Deutsche Bank
Research

Current Issues
Natural resources

Germany's "Energiewende" driving power-to-gas

From an idea to market launch

March 11, 2014

Author
Josef Auer
+49 69 910-31878
josef.auer@db.com

Editor
Lars Slomka

Deutsche Bank AG
Deutsche Bank Research
Frankfurt am Main
Germany
E-mail: marketing.dbr@db.com
Fax: +49 69 910-31877

www.dbresearch.com

DB Research Management
Ralf Hoffmann

The massive expansion of renewables in the last few years has led to an increase in the volatility of the power supply. As the implementation of the "Energiewende" is a crucial issue for the new federal government, it also requires innovative solutions that go beyond traditional technical storage facilities. Looking ahead, this turnaround may succeed with power-to-gas as power-to-gas as a storage medium could compensate the continuing sharply rising volatility of the power supply.

In fact, the "Energiewende" is progressing due in no small measure to political protection. Since 2011, all the major parties have pursued similar energy targets. Against this background, there is no doubt about the further expansion of renewables in the primary energy mix and, above all, in power generation.

Although the energy turnaround has been underway for several years and despite varied state intervention, a strong dependence on energy imports and lately even a record energy bill are still typical for Germany. The stronger utilisation of domestic renewables in the future will alleviate these problems.

However, due to the massive expansion of green power sources, fluctuating electricity quantities will increase in the medium and longer term. Power-to-gas offers an intelligent solution to this problem. First, Germany may give up the expansion of traditional electricity storage facilities thanks to its state-of-the-art gas infrastructure (grids, storage facilities). Second, the concept of the traditional gas business, which is currently under pressure as a result of the current German energy policy, brings new opportunities.

The reshaping of the electricity business to incorporate more green output energies pursued in Germany requires innovative solutions that go beyond outside traditional technical electrical storage devices. Chemical electricity storage media such as hydrogen and mainly methane deliver new solutions for the transformation of the electricity sector and connect something unconnected so far. Especially thanks to methanisation, green electricity has all energy utilisation potential at its disposal – including the heating market, mobility and processing in the chemical industry. Thus, chemical electricity media become trailblazers, basic and key technology of our new energy system and the "Energiewende".

The prospects for power-to-gas are favourable. Experts are calling for the installation of power-to-gas systems with an output of a total of 1,000 MW by 2022 to establish an "emerging" market. If in the time thereafter – as we expect – the demand for electricity storage media continues to rise as a result of increasing green electricity generation and fluctuations, power-to-gas is an appropriate answer to the currently still open question of a sustainable technical solution.

Energy issues still very important for Germany

Energy issues have been of major importance for Germany since the beginning of industrialisation and the onset of modern means of transport. For a long time, the triangle of objectives of energy policy was dominated by security of supply and economic efficiency. By contrast, environmental aspects have gained the importance they deserve for only roughly two decades.

Since the recalibration of government policy by the conservative-liberal coalition following the disaster at the Fukushima reactor complex in Japan in 2011, all the major political parties have pursued in principle similar energy-policy objectives, which have been given the highly symbolic moniker "Energiewende" – with its echoes of the momentous fall of the Berlin Wall. Such a consensus on energy policy had not existed in Germany for very many years.

Unanimity always harbour risks, though, as few people call it into question. No wonder that for quite some time relatively serious newspapers in articles and special reports have been devoting quite a lot of space to the "Energiewende" in Germany and its readjustment along with the formation and strengthening of the Grand Coalition und have been asking important, critical questions concerning the upcoming challenges as well as the related costs.[1] Nevertheless, a renewed, fundamental readjustment of energy policy is rather unlikely in the longer term as there is currently no large energy policy opposition to the grand coalition of CDU/CSU and SPD.

Thus, the indications of challenges regarding the energy turnaround[2] can by no means – given the timescale and the lack of a probable, fundamental readjustment following a change of political majorities – be observed in so cool and relaxed way as the "first nuclear power exit" under the Red/Greens government. And this regardless of the fact that the previous "guarantor" for a readjustment, the coalition of the conservatives and the liberals, met expectations for more than a year – i.e. during the startup phase of the previous government.

Central statements in the key point paper on the reform of the law on renewable energies (EEG) 1

Expansion of the corridor: As a result of the reform of the EEG the share of renewable energies in power supply is to rise to 40%-45% by 2025 and to 55%-60% by 2035. It is of major importance that affordability and security of supply alike are secured for households and business.

The reform of the EEG will be shaped in conformity with European law, and the EEG will be simplified considerably.

Direct marketing: In the future, new renewable energy plants will have to market their electricity directly.

Incentive: Excessive incentives will be curbed, compensations will be reduced and bonuses abolished. This will strongly increase the cost efficiency of incentives. The switch from incentives to tenders is being prepared.

Exceptions: The federal government wants to limit total or partial exemptions from the EEG levy on energy-intensive companies in international competition.

Source: Federal government, Jan 22, 2014

Still high import dependency and record energy bill

It is well known that environmental and especially climate problems have been getting more attention in Germany than in many other major countries for years. And this still applies, despite all the controversies surrounding the readjustments following the federal election in 2013, which on the basis of the EEG key point paper presented by energy minister Sigmar Gabriel are to be specified by Easter 2014 and to become law by the parliamentary summer break at the latest.

To date, even the "more traditional challenges" of German energy policy are far from being settled. In 2012, Germany had to cover as much as 68% of its energy requirements abroad. Even if nuclear energy whose basic raw material uranium is actually sourced completely from foreign countries, is rated as a domestic energy source thanks to the good inventory situation, the import ratio, at 60%, continues to be remarkably high. Furthermore, the 2012 energy import bill, at EUR 94.4 bn, marked a new peak in absolute terms (2011: EUR 88 bn),

[1] For a proof with regard to the time before the federal election 2013 see for example Irrsinn Energiewende. Handelsblatt. August 16, 2013 pp. 42-51.

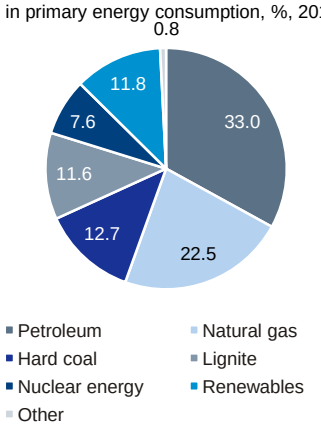
[2] For a general analysis see Auer, Josef/Alexander Karnick/Lars Slomka (2013). Energiewende 2.0 - don't risk competitiveness. Deutsche Bank Research. Standpunkt Deutschland. Frankfurt am Main.

Germany's "Energiewende" driving power-to-gas

80% of energy consumption in DE still fossil-based

2

Share in primary energy consumption, %, 2013

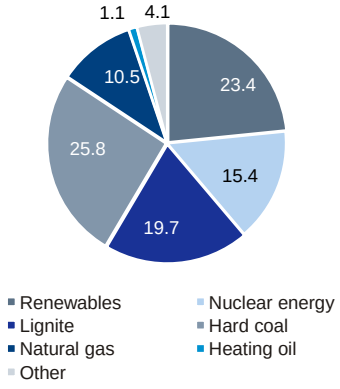


Source: AG Energiebilanzen

23% of power generation in DE from renewables

3

Shares in gross power generation, %, 2013

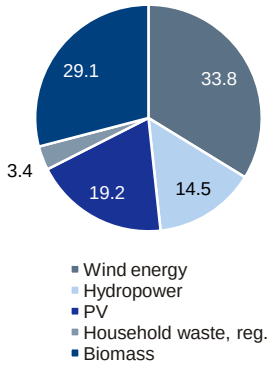


Source: AG Energiebilanzen

Wind energy and PV contribute more than 50% in DE to green power generation

4

Share of power produced from renewables, %, 2013



Source: AG Energiebilanzen

which, according to initial estimates, was more or less matched in 2013[3]. In 2012, the lion's share, at a total of EUR 95.8 bn – in line with the previous years – was made up by the fossil fuels crude oil (including oil products), natural gas and hard coal. On the other hand, the 2012 net value of electricity exports amounted to EUR 1.4 bn.[4] The absolute increase in the energy bill by EUR 6.4 bn versus 2011 masks the fact that the price and volume components of the various fossil energies by no means moved in the same direction; price and volume components for imported crude oil pushed up the oil import bill. By contrast, the import bill for hard coal declined as the slight increase in hard coal imports in volume terms was more than compensated by the price decline for third-country-coal (i.e. non-EU hard coal).

Last but not least, it is of economic importance that in 2012, Germany – despite several years of effort to implement the "Energiewende", which in the years before did not bear this name, though – paid an energy bill roughly twice as high as the annual average between 2000 and 2010. In the last decade, the energy bill in relation to GDP was always below 3% whereas a remarkable level of 3.6% was reached in 2012.[5] However, especially the historic price increase of crude oil, as well as related further effects – as the long years of typical pricing for import gas in Germany – played important roles. Nevertheless, the development of the energy bill – which despite all energy policy efforts and despite the fact that the primary energy consumption is currently one-tenth lower than the level in the year after German reunification in 1990 – makes it clear that German energy policy and its current concept, the "Energiewende", is still far from achieving even traditional energy targets.

"Energiewende" drives P2G idea

The "Energiewende" is an important driver of the idea and the concept of power-to-gas (also called "P2G" or "PtG"), for P2G enables the storage of the increasing amount of surplus power resulting from the "Energiewende" and its activation as required. The by now clear commitment of all the big parties to the new German energy policy as well as the further expansion of renewables in the domestic primary and secondary energy mix lead to many new challenges. Especially due to the rapid expansion of renewables as well as its intended continuation in the coming decades new energy territory is being charted in some places. The range of problems consists of diverse energy topics, such as the restructuring of power plants, the readjustment and expansion of infrastructure networks as well as storage issues.[6]

The progress in the various subject areas is neither equally distributed nor is it occurring at the same time:

— On balance, the expansion of green power plants in the last few years has proceeded so quickly that the ambitious energy target of a green electricity share of 35% by 2020 could even be exceeded. The expansion corridor[7] laid down in the coalition agreement for the share of renewables of 40% to 50% in 2025 as well as 55% to 60% in 2035 at best slows down the dynamics but by no means reverses the expansion trend.

[3] True, slightly higher energy consumption is expected for 2013; however, imports of oil and coal – at lower world market prices – will probably be lower. See AG energy balance sheets (2013). Energieverbrauch steigt moderat. Press service. No 8. pp. 1-5.

[4] See Schiffer, Hans-Wilhelm (2013). Deutscher Energiemarkt 2012. Energiewirtschaftliche Tagesfragen. 63. Jahrgang. Vol. 3. pp. 83/84.

[5] See Häuser, Wolfgang (2013). Deutsche Energierechnung 2012. WiSt. Vol. 7 pp. 408-411.

[6] For a general analysis see Auer, Josef/Jan Keil (2012). State-of-the-art electricity storage systems. Indispensable elements of the energy revolution. Deutsche Bank Research. Current Issues. Frankfurt am Main.

[7] See Deutschlands Zukunft gestalten (2013). Koalitionsvertrag zwischen CDU, CSU und SPD. 18. Legislaturperiode. p. 51.

Areas of activity in power-to-gas roadmap until 2020/25 — 5

	Area of activity	Time horizon
1	Energy policy fundamentals for the utilisation of non-integrable power generation from renewables	2012-2014
2	Complementary P2G technology research	2012-2015
3	Applied research: Technology testing and further development of P2G	2012-2020
4	Creation of the required systems capabilities for large-scale P2G utilisation	2012-2020
5	Creation of foundations and environment for (long term) energy storage in (European) power market	2012-2020
6	Creation of propensity to invest in large-scale P2G utilisation	2020/ ongoing

Source: dena (2012). Key points of a Power-to-Gas Roadmap. Berlin. For details see especially pp. 3-13

— And in reaction to the uneven regional distribution of the generation of green electricity, which, in addition, occurs with much more volatility than before, and its consumption policymakers meanwhile set the course for the expansion of new, high-performance power networks. This materialises – for instance via a shift in competencies – especially for the long-distance transport of offshore power from the North to the consumption centre of the South. The fact that in some places the "sea socket" – i.e. the grid connection for the electricity transport on land – is nonexistent or not provided in time is no trifling matter.

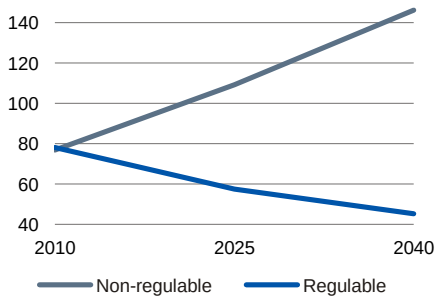
— The solution of power storage as an alternative or supplement to grids has also been attracting more attention of late. True, it is gratifying to note that for the flexible short-term storage of smaller volumes of electricity and their needs-based retrieval in a regional context plenty of experience has already been gained and thus proven, mature solutions exist. The range contains varied technologies such as battery systems and pumped storage plants. Nevertheless, there is as yet still no "solution" to the still massively rising but fluctuating power volumes also in the medium and longer term that are the product of the "Energiewende".

— In global models of perfect electricity worlds a permanent market compensation in terms of space and time between power input and power requirements may under various conditions be successful across many national borders. The real energy world in Europe and its geographical centre, Germany, marked by complex industrial structures and ways of life requires compensation options, however, which make possible lasting and sustainable Power Safety also beyond ideal model assumptions. True, PSP may also overcome the problem of the decoupling of electricity input and electricity demand in principle. But for the as a result of the "Energiewende" still strongly growing, high volumes, a continued PSW extension is hardly sufficient even under ideal conditions. To overcome the prospective storage gap due to the energy turnaround, strong efforts were made to find a technically high-performance solution which makes possible a storage management of even large volumes over long periods of time.

P2G connects power/grid and gas/grid as well as energy infrastructure

Power generation increasingly difficult to manage — 6

Development of net power plant capacities, 2010, 2025 and 2040 in GW



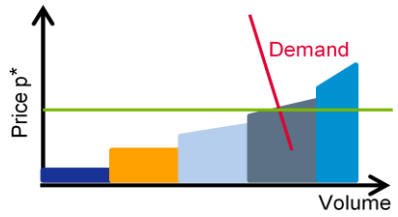
Source: Deutsche Bank Research

Only for a couple of years has the topic P2G been getting increasing attention. It is a good sign that the coalition agreement as well as a result of the expansion of renewables sees the need for long-term storage methods, "which can smooth out seasonal fluctuations, such as power-to-gas"[8].

The main reason is that even at first sight P2G provides a very simple solution to a near-term mega problem. Furthermore, it seems to make it possible to kill two birds with one stone: first, the installation of further large traditional electricity storage facilities is less urgent as Germany already has a state-of-the-art gas infrastructure with large gas grid and gas storage capacities. This reduces local sensitivities and thus also opposition. Second, the concept also offers new opportunities for the established, traditional gas business. This should by no means be underestimated for two reasons: in the current environment of the "Energiewende", even state-of-the-art and relatively energy-efficient gas stations in Germany due to their position in the right section of the

[8] See Deutschlands Zukunft gestalten (2013). p. 57. The coalition is betting on demonstration projects, which are to gradually develop the technology, optimise it and make it ready for the market.

Electricity market last decade 7

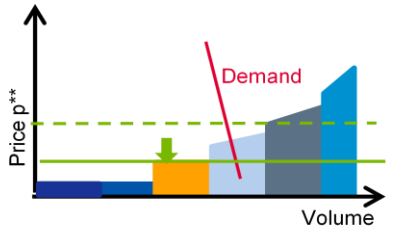


Renewables (currently), nuclear energy, lignite, hard coal, gas

p* = Current wholesale price

Source: Deutsche Bank Research

Electricity market in the future
Merit-order effect as a result of expansion of renewables 8



Renewables (currently), expansion of renewables, nuclear energy, lignite, hard coal, gas

p** = Current wholesale price tomorrow

Source: Deutsche Bank Research

merit-order-curve[9] (see illustrations) are "under pressure", which reduces the gas sale prospects in power generation. Furthermore, the demand on the heating market is worrying, both currently and with a view to the future. Given the current trends in housing completions as well as the politically promoted renovation of heating systems in the existing housing stock, the prospects for natural gas are by no means as favourable as after the first oil crisis, when natural gas started its unprecedented success story as a heating alternative (vis-à-vis oil and in part coal) for private households.

More advanced solutions than technical electricity storage systems required

The refocusing of the electricity business towards green output energies that is being pursued in Germany calls for innovations which are more advanced than traditional technical storage solutions, i.e. from the current pumped storage power stations to the future compressed air storage units. Even for experts, there is currently no purely electrical solution for the very high storage requirements on the horizon.[10] By contrast, chemical storage systems are seen as more promising to store the surplus of electricity generated from renewables also over a longer period of time (months). A chemical storage system is ideal, though, if it can be charged to a high capacity relatively quickly and can be discharged at a much lower rate over a longer period of time. Thus, these storage units would be a good alternative or supplement to the traditional electrical and mechanical storage systems[11].

Chemical storage systems open new markets for surplus electricity

The starting point of the new production chain is the increasing electricity generation due to the expansion of green electricity sources, especially wind and solar energy. In the event of manageable volumes of green electricity – currently standard – the feed-in is not a technical problem as the green electricity volumes are also finding buyers on the market. In the event of surplus volumes of green electricity – that will increase from year to year in the future – serious problems will occur more and more often. The target coordinates of German energy policy with the clear commitment to expanding renewables no doubt point to a dilemma that will grow in the future. True, green electricity exports to foreign countries are an alternative. However, the rising electricity export volumes are becoming an ever greater challenge also for the neighbouring countries.

For this reason, it makes sense to search for and develop a solution of one's own. The chemical approach to solve the problem delivers such a solution in two ways: first, by using electrolysis, the surplus electricity can be utilised to decompose water into oxygen (O_2) und hydrogen (H_2). The generated hydrogen can in principle be stored for an unlimited period. What is more, a reconversion into electricity via gas turbines, car engines or fuel cells is possible. As hydrogen can (on a small scale) be added to natural gas, it also becomes "mobile", so to speak. Versus "option 2", methanisation (see below), the hydrogen option seems to be preferable for several reasons: for instance, the efficiency remains

[9] The merit order curve illustrates the order of the operation of power plants according to their short-term marginal costs. Renewables have a price-dampening effect as they incur hardly any variable costs and thus with rising supply will take the place of traditional power plants with higher variable costs according to the merit order curve. This leads to lower electricity prices on a wholesale basis. For an overview of the attempts at quantification of the merit order effect in Germany see the BMWi (2012). Erster Monitoring-Bericht. Infrastruktur der Zukunft. Berlin. p. 40.

[10] See, for example, Bußmann, Werner (2013). Die Stromversorgung aus regenerativen Quellen und ihre Zwänge. BWK. Das Energie-Fachmagazin. Vol. 65, No 7/8. pp. 9-11.

[11] For a more detailed discussion of mechanic storage systems see Auer, Josef/Jan Keil (2012). pp. 7-10.

relatively high due to a lack of additional hydrogen conversion (into methane) and since a methanisation plant is unnecessary investment and production costs are saved. However, all this cannot conceal the challenge that "technical limits" strongly curb potential volumes, for hydrogen – compared to "option 2" (see below) – can only be added on a smaller scale. For it is also a fact that the gas mixture finally ends up or is combusted in various grid and consumption plants as well as storage systems, which, in turn, by no means can bear all levels of blending. And – last but not least – "society's acceptance" of the direct use of hydrogen (because it is quite flammable) via the natural gas grid does not seem by any means complete yet.

Production and utilisation paths of P2G 9

Production paths

— Hydrogen production

— Methanisation

Utilisation paths

— Mobility

— Industry

— Heat supply

— Reconversion into electricity

Source: dena

Against this background, the second option becomes interesting. In an additional step in the process chain, hydrogen (as described, "green generated") is transformed into synthetic methane; this, in turn, corresponds to chemically normal natural gas. Thanks to methanisation and the resultant greater security, the natural gas grid can be loaded and thus be used with much higher volumes than via the traditional hydrogen channel. Via the methane chain, the sustainably generated electricity – for which the time of day is not a restricting factor – has in principle all energy utilisation channels, i.e. from electricity generation via the domestic heating market and heating market towards mobility and reprocessing in chemical industry.

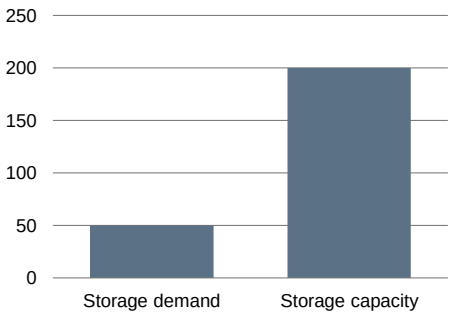
Chemical storage systems offer new solutions and connect the previously unconnected

Evidently, chemical energy storage systems have the potential to become a sustainable and realistic solution to one of the main challenges of the energy turnaround. This is the establishment of a medium that enables an offsetting of the future increase in the time gap between power and energy production on the one hand and its consumption on the other. Against this background, chemical storage systems could prove to be trailblazers, and basis and key technologies of the transformation of our energy system and the "Energiewende".

Furthermore, the P2G approach connects energy worlds, which seemed relatively unconnected to date and thus lead (led) some kind of separate life, which not least is shown by the very large number of market analyses on the subject. P2G namely connects power generation and electricity grid with gas provision and gas grid infrastructure. The closer interlinking and "wiring" of primary and secondary energies, as well as otherwise separate grid infrastructures open new opportunities, enable more flexibility and thus fundamentally modernises and revolutionises our energy world.

Electricity storage capacity of gas distribution grid 2050 exceeds demand 10

Electricity storage demand and capacity of the gas distribution grid, 2050, TWh



Thüga forecast, presented at dena annual conference 2013

Sources: BDEW, Thüga

Growing P2G market maturity requires reliable legal environment

The large number of research and application trials relating to P2G are bringing the technologies closer to market readiness. As the new technologies outgrow laboratory conditions, however, and first P2G pilot plants produce so much hydrogen or synthetic methane that a feed-in to the established natural gas grid is the next logical step, new questions and challenges emerge.

Policymakers are in principle on the right track to accelerate and simplify market penetration. As not least legal uncertainties may stand in the way of potential investment activity, policymakers are trying to establish clear(er) regulations. Under the condition that hydrogen and the synthetic methane were produced by way of water electrolysis and methanisation from electricity and carbon oxides from renewable energies, both materials are taken up into the definition of biogas (according to Paragraph 3 No 10c) of the Energy Sector Act (EnWG). As a consequence, they are granted the privileges of Section 6 of the Gas Grid

Partners of P2G strategy platform under the umbrella of dena 11

1	Bayerngas GmbH
2	Biogasrat+ e.V.
3	Robert Bosch GmbH
4	BTU Brandenburgische Technische Universität Cottbus
5	DBI-Gastechnologisches Institut gGmbH
6	DVGW Deutscher Verein des Gas- und Wasserfaches e. V.
7	EnBW Energie Baden-Württemberg AG
8	ENERTAG AG
9	E.ON
10	ETOGAS GmbH
11	Evonik Industries AG
12	EWE AG
13	Fraunhofer-Institut für Windenenergie und Energiesystemtechnik IWES
14	Gasunie Deutschland
15	GDF SUEZ Energie Deutschland
16	GP JOULE
17	Hydrogenics
18	Institut für Elektrische Anlagen und Energiewirtschaft IAEW
19	ITM Power
20	IVG Caverns GmbH
21	Open Grid Europe
22	Performing Energy
23	RWE Deutschland AG
24	Thüga AG
25	Trianel GmbH
26	Untergrundspeicher- und Geotechnologie-Systeme GmbH
27	Verband kommunaler Unternehmen VKU
28	VNG Gasspeicher GmbH
29	Viessmann Werke GmbH & Co. KG
30	Volkswagen AG
31	WINGAS GmbH
32	Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg ZSW

Source: dena

Access Directive (Netzzugangsverordnung (GasNZV) including various regulations of the Gas Grid Access Directive (GasNEV). Renewable hydrogen and synthetic methane can thus benefit from privileged gas grid access; if the rules of biogas balancing are implemented, no feed-in fees have to be paid; there is a flat fee for avoided grid cost. As, however, there are perceptible differences in the P2G plant engineering compared to traditional biogas production and processing as well as the gas properties, the Federal Network Agency has been addressing the fundamental questions since 2013 and has been searching for the right answers – in a dialogue with those concerned.[12]

Clarify the economic acceptance and challenge of hydrogen

In the context of feeding-in – besides general questions surrounding the availability of the connection and minimum feed-in capacity – the clarification of the economic acceptance is a core issue for the grid operators. Here, the Federal Network Agency holds the view that the grid operator can indeed refuse a grid connection, if it is economically unviable or technically impossible. However, according to the Federal Network Agency, economic unviablility cannot simply and solely be derived from the intermittent feeding-in of P2G as especially the P2G feeding-in is based on fluctuating electricity sources such as wind or solar energy.

However, in the feed-in context, hydrogen is also of major importance, as its composition and flammability properties differ from basic gas, i.e. it cannot only be treated as additive gas (with the same properties). Against this backdrop, the degree of admixture of hydrogen has to be clearly specified[13], which, in turn, has to take a large number of aspects into account. This leads to admixture restrictions due to the requirements of general gas supply and thus the interoperability of various gas grids, gas storage systems and forms of gas utilisation (currently above all heat and power). All in all, the new gas mixture also has to meet the higher quality requirements of, for example, CHP engines, pore storage facilities and gas turbines. What is more, the H_2-blend has to take into account the demands of the existing (roughly 900) natural gas stations and natural gas vehicles (ca. 96,000) on gas quality[14]; this all the more true as natural gas could become even more important for individual mobility.[15]

Interesting prospects for P2G

To promote the new P2G technologies the "Strategieplattform Power-to-Gas" (P2G Strategy Platform) has been formed in Germany by Deutsche Energieagentur (dena) and nearly 30 partners from the worlds of business, research and industry associations. It is their task to support the further development of the P2G system solution. In principle, P2G is currently technologically already fully operational, with procedures and components currently being refined and optimised to ease the market launch. To enable economical P2G plant operation during the demonstration and market launch period, policymakers should promote this with the help of market

[12] In mid-December 2013 the Federal Network Agency published a P2G position paper, for which comments were welcomed until the end of January 2014. See German Federal Network Agency (2013). Position paper on the application of regulations of the feed-in of biogas on the feed-in of hydrogen and synthetic methane in gas supply networks. Bonn.

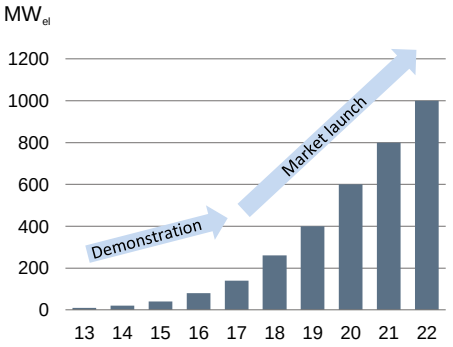
[13] Currently, the hydrogen share in the total volume of gas within a gas grid must in many areas not exceed 2% due to technical conditions. See Federal Network Agency (2013). Press release position paper power-to-gas. December 10.

[14] For details see also Hoppe, Manfred (2012). Aspects of hydrogen addition to natural gas for CNG vehicles. DBI expert forum hybrid storage systems – hybrid grids. Berlin. December 11-12.

[15] For a detailed research analysis of the complex admixture issues and a general discussion see Deutscher Verein des Gas- und Wasserfaches (DVGW, 2013). Development of modular concepts for the production, storage and feed-in of hydrogen and methane into the natural gas grid. Final report. Bonn. Especially pp. 24-198.

Germany's "Energiewende" driving power-to-gas

Intended installation of P2G systems in DE until 2022 — 12



Source: dena

Setting up P2G projects in DE starts — 13

- Roughly 10 plants in planning stage
- 3 plants under construction
- 9 plants in operation
- Plant capacities of below 100 kW to 6 MW
- Research and demonstration projects
- Challenge: Transition into an industrially available and economically exploitable technology
- Target learning and economies of scale effects by market launch and mass production technology

Source: dena, June 2013

launch instruments limited in time and quantity. The platform experts favour the installation of P2G systems with an electrical capacity of a total of 1,000 MW for the purpose of a commercial market launch by 2022 to establish a "relevant market". In the longer term, P2G market integration should proceed in line with actual demand, though.

The development path aimed for by the strategy platform seems to make sense, for by the middle of the 2020s mechanical storage systems can accomplish the required market balancing. For both the strong and weak wind periods on a weekly basis, which will intensify until 2040, and seasonal fluctuations, P2G power storage systems to be developed by then would be a much more sustainable solution to the problem.[16]

Conclusion: P2G development starts at the right time

The "Energiewende" is transforming the domestic energy world and is creating new challenges. The politically desired expansion of renewables and especially their greater utilisation for power generation causes storage problems which did not previously exist. In the coming decade, mechanical storage systems and electricity trading will still be able to balance the market. After that, new solutions such as P2G are a sine qua non. If the research and development path just embarked upon finds the required support of policymakers, research institutes and business enterprises, the intended P2G market launch will succeed by the mid-2020's. If the "Energiewende" proceeds according to plan – not least thanks to the P2G innovations – the massive expansion of renewables and their key role in electricity give no reason to fear what lies ahead. True, the volume of wind and solar power fluctuations is growing. But P2G is a high-performance technology that surpasses traditional solutions and stands ready.

Josef Auer (+49 69 910-31878, josef.auer@db.com)

[16] For details see Auer, Josef and Jan Keil (2012). pp. 10-11.

Printed by: HST Offsetdruck Schadt & Tetzlaff GbR, Dieburg

Print: ISSN 1612-314X / Internet/E-mail: ISSN 1612-3158