# TECHNOLOGIES for HYDROGEN TRANSPORTATION

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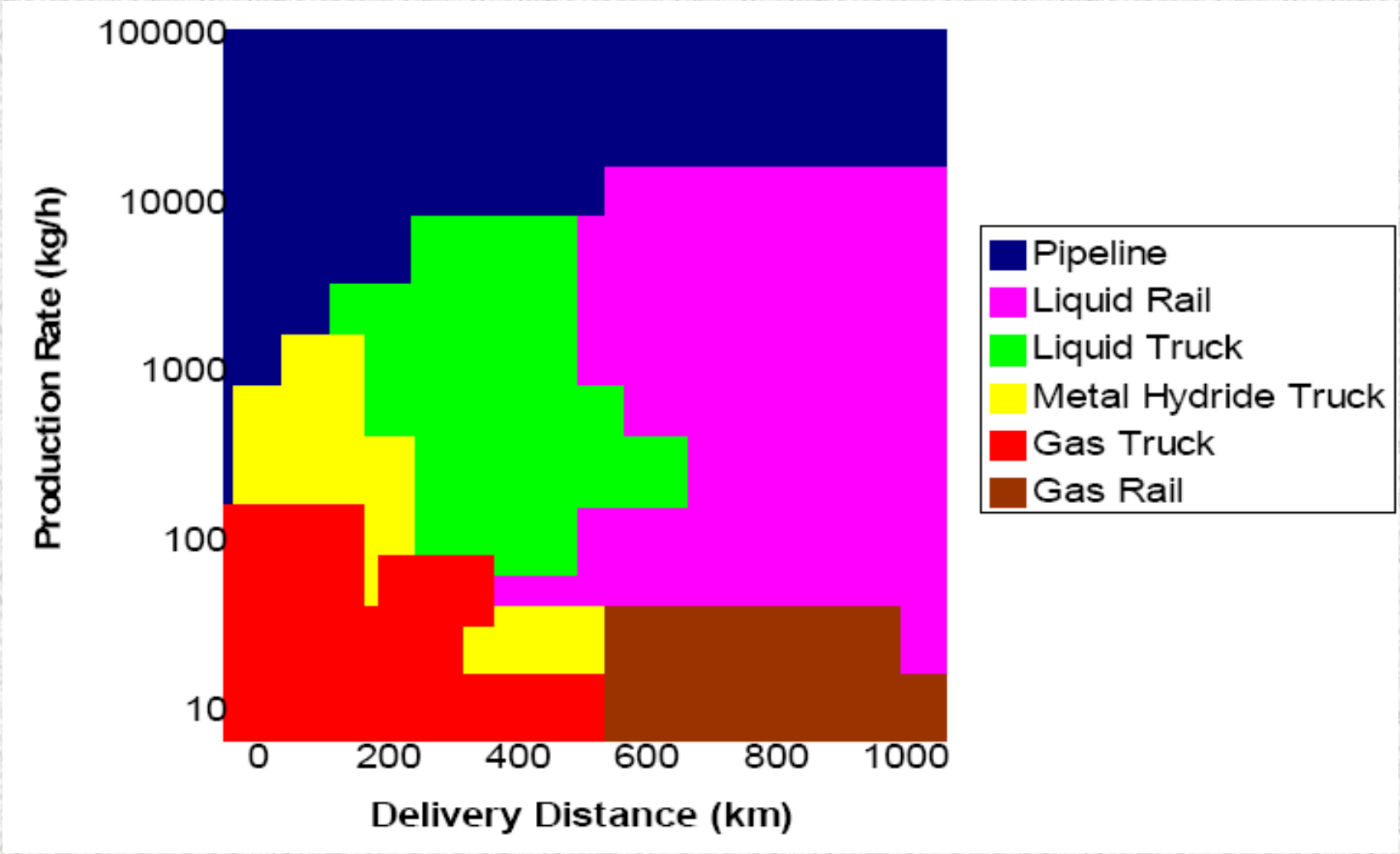
ГАЗПРОМ ВНИИГАЗ

**Development of effective methods of hydrogen transportation is necessary for building an advanced hydrogen delivery infrastructure.**

**Methods of hydrogen transport and storage are closely connected and often transportation methods determine optimal storage technology and vice versa.**

**Hydrogen can be transported the same way as stored – as gaseous or liquid hydrogen, in a form other than free molecules - in solid or liquid carriers (adsorbents, metal hydrides or other hydrogen-rich compounds), and in chemical compounds which produce hydrogen via decomposition (ammonia, liquid hydrocarbons)**




**Efficiency of transportation methods depending on production rate and delivery distance [Yang C., Ogden J. / Proceedings of the 15th Annual U.S. Hydrogen Conference National Hydrogen Association. –26-29 Apr 2004.2].**

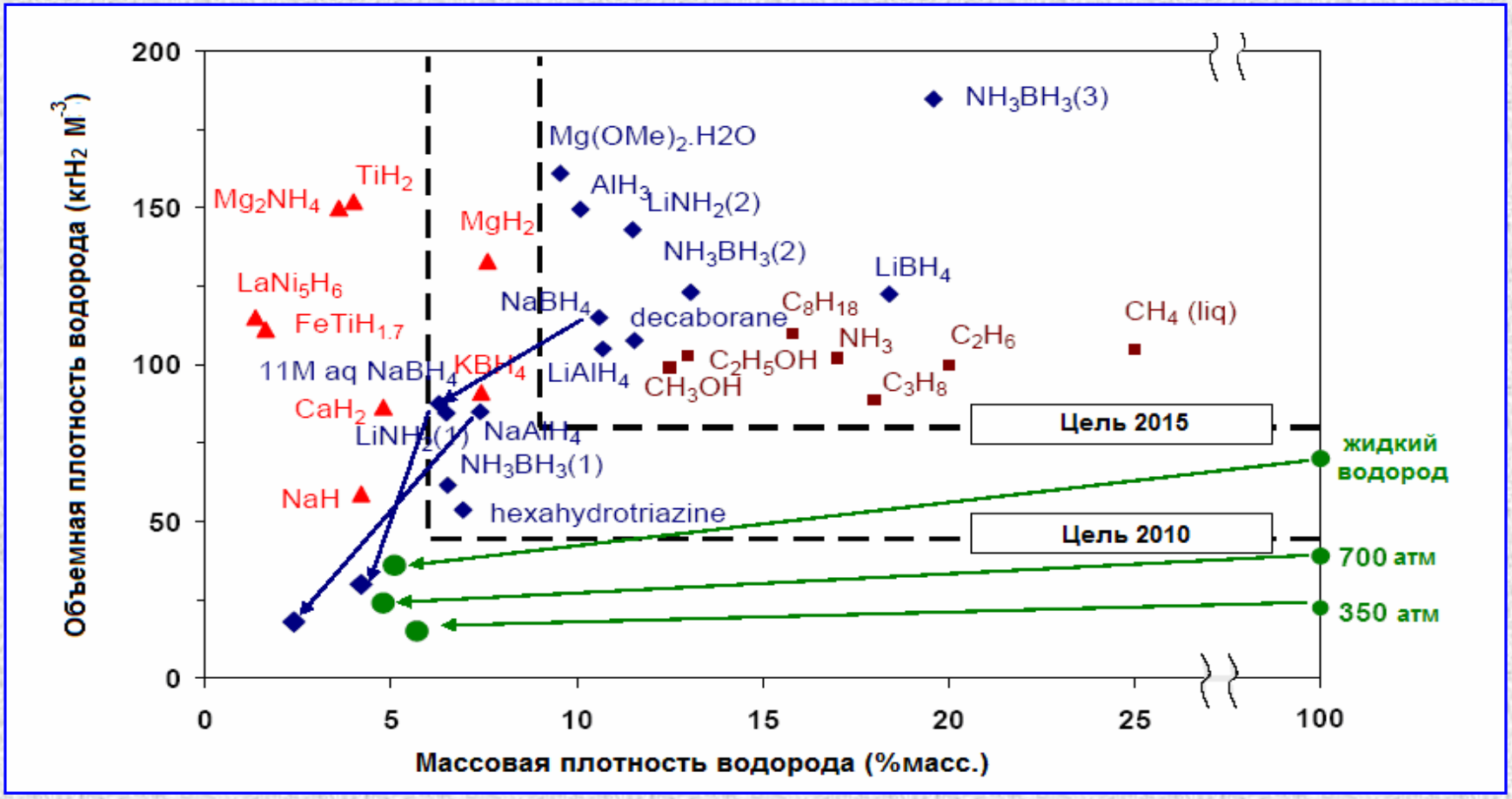
Tube trailers and trucks with compressed hydrogen vessels (hydrogen ~4-6 mass%, 20 kg/m3 at 35 MPa), including composite vessels, have better satisfy the requirements of relatively small markets.

Cryogenic high-pressure (20-40MPa) gaseous vessels are under development to increase volume capacity and reduce costs associated with hydrogen liquefaction. They can be filled with either compressed or liquid hydrogen. Parameters of such vessel (about 150 L internal volume) at 34.5 MPa are ~6 mass%, 33 kg/m3

**Cryogenic tank truck delivery is cost-effective for middle market penetration. Due to mass and volume capacities (hydrogen ~5 mass%, 40 kg/m3) many car manufacturers consider cryogenic storage of liquid hydrogen on-board vehicle as competitive to compressed gas storage.**

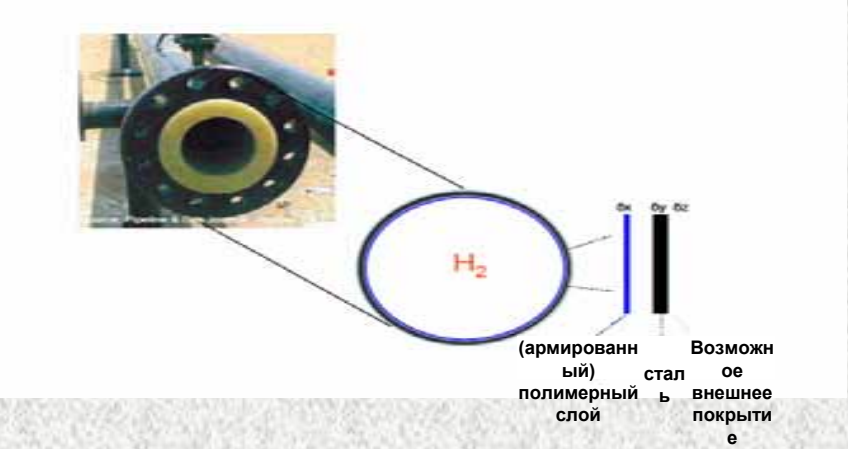
Liquid hydrogen tank РЦГВ-250/0,25 is transported to it's destination


Liquid hydrogen fueling stations




**Mass → and volume ↑ density of hydrogen in different carriers**

**Transportation using carriers such as granulated hydrides of intermetallides seems to be optimal in the case when containers which will be directly used in energy system, are transported. Such delivery systems can operate at moderate temperature and pressure and are the most safe ones, however hydrogen capacity of commercial systems is still not higher than ~1,5 mass% and this transportation method has limited application. Chemical compounds for further hydrogen production – large scale transportation or for long time operating systems**




Protection cover for steel tube

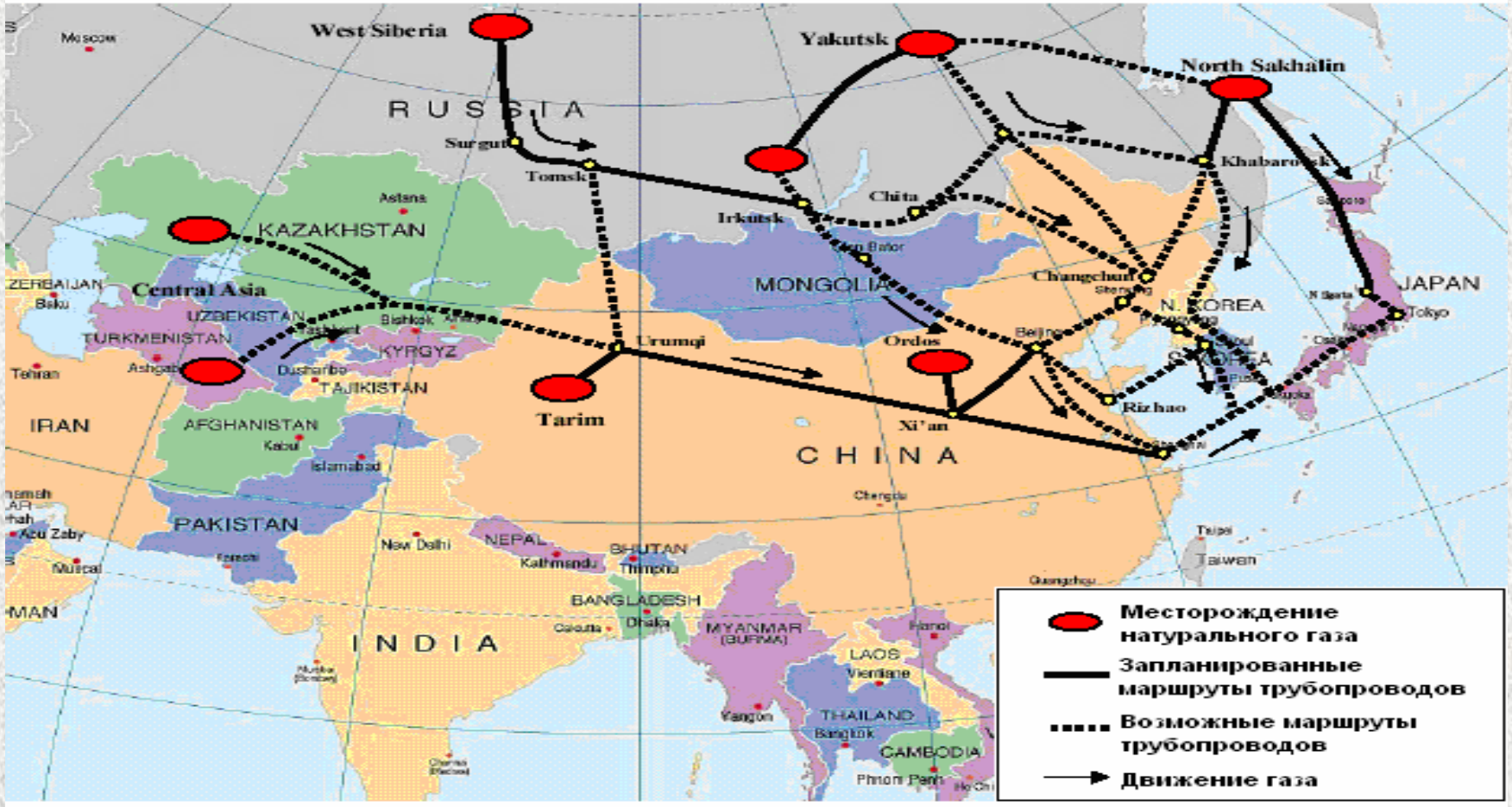
**Actually natural gas pipelines can serve during unlimited period and at any time they can be used for transportation of pure gaseous hydrogen or its mixture with natural gas. However natural gas transmission and distribution infrastructure is heavily utilized and natural gas consumption continues to grow. Taking into account wide experience in this field hydrogen delivery by pipeline can become the main transport technology in the future. At the same time the fact that for the steel pipelines mainly used at present the problem of hydrogen embrittlement exists and cannot be disregarded. Therefore additional researches and development are needed.**

**Plastic pipeline - Fiberspar LinePipe, LLC.**

# Gas transport system of Russia


**The existing pipeline network can be used for hydrogen transport only during the transition phase. However this variant can become essential part of new hydrogen economy, especially for Russia: total pipelines length is more than 514 000 km (pipelining gas volume is more than 316 billion cubic meters). Hydrogen mixtures (10-20%) with natural gas could be transported without significant transportation system changing.**

# Development of gas transportation systems in Siberia and Far East




**Hydrogen produced in Russia in future (including nuclear power station production) could be transported to other countries using pipeline systems.**

**Hydrogen export (transportation) from "nuclear countries" excludes nuclear material all over the world distribution. Hydrogen not only economy!**

# Thank you for your attention