

Итоговые комментарии на заключительной сессии “Водород: хайп или надежда”.

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Concluding remarks at the final session “Hydrogen: Hype or Hope”.

Prof. Dr. A.A.Konoplyanik,

Adviser to Director General, Gazprom export LLC;

Co-chair of Work Stream 2 “Internal Markets”, Russia-EU Gas Advisory Council;

Member of Scientific Council on System Research in Energy, Russian Academy of Sciences

**XIII International Scientific Conference “ENERGETIKA-XXI: Economics, Politics, Ecology” –
“Russia and Global Carbon Neutrality”,
November 17-19, 2021, FINEC – JSPC Gazprom, Saint-Petersburg, online**

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Concluding remarks at the final session “Hydrogen: Hype or Hope”.

Possible alternative titles:

(1) H2: Hope? Hype? Or maybe even “Deep-fake”?

(2) H2 – a New Fusion?

Bituminous sands? Shale O&G?

i.e.: Samuel Furfari.
The hydrogen illusion
// Independently
published, 2020,
160 pp.

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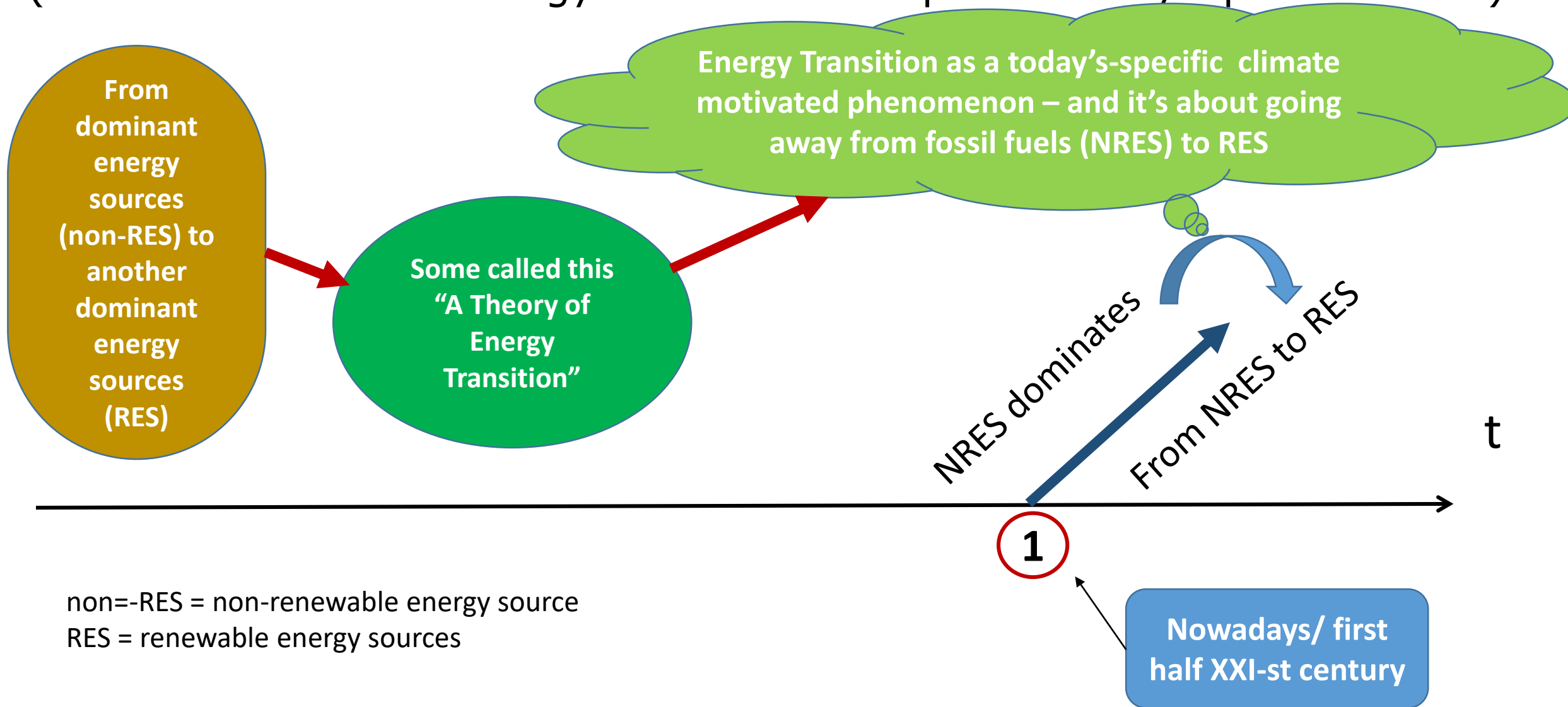
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**«Переходить от уровня событий к уровню тенденций и
счищать пропагандистскую чепуху»
(Андрей Фурсов, российский историк)**

- 1) «Человек не способен объективно оценить информацию, но важно, чтобы он верно уловил тенденцию – тогда он способен правильно делать выводы» *(Аллен Даллес)*
- 2) *Он же (вариант):* «Человека легко запутать фактами, но, если он понимает тенденции, его уже хрен обманешь»
- 3) «Все есть яд и все есть лекарство, и только мера превращает одно в другое...» *(Авиценна/Ибн-Сина? Парацельс?)*

Energy transitions: duration of historical period does matter (1)

(those who consider Energy Transitions as specific today's phenomenon)



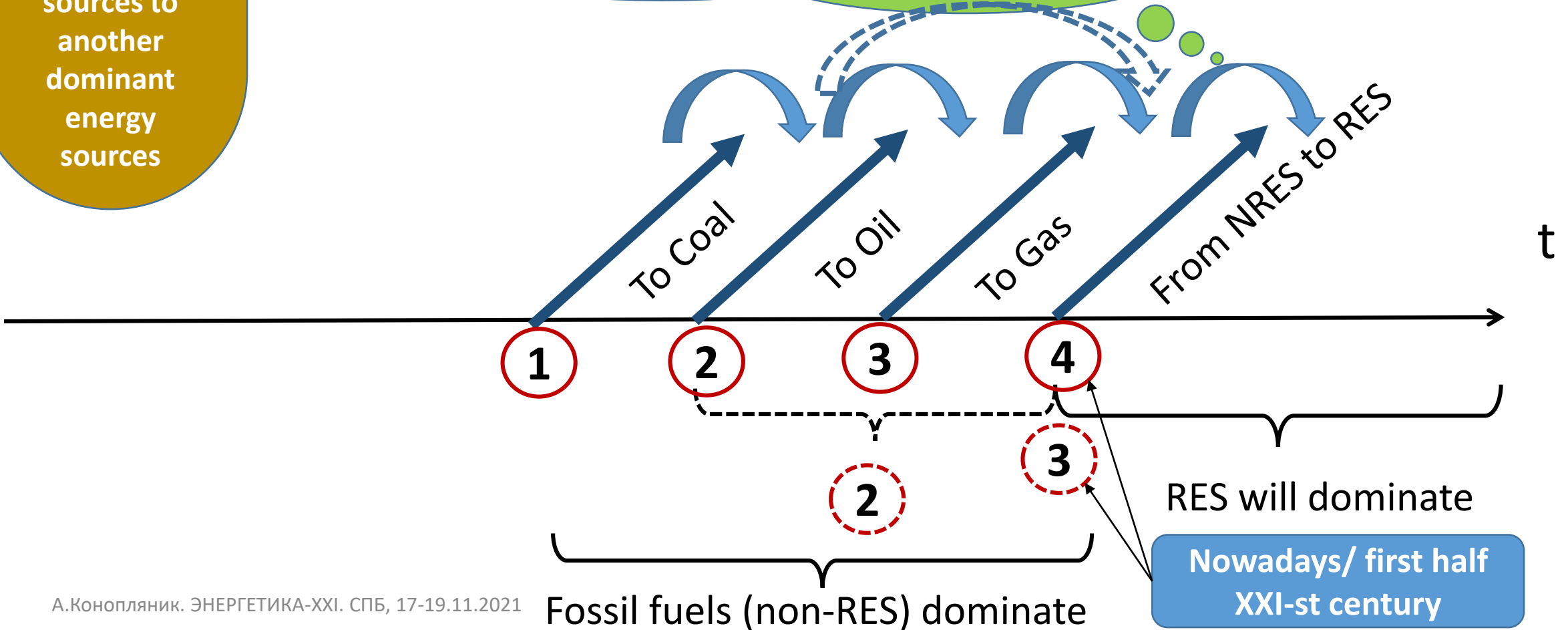
non-RES = non-renewable energy source
RES = renewable energy sources

Energy transitions: duration of historical period does matter (2)

(dominant/most popular today's vision/numbering – Skolkovo etc.)

From dominant energy sources to another dominant energy sources

Energy Transition as a regular phenomena since First Industrial Revolution – and it's about going first from one dominant fossil fuel to another and nowadays - away from fossil fuels to RES



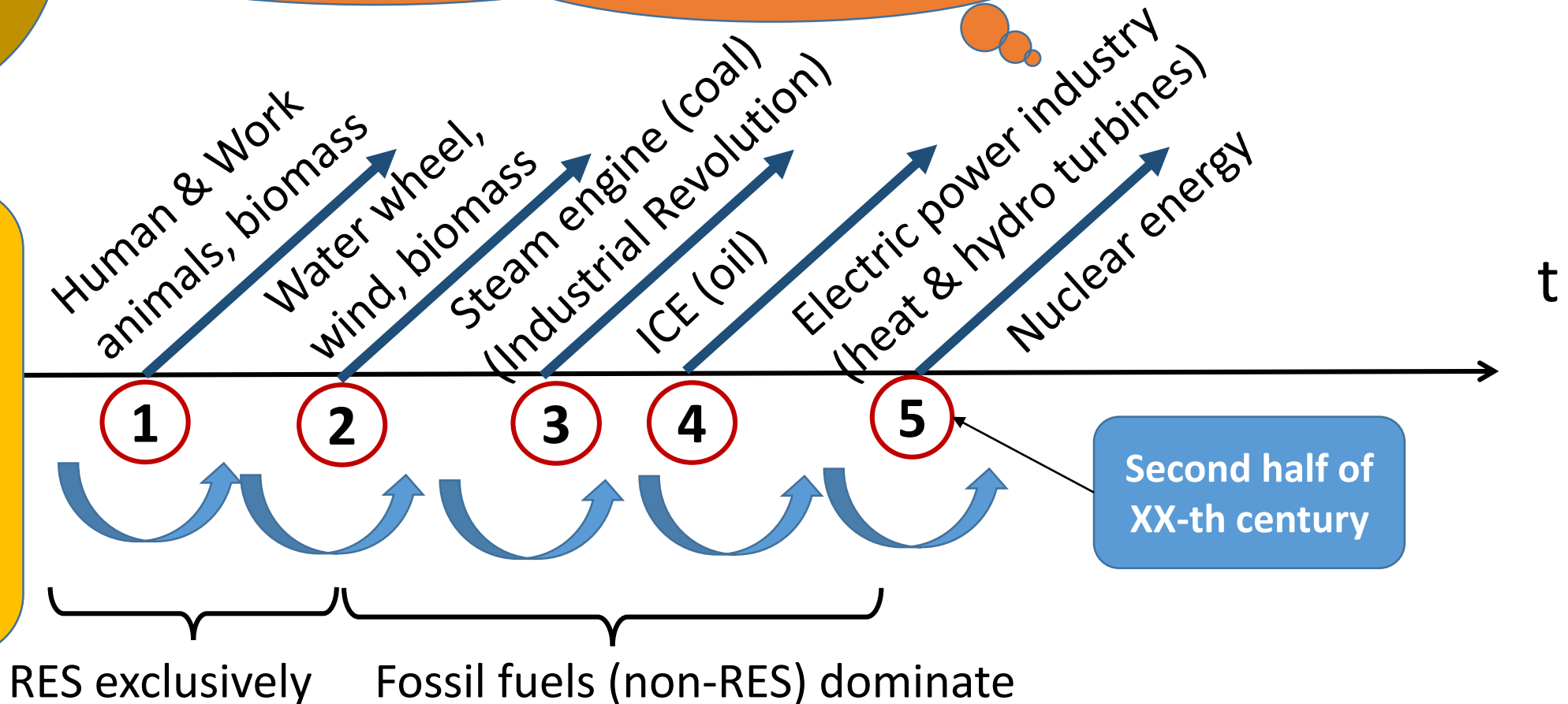
Energy transitions: duration of historical period does matter (3)

(acc.to "Energy Thresholds" theory of acad.Krzhizhanovsky-Melentiev-Makarov)

From dominant energy technology (=> energy source) to another dominant energy technology (=> energy source)

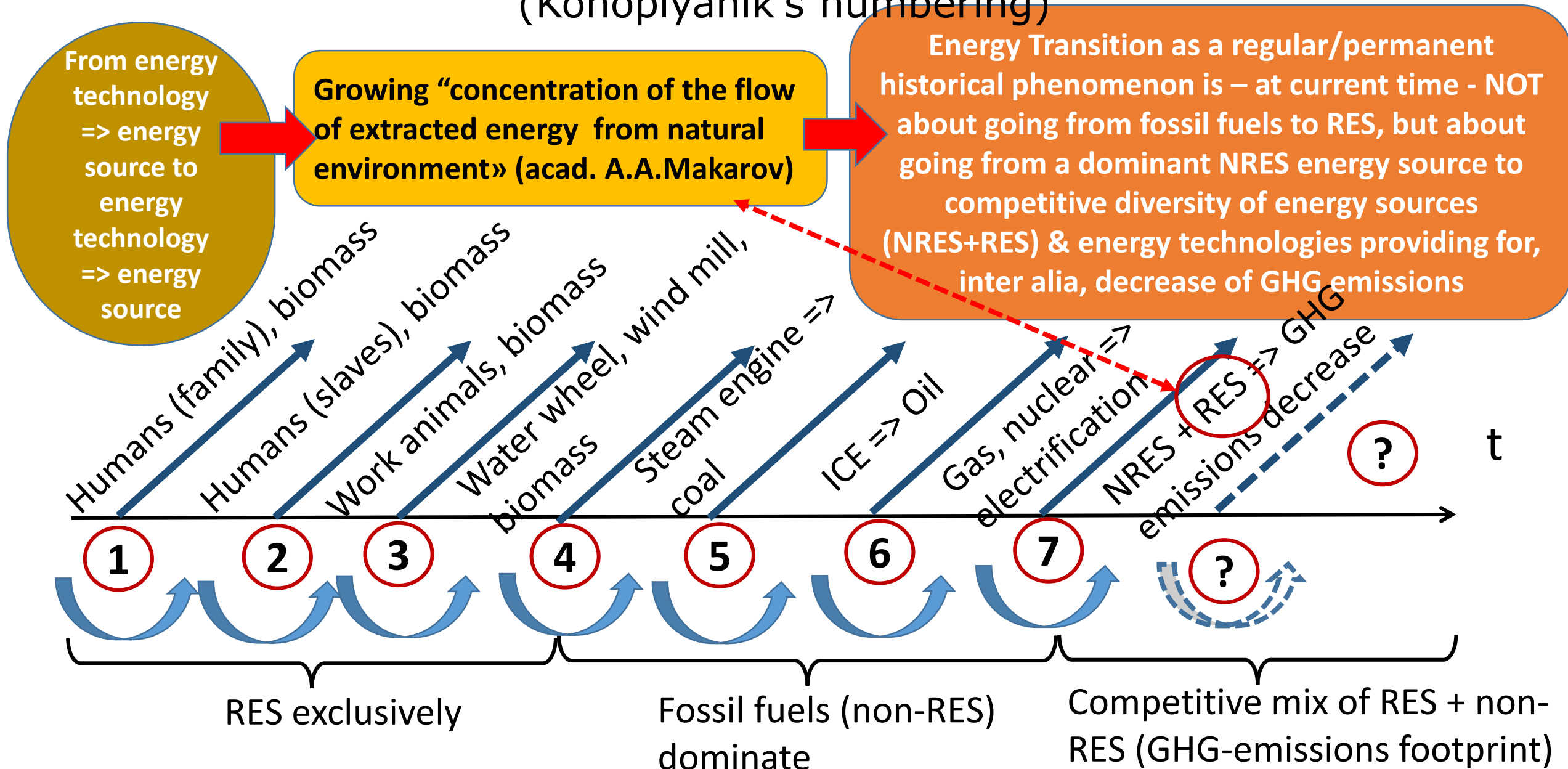
Energy Transition as a regular/permanent historical phenomena – as a passing of Energy Thresholds => it is NOT about going from fossil fuels to RES, it's about changes of dominant energy technologies creating demand for new energy sources

Growing "concentration of the flow of extracted energy from natural environment» (acad. A.A.Makarov)



Energy transitions: duration of historical period does matter (4)

(Konoplyanik's numbering)



Hydrogen for politicians, statesmen, energy professionals, etc...

Short-term vision: to maximize

Media (populist, conflict new vs old businesses/elites)

Politicians (next elections/populist): RenH2+RES = new oil = universal solution to save the climate

Energy companies (in public media)

Start-ups (state support)

Public funds, NGO, ecologists, "greens" (green perceptions)

Statesmen (state interests): how to balance professionals, electorate, geopolitics...

Economists (long-term ROI)

Financiers (long-term ROC)

Engineers (long-term technical safety)

Consumers (low energy bill, secure supply)

Long-term vision: to optimize

Less

More

H2 optimal niche in end-use & primary energy mix

Energy professionals: RenH2 nor H2 can not become a new oil, but it might find its optimal niches in the specific end-use sectors – different for different states

Long-term vision: to optimize

Водород: путь инноваций = аналог «Диаграммы Арпса» (воронка сближения позиций)

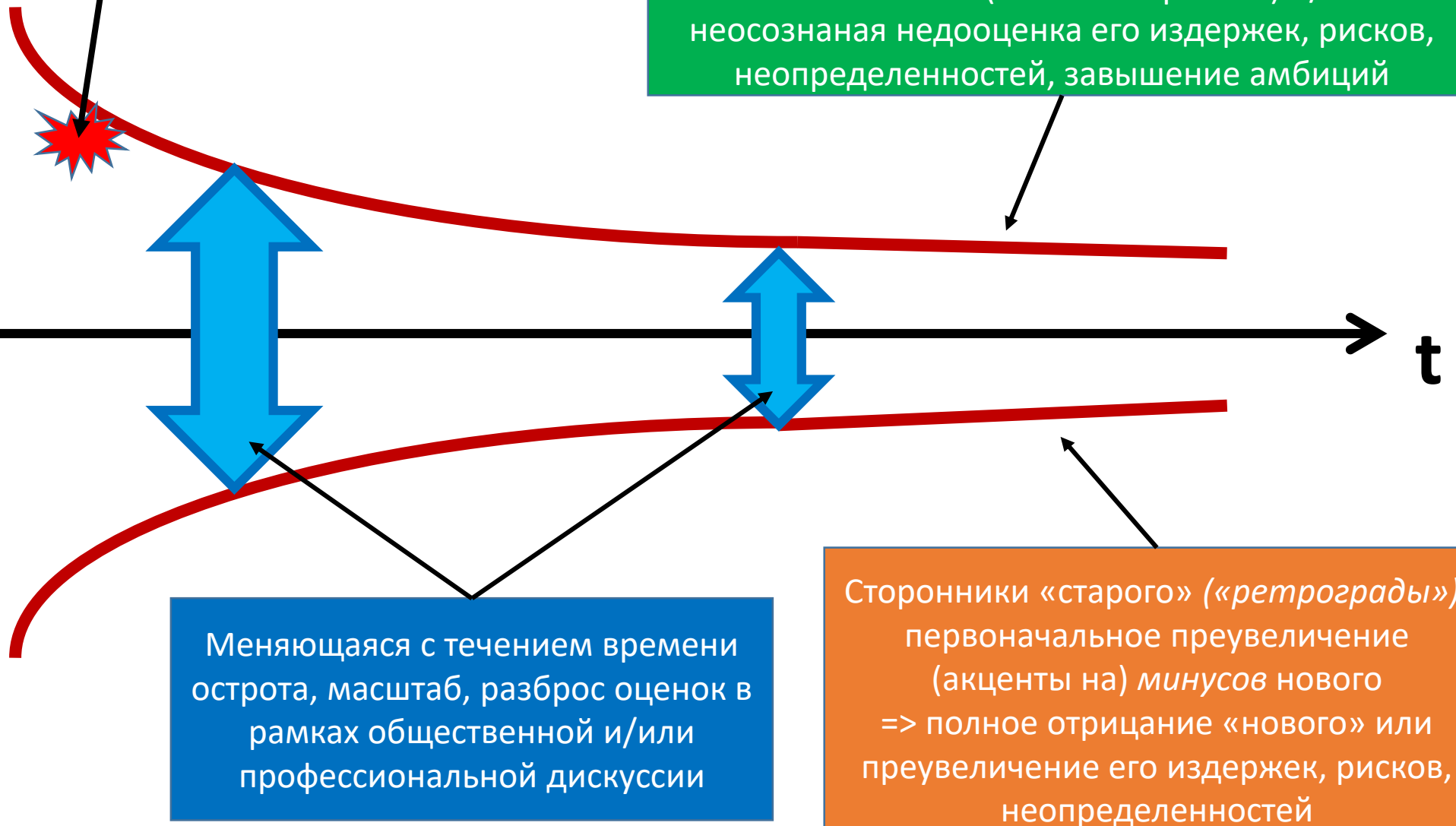
Формируемое сегодня доминирующее общественное мнение: $RenH_2+RES$

Сторонники «нового» («прогрессисты»): первоначальное преувеличение плюсов нового => осознанная («Окно Овертона») и/или неосознанная недооценка его издержек, рисков, неопределенностей, завышение амбиций

Отклонения «в «плюс»

Разброс мнений – отклонения от оптимальной конкурентной ниши

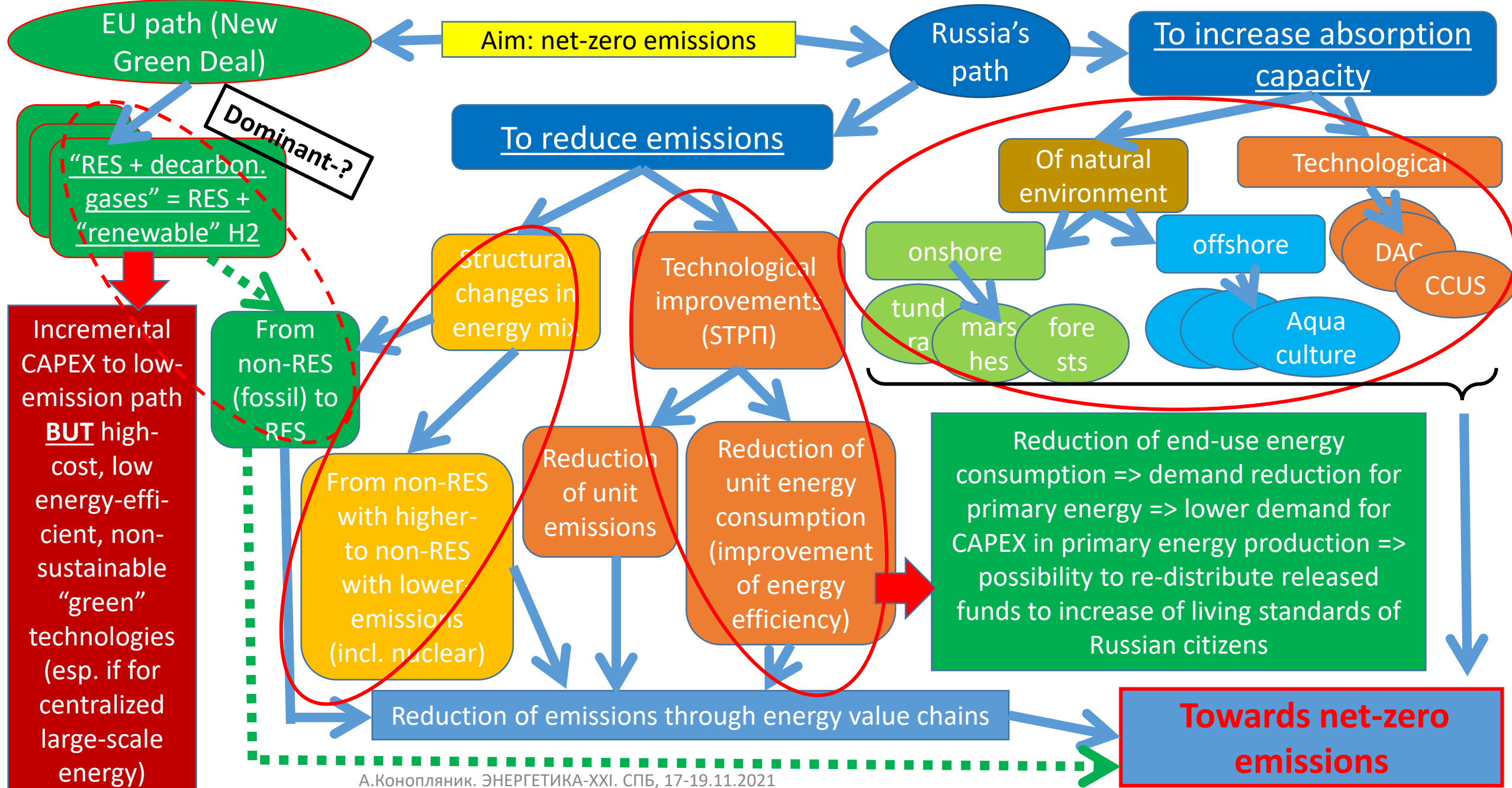
Отклонения «в «минус»



Меняющаяся с течением времени острота, масштаб, разброс оценок в рамках общественной и/или профессиональной дискуссии

Сторонники «старого» («ретрограды»): первоначальное преувеличение (акценты на) минусов нового => полное отрицание «нового» или преувеличение его издержек, рисков, неопределенностей

EU & Russia: two ways to net-zero emissions in energy



What is clean energy? Depends on how you calculate/consider it...

Wrong perceptions as if renewable H2 is the only clean H2 and, moreover, that it is clean at all

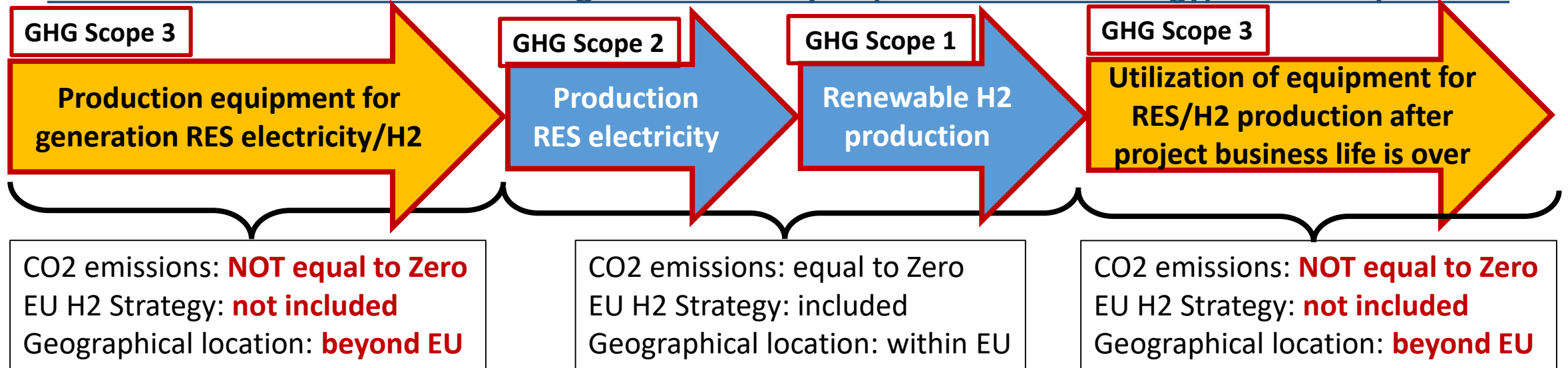
A hydrogen strategy for a climate-neutral Europe (Brussels, 8.7.2020 COM(2020) 301 final):

'Renewable hydrogen' is hydrogen produced through the electrolysis of water (in an electrolyser, powered by electricity), and with the electricity stemming from renewable sources. The **full life-cycle greenhouse gas emissions of the production of renewable hydrogen are close to zero <...>** 'Clean hydrogen' refers to renewable hydrogen.

Siemens/Gascade/Nowega (Hydrogen infrastructure – the pillar of energy transition..., Sept.2020):

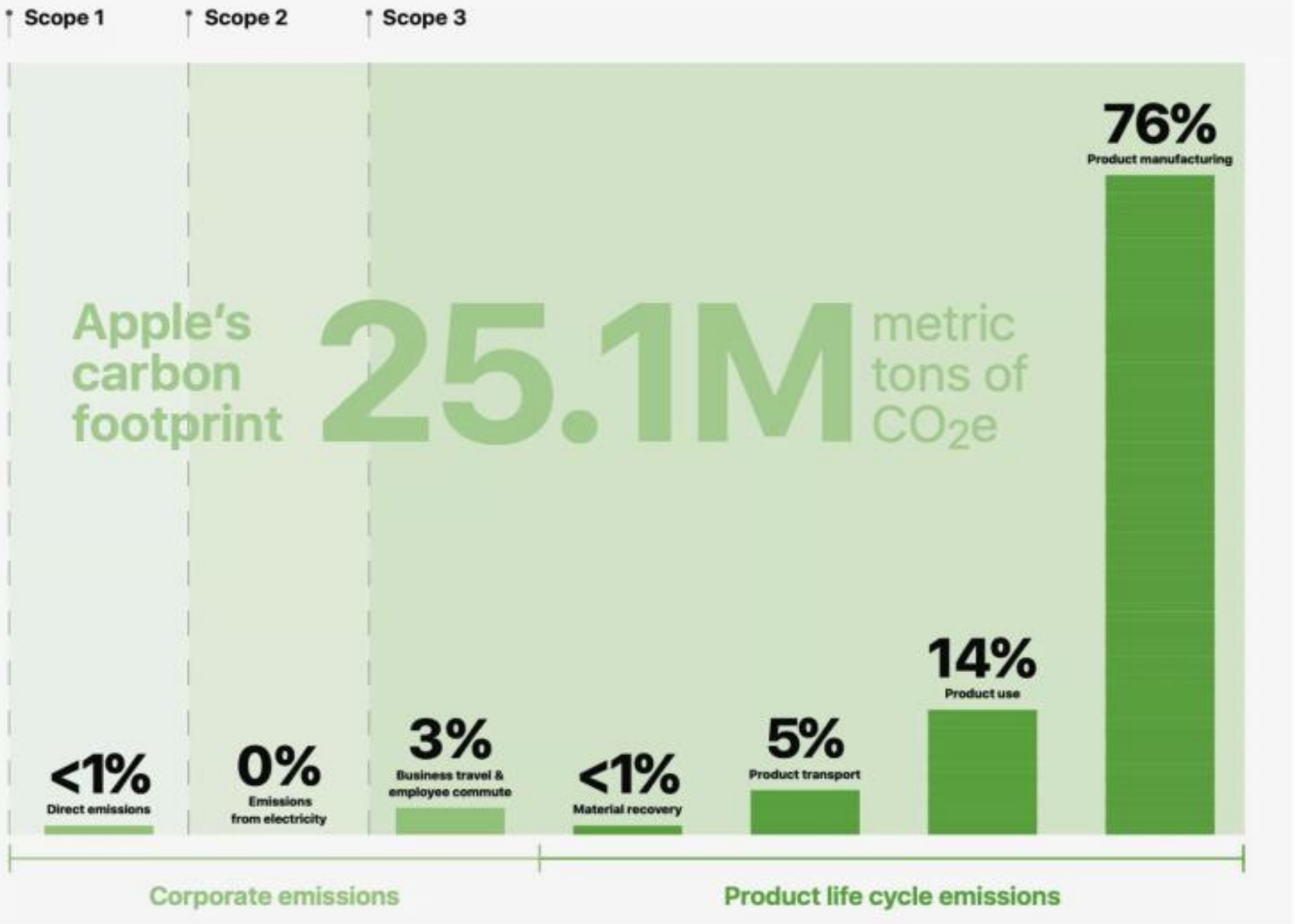
"If the electricity required for electrolysis comes exclusively from renewable, CO2-free sources, the **entire production process is completely CO2-free.**"

Carbon track of renewable H2 through the full life-cycle (acc. to EU H2 Strategy) – GHG Scopes 1-2-3



Daniel Yergin, Pulitzer Prize winner for "The Prize" book at presentation of his new book "The New Map":
"NEW SUPPLY CHAINS FOR NET-ZERO CARBON REQUIRES CARBON!!! ... They require diesel to operate shuttle in mining..."

(Source: A conversation with Pulitzer Prize winner and energy expert Daniel Yergin, Atlantic Council, 25.09.2020; <https://www.youtube.com/watch?v=hWMOU8IjRhI>)



Why it is important to consider GHG emissions within all THREE Scopes?
 (Illustrative example from Apple which it has presented to the public voluntarily – direct analogy with “green” H2)

Source: What are Scopes 1, 2 and 3 of Carbon Emissions? // PlanA Academy, 12.08.2020
[\(https://plana.earth/academy/what-are-scope-1-2-3-emissions/\)](https://plana.earth/academy/what-are-scope-1-2-3-emissions/)

The importance of scope 3 emissions – Apple carbon footprint.
 Credit: Apple

Geography of nuclear & hydro power stations and major area of gas production in Russia (Nadym-Pur-Taz & Yamal) – proposed domestic production of H2 for export would be deep inside Russia & will require long-distant large-scale transportation of H2/MMH to the EU via existing RF-EU GTS to be deeply modernized



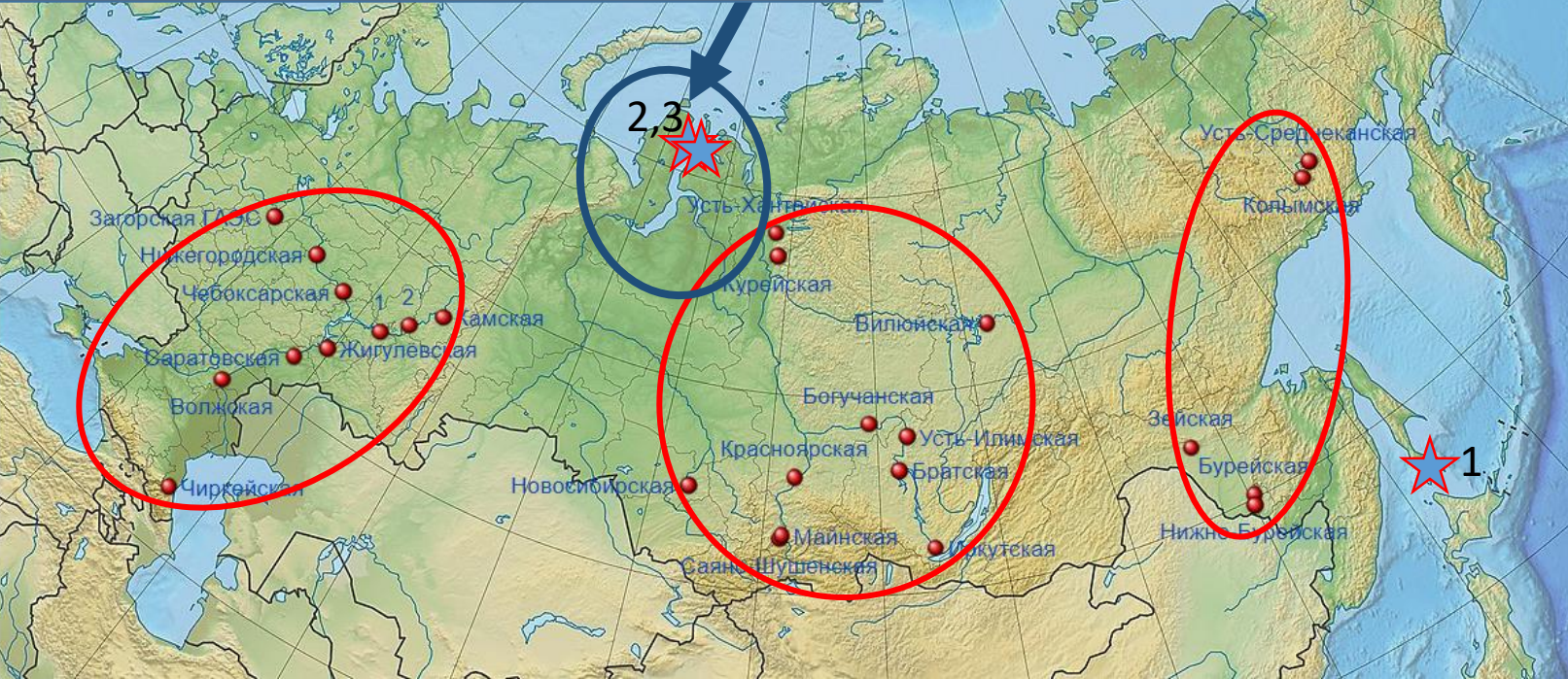
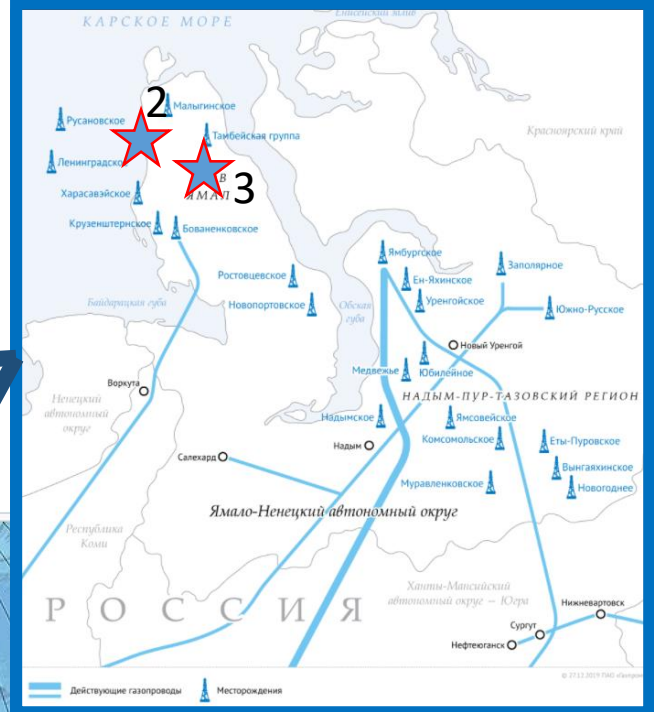
○ Nuclear ○ Nadym-Pur-Taz & Yamal
○ Hydro

★ Large-scale LNG plants, acting: (1) Sakhalin-2; (2) Yamal LNG; (3) Arctic LNG

Sources of maps:
<https://www.gazprom.ru/f/posts/15/770293/map-yamal-ru-2019-12-30.png>;
[https://ru.wikipedia.org/wiki/Атомная_энергетика_России](https://ru.wikipedia.org/wiki/Атомная_энергетика_России;);
https://ru.wikipedia.org/wiki/Список_гидроэлектростанций_Росси;
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Concept of Russian H2 Strategy (05.08.2021) => four territorial export-oriented H2 clusters:

1. North-Western: export H2 to the EU,
2. Eastern: export H2 to Asia,
3. Arctic: zero-carbon energy supply systems for Arctic zone RF and/or export H2 & H2-based energy mixes,
4. Southern (based on NatGas & RES): close to export ports



Russian Atlas of Low-Carbon and Carbon-Free (*) Hydrogen and Ammonia Production Projects

(*) more correctly would be: with low & zero direct emissions

1 Export-oriented H2 clusters (acc. to Gov't "Concept of Russian H2 Strategy", 05.08.2021): **1** – North-Western, **2** - Arctic, **3** – Eastern, **4** – Southern



A Regional Carbon Testing Sites (**): **A** -Yamal ("Seven larch-trees"); **B** – Kaliningrad obl.; **C** - Chechnya; **D** – Krasnodar kr.; **E** – Sverdlovsk obl.; **F** - – Kuzbass; **G** – Novosibirsk obl.; **H** - Sakhalin => to be expanded to 14 regions

(**) Ministry Education & Research pilot project to create integrated system GHG gases movements

1. Project company
2. "Colour" of H2
3. Technology
4. Source of end-use energy
5. Time of start-up: 2021-2031
6. Region, place
7. Target markets
8. Production volumes, t/Y : 13 (Krasnodar) – 5/6 mln t (Kamchatka/Yakutia)
9. Logistics: Hydrogen transportation to customers [within Russia and] of European countries/Asia-Pacific
10. Consumption: Long-term contracts with [Russian and] European/AP customers

33 projects in 18 regions, incl.:
 25 - Green H2 (- wind, - tidal, - hydro),
 5 - Blue H2
 1 - Turquoise H2
 2 - Yellow (low-carbon) H2
 11 - incl. Ammonia

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Source of basic slide:
https://minpromtorg.gov.ru/common/upload/docVersions/6169d30a61364/actual/Atlas_en_15102021_compressed.pdf

Decarbonisation upstream: some physical & chemical barriers to long-distant high-pressure transportation & storage of H₂ (acc. to Litvinenko et al, SPB Mining University) (*)

(1) Effectiveness of gas pipeline transportation is directly contingent upon quantities of the product, and thus on the density of gas. **As concentration of H₂ in MHM increases from 10 to 90 %, density of MHM decreases more than four times.**

(2) **Energy obtained from one volume of H₂ is 3.5 times less than the energy obtained from methane.**

(3) Increase in energy required to compress 1 kg of MHM to raise the pressure by 1 MPa with increasing proportion of H₂. While **H₂ content in MHM rises from zero to 100%, energy costs (work) are raised by around a factor of 8.5.**

(4) Increasing proportion of H₂ in MHM increases explosion risks of the MHM

(5) Export/storage of *liquid* H₂: **CH₄** liquefies at atmospheric pressure and temperature below - 161.5 °C, LNG volume is 600 times less than its gaseous form. **H₂** liquefies at atmospheric pressure and temperature below -252.87 °C, it reduces in volume by 848 times. (ii) The closer temperature of a substance to absolute zero, the more **quantum properties** (superfluidity, superconductivity, etc.) begin to appear. (iii) Under same conditions and tank capacity it is **possible to store or transport almost 5.9 times more LNG than liquid H₂.**

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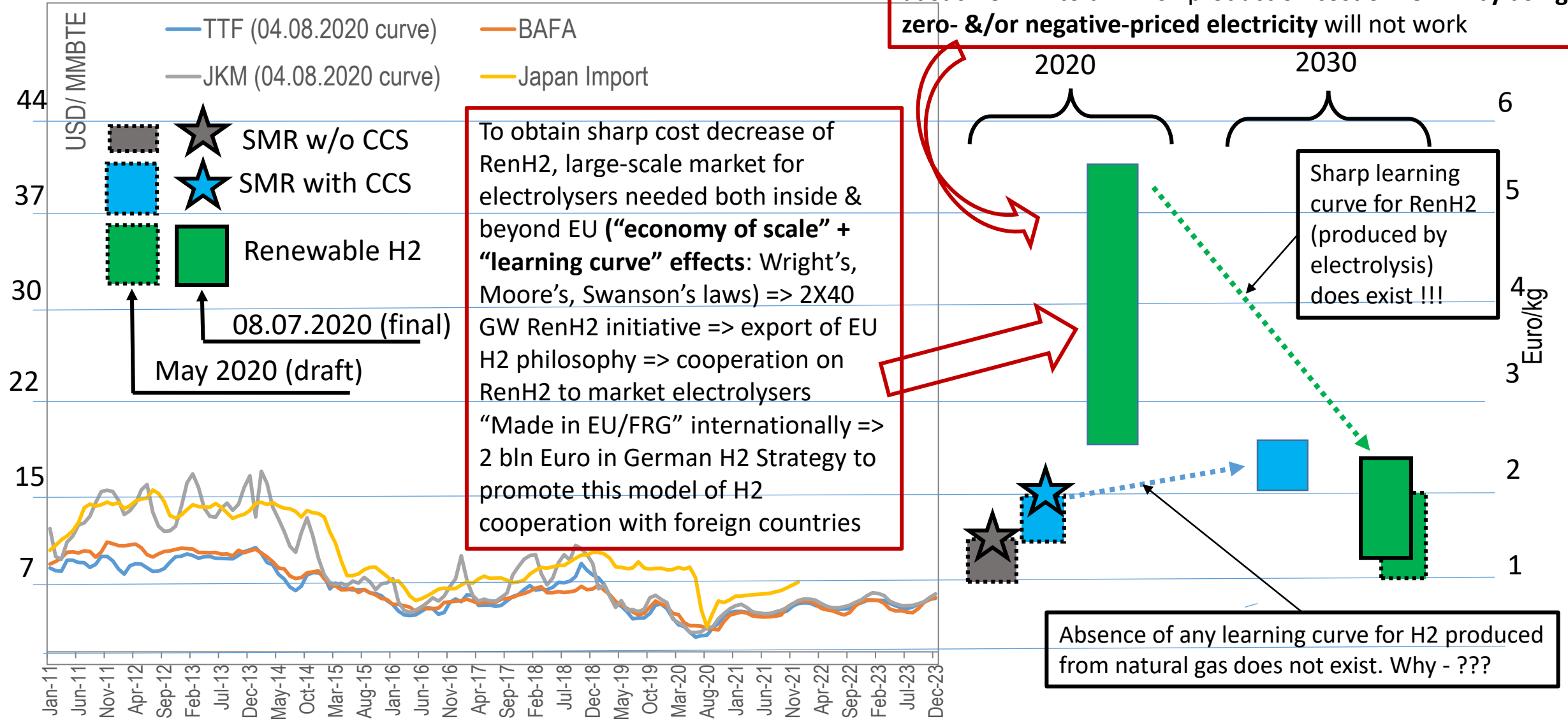
(6) H₂ has extremely high penetrating ability, its molecules spread faster than molecules of all the other gases in the media of another substance and penetrate through almost any metal. **Pressurized H₂ is capable to escape even from airtight tanks during long-term storage.**

(7) Research into effect of H₂ on metals has been carried out for decades. Back in 1967 in USSR scientific discovery "Depreciative effect of hydrogen on metals" was made (N 378), however, the reactivity of hydrogen is still not sufficiently studied, whereas its negative effects have already become a substantial technical issue (**stress corrosion**). Due to stress corrosion Gazprom replaced over 5,000 km of large-diameter pipelines.

(*) Within **43** items of RF Gov't Action plan on H₂ Saint Petersburg Mining University is mentioned as co-participant in **42** items

European Commission's estimated costs of H2 production by the key technologies (as presented in the EU Hydrogen Strategy as of 08.08.2020) – and natural gas prices

Germany (2019): "excessive" RES electricity = 211 from 8760 hours/y => utilization rate (UR) = 2.5% => no ever economics at such UR => to diminish production cost of RenH2 by using zero- &/or negative-priced electricity will not work



To obtain sharp cost decrease of RenH2, large-scale market for electrolyzers needed both inside & beyond EU ("economy of scale" + "learning curve" effects: Wright's, Moore's, Swanson's laws) => 2X40 GW RenH2 initiative => export of EU H2 philosophy => cooperation on RenH2 to market electrolyzers "Made in EU/FRG" internationally => 2 bln Euro in German H2 Strategy to promote this model of H2 cooperation with foreign countries

2020

2030

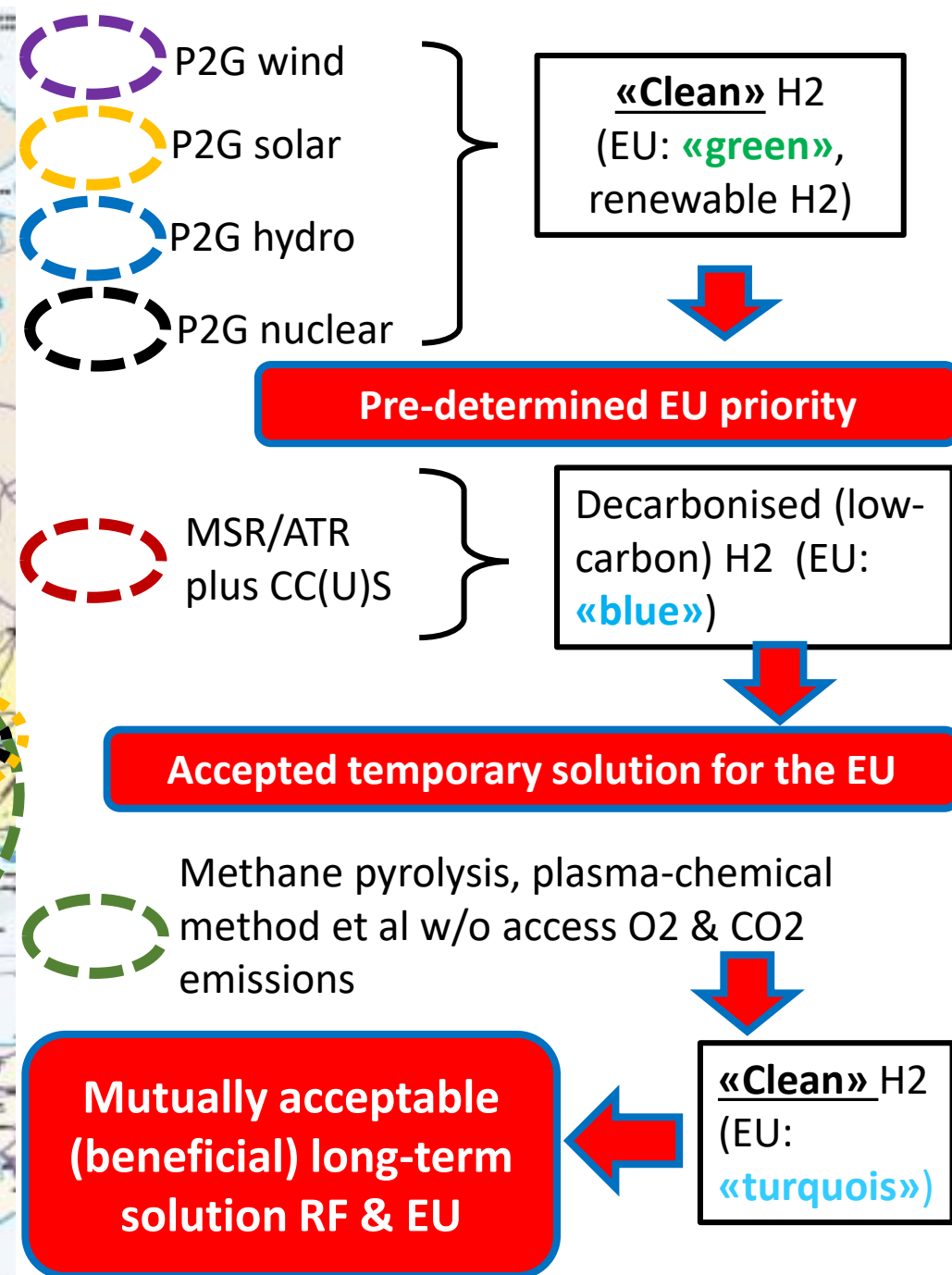
Sharp learning curve for RenH2 (produced by electrolysis) does exist !!!

Absence of any learning curve for H2 produced from natural gas does not exist. Why - ???

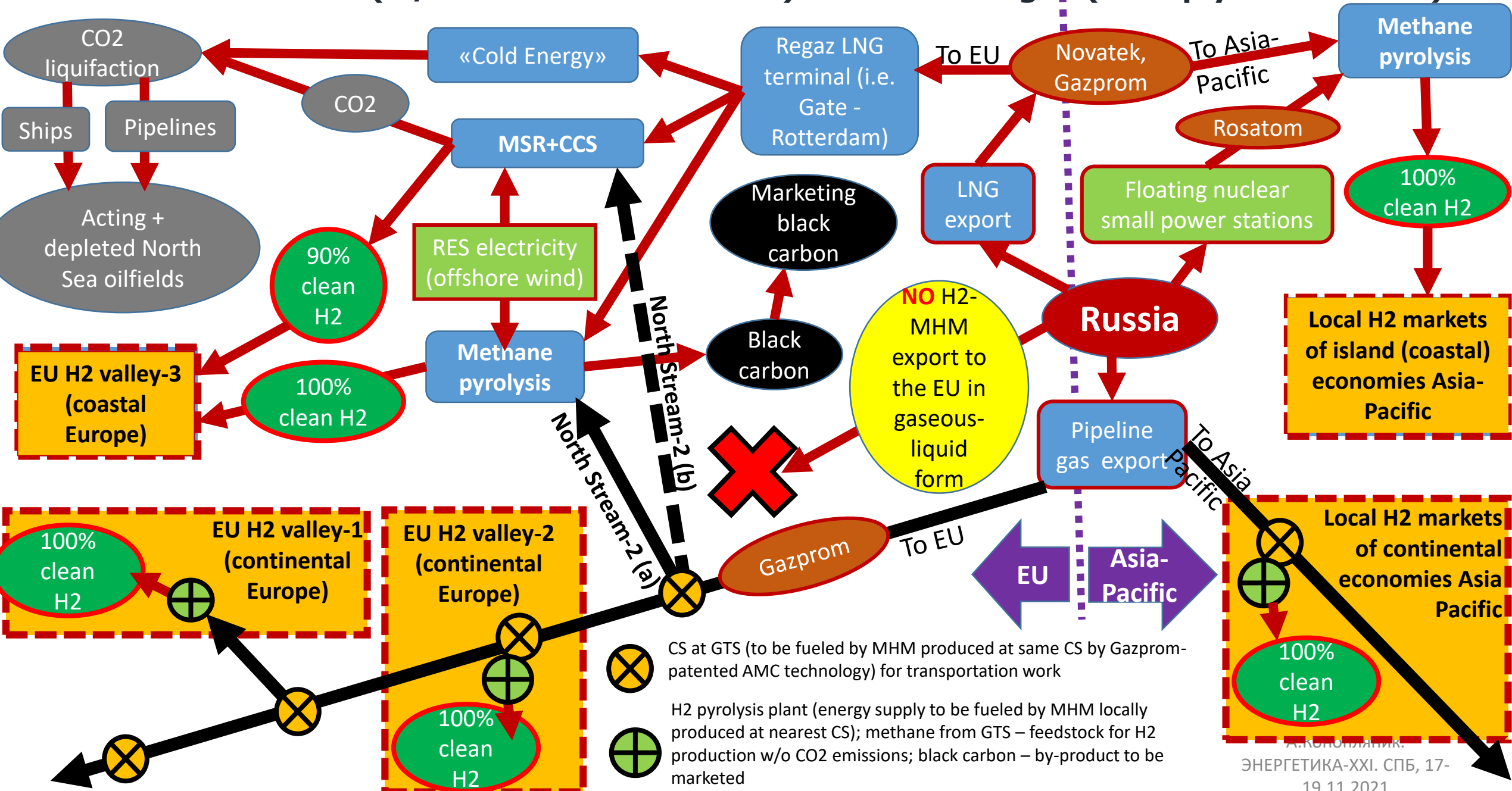
Approximate potential areas of preferential use of key H2 production technologies in Europe under state regulation based on “technological neutrality” principles – potential new competitive niche for Russian gas & technologies for H2 production w/o direct CO2 emissions

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

Map source: ENTSOG



Alternative concept for export-oriented segment of Russian hydrogen energy economy – based on clean H2 (w/o direct CO2 emission) from natural gas (Konoplyanik's vision)



Thank you for your attention!

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