Via Azul Energy Supply Grid (VA ESG)

I. The VA ESG shall be the base for one of the key objectives of the simultaneous VA implementation:

Synergy infrastructure for mobile energy carriers Electricity and Hydrogen + Initial BEV, PHEV, FCEV fleets!

- Implement VA ESG on initial 10 VA highways as efficient and compatible mix of state of the arte transmission technologies:
    - European Wide Area Network (WAN) Smart Grid: HVDC buried highway cable, connecting energy resources (north-south and ESG intersections)
    - Local Area Networks (LAN) Smart Grid extensions: HVDC/AC buried highway cable, for WAN energy provisioning to PoS
    - Local Hydrogen Grids (HyG): Distribution of locally produced Hydrogen within local PoS clusters
- Reduce risk and secure ROI on VA infrastructure and fleet developments for the business model: European Mobility on Renewable Energy
- Establish VA ESG intersections with local crossing Mobility sub grids
    - i.e. Fast and Metropolitan Train Networks and other stationary applications of the mobile energy carriers Electricity and Hydrogen

II. The VA ESG shall be Composed of a European wide electricity transmission grid (Smart Grid), amplified by local hydrogen distribution grids, for the transportation sector.

Enabling an integrated and efficient supply of the two mobile energy carriers: Electricity and Hydrogen!

A. The electrical Via Azul Smart Grid (Figure 1+2),

shall consist of the following two network types, where the implementation sequence might depend on local conditions (i.e. VA pilot regions: 1st LAN, 2nd WAN):

1. Wide Area Network (WAN),

connecting European wide spread and ever-growing renewable (low-carbon) sources (RES: Solar Power plants, Wind Power plants, Hydro Power plants, Biomass Power plants etc) with the VA highway fuelling station network (see VA fuelling station concept 3+4) through demand balancing supply to the LANs.

2. Local Area Networks (LAN),

supplying energy from local renewable sources to local energy applications in the transportation sector (see VA fuelling station concept 3+4) and others, as well as receiving supplementary power supply from the WAN. LAN overcapacities shall be provided to the WAN for wide area supply/demand balancing.

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The **Via Azul Smart Grid (WAN/LAN)** shall be implemented in the first place as highway (main streets) underground cables, applying the HVCD (high-voltage, direct current) power transmission technology, locally reasonable combined with HVAC (high-voltage, alternating current, preferably underground cable: i.e. GIL) technology.

- Contain an Energy Dispatching WAN-IT-Network, to assure real-time information exchange about decentralize renewable (low-carbon) energy generation vs. local demands, to enable an efficient supply/demand balancing at any point in the network (WAN/LAN), i.e. by IT controlled Demand Side Management (DSM) for the performance (intensity of H2 onsite production) of all local PoS electrolysers in the European network.
- Provide failure knot/line bridging capabilities, as know and proven from the Internet

B. The Via Azul Hydrogen Grid, (HyG),

consisting of the two following hydrogen distribution types:

1. Local hydrogen pipelines,

for short distance supply of locally centralized hydrogen generation, either from VA Smart Grid or directly from local renewable sources ((i.e. High Temperature Electrolysis: Hydrosol plants, Waste-Pyrolysis plants, or others Solar, Wind, Hydro, etc.), to divers local hydrogen flow dependent consumers (i.e. urban fuelling station network and industrial/commercial applications). During economically feasible periods, daily overcapacities of the so maintained hydrogen flow can be converted via stationary Fuel Cells into LAN electricity.

2. Local hydrogen container supply,

for local distribution/pick-up of a standardized hydrogen container set, for local industrial/commercial and household hydrogen applications (i.e. hospitals, stationary Fuel Cell backup power plants, etc.)

III. VA ESG Benefits

The BENEFITS FOR EUROPEAN ECONOMIES will be tremendous, not only in AUTOMOTIVE (BEV, FCEV breakthrough) AND THE RENEWABLE ENERGY SECTOR (E-Production, E-Transmission and E-Storage), but overwhelming in the SECTOR OF TRANSPORTATION (E-Application), the bloodstream for each economy. The common benefits would be even more groundbreaking, when the VA ESG will be connected with DESERTEC and TRANSGREEN resources, providing high pike energy generation cycles among shifted European time zones.

The Electrical Energy Transmission from RES to PoS, applying HVDC/AC buried cable technology, implemented on mostly public ground highway trails (10 VA highways), can substantially shorten line approval cycles for the new combined/complementary WAN/LAN network (The TRANSPORTATION SECTOR SUPER GRID) within the VA ESG, enabling charging/fuelling every 50 km and local energy storage, through the applied Energy Vector Hydrogen. The ESG WILL SUPPORT SECURE SUPPLY/DEMAND BALANCING, through up to 100% IT CONTROLLED DEMAND SITE MANAGEMENT (DSM – flexible Electrolyser and Battery Charging Station performance), FOR THE RENEWABLE ENERGY arriving at the PoS.

Via Azul Energy Supply Grid (VA ESG)

IV.VA ESG Graphics

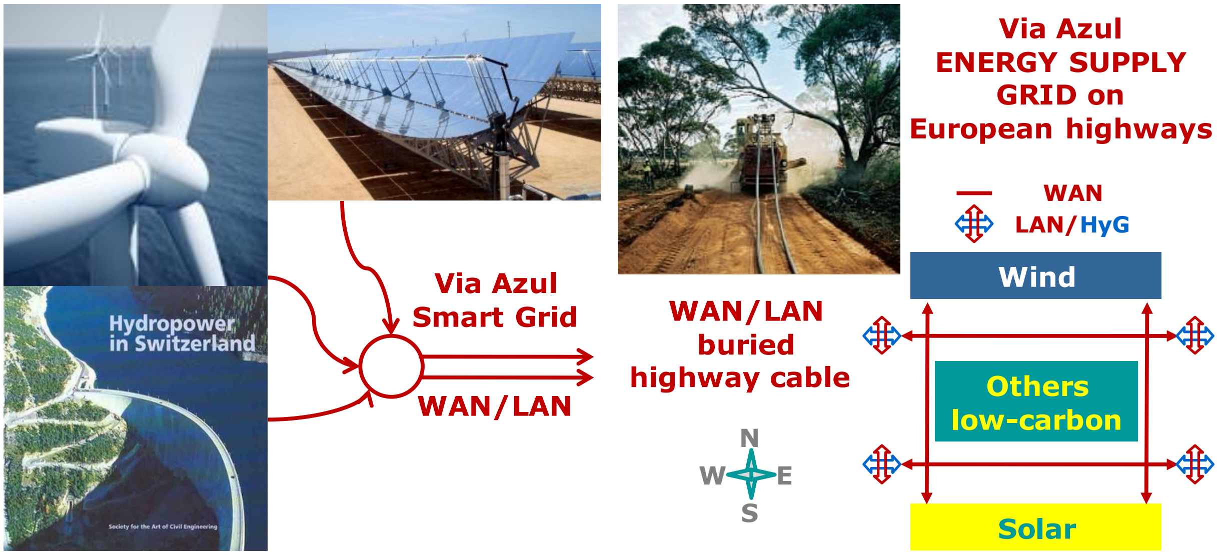


Figure 1 Via Azul Energy Supply Grid I

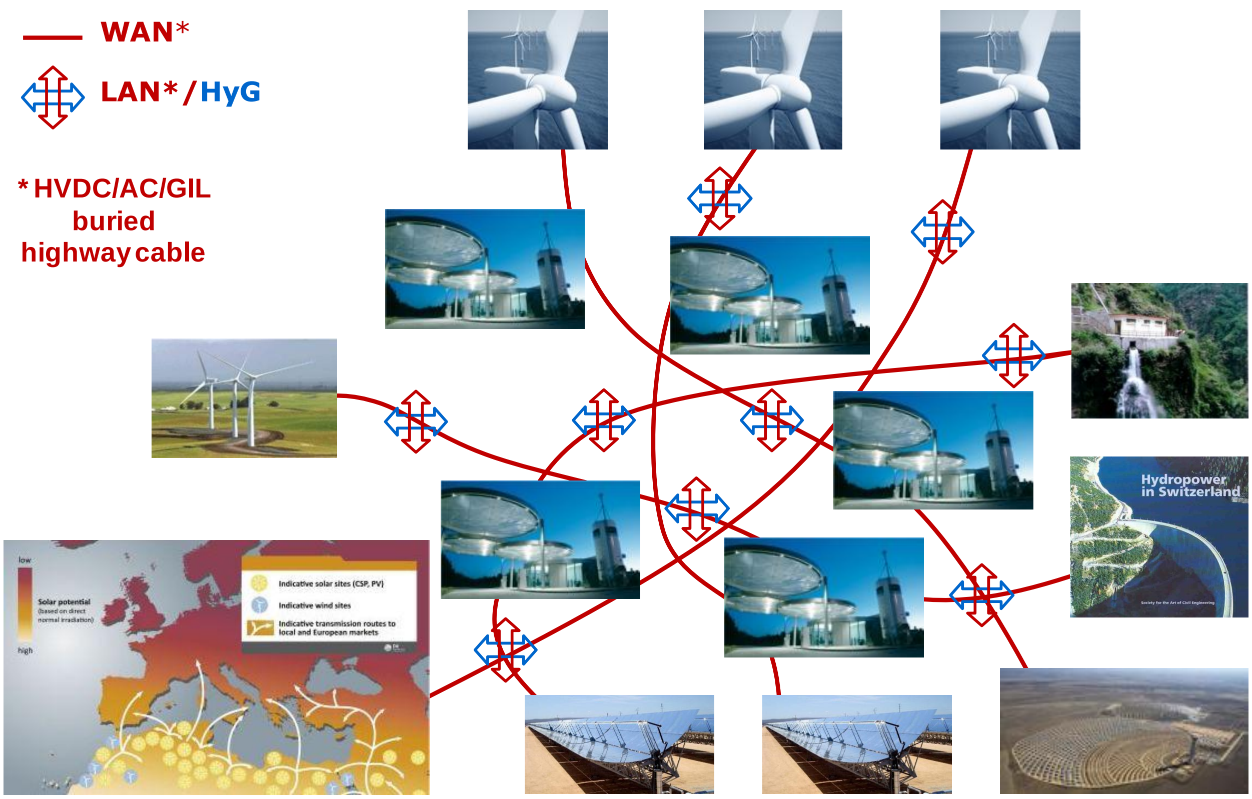


Figure 2: Via Azul Energy Supply Grid II

Via Azul Energy Supply Grid (VA ESG)

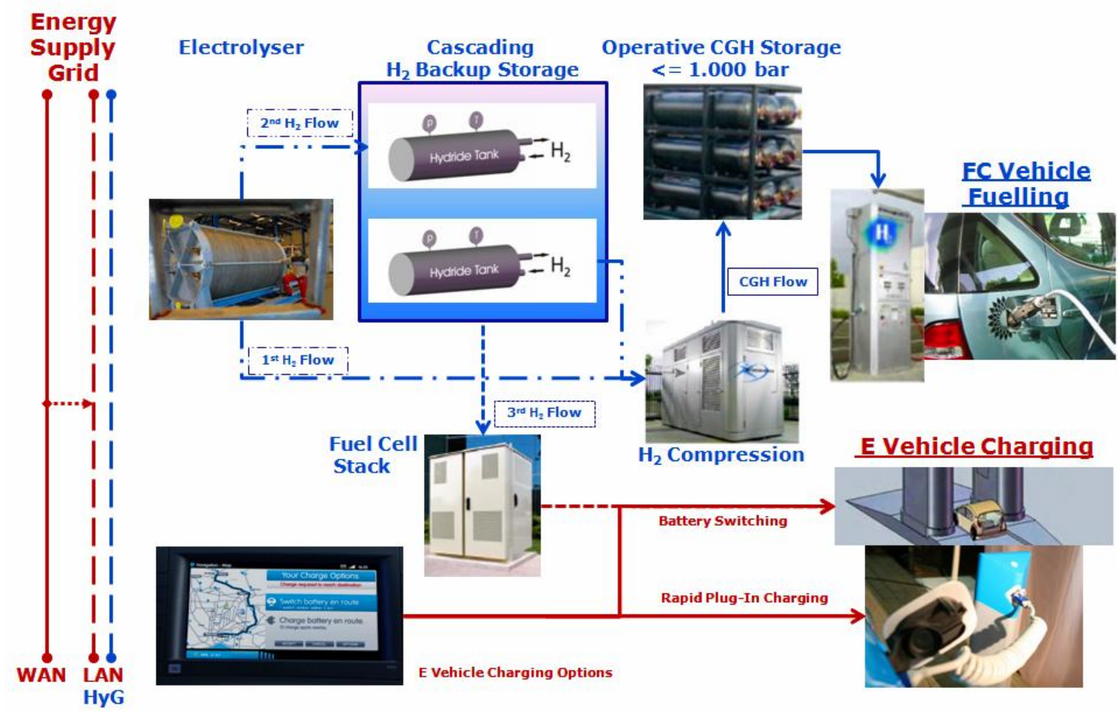


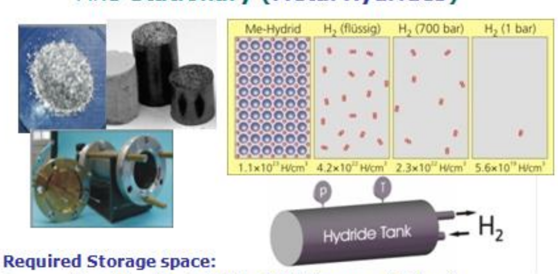
Figure 3: Via Azul fuelling station concept

Hydrogen storage: **Mobile** (5kg-H2; pressurized, 700bar)

Storage Parameter	2005	2010	2015
Gravimetric Capacity (Specific energy)	1.5 kWh/kg 0.045 kg H_2/kg	2.0 kWh/kg 0.060 kg H_2/kg	3.0 kWh/kg 0.090 kg H_2/kg
System Weight:	***111 Kg***	***83 Kg***	***55.6 Kg***
Volumetric Capacity (Energy density)	1.2 kWh/L 0.036 kg H_2/L	1.5 kWh/L 0.045 kg H_2/L	2.7 kWh/L 0.081 kg H_2/L
System Volume:	***139 L***	***111 L***	***62 L***
Storage system cost	$6 /kWh	$4 /kWh	$2 /kWh
System Cost:	***$1000***	***$666***	***$333***
Refueling rate	.5 Kg H_2/min	1.5 Kg H_2/min	2.0 Kg H_2/min
Refueling Time:	***10 min***	***3.3 min***	***2.5 min***

HyFLEET:CUTE/BVG	ICE bus needs 40 kg H2 per 200 km → **100 kg H2 / day for 500km**
Atmospheric Electrolyser Production:	48 kg/h → **1152 kg/day** (11.520 m³/day) → **sufficient for 11 buses** **or 5 buses + other vehicles**
Required transformation energy:	4,3 kWh / 1 m³ H2 (10 m³ = 1 kg)
Power/Energy balance:	48 kg/h need 2,1 MW (req. Power) → **50,4 MWh / day (req. Energy)**
Energy Price:	100,- € / MWh → **5.040,- € /day**
Energy Price/Kg-H2	→ **4,38 €** (+ fuelling station operation costs + TAX)

AND **Stationary (Metal Hydrides)**



Required Storage space:

- ~ 30 – 50 m³ for 2.500 kg-CGH (Reserve 2,5 days)

Metal Hydrides H_2 Storage capacity (at normal conditions):

- ~ 2,5 x LH2 (at -253 °C)
- ~ 4,5 x CGH2 (at 700 bar)

Figure 4: Power Electrolysers and H2 Storage technology