


Razvoj vodikovih energetskih tehnologija i njihova uloga u energetskom sustavu 100% baziranom na obnovljivim izvorima energije

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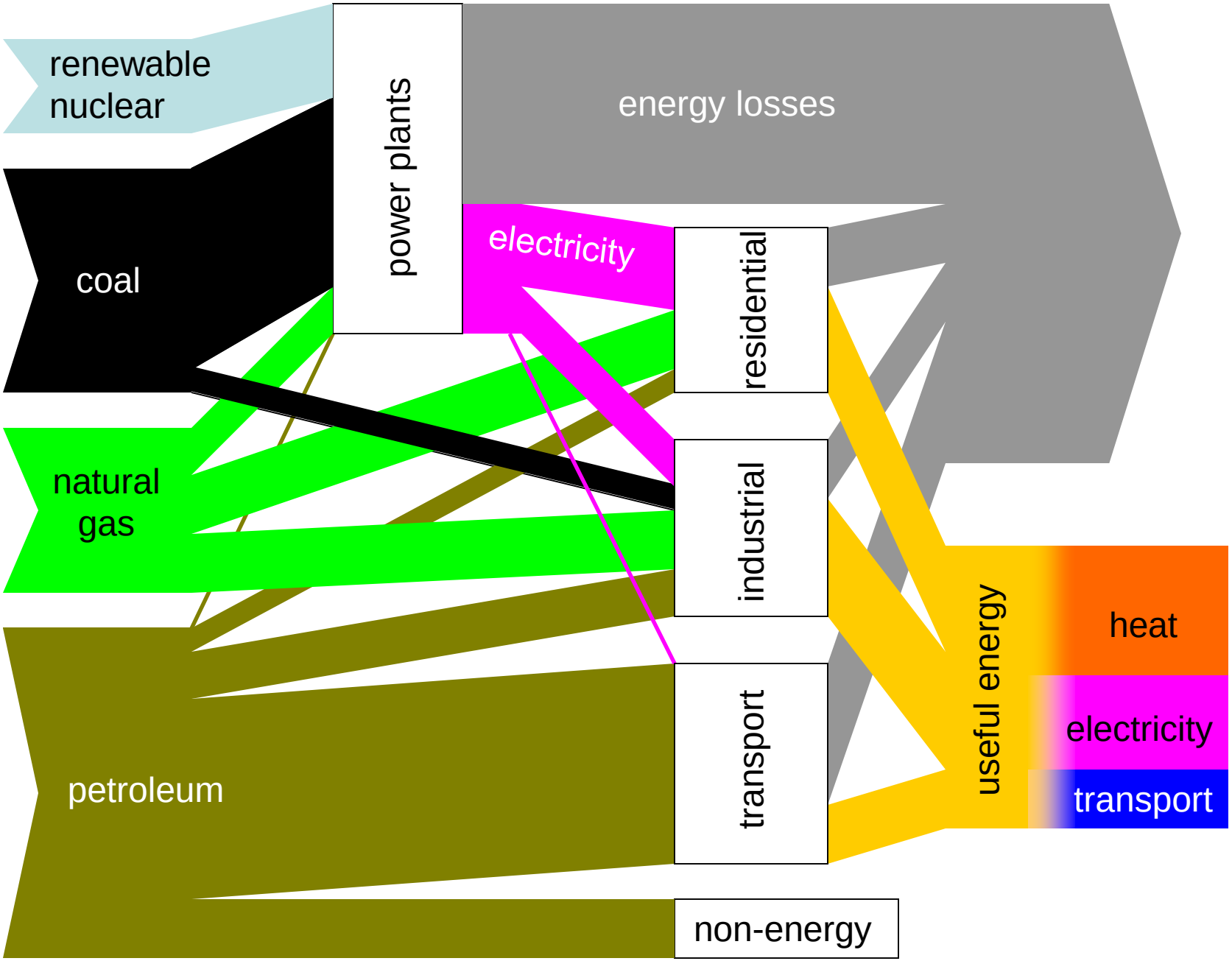
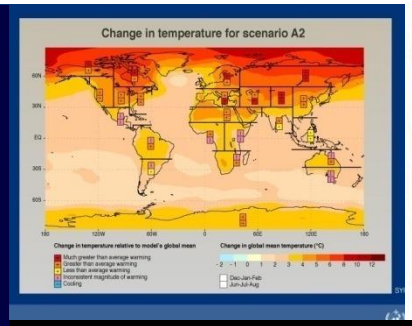
Sadašnji globalni energetski sustav



Problemi s današnjim energetskim sustavom:

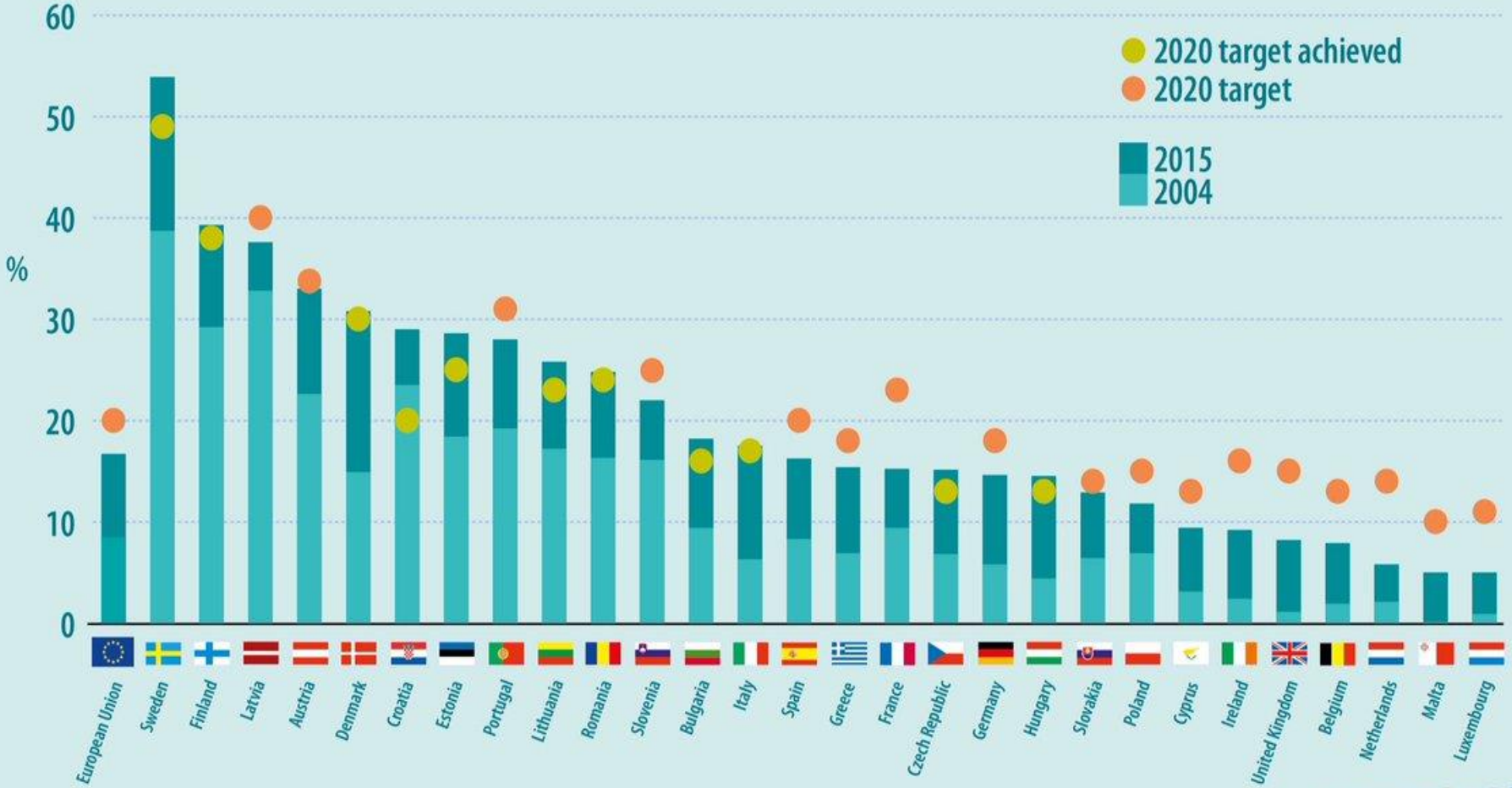
- Ekonomski: energija dolazi sve skuplja
  (i) sve više i više ljudi je koristi sve više i više
  (ii) sve je teže doći do nje, naći je, izvaditi iz zemlje, …
- Fizički: Rezerve fosilnih goriva su ograničene (pogotovo nafte i plina)
- Utjecaj na okoliš: Lokalni, regionalni i globalni problemi s onečišćenjem okoliša: zagađenje zraka, izljevi nafte, globalno zatopljenje – promjena klime
- Geo-politički: Preostale rezerve nafte i plina će biti uzrok ratova






Share of energy from renewable sources in the EU Member States

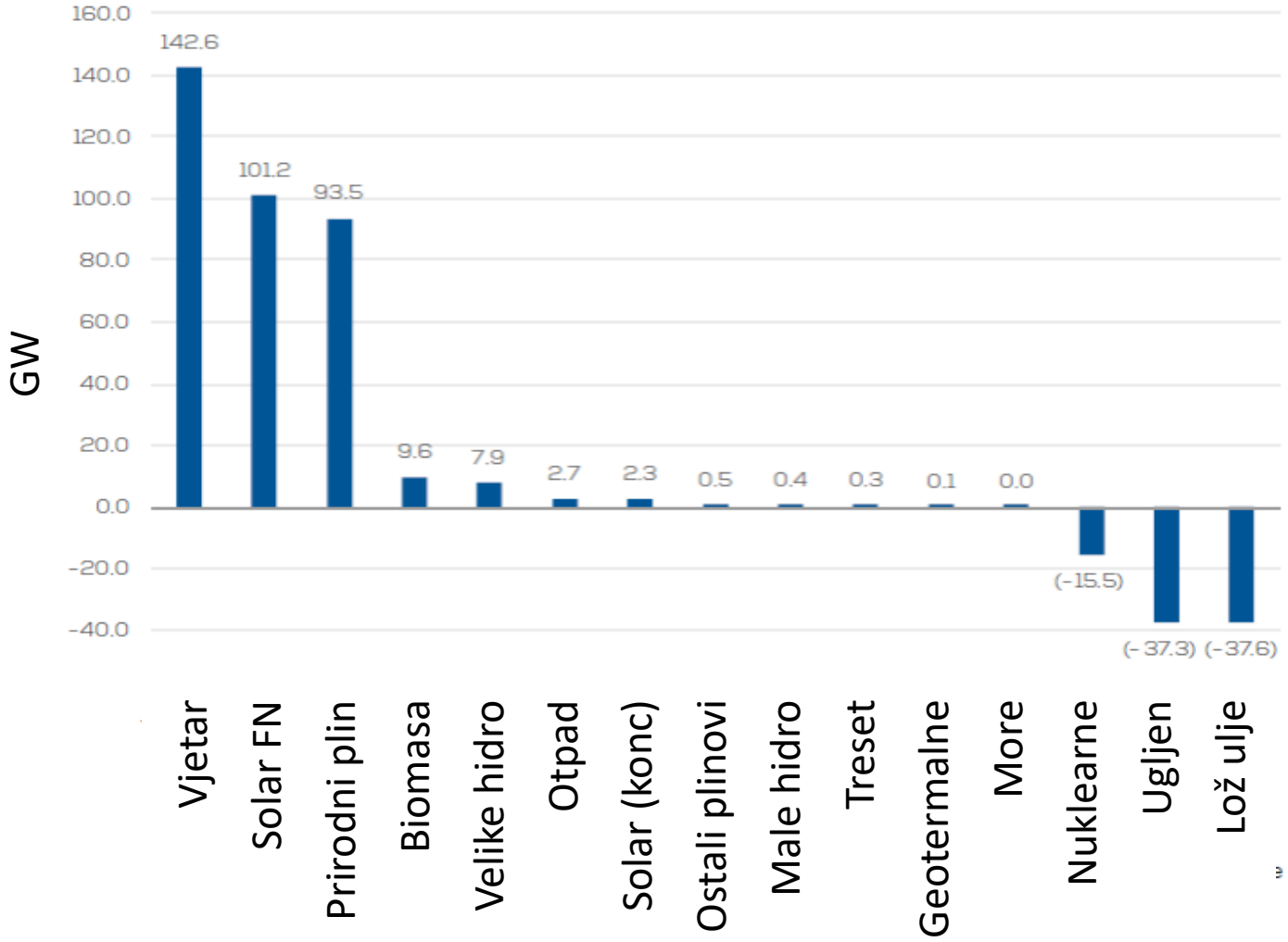
(in % of gross final energy consumption)



eurostat

Tranzicija je već započela...

Neto instairani kapacitetu za proizvodnju el. energije u EU 2001-2016



Hrvatska tek započinje s povećavanjem udjela obnovljivih izvora energije

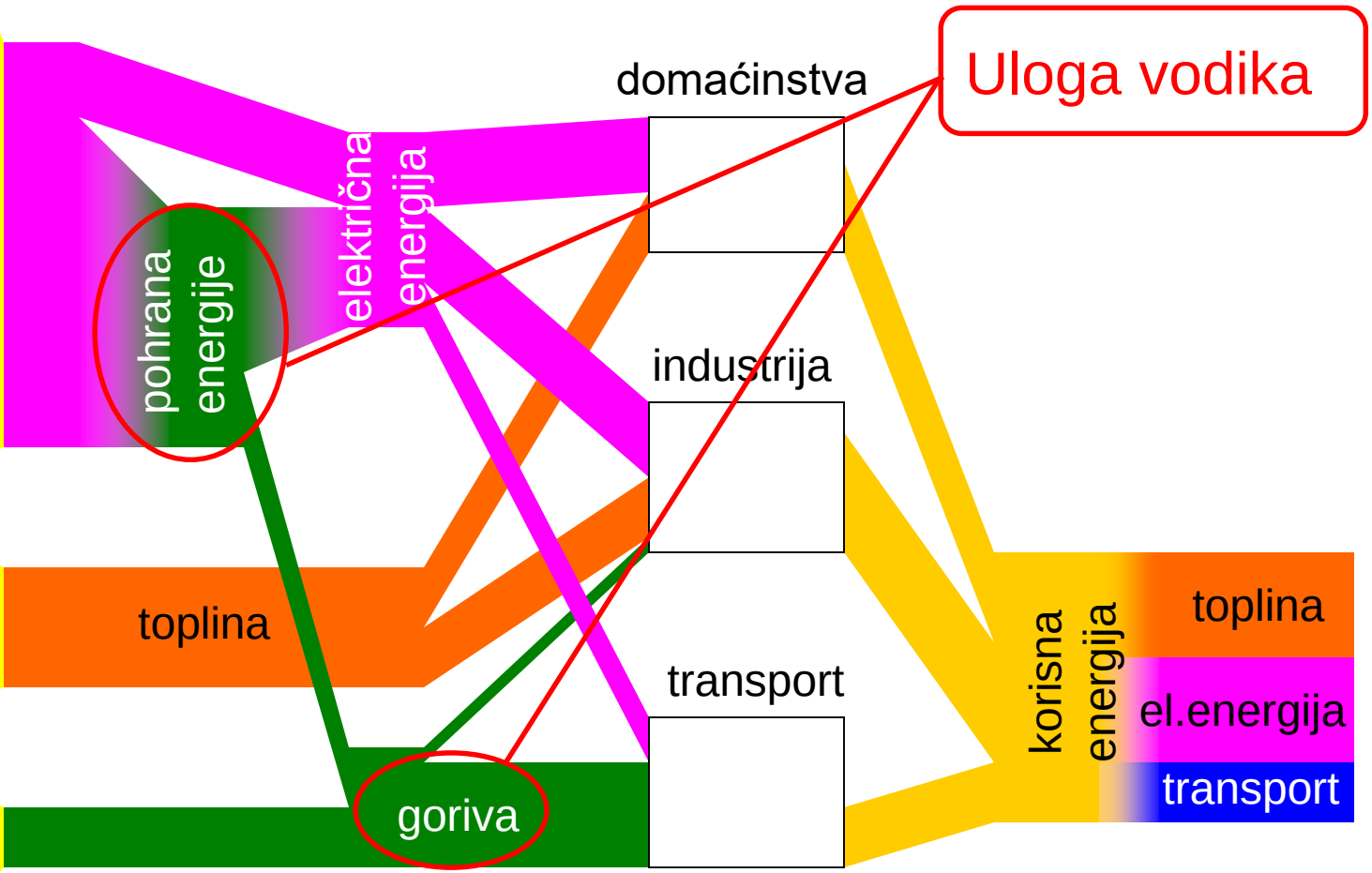
Do sada instalirane elektrane s garantiranim otkupnim cijenama (početak 2016)

	Broj elektrana	Installirana snaga (MW)	CF	Proizvdnja GWh	Udio %
Vjetro elektrane	19	418.0	26%	951.9	67.6%
Solarne FN	1213	44.0	13%	50.1	3.6%
Male hidro	8	3.0	60%	15.7	1.1%
Biomasa	10	24.6	75%	161.5	11.5%
Bioplin	18	20.9	85%	155.9	11.1%
Plin s odlagališta	2	5.5	65%	31.3	2.2%
Kogeneracija	5	13.3	35%	40.8	2.9%
Geotermalne	0	0.0	80%	0.0	-
Total	**1275**	**529.2**		**1407.2**	**100%**

8.3% od ukupne potrošnje u Hrvatskoj

Hipotetski energetski sustav budućnosti baziran na obnovljivim izvorima energije

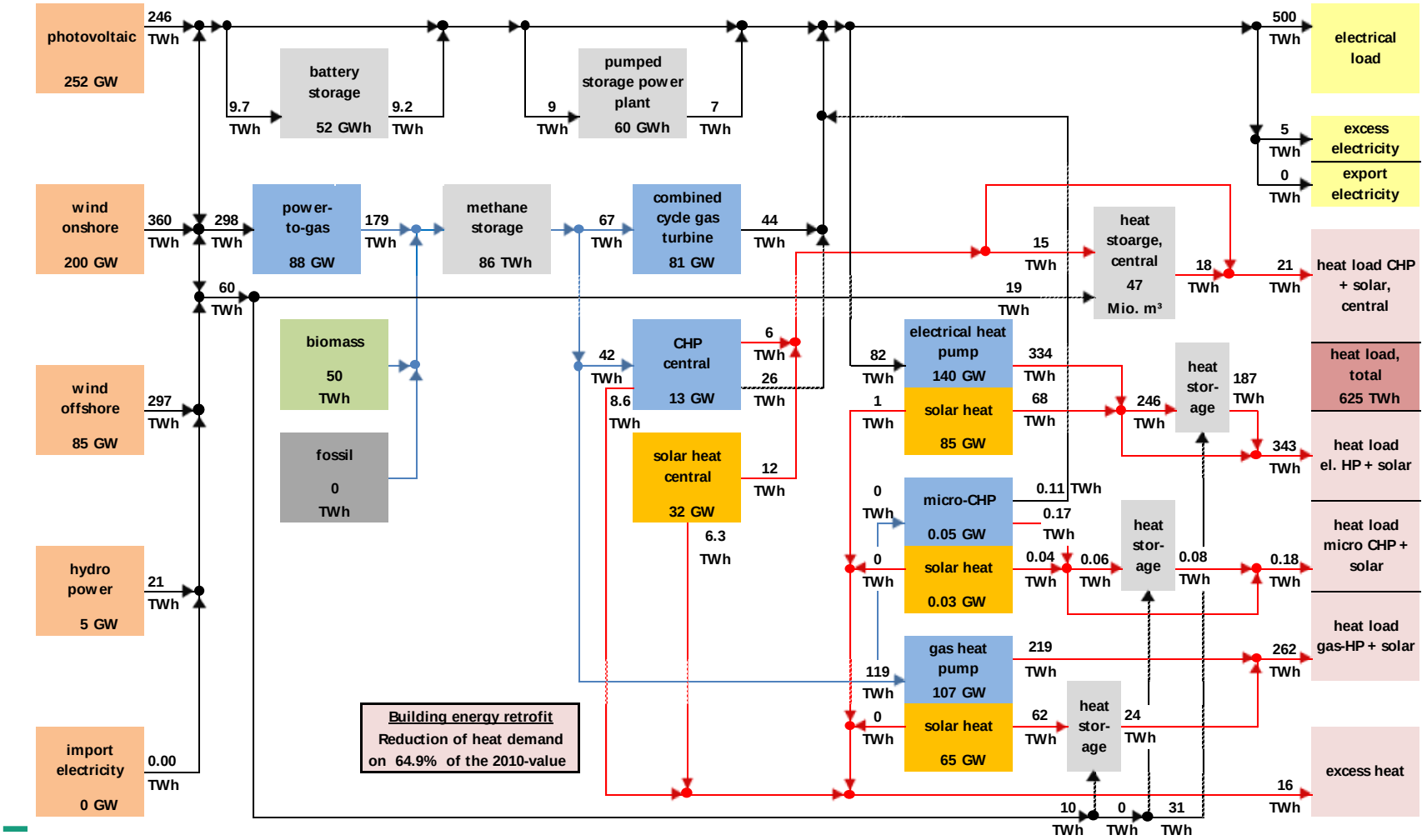
Obnovljivi izvori energije: sunce, vjetar, hidro, biomasa …



100 % Renewables for Electricity and Heat in Germany

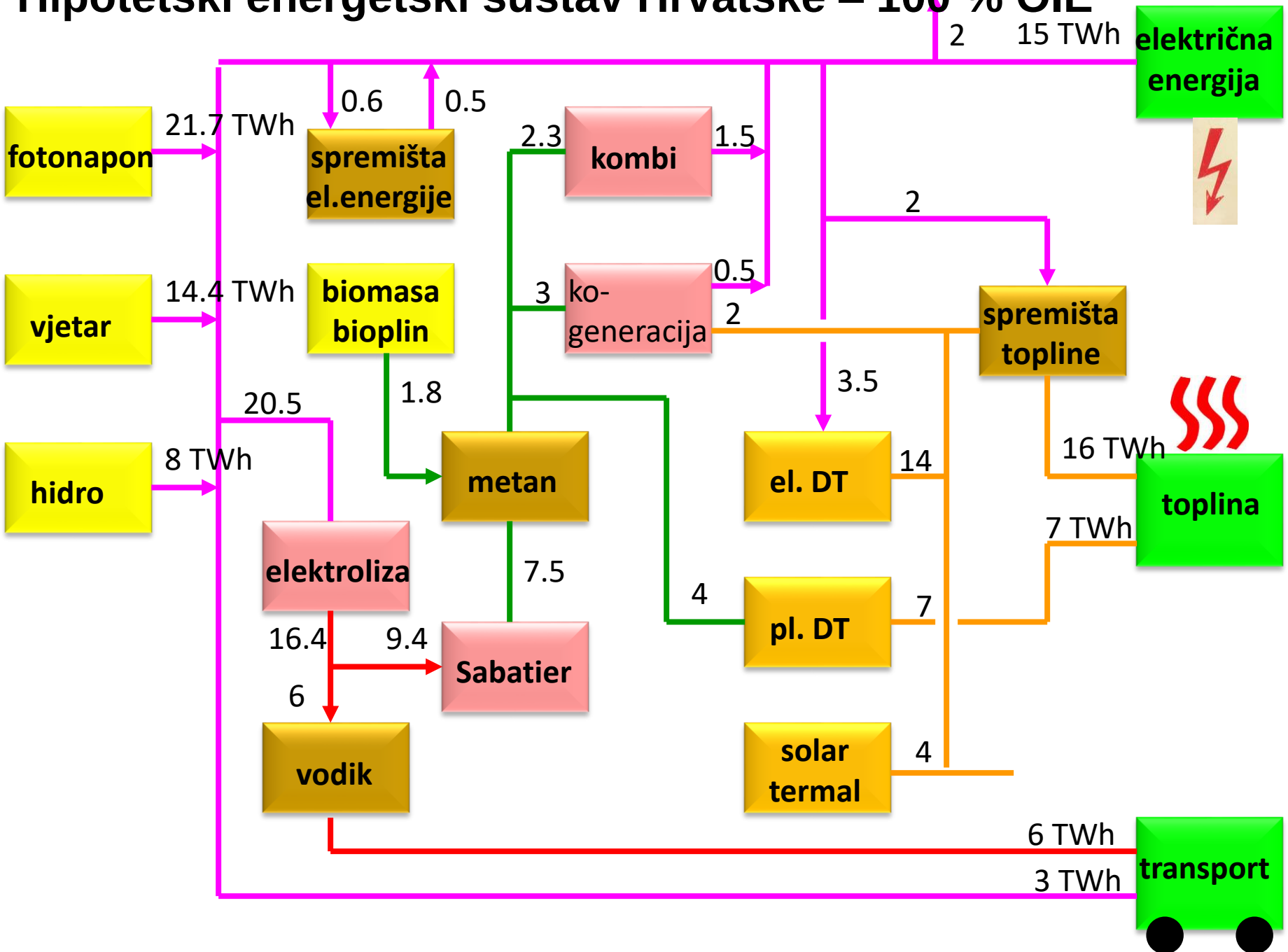
A comprehensive model of the German energy system

H.-M. Henning, A. Palzer, Fraunhofer Institute for Solar Energy Systems ISE



Fraunhofer ISE

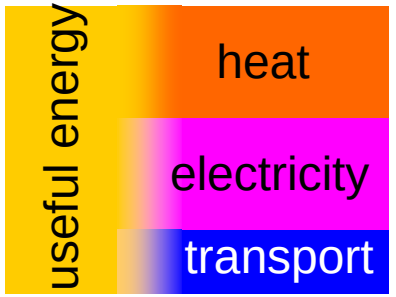
Hipotetski energetski sustav Hrvatske – 100 % OIE



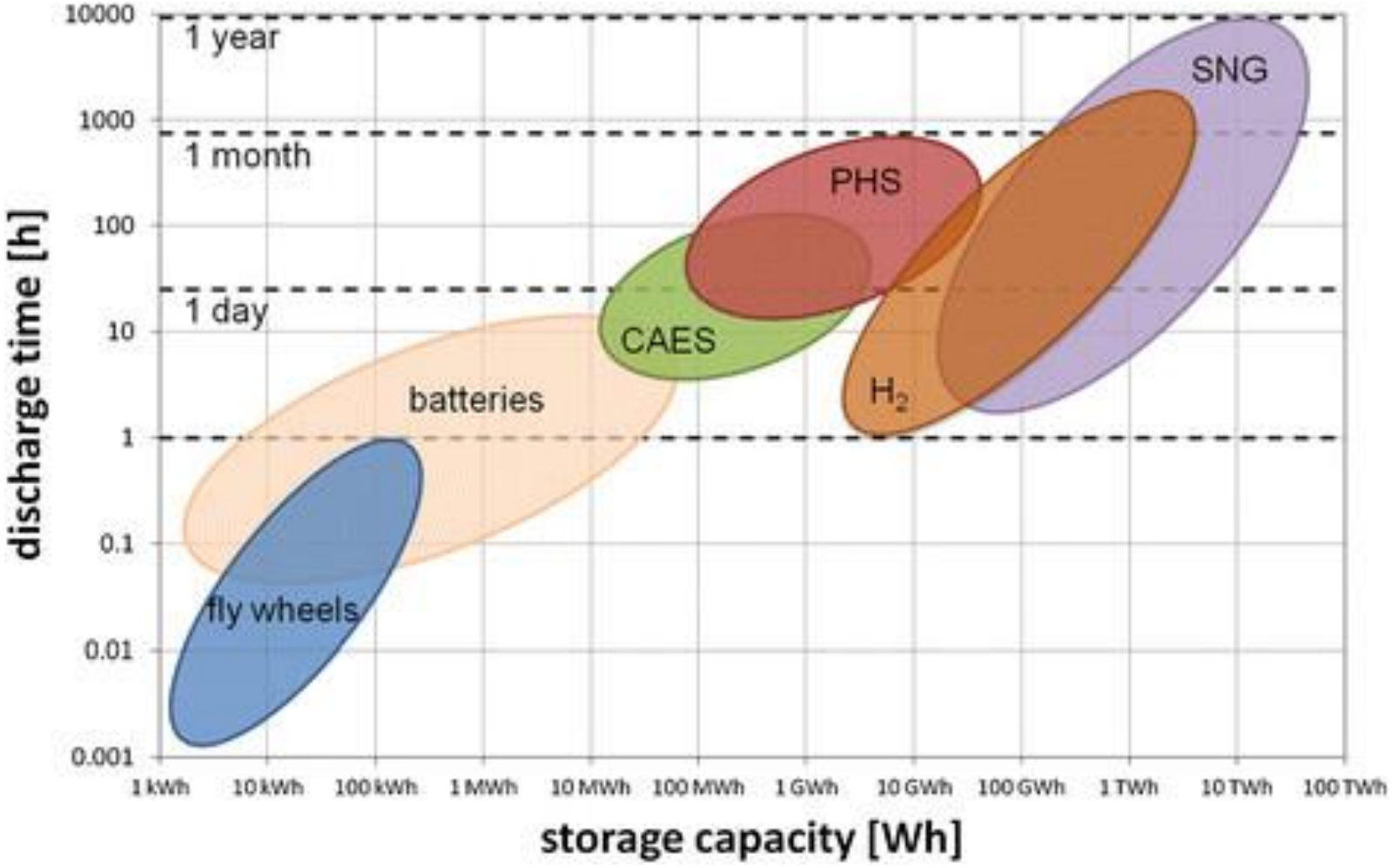
Obnovljivi izvori energije: sunce, vjetar, hidro, biomasa …

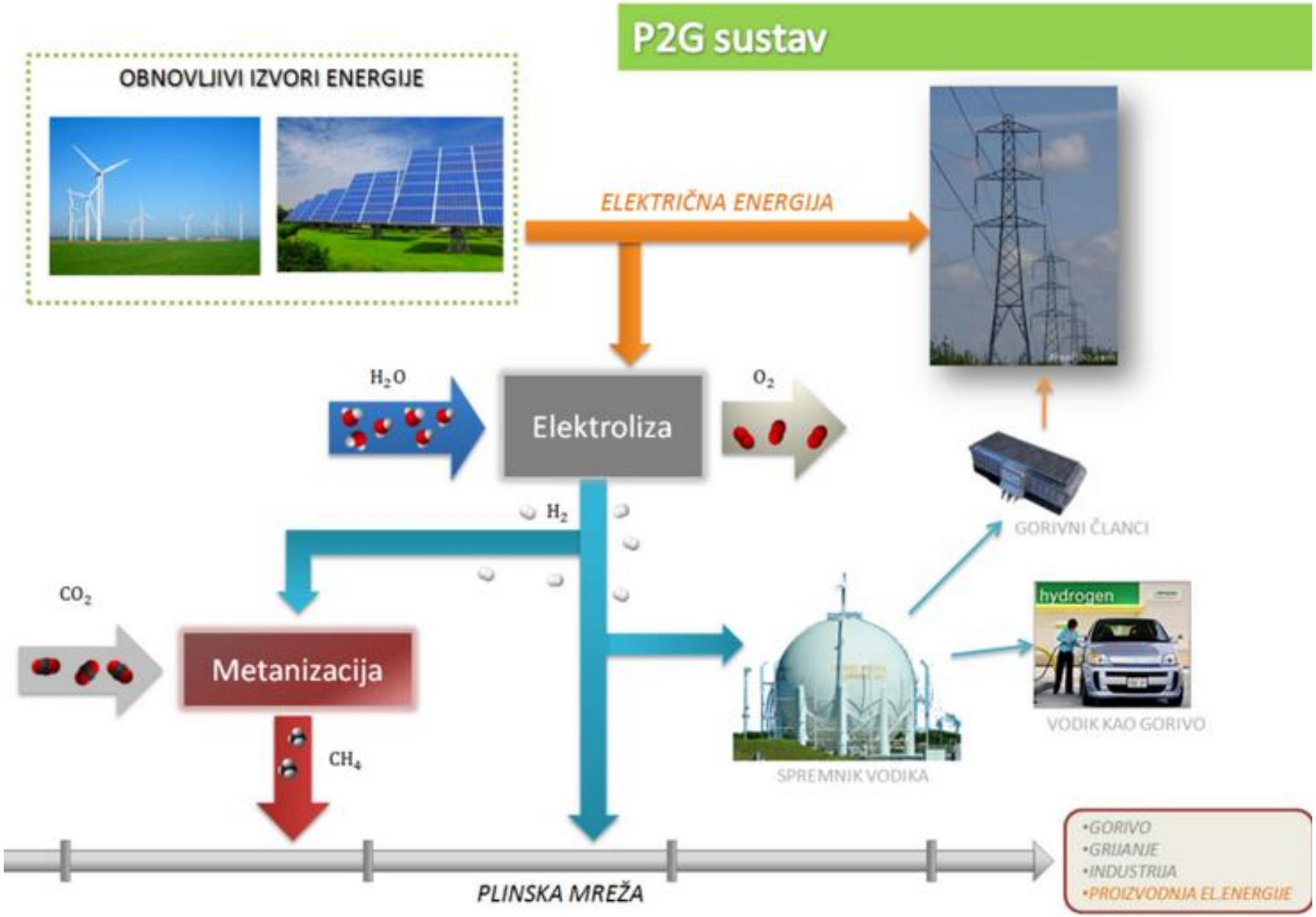
Po čemu se ovaj sustav razlikuje od sadašnjeg sustava

- Izvori: obnovljivi : sunce vjetar, biomasa
- Centralizirana/decentralizirana proizvodnja
- Pohrana energije: električna
  kemijska { Vodik, Metan } Power to gas
  termalna
- Nova elektrodistribucijska mreža
- Integracija transporta – električni automobili { Vodik, Baterije }
- Mjere energetske učinkovitosti
- Integracija grijanja
- Kogeneracija
- Dizalice topline
- Pametne mreže/upravljanje potrošnjom



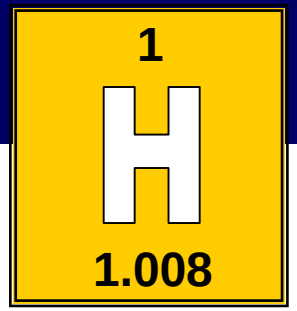
Pohrana energije



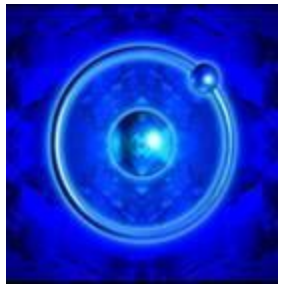


Izvor: https://hr.wikipedia.org/wiki/Power_to_Gas_sustav_(P2G)

Što je vodik?



- Vodik je plin
- 1 elektron + 1 proton
- bez boje, mirisa i okusa
- nije toksičan
- lakši od zraka
- zapaljiv
- najrasprostranjeniji element u svemiru
- na Zemlji je prisutan samo u spojevima (H_2O, C_XH_Y …



Vodik gorivo budućnosti

- Vodik nije izvor energije nego gorivo koje se može se proizvesti iz bilo kojih izvora energije
- Posebno je interesantna sprega vodika sa obnovljivim izvorima energije
- Može se skladištiti
- Može se koristiti u svim primjenama umjesto sadašnjih fosilnih goriva
- Gorivni članci – nova tehnologija koja omogućuje proizvodnju električne energije sa visokim stupnjem iskoristivosti
- Automobili na vodik su stvarnost
- Proizvodnja vodika (iz obnovljivih izvora energije) i njegovo korištenje nisu štetni za okoliš
- Omogućuje sustav 100% baziran na obnovljivim izvorima energije

el.energija

$$H_2O \rightarrow H_2 + \tfrac{1}{2} O_2$$

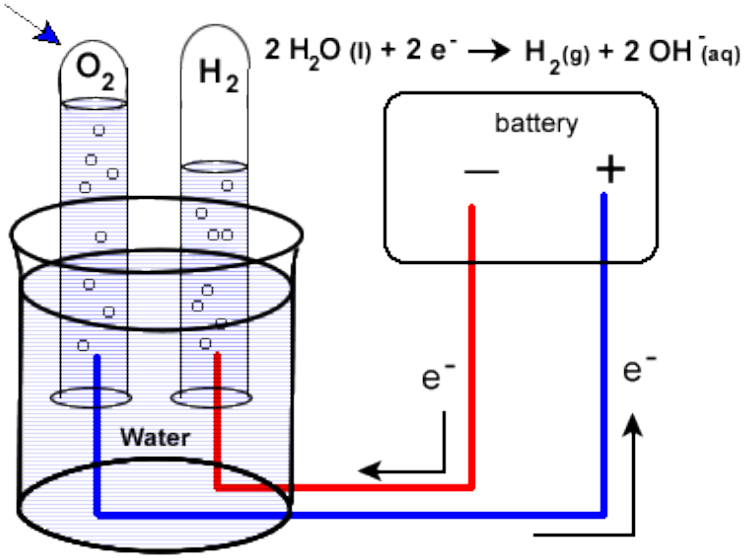
el. energija

voda

elektroliza

H_2 vodik

O_2 kisik



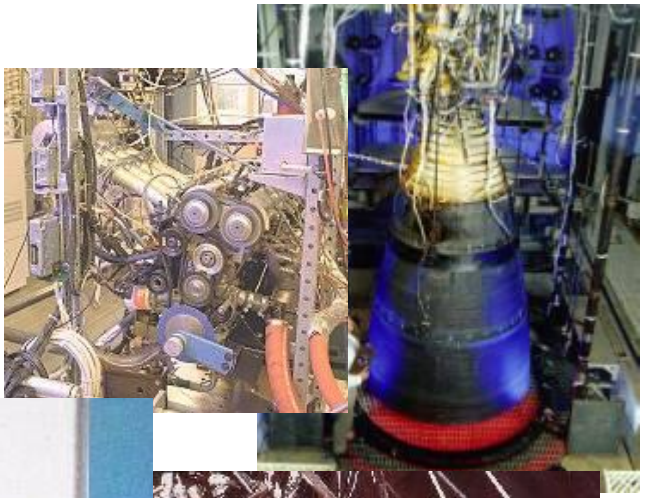
Vodik se može skladištiti

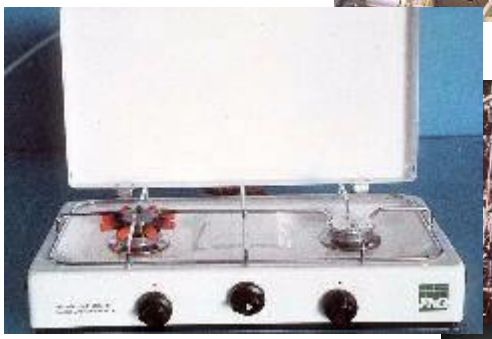
- Stlačeni plin
- Tekući vodik
- Metalni hidridi
- Ostali
  - Aktivirani ugljik
  - Ugljikove nanostrukture
  - Staklene mikro kuglice
  - Kemijski hidridi
- Velika podzemna skladišta

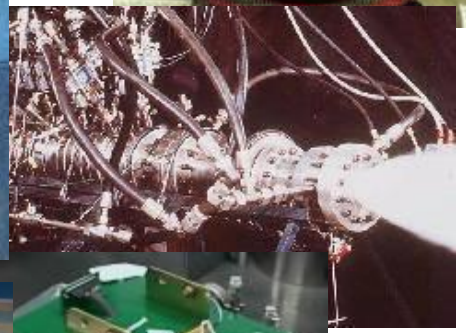
1 kg vodika stlačen na 200 bara zauzima 68 litara
350 bara 43 litara
700 bara 25 litara

Tehnologije za korištenje vodika

- Izgaranje
  - Motori s unutrašnjim sagorijevanjem
  - Mlazni i raketni motori
  - Proizvodnja pare
- Katalitičko izgaranje
- Primjene hidrida
- Elektrokemijska konverzija
  - Gorivni članci







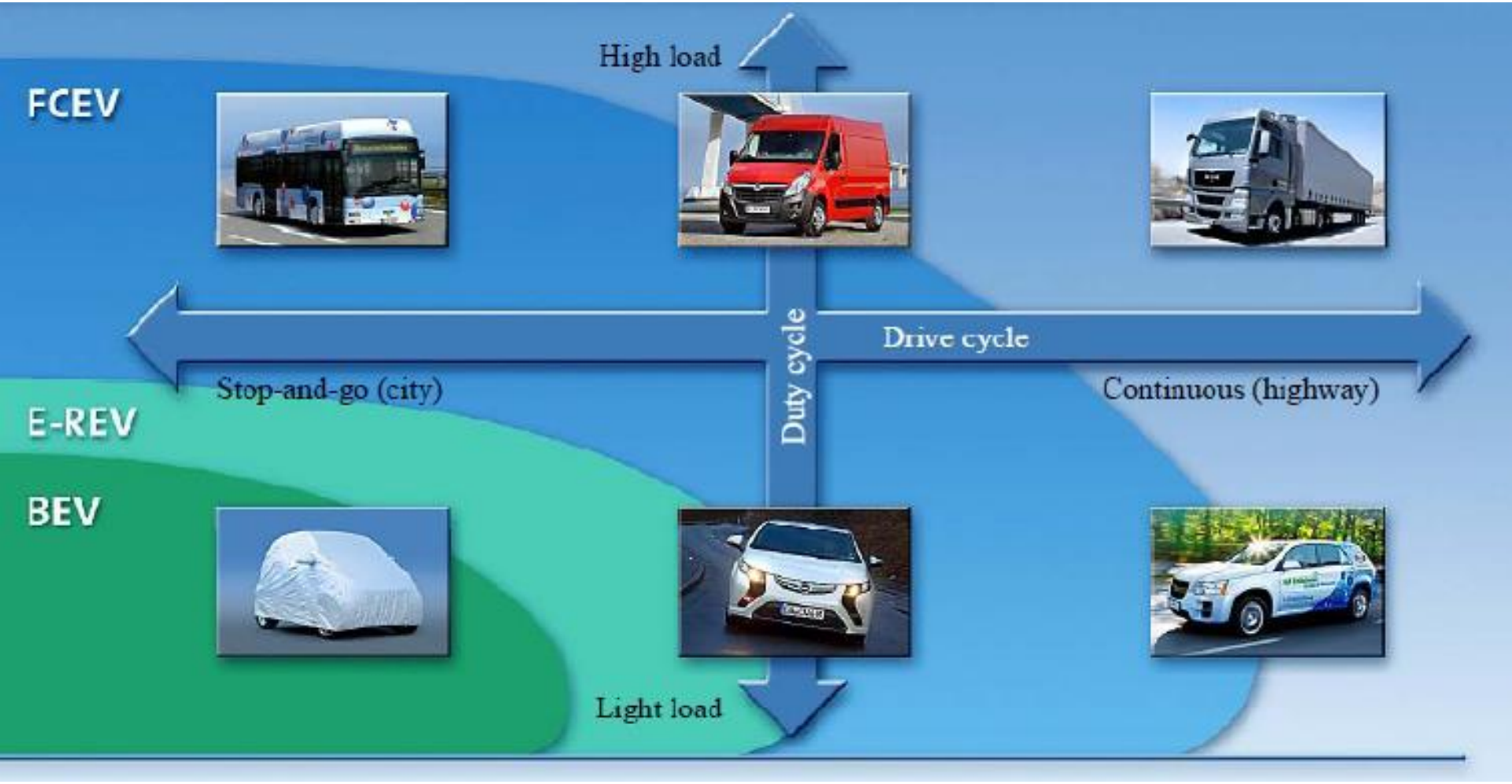
$$H_2 + ½\ O_2 \longrightarrow H_2O + \text{el.energija}$$

Toyota Mirai – prvi komercijalni automobil na pogon vodikovim gorivnim člancima u prodaji od 2015

Tesla Model S vs. Toyota Mirai

Vehicle	Performance 0 - 60 (sec)	Fuel Efficiency	Specs	Cost	Total Cars in 2017
Tesla Model S	3.2 to 5.9 sec 302 to 691 hp	89 MPGe 265 miles range	Wt: 4670 lbs. H: 56.5" W: 77.3" L: 196" Seats: 5/7	$71,070 to $105,670	About 160,000
Toyota Mirai	9.0 sec 153 hp	60 MPGe 300 miles range	Wt: 4078 lbs. H: 60.4" W: 71.4" L: 192.5" Seats: 4	$57,500	About 3,000

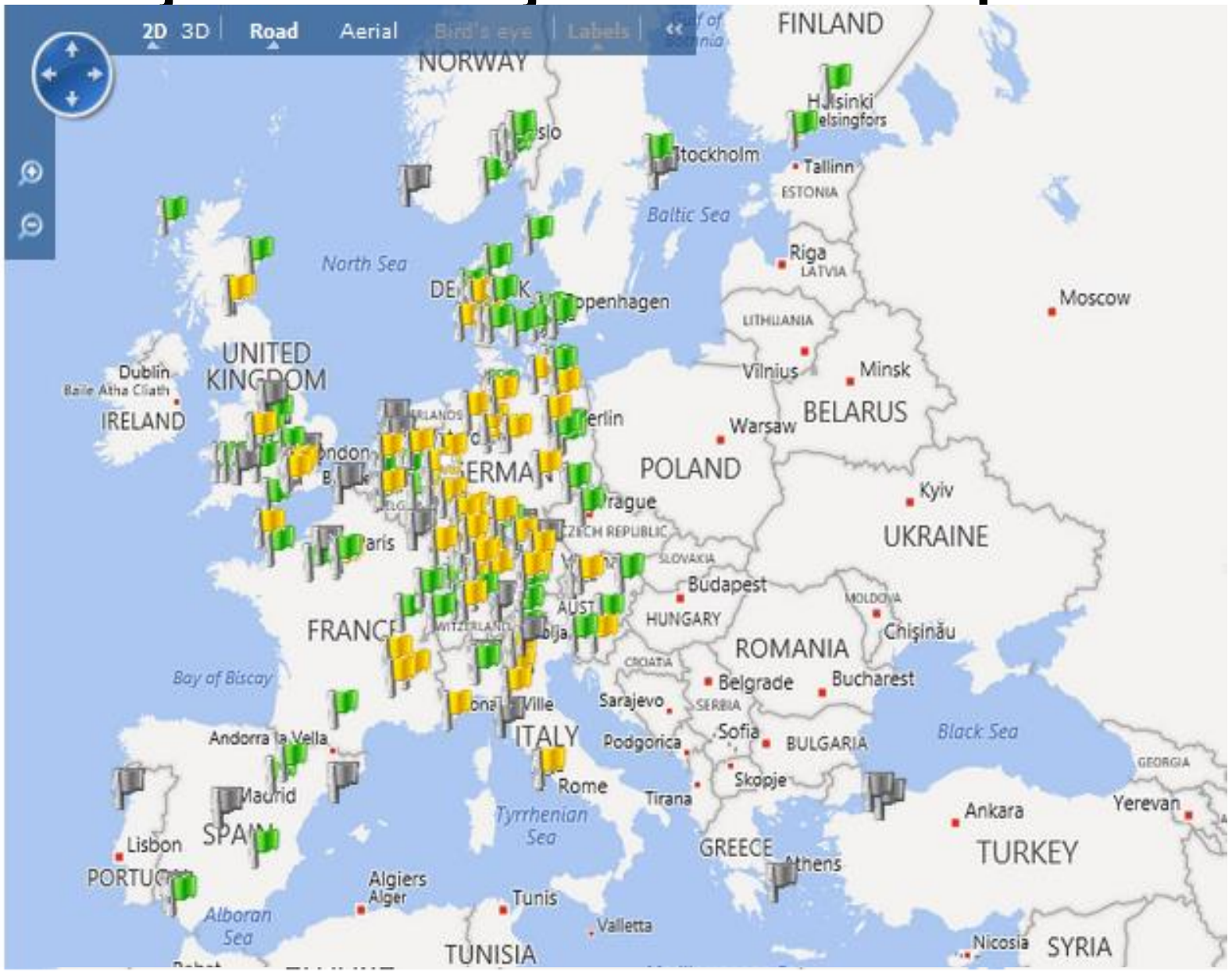
Mapa razvoja i primjene automobilskih tehnologija




Aberdeen
Hydrogen Bus Project
First
Powered by Hydrogen
H2
Powered by Hydrogen
SV14 FYR


Aberdeen
First
Sorry, not in service
BOC
Aberdeen
WP66 PXF

Postaje za natakanje vodika u Europi



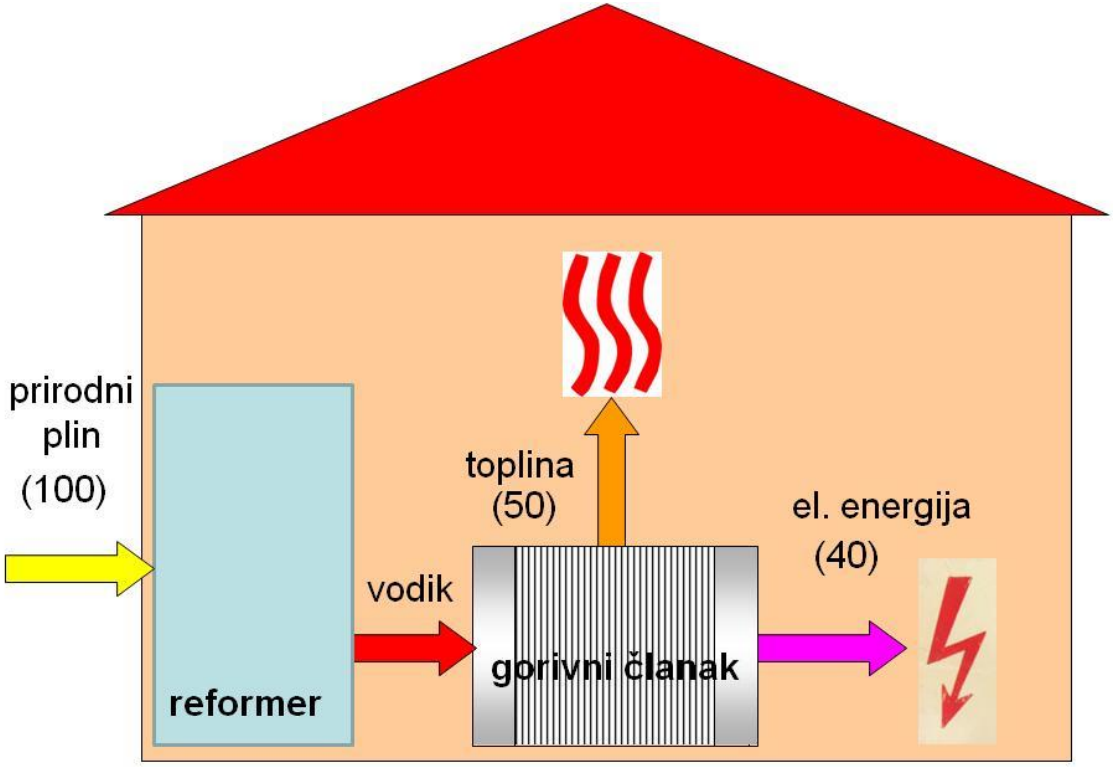
FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

FCH Hydrogen Regions

A new study launched in 2017

- assess the business cases for fuel cell and hydrogen applications that local authorities are seeking
- put them directly in touch with industry players
- help them map their local capabilities so that they can exploited in the future
- identify existing funding sources to implement future project

Druga primjena gorivnih članaka: kogeneracija

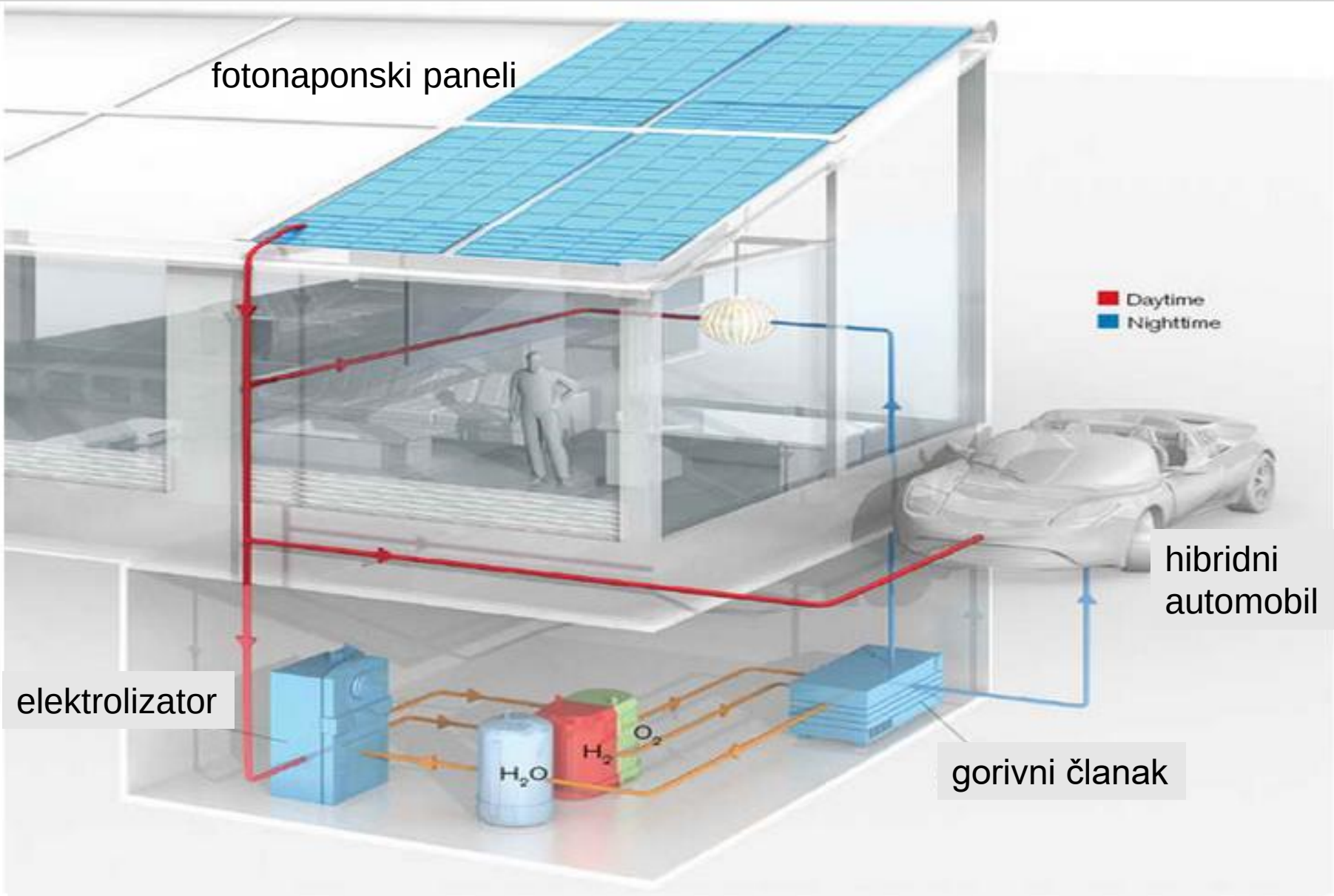


- Mikro-kogeneracija: 1-2 kW za kuće i stanove
- Mini –kogeneracija: 10-50 kW za komercijalne zgrade
- Preko 50,000 jedinica ugrađeno u Japanu (ene-farm)
- Velki demonstracijski projekti u Europi (ene.field)

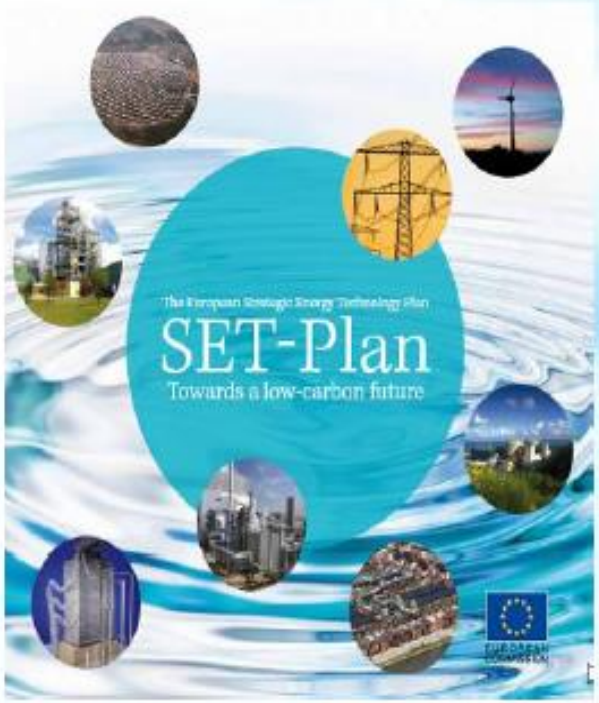
RESIDENTIAL FUEL CELL ENE·FARM

ene.field

Kuća budućnosti



The European Strategic Energy Technology-Plan (SET-Plan)



Joint Technology Initiative →

Joint Undertaking

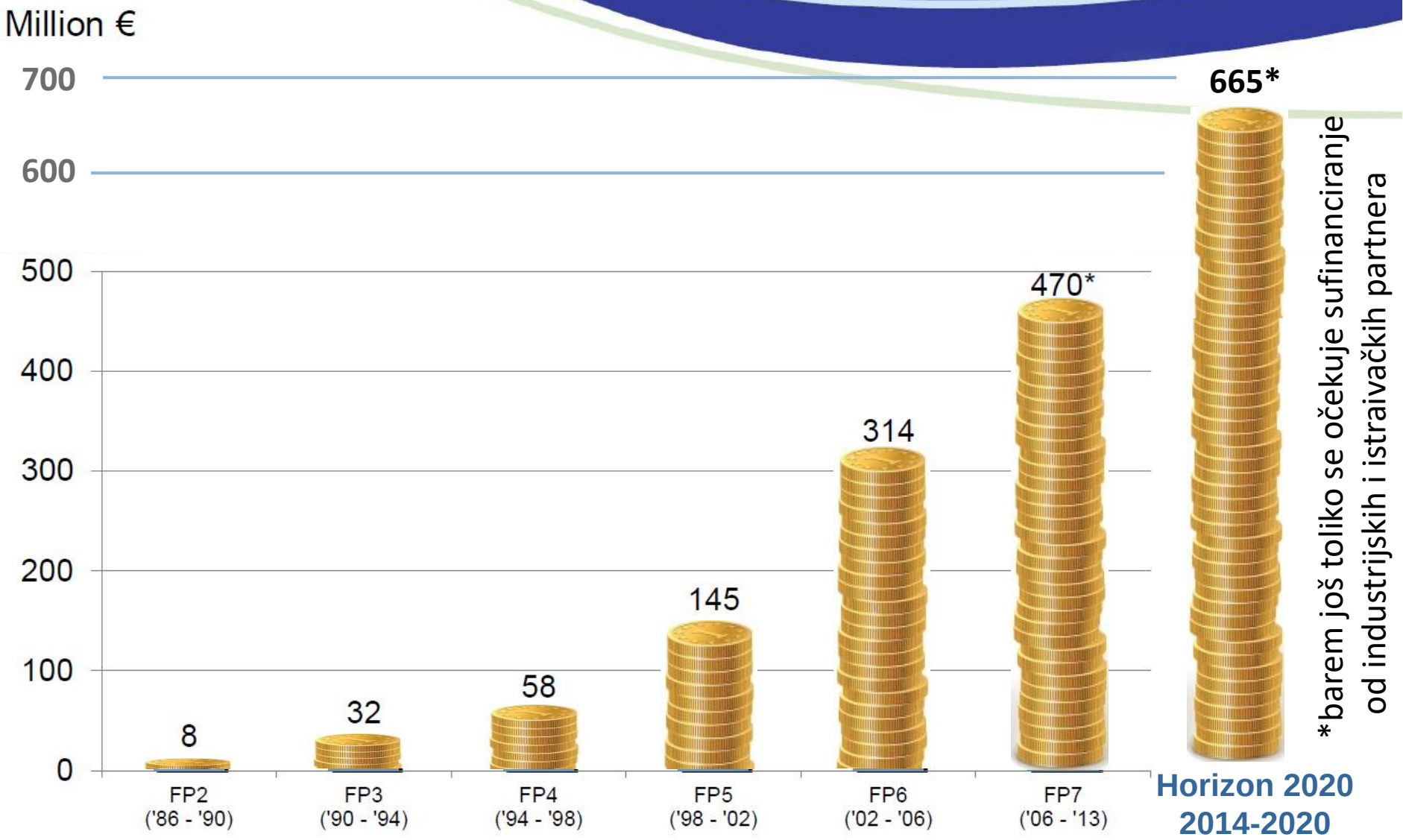
Council Regulations:

521/2008 of 30 May 2008 **(FP7)**

1183/2011 of 14 November 2011

559/2014 of 6 May 2014 **(H2020)**

Financiranje razvoja vodika i gorivnih članaka u EU preko FCH JU javo-privatnog partnerstva



Projekti na FESBu

- Water and Heat Management and Durability of PEM Fuel Cells, Croatian Science Foundation, 2014-2018
- Research and Development of Hydrogen Energy System in Conjunction with Renewable Energy Sources, EU Regional Development Fund through Central Financing and Contracting Agency (SAFU), 2014-2016
- System Automation of PEMFCs with Prognostics and Health management for Improved Reliability and Economy (SAPPHIRE) EC FCH JU (FP7), 2013-2016
- Automotive Derivative Energy System (AutoRE) EC FCH Joint Undertaking (Horizon2020), 2015-2018
- GiantLeap Giantleap Improves Automation of Non-polluting Transportation with Lifetime Extension of Automotive PEM Fuel Cells, EC FCH JU (H2020), 2016-19
- STIM Center of Excellence for Science and Technology and Integration of the Mediterranean Region, Ministry of Science, Education and Sport, EU Structural Funds 2015-2020 ??

SAPPHIRE

GIANTLEAP

AutoRE

STRUKTURNI I INVESTICIJSKI FONDOVI

safu

hrzz

Hrvatska zaklada za znanost

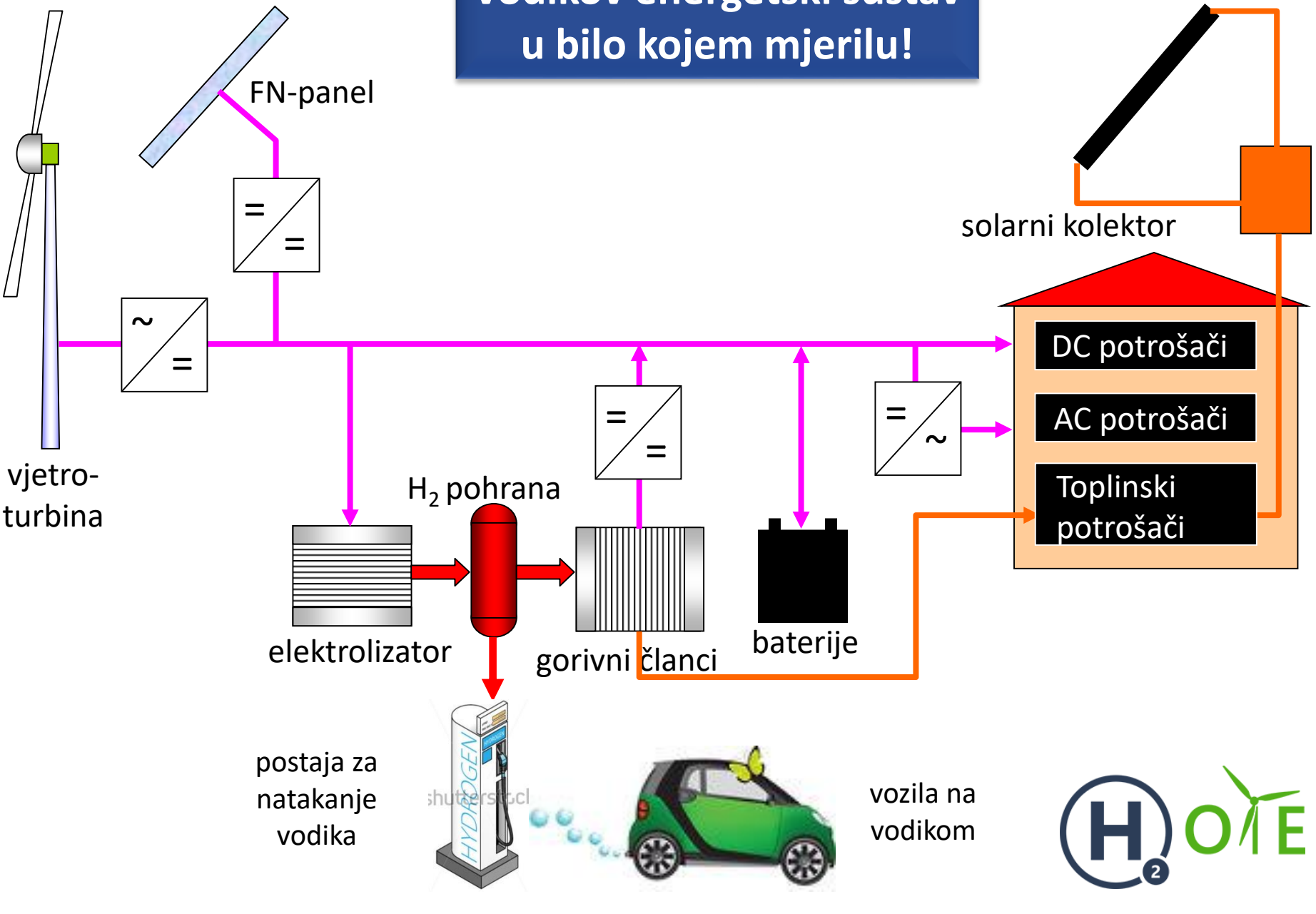
HORIZON 2020

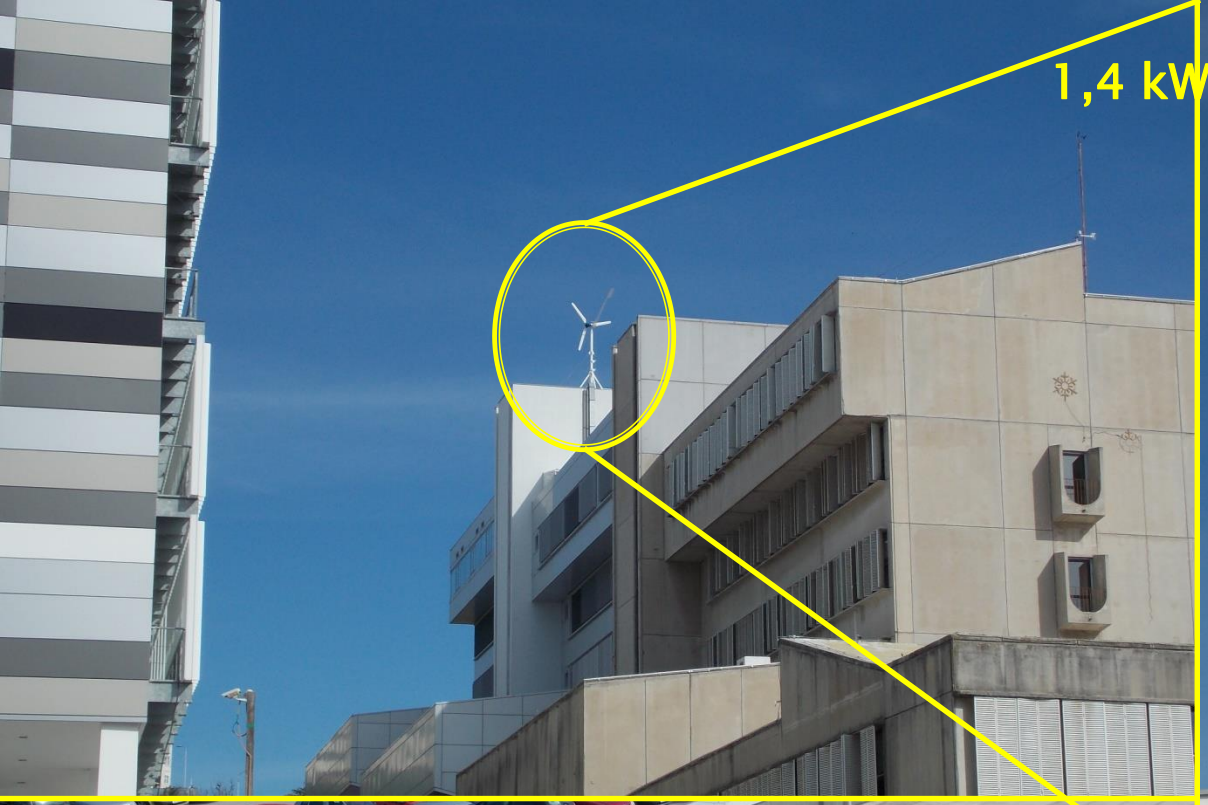
THE FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION

FCH

STIM

Vodikov energetski sustav u bilo kojem mjerilu!





1,4 kW vjetroturbina na krovu FESBa

1,6 kW fotonapona na krovu FESBa

za spajanje na vodikovo postrojenje u laboratoriju

H2 sustav u laboratoriju

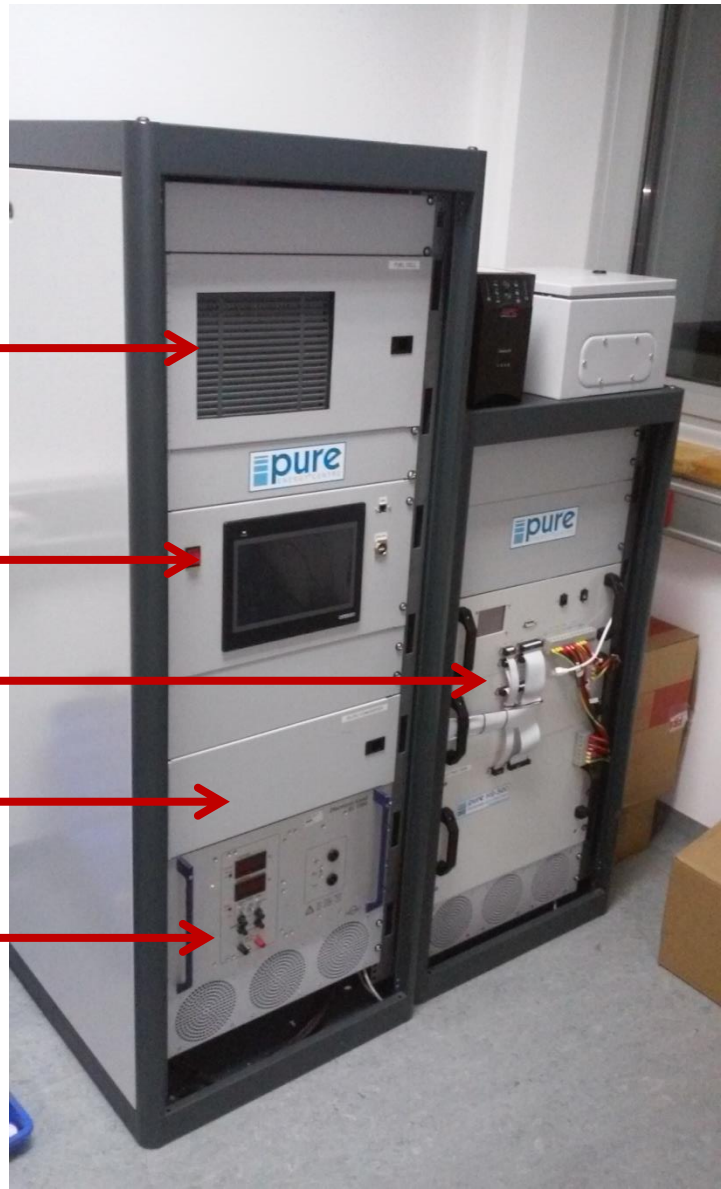
Gorivni članak1,2 kW

Upravljačka jedinica

Elektrolizator (3 kW)

DC/DC konverter

Electronsko opterećenje 1,5 kW

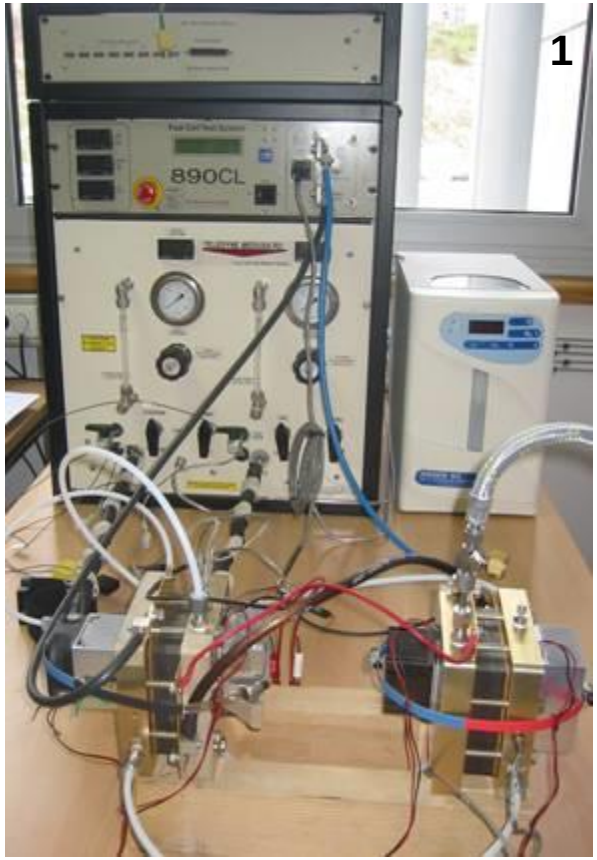


ATV Motorkotač pogonjen gorivnim člancima

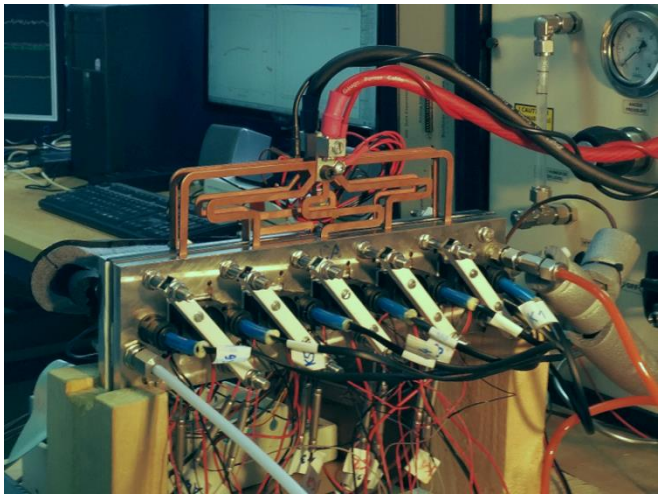
Vodik je spremljen u spremnicima s metalnim hidridima

Laboratorij za nove energetske tehnologije

1



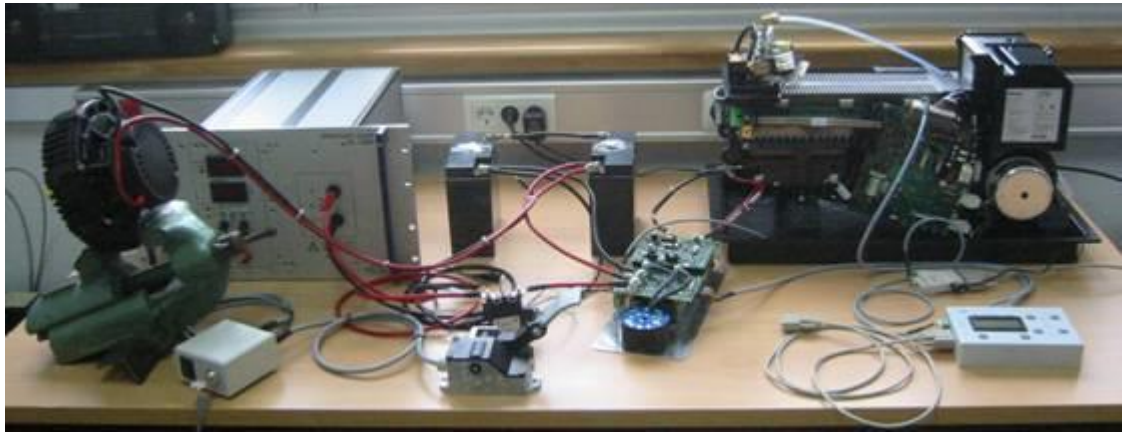
4



- Fuel cell test station (1)
- System integration; components testing (4)
- Electrolyzer (single cell) test station (3)
- Segmented fuel cell (4)

3

2



Hvala na vašoj pozornosti!