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Hydrogen Energy and Reducing the Environmental Impact of Megacities

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Air pollution in Moscow and in another megacities leads to the continuous growth of asthmatic diseases in children and high mortality among the elderly, especially during periods of summer smog.

Motor, power plants and gas stoves exhaust fumes is the main factor that defined the poor air condition in megacities. Purification filter – catalysts is not the good decision this problem. There should be another decisive shift to clean cars and fuel.

It would require the following successive steps[1].

1. Develop Diesel-Hydrogen Vehicles (DHV), Petrol-Hydrogen Vehicles (PHV) or Methane - Propane-Hydrogen Vehicles (MPHV). This is especially important for Lorries, tracks and buses. DHV, PHV and MPHV use hydrogen in an urban settings but traditional hydrocarbon fuels are burned in the country. Is a vehicle in a traffic jam - is switched to hydrogen supplying, when vehicle leaves the urban roads it begin using a more powerful hydrocarbon fuels. NAHE (National Hydrogen Energy Association, president A.Yu.Ramensky) already develop such type of vehicles (prototype of the base of minibus AvtoGAZ “Gazel”). Unfortunately, the authorities do not give permission to replicate them yet.

2. Changing fuel for traditional gas stoves from natural gas to mixture consist the high hydrogen content. The best mixture “Hitan” includes at least 20% hydrogen. This is the cheapest way to provide fulfill standards for low emission vehicles (Euro 4, Euro 5 and so on.). No any deep purification of hydrogen. Moreover this way means use the existing infrastructure delivery and distribution of natural gas without any additional capital costs.

3. Without any doubts the mixture of "Hitan" would be widely used not only for transportation but also for stationary power plants for domestic heating systems (gas stoves, columns, etc.)). As a result we can achieve multiple reductions of NOx and other toxic emissions from vehicles, power plants and gas stoves for domestic purposes. Moreover it would be increased of 20-30% of the energy efficiency of internal combustion engines.

4. The final stage - the technological transfer of all consumers of hydrocarbon fuel into hydrogen

Q: Where to get the hydrogen?

• **Answer:** The hydrogen on an industrial scale can be produced in wind turbine-electrolysis plants. It means development big complexes of the wind turbine as electricity generator, high-pressure electrolyzers as tool for Hydrogen producing and gas wells as source of hydrogen-

containing raw material in the Far North to Hydrogen producing and pumping it to the South, densely populated areas of the country. It is important that existing network of transcontinental trunk pipelines (from Yamburg, Bovanensky, Russkinskaya etc) can be used.

Wind generators (WG) practically do not consume fossil fuels. WG can reduce annual specific emissions of CO2 to 1,800 tons per MW, of SO2 to 9 tons per MW, of nitrogen oxides to 4 tons per MW of WG installed power.

The cost of electricity produced WG depends on the wind speed: under 7 m / s production cost is 5 cents per KWh; under 9m / s is 3 cents per KWh etc.

Annual gas consumption of Moscow is at least 50 Billion cubic meters of natural gas. This volume of gas consumption is required for stationary power plants and domestic heating and cooking systems (gas cooker, speakers, etc.). So, mixture "Hitan" (20% hydrogen) can reduce annual gas consumption from 50 Billion cubic meters to 40 ones.

Thereby it is very simple process: Hydrogen is produced by the electrolysis of water; Energy for electolysis is produced using wind power capacity up to 3 MW. The main tool of this process is the high-pressure electrolyzer.

The calculation of the performance of the basic unit to produce Hydrogen (together with a 3 MW installed power wind turbine) is:

If the unit voltage U = 1,75 V and current density I = 1 A / cm^2.

Then the specific power consumption of the cell will be N = 1.75V x 1A = 1.75 W / cm^2.

If the generator power is 3 MW, the total area of the unit is S = N / N sp. = 3 000 000W / 1.75W/sm^2 = 1 714 286 cm^2.

If the area of the elementary unit is s = 400sm2 = 20x20 cm^2, it is necessary to n = S / s = 4286 units or 43 modules of 100 units each.

In this case the volume of hydrogen produced will be M = I * 0,99 * n / F = 400 * 0.99 * 4286 / 26.8 = 63,970 mol or 1 433 m^3 / h

The electrolyzer will produce 1433 m^3 of hydrogen per hour, or 12, 553 million M3. So, 800 electrolysers is required[3,4]

Where to place Vertically Rotor Hydrogen Plants (VRHP).

The big industrial VRHP (BIvp) should be placed near gas wells directly on the northern gas gathering fields with total capacity of up to 50 industrial units VPHP with installed capacity of 125-150 MW each. They would be ensured the production of not less than 600 million cubic meters of Hydrogen per year.

There is required 20 BIvp in Moscow region.

What are the 3 MW wind turbines?

According to the plans of the chief designer, Prof. D.D. Skorluhanov, VPHP is the low-speed vertical rotary wind turbine with automatic mechanical axis-turning changing wings (working blades (06, 08 or 12 pairs). Front rotor efficiency is approximately 0.8; Pilot version of VPHP unit is up to 3 MW of installed capacity.

These vertical rotor wind turbines structurally got significantly greater installed power because diameter of working sails can be more than 200 meters but the blade pairs can provide no more than 50 meters working sails diameter.

The height of VPHP is no more 50 meters. The blades in this case are designed for aerial wind flows, while the orientation of these streams may differ variably 90-110 degrees and received oblique wind flows. Wind turbine towers set on the foundation piles of slaughtered at a depth of 30 meters. Multiple Row Design (MRD) of blades provides increasing of the sail area. The most convenient is 6 console design ("Beetle"-type).

This slow-moving energy conversion plant may not cause harmful noise, since the velocity of the optimal diameter of the rotor in the 90-150 meters, even under heavy winds (over 24 m / s) will not exceed 2-10 rpm.

VRHPs are able to breed birds. This is very important for Arctic nesting places especially on the shores of the Arctic Ocean because of area for nesting is limited. It should be noted that the wind wheel with vertical rotation axis, unlike those with a horizontal, located in the operating position for any direction of the wind.

VRHP will be assembled on the base of mass-production facilities of aerial and space industry.

All components, parts, tools on-site installation will be assembled "on - Space 'dock with each other" into a single, harmonious, high-tech, self-contained and very secure complex, like a spacecraft, but only with a very long life (50-150 years), in particular "terrestrial" circumpolar Arctic conditions (Temperature more than -50 C).

What will VRHP?

Manufacturing VRHP gives impetus to the development of iron and steel (alloy steel) and metal industry, automotive (ecological vehicles), design and project teams, and others.

There are widely used to achieve patriotic aerospace technology for the development of innovative energy projects.

Types of VRHP (3MW of installed power on the left and 0.5MW of installed power on the right)

Small wind turbine can be used for domestic applications [2].

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