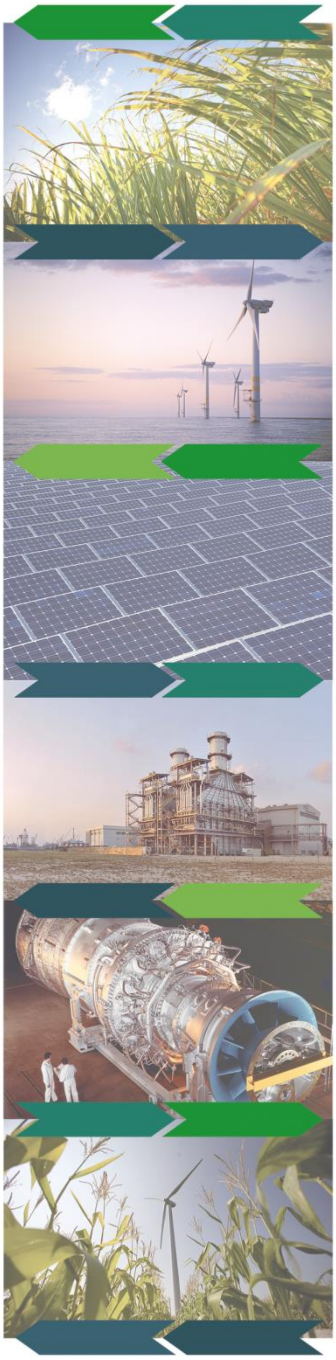
Navigating the Roadmap for Clean, Secure and Efficient Energy Innovation



Issue Paper

The role of natural gas in an electrifying Europe

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1 Introduction

Due to its moderate carbon content compared to other fossil fuels yet significant carbon content compared to renewable energy generation options, it is not yet clear for how long and what role natural gas can play in the future European energy system.

In this paper we outline issues and challenges concerning the role of natural gas in an electrifying Europe and share insights and implications obtained from analyses performed with a European and a global model for gas market and infrastructure analysis. Modelling approaches and specific model results are discussed in the Annex.

The SET-NAV project has defined and analysed four ambitious decarbonisation pathways for the EU, while envisaging alternative technologies and fuel mixes in the EU28. Natural gas, even though it tends to be the cleanest fossil fuel, will be largely removed from the primary energy mix in the pathways over the next three decades. Assumptions and modelling of the demand side (building, industry, transport, power and heat sector) result in a massive reduction in gas demand. The SET-Nav scenarios, aiming for a 95% CO_2 emission reduction, foresee a European natural gas consumption decrease of 40-75% to about 1,500-2,500 TWh/year (125-230 bcm/y) by 2050.

Considering the rapid and drastic decrease in demand for natural gas, as projected in the SET-Nav pathways, new natural gas infrastructure will not be necessary. Consequently, our gas market analysis has considered the changing role and possibilities of the natural gas markets of Europe, if the decarbonisation of the EU leads to natural gas losing its share in the energy mix.

2 Natural gas: a high or low carbon fuel?

While natural gas is less carbon intensive than many energy sources used today, longer-term usage would add significantly to the CO_2 stocks in the atmosphere. Nevertheless, in the medium term, natural gas can be a significant contributor to realising emissions reductions, and combined with carbon capture and storage (CCS) it may also be compatible with deep decarbonisation. Contrasting some aspects indicates that this is not a trivial question:

Natural gas: a low carbon resource

- Compared to other fossil-fuel based power generation the lifecycle GHG emissions of gas-fired power generation are 40% lower than oil-based, and 50% lower than coal-based power generations.[1]
- Compared to petrol and diesel, fuelling a vehicle using natural gas reduces CO_2 emissions by 12-27%, and NO_x, PM and SO_2 emissions by 70-99%.[2]

Natural gas: a high carbon resource

- Compared to renewable and nuclear based power generation the lifecycle GHG emissions of gas-fired power generation are 10-100 times as high.[1]
- Replacing all oil and coal used for power generation by natural gas today would reduce annual global CO_2 emissions by about 10 Gt only and gives only about 3-5 years extra to use up the 2°C carbon budget.[3]

[1] Based on median values Table A.II.4 *IPCC 2012 Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN) www.ipcc.ch/report/srren/*

[2] http://www.fluxys.com/belgium/en/About%20natural%20gas/fuelfortransport/CNG/CNG

[3] Own calculations based on BP and IEA WEO 2017.

- The lifecycle GHG emissions of best-case gas-fired power generation with Carbon capture and storage are lower than poorly implemented wind power and about four times as low as poorly implemented solar PV.[4]
- The methane leakage rate in shale gas production is two to four times higher than the global average for natural gas, which makes its life-cycle emissions when used in gas-fired power generation on par with or worse than coal-fired power.[5] This effect worsens when the gas is liquefied for long-distance transportation.

When discussing the future role of gas in Europe, in view of the above, it is important to consider a few key questions. These include what it is replacing, and thus if it can have a role in the medium term transition, as well as how it is produced, transported, what it is used for, and what the alternatives are. Where the emissions end up, whether in the air or captured and stored, will be a critical determinant for the role of natural gas in a decarbonising Europe in the long term. Moreover, it is of relevance that current uncertainties on the rate of fugitive GHG emissions as well as on cost and performance of CCS will be reduced and how this will work out on the resulting emissions characterisation and the cost competitiveness of power generation based on natural gas.

3 Main drivers and outlooks

3.1 Supply side drivers

Globally there is plenty of supply, both considering conventional resources in Russia, the Middle East and other regions, as well as shale gas, for instance in the USA. There are increasingly more LNG exporters, and shipping distances have become shorter with the opening of the new Panama Canal and the Northern Sea Route becoming ice-free for longer periods each year. Specifically for Europe: as of last year, the Netherlands has become a net importer. Norway is the only exporter. PCI projects have been put on hold.

3.2 Demand side drivers[6]

Growing population and GDP will drive up global energy consumption by 30% (2040 vs 2015), but most of this growth in demand will come from Asia.

Globally, industry is likely to be the most important driver of gas demand growth from 2015-2040. For some processes, natural gas is a preferred input, which is difficult to replace by something cleaner. To deliver the necessary high-grade process heat, heat pumps and electric furnaces need to be powered. Unavoidable emissions also exist, e.g. in cement, and steel production processes. These must be compensated by negative emissions elsewhere or with CCS. At present, CCS is expected to be much cheaper (starting at 50-75 €/ton).

Electric power will be the second most important driver for gas demand growth. Electrification will increase the share of electricity in Europe's final energy consumption. Rapidly falling costs of renewable power generation technologies put gas at a disadvantage. However, there will be a need for solutions that can provide large-scale back-up, flexibility and balancing in the power sector.

[4] Based on median values Table A.II.4 IPCC 2012 Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN) www.ipcc.ch/report/srren/

[5] Howart et al. (2011), IEA WEO 2017.

[6] Based on various sources including SET-Nav Deliverable 4.3, IEA, MIT, participants NETI 2018

Regional and global policy contexts will also matter, e.g. policies such as the Emissions Trading System (ETS) or carbon prices.

Demand for individual mobility and freight transport may be challenged by increasingly stringent emission reduction targets for road and water vehicles. Compressed / liquefied natural gas is quite suitable as a fuel for specific modes of transport, such as road freight, ferries, short-sea shipping and inland navigation. For fuelling long-distance transport, battery electric is at a disadvantage because of weight and low energy density.

Bio-based synthetic gas, hydrogen (blue or green), CCS, and negative emissions technologies could potentially provide opportunities for the future of gas in a decarbonising Europe. However, there are caveats to each. First of all, there will be strong competition for biomass. Blue hydrogen requires CCS to be compatible with deep decarbonisation, while green hydrogen requires significant amounts of low-carbon electricity and steep cost reductions in the electrolysing process. CCS requires development of transportation and storage infrastructure, and negative emissions technologies are not yet available at scale.

3.3 Challenges

In order to decarbonise and decentralise the European energy system over the next two to three decades, large volumes and capacities for backup, balancing and flexibility on various time scales are needed. Today, large-scale electricity storage other than hydro reservoirs is still too expensive. For different technologies, specific challenges exist:

In the short to mid-term, a large increase in hydrogen usage is unlikely. Currently, the value chain for blue as well as green hydrogen is immature. Public acceptance and perceived safety can be hurdles for implementation. Lastly, there is a clear “chicken and egg” problem as infrastructure development requires foreseeable demand for hydrogen, and demand for hydrogen needs foreseeable supply. A disadvantage of hydrogen is that, even when liquefied, its low energy content hampers the competitiveness of long-distance transport.

Similarly, in the short to mid-term, CCS is not likely to take off. It suffers from similar challenges concerning the immaturity of the value chain, public acceptance and perceived safety, and a further chicken and egg problem concerning infrastructure development and demand for CO_2 storage. CCS on rapidly ramping gas-power is technically possible, but CCS is capital intensive, requiring many hours of operation to earn a return on investment. This does not fit with natural gas as a peak load provider. The lumpiness of transmission infrastructure investment can be circumvented by liquefying CO_2. Shipping costs per m^3 are in the order of 30% of those for LNG, which is not a show stopper. Moreover, significant uncertainty exists on the cost of CCS.

Natural gas can provide a flexible backup for short to mid-term supply disruptions. Considering the demand side, both in cold weather – gas for heating, gas for power for heating, and in hot weather – gas for cooling, gas for power for cooling. Considering the supply side, during a *Dunkelflaute* (the “dark doldrums” when neither solar nor wind power is available in sufficient amounts) gas could provide power. Supply disruption risks may be (very) short when caused by local issues, such as safety precautions, but disruptions due to regional, geopolitical issues will possibly last longer. An advantage is that much of the gas supply and power generation infrastructure is already there. The question is if this infrastructure will remain available.

4 Outlook

The IEA WEO 2017 New Policies Scenario foresees about 45% growth in global gas demand to about 5,300 bcm by 2040, which does not leave us on track to achieve the Paris targets. Trade will grow faster than consumption, and LNG trade even more. Recent IEA scenarios that are on track for the Paris targets: the 450 scenario and Sustainable Development Scenario, foresee marginal increase in global natural gas consumption. This would however require very stringent policies and commitment.

Europe is the only region in any WEO scenario where production and consumption are set to decrease. Yet imports are likely to increase. Indeed, the Netherlands became a net importer in 2018. Due to the phasing out of the Groningen field, the seasonal swing capacity will greatly reduce if not completely diminish by 2030. Norway will remain the only major producer-exporter in the EEA; with a flat production outlook. However, the issue of when to start phasing out Norwegian gas (and oil) production is frequently brought up by some political parties in the country, which may impact production.

All four SET-Nav 95% CO_2 reduction “On track for Paris outlooks“ foresee European natural gas consumption reducing by 40-75% to about 125-230 bcm/y by 2050.

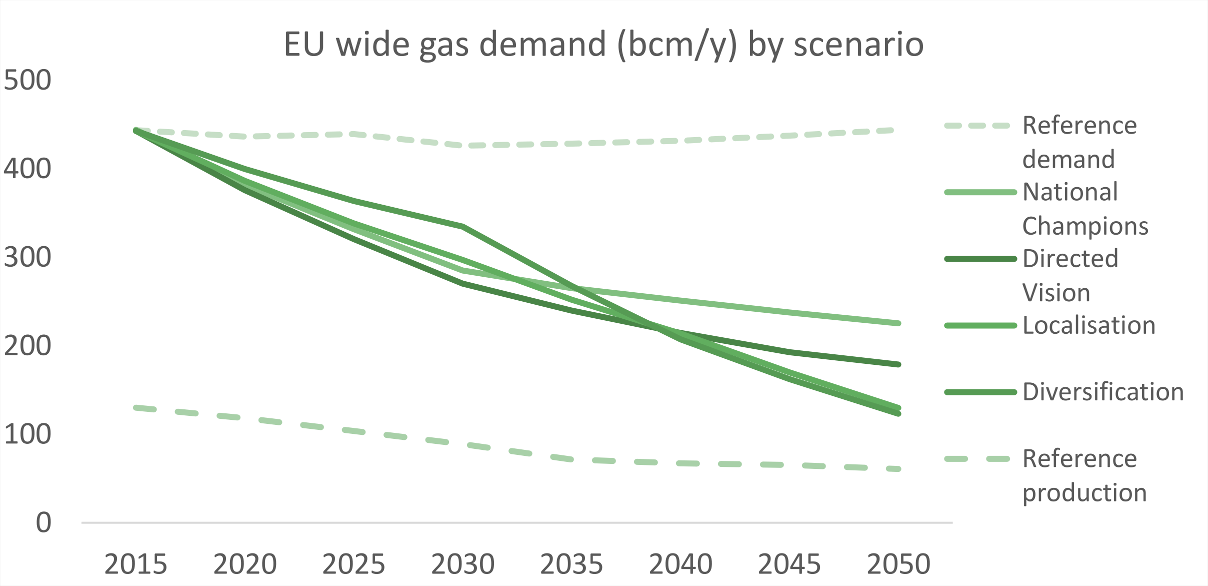

Figure 1: EU-wide gas demand by scenario

5 Does natural gas have a role in the future EU energy system?

The current status of technologies and costs will not push natural gas out of the EU energy mix over the next decade until 2030. However, the need to decarbonise and anticipated technological innovation and cost improvements are likely to make the role of natural gas much smaller in the decades after that. This may only change if CCS becomes cost effective and politically acceptable.

Table 1 A subjective back of the envelope perspective on future roles of natural gas

Horizon / Application	2030	2050
Base-load power	Yes	Unlikely
Flexi power	Yes	Probably
IND - Feed stock	Yes	Probably
IND - Process heat	Yes	Probably
Building heating	Yes	Maybe
Transport	Specific segments	Maybe
Hydrogen feedstock	Yes	Probably

6 Findings and policy recommendations

Large decrease in EU (EU28) gas consumption. In the drastic, 95% decarbonisation scenarios of the EU economy and energy system, natural gas consumption in Europe will undergo a drastic reduction. Especially in building heating and power generation, but also in industry. The transport sector may use much larger amounts of natural gas than at present, but this would only affect the overall demand decrease moderately. SET-Nav scenarios foresee that by 2050 gas demand will fall from the current approximately 5,000 TWh/year (450 bcm/y) to about 1,500-2,500 TWh/year. Taking into consideration domestic European production potential including Norway, two of the four pathways may result in the EU being independent of non-European gas imports.

Change in patterns of main consuming sectoral gas consumption. At present, the relative share and significance of highly seasonal and temperature-dependent gas consuming sectors such as building heating and power generation account for 60% of gas consumption. Consumption shares in these sectors are projected to shrink to 30%-40% by 2050. In contrast, there is barely any seasonal pattern to industry and transport sector gas consumption. This shift from the current seasonal nature of gas consumption has a detrimental effect on the business model of existing natural gas infrastructure operators, as storage facilities and pipelines are currently designed to accommodate highly seasonal swings.

Huge tariff increases or decommissioning of infrastructure. The average utilisation rate of European gas infrastructure will decrease to 10-15% by 2050. The daily peak load demand of the system is likely to decrease. The low utilisation rates will lead to decommissioning of storage, LNG facilities and pipelines. To convince industry actors to stay in the market and keep capacity available for security of supply reasons, the regulated capacity-based exit tariffs to consumers should be increased by on average 1-3 €/MWh (€ 0.11- € 0.35 per m^3).

No strategic pricing is possible in a shrinking market. Although the EU's own gas production will continue to decrease, no significant price increase is expected. Shrinking European gas markets, globalising LNG markets and increased LNG supply give rise to more competition between EU gas suppliers.

Gas import dependency problem is solved by decarbonisation. Lower natural gas demand will lead to drastically reduced imports and import dependency for the EU by 2050. Since Norway has no significant other outlets, Russian supply shares in the EU will be very sensitive to demand. However, if current EU demand maintains its level until 2050, the Russian share might be up to 38%, whereas the lowest share in SET-Nav scenarios is only 15%.

No new gas infrastructure is needed. With the exception of some small LNG terminals that may be needed to cover temporary demand increases in Scandinavia, no other import capacity will be needed. More generally, LNG and other options should not be ruled out as measures for security of supply and they may well need (national) public support to be put in place and be kept operational. However, European PCI support should instead be directed to electricity infrastructure and energy efficiency.

SET-Nav pathways are very ambitions decarbonisation scenarios. Industry outlooks do not foresee the same decreases in EU gas demand. Decarbonisation in IEA, Eurogas, Eurelectric and other scenarios and outlooks allow for large-scale application of other technologies such as CCS and renewable, biomass-based gas. They consider gas as an important part of the supply mix in a longer term perspective.

The anticipated continued technological innovation and cost decreases in RES will improve their competitive advantage and most probably result in a RES dominated energy supply by 2050. For natural gas to play a role in the long-term future energy supply, its value chain must become (nearly) carbon neutral, e.g., considering negative emissions elsewhere or CCS.

7 Annex

7.1 Methodology for pathways analysis and scenario definition

For modelling the possible infrastructure needs of natural gas markets in Europe and to see how gas sector stakeholders of are impacted by decarbonisation, a sectoral demand modelling was performed with the building sector (Invert/EE-Lab), industry sector (FORECAST), transport sector (Astra) and heat and power sector (ENERTILE/TEPES) models. An output of the sectoral models was the natural gas consumption with which the decarbonisation targets can be reached.[7] Based on the gas demand projected by other models, EGMM calculated the consumption level of natural gas per country with a monthly granularity, the wholesale price of natural gas, the utilisation of gas infrastructure (interconnectors, gas storages, LNG regasification infrastructure) and the main sources of imports to European markets.

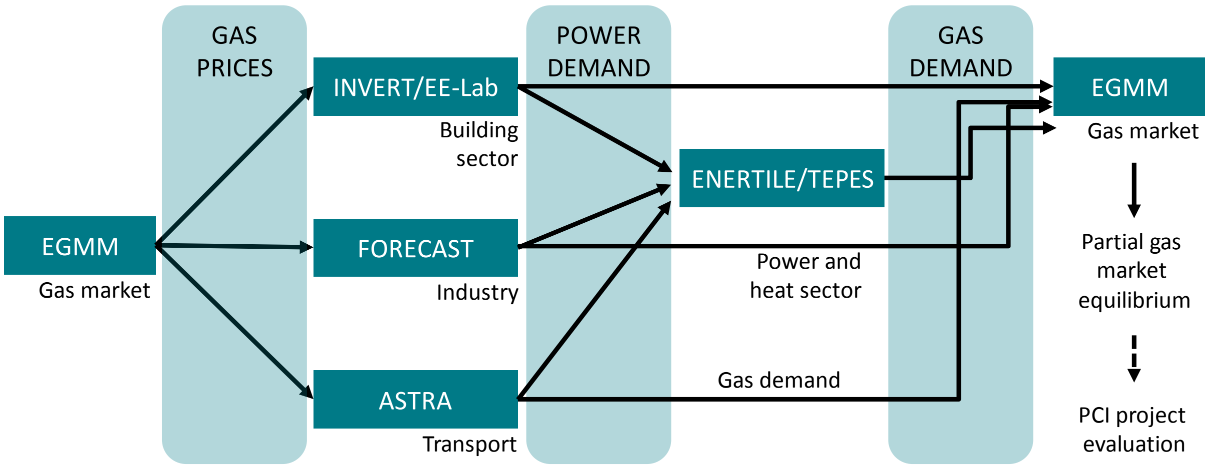

Figure 2. Schematic representation of data flows between models

7.2 Defining pathways scenarios for gas sector modelling

Pathways are decarbonisation scenarios drafted based on the findings of the case studies in the SET-Nav project.[8] The four scenarios share the common assumption that by 2050, 85% of GHG reduction compared to 1990 emissions will be reached on an EU28 level. Pathways have a 2030 intermediate GHG target (40% GHG reduction compared to 1990), in which policy adjustments or checkpoints might be included (e.g. lessons learnt from case studies). All pathways follow the concept of the PRIMES reference scenario for the near future (2020).

Scenarios were designed on two axes:

- Decentralisation versus path dependency
  - Path dependency scenarios assume a business-as-usual case, where the energy sectors are characterised by the current status quo and not prone to change.

[7] For detailed modelling results, refer to the relevant sectoral report.

[8] Pedro Crespo del Granado, Ruud Egging (NTNU), Gustav Resch, Marijke Welisch (TU Wien), Charlie Wilson (UEA): Definition of SET-Nav pathways – Description and objectives. May 2018. An internal document compiled within the SET-Nav project - Work Package 9, Task 9.2

- Decentralisation scenarios incorporate the trend of higher use of small-scale technologies in power and heat generation, developments in the local energy grids as opposed to the current top-down design of energy systems.
- Cooperation versus entrenchment
  - Cooperation means higher integration of EU energy markets, infrastructure and policy.
  - Localisation cements the current level of integration of the European energy markets: some integration with isolated energy systems on the fringes of Europe (in the case of gas markets).

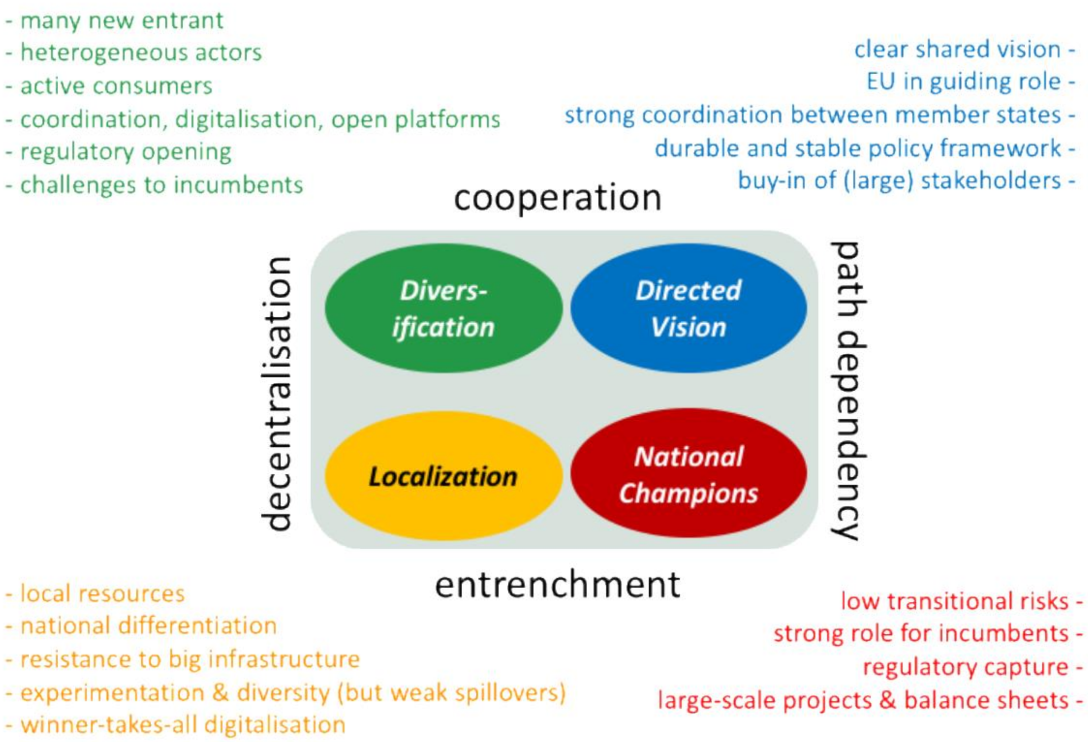

Figure 3. Main features of four storylines (pathways) for the EU energy system

Gas market modelling highlights the effect of decarbonisation on the stakeholders of the sector and how this affects market outcomes.

Besides simply plugging in the demand figures of other modelling teams to our market model, we have identified the main messages of the pathways scenarios for the gas markets.

A **reference scenario** was also created, which served as a business as usual case assuming non-decreasing gas demand in the main consuming sectors. We used Primes 2016 gas demand in the reference scenario. Concerning all other assumptions, the reference scenario is identical with the National Champions scenario.

Pathway scenarios: On the decentralisation/path dependency axis we envisaged two main trends in gas markets – the future of biomethane and Russian strategy (including infrastructure plans regarding Europe):

- Decentralisation means higher use of local resources and shifting the sector from the highly import dependent Europe to the increased production of greener gas. To model this effect, increasing biomethane production for the natural gas network was added in the Diversification and Localisation pathways, based on ENTSOG 2018 TYNDP Distributed Generation scenario.[9] This scenario was selected because it had the highest level of biomethane injection to the natural gas networks. For the other scenarios (Reference, Directed Vision and National Champions), no additional biomethane production was considered. Increasing biomethane injections to the gas grid are assumed to keep EU gas production at 1,000 TWh/year by 2050 in the Decentralisation scenarios (Localisation and Diversification) as opposed to the more conservative Path dependency scenarios (Reference, Directed Vision and National Champions), which show 500 TWh/year domestic production for the EU28.
- Assuming that its pricing strategy will not change, Russia is expected to keep or increase its market share in the shrinking European market for the Path dependency scenarios (Directed vision and National champions), while lower market shares are to be seen in the Localisation and Diversification scenarios.
  There is a great deal of uncertainty about Russian gas marketing strategy regarding Ukraine and the future of major transit pipelines. TurksStream 1 is considered as part of all scenarios. Nord Stream 2 and TurkStream 2 are assumed to be commissioned in the Path dependency scenarios (Directed Vision and National Champions, as well as Reference), while they are not part of the scenarios in the Decentralisation cases (Diversification and Localisation). Consequently, if the alternative pipeline infrastructure Nord Stream 2 and TurkStream 2 are in place in the path dependent scenarios, Russian long-term contracts will be delivered using a different route to Europe that bypasses Ukraine. Routing and delivery points remain unchanged compared to the 2018 market situation in the Decentralisation scenarios (Diversification and Localisation).
  Russian gas sales are possible via the Ukrainian system based on short-term, flexible contracts, but not on a long-term basis in all scenarios.
- On the cooperation/entrenchment axis, the future development of the internal EU natural gas market was considered. In the cooperation scenarios (Diversification and Directed Vision) we assumed that no internal tariffs are to be paid in inter-EU28 interconnecting points, while for the Entrenchment scenarios, current (as of early 2019) tariffs are kept constant for the modelling period.

[9] ENTSOG TYNDP 2018 Final Scenario Report Supply https://www.entsog.eu/sites/default/files/entsog-migration/publications/TYNDP/2018/entsog_tyndp_2018_Final_Scenario_Report_Supply.xlsx

Table 2. Main assumptions of pathways and reference scenarios in gas modelling (EGMM)

Heading	Reference	Diversification	Localisation	Directed Vision	National Champions
Cooperation/ Entrenchment	Entrenchment	Cooperation	Entrenchment	Cooperation	Entrenchment
Path dependency/ Decentralisation	Path dependency	Decentralisation	Decentralisation	Path dependency	Path dependency
EU28 biomethane production	Current	High	High	Current	Current
Nord Stream 2, TurkStream 2	yes	no	no	yes	yes
Russian transit via Ukraine	only spot	yes	yes	only spot	only spot
EU28 gas consumption	PRIMES reference	Pathways	Pathways	Pathways	Pathways
Internal tariffs on EU28 system	current tariffs	no tariffs	current tariffs	no tariffs	current tariffs

7.3 Effects of pathways scenarios on the natural gas sector in Europe

7.3.1 Consumption

Gas consumption figures provided by demand sector models reported a **significant decrease of total gas consumption:** total gas consumption falls from the current ~5,000 TWh/year to the ~1,500-2,500 TWh/year range.

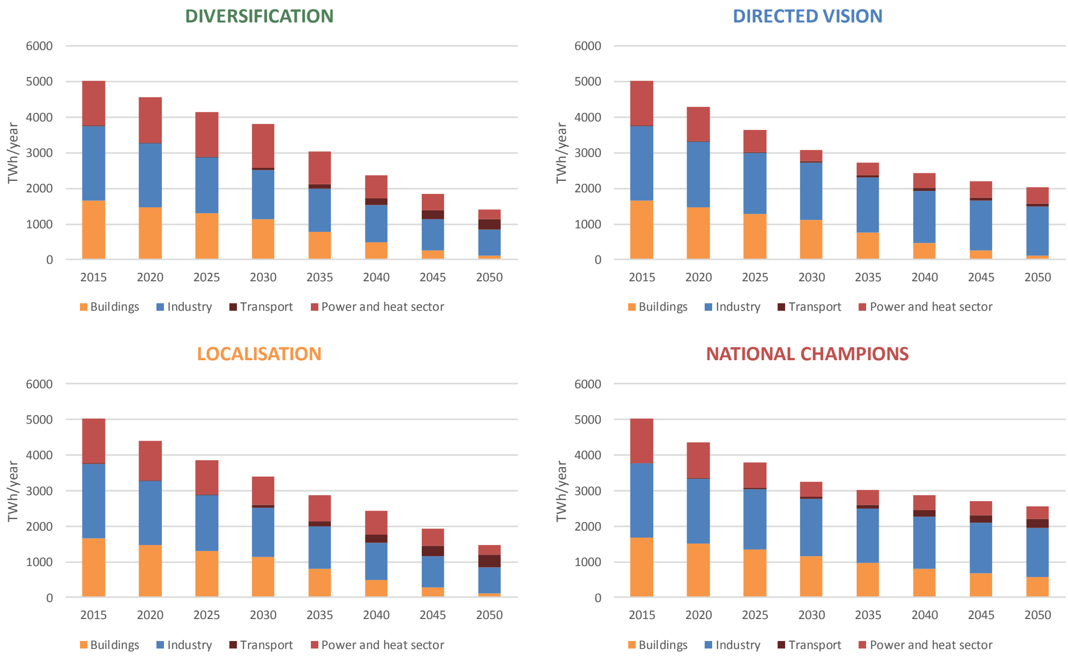

Figure 4. Share of the four demand sectors in total gas consumption, TWh/year

Source: based on SET-Nav D.5.8: WP5 Summary report -Energy Systems: Demand perspective.

Change in patterns of main consuming sectoral gas consumption: relative shares and significance of highly temperature-dependent and seasonal gas consuming sectors such as the building and power sectors accounted for 60% of gas consumption. Consumption levels in these sectors is expected to shrink to ~30%-40% in the pathways scenarios. Industry and transport sector gas consumption has no seasonal pattern whatsoever. This shift from the currently seasonal nature of gas consumption has a detrimental effect on the existing natural gas infrastructure, as storage facilities and pipelines are accustomed to accommodating high seasonal swings.

7.3.2 EU supply structure

7.3.2.1 Production

Historically, natural gas consumption in the EU28 is characterised by high import dependency. Around 25% of total consumption is supplied from the domestic European fields (~70% of production originates from gas fields located in the Netherlands, the UK and Romania). However, these reserves are running out. In the Primes Reference, Directed Vision and National Champions scenarios, by 2050 production in the EU drops to ~500 TWh/year from 1,200 TWh in 2020, accounting for 10% of European consumption. In the Diversification and Localisation scenarios the diminishing European natural gas production is supplemented by biomethane, which will make up 50% of total European gas production volumes by 2050.

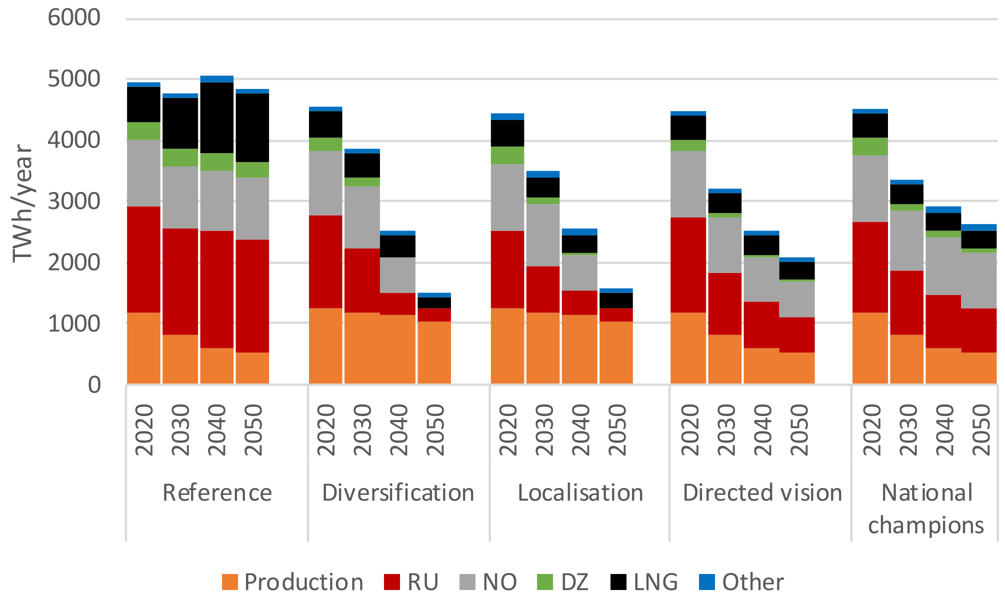

Figure 5. Supply structure of the EU28 in the reference and pathways scenarios, TWh/year

Source: SET-Nav D6.7 Work package summary report on Infrastructure.

7.3.2.2 Import dependency

The import dependency indicator shows how much of the gas imported to the EU28 originated from outside the EU28.[10]

[10] The imported volumes include natural gas which is not consumed in the EU28, but sold to neighbouring third countries (e.g. Ukraine, Turkey and to smaller extent Balkans countries).

In the Reference scenario, the 75% import dependency increases to 90%. The same pattern can be observed in the National Champions scenario (from 75% to 80%). Dependency stagnates in the Directed Vision scenario, but falls to 32-35% by 2050 in the Diversification and Localisation scenarios, due to falling consumption and increased biomethane production. **Lower import dependency could result in higher competition between Europe's suppliers**.[11]

7.3.3 Effects on consumers

Due to the considerable decrease in gas consumption and switch from natural gas to alternative fuels in the building, industry and power sectors, the **total cost of gas procurement for European consumers drops from ~100 Bn EUR/year in 2020 (Reference) to 23-45 Bn EUR/year by 2050 (Pathways scenarios).** The reduction in the gas bill is partly driven by the decrease in prices (5-15%), but mostly by the fall in consumption. This decrease in the gas bill must be contrasted with the increased costs and investment needed in other in the building, industry, transport and power sectors. The detailed effects of this phenomenon are described in D.5.8: WP5 Summary report - Energy Systems: Demand perspective.

7.3.4 Effects on the TSOs and SSOs

In the Reference scenario, total flows on the EU-EU internal pipelines grow from 2,400 TWh/year to 2,700 TWh/year from 2020 to 2050. In the pathways scenarios, falling demand results in diminishing trade in the European network.

Regulatory intervention, e.g. **lower tariffs on interconnectors (such as in the Diversification and Directed Vision case) can partly mitigate this decrease in flows and slow down the drop in utilisation of pipelines.**

However, the 10%-15% average utilisation of the EU gas network by 2050 in the pathways scenarios raises questions that extend beyond our modelling exercise: whether the operation of the network is technically feasible.

[11] Péter Kaderják, Péter Kotek, Alfa Diallo (2018): Will Russian Natural Gas Long-term Contract Prices Remain Oil Price Determined after the End of Oil-indexation? IAEE Energy Forum, Groningen Special Issue 2018. ISSN 1944-3188. http://iaee2018.com/wp-content/uploads/2018/09/Energy-Forum-Groningen-Issue.pdf#page=11

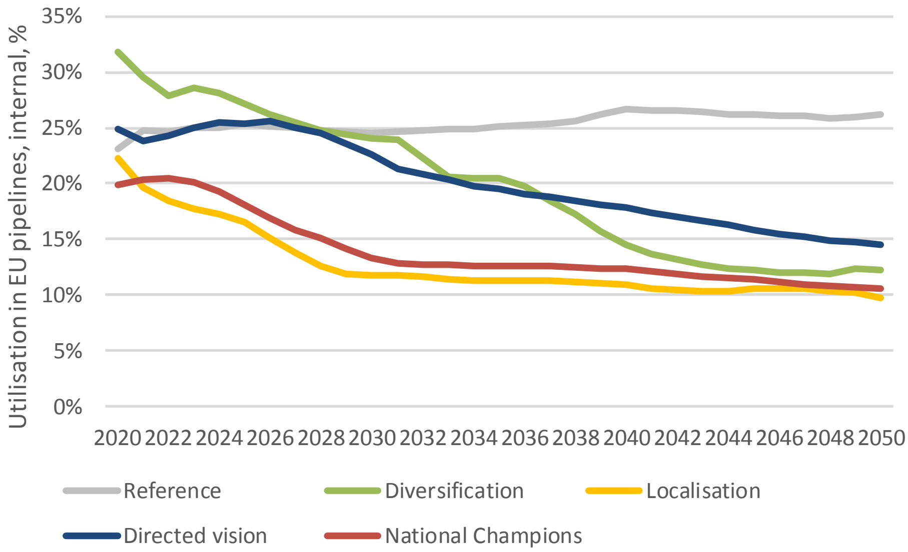

Figure 6. Total utilisation of EU-EU pipelines (internal infrastructure), %

In the reference scenario, total modelled TSO revenues on the EU28 level are around 6.7 Bn EUR/year for 2020. Modelled IP related revenue makes up 45%, domestic exit 42% and domestic entry 9%. The remaining 4% is storage and LNG-related feed of the TSO.

In the Diversification scenario, TSO revenues fall below 2 Bn EUR/year. Moreover, lower revenues are realised on the IPs (due to the scenario definition that tariffs on EU-EU interconnectors are decreased to a marginal cost). Revenues on domestic production also decrease in all scenarios: lower conventional gas production is the case in the Reference, Directed Vision and National Champions scenarios; in the Diversification and Localisation scenarios, where higher biomethane is produced it is not injected into the transmission network but consumed locally.

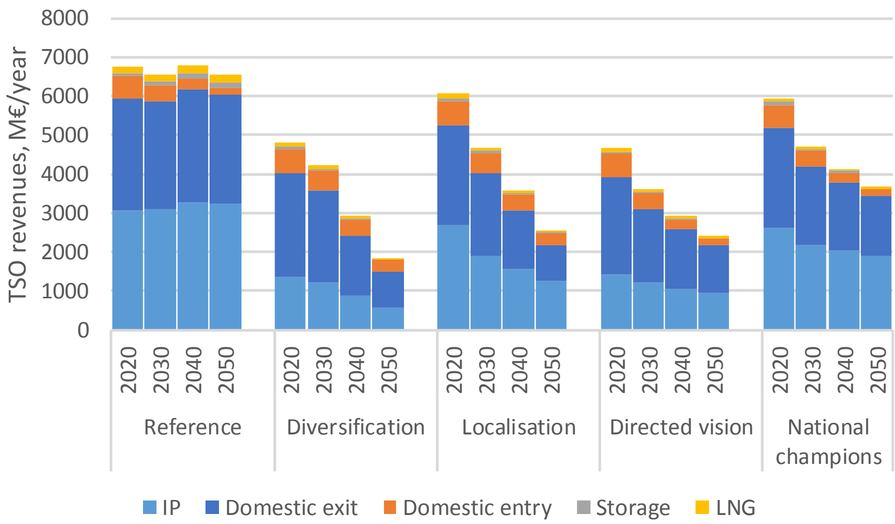

Figure 7. Revenue structure of TSOs in the EU28, M€/year

Source: D6.7 Work package summary report on Infrastructure.

If the difference in TSO revenues by 2050 between the reference case and the pathways scenarios is to be covered by increased domestic exit tariffs, an increase of 1-3 €/MWh is expected in all European domestic exits to the distribution grid or to final consumers.

Effects of the pathways scenarios on TSOs are:

- **Loss of tariff revenues:** Total flows on into-EU and EU-EU interconnectors are falling due to lower gas demand. The changing pattern requires a reworking of the financing of TSOs and greater reallocation of the tariff structure to the domestic exit and entry points, to recover the required revenue for operation. Most probably the decommissioning of certain pipelines and an increase in tariffs on the remaining ones is foreseen.
- **Possible pressure issues:** Lower flows may jeopardise the workings of the gas networks, as required pressure cannot be maintained with such low flows.[12]
- **Stranded assets:** due to low utilisation, pipeline infrastructure may fall out of use. The low import needs in the Diversification and Localisation scenarios may render gas infrastructure unnecessary.
- **Growing markets on the fringes:** Turkish and Ukrainian markets show a growth in gas demand, opening possibilities for European transits and the option for some regional TSOs for cross-financing.
- **Temporary surges in demand:** Power sector gas consumption spikes in some fringe markets (Sweden, Baltics) may create congestion on the existing network. However, investing in pipeline infrastructure in this case can create huge stranded assets: if power sector demand is satisfied by alternative sources of energy or disappears, the gas sector investments will remain under-utilised. For this reason, it is suggested to invest in flexible FSRU capacities, if possible, or to strengthen the electricity grid to curb gas consumption.

Effects of the pathways scenarios on storage operators:

- In the Reference scenario, falling European production and increased import curbs increase the need for storage.
- Diminishing demand causes and falling import needs make seasonal storage facilities unnecessary in the pathways scenarios.
- **Non-seasonal demand:** Increase in non-seasonal sectoral (transport, industry) demand may further jeopardise the operation of UGS facilities.

7.4 Project of Common Interest – CBA analysis

Projects of the third PCI list were assessed as suggested by ENTSOG methodology: new infrastructure was added to the 'without project' case, and the relative changes in the welfare of consumers, producers, infrastructure operators and traders were listed as the welfare gains of the project. Benefits were calculated on the basis of a lifetime of 25 years from commissioning. Annual benefits were discounted to real 2018 euros applying a 4% social discount rate. One-off CAPEX of infrastructure was considered as the only cost of the new pipeline. OPEX costs were considered to be financed from the tariffs applicable for the use of infrastructure.

[12] Hydraulic modelling is not part of EGMM, as it is a market model not an engineering one. Further inquiry is needed from ENTSOG or TSOs to calibrate the minimum flow for the safe and economical operation of the gas transmission networks.

In the reference scenario, only some LNG terminals exhibit a positive NPV, i.e. we suggest that other interconnector projects should not be financially supported, as flows on this infrastructure do not recover the CAPEX. In the pathways scenarios, only the small-scale LNG terminal in Sweden has a positive NPV.

Overall, based on the current reference setting and pathways scenarios, we suggest that no additional PCI interconnection investment is made in natural gas infrastructure. Even with stagnating demand and falling European production (Reference), no interconnection projects exhibit positive NPVs. (Please consider that projects with a FID by February 2019 were part of the without project case: e.g. Balticonnector, Krk LNG, BRUA first phase) Congestion on the European network only appears for a few years in the 2030s and disappears by 2050. Our results are extreme in the sense that the demand drop challenges the current TSO, SSO and LNG operator business model. Since the EU targets decarbonisation goals by 2050 and sectoral modelling suggests that these can only be reached by a drastic phasing out of gas from the primary energy mix, if this vision were to be accepted, then no further investment will be made in the EU natural gas infrastructure apart from TYNDP FID projects. This means that no PCI status should be granted to gas infrastructure, as it would give mixed signals to the stakeholders about the role of gas in the future EU energy mix.

SET-Nav
Strategic Energy Roadmap

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About the project

SET-Nav aims for supporting strategic decision making in Europe's energy sector, enhancing innovation towards a clean, secure and efficient energy system. Our research will enable the European Commission, national governments and regulators to facilitate the development of optimal technology portfolios by market actors. We will comprehensively address critical uncertainties facing technology developers and investors, and derive appropriate policy and market responses. Our findings will support the further development of the SET-Plan and its implementation by continuous stakeholder engagement.

These contributions of the SET-Nav project rest on three pillars: modelling, policy and pathway analysis, and dissemination. The call for proposals sets out a wide range of objectives and analytical challenges that can only be met by developing a broad and technically-advanced modelling portfolio. Advancing this portfolio is our first pillar. The EU's energy, innovation and climate challenges define the direction of a future EU energy system, but the specific technology pathways are policy sensitive and need careful comparative evaluation. This is our second pillar. Ensuring our research is policy-relevant while meeting the needs of diverse actors with their particular perspectives requires continuous engagement with stakeholder community. This is our third pillar.

Who are we?

The project is coordinated by Technische Universität Wien (TU Wien) and being implemented by a multinational consortium of European organisations, with partners from Austria, Germany, Norway, Greece, France, Switzerland, the United Kingdom, France, Hungary, Spain and Belgium.

The project partners come from both the research and the industrial sectors. They represent the wide range of expertise necessary for the implementation of the project: policy research, energy technology, systems modelling, and simulation.