



PROMOTioN – GE's perspective

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Imagination at work

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The new GE Grid Solutions Business



GE's MISSION:

TO INVENT THE NEXT INDUSTRIAL ERA, AND BUILD, MOVE, POWER AND CURE THE WORLD

Imagining the things others don't / Building the things others can't / Delivering outcomes that make the world work better



*ENERGY
CONNECTIONS
~\$11B



POWER &
WATER
~\$30B



RENEWABLE
ENERGY
~\$9B



OIL & GAS
\$18.7B



HEALTHCARE
\$18.3B



AVIATION
\$24B



TRANSPORTATION
\$5.7B



CAPITAL
\$42.7B

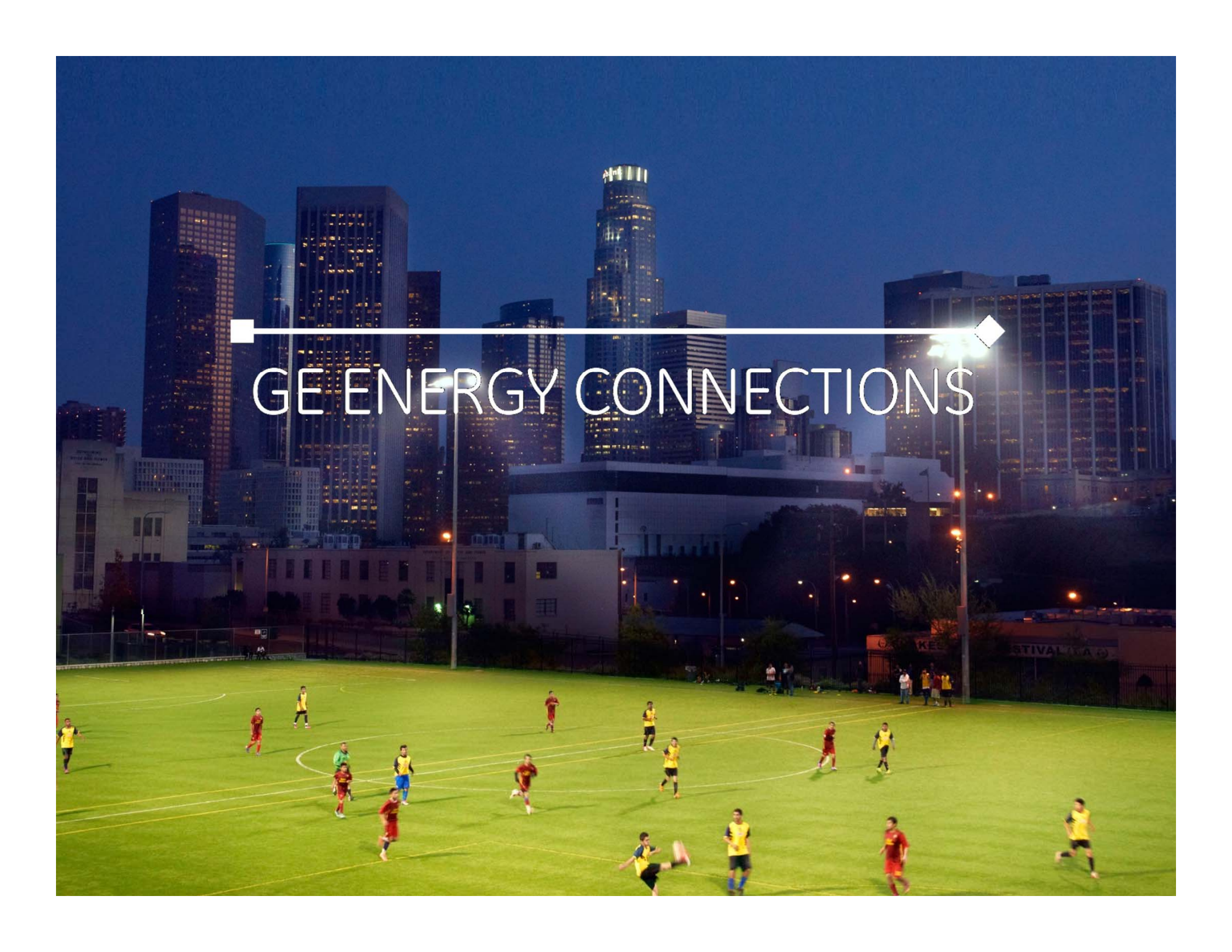


APPLIANCES &
LIGHTING
\$8.4B

2014 Revenues

*New name in 2016





GE ENERGY CONNECTIONS

Energy Connections business

Markets



Marine



Grid



Oil & Gas



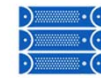
Heavy
Industry



Commercial & Industrial
Construction



Renewables



Telecom &
Data Centers

Solutions for tomorrow's energy challenges



Helping to meet
tomorrow's
ENERGY
DEMAND



Addressing
AGING
INFRASTRUCTURE
around the world



Helping our
customers meet
EFFICIENCY
needs



DIVERSIFICATION
in energy sources

Businesses

Power Conversion

We apply the science and systems of power conversion to help **drive the electric transformation** of the world's energy infrastructure.

Grid Solutions

We equip 90% of power utilities worldwide to bring power reliably and efficiently from the point of generation to the end power consumers

Industrial Solutions

We create advanced technologies that safely, reliably and efficiently **distribute and control electricity** to protect people, property and equipment; We also provide **high performance control solutions** for a connected world.



Grid Solutions

Grid Solutions, a GE and Alstom joint venture, is serving customers globally with more than 20,000 employees in over 75 countries. Grid Solutions equips 90% of power utilities worldwide to bring power reliably and efficiently from the point of generation to the end power consumers.

Helping to meet growing energy demands



Improving grid resiliency and energy efficiency



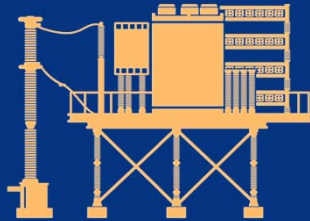
Upgrading and digitizing aging infrastructure



Enabling renewables and a diversified energy mix



Advanced products and services



Power Electronics

High Voltage DC
Flexible AC Transmission Systems
Industrial DC Substations
Energy Storage



High Voltage Equipment

Transformers
Gas Insulated Substations
Air Insulated Substations
Capacitors & Reactors



Automation & Protection

Protection & Control
Substation Automation
Communications & Metering
Monitoring & Diagnostics



Software Solutions

Distribution & Outage Management
Energy Management Systems
Geospatial & Mobile Solutions
Gas & Pipeline Management



Projects & Services

Turnkey Projects & Consulting
Electric Balance of Plant
High Voltage Substations
Maintenance & Asset Management

GE in PROMOTioN

H2020 LCE5 – Multivendor Meshed
Offshore HVDC Grids



GE Motivation and Participation

- Support definition of fair (multi-vendor) Offshore AC/DC network requirements
- Increase visibility of GE's technology
- Understand future market context to better tailor GE's solutions portfolio



- GE's role in **PROMOTioN** is mainly observatory and advisory

Work Package	1	2	11	12
Man Months	6	4	8	2

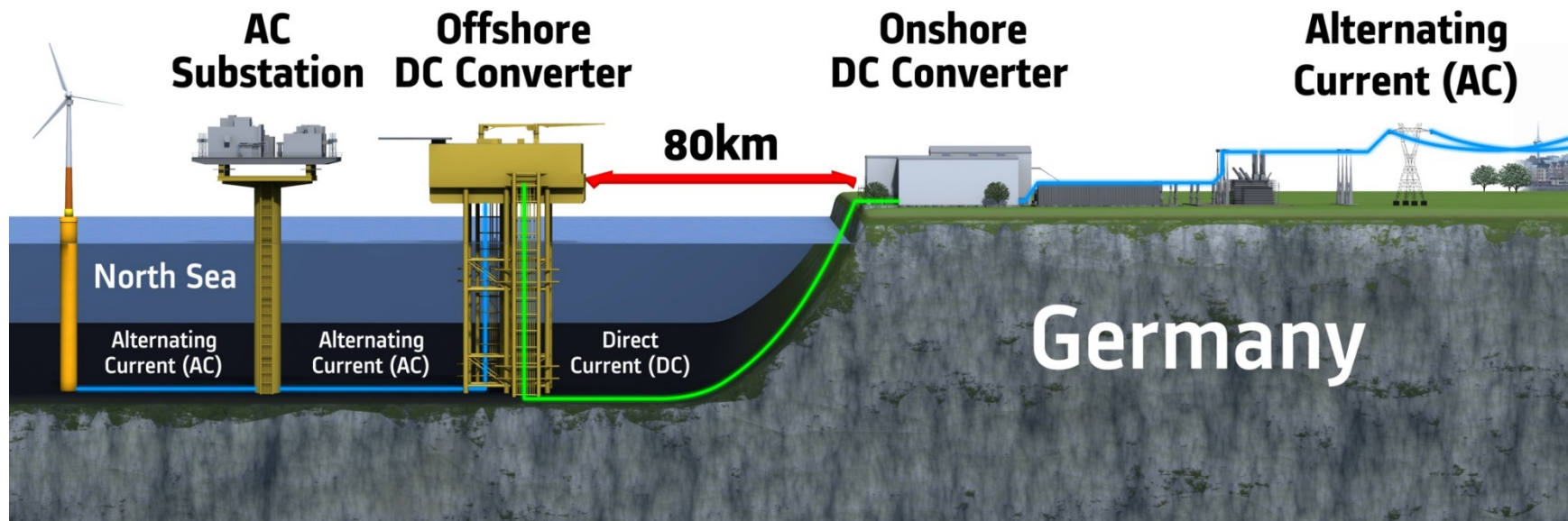


GE technology for meshed offshore grids

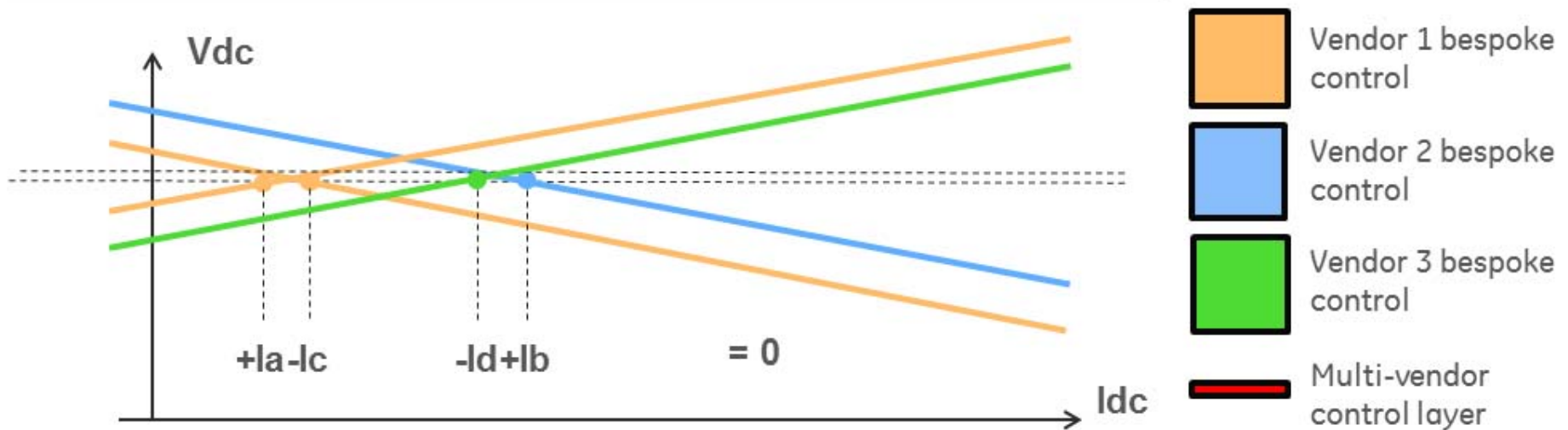
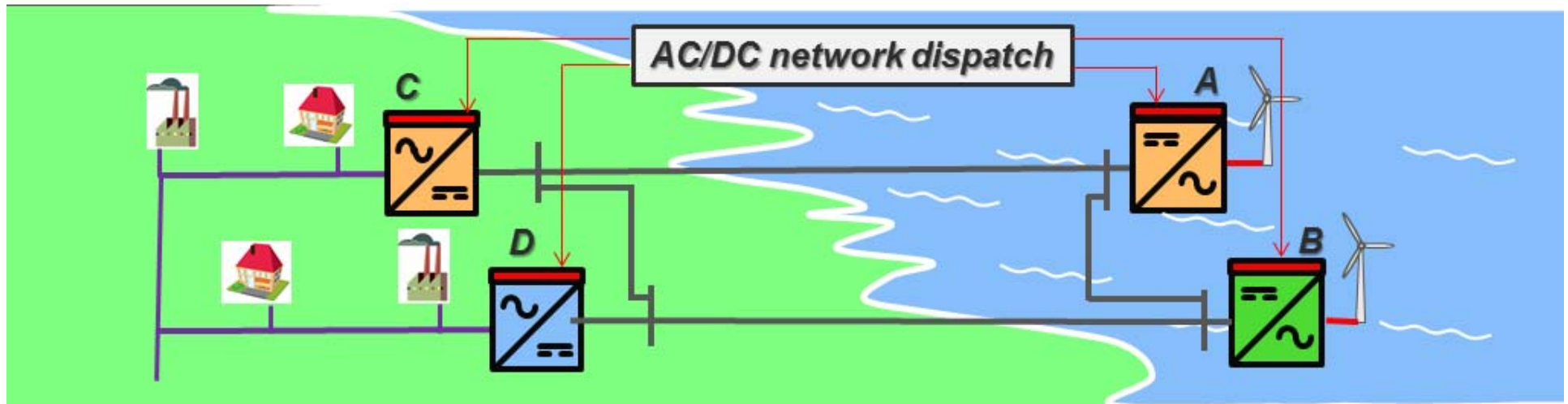


VSC Offshore Wind: DolWin 3

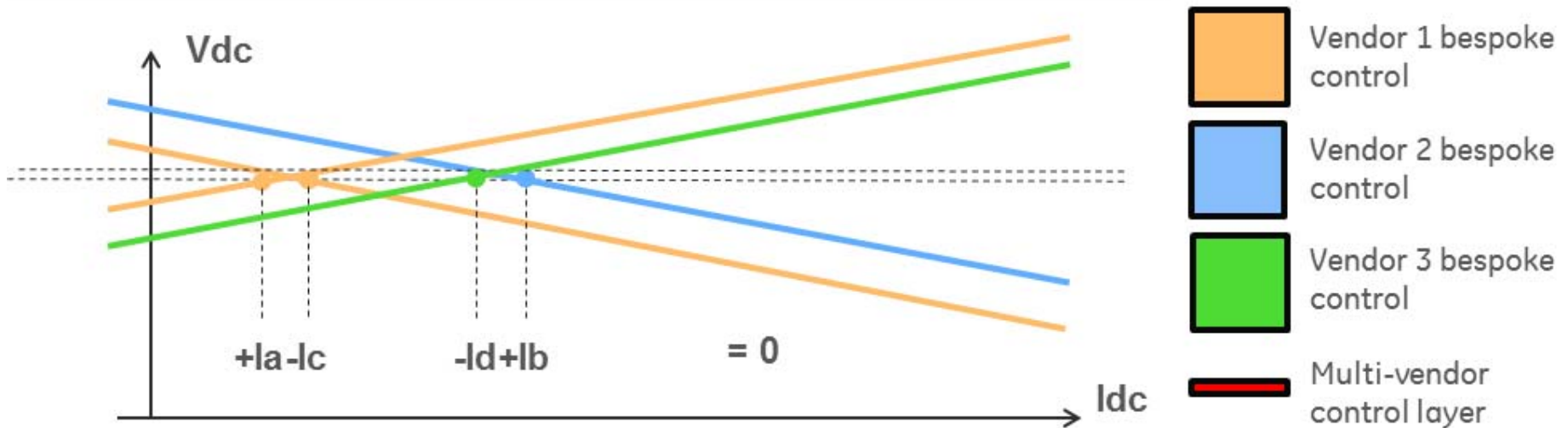
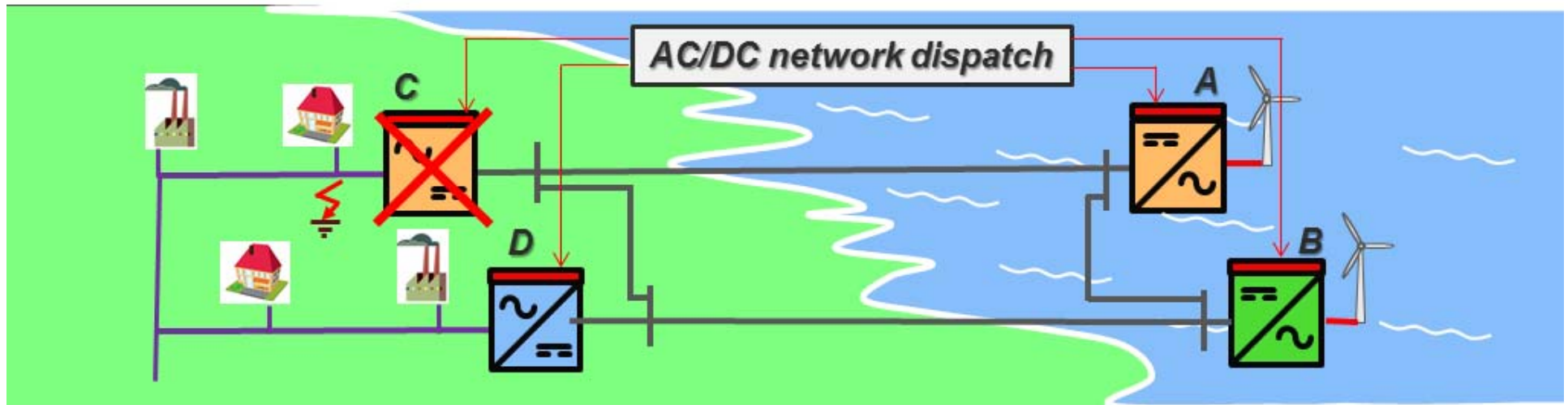
- **900 MW** capacity
- **± 320 kV** - **160km** transmission link to the German mainland
- To be commissioned in **2018**



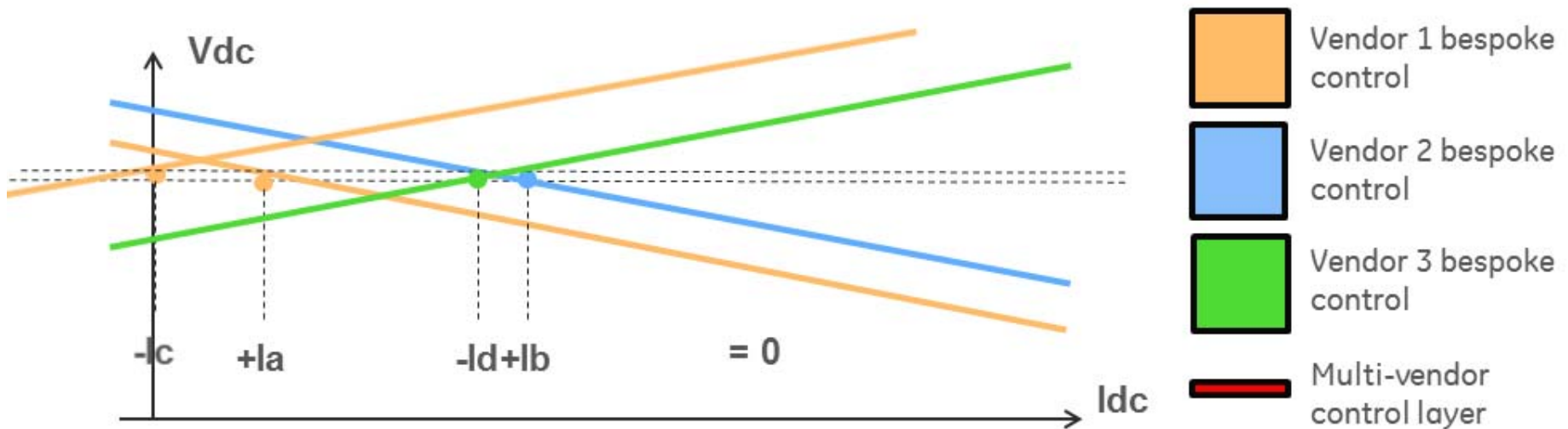
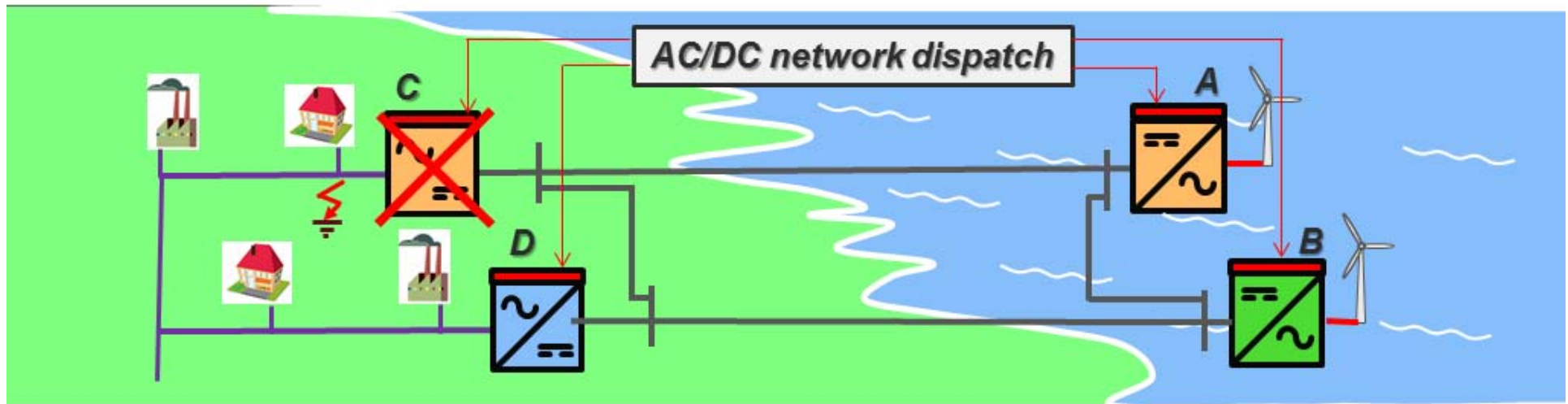
Multi-vendor control philosophy



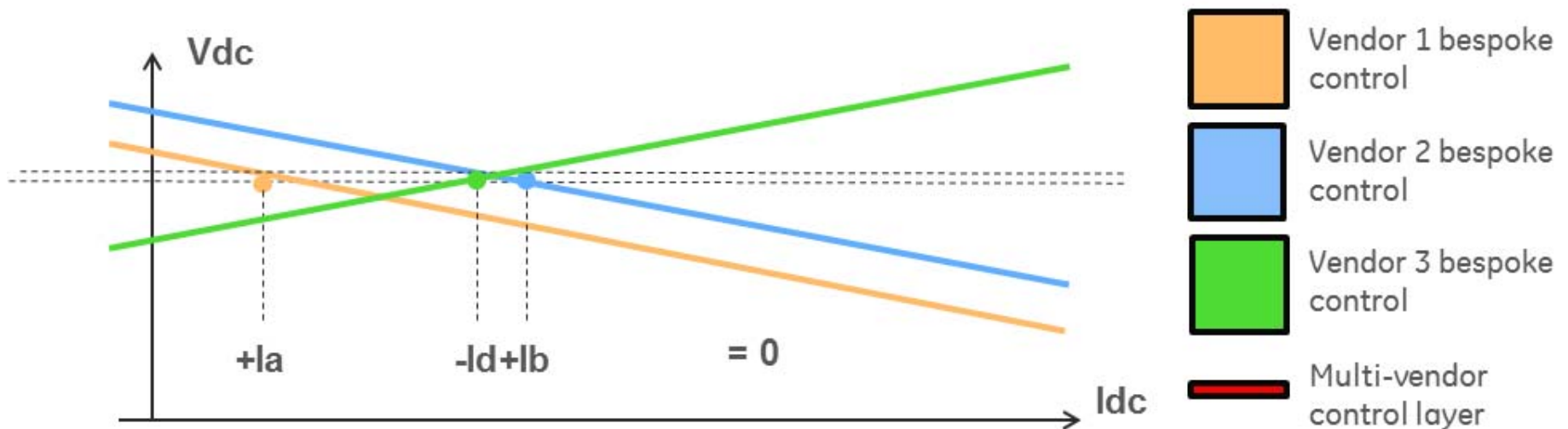
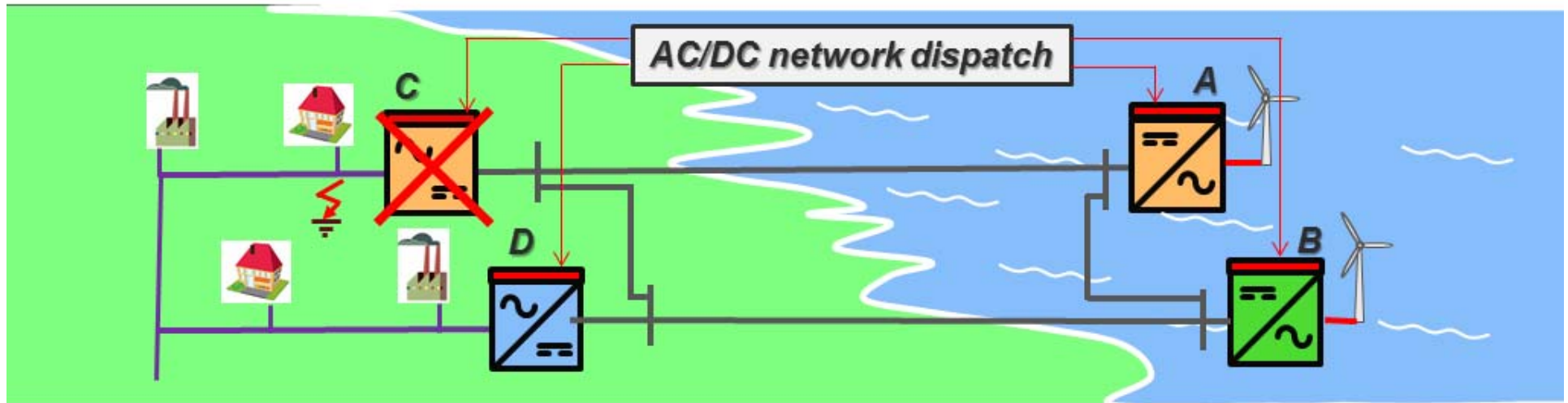
Multi-vendor control philosophy



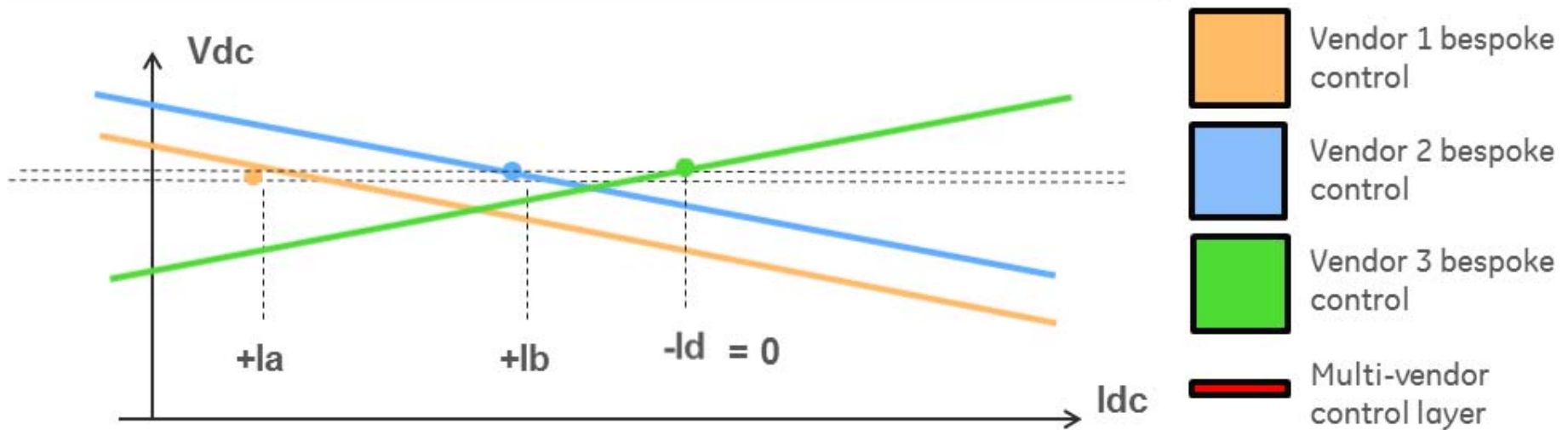
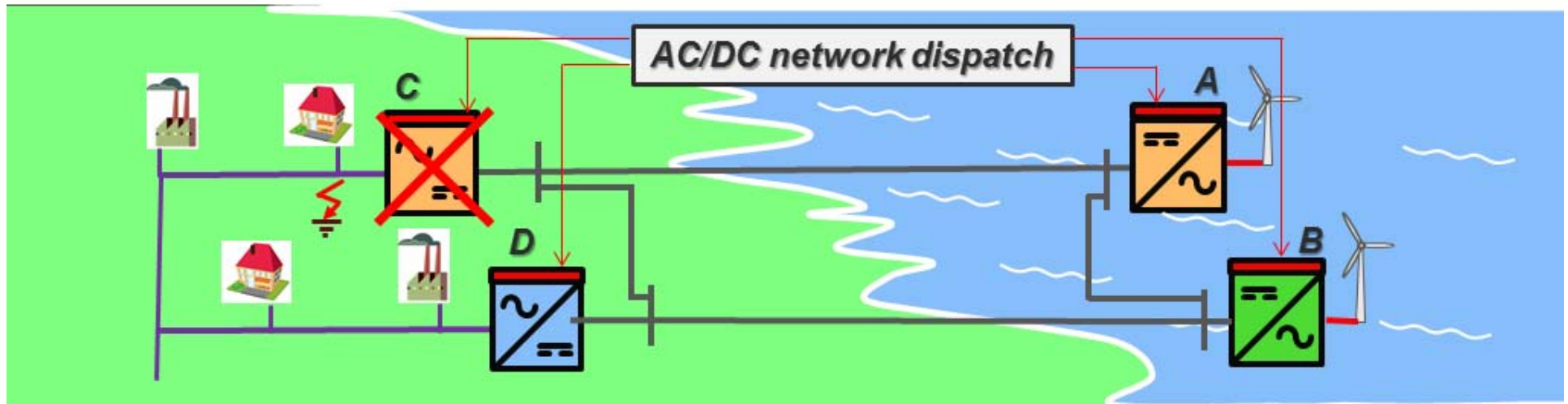
Multi-vendor control philosophy



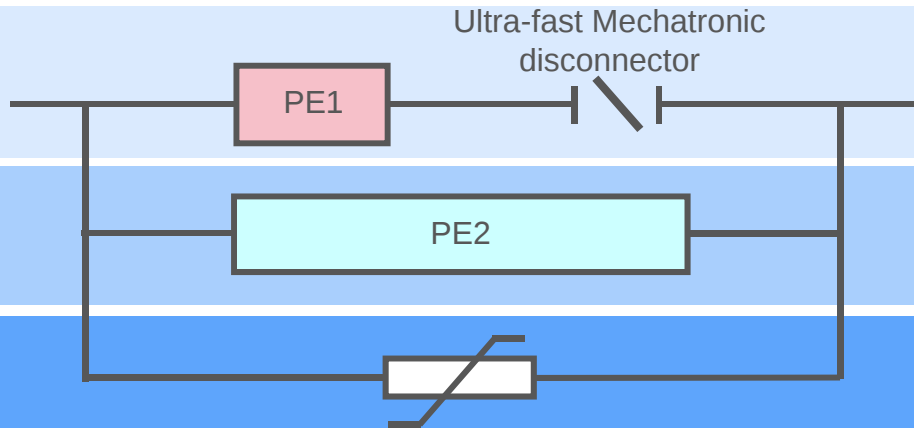
Multi-vendor control philosophy



Multi-vendor control philosophy



HVDC Circuit Breaker (UFMCB)



Main branch:

- Permanent current
- Very low losses

Auxiliary branch:

- Takes over current during breaking operation
- Shapes transient voltage profile across the breaker

Extinguishing branch:

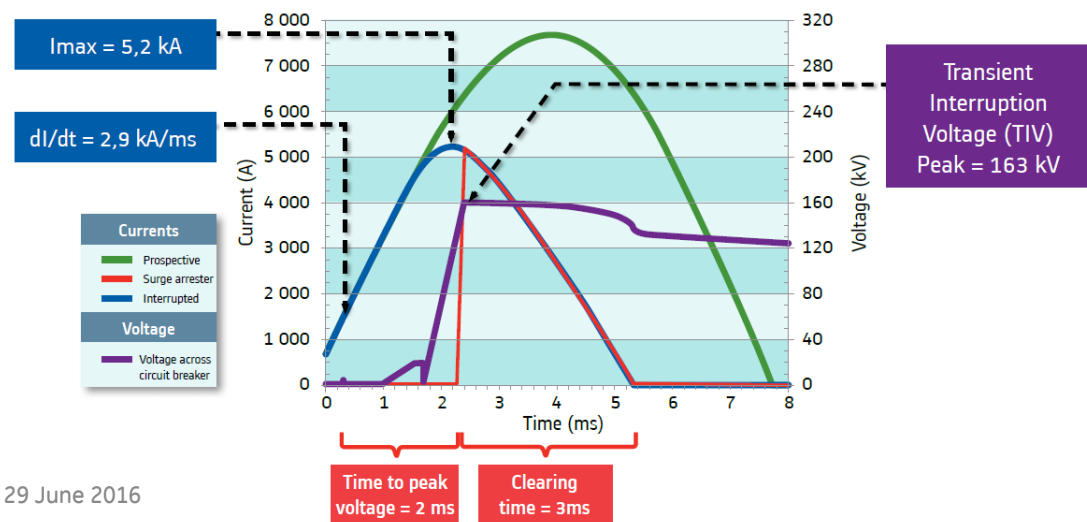
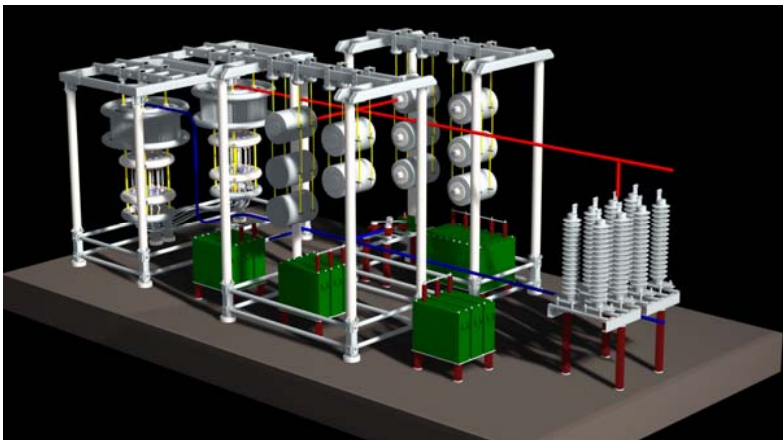
- Absorbs network energy to stop current flow

120 kV DC Circuit Breaker prototype

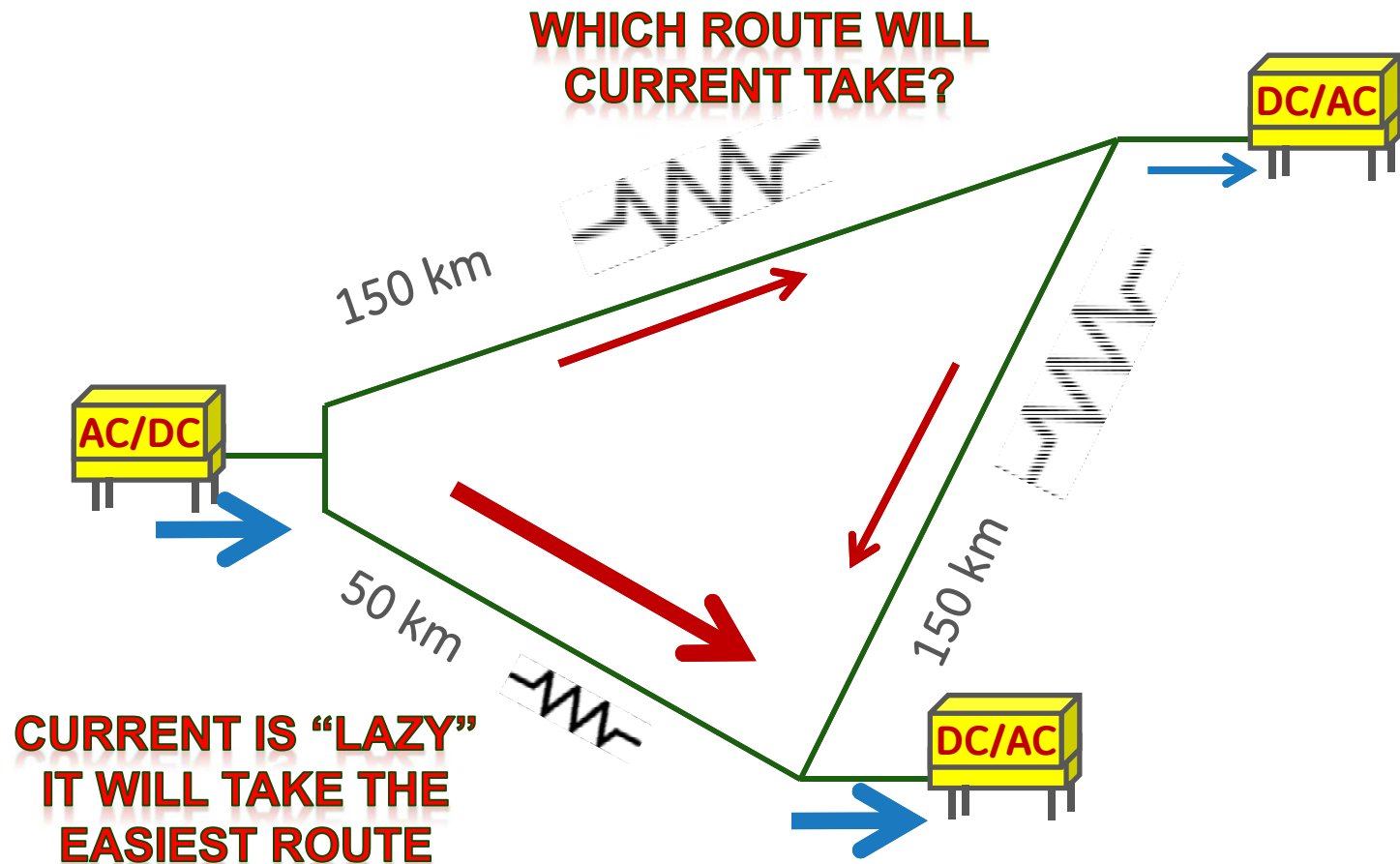
$di/dt = 2.9 \text{ kA/ms}$; TIV = 163 kV ; $I_{max} = 5.2 \text{ kA}$

Energy absorbed = 1.2 MJ

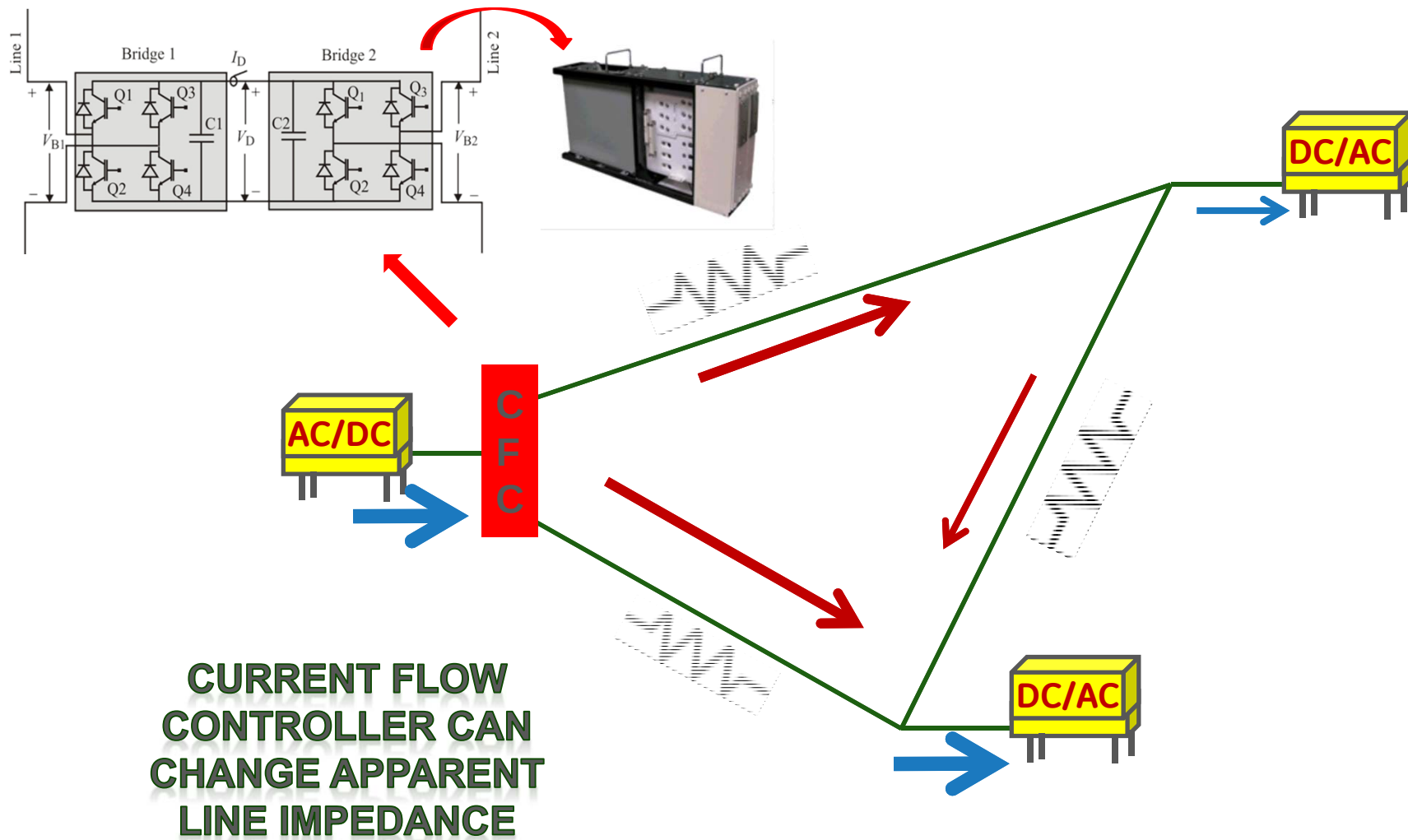
Preclearing time = 2 ms ; Clearing time = 3 ms



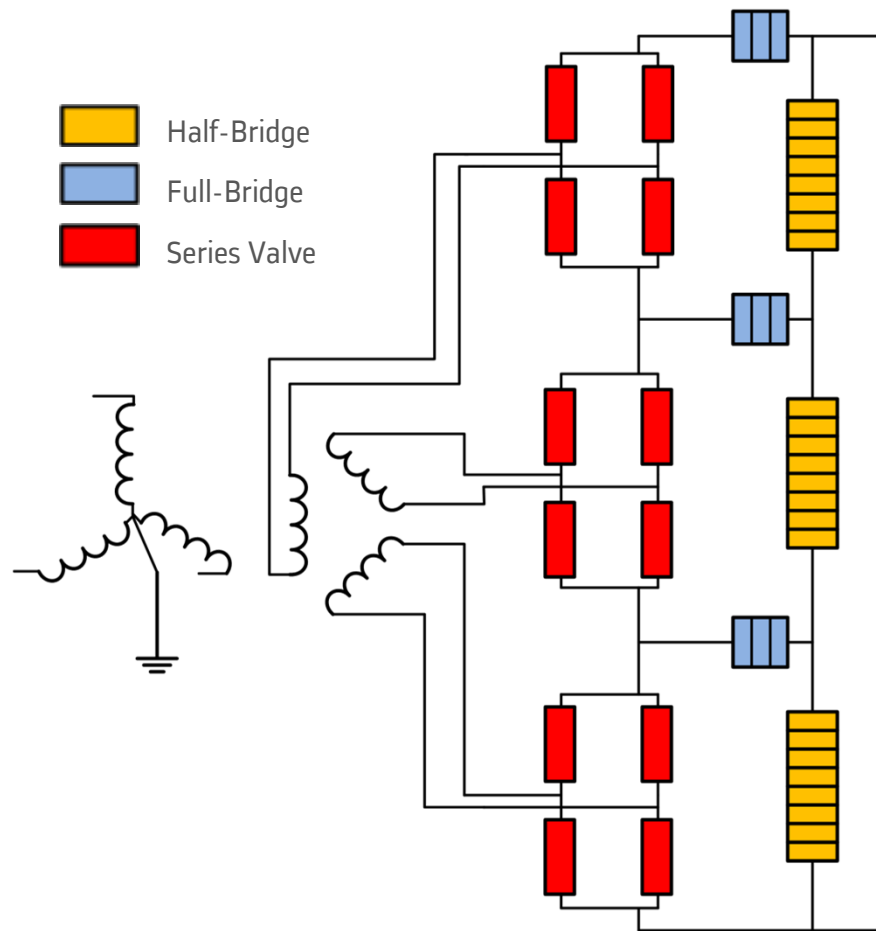
Current Flow Control in DC Networks



Current Flow Control in DC Networks



Compact VSC Converter for Offshore: SBC



Series Bridge Converter features:

- Much smaller footprint compared to "standard" VSC (HB-MMC) - 80% of power processed by series valve (red)
- Harmonic free AC and DC output - Few chain linked full-bridge modules (blue) provide active filtering
- Reduced converter loss - Half-bridge chain-links allows soft switching (yellow)



GE has technologies to make
meshed offshore grids
happen....



