

# Overview of the selected/proposed gas and electricity TYNDP 2018 2040 story lines

Date: 19 September 2016

## Contents

<b>1. OVERVIEW OF ALL THE THREE 2040 SCENARIOS .....</b>	<b>3</b>
<b>2. SCENARIO GLOBAL CLIMATE ACTION .....</b>	<b>4</b>
<b>3. SCENARIO SUSTAINABLE TRANSITION .....</b>	<b>7</b>
<b>4. SCENARIO DISTRIBUTED SCENARIO .....</b>	<b>9</b>

## 1. Overview of all the three 2040 scenarios

Scenario		Global climate action	Sustainable Transition	Distributed Generation
Category	Criteria	Parameter		
Macroeconomic Trends	Climate action driven by	Global ETS	EU ETS & direct RES subsidies	EU ETS
	EU on track to 2030 target?	Beyond	On track	Slightly beyond
	EU on track to 2050 target?	On track	Slightly behind	On track
	Economic conditions	High growth	Moderate growth	High growth
Transport	Electric and hybrid vehicles	High growth	Moderate growth	Very high growth
	Gas vehicles	High growth	Very high growth	Low growth
	Demand flexibility	High growth	Moderate growth	Very high growth
	Electricity demand	Moderate growth	Stable	Moderate growth
Residential / Commercial	Gas demand	Reduction	Slight reduction	Reduction
	Electric heat pump	High growth	Low growth	Moderate growth
	Energy efficiency	High growth	Moderate growth	High growth
	Hybrid heat pump	High growth	Moderate growth	Very high growth
Industry	Electricity demand	Stable	Stable	Moderate growth
	Gas demand	Stable	Stable	Reduction
	CCS	Low growth	Low growth	Not significant
	Demand flexibility	Moderate growth	Low growth	Very high growth
Power	Merit order	Gas before coal	Gas before coal	Gas before coal
	Nuclear	Depending on national policies	Reduction	Reduction
	Storage	Moderate growth	Low growth	Very high growth
	Wind	High growth	Moderate growth	High growth
	Solar	High growth	Moderate growth	Very high growth
	Other bio-energies	Moderate growth	Moderate growth	High growth
	CCS	Not significant	Not significant	Not significant
Adequacy	Some surplus capacity	Some surplus capacity	High surplus capacity	
Non-fossil gas sources	Power-to-gas	High growth	Not significant	High growth
	Bio Methane	High growth	High growth	High growth

## 2. Scenario GLOBAL CLIMATE ACTION

The “Global climate action” story line considers global climate efforts. Global methods regarding CO<sub>2</sub> reductions are in place, and the EU is on track towards its 2030 and 2050 decarbonisation targets. An efficient ETS trading scheme is a key enabler in the electricity sector’s success in contributing to Global/EU decarbonisation policy objectives. In general renewables are located across Europe where the best wind, solar resources are found. As non-intermittent renewables bio methane is also developed. Due to the focus on environmental issues no significant investment in shale gas is expected.

A CO<sub>2</sub> market price provides the correct market signals that trigger investments in low-carbon power generation technologies and for flexibility services. A technology-neutral framework is established, which supports especially investments in renewables. Power-to-gas becomes a commercially viable technology for use as energy storage. The CO<sub>2</sub> price makes natural gas fired CCGTs appear before coal in the merit order. Gas-fired units provide flexibility needed within the power market, helping facilitate intermittent renewable technologies within the market. Nuclear mostly depends on Country specific policies and there may be potential for some minimum new units in some countries. Carbon capture and storage is not an economically viable option but it still represents technically viable option for industries whose processes are characterized by high loads factors. System adequacy is driven by price signals, which allows market-based investments in peaking power plants to be made.

The efficient and widespread implementation of global climate schemes prevents carbon leakage between countries, therefore improving the relative competitiveness of energy intensive industries within Europe.

Electricity and natural gas are both key components for the transport sector in reaching emission reduction goals. The impact of electrification is that demand for electricity use in the private and small commercial transportation sector increases. There is an increase in the use of LNG for the transportation especially where electricity does not represent an alternative fuel, such as heavy goods and shipping sectors. There is a limited penetration of hydrogen vehicles.

Electric and hybrid heat pumps are a significant technology in heating sector, helping to offset the use of fossil heating fuels. All electric heat pumps are installed in new high efficiency buildings, while hybrid heat pumps are installed in existing lower efficiency buildings with an existing gas connection. Together with electric and hybrid heat pumps, district heating plants represent an efficient solution.

Demand response in both industrial and residential sectors has increased - increased automation and internet of things gives consumers the option to move their demand to the lower-priced hours. The overall impact of energy efficiency is higher on the residential sector while offset by strong economic growth in the industrial sector. Demand flexibility is also a key factor ensuring system adequacy due to its ability to shift demand peaks.

Yearly electricity demand has increased in various sectors; overall electricity demand growth is limited by increasing energy efficiency. High GDP growth means that people invest in high efficiency produces such as, lighting, computers, and white goods all of which help to reduce the overall residential energy consumption.

Yearly final gas demand is increasing in the transport sector whilst decreasing in the residential sector, driven mainly from improvements in technology efficiencies and building insulation measures. Gas demand stable in the industrial sector where the impact of energy efficiency measures offsets the increase due to the strong economic growth. Gas is required for peak demand situation, such as, cold weather conditions. Industrial gas demand for heating is stable in this scenario.

Factor		Scenario Overview				
Scenario		Global climate action	Sustainable Transition	Distributed		Distributed
Category	Criteria	Parameter				
Macroeconomic Trends	Climate action driven by	Climate action low	EU ETS	EU ETS & direct RES subsidies	Global ETS	Global ETS & direct RES subsidies
	EU on track to 2030 target?	Behind	Slightly behind	On track	Slightly Beyond	Beyond
	EU on track to 2050 target?	Behind	Slightly behind	On track	Slightly Beyond	Beyond
	Economic conditions	Low growth	Moderate growth	High growth		
Transport	Electric and hybrid vehicles	Low growth	Moderate growth	High growth	Very high growth	
	Gas vehicles	Low growth	Moderate growth	High growth	Very high growth	
Residential / Commercial	Demand flexibility	Low growth	Moderate growth	High growth	Very high growth	
	Electricity demand	Reduction	Stable	Moderate growth		
	Gas demand	Reduction	Stable	Moderate growth		
	Electric heat pump	Low growth	Moderate growth	High growth	Very high growth	
	Energy efficiency	Low growth	Moderate growth	High growth	Very high growth	
	Hybrid heat pump	Low growth	Moderate growth	High growth	Very high growth	
Industry	Electricity demand	Reduction	Stable	Moderate growth		
	Gas demand	Reduction	Stable	Moderate growth		
	CCS	Not significant	Low growth	Moderate growth	High growth	
	Demand flexibility	Low growth	Moderate growth	High growth	Very high growth	
Power	Merit order	Coal before gas	In par	Gas before coal		
	Nuclear	Reduction	Stable	Minimum new units	Potential for growth	Depending on national policies
	Storage	Low growth	Moderate growth	High growth	Very high growth	
	Wind	Low growth	Moderate growth	High growth	Very high growth	
	Solar	Low growth	Moderate growth	High growth	Very high growth	
	Other bio-energies	Low growth	Moderate growth	High growth	Very high growth	
	CCS/U	Not significant	Low growth	Moderate growth	High growth	
	Adequacy	Low surplus capacity	Some surplus capacity	High surplus capacity		
Non-fossil gas sources	Power-to-gas	Not significant	Low growth	Moderate growth	High growth	
	Bio Methane	Not significant	Low growth	Moderate growth	High growth	

### 3. Scenario SUSTAINABLE TRANSITION

In "Sustainable Transition" story line, climate action is achieved with a mixture of national regulation, emission trading schemes and subsidies. National regulation takes the shape of legislation that imposes binding emission target. Overall, the EU is just on track with 2030 targets resulting slightly behind the 2050 decarbonisation goals. However targets are still achievable if rapid progress is made in decarbonising the power sector during 2040's.

The economic climate in the Sustainable Transition scenario is moderate growth, regulation and subsidies are achievable since there is the capital available by national governments to fund RES projects (both intermittent and non-intermittent). There is a societal ambition to support and participate in climate action, as long as the climate action is seen to be managed in a cost effective way. As a result shale gas is not developed significantly.

Gas-fired power generation flourishes due to relatively cheap global gas prices and strong growth of bio methane. A regulatory framework in place decreases the use of coal-fired power stations. Gas-fired generation provides the necessary flexibility to balance renewables in the power system. There is a decrease in CO<sub>2</sub> emissions since much coal fired base load power generation retires or is out of merit due to a reasonably high ETS Carbon prices and governmental policies. Depending on national policies there could still be room for a minimum number of new units but overall number of nuclear plants in Europe is decreasing. Carbon capture and storage does represent a viable option in industries for those processes characterized by high loads factors. Efficient electricity market and strong price signals ensure necessary investment to peaking power generation, with gas being the preferred fuel. In this context there are increasing investments in Power-to-Gas as in order to optimise the use of available capacity either in gas or electricity network and taking benefit of huge gas storage capacity

There are no significant changes in the heat generation; in most countries, gas will remain the most prominent source, however the use will decrease due to increasing energy efficiency. Hybrid heat pumps are considered an option in new buildings. Industrial gas and electricity demand is relatively stable. Development of energy efficiency is moderate. Driven by cheap gas prices natural gas is the preferred option for passenger cars to switch from oil in reaching emission reduction goals while electricity use for residential transport is growing moderately. Increase in the LNG use in heavy goods and shipping sectors. There is a limited penetration of hydrogen vehicles.

Overall electricity demand stagnates or grows moderately. Use of gaseous fuels increases for transport and power generation, but slightly decreases for heating.

Factor		Scenario Overview				
Scenario		Global climate action	Sustainable	Distributed		
Category	Criteria	Parameter				
Macroeconomic Trends	Climate action driven by	Climate action low	EU ETS	EU ETS & direct RES subsidies	Global ETS	Global ETS & direct RES subsidies
	EU on track to 2030 target?	Behind	Slightly behind	On track	Slightly Beyond	Beyond
	EU on track to 2050 target?	Behind	Slightly behind	On track	Slightly Beyond	Beyond
	Economic conditions	Low growth	Moderate growth	High growth		
Transport	Electric and hybrid vehicles	Low growth	Moderate growth	High growth	Very high growth	
	Gas vehicles	Low growth	Moderate growth	High growth	Very high growth	
Residential / Commercial	Demand flexibility	Low growth	Moderate growth	High growth	Very high growth	
	Electricity demand	Reduction	Stable	Moderate growth		
	Gas demand	Slight reduction	Stable	Moderate growth		
	Electric heat pump	Low growth	Moderate growth	High growth	Very high growth	
	Energy efficiency	Low growth	Moderate growth	High growth	Very high growth	
Industry	Hybrid heat pump	Low growth	Moderate growth	High growth	Very high growth	
	Electricity demand	Reduction	Stable	Moderate growth		
	Gas demand	Reduction	Stable	Moderate growth		
	CCS	Not significant	Low growth	Moderate growth	High growth	
Power	Demand flexibility	Low growth	Moderate growth	High growth	Very high growth	
	Merit order	Coal before gas	In par	Gas before coal		
	Nuclear	Reduction	Stable	Minimum new units	Potential for growth	Depending on national policies
	Storage	Low growth	Moderate growth	High growth	Very high growth	
	Wind	Low growth	Moderate growth	High growth	Very high growth	
	Solar	Low growth	Moderate growth	High growth	Very high growth	
	Other bio-energies	Low growth	Moderate growth	High growth	Very high growth	
	CCS/U	Not significant	Low growth	Moderate growth	High growth	
Non-fossil gas sources	Adequacy	Low surplus capacity	Some surplus capacity	High surplus capacity		
	Power-to-gas	Not significant	Low growth	Moderate growth	High growth	
	Bio Methane	Not significant	Low growth	Moderate growth	High growth	



## 4. Scenario DISTRIBUTED SCENARIO

In the "Distributed generation" story line, significant leaps in innovation of small-scale generation and residential /commercial storage technologies are a key driver in climate action. An increase in small-scale generation keeps EU on track to 2030 and 2050 targets. A "prosumer" rich society has bought into the energy markets, so society is engaged and empowered to help achieve a decarbonized place to live. As a result no significant investment in shale gas is expected.

Small-scale generation technologies costs have been rapidly declining. Technologies such as solar offer a non-subsidised option for "prosumers" in most parts of Europe. Major advances in batteries enable "prosumers" to balance their own electricity consumption within a day. Nuclear mostly depends on Country specific policies. Power-to-gas technologies become commercially viable for use as energy storage. Technological leaps in small-scale generation challenge large-scale power generation, pressurizing the profitability of traditional power plants. System adequacy is maintained through a centralised mechanism that retains enough peaking capacity, district heating CHP are suitable for both heating and electricity adequacy. The scenario has a strong ETS scheme which favours gas before coal in the power market, and an increasing share of bio fuels.

There is a strong EU climate policy in place, the decreasing cost of small-scale generation technologies drives down the cost of climate action. As solar yields are higher in Southern Europe, investments are likely to be higher in these regions, in comparison to Northern Europe.

Electricity demand flexibility has substantially increased, both in residential and industrial solutions, helping electric power adequacy. However, wintertime with high heating needs and low solar availability remains a challenge, since batteries cannot be used for seasonal storage.

Electricity and gaseous fuels are both key components for the transport sector in reaching emission reduction goals. Lower battery costs have significantly increase demand for electricity in transportation sector. There is an increase in the use of LNG for the transportation of heavy goods and also in the shipping sectors. There is a limited penetration of hydrogen vehicles.

Electric and hybrid heat pumps are a significant technology in heating sector, helping to offset the use of fossil heating fuels. With improved building efficiencies into both existing and new buildings hybrid heat pumps are the preferred option by the 'prosumer's'. Hybrid heat pumps allow the 'prosumer' to choose which source of energy to meet their heating needs. District heating CHP represent an alternative solution for residential districts.

Yearly electricity demand has increased in the heating and transport sectors, overall electricity demand growth reduced in the residential sector due to 'prosumer' behaviour, high efficiency goods and building efficiency measures. Demand responds well to market prices, the daily electricity demand profile is smoothed, the effect is that peak electricity demand is reduced in this scenario.

The yearly final gas demand is increasing in the transport sector. Annual gas demand is decreasing in the residential sector, driven mainly from all electric heating technologies, and building insulation measures. Gas is required for peak demand situation, such as, cold weather conditions. Natural gas for industrial use is decreasing in this scenario driven by electrification of industrial process heating, however gaseous fuels are still required to cover peak demands. The gas demand for other energy intensive industry processes is stable.

Factor		Scenario Overview				
Scenario		Global climate action	Sustainable Transition	Distributed		
Category	Criteria	Parameter				
Macroeconomic Trends	Climate action driven by	Climate action low	EU ETS	EU ETS & direct RES subsidies	Global ETS	Global ETS & direct RES subsidies
	EU on track to 2030 target?	Behind	Slightly behind	On track	Slightly Beyond	Beyond
	EU on track to 2050 target?	Behind	Slightly behind	On track	Slightly Beyond	Beyond
	Economic conditions	Low growth	Moderate growth	High growth		
Transport	Electric and hybrid vehicles	Low growth	Moderate growth	High growth	Very high growth	
	Gas vehicles	Low growth	Moderate growth	High growth	Very high growth	
Residential / Commercial	Demand flexibility	Low growth	Moderate growth	High growth	Very high growth	
	Electricity demand	Reduction	Stable	Moderate growth		
	Gas demand	Reduction	Stable	Moderate growth		
	Electric heat pump	Low growth	Moderate growth	High growth	Very high growth	
	Energy efficiency	Low growth	Moderate growth	High growth	Very high growth	
	Hybrid heat pump	Low growth	Moderate growth	High growth	Very high growth	
Industry	Electricity demand	Reduction	Stable	Moderate growth		
	Gas demand	Reduction	Stable	Moderate growth		
	CCS	Not significant	Low growth	Moderate growth	High growth	
	Demand flexibility	Low growth	Moderate growth	High growth	Very high growth	
Power	Merit order	Coal before gas	In par	Gas before coal		
	Nuclear	Reduction	Stable	Minimum new units	Potential for growth	Depending on national policies
	Storage	Low growth	Moderate growth	High growth	Very high growth	
	Wind	Low growth	Moderate growth	High growth	Very high growth	
	Solar	Low growth	Moderate growth	High growth	Very high growth	
	Other bio-energies	Low growth	Moderate growth	High growth	Very high growth	
	CCS/U	Not significant	Low growth	Moderate growth	High growth	
	Adequacy	Low surplus capacity	Some surplus capacity	High surplus capacity		
Non-fossil gas sources	Power-to-gas	Not significant	Low growth	Moderate growth	High growth	
	Bio Methane	Not significant	Low growth	Moderate growth	High growth	