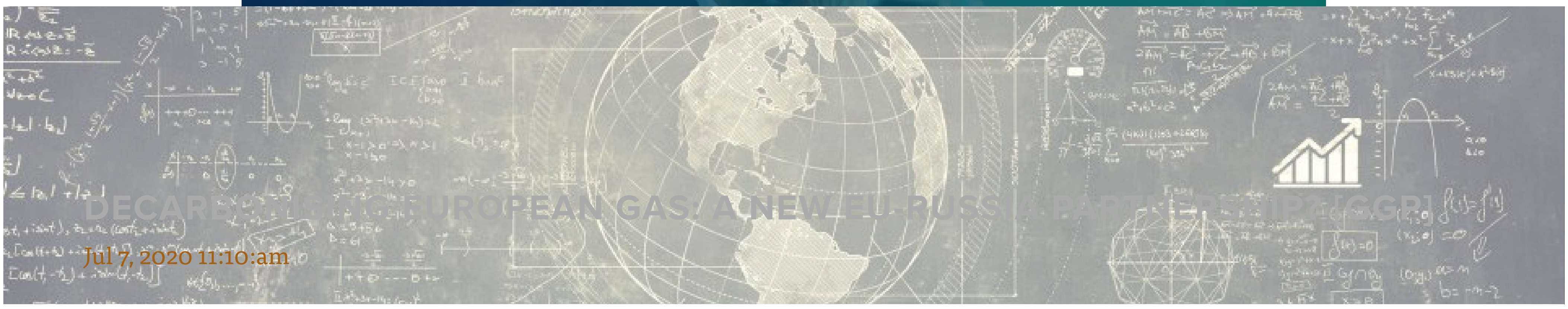

DECARBONISING EUROPEAN GAS: A NEW EU-RUSSIA PARTNERSHIP? [GGP]

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SUMMARY

Clean Hydrogen is a new prospective area for Russia-EU Co-operation, writes the Russian co-chair of Work Stream 2 of the EU-Russia Gas Advisory Council on the eve of its meeting.

BY: ANDREY KONOPLYANIK

The European Union's declared goal of decarbonising its economy and its gas industry creates opportunities for Russia-EU co-operation that go beyond the mere transfer of gas. It could include joint participation in a new technological pathway based on hydrogen.

Achieving the EU's declared carbon neutrality – though I would prefer it is called climate neutrality since it is first and most about CO2 emissions – by 2050 is a priority that will easily consume all its resources. Its Green Deal is a massive bet on electricity from renewable energy sources (RES) and decarbonised gases, primarily hydrogen. Moreover, the EU sees hydrogen both as an energy carrier and as means of storing excess RES.

The economic recovery will be based on a low-carbon energy model, even "greener" than was planned in pre-pandemic time. This means maybe less Russian natural gas than formerly in some traditional sectors, but also new demand for it as a feedstock for hydrogen – especially blue hydrogen – production.

Since 80% of the GHG emissions through Russia-EU gas value chain occur downstream, the onus is on the EU to decarbonise close to the end-use through clean hydrogen production.

Technology

NATURAL GAS WORLD

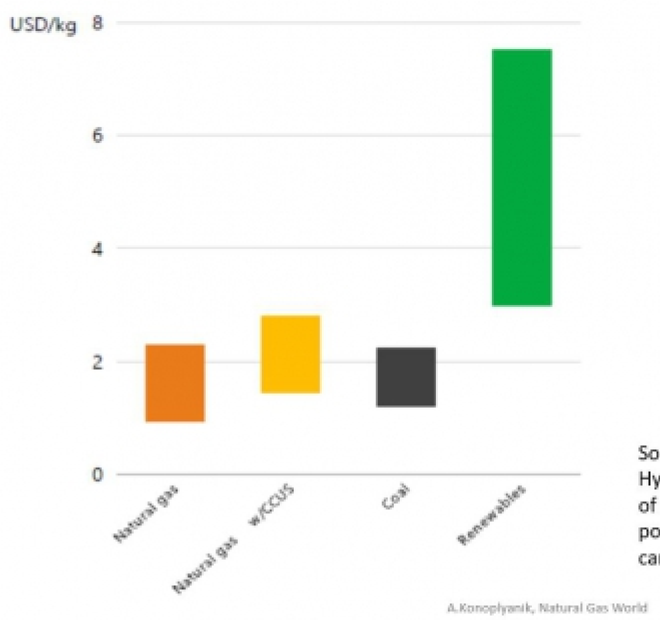


Figure 1. Hydrogen production costs, 2018 (IEA)

Source: Jose M Bermudez, IEA. "IEA: The Future of Hydrogen". // IAEE Webinar "The Swiss Army knife of the Circular Carbon Economy: hydrogen has the potential to Reduce, Reuse, Recycle and Remove carbon emissions", 3 June 2020

But according to Gazprom, while methane pyrolysis requires just 0.7–3.3 kWh to create 1 m^3 of hydrogen, electrolysis requires 2.5–8.0 kWh, or almost three times as much on average. According to BASF, the difference is almost ten times.

The industry group Hydrogen Europe considers that gigawatt-sized electrolysers at wind and solar hydrogen production sites will be able to produce renewable hydrogen cost competitively with low-carbon hydrogen production (€1.5-2.0/kg) in 2025 and with grey hydrogen (€1.0-1.5/kg) in 2030.

The EU is betting on this kind of green hydrogen. In its draft communication "Towards a hydrogen economy in Europe: a strategic outlook", the European Commission (EC) wants a significant increase in volumes to bring down the price of hydrogen to a range of €1-2/kg as quickly as possible, through the roll-out of green hydrogen production within or outside the EU, mainly in dedicated green hydrogen factories with integrated RES generation.

But this will require either special long-distance hydrogen transportation grid (such plans do exist), or mixing hydrogen with methane upstream, to transport a mix of methane and hydrogen (MHM) to final destinations using the existing networks and only separating the two gases as they leave the pipe. Both will add significantly to the cost of hydrogen compared with producing hydrogen where it is needed.

Second, methane steam reforming (MSR) and/or auto-thermal reforming (ATR) which is the most advanced technology of hydrogen production and much cheaper than "green" hydrogen.

But it is accompanied by CO2 emissions and therefore requires the use of CO2 capture and sequestration technologies (CCS), which add at least 20% to the cost budget of hydrogen produced by MSR. (MSR+CCS is a "blue" hydrogen in EU terminology).

Third**,** a set of technical solutions to produce hydrogen from methane without access of oxygen (pyrolysis and so on), and, hence, without CO2 emissions. Which means clean hydrogen.

There is an understanding in the EU that "renewable" hydrogen (produced by electrolysis) is the ultimate goal. But without the parallel production and use of hydrogen based on natural gas this will not be possible by 2050. But in the EU public debate, the latter normally means only MSR/ATR+CCS. Pyrolysis is mostly ignored.

For example, in the fundamental and very detailed "Hydrogen Roadmap Europe" it says: "Hydrogen production will be a mix of mostly electrolysis and SMR/ATR with CCS in Europe". Moreover, "where CCS is technically not feasible, biomethane reforming, water electrolysis, and longer-term biomass gasification will be the only ultra-low-carbon hydrogen production methods." Clean hydrogen from natural gas is not even mentioned.

'Green' hydrogen vs 'clean' hydrogen

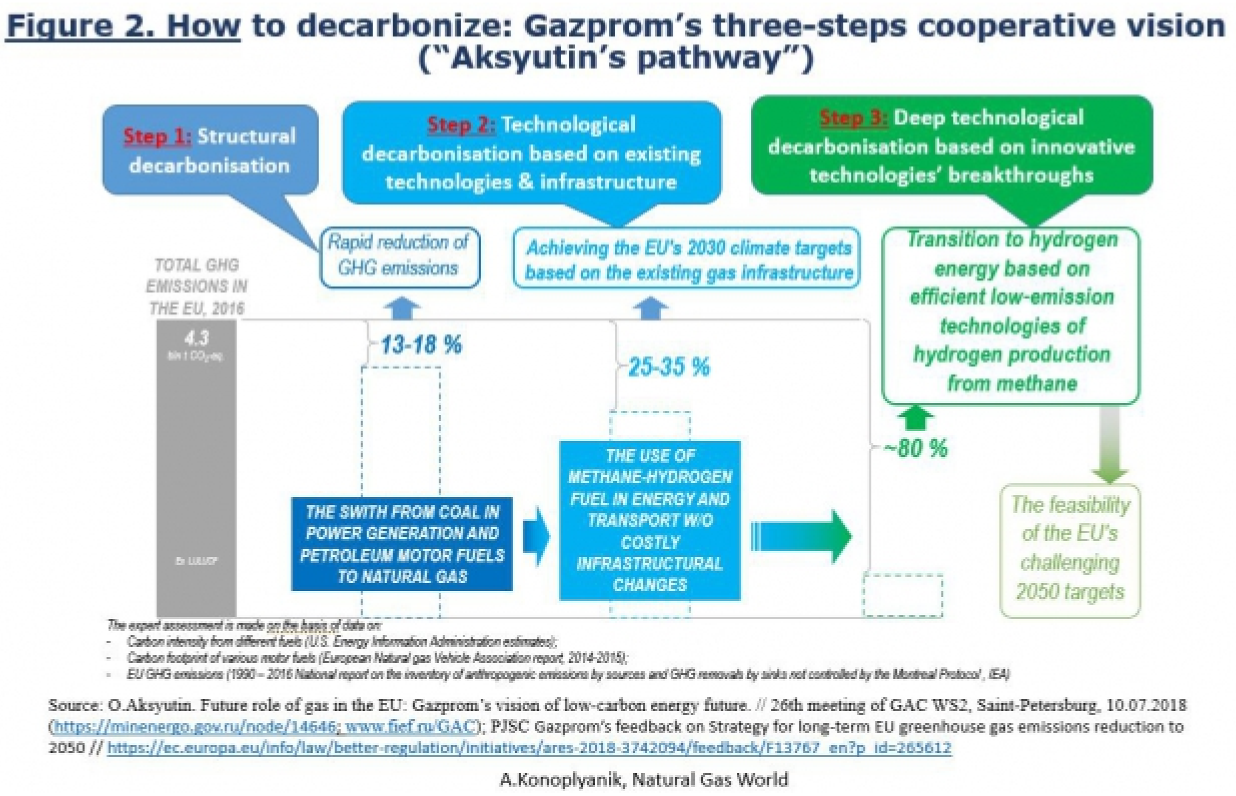
It seems that while green and clean hydrogen are used interchangeably in EC documents and the EU public domain, this is misleading as the RES equipment manufacturing and supply part of the process in not green at all. It is still an ecologically dirty chain of processes, starting with the rare earth materials extraction stage.

Whether hydrogen is "clean" or "not- clean" should depend not on the presence or absence of carbon molecules in the input of the processes (CH4) used to produce hydrogen, but on the presence or absence of CO2 emissions in the end-results of this processes. Hydrogen produced by MSR/ATR without CCS is not "clean" but hydrogen produced by pyrolysis and/or the plasma-chemical method (without O2 access and without CO2 emissions) is actually "clean" without incremental costs associated with CCS. And it fully meets EU requirements for decarbonisation and carbon neutrality without CCS though it presents also "blue hydrogen" since being produced from natural gas. This means that "colouring" of hydrogen produced from different sources being broadly used in the EU might be misleading.

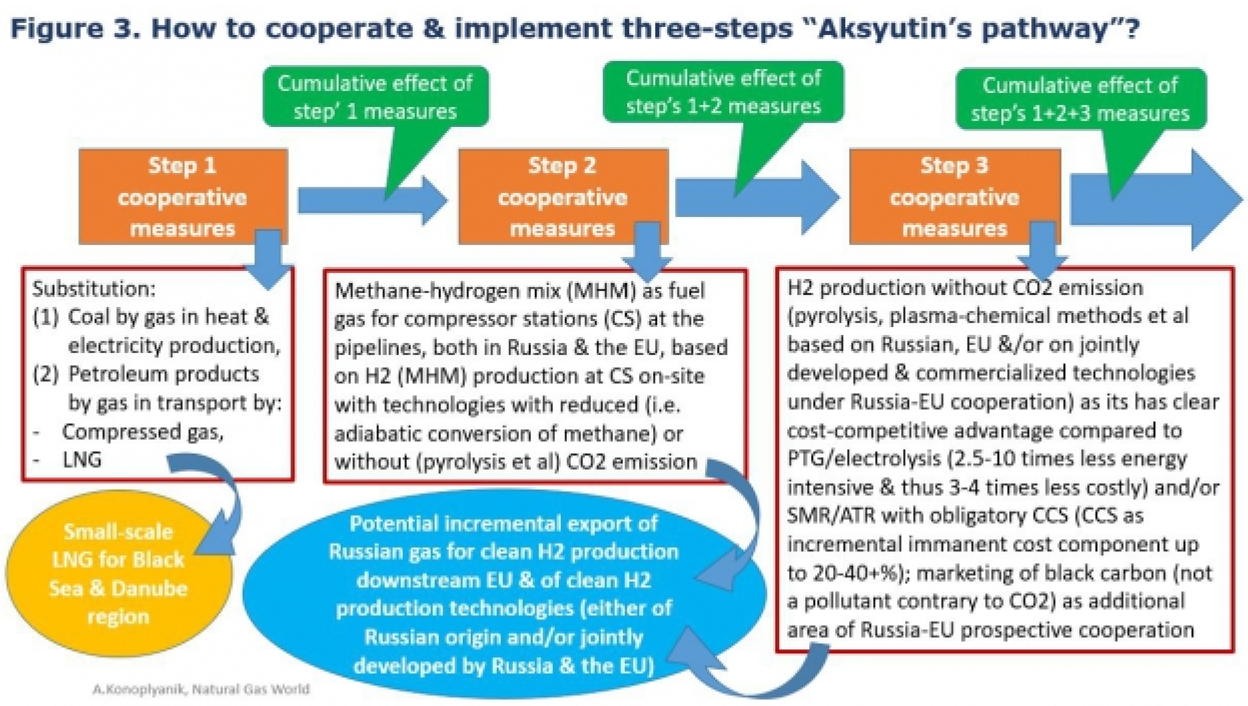
Even "carbon neutrality" is misleading: ecologically-neutral solid carbon, a by-product of pyrolysis, finds itself in the same category as ecologically harmful GHG/CO2 emissions (a by-product of SMR/ATR). This might create same negative perceptions towards ecologically-neutral (if CO2 is considered) pyrolysis compared to ecologically-harmful SMR/ATR.

Conceptual basis for co-operation: "Three-step Aksyutin pathway"

In view of the above, one possible approach for Russian participation in the EU decarbonisation agenda could be based on the three-stage proposal by a deputy CEO of Gazprom, Oleg Aksyutin, two years ago at an EU-Russia Gas Advisory Council Work Stream 2 "Internal Markets" meeting in St Petersburg (*see Figure 2*).



The first stage is the substitution of coal by gas in power generation and of liquid fuels by both CNG and/or LNG in the transport sector. This is structural decarbonisation. Then comes technological decarbonisation based on a methane-hydrogen mix (MHM) at compressor stations and its use as fuel gas instead of methane, which reduces CO2 emissions by about a third. The third step is deep decarbonisation based on the transition to hydrogen production from methane without CO2 emissions, with a view to the future use of hydrogen (*Figure 3*).



The co-operation between Russian and EU research institutions and companies for the fastest possible commercialisation of the latter group of technologies can be a win-win solution. It will expand Russian gas supplies to the EU for clean hydrogen production; it will help develop innovative clean hydrogen production facilities on a joint Russia-EU basis to be used within the "Broader Energy Europe" (which includes both the EU and Russia as well as other territories covered by this diversified cross-border energy grid) and maybe beyond it at the later stage. And it will reduce the cost of decarbonisation for the EU. That is, it will lead to increased welfare of both Russian and European citizens.

'Clean hydrogen from Natural Gas Alliance'

This author proposes that EU-Russia co-operation can be set up with a section under the umbrella of Work Stream 2 GAC with an open participation within the "Clean Hydrogen Alliance".

In its communication on "A New Industrial Strategy for Europe," the EC said it planned to launch a new European Clean Hydrogen Alliance bringing investors together with governmental, institutional and industrial partners. The alliance will build on existing work to identify technology needs, investment opportunities and regulatory barriers and enablers. According to Hydrogen Europe, this initiative is already supported by the CEOs of 90+ European companies.

This newly proposed Russia-EU section could be entitled "Clean Hydrogen from Natural Gas Alliance" since as of today the substance of the "Clean Hydrogen Alliance" seems to address mostly/only the issues of "green" hydrogen as the EC defines it.

There is no such special undertaking anywhere yet in regard to clean hydrogen from natural gas which is quite a specific avenue compared with the two other technological avenues of hydrogen production. At least I have not managed to find among the 229 projects at the Hydrogen Europe website any that follow this specific technological path.

There are few companies and/or institutions dealing with this "third avenue" of hydrogen production using methane without resulting CO2 emissions. In Russia there are Gazprom, the Tomsk Polytechnic University, in Germany - BASF, Wintershall, Linde, Uniper, the Karlsruhe Institute of Technology; in Spain there is the Madrid Polytechnic University (ETSII); and there are a few others elsewhere.

Some have made presentations at earlier WS2 GAC meetings. The benefits of co-operation are well-known: it can speed up the start of the "learning curve" and bring down costs faster. Co-operation in clean hydrogen from natural gas can be the main element of coming Work Stream 2 GAC activities.

Hydrogen Europe might play a co-ordinating role on the EU side. In its latest publication "The EU Hydrogen Strategy: Hydrogen Europe's Top 10 Key Recommendations" this industry association proposes to launch the Clean Hydrogen Alliance and establish hydrogen as a key element in global EU climate diplomacy and neighbourhood policy, where hydrogen is to be the key component of the ongoing EU-Ukraine energy co-operation as well as the EU-Africa and Euro-Mediterranean partnerships. The Russia-EU GAC can add to its continuous decade of activities "clean hydrogen from natural gas" without conflicting with the existing partnerships above.

And this is in addition to other technological avenues of low-carbon and/or clean hydrogen production efforts, based on their geographical complementarity, within "Broader Energy Europe".

Co-operation based on complementary technology

There are several geographical areas within "Broader Energy Europe" where certain hydrogen production technologies enjoy a natural advantage (*Figure 4*). If a technologically neutral regulatory approach is undertaken, as promised, in the EU, all these technologies can find their competitive niches and add to EU's decarbonisation path.

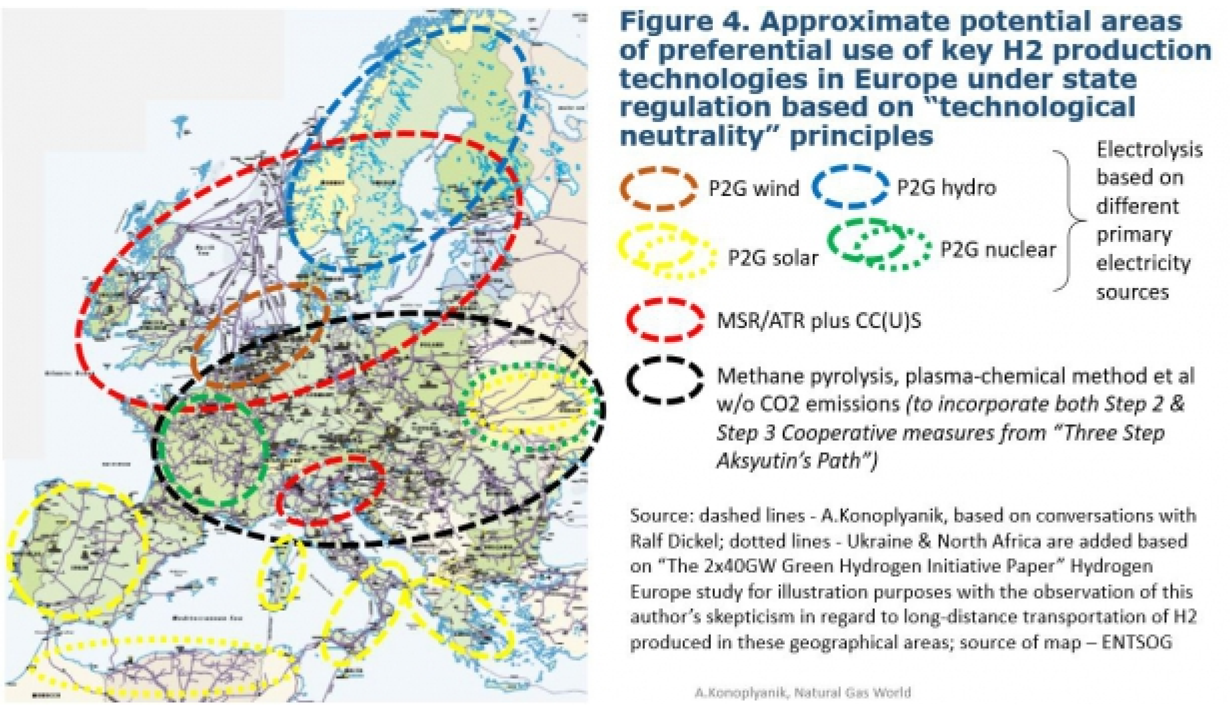


Figure 4. Approximate potential areas of preferential use of key H2 production technologies in Europe under state regulation based on "technological neutrality" principles

Source: dashed lines - A.Konoplyanik, based on conversations with Ralf Dickel; dotted lines - Ukraine & North Africa are added based on "The 2x40GW Green Hydrogen Initiative Paper" Hydrogen Europe study for illustration purposes with the observation of this author's skepticism in regard to long-distance transportation of H2 produced in these geographical areas; source of map – ENTSOG

Where renewable electrolysis is concerned, some regions have long hours of sunshine (Spain, Mediterranean); others, abundant wind (coastal North Sea areas); others again, hydro (Nordic states). Nuclear power generation can be directed at nocturnal electrolysis in France to flatten the demand load.

SMR with CCS is now being actively developed by Equinor (including CO2 capture from industrial plants on the North Sea and Baltic coasts and transportation for sequestration in depleted fields); in particular, the Norwegian Petroleum Directorate offers depleted oil and gas reservoirs for CO2. A zone covering this area could become a zone for testing competitive SMR/ATR technology with CCS.

Finally, methane pyrolysis and similar technologies will spread (in case of their accelerated transition from laboratory testing and pilot units to industrial application, including through co-operation between Russia and the EU) in Continental Europe based on the extensive well-diversified cross-border gas transmission grid, with reliance on the second and third steps of the aforementioned three-stage process.

What would an action plan look like?

At the 29th WS2 GAC meeting in Berlin in October 2019 (*see image below*), well-attended by both sides (*Figure 5*), the co-chairs initiated discussion on potential joint research/investigation in key decarbonisation issues of interest to both sides. One line of thought might be the following.

Clean hydrogen from methane is to be produced downstream EU, close to demand centres for hydrogen, near compressor stations (CS) at cross-border gas transmission grid within "Broader Energy Europe". Natural gas transported through this grid is to be used: (1) for on-site production of MHM to be used as fuel gas at CS and (2) as energy input for clean hydrogen production at plants to be built near CS to meet prospective hydrogen demand from the neighbouring area (this is my proposed alternate interpretation of "hydrogen islands/valleys" term), and (3) as a feedstock for clean hydrogen from methane production plants near CS.

The capacity of clean hydrogen production plants near existing CS will depend on demand for hydrogen from local areas (within local hydrogen valleys/islands). In such model the costly needs for hydrogen transportation through a newly developed hydrogen grid and/or existing gas grid to be adapted to transportation of MXM or pure hydrogen will be downgraded to the reasonable minimum.

Conversely, this decarbonisation method extends the economically proven life of existing cross-border capital-intensive fixed gas infrastructure within "Broader Energy Europe". This is if compared to proposed (yet dominant) scenarios where clean RES-based hydrogen is to be produced far beyond the EU in gigawatt-sized electrolysers to obtain 'economy of scale" cost saving, though such savings will be eliminated by incremental investments in developing new long-distance hydrogen infrastructure.

At the coming WS2 GAC meetings we plan to continue discussing this avenue of Russia-EU co-operation in "clean hydrogen from natural gas" in the EU hydrogen strategy that is to be officially presented by the Commission on July 8 and to be further developed so both parties will mutually benefit from co-operation in clean hydrogen.

Dr Prof. Andrey A Konoplyanik *(www.konoplyanik.ru, pictured kneeling above left)*

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The views presented in this article do not necessarily reflect the official position of Gazprom Group and/or Russian authorities and are the sole responsibility of this author.

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