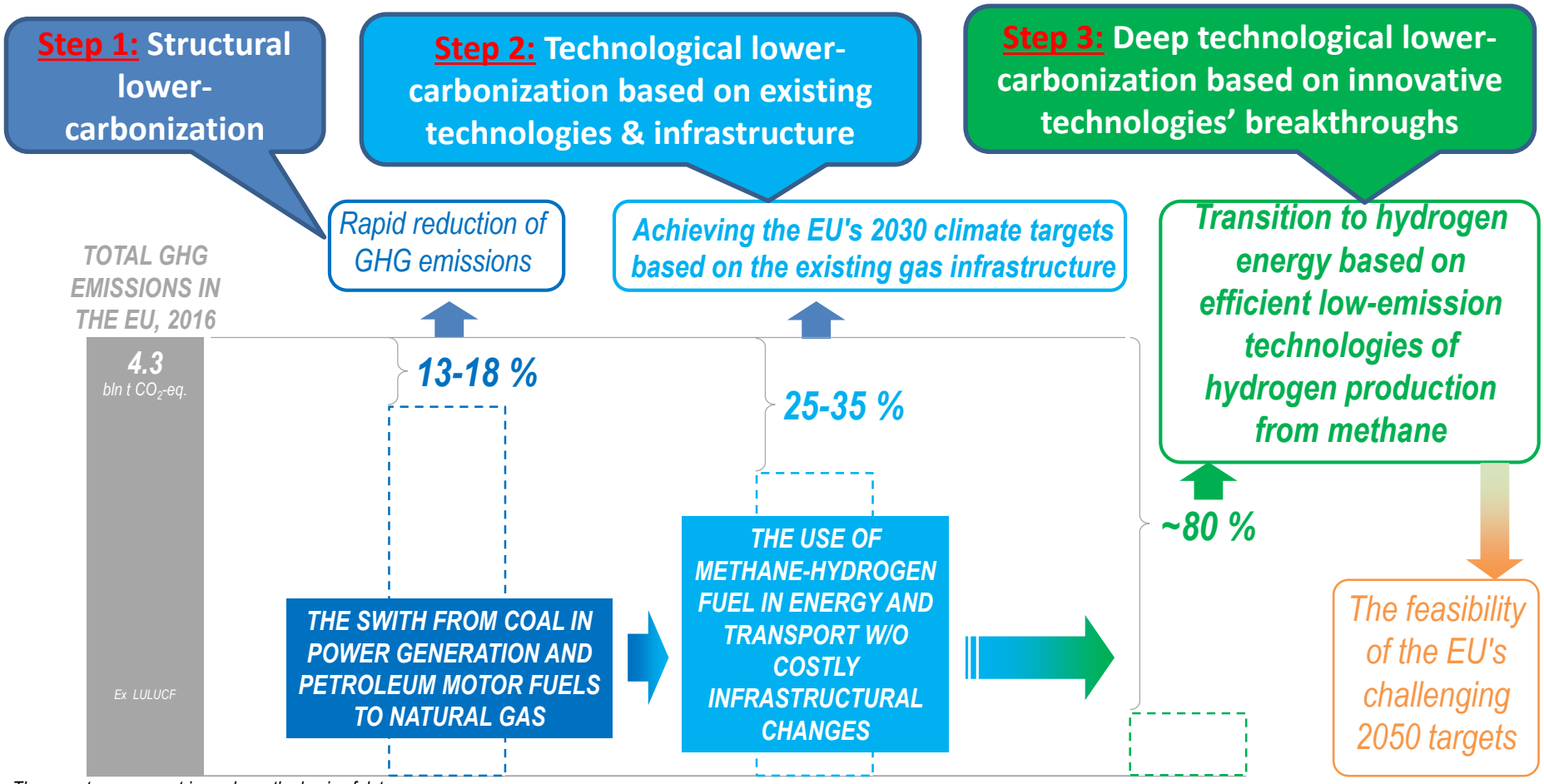
Discussion on potential joint research on key decarbonization issues of mutual interest

Leaded by Co-chairs Work Stream 2 “Internal Markets”, Russia-EU Gas Advisory Council

29th meeting of the EU-Russia Gas Advisory Council’s Work Stream on Internal Market Issues (GAC WS2), Berlin, Germany, 21 October 2019

HOW to decarbonize: Gazprom's three-steps cooperative vision ("Aksyutin's pathway")

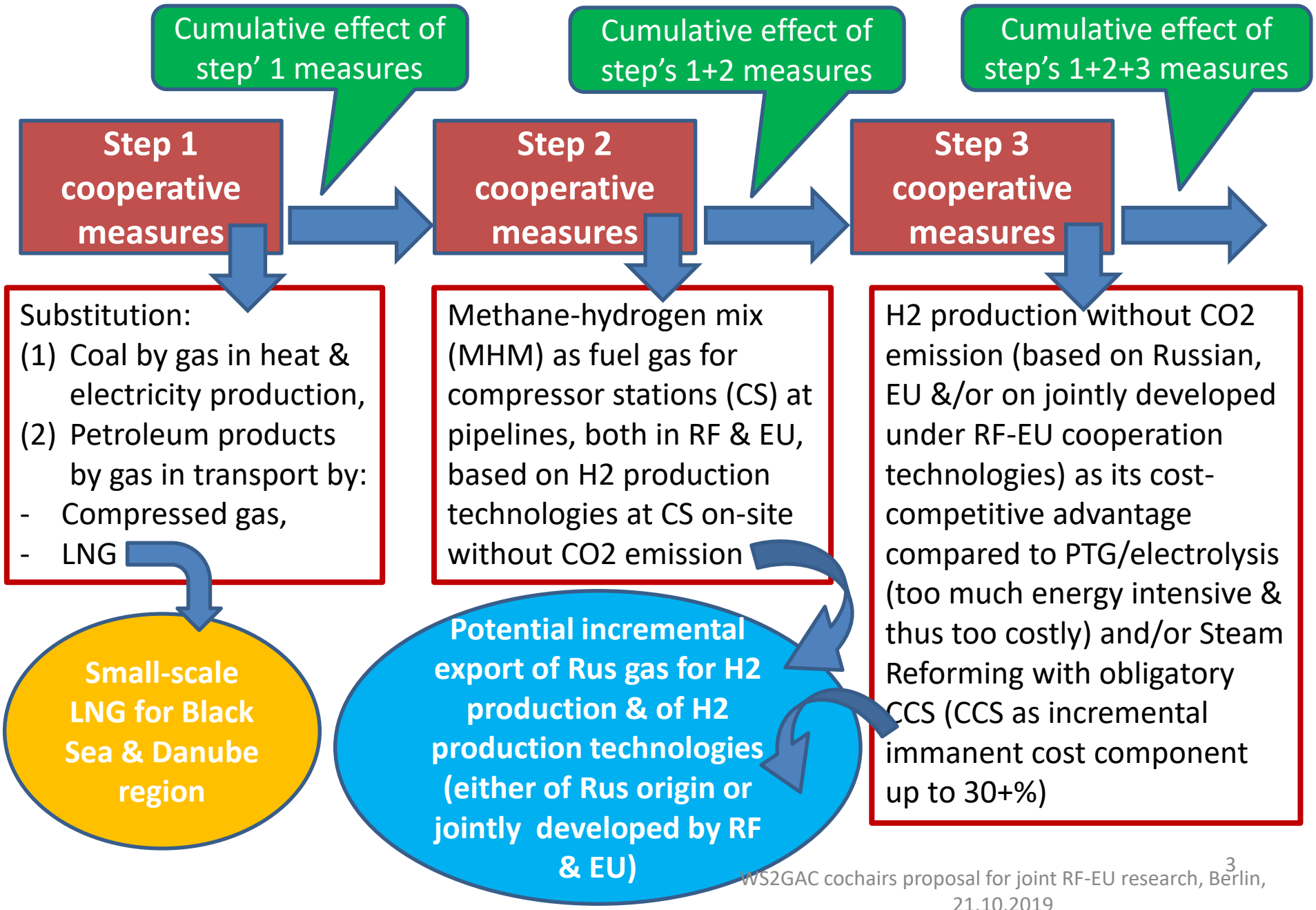


The expert assessment is made on the basis of data on:

- *Carbon intensity from different fuels (U.S. Energy Information Administration estimates);*
- *Carbon footprint of various motor fuels (European Natural gas Vehicle Association report, 2014-2015);*
- *EU GHG emissions (1990 – 2016 National report on the inventory of anthropogenic emissions by sources and GHG removals by sinks not controlled by the Montreal Protocol , IEA)*

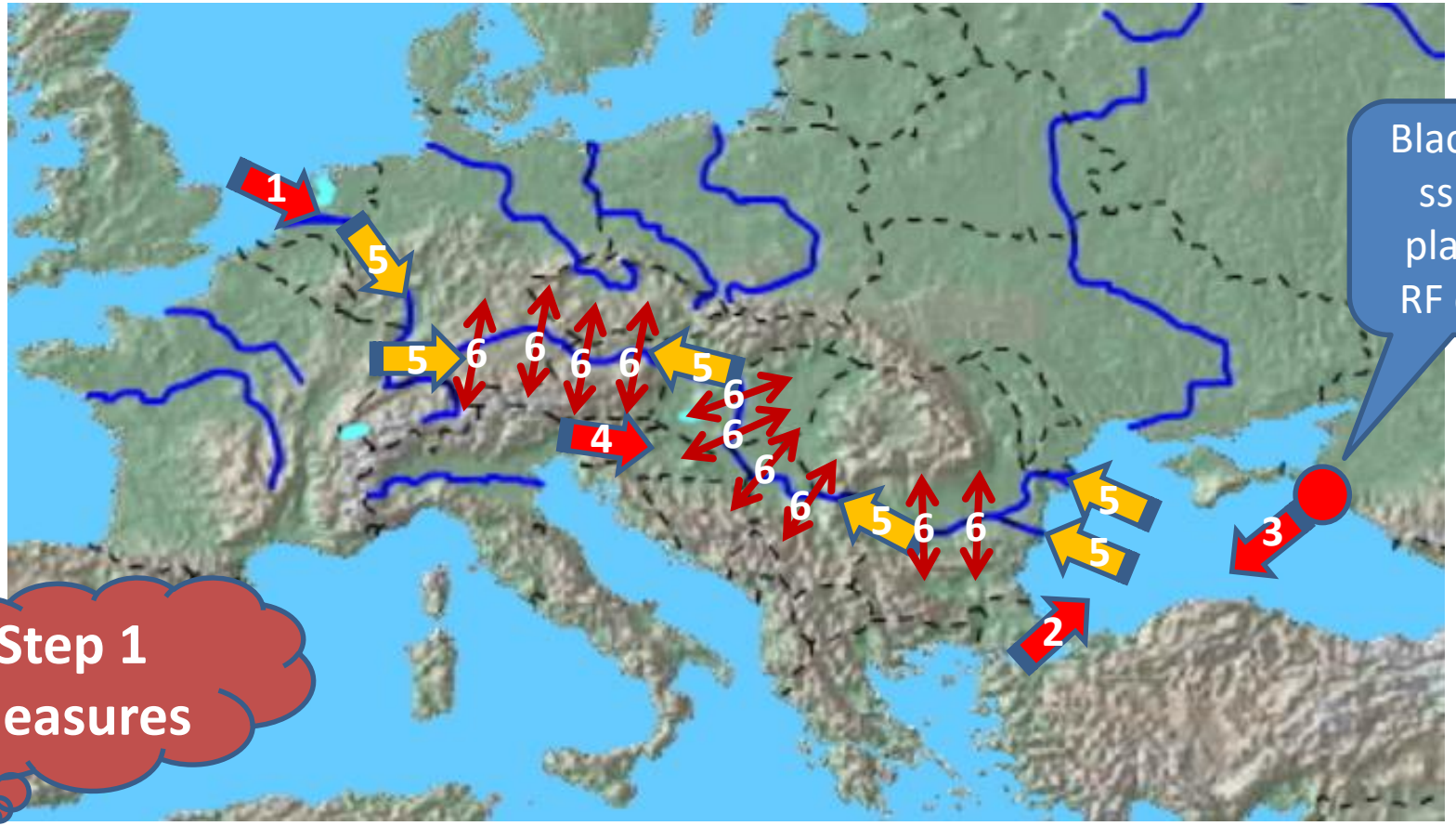
Source: O.Aksyutin. Future role of gas in the EU: Gazprom's vision of low-carbon energy future. // 26th meeting of GAC WS2, Saint-Petersburg, 10.07.2018 (www.fief.ru/GAC); PJSC Gazprom's feedback on Strategy for long-term EU greenhouse gas emissions reduction to 2050 // https://ec.europa.eu/info/law/better-regulation/initiatives/ares-2018-3742094/feedback/F13767_en?p_id=265612

How to cooperate & implement three-steps "Aksyutin's pathway"?



Step 1 cooperative measures

Prospects of creation of Black Sea-Danube/CSEE ssLNG market



1-4 = ssLNG supplies to SEE (1 = from NS area by barges; 2 = through Turkish Straits (limited); 3 = from Black Sea RF plant by sea-river vessels; 4 = by trucks via N.Italy); 5 = supplies within Rheine-Danube waterway by barges/see-river vessels; 6 = ssLNG fueling stations

Black sea plant

Location	Black sea coast of Russia
Capacity	0.5 – 1.5 mtpa
Status	Prefeasibility study
Delivery countries	Countries of South-Eastern Europe, countries of Danube river region, Turkey.

– potential bunkering areas

Source: K.Neuymin (Gazprom). Development of Small and Medium –Scale LNG Infrastructure in Russia. Presentation at 9th SPB International Gas Forum, 1-4.10.2019

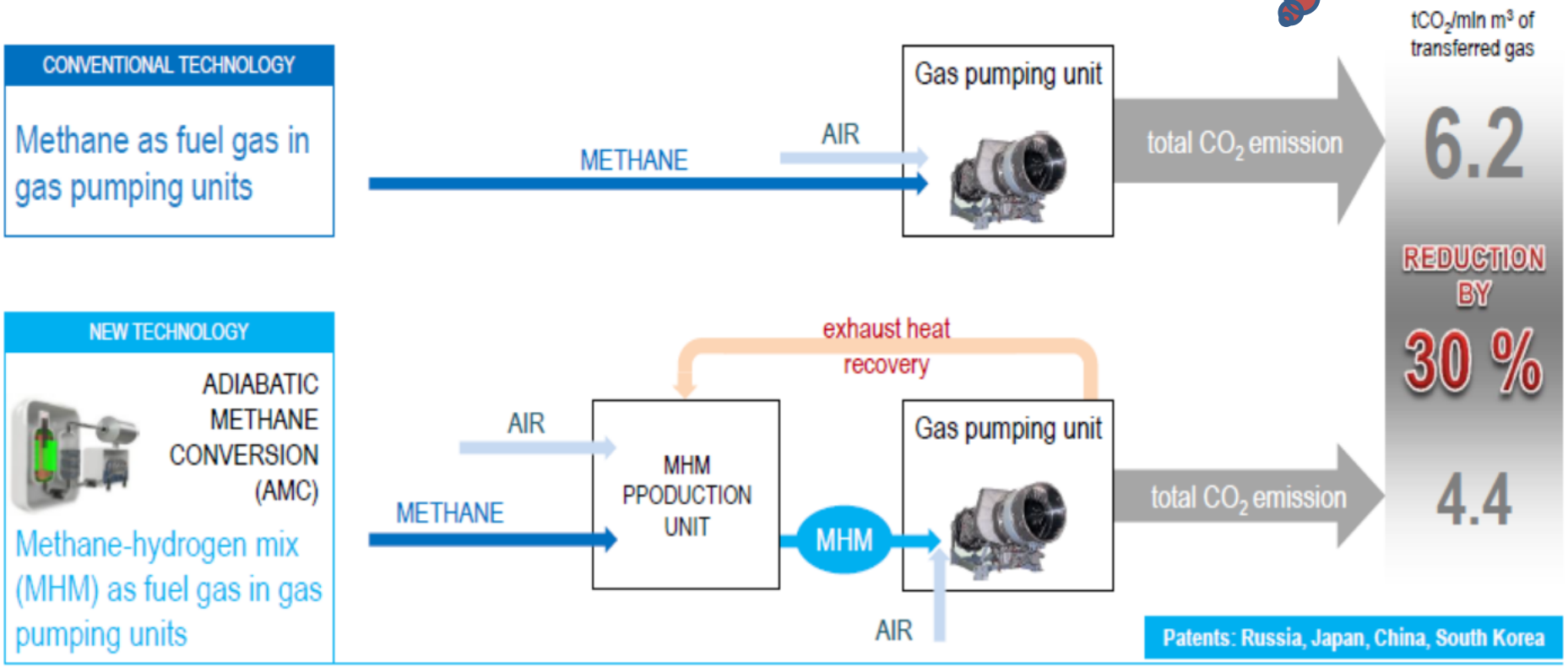
Draft proposals for joint RF-EU research (1)

- Prospective topic:
  - Assessment of aggregated demand for ssLNG within Black Sea-Danube area (bunkering (sea/river vessels), trucks (intra- & inter-city transport), off-grid households) and prospective sources of its competitive supply
- Prospective participants:
  - EU side:
    - Academic/research level: IENE (research center for SEE energy), …
    - Intergovernmental level:
      - Energy Community Secretariat (know-how & information hub for SEE),
      - Organisation for Black Sea Economic Cooperation (regional development organisation)
      - EU institutional support
    - Business level: OMV, …
  - RF side:
    - Gazprom & its affiliations/institutes:
    - …

Step 2 cooperative measures

ADIABATIC METHANE CONVERSION

Step 2 Measures



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Expert review by the Center for Integrated Development of Technologies and Energy Technology Systems (KORTES Center LLC), Gazprom-Geotekhnologii LLC

Source: O.Aksyutin. Future role of gas in the EU: Gazprom's vision of low-carbon energy future. // 26th meeting of GAC WS2, Saint-Petersburg, 10.07.2018 (www.fief.ru/GAC)

Draft proposals for joint RF-EU research (2)

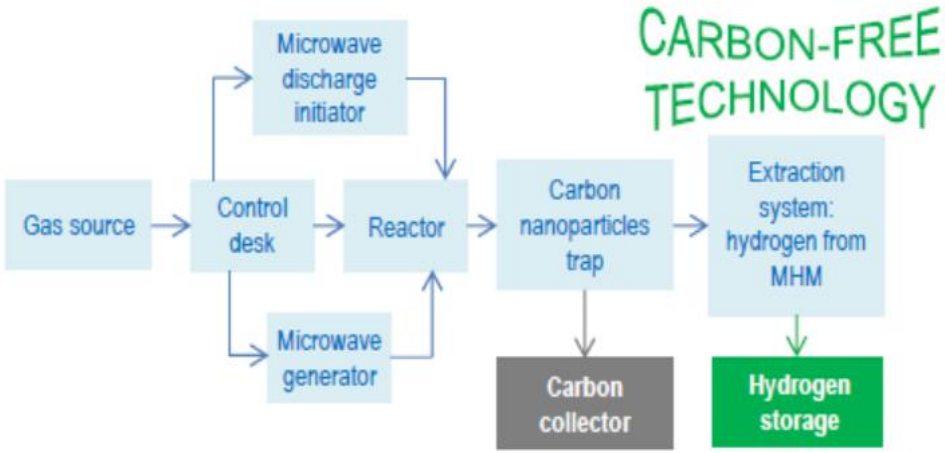
- Prospective topic:
  - Assessment of prospects & potential effects of implementation of adiabatic methane conversion (AMC) technology at the compressor stations within Russia & EU gas grids (200+ CS in Russia & … CS in the EU) – and beyond
    - Pioneering exercise (in favour of recent Baumgarten's 60th Anniversary – the key gas delivery point within USSR/Russia-EU cross-border gas supply chain): Prospective effect of implementing AMC technology within cross-border gas supply chain from Nadym-Pur-Taz through Baumgarten to Waidhaus
- Prospective participants:
  - EU side: Gas TSOs, ENTSOG, …
  - RF side: Gazprom, …

Step 3 cooperative measures

HYDROGEN PRODUCTION IN A LOW-TEMPERATURE NON-EQUILIBRIUM PLASMA

Step 3 Measures

The impact of low-temperature non-equilibrium microwave-induced plasma on hydrocarbon gas molecules



CARBON-FREE TECHNOLOGY

PROTOTYPE PLANT

CARBON MATERIAL

CAPACITY OF:
- hydrogen – up to 1 м3/h;
- carbon material – up to 80 g/h

The hydrocarbon gas conversion takes place in a closed plasma-chemical flow reactor **in the absence of oxygen** and at ambient pressure

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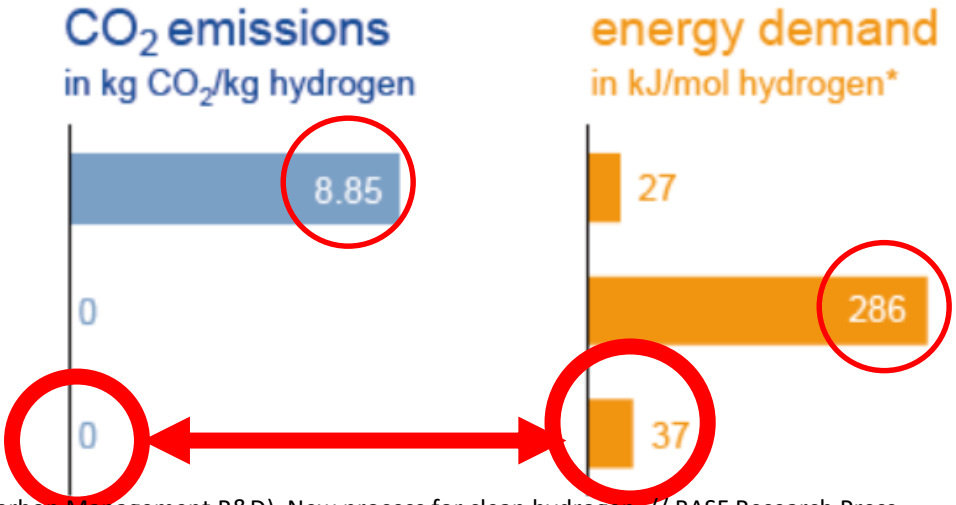
Source: NATIONAL RESEARCH TOMSK POLYTECHNIC UNIVERSITY

Source: O.Aksyutin. Future role of gas in the EU: Gazprom's vision of low-carbon energy future. // 26th meeting of GAC WS2, Saint-Petersburg, 10.07.2018 (www.fief.ru/GAC)

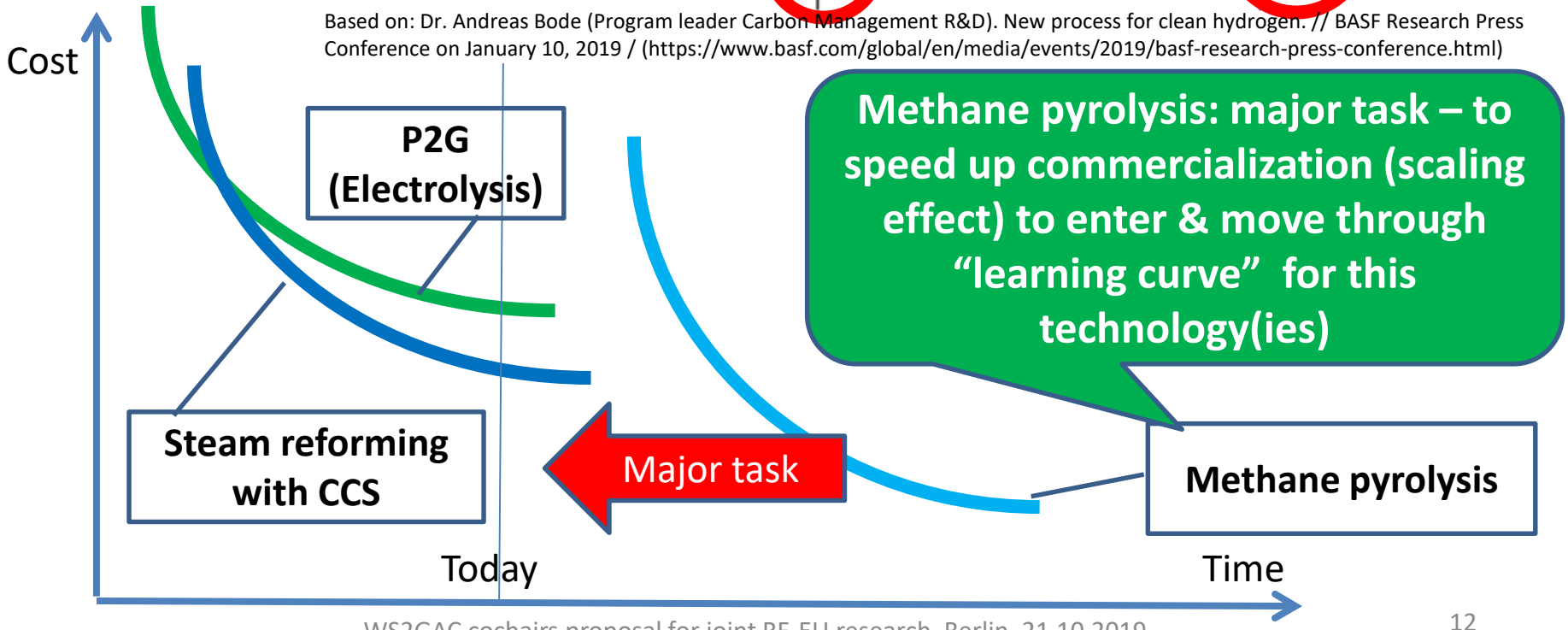
All other conditions being equal, & under technologically neutral regulation, methane pyrolysis might win competition in hydrogen production with two other key technologies

CC(U)S is needed!!! => additional imputed costs (CAPEX + OPEX) => add. 20/30+%

Steam reforming of natural gas	$CH_4 + 2H_2O \rightarrow 4H_2 + CO_2$
Water electrolysis	$2H_2O \rightarrow 2H_2 + O_2$
Methane pyrolysis	$CH_4 \rightarrow 2H_2 + C$



Based on: Dr. Andreas Bode (Program leader Carbon Management R&D). New process for clean hydrogen. // BASF Research Press Conference on January 10, 2019 / (https://www.basf.com/global/en/media/events/2019/basf-research-press-conference.html)



Methane pyrolysis: major task – to speed up commercialization (scaling effect) to enter & move through "learning curve" for this technology(ies)

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

- P2G wind
- P2G solar
- P2G hydro
- P2G nuclear
- Steam reforming plus CC(U)S
- Methane pyrolysis & similar (w/o CO2)

Based on conversations with Ralf Dickel

Source of map: ENTSOG

Draft proposals for joint RF-EU research (3)

- Prospective topic:
  - Quantitative and qualitative assessments of economic & ecological effects for the three H2 production technologies
  - Analyzing alternative system approaches for the 3 technologies
    - Where to do this in EU/in RF/..
    - Who to do this (Producers, mid-streamers, TSOs,..)
    - How to progress on the learning curve (large pilots)
    - How to finance pilot ?
- Prospective participants:
  - RF side: Tomsk, Samara, etc…
  - EU side: Karlsruhe, BASF, Madrid, etc…

Possible Additional Cooperative Measures ?

Thank you for your attention!

WS2 GAC Co-chairs