Finance for innovation:

Towards the ETS Innovation Fund

Presented by

Peter Sweatman, CEO Climate Strategy

as Rapporteur for Industry Stakeholders at [EVENT]

in Brussels on 12th June 2017.

Supported by:

CLIMATE & STRATEGY PARTNERS

What is Understood by “Innovation” ?
Novel ideas that can positively affect society

“When you’re doing innovation, the first question is not ‘Is this going to work?’ but rather, ‘If it works, would it matter?”

Eric Toone,

Vice Provost and director of Duke Innovation & Entrepreneurship Initiative and former principal deputy director of the US Department of Energy’s Advanced Research Projects Agency

“Innovation” for Funds and Financial Instruments…

Innovation Funds

Often intentionally trade-off probability of success for greater potential impacts

Focusing on:

transformative or **“break-through”**, and **incremental solutions** with significant decarbonisation potential

Innovative Investments

May have a higher risk of failure

They also:

Have the potential to be truly **game changing** if they succeed

Engagement Process, Design & Mobilization

Jan 2017, DG CLIMA Launched Consultation Process

Experts and financiers started with a high-level conference that was followed by ten expert roundtables over 3 months

to collect expert views on:

a. Future pathways and technologies for **low-carbon innovation**

b. How the proposed **Innovation Fund** could be ideally designed to **mobilise the required investments**

Sectors Covered

1	Ferrous Metals	**Energy intensive industries**
2	Non-ferrous Metals	
3	Pulp & Paper	
4	Oil Refining	
5	Chemicals & Bio-based Industries	
6	Cement & Lime	
7	Glass & Ceramics	
8	Renewable Energy	**RES, Storage & CCS**
9	Energy Storage	
10	CCS	

Thanks to 250 experts from 195 organisations guided by 14 moderators…

High-level Summary Report Launched

Sector-specific consultation sessions attended by more than 250 experts

Moderated by:

Mukund Bhagwat, Jean-Pierre Birat, Hans Bünting, Patrick Clerens, Bernard de Galembert, Vincent Gilles, Eberhard Gschwindt, Jonas Helseth, Alan Kreisberg, Marco Mensink, Gianpiero Nacci, Jean-Baptiste Renard, Fabrice Rivet, and Peter Sweatman.

Contributions from 195 firms & organisations

The following organisations participated at the expert workshops:

A.SPIRE
Aalto University
AAT Geothermae
Adelphi
ADS tec
Air Liquide
Aker Solutions
AkzoNobel
Albermarle Europe
Alcoa
Alfa Mediterranean Enterprises Limited
ArcelorMittal
Ardagh
Argex
Arkema
Atlantis resources
Aurubis
BA Vidro
BASF
Bellona
Bio-based Industries Public-Private partnership (EU Joint Undertaking)
Bolloré
Borealis
BP
Caisse des Dépôts et Consignations
Cambridge Energy Partners
Carbon Capture and Storage Association (CCSA)
Carmeuse
CCS project Cork
Celsian
Cemex
Centro Ceramico Bologna
Confederation of European Paper Industries (CEPI)
The European Ceramic Industry Association (CERAME-UNIE)
Clariant
CMI Group
CO2GeoNET
Complexul Energetic Oltenia
Concawe
Corbion
Covestro
Credit Suisse
CRM Group
CSS Association
Centre Technique du Papier
DCNS Group
Diehl
Dow Chemicals
DP Energy
DSM
Ecocem
Ecofys
European Cement Research Academy (ECRA)
Electricite de France
EGS Energy Ltd
Eiffel IG
Elkem AS
Emerson
Enel SpA
ENGIE
ENI
Ervia
Estela Solar
EuLA/IMA Europe
The Union of Electricity Industry (EURELECTRIC)
Euroatomizado
European Steel Association (EUROFER)
European Non-ferrous Metals Association (EUROMETAUX)
European Association of Mining Industries (EUROMINES)
EuropaBio
European Aluminium Association
European Association for Storage of Energy (EASE)
European Zero Emission Technology and Innovation Platform (ZEP)
European Bank for Reconstruction and Development (EBRD)
European Biomass Industry Association (EUBIA)
European Cement Association (ECA - Cembureau)
European Chemical Industry Council (CEFIC)
European Copper Institute
European Geothermal Energy Council (EGEC)
European Investment Bank
European Power Plant Suppliers Association – (EPPSA)
Evonik Industries
Joint Undertaking (FCH-JU)
Fuels Europe
Gaelectric
GasNatural Fenosa
Gassnova
General Electric Grid Solutions
GE Power
Glass Technology Service
Global Bioenergies
Global CCS Institute
GreenStream Network Ltd
Heidelberg Cement AG
Hüttentechnische Vereinigung der Deutschen Glasindustrie
Hydrogen Europe
Hygear
Iberdrola
IF Steelman
IG BCE
Imerys
Institute for Infrastructure, Environment and Innovation (IMIEU)
Industriall Europe
Ineos
innogy SE
International Bromine Council (BSEF)
International Association of Oil & Gas Producers (IOGP)
Irish Cement Limited
ISPT
Lasselsberger
Leclanché
Lhoist
Lime Trade Association
Linde
LKAB
LyondellBasell
Magnesitas Navarras
Miltton
Ministry of Petroleum and Energy, Norway
Mitsubishi Hitachi Power Systems
Moixa
Neste
Netherlands Enterprise Agency
Nickel Institute
Norsk Hydro ASA
North Sea Basin Task Force
Nippon Sheet Glass
Ocean Energy Europe
Owens-Illinois
Owens Corning
Papiertechnische Stiftung
PGE Polska Grupa Energetyczna
Plastics Europe
Port of Rotterdam
Pöyry Management Consulting
Repsol
RHI AG
Innventia
ROAD Project
Shell
Siemens
Sofidel
SolarPower Europe
Solvay
SSAB AB
Statoil
Stazione Sperimentale del Vetro
Stoelzle Glass Group
Stora Enso
Summit Power
TAQA
Tata Steel
The European Biomass Association (AEBIOM)
Thyssenkrupp AG
Tocardo
TOTAL
TRIMET Aluminium
Turboden
Uniper
UPM
Valmet Oy
Veerhavencapital
Verallia
Vestas
Vesuvius
VoestAlpine
Voith
VTT
Wienerberger
Wind Europe
WVMetalle
Yuasa

Over 80 technologies identified and “Techno-hubs”

80+ Pathways & Technologies

Which are economically and societally optimal?

Optimal Pathways are likely to involve:

a. **Cross-sectoral technology solutions**

b. **Collaboration**

Cross-sectoral Initiatives:

Promotes research and **innovation** efforts across Europe by supporting the most **impactful technologies** in the EU's transformation to a **low-carbon energy system**

EU SET-Plan
Strategic Energy Technology Plan

European Technology Platforms

Comprising 41 platforms, ETPs fosters **research & innovation agendas** and **roadmaps** for action at EU and ntl level to be supported by both private and public funding

High-level Panel on the European Decarbonisation Pathways Initiative

Steers the implementation of the **European decarbonisation pathways initiative** (EDPI), through the provision of independent strategic advice on objectives and milestones.

Supported by the **WBCSD** and comprising **165 companies** and numerous sectoral technology plans

LCTPi

Key Cross-Cutting Recommendations

Five Key Drivers for Decarbonisation:

Cost Savings and Competitiveness	• To the extent that emissions reductions translate into cost reductions this will drive low-carbon innovation.
Carbon Price	• Price of carbon is a critical element in driving investment decisions especially the long-term expected price.
Developing Industrial Ecology Contracts/ "Robust Collaboration Models"	• There is a clear need to create greater synergies between complementary industries and robust collaboration models which ensure industrial cooperation for decarbonisation
Reduced Environmental Externalities (delivering Improved Corporate Sustainability Reputation)	• Economically these are mainly reductions in GHG emissions, and yet there are many other environmental externalities such as particulate emissions, black carbon, effluents to water-ways, toxins, waste to landfill, excess heat and so on.
International Competition for Green (or Bio) Products	• If non-European producers of steel, non-ferrous metals, cement, lime, glass and ceramics, chemicals and paper began to develop and compete on delivering "green" , "bio" or low-carbon footprint products this would create larger markets for European "green", "bio" or low imbedded carbon products and hence spur innovation and investment in this area.

Barriers and Risks Identified tended to focus on:

A — Need to Improve, strengthen or identify

- The business case and drivers for long-term and deep decarbonisation beyond incremental and short-payback measures.

B — Often changing/ not fully developed regulatory frameworks

- Many less mature technologies (e.g. second generation renewables, energy storage, self-generation, demand response, CCU and hydrogen infrastructure) have uncertain future frameworks and some mature technologies also impacted by changing policies.

C — Project Approvals

- Issues around permitting, licensing and technical quality approvals for new technologies and low carbon products.

D — Collaborative Solutions

- The overall immaturity of “collaborative solutions” and their frameworks.

IF: The “right amount” of funds, “at the right time”

When is Innovation Funding Needed?

“valley of death” typically the critical upscaling demonstration phase found between technology readiness levels (TRLs) 6-9

- Often represents a significant up-scale in funding amounts
- Generally banks and private equity are not yet willing to take the risk of unproven technologies and business models at this point

How much Funding is needed per “transaction”?

Total financial needs for Europe’s industrial decarbonisation are very substantial & far above the current envisaged allocation of the IF

- CCU needs about Euro 10 million per unit
- CCS and its infrastructure needs around Euro 60-100 million for a pilot/ demonstrator;
- A full roll-out of a “break-through” technology might need an investment of Euro 1-6 billion to 2050

IF: How long to fund and what IRRs to expect ?

What is the maturity or term of the financing need?

Many industries noted the long-term nature of innovation investments, recognising that facilities can have economic lives of 15-40 years and serious refurbishment opportunities once every 15 years.

- Experts felt that the likely development cycle for a successful technology that is funded at TRL 7 would be 5-10 years to become commercial
- Long-term financial support is of the essence for successful projects to proceed to high TRLs

What kind of returns can be expected of Innovation Finance?

The required payback time of innovative projects is strongly influenced by the policy framework: the more stable it is, the longer the payback can be (lower required returns).

- One sector felt that payback periods needed to be between 1-10 years with IRR targets of 5-50%
- IRR concept can be a limiting tool for innovation. Break-through innovation has binary returns: failure or very high. IRR can be more relevant for high TRL projects, demo and non-grants.

IF: Which Instruments, Procedures and Structure ?

What Instrument(s) are needed from the Innovation Fund?

Experts discussed wide spectrum of instruments such as: grants, concessionary debt or equity, risk sharing instruments, guarantees, revenue support, insurance, working capital facilities (OPEX) and various hybrids.

- There was a tendency to prefer grants from all the sectors
- The need for working capital (or OPEX) financing as well as CAPEX.

What procedures and structures are needed by the market?

The Innovation fund should have transparent procedures, simple administration, reduce the "weight" of procedures through a two-stage application and provide funding upfront and against milestones.

- The IF should remain flexible, as much can happen over a decade
- IF can target support at projects that produce collaborative partnerships

IF: Nine Key Recommendations

1	Transparent and Clear Qualification Criteria
2	Clear list of finance products on offer (primarily grants; and complementary de-risking products (e.g. FLP, loans, equity))
3	The Innovation Fund should ideally be a revolving fund
4	Simple, two-stage application process with multiple competitive calls
5	Expert and independent decision making processes and adequate resources
6	Milestones-based disbursement logic
7	Signposting (and potentially project development assistance) as a complementary "Service" provided by IF
8	Advantages for "collaborative consortia with cross-sector technologies" (at stage 1)
9	Stable regulatory environment for the Innovation Fund

- Each sector has identified incremental and breakthrough technology needs.
- Many of the production sectors can also benefit from cross-cutting decarbonisation technology solutions such as:
  - Carbon Capture and Storage/Use
  - Green Hydrogen
  - Intelligent Energy Management
  - Renewables and Storage

Innovation Fund as “One-Stop Shop”

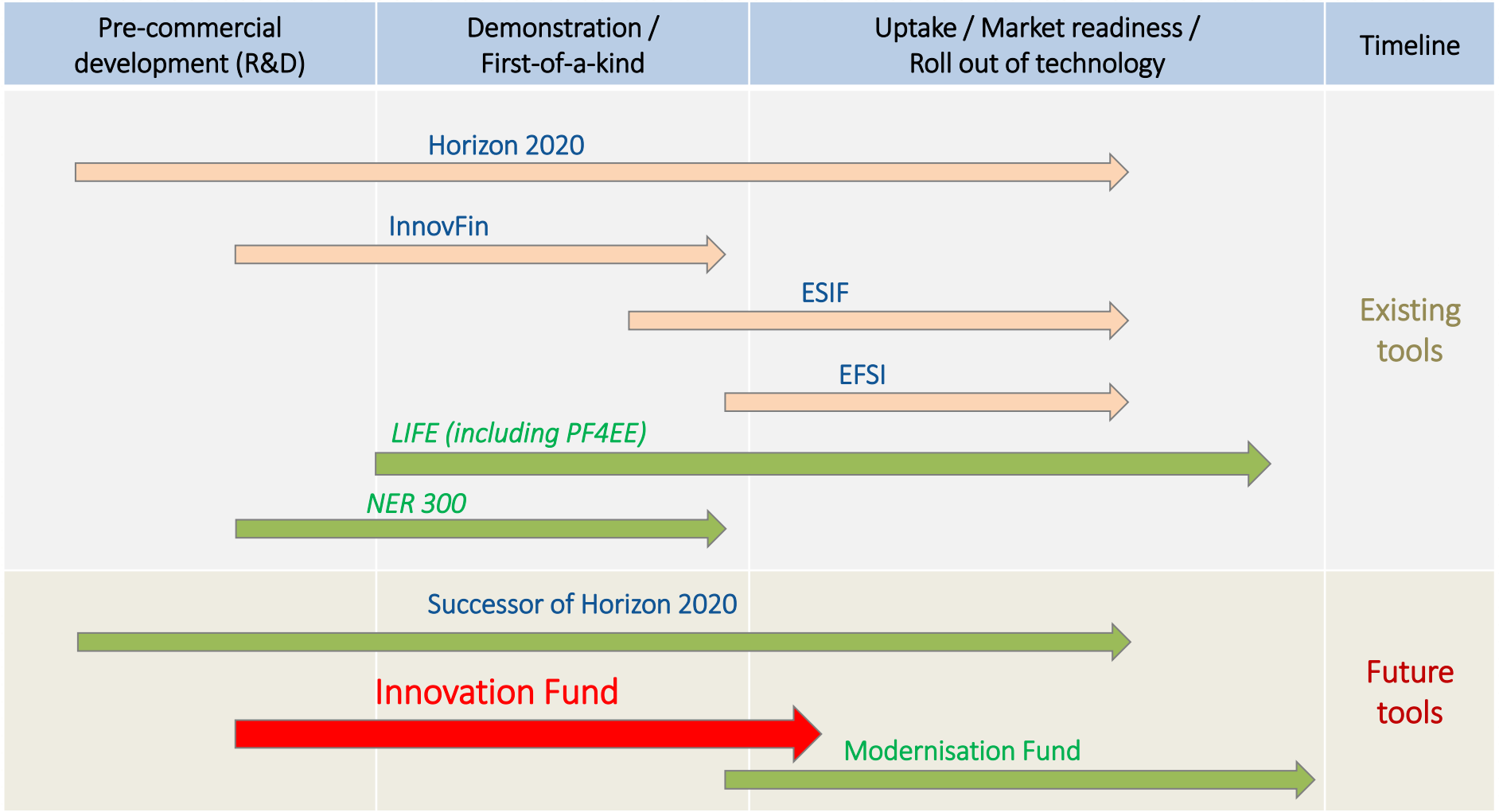
Can IF be a “One stop shop”?

Many experts expressed a desire for the IF to be a “one stop shop” for all kinds of financing needs at multiple TRLs

- EU Funds
- Member State level Funds
- H2020
- EIB Innovfin Demo Project Fund
- EU’s Research Fund for Coal and Steel (“RFCS”)
- Other public EU and national funds

- The relationship of the IF with **complementary EU funds** such as the H2020 and the EFSI should be **very clear** so that applicant and reviewer time is optimised.
- Many groups expressed an interest in **public/private financing combinations**.

How IF fits into the Landscape of EU Programmes…



Thank you (part 1)

CLIMATE & STRATEGY
PARTNERS

Binary Challenges for Low-carbon Industries:

Process, Product or System Innovation

"Where" in the supply chain to deliver the final customer outcome the decarbonisation technology innovation is required

a. **Upstream**
   - Decarbonising energy and resource inputs

b. **Process**
   - Decarbonising the existing transformation assets

c. **Downstream**
   - Decarbonising demand through product recycling or replacement with lower carbon intense alternatives

Cross-cutting, multi-sector Collaborative Technologies:

Need to "collaborative consortia" that offer multi-sectoral opportunities to demonstrate key "end of pipe" breakthrough solutions

Industrial Ecology to deliver:

a. **Intelligent Energy Management & Storage**

b. **Green Hydrogen Solutions**

c. **CCS**

Technology Innovation Roadmaps: Metals Production

Steel

1. Improving energy efficiency beyond the state-of-the art
2. New Smelting Reduction technologies
3. Direct Reduction technologies, based on natural gas
4. Direct Reduction technologies, based on hydrogen
5. Direct use of electricity for iron ore reduction
6. Use of biomass in steel production
7. More recycling of steel
8. Other breakthrough solution paths for low-carbon steel production

NFM

1. Switching fuel / reaction agents
2. Innovating the extraction, refining and electrolysis metallurgy
3. Developing new, highly performing NFM alloys and compounds
4. Developing simulation models and emulators
5. Establishing new circular value chains, Leasing of metals
6. 3D printing for bionic design and more efficient use of materials
7. Creating a market for ‘green products’
8. Substitute carbon intensive products with low-carbon products. (e.g. Anodes in Al processing).
9. New CCU techniques to capture carbon from waste gases and converting it to either synthetic fuels or other useful products on an industrial scale needs to be demonstrated.

Technology Innovations: Pulp & Paper, Oil Refining & Chemicals & Bio-Based

Pulp & Paper

1. Integrated process management (e.g., Deep Eutectic Solvent, foam forming technologies, superheated steam drying, water removal without evaporation, drying techs including: Condebelt, osmotic, infrared, diffusion and yankee cylinders)
2. Fuel switching
3. Material efficiency
4. Material substitution
5. Innovative technologies for recycling and reuse

Oil refining

1. Process improvement technologies that reduce operations emissions
2. Heat recycling and reuse
3. Renewable ("green")/low CO2 hydrogen
4. Alternative feedstocks, advanced biofuels

Chemicals & Bio-Based

1. Significantly increased resource and energy efficiency of process technologies
2. Utilization of renewable electricity, alternative energy sources, production of "green" H2
3. Better utilization of alt. sources of carbon: biomass, waste & recycled materials (CO2 from industrial flue gases, CO2 chemical valorization)
4. More robust and tolerant production systems
5. Integration of advanced process modelling, control technologies and digitization
6. Industrial symbiosis
7. Materials "breakthroughs" including better eco-design of materials, development of advanced sustainable recycling process, high performance functional materials for low-carbon energy, mobility and housing.

Technology Innovation: Cement & Lime

Cement

1. Reduction in Manufacturing Emissions (EE, Fuel switch, WHR and alternate fuels)
2. Lower clinker content in concrete (Ultra-low clinker concrete & additives)
3. Changes in concrete composition (CEM X, CSA-Belite, Suplhated, Alt CSH, Geopolymer, Solidia, Carbstone)
4. Use of recycled materials/ components (cement recycling, use of carbonated wastes, by design)
5. Extension of lifetime (e.g. Self-healing concrete)
6. Reduced user energy consumption in Use phase (Core activation, EE in Buildings)
7. Carbon capture in concrete (Mineral CO2, Carbon8, Solida, Carbstone)
8. Carbon capture (Separation of CO2 streams in process)
9. Co2 Utilisation (Reutilisation processes, Reuse in fuels, biofeed, Storage)

Lime

1. Increase of CO2 concentration e.g. by looping
2. Indirect calcination
3. Methanisation
4. Low concentration CO2 -> Direct use for e.g. plant/algae/bacteria growth/feeding or flue gas cleaning
5. Combination with Oxyfuel process
6. Carbonation
7. Carbon dioxide Storage by Mineralisation (CSM)

Technology Innovation Roadmaps: Glass & Ceramics

Glass

1. Electric furnaces (subject to power sector decarbonisation and electricity price)
2. Fuel switch to bio fuels and hydrogen
3. Fuel flexibility (firing of different fuels)
4. Waste heat recovery
5. Closed loop glass recycling
6. Batch reformulation & batch palletisation (e.g. non-carbonated materials or glass with lower melting temperature).

Ceramics

1. Electric furnaces and dryers (subject to power sector decarbonisation and electricity price).
2. Natural gas in gas-fired furnaces (state of the art) not only to provide heat, but is also a reaction partner for some types of ceramic products (i.e. tableware/porcelain products, bricks, some types of refractories).
3. Waste heat recovery
4. Design of non-fired/ low-fired products (products which don't need to be put in a furnace/ low Temp furnace, yet achieve the same technical quality)
5. Increase of recycling
6. 3D-printing only for prototyping
7. Other product innovations (light weight).

Thank you (part 2)

CLIMATE & STRATEGY
PARTNERS

Cross-sectoral Segments have Unique Challenges:

Decarbonising Energy Generation

Challenge to Identify the most fertile areas for Technology Innovation – hand in hand with evolving regulatory markets

a. **New Generation Renewables**
   - Adding to mature renewable technology portfolio

b. **Smart Distribution Models**
   - Enabling modern and efficient energy networks

c. **Storage as Enabler**
   - Cost effective energy storage can play different and evolving roles as renewable and EV shares increase.

CCS and other potential transformational technologies require collaboration:

Need to "collaborative consortia" that offer multi-sectoral opportunities to demonstrate key "end of pipe" breakthrough solutions

Industrial Ecology to deliver:

a. **Green Hydrogen Solutions**

b. **CCS (and CCU)**

Technology Innovations: Renewables and Energy Storage

Renewable Energy

1. Innovations in Wind (next gen turbines, floating foundations, data and energy management systems)
2. Innovations in Solar energy (e.g. Concentrated Solar Power, building integrated PV, flexible organic cells, solar roof-tiles, solar highways, floating PV installations)
3. Synthetic fuels produced with renewable electricity (e.g. high density liquid fuels, renewable methanol, synthetic natural gas, hydrogen)
4. Advanced biofuels.
5. Hybrid systems" of renewable electricity generation plus storage (e.g. battery, hydro-pumped storage, power-to-gas storage)
6. Smart technologies and innovative management in the distribution grid
7. Thermal grids and networks, low temperature district heating and cooling
8. "Synergetic applications" with co-uses (e.g. desalination, water management, horticulture, Digital economy, pharma or electric car industry)
9. Ocean Energy
10. Geothermal energy

Energy Storage

1. Process innovation: Including approaches through:
    1. Electric Vehicle for the Vehicle to Grid application
    2. Thermal Storage: Sensible heat, latent heat and thermos-mechanical heat storage
    3. Power to X
    4. Pumped Hydro Storage
    5. Flow Batteries
    6. Lithium Ion technology & post lithium technologies (M-air, Na-Ion)
    7. Compressed Air and Liquid Air Energy Storage;
2. Product innovation; including: Energy Management Systems, Block chain technologies and Artificial Intelligence (AI); and
3. System innovation; including approaches which replace existing systems in their entirety.

Technology Innovations: “Green Hydrogen” and CCS

“Green” Hydrogen

1. HYBRIT, H2Future, SuSteel and SALCOS (Steel)
2. Hydrogen as a reducing agent (cf. the CIRCORED process – Steel)
3. Hydrogen based production processes (NFM)
4. Hydrogen to take Sulphur out of transport fuels and for conversion schemes (O&R)
5. Fatal H2 generated as side stream (C&BB)
6. Hydrogen as low-carbon fuel for the transport sector (RES)
7. Renewable hydrogen as storage medium (ES)
8. Hydrogen production with CCS

CCS

1. Detailed feasibility study, complete with requests for storage authorizations, was an integral part of the ULCOS-II program proposed around the ULCOS-BF project under NER-300
2. Carbon2Chem (ThyssenKrupp) and Steelanol (ArcelorMittal & Lanzatech)
3. Building materials incorporating CO2 (C&L)
4. Conversion to Syn-fuels (NFM)
5. Biogenic & boosting forest carbon capture (P&P)
6. Chemical valorization of CO2 (& CO) from gaseous industrial effluents (C&BB)
7. Pre-and post-combustion capture (O&R)
8. Soda-ash production (local small scale application - G&C)
9. Carbon sequestration and reuse (C&L)
10. Second generation capture technologies (such as high pressure turbines or subsea separation)
11. Innovations in transport of CO2 (gas pipelines, buffer storage, ship transport and their combinations and sharing of infrastructure)
12. Increasing of storage capacity by pressure management, better knowledge sharing, development of CCS hubs and clusters, Enhanced Oil Recovery demonstration

Thank you (part 3)

CLIMATE & STRATEGY
PARTNERS