

Electro Mobility and the Energy Vector Hydrogen

A supporting initiative:

Via Azul Europe 10 – EU Pilot Regions

Promoters:

**INITIUM SOLUCIONES COMERCIO ELECTRONICO Y ENERGIAS
RENOVABLES S.L. (ISCEER)**

UNIVERSIDAD DE MÁLAGA (UMA)

Definition of Terms

- Electro Mobility
 - Should NOT be an initiative for battery driven cars only!
 - Should establish an efficient infrastructure, enabling fleets of new vehicle generations, to be fueled/charged at the Point of Sales with energy from renewable resources
 - Vehicle fleets shall comprise cars with electric engines (Rechargeable Batteries, Hybrids with Fuel Cells) and Internal Combustion Engines (ICE-H2)
- Concept: Energy Vector Hydrogen
 - Hydrogen can be used as a medium to locally transform (electrolysis) and store sufficient amounts of the electrical energy, generated from renewable resources, if local storage points can be connected via an efficient electrical grid
- Via Azul Europe 10:
 - Is an initiative, focusing on a balanced establishment of both at once:
 - Initial EU highway Fuelling Station (POS) infrastructure, connected with renewable energy resources via a HVDC Smart Grid
 - AND Initial corresponding vehicle fleets (buses, cars) in highway tangential major cities
 - **Innovation: Move electrical energy to POS ... NOT fuels ...!**
 - For local H2 production/storage, as load/demand balancing for renewable energy resource power
 - Via HVDC highway underground cable (reduced losses) on public ground (short planning approval procedures)

“Vía Azul Europe 10” Business Model

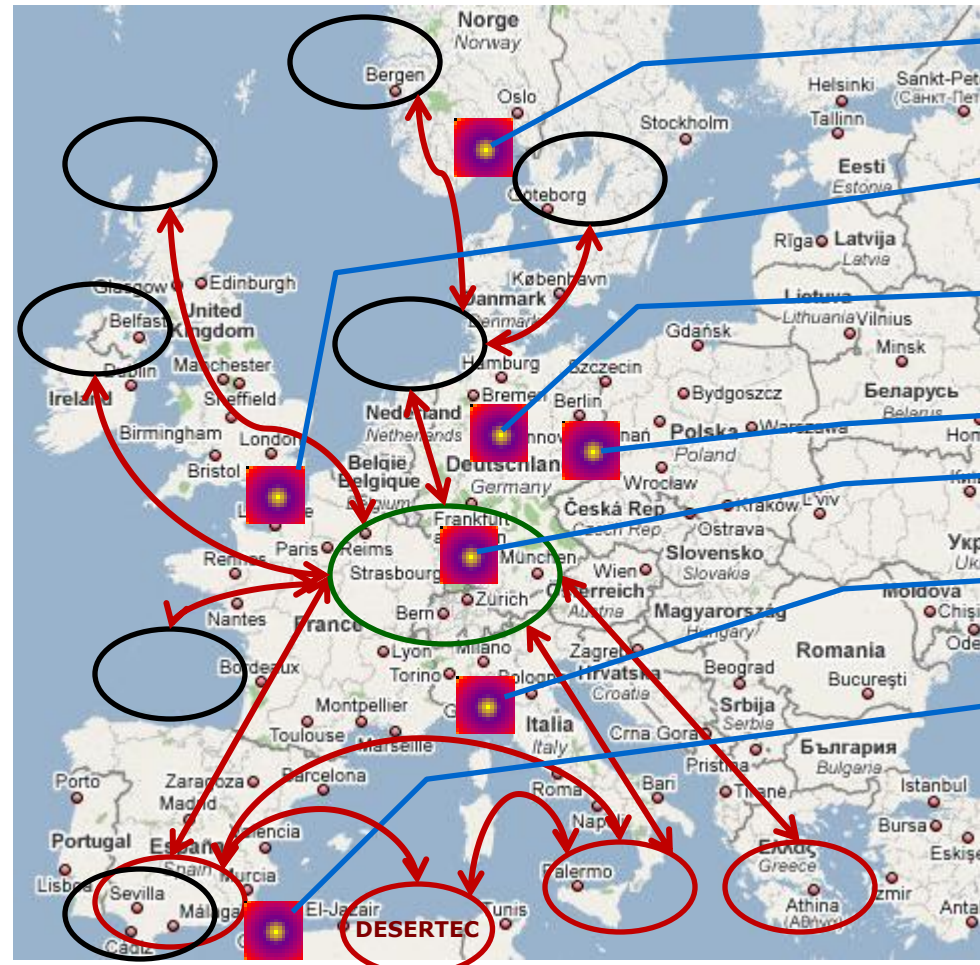
Connect EU Pilot Regions:

CSP

Wind

Others renewable

Electro Mobility Applications



HyNOR

London

Hamburg, NRW, Frankfurt

Berlin

Bodensee

Milano

Málaga Via Azul Pilot

Highway Fuelling Stations

Renewable Energy Resources and Electro Mobility applications

Pilot Region "Vía Azul (M)"

CSP and Wind resources + Highway Smart Grid + local H₂ production (AE) /energy storage

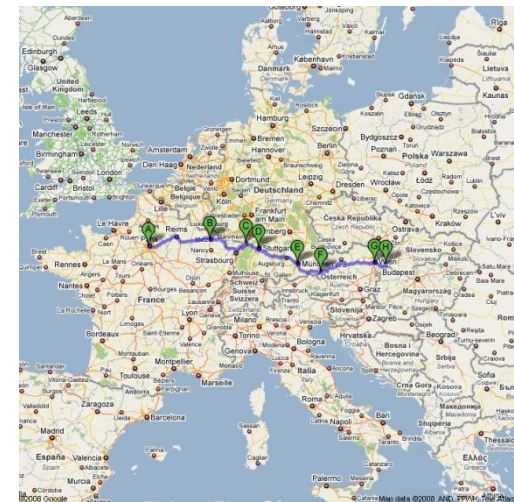
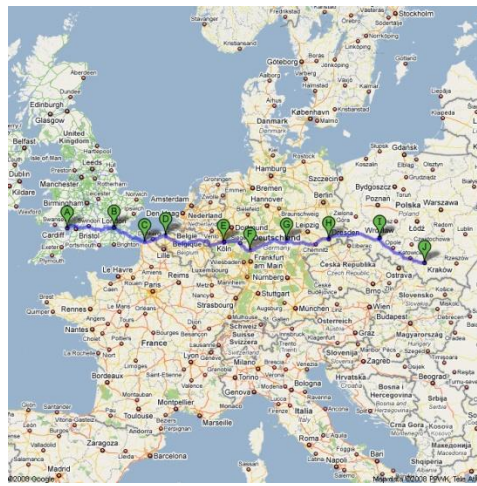
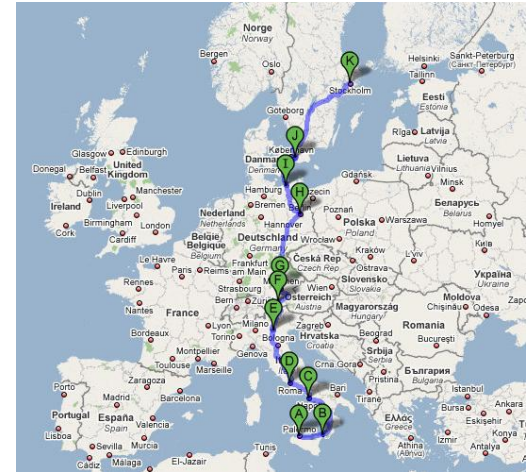
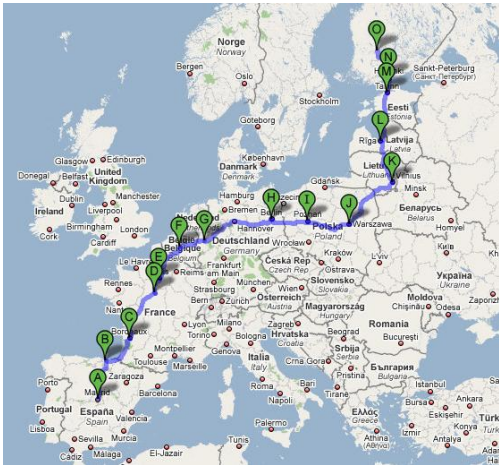


Local Sustainable energy production about to pass soon capacity of 1 nuclear plant (800 MW)

AE: Atmospheric Electrolyser: 485 m³(H₂)/h at 2,1 MWh

CSP: Concentrating Solar Thermal Power Plants

6/10 "Vía Azul Europe 10" Highways



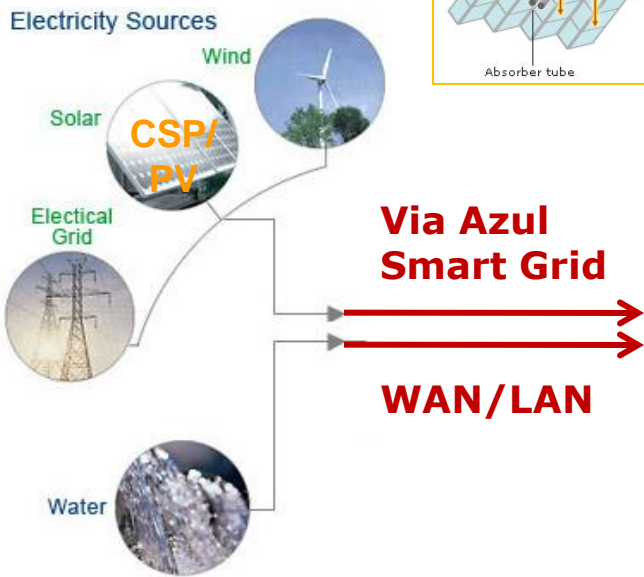
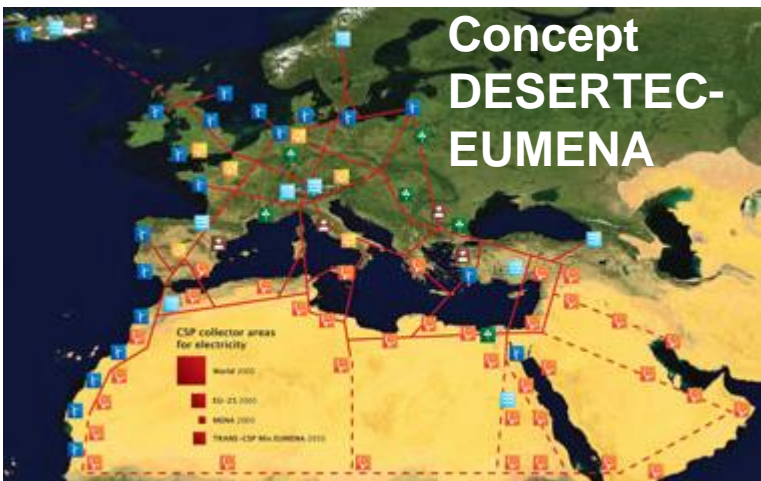
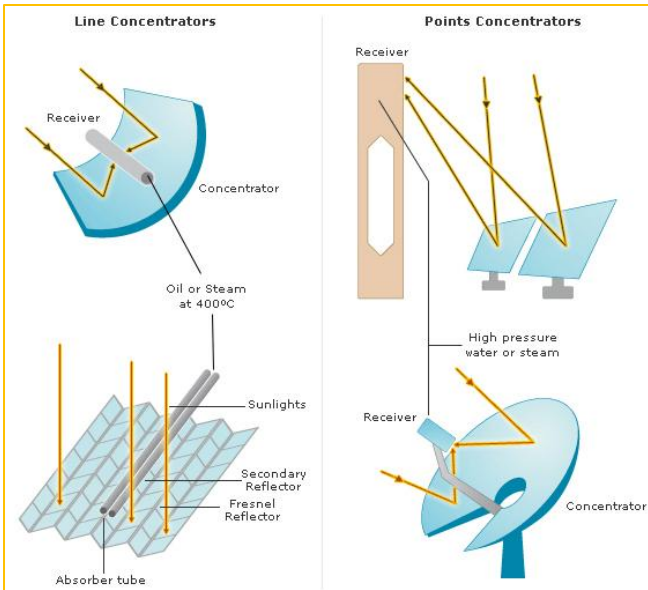
“Vía Azul Europe 10” ingredients

- ✓ Increasing Sustainable Energy Resources
- ✓ Smart Grid Technology
- ✓ Power Electrolysers and H₂ Storage technology
- ✓ Electro Mobility Vehicles
- ✓ Network of existing Highway Fuelling Stations

- !! Feasibility study Via Azul Pilot Region Andalucía
- !! European Via Azul Stake Holders
- !! EU Consortium Via Azul
- !! Via Azul proof of concept/startup in Pilot Region
- !! Roadmap for European Via Azul Rollout

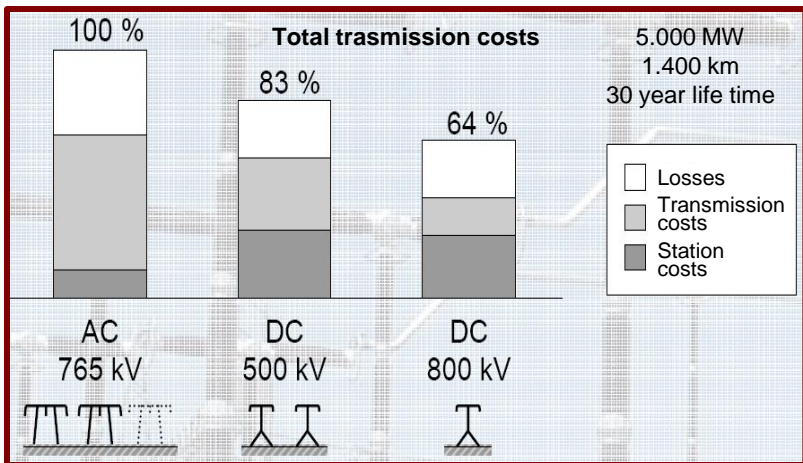
✓ Sustainable Energy Resources

Parabolic trough	Tower	Dish Stirling	Photovoltaic
			

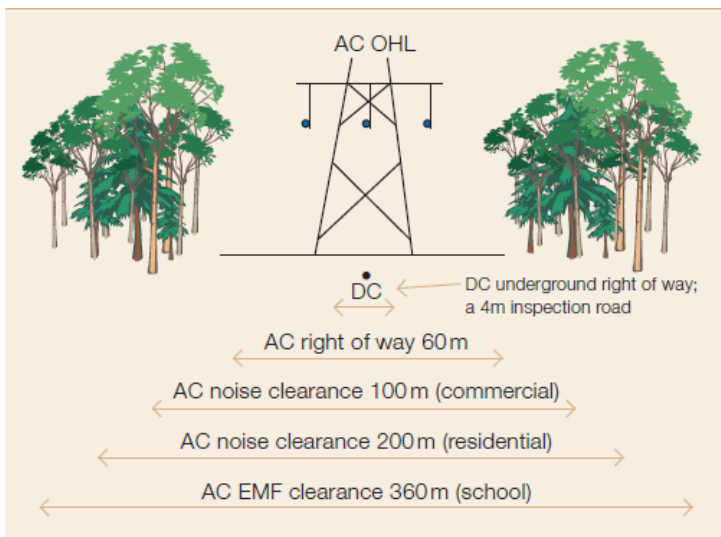


Smart Grid Technology to control capacity/demand balancing

Power transmission: HVAC versus HVDC



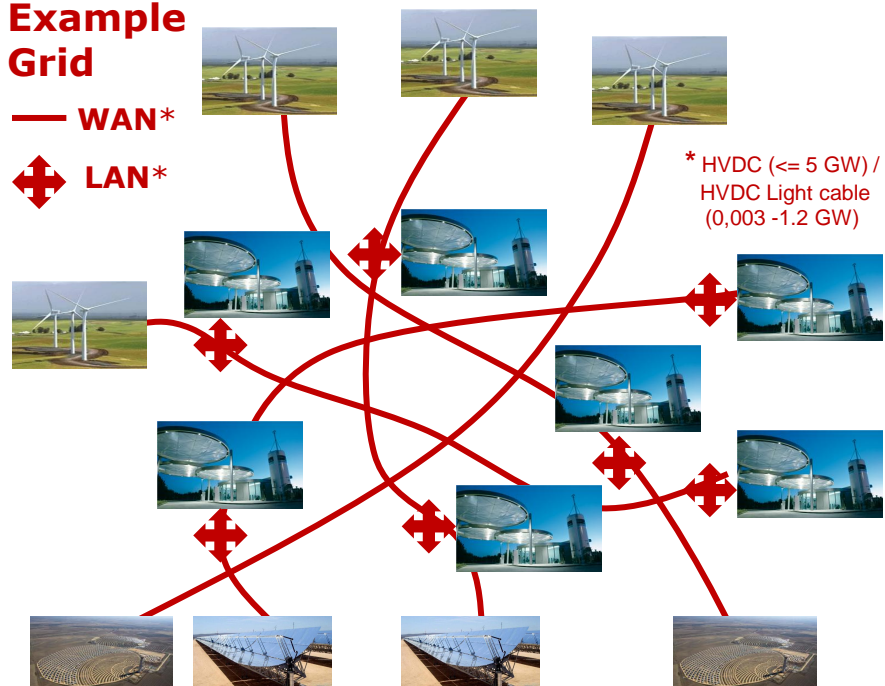
Material	DC underground	AC OHL
Aluminium	3.3 kg	2.1 kg
Copper	1.4 kg	
PVC	2.3 kg	
PEX	6.1 kg	
Steel		100.0 kg
Ceramics		0.3 kg
Concrete		378.3 kg
Total	13.1 kg	478.8 kg



Example Grid

— WAN*

⊕ LAN*



✓ Network of existing/amplified Highway Fuelling Stations

Smart Grid



WAN LAN

H₂ Storage



H₂ Fuelling



H₂ Electrolyser



H₂ Fuel Cell Stack

Battery Switch Point



Rapid Plug-In Charge



✓ Power Electrolysers and H2 Storage technology



Hydrogen storage: **Mobile**

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 H ₂ per 200 km → 100 kg H₂ / day for 500km
Atmospheric Electrolyser Production:	48 kg/h → 1152 kg/day (11.520 m ³ /day) → sufficient for 11 buses or 5 buses + other vehicles
Required transformation energy:	4,3 kWh / 1 m ³ H ₂ (10 m ³ = 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
(up to 40.000 l or 40 m³ / LH₂: max. 70 kg/m³
→ **2.800 Kg-LH₂ ~2,5 days reserve**)



✓ Electro Mobility Vehicles

Battery Electro Vehicle



Hybrid (Fuel Cell) Electro Vehicle



ICE-H2 Vehicle



Vía Azul estimated key figures

Key Investments (Infrastructure + Initial H2 vehicle fleets):	
Project Phase	Investment** (Mio Euro)
Pilot Region (Andalucia)	1.324
Extension Madrid (incl. City)	325
Via Azul Europe 10 Consortium Total	21.686

Potential H2 usage (OR)		
1.526.216	kg-H2/d	Fuell. Stations 662
15.262	100kg/500km*d	Buses FC/IICE
2.034.954	0,75Kg/50km*d	Cars FC
872.123	1,75Kg/50km*d	Cars ICE

CO2 reduction*
Mio Tones per year
-3,24
*produced H2 substitution quantity

Key Figures from Items involved		
Item	Number	
Net of fuelling stations* (per 50km) CGH2 for FC vehicles + Grid/FC for E-vehicles	662	
Electrolysers per fuelling station	2	
Highway cable (km)	32.876	
CSPs (50 MW)	55	
H2-Buses***	FC / ICE	830
H2-Cars****	65% FC - CGH2	10.790
	35% ICE - LH2	5.810
* Thereof every 2nd H2 fuelling station (per 100km) add. incl. local Liquefaction ** LH2	331	
**Local Liquefaction would raise Investments by 5-10%, but will enable FC and ICE vehicles immediately and in parallel!		
***Included in investment figures as jump-start investment in clean public transportation		
****NOT included in investment figures, but estimated for initial fleets and fuelling capacity planning/efficiency		

Electrical energy demand and potential local sustainable resources		
Energy provisioning for fuelling stations in phases	Quantity CSP	Electrical Potencial MW
Andalucia (Pilot area)	3,31	165,51
Madrid extension	0,83	41,71
Via Azul Europe 10	50,95	2.547,40
Total	55,09	2.754,61
Sustainable Energy Resources in Andalucía (Spain)		
Parque Eólico Tarifa	Wind	74
Andasol I-III	CSP	150
Abengoa Solúcar	CSP	300
Total (operative)		524
20 plants under constr. in E	CSP	750
Total (2010-15)		1.274
Sustainable Energy Resources (Wind Off Shore) Europe		
UK, DK, IRL, S, NL	operative	827
Germany	planned/	27.300
UK, DK, IRL, S, NL, F, E, B	u.constr.	14.913
Capacity sustainable Energies related to projected Via Azul Europe 10 demands	1560%	49%

!! Roadmap for European **Vía Azul** Rollout

- Feasibility study Via Azul pilot region
 - ISCEER/UMA + Collaborators (2010/Q1-Q4)
- European Via Azul stakeholders
 - To be engaged, based on Feasibility Study 2011/Q1-Q2
- EU Via Azul Consortium
 - To be founded at International Via Azul Kickoff in Málaga July 2011
- Rollout Via Azul Pilot Region,
incl. Madrid connection, for proof of concept/startup
 - 2011-2013
- Rollout Via Azul Europe 10 (initial Highways)
 - 2014-2018

!! Vía Azul Stakeholder analysis

- Current status:
 - EHA/HyRAMP
(Strongly supporting the initiative)
 - Energy Agency Andalucía
(Leading organization for establishment of local supporter network)
- Furthermore required supporting institutions/organizations/initiatives:
 - EC: DG Energy / DG Mobility and Transport
 - EIB/ELENA for financing of feasibility studies/rollout program developments, Fuelling Station transitions, Smart Grid rollout and additional CSP resources in southern EU, etc.
 - DESERTEC and other existing providers of sustainable energy resources
 - EU Smart Grid initiative
 - Highway Fuelling Station network brands/owners
 - Fuelling Station technology providers
 - Electro Mobility Vehicle providers, HFP-JTI/HyFLEET-Cute, Clean Energy Partnership (CEP), etc.

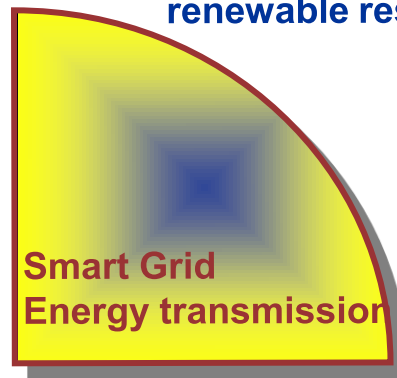
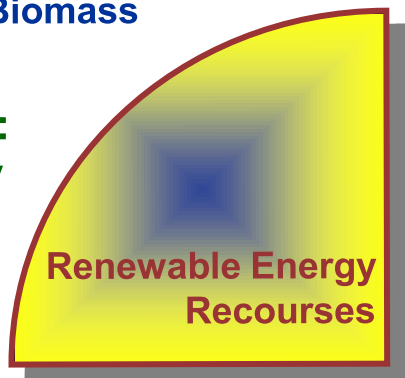
!! Concept for the Vía Azul Consortium

- Publicly controlled (EUC) professionally managed (EU holding)
- Funding: Public private partnership, with considerable stock emissions for sustainable growth investors
- Owner of Via Azul highway Smart Grid and required additional CSP¹
- Vendor of the sustainable energy for H2 production and electricity provisioning at local Fuelling Stations
- Driver for Fuelling Station transitions, enabling rapid adoption of Electro Mobility technologies
 - Special financing offers (EIB!) to Fuelling Station brands/owners, enable efficient investment in amplified Electro Mobility equipment, incl. Electrolyser
- Driver for strategic production planning of Electro Mobility Vehicles and establishment of sufficient local fleets
- Driver for future global export of joint solution components and know how
- Required Entities:
 - EC: DG Energy / DG Mobility and Transport
 - EU and Public/private funding sources, i.e. EIB/ELENA
 - Providers of the sustainable energy resources and Smart Grid technologies
 - Fuelling Station brands
 - Fuelling Station technology providers
 - Electro Mobility vehicle providers

How to proceed? Establish the Critical Mass!

Solar (CSP/CPV) + Wind (Off shore)
+ Hydro + Biomass

Power/Demand Balancing for
renewable resources



✓ Energy Prod. Regions

✓ Super Grid Transportation

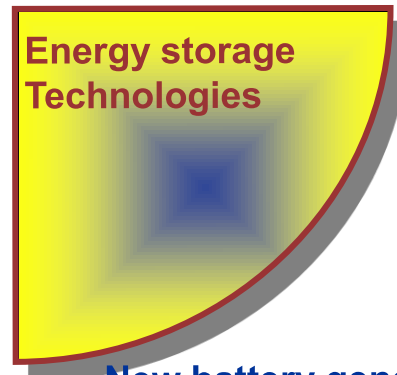
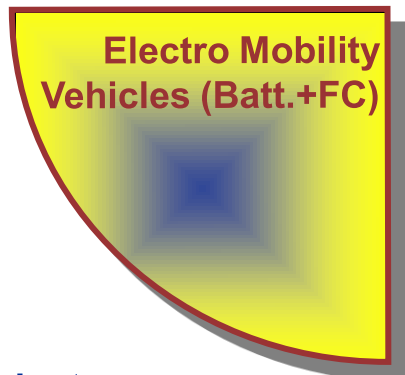
✓ European Energy Strategy Transportation

Vía Azul Eurpe 10: Enabling EU Electro Mobility!



✓ New Gen. Vehicle Fleets

✓ Fuelling station infrastructure



Energy efficient driving technologies

New battery generations
H₂ Electrolysers / Fuel Cells

European Orgs./Initiatives:

- ✓ EC: DG Energy / DG Mobility and Transport
- ✓ EIB / ELENA
- ✓ SET-Plan (Smart Grids)
- ✓ DESERTEC
- ✓ EHA / HyRaMP / FCH JU

Local Drivers:

- ✓ Public Authorities
- ✓ Financial Entities
- ✓ Investors
- ✓ Technology companies

**Expert Community:
Shared Think Tank**
www.electromobility.ning.com

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The challenges of Electro Mobility

Posted by Peter Kindziński on April 7, 2010 at 5:15pm in European Energy Policy (Change)

View Discussions

It's often times misunderstood as an initiative for battery driven cars...
But it's much more than this..!

It's an initiative to establish an infrastructure enabling new generations of vehicle fleets, fueled/charged from sustainable energy resources.

Vehicle fleets will comprise cars with electric engines (Rechargeable Batteries, Hybrids with Fuel Cells) and Internal Combustion Engines (H2-ICE).

The energy will be provided through the Energy Vector Hydrogen Concept, enabled by separate Smart Grids, connecting sustainable energy resources all over (i.e.) Europe with Fueling Station Charging (Batteries) and Reload (H2 for Fuel Cells and ICE) Terminals.

See more details at:
www.via-azul.eu

OR

use the common knowledge base for further detailed subject matter research at:
www.h2-today.com

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Electro Mobility and the Energy Vector Hydrogen

An initiative for a European Energy Strategy Transportation

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Schedule

The following projects are work in progress or in preparation for start-up soon:

Projects (Draft schedule)

- **Feasibility Study (Via Azul Pilot Region)**
2010/Q1-Q4
Evaluate current draft calculations and estimations, to provide exact investment plan and roadmap for phases Andalucía - Madrid.
Define exact investment plan and roadmap for CTR2.
Provide general and improved proposal for European Rollout.
- **Feasibility Study Integration in HFP-JTI Projects**
2010/Q1-Q2 (application)
Seek for options of integration and collaboration with Items 1,2 and 7 of the Fuel Cells and Hydrogen Joint Undertaking - Annual Implementation Plan 2008 (SET/HFP-JTI) and other projects in the context of H2AHP and CTR2.
- **Foundation initial Via Azul HQ in Málaga**
2010/Q3
Ibid. after Feasibility Study
- **Phase 0 - Via Azul Andalucía (Málaga)**
2011
Ibid. after Feasibility Study
- **Phase 1-3 - Via Azul Andalucía**
2012-2013
Ibid. after Feasibility Study
- **Phase 4 - Via Azul Extension Madrid (incl. City/Sub urban areas)**
2013

Draft Investment calculations

Key Investments (Infrastructure - Initial H2 vehicle fleets):

Project Phase	Investment** (Mio Euro)
Pilot Region (Andalucía)	705
Extension Madrid (incl. City)	169
Via Azul Europe 10	11.399

Key Figures from Items Involved

Item	Number
Net of H2 fuelling stations (every 50km) incl. a local Electrolyser CGH2 for FC vehicles	662*
*Thereof shall be every second H2 fuelling station (every 100km) additionally incl. local Liquefaction** LH2 for ICE vehicles	331
Highway cable	32.876 km
CSPs	26
H2-Autobuses***	820
H2-Cars****	16.400

Electro Mobility and the Hydrogen Energy Vector

International Hydrogen Knowledge Center Málaga

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The Hydrogen Economy's breakthrough can be enforced through paradigm shifts and efficient international collaboration, based on a long term Energy Strategy.

Best Practice Knowledge, available to everyone involved, drives required and efficient change.

The corresponding momentum of change turns into self-dynamics once transparently published and accessible to drivers and beneficiaries.

It's time... to lift the Curtain!

**Support: Feasibility Study
Via Azul Pilot Region Andalucía**
www.via-azul.eu

**Sponsoring:
Shared online Knowledge Center**
www.h2-today.com

Temp. Financing through Sponsoring



**Participation:
Kick Off Via Azul Consortium**
July 2011 - Palacio de Ferias y Congresos de Málaga
www.via-azul.eu

Dynamic online info base Electro Mobility – H2-TODAY.com

InfoCodex search tool
www.h2-today.uma.es/ic-portal/view.php?setP=0:548#

Collection: **Electro Mobility**

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		29.05.10	1784	green.autoblog.com	hybridization, motor show, diesel	<input type="checkbox"/>	
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- H2 Production Logistics C...
- Hydrogen Production
- HyRaMP
- HFP Europe - JTI
- ACEA European Automobile
- European Energy Policy
- EHA - European Hydrogen
- Hydrogen vehicles
- Via Azul Europe 10
- DESERTEC
- Electro Mobility
- Hydrogen Energy Vector
- DWV - Deutscher Wasserst
- Open Innovation



Vía Azul Europe 10 – EU Pilot Regions

**An efficient application of early results from the
3rd Technology Revolution:**

National and international stakeholders welcome!

Peter Kindzierski

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