From stability to change; The new strategy for a Dutch gas distribution grid operator to adapt to the changes in heating demand

Elbert Huijzer[1]

June 10, 2016[2]

Changes, changes, changes…

The environment of the Dutch gas grid operator has changed from a stable environment ('NUTS') to an environment in turmoil. Changes in the acceptance of natural gas, changes in heating demand, changes in mobility and changes in regulations are moving fast and will move even faster.

The view on natural gas in the Netherlands has changed dramatically in the last years. First of all there is the need to decrease the emission of greenhouse gases (GHG) because of the effect on the climate. Furthermore, the natural gas reserves of the Netherlands itself are nearing an end within a foreseeable timespan. And on top of that, the earthquake problems in Groningen and the public distrust of fracking technologies have put the once popular and money-bringing energy source definitively in the list of 'wrong choices', together with oil, coal and, for many people, nuclear power.

In the Netherlands, heating by using natural gas is the standard for 95% of the households. This number is only slowly decreasing, because it is expensive to change the heating system of an existing building (around € 60.000[3]). Building regulations will lead to new-build houses with near-zero energy demand (so-called BENG: "Bijna Energie Neutrale Gebouwen") [4] thereby making other choices than gas heating viable.
In 2050, the CO_2 emission in the built environment has to be reduced by 80%-95 %. This can only be reached by a drastical reduction of the use of natural gas for heating.

The influence and goals of the European Union

Many national climate plans stop at the border, as if climate and energy do not have interaction with the neighboring countries. The technical and commercial truth is that energy is being transported and traded all over Europe. Measures in one country have therefore a direct effect on other countries. The European Union has recognized this and has established the Energy Union[5]. The goal of the Energy Union is to ensure that Europe has secure, affordable and climate-friendly energy. The strategy is therefore made up of 5 dimensions:

1. Supply of security
2. A fully integrated internal energy market
3. Energy efficiency
4. Climate action and emission reduction
5. Research and innovation

As with most European institutes, the influence of the Energy Union on the national policy is expected to increase. The goals and measures of the Energy Union are not necessarily in line with the Dutch political goals and measures. To be noted with respect to the Netherlands is that although the TTF hub is the most volatile gas hub in Europe, retail prices for gas are above the European average. Actual energy costs for citizens are twice the average of Europe. But the prices for gas and electricity for the industry are lower than the European average. This is

---

[1] Elbert Huijzer, Liander, +31-652400140, e.huijzer@alliander.com. The essay is written as personal opinion
[2] Essay for the course: 'Energy Transition & Innovation', 12-15 April/16-18 June 2016 by the Energy Delta Institute and Nyenrode University
[3] "Stroomversnelling Nederland; 4,5 miljoen woningen naar Nul op de Meter"; Stroomversnelling 2015
[4] Dutch implementation of the European Energy Performance of Buildings Directive; www.rvo.nl
[5] All data about the Energy Union are taken from http://ec.europa.eu/priorities/energy-union/index_en.htm.

especially true for gas. Therefore, the fiscal policy of the Dutch government is very important for the choices that are going to be made by end-users. Higher prices for the industry may lead to a decrease in activities, which may harm the economy. And when consumers have the opportunity to choose between various energy carriers, the price will be one of the main motives.
The current sentiment in fiscalism is a shift from electricity to gas[6]. In 2014 the taxes per quantity of energy where on electricity about 6 times higher than for gas. A shift to equalize this, will strengthen the position of electricity against gas in the heating market.

Of course, the COP21 in Paris has given a huge boost to the awareness of the global impact of carbon emissions and the need for all countries to take their responsibility in decreasing these emissions. For the coming years, the commitment to the 'moral obligations' of the Paris outcome are to be taken as granted.

Scenarios to accept and deal with uncertainty

From a stable framework with 40+ years of stable regulated revenues the gas grid operators are now in an almost existential uncertainty about the investments and outlook for gas. Where existing players often see a remaining role for the gas industry (see IEA[7] or Shell[8] scenario's), there are also scenario's where around 2050 all gas grids will be stranded assets (see WWF[9]).
With the uncertainty about the outcome, it is no surprise that the variation in possible transition paths towards a world where sustainable energy and low CO2 emission are the norm is even more divers.

What are scenarios

Scenarios are a way of dealing with an uncertain future. The word scenario can have different meanings. In this essay a scenario is a consistent and plausible description of a possible future. Scenarios interpret a range of possible developments, and are not meant to choose the 'best' or 'most likely' scenario. Scenarios are based upon key forces. Key forces are the elements that have a large impact and a large uncertainty and therefore cause the essential differences between the scenarios.

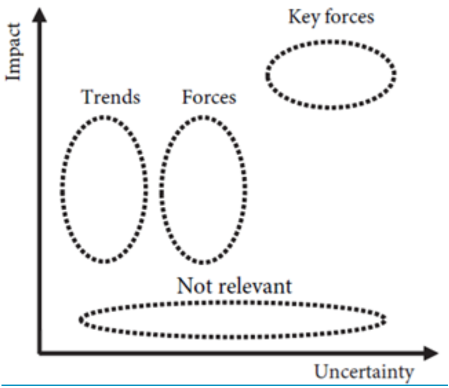

Figure 1: Impact and uncertainty make the difference between different scenarios

In an in-company process[10], scenario's for the changes in dealing with energy have been discussed. This resulted in three sets of fundamental factors; the choice of citizens, the economic factors that influence energy choices and the influence of political choices[11] . For each fundamental factor, two key-forces have been identified that are

[6] Nieuwe spelregels voor een duurzaam en stabiel energiesysteem; Overlegtafel energievoorziening; September 2015
[7] World Energy Outlook 2015; International Energy Agency; 10 November 2015
[8] Shell New Lens scenario's, 2013, and the supplement "A better life with a healthy planet", 2016
[9] "EU building blocks for a successful energy transition"; April 2016; World Wild Fund for Nature
[10] This chapter on scenarios is a summary of the results achieved within the company. Because this has been in-company, strategic work, there is no public reference available.
[11] These three sets cover the Political, Economic and Social aspects of the PEST analysis. The Technical aspect is expected to be a scenario independent enabler. All scenarios are possible with current (nearly) available techniques.

independent from each other. Moreover, they have been chosen in such a way, that by superposing the three sets of factors, the effects strengthen each other and form a logic storyline.

Citizens' key forces

The first key force that is identified for citizens is the choice between an active role in dealing with the climate issue or to leave it to the government. The effect will either be a future with small local sustainable solutions with a lot of variety or a more centralized approach like off-shore wind or CCS.
The second key force for the behavior of citizens is the acceptance of local emissions against a choice for clean air (in the city). When clean air is leading, electrification will be the main consequence, although using biogas for mobility may play a role for heavy traffic. When local emissions are accepted, renewable gases could play a larger role, also in the heating market.

These two key forces lead to the following scenario-cross:

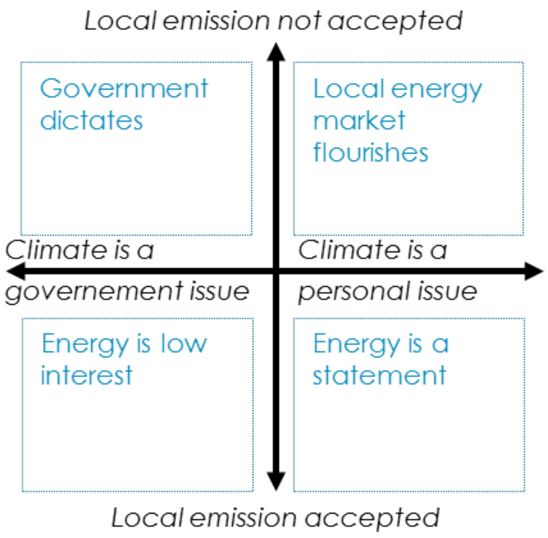

Figure 2: Different scenarios based upon the behavior of citizens

Economic key forces

With respect to the economic factors that influence energy choices, the first key force is the stagnation or growth of the (national) economy. In a stagnating economy, investing in new energy production is difficult. The focus will be on using less energy within the existing energy system. When the economy flourishes, there is money to invest in renewable energy and building new infrastructure.
The second economic key force is the relation between the price of energy one can buy from the suppliers and the price of self-produced energy. If buying electricity, gas or heat from the grids is cheap, there is no need to invest in local renewable production. On the other side, if buying energy becomes expensive, local production will grow.

These two key forces lead to the following economic scenario-cross:

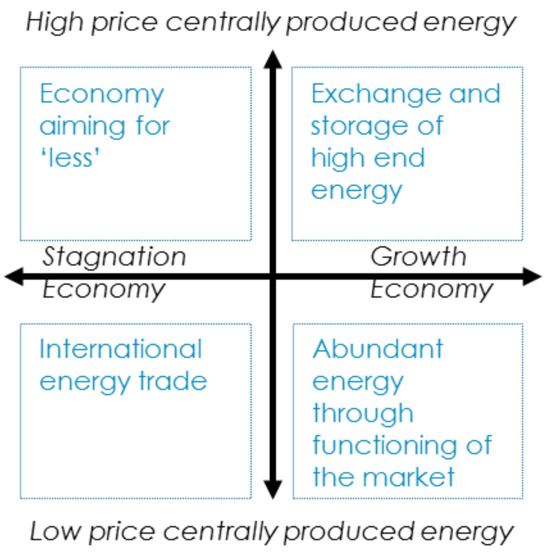

Figure 3: Different scenarios based upon economic developments

Political key forces

The third set of factors is related to politics. The two key forces identified here are the regulatory rules and national emission restrictions.

Regulatory rules for the grid operators are now based upon cost efficiency. This is based upon a stable system where citizens have few choices. Strict cost-efficient rules do not allow changes and variety in the system. Therefore, to encourage energy transition, politics might opt for deregulation, whereby competition between various options of energy production and distribution can develop.

National GHG emission restrictions can be very strict or give room for less decreasing emissions. This is not the same axis as the acceptance of local emissions by the citizens, although it is logic that they tend to point in the same direction. As an example, electrical cars powered by non-CCS coal power plants do help against local emissions, but do not really help to decrease the national GHG emissions. European policy and international agreements like the Emission Trading System (ETS) will play a big role on this axis.

These two key forces lead to the following scenario-cross:

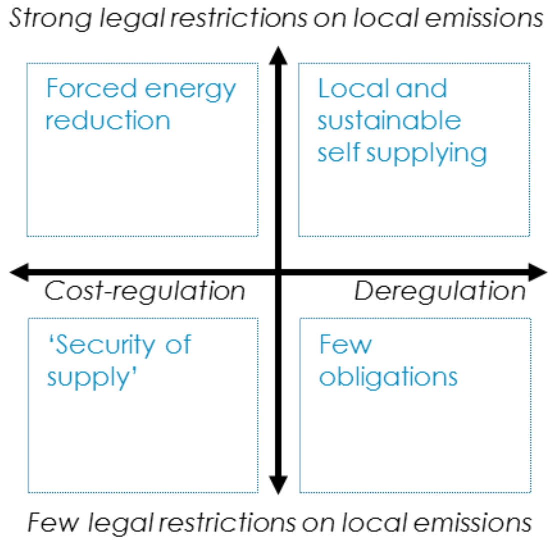

Figure 4: Different scenarios based upon political choices

Key forces coming together

When all these key forces are brought together in a plausible set of scenarios, the following four possible futures are resulting:

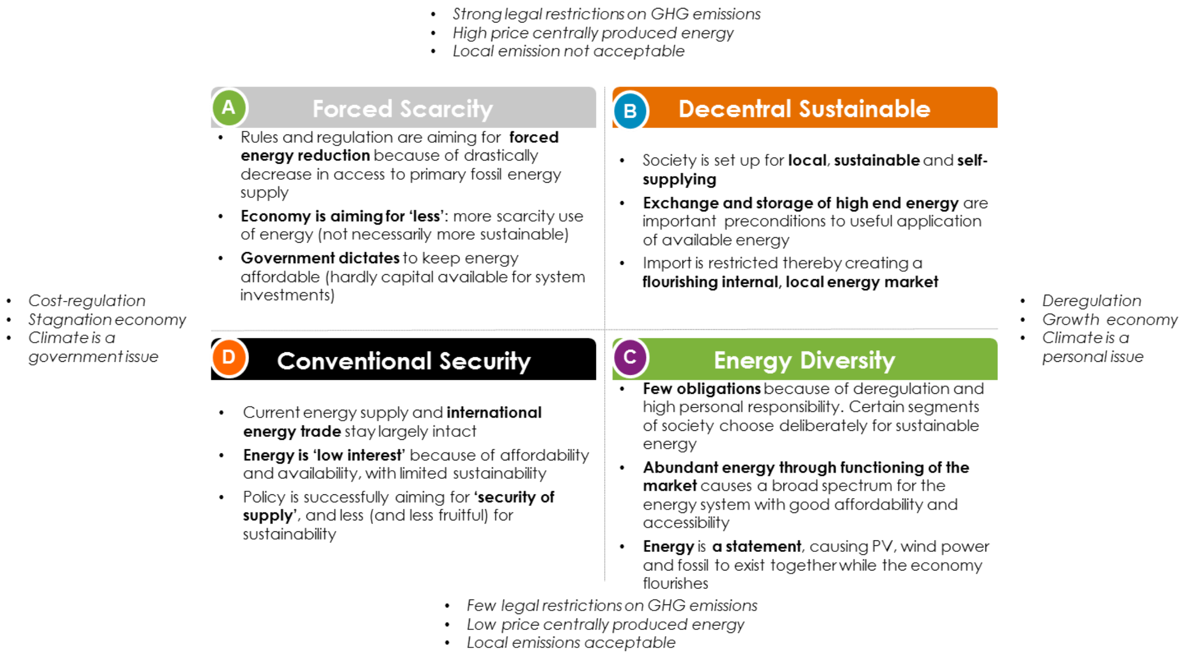

Figure 5: General scenarios when all key-factors are combined

When these scenarios are applied specific to gas, the following observations can be done when looking roughly 15 years forward (2030):

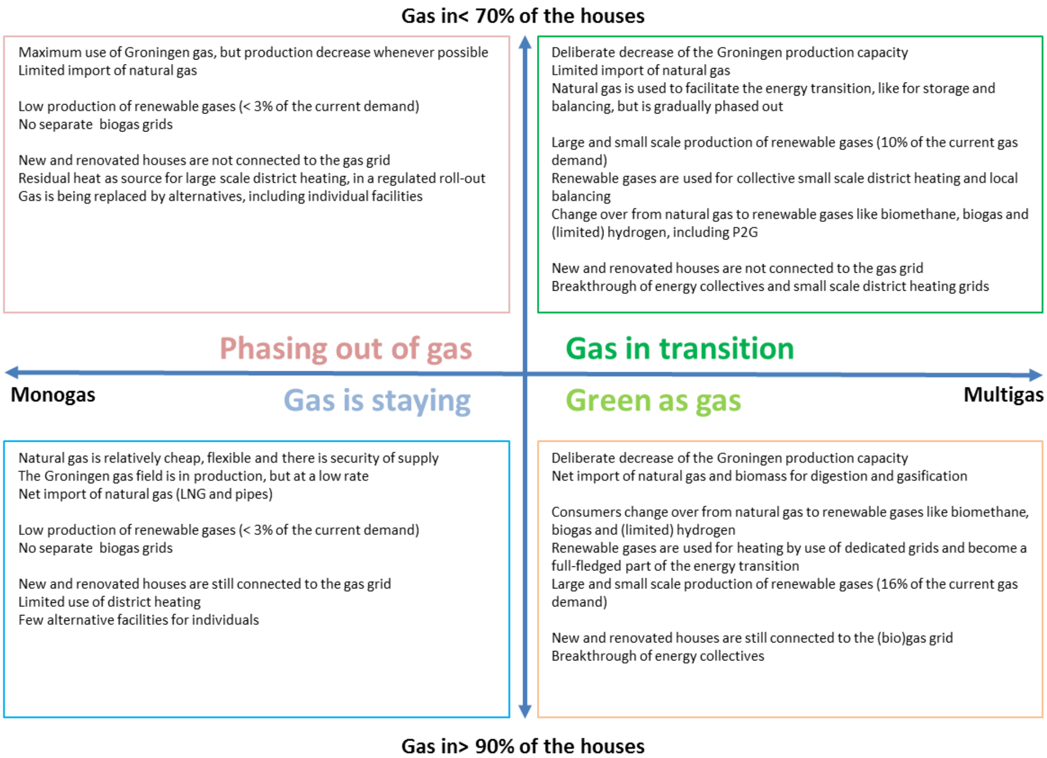

Figure 6: General scenarios applied to gas

The “Gas is staying” scenario in the bottom left corner, is a scenario where changes go slower than necessary to reach the 2050 goals as agreed in Paris and written down in national ambitions. But when the current regulation stays as it is, people do not make individual sustainable choices in large numbers but keep looking at the government, when oil and gas prices stay low and there is no financing of comprehensive building renovation programs, this scenario might be true in 2030.

If the government does take action and puts its financial means into large scale renewable energy like wind farms, and not on consumer participation, putting high taxes on fossil energy use and a high price for emissions, but with limited room for investments and limited possibilities for energy import, the scenario of “Phasing out of gas” will be the reality.

In the opposite corner the “Green as gas” scenario is a result of deregulation and giving consumers and companies more individual choices. Choices based upon local and regional opportunities will be leading and people prefer not to wait for the government but make their choices upon personal preferences. Open markets and flexibility in products and regulations are necessary for this scenario.

The top right corner looks most like what most people see as the ‘goal’ of the energy transition. If investments in local sustainable energy are stimulated, and fossil energies will have a high price (as a commodity or by taxation), if there is a strong up come of cooperatives and commitment to deal with global and local emissions, supported by regulation on energy use in buildings or mobility, this ‘Gas in transition” scenario might already be reached in 2030.

What is the direction to be chosen?

What do all scenarios have in common? Which trends and developments are certainly going to happen, even if the pace may vary? Is a ‘no regret’ strategy sufficient, or is it to defensive when it comes to the big issues of energy production, distribution and use? Asking the question is answering it. A ‘no regret’ strategy for a gas distribution company would be to stay strictly within the legal regulation. Nobody can ever blame you for doing what you should legally do. But in a fast changing world that is not enough. The answer to change is change. To be relevant in 2050 the distribution grid operator has to change its current policy based upon stability into a strategy aiming for change. This change involves a strong reduction of the heating demand, a change from natural gas to sustainable energy and a strong reduction in costs of the remaining gas grids to stay attractive for customers.[12] All three directions are relevant in all four scenarios. And in all three directions the gas distribution grid operator can make a relevant difference.

Reduction of heating demand

Reduction of heating demand asks for strong insulation measures and therefore collaboration with (institutional) home owners. New, more efficient, heating techniques need to be introduced that need less primary energy (e.g. heat pumps).

The first step in reducing emissions should always be to reduce the energy demand. This simple truth asks for a significant change in the way the Dutch houses are insulated. If all houses will be significantly energy-renovated, the CO_2-emission based upon heating can be reduced by 50-80% in 2050[13]. Solar energy will then be the main source for energy for about 50% of the households. The other houses will have a strongly reduced heating demand. The drawback of this possibility is that although it is technically feasible, there is no financial advantage for the house-owners. The measures are too expensive compared to the reduced energy demand.

The other alternative in bringing down the energy demand is by using more efficient techniques[14]. The COP of a heat pump is around 3 because ambient heat is effectively used. This is much better than even a high-efficiency boiler, which approaches a COP of 1 (98% efficiency). Hybrid concepts are already on the market, where the base load is produced by a small electric heat pump, whereas peak loads, for hot water or during really cold days, can

---

[12] Gas for mobility is not considered an issue. Even if this grows to the maximum demand mentioned in some studies, the additional gas use can be absorbed by the existing gas infrastructure without problems.

[13] “Op weg naar een klimaatneutrale woningvoorraad in 2050”; Planbureau voor de Leefomgeving (PBL); publication number 738; 13 February 2014

14 Several concepts are compared in “De systeemkosten van warmte voor woningen” by Ecofys.

be delivered by a gas boiler. Electrifying the heat demand has as advantage that decarbonizing the electricity production is an ongoing process with positive outlook[15]. But from a grid point of view, the electricity peak demand should not increase too much, otherwise the electricity grids need strong reinforcements (see Figure 7).

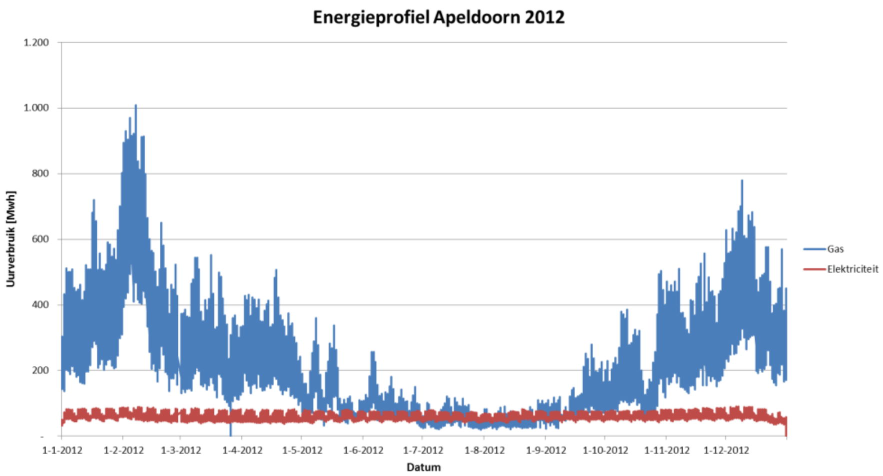

Figure 7: Example of the difference between the gas demand (blue) and electricity demand (red) in a Dutch city

The result of a strong reduction of heating demand is a strong reduction of the need for natural gas and therefore a strong reduction of the need for gas grids. The focus of the DSO has to be on effective phasing out of gas grids. The place and time of the redundancy is dependent upon local and regional developments.

A financial risk for grid operators and societal disadvantage is that most gas grids are not yet financially amortized. Phasing them out, leads not only to additional operational costs, but also disturbs the regulated model of the earnings of a grid operator. Income will fall behind the expectations, which will lead to higher costs for the customers that still are connected.
From the grid operators point of view it is therefore important that phasing out of the gas grids is based upon residual life time expectancy and residual balance sheet value. The first grids to be phased out should be the amortized grids with the shortest residual life time expectancy. This is a technical issue where risks are being considered in the same way as grid operators have been doing for years. Only after that, the grids that still have balance sheet value, should be phased out, whereby balance sheet value should be the indicator. Ideally, the grid operator informs the stakeholders when he expects a particular part of the gas grid to be ready for replacement, after which the stakeholders decide whether an alternative energy infrastructure would be a better solution than replacing the old gas infrastructure by a new one. Combining the life expectancy issues with the energy transition issues then prevents double investments. However, there are many reasons for all stakeholders involved in the changes in heating demand, that lead to a different order of phasing out.

Renewable alternatives for natural gas

Where possible, natural gas should be replaced by renewable gases, sustainable heat or sustainable electricity, based upon local circumstances.

Renewable gases

The gas industry has a lot of knowledge about renewable gases. “Renewable gases” is the overall name for biogas, bio synthetic gas and biomethane. In order to be called renewable gas, the biomass should be renewable.

[15] “Energy Technology Perspective 2014 – Harnessing electricity’s potential”; IEA

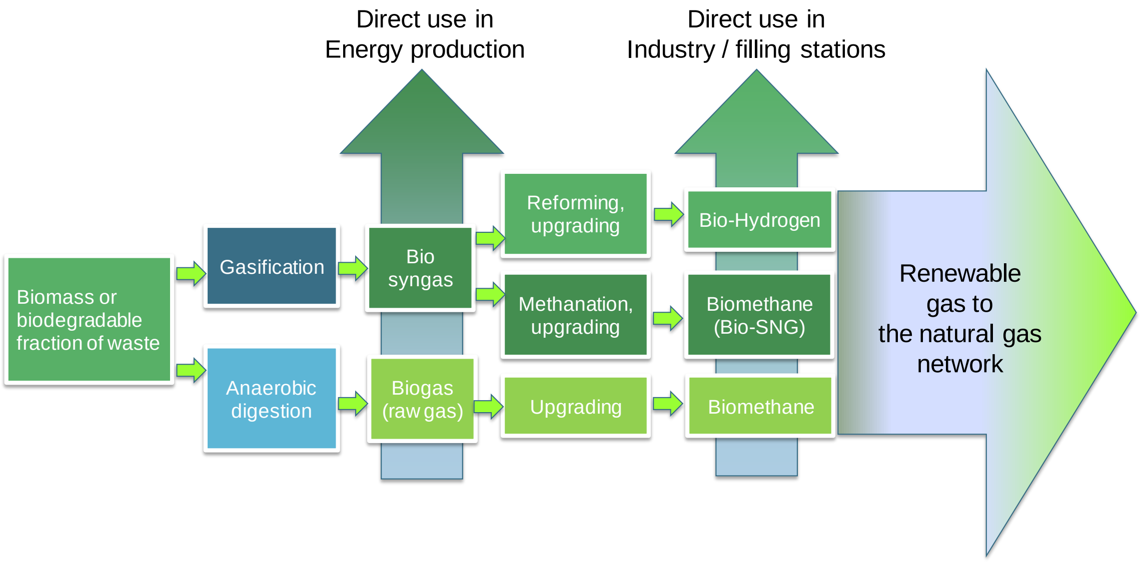

Figure 8: From biomass to renewable gas

"One of the most obvious reasons to use bio-energy is the decreasing effect on greenhouse gas emissions compared to fossil fuels. A second reason is that renewable gases fit into the concept of a circular economy Another advantage of producing biogas is that it is a way of turning waste into money. The residual products from the digestion or gasification processes, can often be used in other processes again, creating added value.
In many industrialized countries we see that people are willing to spend time in making small-scale circular economies possible. This all leads to a trend of small, local and self-supporting. In this trend, the use of local energy made from biomass, is a good fit. It bridges the gap between the traditional world of the gas industry and the needs for sustainable living"[16]. Gas distribution grid operators should encourage the production of renewable gases and be ready to distribute them.

Sustainable heat

When talking about collective heating, one enters immediately into a world of dilemma's. There is a lot of heat wasted in the Netherlands, so it is logic to use that waste heat in district heating systems. But one can question the efficiency of the process that generates the waste heat. And once the waste product has a value and a there is a need to produce heat, the process might need to be adapted to produce the right amount of heat at the right time. Therefore, district heating systems that are dependent upon one producer, with a financial scheme behind it where the costs of the grid and the costs of the commodity are interdependent, are not the right choice for the future.
A second dilemma is that the investments for a heating system are high compared to gas and electricity infrastructure, whereas the first choice in reducing emissions is to reduce the heat demand. These two trends are not in line with each other.
When focusing on the same words as for renewable gases, like circular economy, small and local, the vision is that collective heating systems should get their energy from local, renewable heat sources. Waste heat is an opportunity to be used, but only if there are multiple sources. Preferably, the heat is produced from local renewable sources, like biomass, solar or sewage systems. Prices should be transparent and production and transport should be unbundled. Gas distribution grid operators have knowledge of underground piping systems and can take this responsibility within a legal framework that is comparable to those of electricity and natural gas.

Sustainable electricity

The largest change should come from using renewable electricity for heating. Solar panels will be standard on all roofs and many other surfaces, leading to high feed in of local sustainable electricity. When there is low heating demand by good insulation and the use of efficient (hybrid) heat pumps, the use of electricity for heating is a good choice.

[16] Text and figure taken from "Renewable gas: the sustainable energy solution"; International Gas Union; June 2012

Wind power will produce a larger amount of energy, but not as deep into the infrastructure as solar panels. Wind parks can be connected in the same way as we now are connected to central power plants or CHP.
With sustainable electricity production close to the consumers, it is logic that electrification of the energy use is an important means of decarbonizing the energy sector, even for heating.
In the scenarios, the pace of growth of sustainable electricity for heating is one of the main uncertainties. The financial effects on redundancy of the gas grid and strengthening the electricity grid are huge. For the operator it is essential to build scenarios based upon local building conditions and demographic data to make relevant forecasts.

Cost reduction for the remaining gas grids

Remaining (natural or renewable) gas grids should be less costly, to remain attractive for customers, underlying the need for more efficient working methods and changes in regulation.

Product improvement and productivity increase are necessary to decrease operational costs. Temporary (operational) and remaining (spatial planning) hinder for the environment need to be minimalized. New operational techniques that are faster and cheaper are needed to bring down the cost and stay attractive for the decreasing amount of customers.

Insight needs to be generated in ageing processes of assets and to increase the remaining lifespan under different conditions of use and laying conditions. To be able to analyze better, the registration of new and existing assets needs to be improved and be made accessible for a variety of analytic software. The condition of the assets should be monitored by combining information from this registration, sensors, periodical diagnoses and exit assessment. The modelling tools used for ageing processes need to be improved based upon data from this monitoring.

Digitalizing an dynamic modelling of the actual use of the gas grids are needed. This provides information to weigh the necessity of grid investments against alternative ways to meet the customers' needs.

Changing the rules of the game

Current (financial) regulations are based upon stability, socializing the costs and long-term payback for investments. This system is not fit for a future with a lot of variety and changes, whereby new roles and functions in the system are necessary. This leads to issues like whether or not customers are free to choose their energy carrier, who is going to fill in new functions like local balancing, cross-overs and system integrality, and spatial planning issues. The rules of the game need to be changed.

The customer and flexible tariffs

Energy decisions will increasingly be made by the customers themselves, rather than by the energy companies. If all customers make these choices without taking account of each other, the energy supply will be jeopardized, because of too much energy consumption at one time and too much energy generation at another. This will influence the reliability, affordability and accessibility of the energy supply. At the same time, our society is becoming increasingly reliant on energy. A network operator has the public task to ensure that – despite all these radical changes – everyone retains access to reliable, affordable and sustainable energy on equal terms.

There is a correlation between high total costs for energy and tenants with a low income. Increasing prices for energy or for access to energy touch harder upon this group of consumers than to the more wealthy home owners[17]. Likewise, the advantages of solar panels and electric cars are at the moment accessible for a small group of customers only. But the costs for adapting the infrastructure are shared between all customers. This leads to increasing inequality.
When customers start using more energy at specific times of day in a particular city, district or street, the traditional response is to upgrade the network. But network upgrading is no longer sufficient to keep pace with the hugely accelerate changes. Moreover, network upgrades are time-consuming and expensive and fail to address the need to safeguard the quality and accessibility of the new energy networks. So it is vital to encourage

[17] "Energiebesparing: voor wie loont dat?"; Planbureau voor de Leefomgeving (PBL); publicatienummer 1221; 2014

customers to make choices that not only make sense to them, but to our energy system as a whole. Such as using more energy when supply is abundant, feeding in more energy when supply is scarce, and using the network as sparingly as possible during peak times.

Variable energy pricing (higher prices when energy is scarce, and lower prices when energy is abundant) and flexible transmission tariffs (based on peak loads on the transmission networks) for all customers are necessary to achieve this. It is important to automate this decision-making in order to minimize the time customers need to spend on this process.

Alternative infrastructures in an open setting

The construction of alternative infrastructures can be a way of preventing costlier investments in the existing network. Suppose, for instance, that residents of a particular area are considering installing individual heat pumps in their homes. In this scenario, there will be spikes in electricity demand at peak times (especially on cold days). Which means, in turn, that the electricity network must be substantially upgraded. It is crucial to ascertain with all stakeholders whether this is the cheapest and most sustainable solution. An innovative heating or biogas network may be a better alternative.

It is vital to keep this new infrastructure accessible ("open") to everyone under equal conditions. Universal access makes these networks more affordable, as the costs can then be shared with the maximum number of users. At the same time, these new infrastructure will be relatively small in the beginning, making it difficult to finance it on the base of only the launching customers. Therefore, there is a logic to bring this new open infrastructure under the umbrella of regulated grid operators, thereby creating better financing conditions.

Because of the restrictions that users will have on their choice for infrastructure, and the expected obligations to change from one energy carrier to another (mainly from natural gas to district heating or all-electric), it is fair to discuss the socializing of the network costs over all consumers and energy carriers. Is it fair that someone who is using sustainable electricity from a nearby solar park pays the same transport tariff as the one who buys his energy from an offshore wind park? Is it fair that someone who buys sustainable gas from a digester nearby pays the same transport tariff as the one who buys H-gas from Norway? Is it fair that someone who is connected to new infrastructure pays the same as those who remain connected to old infrastructure? This is a complex issue which needs to be publicly discussed.

System integrality and cross-overs

The future energy system will no longer be a 'one-size-fits-all" system where everybody has a similar electricity grid connection and a similar gas or heat connection. There will be more variety, depending upon choices made for or by the consumer. Production and use of energy will be largely decoupled because of the leading role of renewable sources like wind and solar power. This leads immediately to new balancing needs on a very local level for which it is not logic that this is carried out by national operating entities like TenneT or GTS. On this local or regional level, it is more logic to store energy in batteries or heat or to transform from one energy carrier to another(e.g. power to gas or electricity to heat). This is not foreseen in the current regulations. For large players, like the incumbents from the past utilities, this are activities on a too small-scale level to be dealt with efficiently. But for new local cooperatives, the investments and risks are too high to build and operate these kind of cross-overs, because the price volatility is not sufficient to cover the costs. Regional grid operators are operating at the right level and have the financial means to invest, but are hindered by strict implementation of unbundling legislation. Storing energy or transforming from one carrier to another are, in a strict interpretation, influencing the market and therefore considered forbidden. In a less strict interpretation, grid operators could build and operate such installations when this results in lower investments than upgrading the grid. For a changing energy system, the rules of the game need to be changed.

The role of the gas distribution grid operator

The role of the gas distribution grid operator has to be considered in coherence with the role of the electricity grid operator or the heat distribution operator. Developments based upon system integrality at local, regional, national and European level are needed to reach the goal of a sustainable energy system. This does not necessarily lead to integration of companies, but all operators should understand that they have to cooperate, and regulations should be such that infrastructural decisions should be measured against public relevance, and not on the financial effect of one operator alone. Informing and influencing on all levels, from local to European, is necessary.

Safety of ageing gas grids shall never be compromised. Technical means to establish actual residual lifetimes and to renovate or replace aged pipes in an efficient way need to be further developed. Minimalizing hindrance should be a key constraint because of the large quantity of pipes to be dealt with.

The gas distribution grid operator has to accept the decreasing need for natural gas and gas grids and be willing to find more sustainable solutions for the customers' needs.

Better analysis of current and expected gas demand in grids gives insight in existing flexibility. This flexibility should be used to serve customers' needs, instead of laying new gas infrastructure.

Investments in new natural gas infrastructure should be prevented. Preferably, new buildings should not be connected to a gas grid, and where this happens, these gas grids and the appliances connected, should be ready for using renewable gases.

Actively building decision support tools to make the change to sustainability in an efficient way will help society. These tools should not only be built upon general trends, but take local conditions into account with respect to the gas grid, the built environment, the demographics and the local sustainable energy production potential. Consequences for the electricity or district heating grid should be taken into account as well.
The regulator needs to find a way to support advanced amortization of gas grids and invest in alternative infrastructure, when this fits into the needed energy transition.

The ultimate goal of a Dutch gas distribution grid operator should be to distribute only renewable gas in 2050, and only in places where emission-free, sustainable, alternatives are not reasonably possible.