tempted to extend their operations into more costly areas of provision of renewable energy, and for instance augment their water storage capacities (discussed above) or "try to catch the wind" by additional turbines in landscapes that are not famous for "too much wind." These measures are likely to be less efficient then the earlier ones.

If this policy should be encouraged but prices kept low, then public subsidies seem to be appropriate. However, once we consider public intervention, then a wide range of alternative policies are available, and some are more promising than luring REPS into inefficient arrangements. Here it might help to reread the fairytale above which, in the end proposes, cooperation of the fairy and the baker with some surplus getting shared between all stakeholders:, i.e., a cooperative solution. Since, in the fairytale, one of the parties is not obliged to cover costs and evaluates revenues only indirectly by the happiness of the costumers, cooperation seems to be feasible without the intervention of a powerful third agent, i.e., the state. This does hardly apply to the REPS and to the owner and managers of the COG power stations.

But let us first look at possible technology that allows for a stable provision of electric power based on renewable energy, e.g., the power-to-gas scheme. Surpluses of energy produced by wind or sun in "good days" are transformed into gas which will be burned in "bad days" in traditional power stations. Figure 1 shows gas as a perfect complement technology for sun and wind - as water would be if there would be more storage capacity for it. But there are several problems related with the power-to-gas technology. For instance, more than 70 percent of the electric energy is lost in this process due to waste heat (terminal discharge). To compensate for this loss a huge capacity of wind and solar power stations has to be built, almost twice as much as necessary for the daily (but not reliable) provision without power-to-gas operations. Another issue is the price arrangement: What price to choose? One might argue for a zero-profit price, of course, covering capital costs and expenditures for the management, but should the price cover the average costs of the REPS, the COG, or of the power-to-gas arrangement? Of course, we would argue in favor of the latter because otherwise a cooperation of REPS and COG seems to be not very likely and the costumers may suffer from instable prices creating uncertainty. Of course, such a price invites undercutting if the particular (short-run) situation implies more favorable costs than the medium or long run.

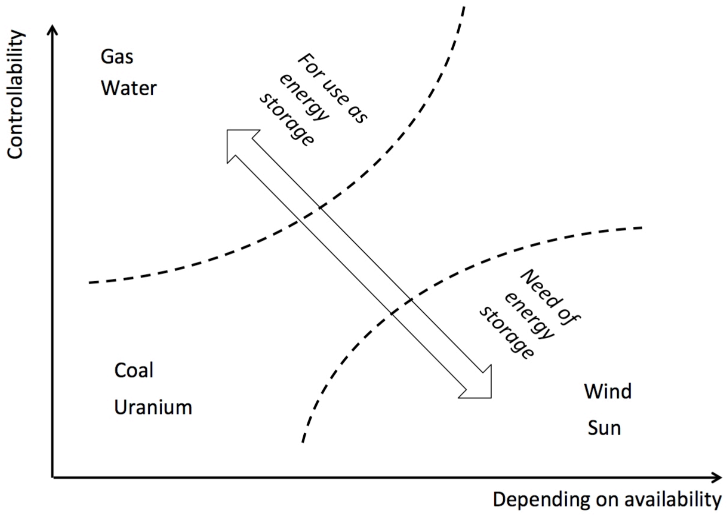

Figure 1: Energy repository depending on technologies[4]

Another problem mentioned, related with the power-to-gas arrangement, is that the very same power station that contributes to the power-to-gas scheme can produce non-renewable energy by burning coal, oil or natural gas. In order to reduce its average costs and earn a share of its sunk costs, it can be tempted to produce electric power even when there is enough wind or sunshine to satisfy the needs of the customers. In principle, the renewable-energy providers could react by lowering the price, but there could be enough legal and technological inertia that allow the COG power stations to earn surpluses by successfully competing with the REPS. There are, e.g., fixed-price contracts with costumers that may not be adjustable in the short-run. However, it seems more likely that the REPS offer lower prices, especially if wind and sunshine are fine over a longer period, thereby undercutting the price that has been fixed for the joint agreement on power-to-gas.

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[4] The relative positions of the power technologies in Figure 1 derive from Table 2 in the appendix.

In the next section we will discuss the conditions for a cooperative arrangement between REPS and COG power stations that guarantees the stable provision of electricity at minimum total costs. Stability implies that no costumer will be excluded from buying who is willing and prepared to pay the price. That is, we abstract from rationing the consumption of electricity.

5. Efficient Market Solution and Raisin-Picking Entry: A Theoretical Appraisal

In this paper we argue that the spot market of electricity arranges short-run entry in the energy market, perhaps on a daily basis, while term markets consider arrangements for longer time period. This proposes to discuss the issue of provision of electricity in terms of market entry and sustainability. For an illustration, this section presents a theoretical introduction to the related problems. We assume that markets are contestable, if policy does not introduce barriers to entry or endogenous constraints evolve. According to Baumol (1982) and Baumol et al. 1982) markets are contestable if entry into the market is free and costless and exit does not entail any costs either. Further this concept assumes that a potential entrant "can go in, and, before prices change, collect gains, and then depart without costs, should the climate grow hostile" (Baumol 1982: 4). It is immediate (for the non-monopoly case) that (a) profits are zero, (b) prices equal marginal costs, and (c) production is efficient. Properties (a) and (b) imply that equilibrium prices are equal to minimum average costs.[5] Because of free entry there are no quasi-rents as identical production techniques are available to entrants as well as to the incumbents without differences in costs.

Let us assume the costs of a joint arrangement of REPS and COG have the pattern as illustrated in Figure 2. Note that the upper part illustrates total costs. The variable x represents quantities of electricity. The lower part of the figure shows the corresponding average costs schedules. They represent supply curves under the zero-profit condition which applies if the market is contestable. On the vertical, we have values of average costs and p-values that represent alternative prices. The curves marked with D_0, D_1, and D_2 illustrate alternative levels of demand; subscripts indicate demand growth.

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[5] An equilibrium (in pure strategies) may not exists if average cost curves are U-shaped (Holler 1985b) or there are more than one equilibria, creating a substantial coordination problem, if cost curves are linear, at least over a finite range (see Holler 1985a).

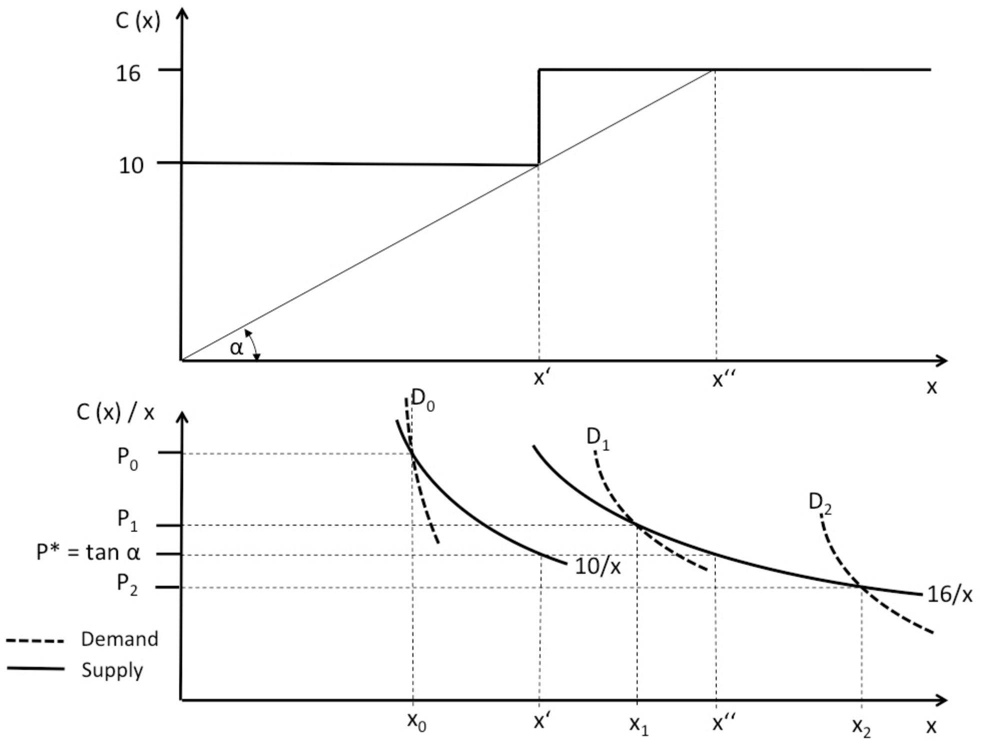

Figure 2: The natural monopoly of the gas-to-power

As costs assumed in Figure 2 are subadditive, the figure illustrates the case of a natural monopoly (Baumol 1982; Faulhaber 1975): Total costs are minimized if the output is produced in a single production unit, whatever quantity of the output. If there are two production units with identical technologies, then total costs will be at least 20 because each unit has fixed costs of 10. An integrated (cooperative) system as shown in Figure 2 has a maximum of total costs of 16.[6]

The total cost curve implies that both entities have zero marginal costs, but (substantial) fixed costs. The assumption of zero marginal costs is a proxy for the cost structure of the REPS. In the case of a COG marginal costs might not be nonnegligible, however, assuming zero marginal costs augments the arguments which we analyze below: It is not the formulized cost structure that drives the result, but the sequence of decisions and the inertia of the outcomes, stability and instability, certainty and risk, etc. As part of these qualifications we assume that the fixed costs of the REPS are sunk, where as COG power stations have quasi-fixed costs – at least to a substantial share –, because, as already said, a COG can use its

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[6] The average cost curves in Figure 1 are parts of rectangular hyperbolas. In the interval [0, x'] and (x', x''') the average cost functions are 10/x and 16/x, respectively. The quantity x''', not in the diagram, is the upper limit of a production that concurs with total costs 16.

equipment, labor and human capital also for inputs such as natural gas and various sorts of coal.

To evaluate the various market outcomes, illustrated in Figure 2, we introduce the notion of a "static equilibrium" (S-equilibrium). It says that as long as demand does not change there will be the same quantity sold at the same price everyday, and there will be one price only and total demand will be satisfied.

Let us discuss the market situation, depicted in Figure 2, under the assumption of contestable markets and thereby, as a first step, abstract from conditions that are specific to the energy market of our analysis. If demand is represented by D_0, then the zero-profit price will be p_0. One supplier will serve the market, and there will be no entry of an additional supplier to the market. This of course implies that the fixed costs matter, i.e., have to be covered. Price p_0 equals the amortization rate of C/x_0. If the incumbent asks for a price larger than p_0 then a competitor will enter if the market is contestable. Note that, in principle, contestable markets imply that there are no sunk costs as market entry is assumed to be free, however, production electricity necessitates large investments – and the larger share is likely to be sunk. But we postulate that, given identical outputs x, the entrant's costs are not larger than the costs of the incumbent.

Next we assume that demand increases to the level of D_2. The zero-profit price is p_1 and the corresponding quantity is x_1. This price however invites entry. A competitor can offer quantity x' at a p slightly smaller than p_1, but larger than $p^* = \tan \alpha$, and thereby make profits. (p^* is the zero-profit price for quantities x' and x".) This way however the demand x_1- x' will not be satisfied. Either we experience rationing, and queues lining up with the fairy, leaving some villagers without buns. Or, the baker will deliver bread, but has to ask for a much higher price than p^*, even under the zero-profit condition. How demand will be allocated to the two prices and what willingness-to-pay is relevant for the baker, cannot be derived from the model. In any case, we can conclude that the conditions of an S-equilibrium will not be satisfied. If both the incumbent and the entrant, i.e., the baker and the fairy, produce buns, then production will be inefficient (given that the fairy has production costs too) as the cost advantages of the natural monopoly will not be realized. Raisin picking is profitable;[7] the natural monopoly, drafted in Figure 2, is not sustainable under contestability assumptions; the price p_1 is not in the core.[8]

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[7] Some authors speak of „cherry picking;" the implications and consequences are the same.

[8] See Faulhaber (1975) for a game theoretical analysis of the natural monopoly, sustainability, and cross-subsidization.

If D_3 represents demand, then entry does not pay if, different from a fairy, the entrant has to cover his or her costs – unless the entrant has access to a more efficient technology (which is however excluded by the theory of contestable markets).

Now let us redefine the x-dimension expressing quantities. The interval [0, x'] captures situations such that the REPS fully satisfy the demand of their costumers everyday: "good wind" and/or "good sunshine." This is the fairy delivering enough buns 30 (or 31) days a month satisfying each consumer. Then there is the interval (x', x"] which illustrates situations in which the supply of the REPS is not enough to satisfy the demand; there are days when there is no wind and no sunshine, and the demand can only be covered if COG power stations produce electricity. This is the fairy delivering 15 buns per month on a random schedule. Total demand can only be satisfied if the baker steps in. But he will not step in, if his (expected) sales do not cover his cost. Here we have a sustainability problem, unless the fairy and the baker find a cooperative arrangement, or the fairy is barred from free entry and costless exit.[9] However, if the fairy and the baker agree to charge p_1 (say 80 Cents) for the daily bun, irrespective of whether the bun is delivered by the fairy or the baker, then there is still the possibility that a raisin-picking fairy enters the market and offers x' at a price somewhat lower than p_1, but above the zero-profit price p*. In this case, however, the market outcome will not be efficient. Either some demand remains unsatisfied, or it will be satisfied at much higher average costs than C/x_1.

If the demand x is equal or larger than x", the share of the REPS will be relatively small compared to total demand. This is when the fairy delivers 5 buns per month on a random schedule. Consumers are happy to take this offer (at a price of zero) but still buy 25 buns from the baker at a price of 1 Euro per day. (We ignore the possibility that their willingness to pay might increase because they do not have to pay for their buns on 5 days of month.) In our fairytale, the baker's monthly revenues and costs will be 25 Euros and 20 Euros, respectively, per costumer – so he will be happy to deliver his buns.

6. The Closing Down of the Spot Market and Other Policy Measures

If we apply the theoretical results above to the issue of provision of electricity, then we have to consider that the costs of the REPS are by-and-large sunk. As a consequence REPS can deliver electricity at a rather low price – however, they will not enter the market if they do not expect to redeem their costs. The regulator may invite entry to REPS by issuing a guarantee

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[9] Since we are in a fairytale, we should consider that the baker and the fairy will marry and live happily after – offering daily buns at a price of 1 Euro to every inhabitant of the village *Sustain*.

of sales. In fact, this is the case with the German “law for renewable energy” (EEG). It guarantees a fixed unit price for “Green electricity” for quantities that are determined by the producers. The market outcome indicates that this price is favorable and invites entry. However, if we reconsider the theoretical analysis, such a policy may prevent, instead of initiate the efficient provision of electricity. The precarious situation of a demand D_1 illustrates possible gains from a cooperative solution that combines the advantages of REPS and COG power stations. But how to sustain such a cooperative solution if entry is profitable? We can think of self-enforcing solutions as a result of repeated interaction between REPS and COG power station, e.g., in the context of power-to gas or related technologies that needs the cooperation of both parties.[10] The public, i.e., government agencies can support such arrangements by designing adequate policies. They can offer subsidies to contracts that *guarantee* the stable provision of an equilibrium quantity of electricity at the equilibrium price. Alternatively, the government can introduce a tax t for the REPS such that their zero-profit price will be 16/x in the example given in Figure 2, or subsidies to the COG power stations such that they can provide electricity at a price 10/x whatever quantity x will be. These policies became prominent under the label “nudging,” i.e., giving incentives or disincentives to decision makers to behave in a desired way.[11]

However, the State can make use of its “coercive authority” and issue regulations that block the entry for providers who cannot give (or do not want to give) a guarantee (which necessitates cooperation between REPS and COG power stations) for fully satisfying the daily demand of electricity. This amounts to the banning of the spot market for electricity in favor of a term market. REPSs have to find COG partners if they want to enter the market. However, if an incumbent combination of REPS and COG already has the capacity to satisfy demand at zero-profits and production is efficient, there will be no entry under the conditions of contestable markets. However, potential entrants may innovate and satisfy total demand for electricity at lower costs.

In her essay “The Entrepreneurial State” Mariana Mazzucato (2014) argues that the State’s innovative activities and the support for private innovators are pivotal for the dynamics of business and economic growth. She suggests that the state massively supports green technology also because green technology forces to reorganize the private sector triggering Schumpeterian creative destruction on a larger scale. The State is large enough to take major

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[10] Theoretical results with respect to iterated games derived from Folk Theorems should be of help to describe conditions that support a cooperative outcome.

[11] For “nudge,” see Thaler and Sunstein (2008). There are many other forms of nudging involved in the “liberal paternalism” that favors green technology. Chapter 6 of Mazzucato (2014) has the title “Pushing vs. Nudging the Green Industrial Revolution.” For “liberal paternalism,” see, e.g., Thaler and Sunstein (2003).

risks – and “foolish” enough to be creative and to innovate on shaky grounds.[12] However, State activities might be captured by private business simply to shift the costs of innovations to the public, especially of course if these costs are substantial, but also if the private sector is invited to do so as in a wide range of academic research at state-funded universities. Accepting state activities seems to require an adequate structure of the private sector and, rather likely, a reshaping of markets. An increase of state activities should not be followed by an increase of corruption. A precondition of keeping corruption low of course is to inform about the degree, range and contribution of state activities, e.g., in the promotion of renewable energy, and to understand its economic preconditions and consequences.

Our analysis shows that the support of green technology has to be balanced and not be exclusively be determined by what we can do but also considering what we need and what we want. We do not need a bun every day, but a fairy that delivers buns 15 days a month at random might not make us happy even if the buns are given to us as a present, if the baker has to close down his business.

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[12] See Mazzucato (2014: 3). Of course this is also due that State agents, public administrates and policy makers are in general not held responsible for failures. This provides the necessary “foolishness” for creativity.

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Appendix

Table 2: Characterization of power generation technologies

Charakteristic	Primary energy	Sun	Wind	Gas	Coal	Uranium	Water	Waves	Tides	Geothermic
Availability of ressource	"Renewable" means, that primary energy may be seen as inexhaustible	"Renewable"	"Renewable"	Exhaustable	Exhaustable	Exhaustable	"Renewable"	"Renewable"	"Renewable"	"Renewable"
Volatility	Volatility of availability of primary energy	high	high	low	low	low	high	high	low	low
Reconversability	Facility to restore the carrier of primary energy from elecricity. It is only meaningful in connection with storability of the primary energy carrier.	yes	yes	yes	no	no	yes	yes	no	no
Storability	Suitability for storage of primary energy	no	no	yes	yes	yes	yes	no	no	no
Storage capacity	(Low) storage costs of primary energy	n.a.	n.a.	high capacity (low storage costs)	high capacity (low storage costs)	high capacity (low storage costs)	low capacity* (high storage costs)	n.a.	n.a.	n.a.
Controllability	Inertance of start and shut down of power station by assumed availability of primary energy ressource	LOW (flexible but only within volatility)	LOW (flexible but only within volatility)	HIGH (full flexibility)	LOW (inertial)	LOW (inertial)	HIGH (full flexibility within storage capacity)	LOW (flexible but only within volatility)	HIGH (flexible within regular precence)	HIGH (full flexibility)
Depending on availability	Dependency of point of time to generate power on availability of primary ressources. Synonym to "no storability", eminently relevant when volatility is high	HIGH (and high volatility)	HIGH (and high volatility)	LOW (Independent on presence)	LOW (Independent on presence)	LOW (Independent on presence)	LOW (Independent on presence within storage capacity)	HIGH (and high volatility)	HIGH (but low volatility)	HIGH (but low volatility)

* In relation to the total market. In relation to the single water power station, the storage capaity is 100% of it's power generation potential