The Netherlands on Solar- and Wind Power without Natural Gas?

Transition? Another Dutch disease by an "Energiewende".
Updated 2019-03-07

Dr.l.noordzij@leennoordzij.nl

www.leennoordzij.me

Content

1.Prologue 2
2.Introduction 2
3.The Problem 3
4.Dealing with The Problem 4
4.1.The alternatives 5
5.Further Considerations on Dealing with The Problem 7
5.2 Intermezzo. Hurricane Heat Pump 9
6.Fallacies 10
7.Solar Energy and Wind Energy 10
8.Electric vehicles 11
9.Energy Transition and the societal consequences. 11
10.Transition 11
10.1 Intermezzo: An Hilarious Solar Park Operator/supplier's proposal 12
11.Newspeak 14
12.Discussion and Conclusions 14
12.1 Intermezzo. The decline and fall of liberal democracy 16
13.Epilogue 18
13.1 Child Crusade and Climate Change 19
14.Literature. 19
Appendix 1: an example. 20
Appendix 2: Efficiencies. 21

"People employ euphemism to obscure
the human cost of the political agenda
they support." George Orwell.

An oxymoron:
A sustainable holiday,
Fly long and far away.

1.Prologue

It is wintertime and unavoidable, winter is there.
I am comfortable reflecting in my house. Did I enough to contribute to reduce climate change? Not too much sun, too much wind, contemplating the non-existence of a massive-electricity-storage system. Well, there is no problem behind the horizon. The base load for my house, warm water to take a shower, is supplied by nuclear power. The heat pump is powered by electricity produced by the swing power plant using natural gas.
Still I have some doubts whether I made the right decisions. Of course I took the passive measures for energy conservation , i.e. maximum possible isolation. However, was it a good move to replace my high efficient central heating boiler powered by natural gas by a heat pump?
I know, I was not left a choice. But still, does my heat pump really contribute to a carbon dioxide (CO_2) reduction?
Let's do some calculations.
My gas fired condensing central heating boiler had an energy efficiency of about 100 %. The heat pump is fired by electricity. Alas, no sun and too much wind. Consequently the electricity I need is produced by the swing system based on natural gas. This centralized electricity production can be delivered by a combined cycle system with an efficiency of 65% or a system without combined cycle and an efficiency of 35%.
As I mentioned, it's a winter day the outdoor temperature is about 5 ℃ . Consequently I am afraid the COP(Coeff. Of Performance) of my heat pump is about 1. It will be not that bad? Since due to the greenhouse gases the winter outdoor temperatures will be less low in my country. Still, I expect the heating of my house goes with an efficiency of 65% or 35%. I start worrying. There is no reduction of CO_2 , at the contrary. I am depleting more CO_2 than I did with my old fashioned gas fired central heating boiler with efficiency of about 100%.
In order not to contribute additionally to the CO_2 level, the COP of my heat pump need to exceed about 2 depending on the type of powerplant.
So winter is really there.

2.Introduction

Due to unacceptable earthquakes related with depletion of the Groningen gas field, the Dutch government decided to fade out the use of natural gas for residential(household) consumption. Did these earth quakes come as a surprise? Well, I think not. However, the income generated by gas consumption of this Groningen gas field constitutes an important part of the governmental

budget.
The solutions for the earth quakes in the northern part of The Netherlands constitute a part of the project to ban fossils fuels of the Dutch market by the year 2050.
No fossil fuels, no natural gas[1], what next? Transition/transformation: which measures to take?
In The Netherlands, the parties concerned(single issue associations[2]) swear by wind-and solar power.
Without security of supply and security of availability, the transition from natural gas to wind- and solar power is a farce.
This transition is forced upon the citizens of The Netherlands showing the vulnerability of the democratic institutions. Parties considering how this transition should look like do not represent the Dutch people. They are not elected as they should be. They represented no constituents, just single issue associations. But, this is just another story(Noordzij).
As a leading principle we should employ energy security: the availability of sufficient supplies at affordable prices:
- physical security and cyber security,
- access to energy,
- national and international policies,
- investment,
- diversification.
(Yergin).

3.The Problem

Natural Gas, what is it all about?
Let's focus on the residential(household) gas consumption.
We may assume the household gas consumption to be about 1500 m^3/y is. In words: fifteen hundred cubic meters per year.
With a massive energy saving(conservation and improvement of efficiency) program this gas consumption per household can be reduced to 1000 m^3/y [3] in the year 2050.
I did not include the energy consumption(electricity) for air-conditioning. It may dwarf the consumption equivalent of natural gas(The Economist, August 25th 2018).[4]
The number of households in The Netherlands is about 6 million. Exact numbers can be found in the reports by CBS. A governmental bureau of statistics. The numbers I use suffice to demonstrate what the order of magnitude of the problem will be.
Total natural gas consumption of the households is 9 billion m^3 per year in 2018.
The type of gas is so-called low calorific gas. This gas is supplied with 100% availability and

---

[1] It would be a real innovation when producing natural gas to leave the carbon part deep down below and bring the hydrogen part above the ground.
[2] NGO's or better call them QAUNGO's since in the Netherlands these associations are subsidised with tax payer's money. QUANGO's: a lot of influence without any responsibility.
[3] With energy saving I mean better insulating of houses. So the houses do need less energy for heating and cooling.
[4] IEA: 2000 TWh/y, T=Terra.

almost 100% security of supply without offtake obligation by the households.
In order to find out about the effects of “The Netherlands without natural gas”, we need to know the energy content of the gas consumed. We assume the energy savings programme results into a consumption of 6 billion m^3/y. Since, before starting with cutting the connection with the gas grid we start to collect so-called low hanging fruit: reduction of energy consumption[5].
The energy content at our doorsteps is presented in the block below.

> The energy content of 1 cubic meter ($\mathbf{1\ m^3}$) is 31,65 MJ/$\boldsymbol{m^3}$; so-called low calorific gas. MJ: mega joule. Mega is $\mathbf{10^6}$ and 1 J(oule)= 1 Wattsec. The calorific value of natural gas, of residential gas consumption, energy conservation and efficiency improvement included,: 31,65× 6× $\mathbf{10^9}$ MJ/y(ear). This is about 200× $\mathbf{10^9}$ MJ/y. We need 2× $\mathbf{10^{11}}$ MWattsec . Usually Wattsec is translated into kWh: 5.5× $\mathbf{10^{10}}$ kWh. Translate this into production capacity: I assume an availability of the production units of 8000 hours/year is a reasonable assumption, not for sun and wind by the way. We need 5.5× $\mathbf{10^{10}}$ kWh, so about 7× $\mathbf{10^3}$ MWatt is necessary.

So, 5.5× 10^{10} kWh is the energy to be produced as replacement of natural gas. Obviously, this amount of energy will be delivered at our doorsteps by means of electricity.
How many electricity production units do we need?
For electricity production the capacity is usually given. See block above. This capacity of 7× 10^3 MWatt is not the production capacity. This 7× 10^3 MWatt is a mean value which could give you the impression the gas consumption to be homogeneously distributed over a year.
It is not. [6]
The problem to be solved is: 5.5× 10^{10} kWh to be delivered at our doorstep on a yearly basis.

4.Dealing with The Problem

As mentioned in the section on The Problem we need a capacity of about 7× 10^3Megawatt to replace residential gas consumption. In this section the assumption is to solve the Problem with reliable technology. Meaning: security of supply and security of availability. In addition everybody has access to the energy supply system.
Natural gas will be replaced by electricity at the doorstep. For example we can choose a production capacity of 1000MW each. We need 7 of them. Keep in mind the number 7 to be the bare minimum. It is not only the average demand that need to be covered, but also the extremes including the additional reserves for calamities. This additional reserve can be estimated to be 20%(Yergin). So we need 8.5× 10^3Megawatt production capacity. However, maximum necessary capacity can still exceed the latter capacity.
We know for sure this transition will be gradual. The gradualism is supported by the availability of alternatives

---

[5] Without massive back-up – or storage systems, solar- and wind power are irrelevant.
[6] The calculations are made for the replacement of natural gas. No attention is paid to the usual consumption of electricity for dish washers, etc.

By assessing of the alternatives I bring to notice natural gas is now delivered to the households with 100% availability, nearly 100% security of supply with no off-take obligation for the households(residential gas consumer).

4.1.The alternatives

Gas from biomass.

We can blend gas from biomass with natural gas. In The Netherlands we have a lot of experience with this type of blending. How much gas from biomass(biogas) can we blend with natural gas? Stated in another way, how much natural gas can be replaced?

Assume the percentage of biogas to be 5% of the residential gas consumption. Hence, we have to substitute 300 million m^3 of natural gas by biogas with the same calorific value. There is a chemical limit to the amount of biogas. Biogas constitutes for example carbon dioxide(CO_2) like nitrogen[7] an inert gas. However, carbon dioxide influences combustion in such a way that cooking appliances do no longer operate in a safe way. Safety is one of the important testing issues of gas appliances.

There are technological solutions to solve the carbon dioxide problem. Alas, a conversion of all cooking appliances is needed. This conversion is far more extended, to say the least, than the conversion needed for the introduction and application of the Groningen Gas field. An operation executed in 1955 through 1965. The conversion was needed to facilitate the switch from town gas [8] to natural gas. Nowadays(2018) there are a lot more appliances than in the years before 1955. The conversion will be a lot more extensive and expensive.

In addition to the question whether we can replace 50% of natural gas by biogas, there is the question of a possible yearly production of 3 billion m^3 biogas equivalent to natural gas. This is sort of begging the question.

Security of supply to mention something?

Hydrogen

There could be an advantage in the application of hydrogen. There is the possibility of using the existing gas transport-and distribution system. Suppose we can use the system for transport and distribution and we replace natural gas by hydrogen. How much hydrogen do we need to replace natural gas?[9] The calorific value of hydrogen[10] is 1/3 of the calorific value of low calorific natural gas per m^3 and the same pressure. To substitute hydrogen for natural gas completely we need 18 billion m^3 hydrogen. Will this happen?

Suppose hydrogen to become the substitute for natural gas. A complete conversion of all the residential appliances is necessary. Prohibitive costs.

I did not comment on all the transport and distribution problems, e.g. higher pressures.

---

[7] In The Netherlands so-called low calorific gas is distributed for households. This gas contains a considerable amount of nitrogen (N_2) about 15%.

[8] Town gas is a mixture carbon monoxide (CO) and hydrogen (H_2) .

[9] Blending of hydrogen with natural gas and /or grid separation I did not consider.

[10] Calorific value of hydrogen(H_2) is 10,8MJ/m^3.

Nevertheless, let us look into the possibility replacing 1/3 of natural gas by hydrogen(not considered to be blending). See block below.

We need to produce 6(=18/3) billion m^3 hydrogen. This will be produced by electrolysis. Furthermore we assume to produce 1 kg hydrogen with about 50 kWh. What capacity do we need? Well, with given density of 0.09 kg/cubic meter we obtain a capacity of about 4×10^3 MW (for 8000 hours). This estimate is based on a homogeneous distribution in a year. This assumptions is not correct. Half of the capacity can be estimated to be homogeneously distributed. So we need 2 units with a capacity of 1000 MW each. This is a sort of base load. The other half is centred around the winter period. In the section on Transition I made a distribution of capacity during a year. I will use the same distribution. So, as a consequence, the peak capacity in addition to the base load can be estimated to be about 4000 MW. We need in in total a capacity of 6000 MW. Now we look into the case the peak capacity is needed during 1/3 of the winter period(=2000 hours). Then we need a peak capacity of 8000 MW. Due to calamities, the installed capacity needs to be about 10000 MW. Here we considered a part (1/3) of the winter period. The peak capacity needed during one day can be higher.

I did not consider storage of Hydrogen. Suppose we have an idea about the logistic of the distributed storage system. In that case a capacity of about 4×10^3 MW (for 8000 hours) will do. In addition I did not pay attention to natural-gas leaks in the present day grid and what that means for using hydrogen in that grid(The Atlantic sept 2018).
The capacity needed to produce hydrogen is based on the assumption that for the power production natural gas is the feed stock. Just for the sake of flexibility.
Natural gas? Think about this for a while. We ban natural gas for residential application. Still, we need it to produce hydrogen. Do we reduce greenhouse gasses in this way? Well, the solution for this problem is wind-and solar power.
How much storage do we need for security of supply of hydrogen?
The subject matter of storage, transportation and distribution of Hydrogen is paid attention to in various publications, e.g. Jain, S. , et al.

Russian gas.

The residential natural gas consumption covered by Russian gas? We export our environmental problems to Russia?
Obviously, Russian gas is not be excluded. In The Netherlands Russian gas, after blending with nitrogen (N_2) is already distributed. In addition we do have the possibility of liquified natural gas(LNG).
By the way, in the so-called soft cold war, Gaz Prom is an excellent actor(Kaplan).

Electricity.

A massive conversion: all residential appliances has to be replaced.
At the doorstep we need 8.5×1000 MW. What fuel mix will be used to produce the electricity? Electricity for which we do not have in The Netherlands a storage system[11]. So we need a flexible production system.
It is of some importance to choose a fuel mix with maximum economic advantages for The Netherlands.

[11] Storage systems, such as pump accumulation, hydropower(cooperation with Norway), are investigated and applied on a small scale.

What to choose as the fuel mix for power production? We can choose: coal, nuclear and natural gas. Coal and nuclear we use for the base load, natural gas for flexibility.
Coal. Limburg will be the county of our choice as the mining site. We do not import coal for the time being. Improvement of employability in the county of Limburg.
From the very beginning we have to pay attention to damage control related with coal mining. When employment in the county of Limburg is not an issue, we can import/buy lignite in Germany. In that case we are in the same "Energie Wende" league as Germany. Germany a favourite country for holidays, vacations, etc. A mild northern climate and a lot of sun. Observe the number of solar panels in the country.
Modern coal gasification technology can be implemented. The advantage: carbon dioxide can be captured at the source at high pressure.
The other element of the fuel mix is nuclear energy. Obviously, the most modern technology will be used. It will be a stimulant for R&D in The Netherlands.
However, the choice for the fuel mix is based on the need for swing production. Consequently, natural gas is included.

5.Further Considerations on Dealing with The Problem

Conversion.

To replace 6 billion m^3 natural gas by electricity, leads to a massive conversion. We do not have any experience with conversion at such a scale. We do have an experience with a conversion from town gas into natural gas. This conversion happened some 60 years ago on a relatively small scale. This experience is not of much help.
To develop a sense of urgency I present hear a number adopted from Rhodes(page 298) for the time it takes to switch: "Since natural gas burns hotter than propane or town gas, some twenty million gas appliances had to be adapted or replaced. That took ten years from 1967 forward."
For the conversion operation we need technicians(m/w). In 2018 these technical trained people are not there.
Conversion costs? Costs have been published in May 2018 by the housing associations for a particular segment of the housing market: counsel housings. A number? The costs are estimated to comprise about € 108 billon. The details? What about the grid?

Sun-and wind power.

So far we did not pay attention to wind-and solar power for replacement of residential application of natural gas. If we do consider wind-and solar power, as an energy source for residential application, we have to compare the security of supply and availability of wind-and solar power with the security of supply and availability natural gas.
100% availability and 100% security of supply without a robust and distributed storage system is impossible for sun-and wind power. This storage problem has to be solved. Grid stability need to be managed . Most probably just 15% of 8500 Megawatt can be covered by wind-and solar power. Even with this percentage we need flexible production units for peak demand.

In the scientific section of the Volkskrant, Sir Edmund(March 3rd, nr 2, 2018) attention is paid how to fit the residential produced electricity into the grid. There is no technological problem. The residential electricity producer(m/w) however, does not guarantee security of supply and availability.

In The Economist December 6th 2014, attention was given to storing renewable energy on the grid. The Economist: “Matching output to demand is hard with wind and solar power. The answer is to store surplus juice on the grid until it is needed”.
It is 2014 and Alevo, a Swiss company is mentioned. A company started to make new batteries that can store serious amounts of electricity. May 2018, Alevo filed for bankruptcy; www.greentechmedia.com .
Well, such things happen. All the hopeful things about stationary storage did not materialize yet. This cost time. Do we have that?
Obviously, new storage technologies will become available for the market: in the Business section of The Economist July 21st 2018 vanadium flow batteries(VRBS) are mentioned. As will be mentioned time and again: to arrive maturity will take decades.
Let us elaborate a little further on solar – and wind power. In the section The Problem we calculated the capacity of 8.5×10^3 MWatt. Here, in this section, we assume this installed capacity to be build up by PV units and wind turbines. Nothing has been said so far about the efficiency of the power production units. Taking into account security of supply and availability is secured one way or the other, we may be lucky to reach an efficiency of 10%. See the block below

What does 10% mean? (See also Appendix 2).Of course we can determine the efficiency of a wind turbine for that matter of a solar system. Under controlled, laboratory conditions we can measure efficiency. Simply stated: output/input. However, in the real world of wind turbines and solar systems we are not always sure about the input. Hence, we better speak of the Probability of Availability instead of efficiency. As a matter of fact all the capacity numbers mentioned subsequently are mean values. In the following text I still use the expression efficiency. Keep in mind: Efficiency is meaningful when a reliable back-up system is available. A back up system could be a mature distributed storage system and/or well-known production capacity based on natural gas, coal and nuclear of 8500 MW. Since the back-up capacity needs to be flexible the only option will be natural gas: imported LNG or imported pipe gas. Conclusion: without a storage system solar – and wind power just add capacity and do not replace incumbent capacity. We need a capacity 8.5×10^4 MWatt, based on the 10% efficiency. Since the capacity of 8.5×10^3 MWatt has been obtained from the amount of energy delivered at the consumer’s doorstep. A production capacity of 8.5×10^4 MW or 85 GW [1G(iga)=1000M(ega)]. Assume half of the production capacity is created by wind. Consequently we need 42.5 GW production capacity of wind turbines. Assume 2 MW per turbine. Then about 22×10^3 wind turbines need to be installed. I did not use a robust, massive and mature storage system. Well, it is not there. The above mentioned number of wind turbines is still based on a yearly mean value. As indicated in Appendix 2 a mean value is meaningless. In the Appendix 1 it is shown the ratio of solar to wind power equals about 1/3 and not to be 1/1.

As mentioned(the block above), we need a production capacity of 85 GW to replace 6 billon $m^3$of natural gas. Keep in mind this amount is obtained by implementing an energy savings(conservation) program resulting in a reduction of use of natural by about 30%(numbers 2018). In addition the 85 GW is assumed to be sufficient for heating even in wintertime. It is not. No wind and no sun: no comfort mildly formulated.

85 GW is deduced from annual energy consumption. However , we know daily consumption fluctuates with major seasonal differences. With help of data from the daily consumption, we get an idea of the need for storage systems and the maximum production capacity needed.

Electrical vehicles.

In the observations no attention is given to the capacity needed, in addition to the 8500 Megawatt, for electric cars(See section on Electric Vehicles). In The Economist, March 3rd-9th 2018, *Reinventing wheels*, an estimation is given for the additional production capacity: “The switch to electric vehicles will require more generating capacity. UBS, a bank, estimates that it will increase European electricity consumption by 20-30% and new infrastructure, such as charging stations and grid upgrades.” Just another element of the transformation process.

Transition/Transformation.

Transition: the consequences of the change from natural gas into electricity are mentioned with ignorance, sort of. However, keep in mind without security of supply and availability(storage capacity) we only can rely on our natural gas distribution system..

Part of transition is conversion of gas appliances. Not just conversion , but also replacement of appliances and adaptation of the distribution system. Talk of the town in The Netherlands is the replacement of central heating boilers by electrical driven heat pumps. Where does the electricity comes from?

5.1 Intermezzo. Hurricane Heat Pump

What is the capacity needed for a heat pump to supply the heat for a shower and for heating the residence? On the basis of the yearly gas consumption and energy conservation, we will obtain a number between 10 and 15 kW(about 12, say). This is based on the assumption of the need for warm water during two hours per day the year round[12]. Furthermore we estimate a need for heating capacity during 1000 hours per year. In addition the cooling capacity is of the order of magnitude of the heating capacity. For a typical winter day we need 10-15 kW. I do not consider the problems related wit a low temperature heating system and warm water production.

Let’s assume to extract from the outdoor air the energy with a temperature difference of 5 ℃. So we have an air to air heat pump. How much air do we need? We take the heat capacity of air at constant volume. For a given density at 10 ℃ we extract 4.4 kWsec/m^3. 12 kW is needed so we have to transport 4 m^3/sec(including losses). Now suppose the diameter of the suction side of the ventilator to .5 m. Then the velocity at the entrance of the ventilator is about 20 m/sec or 72 km/hour. The amount of air whereof the heat is extracted has to leave the ventilator. Velocity difference between entrance and outlet is about 145 km/hour.

This will happen mostly in urban area. What kind of hindrance is to be expected in a representative street of a representative town?

[12] Think about the temperature of the water taking into account health risc.

Any idea about the noise level?
End of intermezzo.

In The Economist, March 17th 2018, some aspects of the complexities of decentralised power are indicated. As a citizen I like to hear the government to communicate about these complexities. Well, I am afraid this will not happen (Noordzij).

6.Fallacies

One of the major problems is the role government, regional(county) and national, trying to play to direct technology development by picking winners. The role of government is to make laws and implement them. The role of government is not to choose technologies. This will kill innovation. In the Netherlands there are a few counties which collected a lot of money by selling their stakes in energy companies. So, for example , the county of Gelderland in The Netherlands obtained some € 3 billion. The county Council is considering to spend over € 300 million to stimulate technology development. Not by making laws, but by picking winners.
The best way to spend this money is not to throw the money of the taxpayer on technology, but give it back to the taxpayer. Obviously, by spending a lot of money during a long period of time, something will be found (www.leennoordzij.me 2,3).
In addition we can wait for the booms and bust in economics of solar- and wind power.

7.Solar Energy and Wind Energy

I will pay attention to the solar- and wind energy situation in The Netherlands(April 2018). A situation indeed. It is becoming much faster a disaster as expected. Instead of security of supply – and of availability, grid stability is rapidly becoming a major problem. How come?
Well, the Dutch government is subsidising solar- and wind energy with billions of euros. Subsidising the so-called proven technology on a large scale. Consequently, solar energy is disturbing grid integrity - and stability, spending and spoiling taxpayers money. In the meantime innovation is killed. Why innovate when proven technology is subsidised? Hence, the taxpayer is supplied with technology, which will be obsolete in a couple of years. This is how transition will work?
In July 2018 in the Dutch regional press attention is paid to the storage problem. The well-known systems are reviewed, batteries, pump accumulation, hydrogen and intelligent grid. None of which has reached maturity. I do not include storage systems where electric cars are involved. This asks for a sort of Plan Economy. A disaster on beforehand. A Dutch professor of Sustainability and Transition Knowledge mentioned even a dictatorship-light to accelerate energy transition since the professor saw a lot of “foot-dragging”. Hopefully, the dictatorship remark was a tongue in cheek remark. If not, a short course in history could wake up the professor. We, still, live in a liberal democracy(as defined by The Economist September 15th, 2018) with laws and rules.

Also energy consumption is mentioned. Well, the least we can do is start with reducing energy consumption.

8.Electric vehicles

Now, let's focus for a moment on electrical powered cars(sedans, etc).
How much capacity we need for feeding the batteries of these cars? Suppose this charging is done by solar – and wind power. What capacity do we need?
We have in the Netherlands 8 million cars, say. Of these cars we assume 10% is on the road on a daily basis. Furthermore, we assume a consumption of 16 kWh/100 km, a small car by the way. We also assume the car is driving 20000 km per year. So this car is consuming 32×10^2 kWh/y. Hence, approximately, all the 8×10^5 cars on the move are consuming 2.5×10^6 MWh/y.
This consumption asks for a capacity of about 300 MW solar and/or wind power. Caveat, now the availability comes into play(i.e., security of supply and security of availability). This results in an efficiency of about 10%. Consequently, for these cars on the road we need a production capacity of 3000 MW.

9.Energy Transition and the societal consequences.

The Netherlands is a liberal[13] representative democracy. So the citizens may expect the lawmakers(legislators) in the House of Representatives to look into the problems related with the complexity of transition and the chaotic start described in the next section. However, in The Netherlands we have a situation. Government has delegated the discussion about transition to so-called platforms. No lawmakers(legislators) involved.
In De Volkskrant June 9th 2018 a survey is presented of the possible societal consequences of energy transition. The title of this survey reads: "Divide the pros and cons of the green revolution in a fair way". Political attention of the related problems is of major importance. The legislative-and the executive branch of government have to pay attention to the problems related with transition in due time. Do not forget about time consuming law -and rulemaking. In this survey my attention was specially attracted by the tacit assumption of the availability of the technology needed to make the transition work.
Without proven technology for storage there is no security of supply as mentioned before. It will take at least a decade or more to show up with mature grid scale battery storage.
In addition it is almost a hoax to make the people believe by consuming electricity they contribute less to greenhouse gasses. Nonsense, the residential electricity consumer is contributing more. Rebound effects included. The consumer thinks electricity to be a sustainable energy. Oh, what an "Energie Wende".

10.Transition

In The Netherlands Transition means to be in the year 2050 only dependent on sustainable energy sources. For the household market this translates into solar- and wind power.
Transition deals with the process: How to reach B(2050) started at A(2018)?

[13] Liberal: The Economist September 15th , 2018.

For B we have to deal with the assumption no natural gas in 2050. I suppose in the transition period we have to rely on natural gas of the same amount as consumed in 2018.
Let's start in 2018 with an example of an alarming story.
In Dutch newspapers you can read stories about household willing to be disconnected from the gas grid and rely only on electricity produced by their solar panels. Oh, by the way, when the sun does not shine obviously the electricity grid, high-and low voltage, is there as a backup. What is alarming, people takes electricity "from the grid" for granted. It comes "out of the wall", just like that. In addition these consumers are happy and proud to tell you that they are contacted by the electricity supplier, the low voltage grid operator, about their strongly fluctuating electricity intake of the grid. They do not have any idea what will happen when a couple of neighbours are also disconnected from the gas grid. A black-out.
This just an example, a small scale residential one.
In The Economist(December, 22nd 2018) you will find more on the subject matter.
What I did not expected the problems related with solar power arise so soon in The Netherlands. However, an additional surprise, the problems showing up in rural areas and not so much in urban areas. This is due to the solar farms operating in rural areas. The grid out there cannot cope with the energy produced.

10.1 Intermezzo: An Hilarious Solar Park Operator/supplier's proposal

As mentioned above problems with grid capacity already arises in rural areas. One of the solution presented by a solar park operator/supplier in January 2019 is to disconnect the solar park from the grid when the grid capacity is insufficient. Well, you cannot believe your eyes. When is the grid capacity insufficient? Indeed, during a period with a lot of sunshine. So, disconnect the solar panels from the grid when the sun shines and reconnect them to the grid with no sun. Subsidies have been collected. So, what is the problem? Problem solved.
End of intermezzo.

There is also a large scale version negligence. In one of the counties in The Netherlands a large wind park will be developed(2018). The capacity of this park is planned to be 320 MW. The legal structure of the park is limited liability company subsidised by the tax payer. The taxpayer is not a shareholder. 320 MW and no robust storage system. The park will be connected to the national grid. Consequently the incumbent power producer is faced with an additional 320 MW power fluctuation. This is obviously the lower limit, since peak demand will be much higher. One could call this free riding on fossil fuels. By the way fossil fuels originate from biomass. The project manager of this 320 MW wind project mentioned this capacity sufficient for 280.000 residential units. No wind? No problem, natural gas is still out there. Furthermore, peak capacity is not indicated.
Both examples indicate the problems we are facing. It is really worrying. The start of the transition in this way can become rather chaotic. The solutions for grid stability and integrity are rather complex to say the least.
Back to "from A to B".
Obviously you need to know what B most probably looks like.

In the section The Problem, I made an estimate of the capacity needed in order to live without natural gas. In that section it was found the capacity needed at the doorstep of the Dutch households to be 7000 MW. Taking into account the extremes and capacity needed for accidents the actual number is 8500 MW. This capacity, I repeat myself, is based on security of supply and security of availability. I translated this security with an efficiency of about 10%. This could be considered unrealistic. I have no problem with this consideration. The alternative is a massive storage system or swing production based on natural gas of at least 5000 MW.
In the block below an example is given based on a not too unrealistic capacity distribution. I consider it to be a lower estimate.

> To illustrate this by a not too unrealistic example. Divide the year in the four seasons. Half of the yearly gas consumption , 5.5×10^{10} kWh given in the section The Problem, for the households is used for taking a shower and things like that: 2.75×10^{10} kWh. This is a homogeneously, at least on a daily basis, distributed consumption pattern. This can be produced by a capacity of 3500 MW. However, heating does not show such an homogeneous pattern. Assume this consumption to be zero during the summer season, 1.375×10^{10} kWh in the winter season, 0.6875×10^{10} kWh in spring and 0.6875×10^{10} kWh in autumn. From this example you will notice the capacity in the winter season to be: 3500 MW$+7000$ MW$=$ 10500 MW . Taking into account the extremes and capacity needed for accidents the actual number is about 12500 MW. If we assume the energy supply for household solely based on solar- and wind power, including extremes and accidents, we need something like 85 GW. You may conclude this latter number based on an efficiency of the supply chain of about 10 %. Obviously you can plug in another number. However, it is important to make an quantitative analysis. This 85 GW is the 2050 situation. Just on solar- and wind power.

Now the next question to be answered is: how much storage capacity do we need in the grid? Alas, it will look like an educated guess, since going “from A to B” is not an abrupt change. It will be a continuous process. I think we need a number for the storage capacity at our “doorstep”. I guess we need something of the order of 100GW, taking into account the security of supply and availability of solar -and wind power. This distributed storage capacity has to be integrated in the grid. A grid that needs to be reliable and stable.
You can make various scenarios for the equilibrium-2050 situation. Scenarios based on hourly energy consumption. Does modelling of the various scenarios make sense? May be. Going “from A to B” is a rather complex process with a lot of players involved. So starting with A, the final B you obtain can be totally different of the B you thought off in the first place. If we take care of the unknown final B in the scenario’s then the modelling makes sense.
Households, those who can afford it, are installing solar panels. Wind farms are built in various communities and counties. The grid operators are busy to cope with increasing fluctuations of the energy supply without a mature intelligent grid. The households installing solar panels are somehow conditioned to consider electricity as a natural given resource. They take electricity “from the wall” for granted. So local, regional and national politicians need to start to communicate the problems resulting from the lack of a mature and reliable storage system. Up till now, 2018, politicians like to talk about B. Talking about B does not make it happen.

People installing solar panels should be aware of the problems related with a lack of storage capacity. As a wake up call these private investors should oblige to the same rules as the incumbent power producers and distribution companies. With no compliance, a fine has to be paid. In addition, these private installers of solar panels should be forced by law to install storage capacity. A capacity sufficient to storage a day production of their panels, say. Furthermore this capacity needs to be increased, by law, with 10% each year, say.

A scenario: Let 's say within about 5 years, no wind and no sun and about 3° C. What will happen? Insurrection, revolution?

11.Newspeak

- Intelligent grid ≡ no massive storage system available.
- Residences disconnected of the gas grid ≡ the connection is replaced upstream but is still there at a huge cost.
- Energy neutral ≡ more electricity needs to be produced by means of gas and/or nuclear energy.

12.Discussion and Conclusions

Conclusion: The Netherlands without natural gas? A technical problem? No?
To replace the household gas consumption by electricity, a capacity based on a not too unrealistic model of 12500 MW is needed. Which fuel? I assumed coal and uranium. Will that happen? I think not. These fuels are just for base load operation.
So we need to have an idea what to do. Expect natural gas to play a key role.

Conclusion: *Low-Hanging Fruit* . In the chapter on The Problem, an energy conservation program is mentioned. This can be considered a lower estimate, since in The Netherlands about 30% of the houses are poorly insulated. But still, let us start with this energy conservation program. Then we obtain with this so-called low-hanging fruit a reduction in natural gas consumption of 3 billion cubic meters. With 1 cubic meter of natural gas we produce about 1 kilogram of carbon dioxide. So by better insulating the houses we reduce relatively easy the amount of carbon dioxide ejected in the atmosphere.

Conclusion: It needs to start with a communication and a dialogue of our political representatives, lawmakers(legislators), about the real problems, costs for example of the steps to be taken in the process of transition. No newspeak shall be used like feed-in tariffs in order to explain the problems. Just tell the consumer, the constituencies, to reduce the dependency on fossil fuels comes with a cost.

> The communication has been started February 2019. It became a drama. The executive used out of date numbers published by one of their Policy Institutes. The costs were estimated far too low. What happened next? An old fashioned way of blaming the messenger. We, the constituency, were told the Policy Institute produced the wrong numbers. Please politicians, you are not forbidden to use your own brains. Is it too much for you to find out, ask a question, whether the data were already obsolete? Data of 2017. It was not an entertaining moment for our liberal democracy. Not of great help to stimulate an energy transition programme.

Explain the necessity of an investment in the residential area of € 235 billion(tax payers money) to reduce just 15 % of the total greenhouse gas production in The Netherlands. Furthermore, it is important to explain all the measures taken in The Netherlands will contribute to a worldwide temperature reduction of 0.0003%(Het Financieele Dagblad December the 29th 2018). Do not let the populists do the job.
As an example the analysis in this paper is based on 30% energy conservation. This can be done by better insulating the houses at a fraction of € 235 billion.
Politicians have to communicate energy conservation comes with a cost. Hopefully, a cost equal or less than the net present value of the conserved energy.
Explain to the constituents in the past we never accounted for the real costs of fossil fuels.
Our lawmakers(legislators) should not delegate their task of dialogue and communication to people with all kinds of fancy thoughts about technology of which the maturity is still behind the horizon. And about the process of implementation of this technology by referring to the conversion in the past of so-called town gas to natural gas. Politicians should protect the citizens from such snake oil salespeople.
Since this conversion from central heating boilers fuelled by natural gas into heat pumps fuelled by electricity will one of the major parts of the transition process. Explain to the people eligibly for choosing the legislation of our liberal democracy how the electricity is produced without any wind, too much wind or no sun. In that situation, it will be by natural gas. So prevent representatives of single issue organisations to explain the necessity of getting rid of natural gas, since it is impossible. People need to know without wind or sun, electricity will be produced by natural gas. In that case it is a small step to conclude with your old fashioned condensing central heating boiler to produce less greenhouse gasses than with your electrical fired heat pump. Electricity produced in the latter case by a natural gas fired central power plant.
So, politicians speak up. Do not let single issue representatives play your role. These people are not interested in your constituents. They think to be always right and, caveat, act in the so-called general interest like any dictator. In addition these people think massive subsidies will do the transition work and stimulate innovations. At the contrary, massive subsidies will stifle innovation.

So, a clear picture is needed. If not, people will make up their own reality.
See the example in the block below.

Sitting in your armchair, listening to the discussions of the legislators(m, w) in the House of Representatives (Tweede Kamer) on climate change and the essentials, a hoax comes to your mind. Why is that?
The depletion of the Groningen gas field leads to a reduction of income for the government. To solve the resulting budgetary problem the usual suspect is to raise taxes. However, this is not communicated. The government's reasoning is, supported by the legislators is to increase the costs of natural gas delivered at the doorstep in order to stimulate(sic) sustainability in the residential energy market, i.e. to reduce the consumption of natural gas to zero. Keep in mind, from the discussion above we learned about the necessity of natural as the swing fuel for electricity production. In addition the budgetary problems are (partially) solved by increased electricity consumption due to all kinds of electronic equipment and the rebound effect. By raising the

tax on natural gas the government thinks to stimulate energy conservation and a transition into electricity consumption. A sort of push system. Well, just a prediction, not changing this push system into a pull system by the residential energy consumer will lead to chaos. What to do about the “stranded assets” resulting from the reduction of natural gas consumption? For example , you have just installed a high efficiency central heating boiler. Depreciate it overnight? So, unless politicians, legislators and the executive branch, start to communicate, conspiracy is around the corner: tax increases disguised after the veil of the climate change program to compensate for the depletion of the Groningen gas field.

12.1 Intermezzo. The decline and fall of liberal democracy

The task of the politicians in The Netherlands becomes more complicated due to the actions taken by single issue associations without political responsibility. Obviously, the actions of those groups are not the real problem. The problem arises when these groups want to be right by means of the courts, the judiciary. One of the branches of the Trias Politica without political responsibility. Then it can happen and it happened(October 2018): a judge side stepping into another branch of the Trias Politica, i.e. the legislation with political responsibility. The vulnerability of our democracy is illustrated by the support given by an opposition party of the verdict. An opposition party of the House of Representatives; the legislators.
End of Intermezzo.

Where does the electricity for the heat pumps really comes from? Wind- and solar power? Wind – and solar power, sustainable energy? It is almost an oxymoron. Capacity problems and grid integrity is not paid attention to. Storage problems will last for a considerable time. Keep in mind the amount of time it takes before a mature storage system penetrates the market in a massive way, 25 years? We do have some experience in this respect. Think of the introduction of electricity in the past. Yergin(page 559): ”’Even accelerated energy transformation will take decades’. Adding to the challenge is the complexity of systems integration. Combining three of four dozen technologies for a smart grid system is far more difficult – and time consuming - than coming up with a new iPhone app”.
Calamities will occur.[14]
The ink is not yet dry of the publicity on heat pumps or Hydrogen becomes **the** replacement for natural gas. Confusing? Yes it is. Well, you have just installed an electrical driven heat pump and all of a sudden in the area where you live Hydrogen is considered to be better to prevent climate change. Please politicians, speak up. Again and again a comparison is made with the conversion of town gas into natural gas. An activity performed some 60 years ago. A conversion an order of magnitude or more smaller than the conversion/transition needed now. Again, politicians speak up. Do not leave this to the so-called specialist lacking the overall view.

---

[14] It happens much sooner than expected. In the beginning of May 2018, no sun and no wind. Capacity shortage did almost happen. Still we are faced in The Netherlands with, order of magnitude, just 10% of the energy supply by sun and wind. Gas powered energy supply is needed as a backup.

In addition government should not pick winners[15] in order to stimulate conversion(Noordzij,2). This system of picking winners will result into a waste of taxpayers' money.
Without Natural Gas after closing of the Dutch gas fields? I hope not. Let's buy some time in order to construct LNG-equipment. To cite Yergin: "Gas-fired generation would swing into action when the wind dies down and the sun doesn't shine". Is this what the Dutch households are told and might hope for?
Conclusion: Without a storage system solar-and-wind power just add to the incumbent power production. The latter based on gas, coal, oil and nuclear. Of these four, gas is the swing fuel, i.e. the back-up fuel.

Gas fired centralized power generation is what we need at least to mitigate to some extend the fluctuations on the grid due to solar- and wind power. Fluctuations which can lead to brown-outs and, even worse, blackouts. Do not forget the gas fired swing system does contribute to the greenhouse gases. Admitted, in a lesser extend than without solar- and wind power. To rap it up: we still need natural gas to mitigate intermittency of wind power not residential distributed, but a centralized system. That will come with a cost. These costs are not communicated with the consumer. Another serious problem.
Yergin mentioned in his book , page 610, (some argue) the possibility of high quality wind resources that are spread out from one another. What does that mean? Suppose we install a wind farm of nominal capacity on the North Sea of 1 GW. This farm exists for example of 100 wind turbines 10MW each. Now one day you sail from Rotterdam Europoort to Newcastle up on Tyne. The North Sea as flat as a pancake. Can that be? Yes it can. So, as a consequence, you need another-mirror- wind farm of 1GW located at a place with high-quality wind resources producing wind power with a security of supply of 95%. Hence each wind farm installed has another 1GW windfarm backup system with a security of supply of 95% and vice versa if and only if you want to get rid of natural gas for your backup system. Costs? Comparable with a storage system?
Conclusion: This 1 GW nominal back-up-or better called mirror-windfarm can be a benchmark, sort of, for a storage system. Or for the swing production system fed wit natural gas. Dependent on the efficiency of the windfarm, 30-50% say, we need a 300-500 MW gas fired power plant. The load following source.
Note: with efficiency I mean real efficiency, i.e. output divided by input. Security of supply is something totally different.

[15] These days (March 2018) the conversion technology for the heating of the houses is proposed to be a hybrid system of a heat pump(electrical driven) and a gas fired boiler. A gas fired boiler? This sounds already as an oxymoron. Spectacular energy saving numbers are communicated. Well, is there any idea about the relation of the outdoor temperature and the efficiency of this so-called hybrid system? During a rather cool winter the COP of the heat pump can fall by about 50%. In addition, this hybrid system indicates another conversion. Another conversion, when natural gas is no longer distributed. This hybrid system is already reality. Rather modern apartment buildings equipped with a heat pump as a central heating system need an auxiliary gas fired boiler for winter time and warm water with a temperature of $60°$ C(health).

Conclusion: For the baseload the option with an equal carbon footprint as solar we need nuclear power plants (Rhodes, page 324).

In The Netherlands the executive started with some action to get rid of natural gas. How? Well, the start is with lowering the tariffs of electricity and raising the tariffs of natural gas. Why? To stimulate the replacement of central heating boilers fired by natural gas by heat pumps fired by electricity. Will people invest on a significant scale in heat pumps? Obviously not. Lowering the tariffs of electricity results into an increase of electricity consumption. A rebound effect, sort of. The consumption of natural gas will not decrease. Et voila, a miraculous increase of greenhouse gases.

Do we contribute in the Netherlands to lowering the depletion greenhouse gases on a world scale? Hardly.
The Economist August 4th 2018, Briefing on Indian Energy, *The Black Hole of Coal.* There you will find sobering conclusions. Like the conclusion: "If demand for electric cars picks up, with growth in the number of electric vehicles, for example, coal may become yet more important in the energy mix and the gains from burning less petrol will be offset".
Well, this offset mentioned by The Economist is already happening in China. There, considering energy from "well head to burner tip", electric vehicles are more polluting than vehicles using gasoline for internal combustion.
Well, reading about India can be very instructive (The Economist, December 8th – 14th , 2018)
"Nothing can be done to save the world as we know it, so nothing need to be done" . The Atlantic, Science Section, September 2018. Cited from the book of W. T. Vollmann: *Carbon Ideologies, Vol. I, page3.*
Cynical? No, very realistic. A few numbers:
about 1 billion people without electricity. Let's supply them with one light bulb of 50 Watt.
The capacity needed is 5×10^4 MW. So for a little bit of light we do need 50 powerplants of 1000 MW each. Well, one could remark this capacity to be small beer with respect of the world capacity of about 20-25 billion GW. However, these 1 billion people are also longing for air conditioning, etc. In The Economist February 9th 2019 this subject is further illustrated in the International section.
By the way, do we know how much agriculture contributes to the greenhouse gases? Could it be possible that this contributions dwarfs the residential contribution due to energy consumption?

13.Epilogue

The above discussion seems to be small beer after reading The Atlantic July/August 2018 issue: Scientist Uncovered a Disturbing Climate Change Precedent . Summary: "During the rise of mammals, Earth temperature spiked in a scary way that the planet may experience again soon". The carbon captured millions of years ago, will be released in our time in a very short period. So there is nothing mysterious about a much higher carbon dioxide content, not to mention methane, of the earthly atmosphere".
What is the above discussed transition all about? Well, alas it most probably is "Kurieren am

Symptom".
To cite Revelle at Harvard(Yergin, page 451): "By bringing fossil fuels to the surface and burning them, human beings are simply returning the carbon and oxygen to their original state".
Is climate change considered to be a problem in The Netherlands? I do not know. After having installed your solar panels, you think you did a great job. So it is time to regale yourself with a vacation on Bali. The so-called rebound effect (The Economist October 27th 2018). Just a few tons of carbon dioxide needed.
Do we need:

13.1 Child Crusade and Climate Change.

February 2019. K12 pupils are demonstrating in The Hague(Governmental and legislative residence of The Netherlands). To what avail? It's great to see children demonstrating against climate change. It would be much better to see children convincing their parents not crossing the Netherlands from north to south and from east to west during the weekend in order to do something jolly("Leuk", in Dutch). To convince their parents not to spend vacation/holidays in Thailand, Bali, South America, etc, to mention a few places outside The Netherlands.

"The earth, a green house planet of the past and of the future".

14.Literature.

Brannen, P. *Scientist Have Uncovered a Disturbing Climate Change Precedent*, The Atlantic Science section July/August, 2018.

De Volkskrant-Sir Edmund, *Iedereen het net op,* 3 maart nr. 2, 2018.

De Volkskrant-OPINIE, *Verdeel de lusten en de lasten van de groene revolutie eerlijk*, 9 juni 2018.

Gutman, R., Dozens of Massachusetts Homes Exploded. A Gas Expert Weighs In. The Atlantic, Science Section, September 2018.
Het Financieele Dagblad, ……*maar de verbouwing kan slimmer en goedkoper*, December 29th 2018.

Jain, S., et al, *Hydrogen: Value Chain and its Challenges as a future Fuel*, Formatex Research Center, www.formatex.info , 2013.

Kaplan, R.D.*, In Europe's Shadow, Two, cold wars and a Thirty-year journey Through Romania and Beyond*, www.Randomhousebooks.com , 2016.

Noordzij, L., *Democracy and its Vulnerability*, www.leennoordzij.me , 2018 .

Noordzij 2, L., *Innovation and its Fallacies*, www.leennoordzij.me ,2018.

Noordzij 3, L, *Government and Innovation*, www.leennoordzij.me , 2018.

Rhodes, R., *ENERGY a human history*, Simon & Schuster, 2018.

The Economist, *Smooth operators*, Technology Quarterly, December 6th 2014.

The Economist, *Reinventing Wheels*, *A special report on Autonomous Vehicles*, March 3rd 2018.

The Economist, *Geopolitics of Energy*, A Special Report, March 17th 2018.

The Economist, *Beauty and long life*, Business section, July 21st 2018.

The Economist, *The blackhole of coal*, Briefing on Indian energy, August 4th 2018.

The Economist, *In praise of air-conditioning*, Leaders, August 25th 2018.

The Economist, *The Economist at 175, Reinventing liberalism for the 21st century*, September 15th 2018.

The Economist, *Energy Efficiency*, Section Finance and Economics, October 27th 2018.

The Economist, *The Environment in India, Poisson all around,* December 8th 2018.

The Economist, *Distributed energy, Solar eclipsed*, Business section, December 22nd 2018.

The Economist, *Electricity for the poor and What light reveals*, International section, February 9th 2019.

Vollmann, W. T., *Carbon Ideologies, Vol. I&II*, VIKING/Penguin, 2018.

Yergin, D., *The Quest: Energy, Security, and the Remaking of the Modern World*, The Penguin Press, 2011.

Appendix 1: an example.

Nowadays you can find in your in-box offers to install solar panels on the roof top.
Let's consider such an offer to represent the mean possible solar system per house. I will use the numbers given in section The Problem.
On the basis of 10 solar panels about 2.4 MWh will be produced. Obviously without a storage system. Consequently the grid is considered to be the storage system.
In the foregoing sections we explained the need to replace 5.5×10^{10} kWh natural gas equivalent. Keep in mind: a massive energy saving program is involved.
With the energy production of 10 solar panels, you find the number of solar panels to replace 5.5×10^{10} kWh natural gas equivalent: 2.4$\times$ 10^{8} solar panels.

The investment for 10 solar panels, tax credit included, is € 3500. So the total investment for 2.4×10^8 solar panels is € 85 billion. To make the comparison with natural gas, a storage system is necessary. It is rather difficult to give a number for the costs of a storage system.
In order to make a complete picture we also need a number for the costs of replacement and conversion of a heating system. I infer the use of heat pumps with a sufficient large COP in order not to need auxiliary equipment in the winter season. How many heat pumps do we need? Well, it depends on the number of houses. On the basis of the solar panels, 10 per house, the number of houses should be: 24×10^6. That is certainly not the case. The number of houses is about 6 million. So we see at once the possibilities of solar system: including a reliable storage system the solar power produces about 25 % of the energy needed[16]. I repeat myself time and again: no storage system involved.
With the number of houses estimated to be 6 million, the investment for installing heat pumps(conversion) becomes 6 million times the costs of installing a heat pump. I estimate the costs of installing a heat pump to be € 10.000. Hence the total costs are € 60 billion.
Notice the number mentioned in the section on Further Considerations on Dealing with The Problem. There the amount of about € 100 billion for a particular segment of the housing market is given: € 100 billion. By the way both conversion costs are of the same order of magnitude.
For a given household consumption of 1000 m^3/y, we find the equivalent 10 MWh. Well, with 10 solar panels the production is 2.4 MWh. So additionally about 7.5 MWh is need to be produced by wind power to have an equivalent of about 1000 m^3/y. As we know, this equivalence is based on simultaneity. This is most certainly not the case. Most of the 1000 m^3/y is consumed in wintertime and most of the 2.4 MWh is produced during summer time. Again, storage capacity is needed.
About 50 % of the 1000 m^3/y is homogeneously consumed on a daily basis for the production of warm water. This equals 1.25 MWh in a ¼ year. Let's assume 80% of 2.4 MWh solar power is produced in a ¼ year. From these numbers the conclusion can be drawn for the need of a daily storage capacity of .625 kW. Batteries for this capacity are available.
To cover 1000 m^3/y , 7.5 MWh produced by wind power is needed. Wind power will be produced more centrally. This is makes the storage problem a bit easier to be solved.

Appendix 2: Efficiencies.

I used various numbers for the efficiency of solar- and wind power. Sometimes 30%, sometime 10%. This illustrated some ambiguity to say the least. Why different numbers and what is efficiency meant to be?
A metaphor:
A person is willing to cross a river. This person can not swim and the mean depth of the river is 1 meter. The height of this person is 1.8 meters. Would you advise this person to cross the river? For solar- and wind power capacities are given. Are these capacities mean values based on a

[16] I did not include so-called solar panel parks(farms). With solar parks included about 50% of the energy is produced.

particular availability and yearly production? Not knowing this is not reassuring. Since for example at the very moment you need peak capacity it occurs no sun and no wind available. So what is the efficiency of a non-available production system?
Suppose we have an output of a particular wind turbine. Then we have a so-called capacity factor. This factor is defined to be the total yearly production of the wind turbine divided by the maximal possible production. This factor is about 30%. So when a capacity of a turbine is mentioned the nominal or maximum capacity is meant.
Further reading on Wind farms: www.nl.mwikipedia.org *Wind Energie.*