NEW TRENDS IN POWER SYSTEMS CONFIGURATIONS

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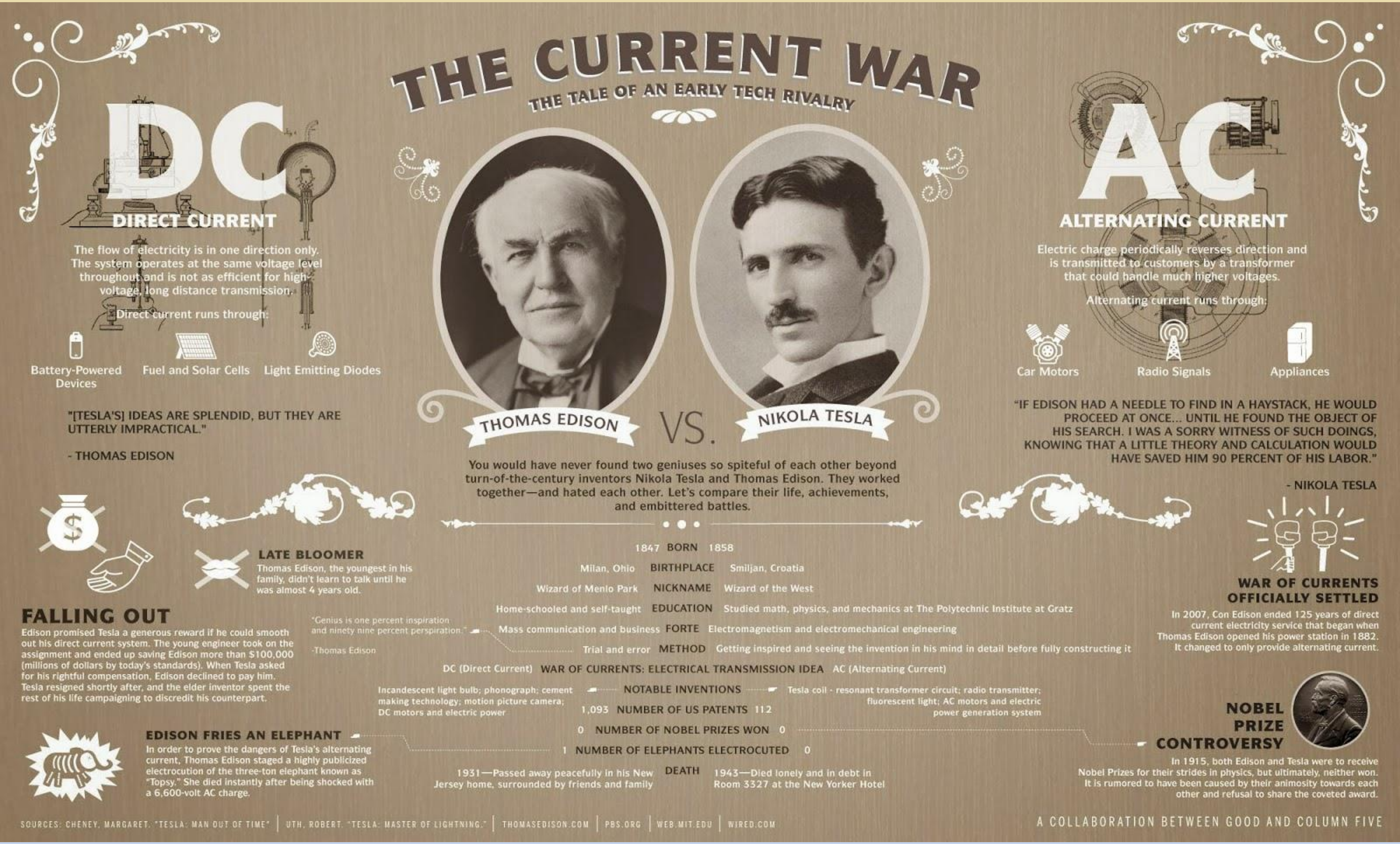
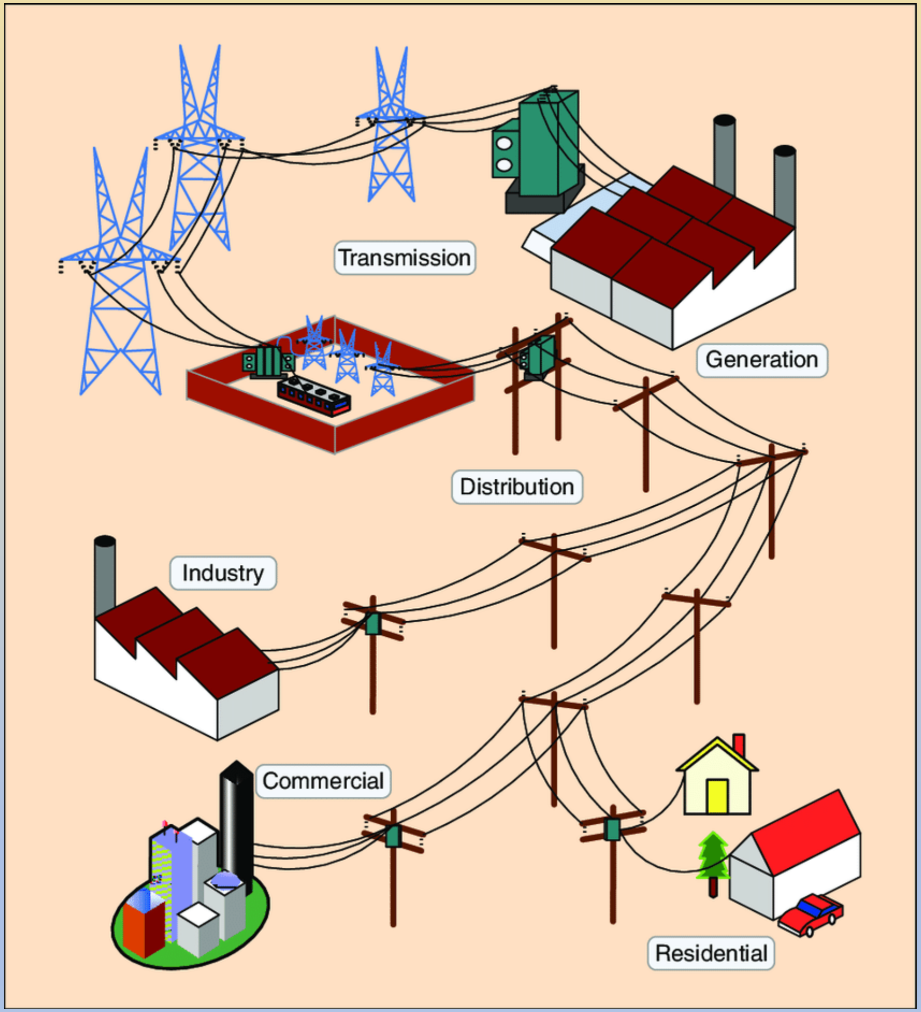
OUTLINE

- **AC VERSUS DC IN POWER SYSTEMS;**
- **SMART GRID CONCEPT;**
- **ENERGY STORAGE TECHNOLOGIES;**
- **HIGH VOLTAGE DC POWER DISTRIBUTION;**
- **RECENT RESEARCH PROGRAMS IN UPT REGARDING ENERGY CONVERSION AND STORAGE;**
- **CONCLUSIONS.**

ALTERNATE VERSUS DIRECT CURRENT

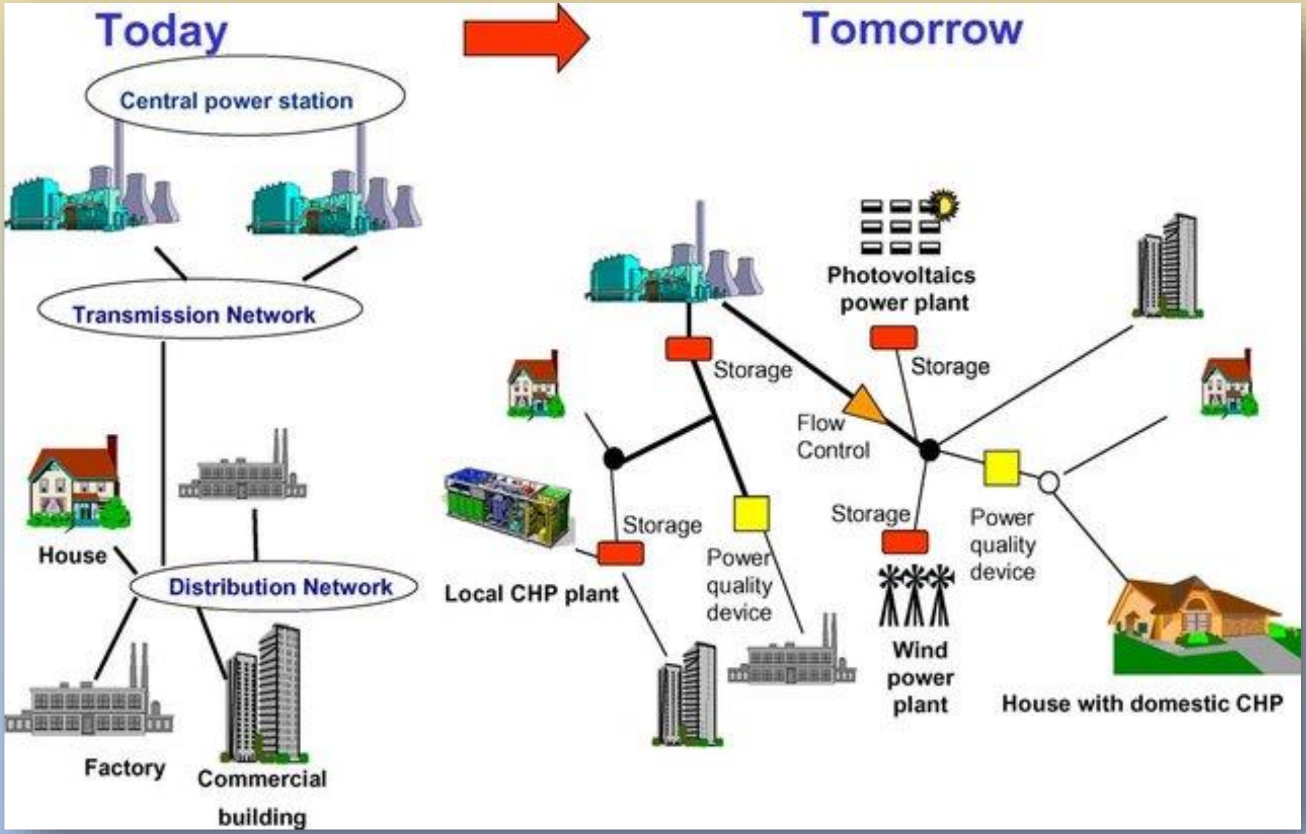


CLASSICAL POWER DISTRIBUTION SYSTEMS



Dushan Boroyevich, Igor Cvetković, Dong Dong, Rolando Burgos, Fei Wang, Fred Lee, *"Future Electronic Power Distribution Systems – A contemplative view"*, Proceedings of the 12th International Conference on Optimization of Electrical and Electronic Equipment, OPTIM 2010, pp. 1369-1380.

SMART GRIDS



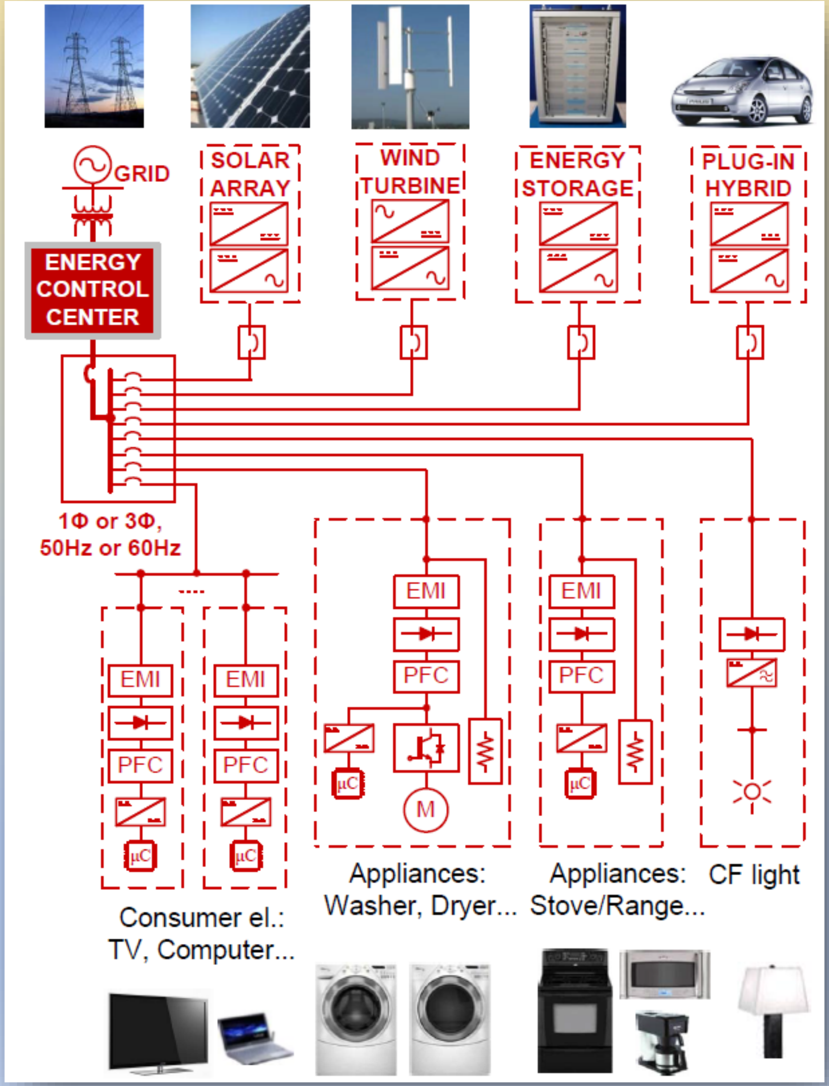
https://www.researchgate.net/publication/223610167_Lead-acid_batteries_in_stationary_applications_Competitors_and_new_markets_for_large_penetration_of_renewable_energies

SMART GRIDS

A smart grid is an electricity network enabling a two-way flow of electricity and data with digital communications technology enabling to detect, react and pro-act to changes in usage and multiple issues. Smart grids have self-healing capabilities and enable electricity customers to become active participants.

https://www.youtube.com/watch?v=JwRTpWZReJk
https://www.youtube.com/watch?v=KciEb1cKyO0&ab_channel=WorldBusinessAcademy

A CONTEPORARY STRUCTURE OF POWER DELIVERY IN RESIDENTIAL HOMES



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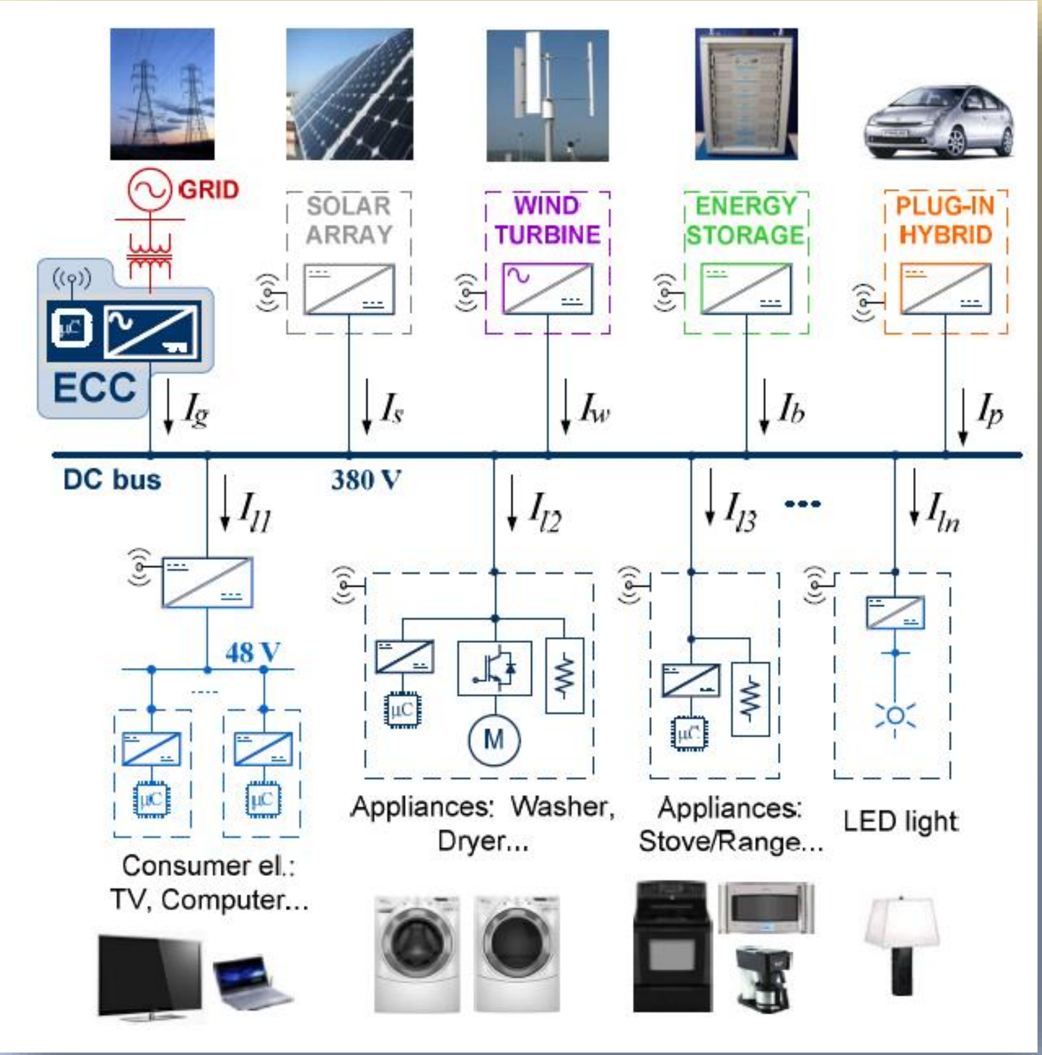
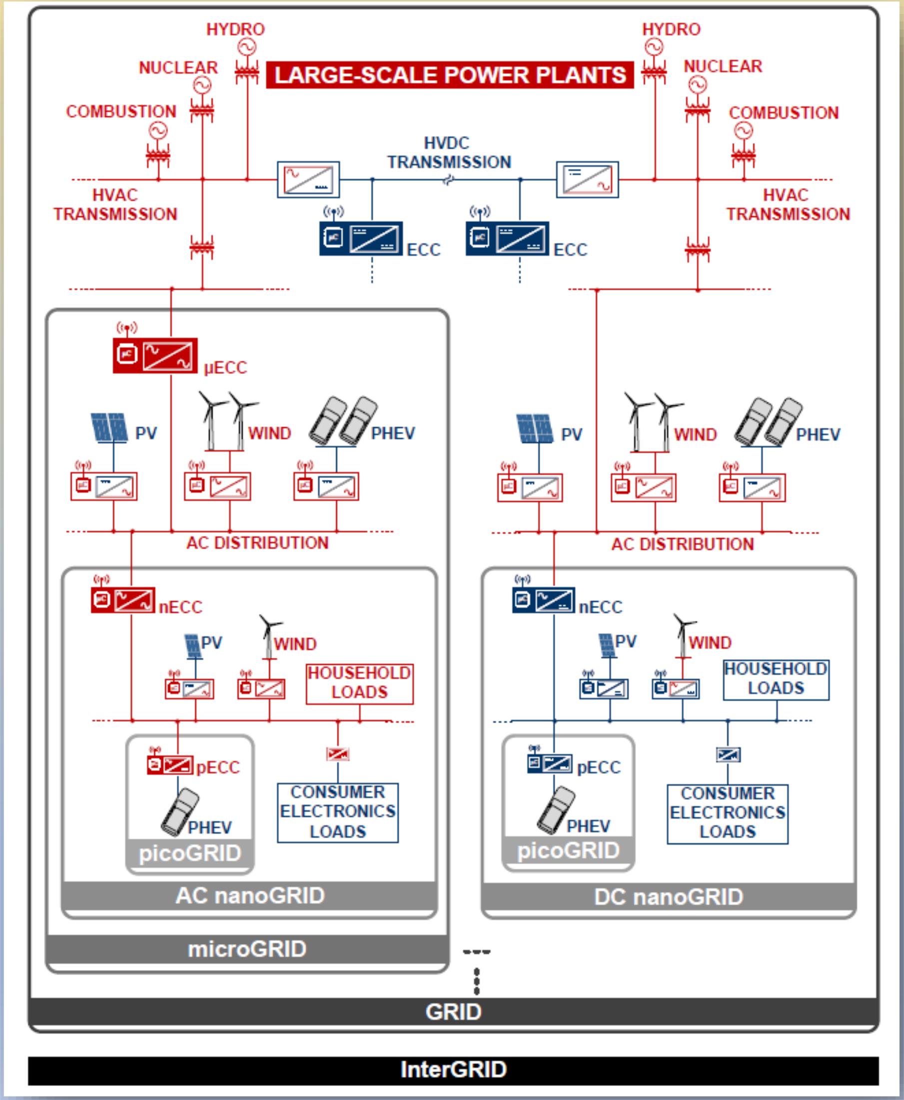
A DC BASED "SMART GRID" (NANO GRID) IN A FUTURE HOME



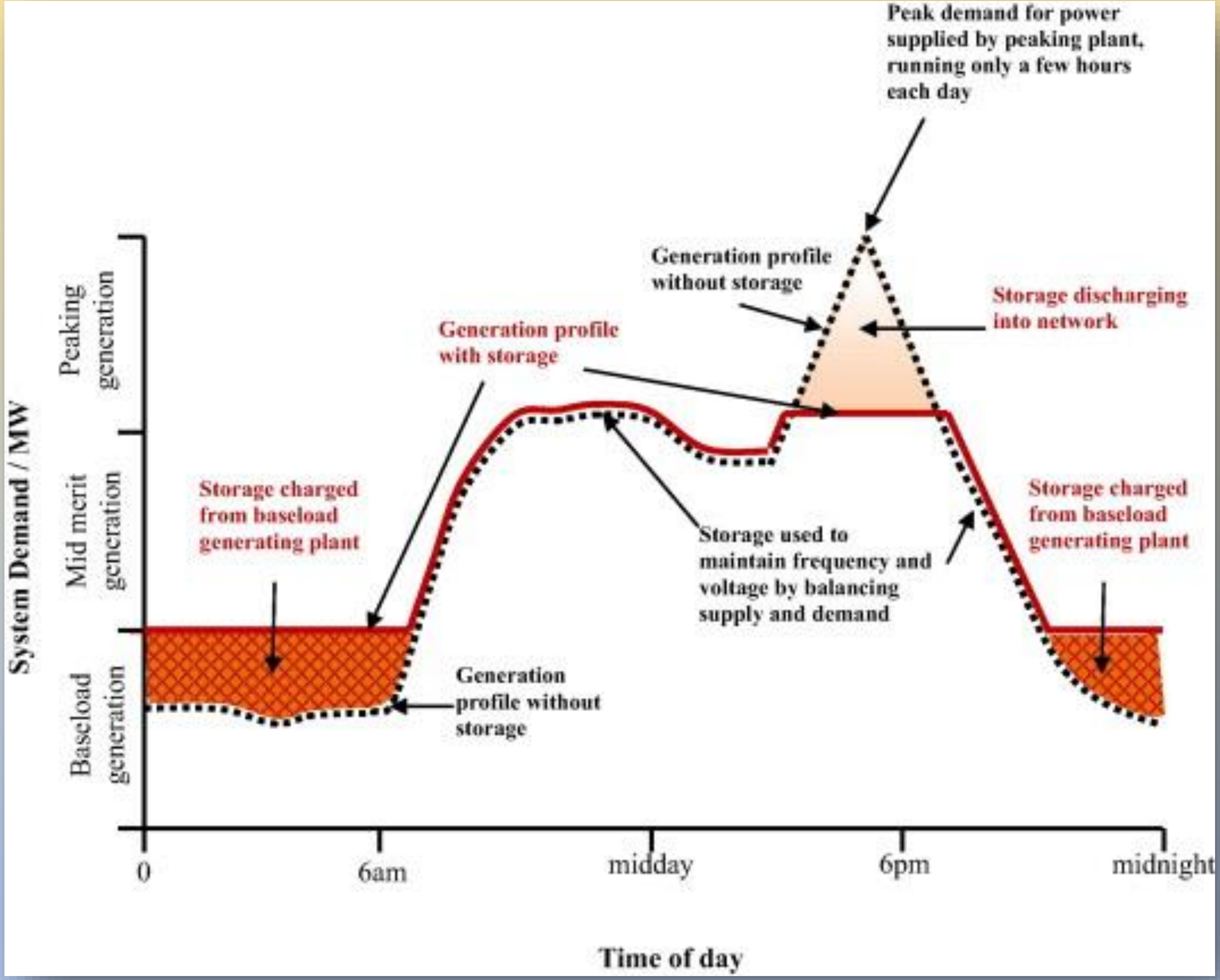
Dushan Boroyevich, Igor Cvetković, Dong Dong, Rolando Burgos, Fei Wang, Fred Lee, *"Future Electronic Power Distribution Systems – A contemplative view"*, Proceedings of the 12th International Conference on Optimization of Electrical and Electronic Equipment, OPTIM 2010, pp. 1369-1380.

CONCEPTUAL INTERGRID SYSTEM AS A HIERARCHICALLY INTERCONNECTED HYBRID MIX OF AC AND DC SUB-GRIDS



Dushan Boroyevich, Igor Cvetković, Dong Dong, Rolando Burgos, Fei Wang, Fred Lee, *“Future Electronic Power Distribution Systems – A contemplative view”*, Proceedings of the 12th International Conference on Optimization of Electrical and Electronic Equipment, OPTIM 2010, pp. 1369-1380.

SMART GRIDS



Load profile of a large-capacity energy storage system

https://www.sciencedirect.com/science/article/pii/S2213138814000708

ENERGY STORAGE TECHNOLOGIES

LEGEND

FBES Flow battery energy storage
VRFB Vanadium Redox flow batteries
PSB Polysulphide Bromine flow batteries
Zn Br Zinc Bromine flow batteries
SCES Supercapacitor energy storage
SMES Superconductive magnetic energy storage
STES Sensible thermal energy storage
PCM Latent-phase change material
TCS Thermochemical storage
PHS Pumped hydro storage

CAES Compressed air energy storage
FES Flywheel energy
ETES Electric Thermal Energy Storage
Li-ion Lithium-ion
Pb-Acid Lead-acid
Ni–Cd Nickel-cadmium
Ni-MH Nickel-metal hydride
Na–S Sodium-Sulphur
NaNiCl2 Sodium nickel chloride
Li–S Lithium-Sulphur batteries
M-ion Metal-ion Batteries
LTO Lithium-titanate-oxide
ORB Organic radical

Hydrogen technologies

ENERGY STORAGE TECHNOLOGIES

Fat **(animal/vegetable)**	37MJ/kg≈10kWh/kg

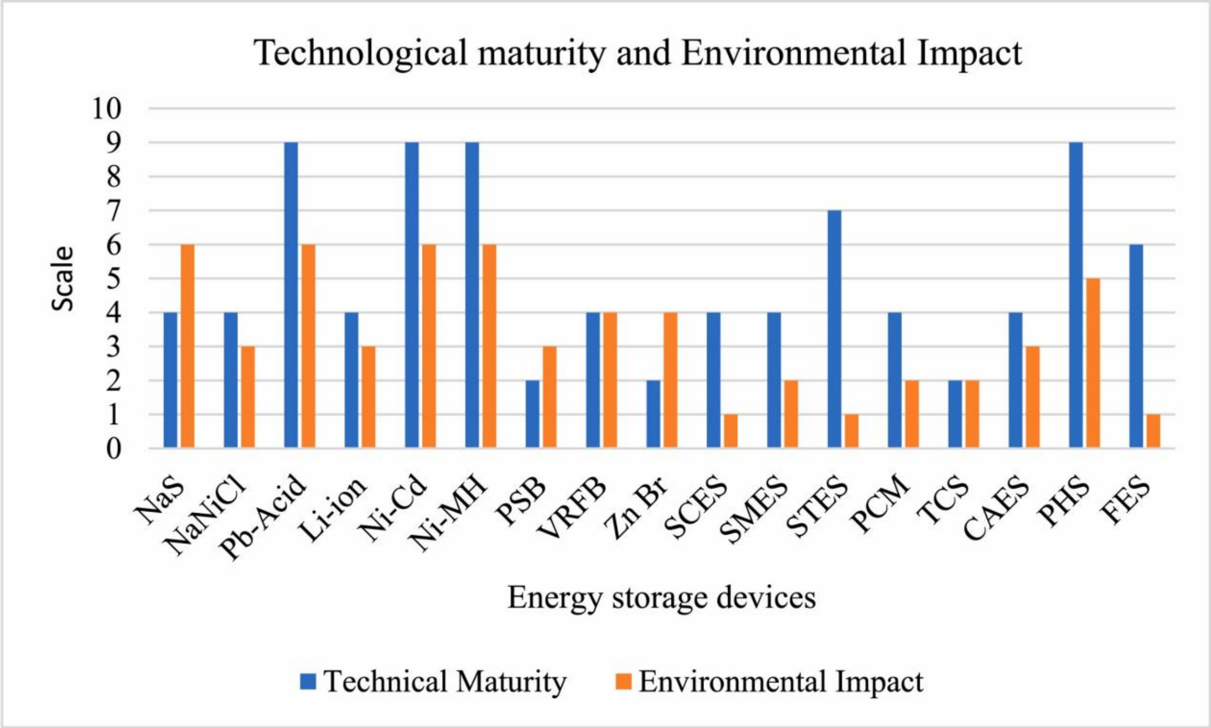
ENERGY STORAGE SYSTEMS

Type	Energy Efficiency (%)	Energy Density (Wh/kg)	Power Density (W/kg)	Cycle Life (cycles)	Self Discharge
Pb-Acid	70–80	20–35	25	200–2000	Low
Ni-Cd	60–90	40–60	140–180	500–2000	Low
Ni-MH	50–80	60–80	220	< 3000	High
Li-Ion	70–85	100–200	360	500–2000	Med
Li-polymer	70	200	250–1000	> 1200	Med
NaS	70	120	120	2000	–
VRB	80	25	80–150	> 16000	Negligible
SCES	95	< 50	4000	> 50000	Very high
Pumped hydro	65–80	0.3	–	$>$ 20 years	Negligible
CAES	40–50	10–30	–	$>$ 20 years	–
Flywheel (steel)	95	5–30	1000	> 20000	Very high
Flywheel (composite)	95	> 50	5000	> 20000	Very high

Vanadium Redox

Compressed air energy storage

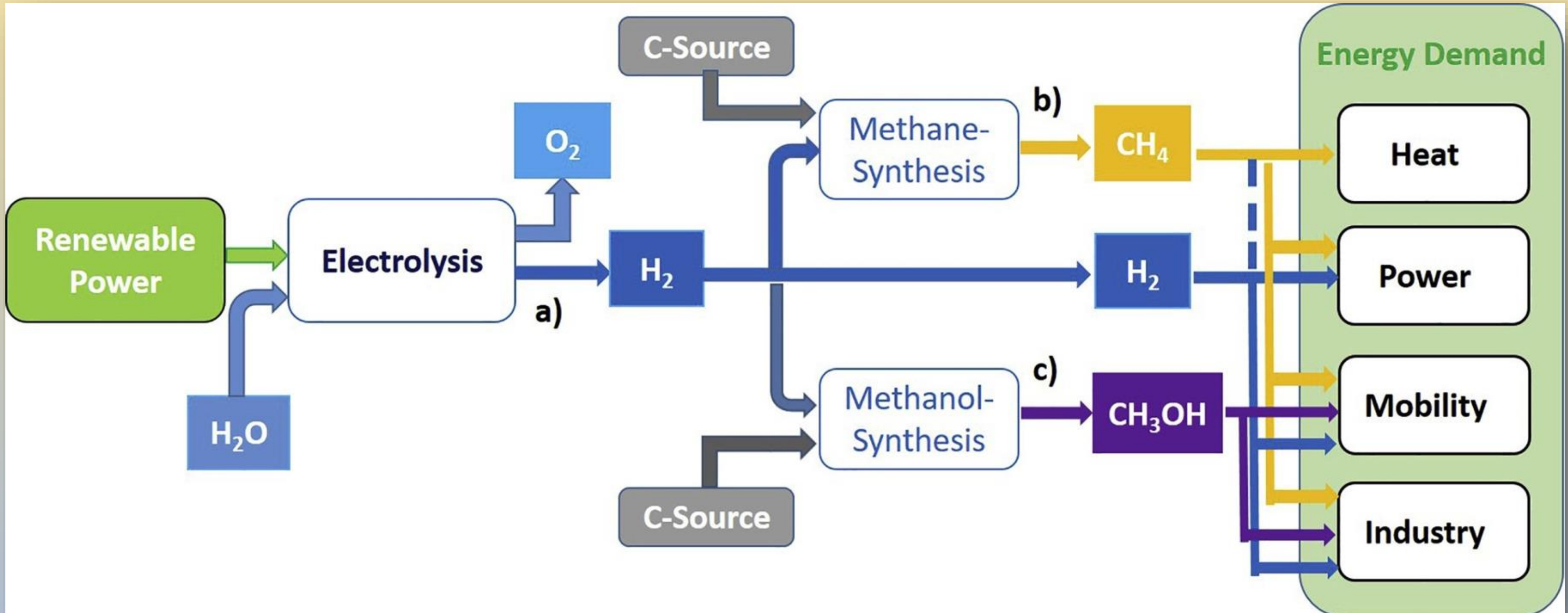
ENERGY STORAGE TECHNOLOGIES



Technical Maturity	Scale Conversion		Environmental impact	Scale Conversion
Very Mature	Fully Commercialized	9	Very High	7
Very Mature	Commercialized	8	High	6
Mature	Commercialized	7	High / Medium	5
Mature	Commercializing	6	Medium	4
Mature	Limited Development	5	Medium / Low	3
Proven	Commercializing	4	Low	2
Proven	Limited Development	3	Very Low	1
Proven	Developing	2		
Research	Developing	1		

Technology maturity and environmental impact comparison of ESDs

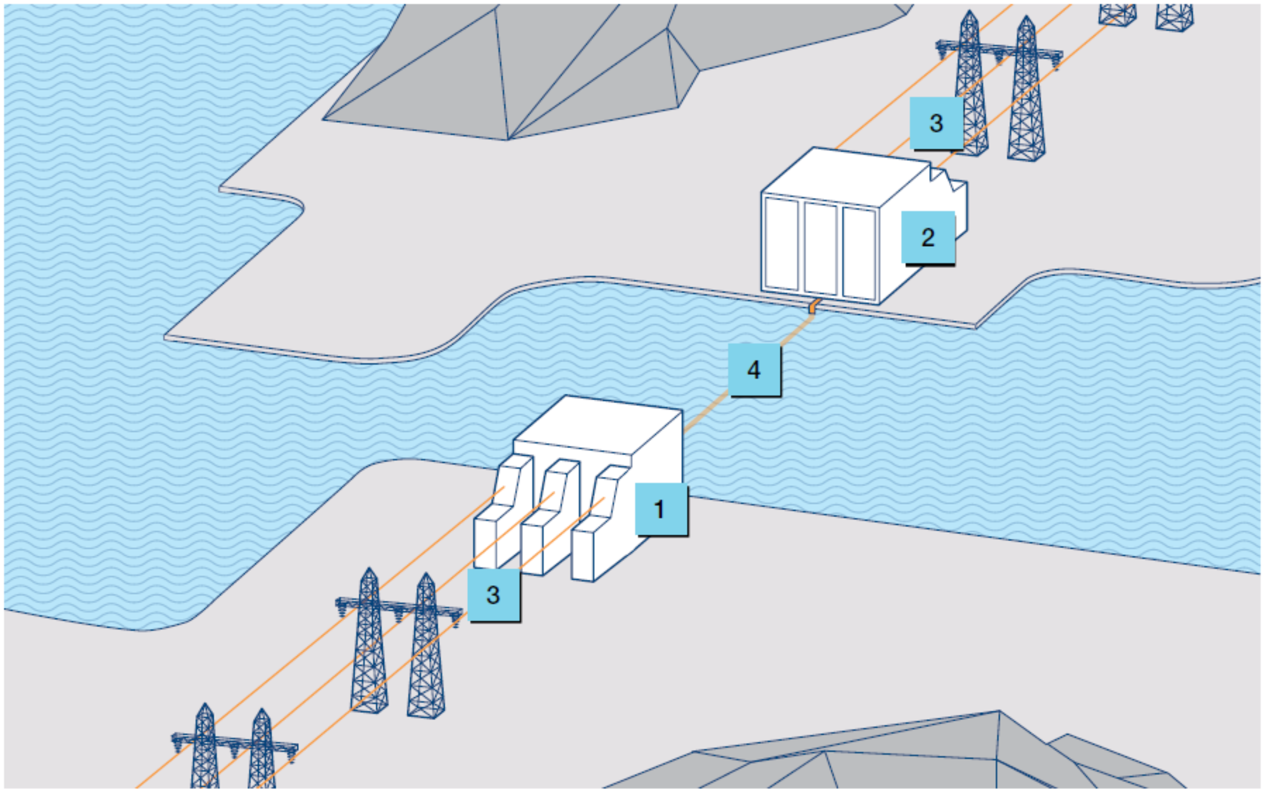
HYDROGEN TECHNOLOGIES



The three P2G methods and their possible applications: a) Electrolysis process resulting in H_2 and release O_2; b) Methanation process converting CO_2 (C-Source) and H_2, into CH_4; c) Methanation process converting an output gas (C-Source) from a biogas plant resulting in methanol (CH_3OH)

https://ars.els-cdn.com/content/image/1-s2.0-S2352152X18301919-gr3_lrg.jpg

HVDC POWER TRANSMISSION



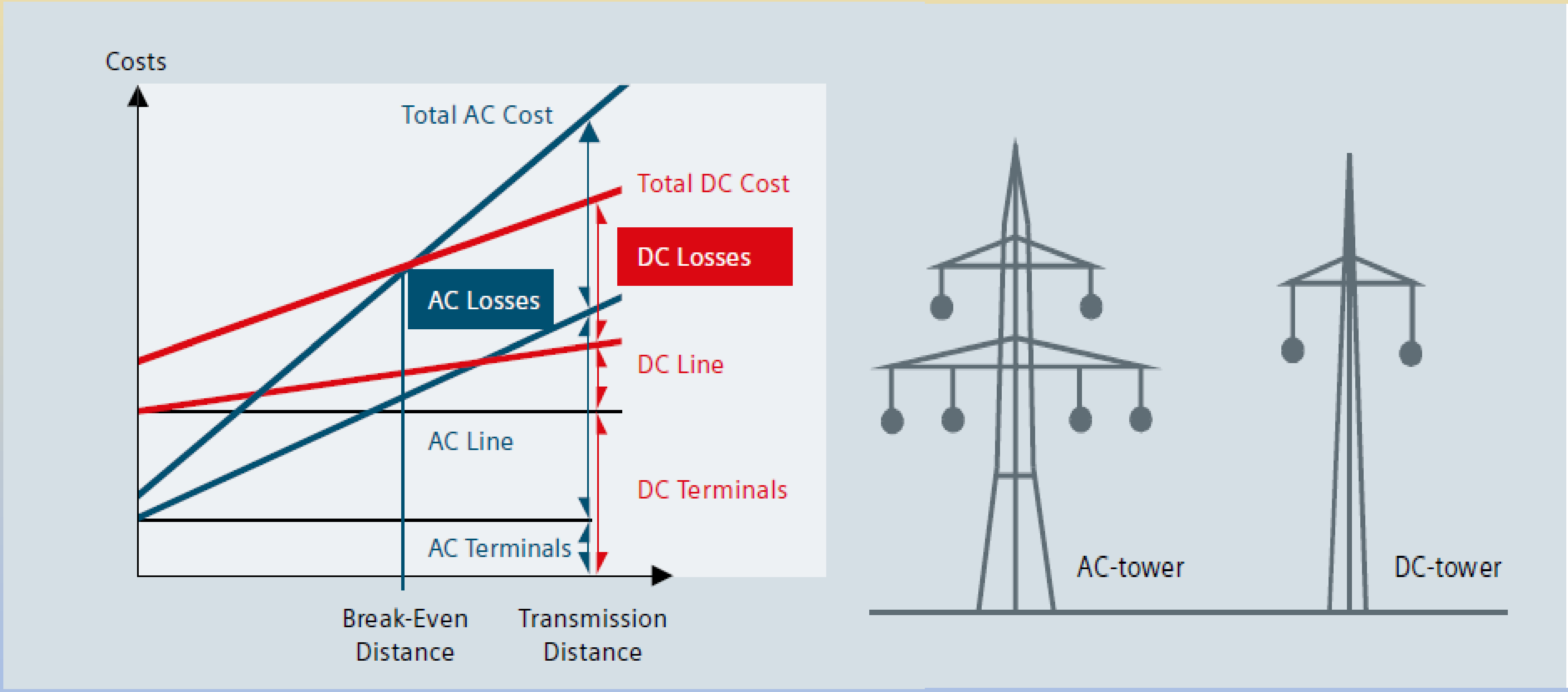
1 HVDC converter station rectifier | 2 HVDC converter station inverter | 3 Alternating current (AC) | 4 Direct current (DC)

A HVDC transmission link consists of three main components:

- a station to convert the alternating current of the grid to direct current;
- the transmission equipment itself in the form of cables and overhead lines;
- another station that converts DC back into AC so that it can be used by consumers.

Introducing HVDC, ABB AB, Uno Lamm HVDC Center, SE-771 80 Ludvika, Sweden, www.abb.com/hvdc

HVDC POWER TRANSMISSION



The break-even distance is in the range of 500 to 800 km depending on a number of other factors, like country-specific cost elements, interest rates for project financing, loss evaluation, cost of right of way etc.

High Voltage *Direct Current Transmission – Proven Technology for Power Exchange* , www.siemens.com/energy/hvdc

HVDC POWER TRANSMISSION

HVDC "Classic"	HVDC PLUS
Line-Commutated Current-Sourced Converter (LCC / CSC)	Self-Commutated Voltage-Sourced Converter (SCC / VSC)
Thyristors with Turn-on Capability only	Semiconducting Switches with Turn-On and Turn-Off Capability, e.g. IGBTs

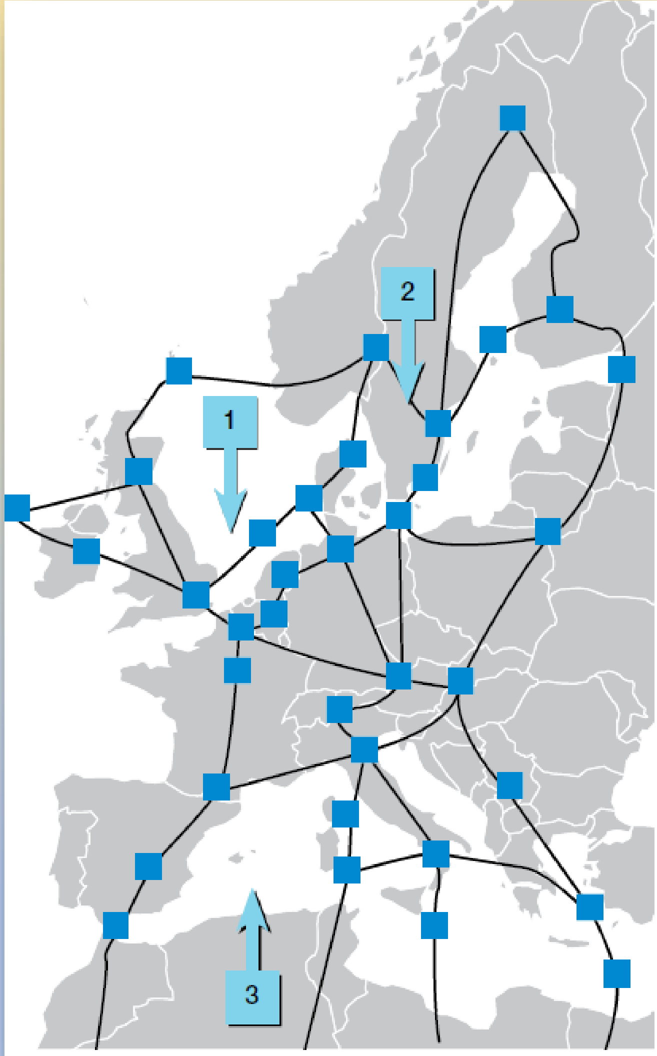
HVDC "Classic" and HVDC PLUS – Technologies

HVDC PLUS – Basics and Principle of Operation , www.siemens.com/energy energy/hvdcplusAnswers for energy.

HVDC POWER TRANSMISSION

An HVDC electricity grid that can operate:
−Independently of one or several disturbances (isolate a failure)
−In different operation modes in the connected AC and DC systems

Technology gaps for the full realization include:
−Power flow control
−Automatic network restoration
−High voltage DC/DC converters



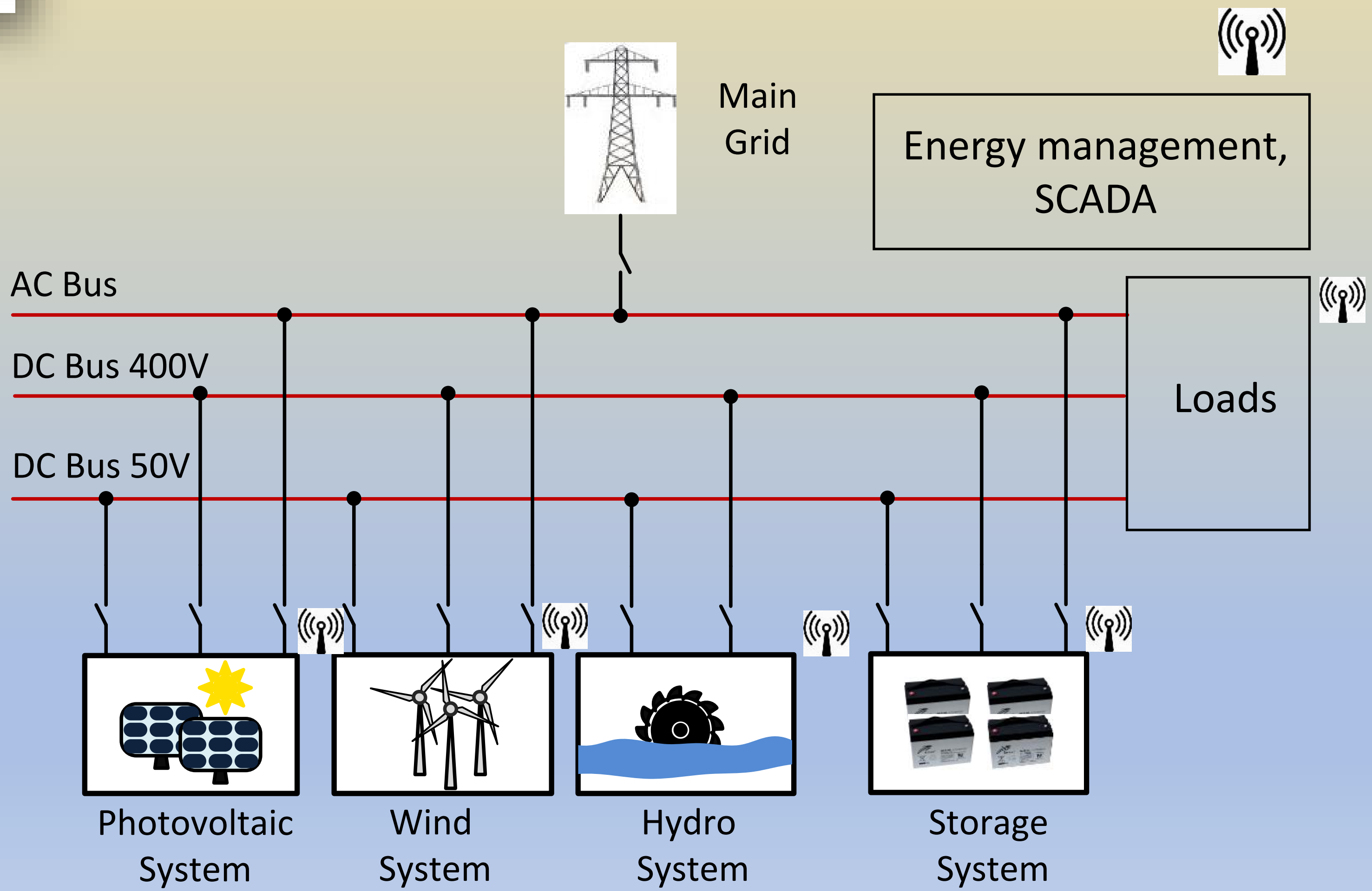
1 Offshore wind | 2 Hydro | 3 Solar

ABB AB Uno Lamm HVDC Center, SE-771 80 Ludvika, Sweden, www.abb.com/hvdc

INTELLIGENT CONTROL OF
ENERGY CONVERSION
AND STORAGE

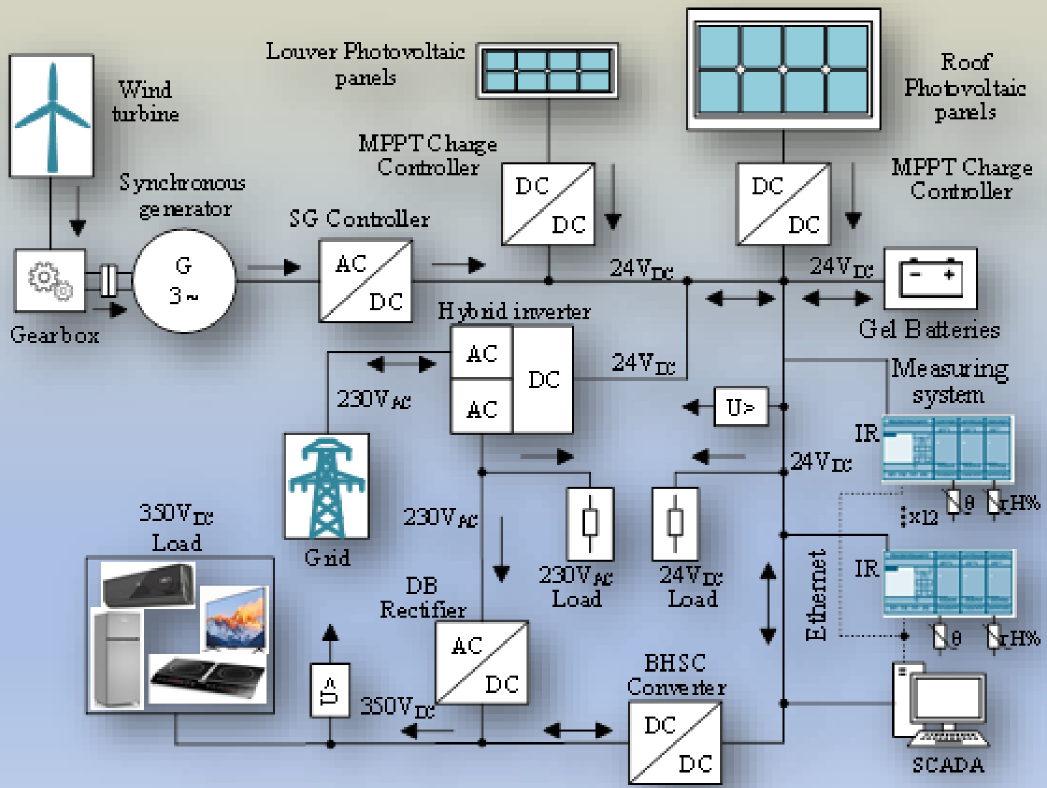
CONFIGURABLE MYCROGRID LABORATORY

THE MICROGRID ARCHITECTURE

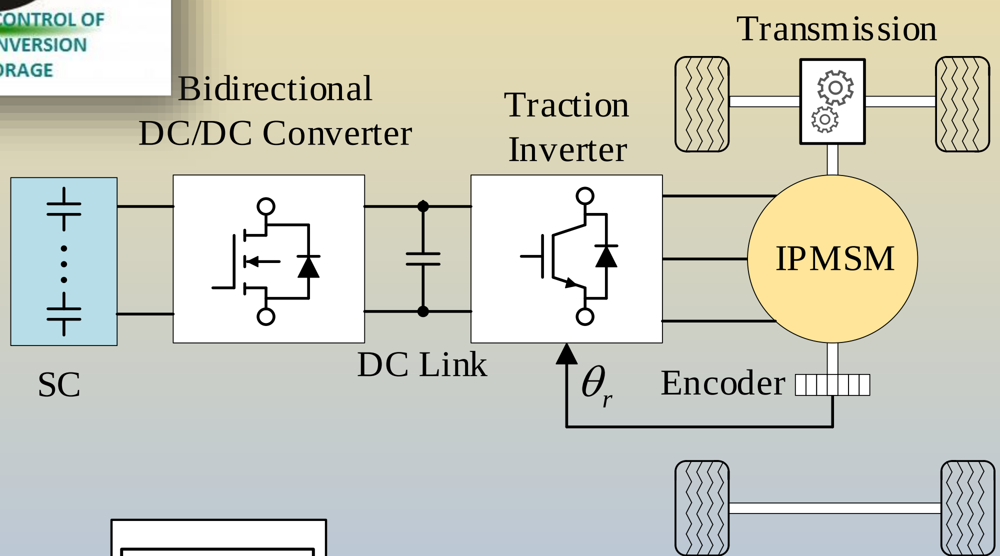


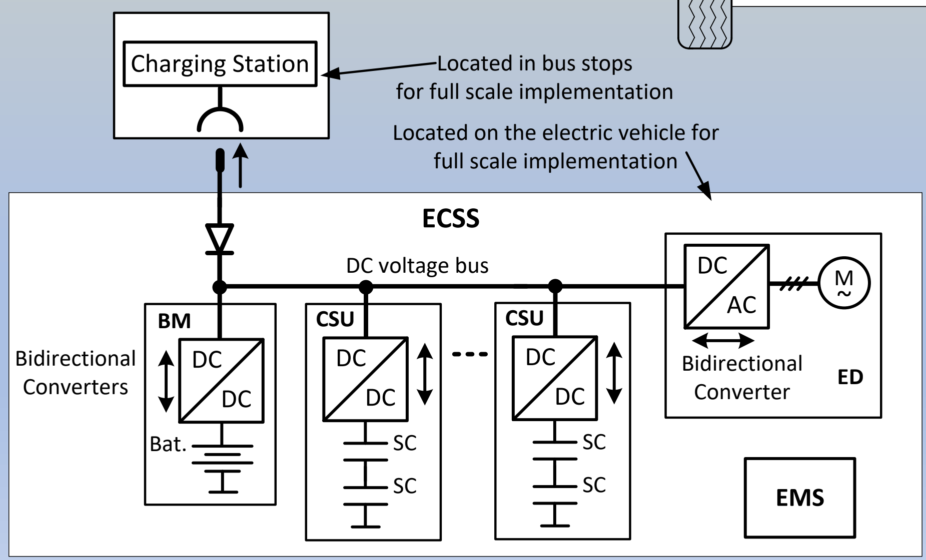
DC NANOGRID WITH INTEGRATED RENEWABLE ENERGY CONVERSION SYSTEMS

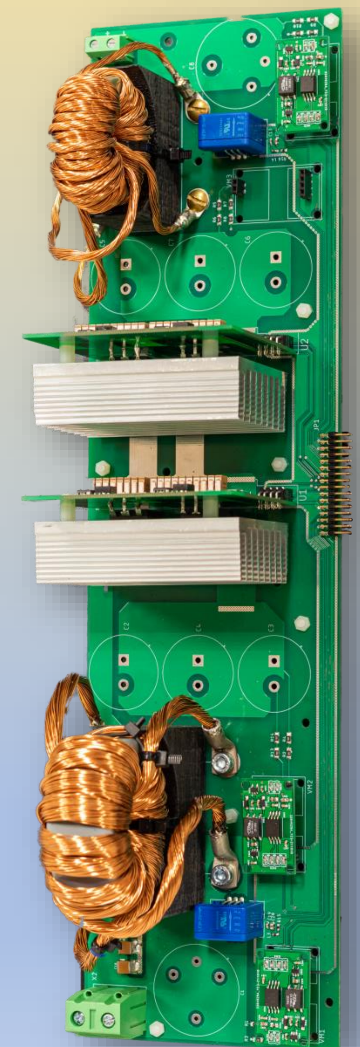
PART OF THE PROJECT: PCCDI Nr.30/2018



ELECTRIC DRIVE FOR E-MOBILITY (PROJECT 307PED2020)







CONCLUSIONS

- THE BATTLE AC/DC IS FAR FROM OVER;
- SMART GRIDS ARE THE FUTURE IN POWER SYSTEMS;
- A MIXT BETWEEN DC AND AC WILL BE THE SOLUTION IN POWER SYSTEMS;
- STORAGE ELEMENTS ARE NECESSARY IN SMART GRIDS, IN ORDER TO USE THE WHOLE AMOUNT OF THE RENEWABLE ENERGY POTENTIAL;
- THE STORAGE ELEMENTS NEED TO BE USED ACCORDING TO THEIR PERFORMANCES IN ENERGY CONVERSION;
- HYDROGEN CAN BE A SOLUTION IN STORAGE AND E-MOBILITY, BUT A VERY COMPLETE ANALYSIS NEEDS TO BE MADE REGARDING EFFICIENCY, COSTS ETC. DEPENDING THE APPLICATIONS.


рахмат
danke
謝謝
ngiyabonga
Баярлалаа
spas
teşekkür ederim
mersi
kia ora
barka
welalin
tack
mahalo
tapadh leat
спасибо
faafetai lava
vinaka
спасибі
blagodaram
dank je
misaotra
matondo
paldies
grazzi
kiitos
dankie
nanni
nandri
dhanyavad
mauruuru
thank you
gracias
хвала
asante
manana
bedankt
bayarlalaa
gracie
hvala
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