Ministry of Environment, Energy and Climate Change of the Hellenic Republic

Project Helios

The Greek Solar Energy Project

November 2011

The political imperative: *Helios* is an integral part of the Greek growth strategy and EU support

"… **Greece commits future cash flows from project Helios** or other privatisation revenue in excess of those already included in the adjustment programme to further induce indebtedness of the Hellenic Republic by **up to 15 billion Euros** with the aim of restoring the lending capacity of the EFSF…"

Source: ***Euro Summit Statement*** *- Brussels, 26 October 2011*

"… We **call for a comprehensive strategy for growth and investment in Greece**… to target the structural funds on competitiveness and growth, job creation and training. We will **mobilize EU funds and institutions** such as the EIB towards this goal and re launch the Greek economy. Member States and the Commission will immediately mobilize all resources necessary in order to provide exceptional technical assistance to help Greece implement its reforms..."

Source: Statement by the ***Heads of State or Government of the Euro area*** *- Brussels, 21 July 2011*

This presentation aims at providing an overview of the project and preliminary answers on key questions

- What is the **aim** of the project and its expected **benefits**?
- Is the implementation of the project **technically possible** and under what conditions?
  - Can the required solar power be produced?
  - How will the power be transferred to Central Europe?
- Is the project **financially viable** and under what conditions?
- What are the key **implementation mechanisms** of the project?
- What kind of **support / action** is required?

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Project Helios aims at producing and exporting up to 10 GW of solar energy generated electricity to EU member states…

- Project Helios is expected to become the key driver of Greece's green economic growth by:
  - Monetizing an abundant natural source (solar energy)
  - Creating favorable conditions for sustainable development in the solar energy sector
  - Facilitating other Member States (MS) in achieving their 2020 RES targets by offering more attractive investment returns for solar PV projects (higher yields for the same cost of investment)
  - Pave the way for exporting other RES generated electricity
  - Cause the creation of the 1st South to North green energy pipeline where other member states may also contribute

"Helios" presents a unique opportunity for the establishment of a mutually beneficial cooperation scheme as it can facilitate the achievement of EU targets for 2020

… while offering significant benefits to all potentially involved stakeholders

EUROPE

- Catalyst to promote EU interconnection strategy
- Promotes EU technology and equipment
- Fits in perfectly with EU growth strategy

EU Member States

- Generates significant cost savings by using RES produced in a country with higher RES potential and lower production costs
- Strengthens the EU's leading position in the RES sector
- Assists in meeting the targets set by RES Directive and adds significant leverage to EU's call for a 2020 target increase from 20% to 30%

GREECE

- Growth prospects improvement and RES capacity built-up
- Significant inward FDI
- Employment creation, regional development and tax receipts
- Contribution to public debt sustainability

INVESTORS

- Extremely attractive from an investment point of view as for the same cost of investment, the higher insolation generates significantly higher returns on investment

The project implementation platform will ensure minimal administrative & bureaucratic burden

- The Hellenic Republic will provide an “all-inclusive” platform to encourage and facilitate investments in the solar sector
- This entails presenting potential investors with ”turn key”, fully licensed project SPVs in specific state-owned site locations, free of any administrative and bureaucratic barriers:
  - Appropriately selected State-owned land parcels across Greece. Achieving a target of 10 GW in solar generated electricity requires approximately 200 Km^2 of land. The parcels will be “leased” out for a specific time period (e.g.25 years)
  - Fully licensed “trouble free” projects with final stage operating permits
  - Relevant connection agreements with the National Grid. The agreement shall refer to the grid connection and not to the sale of energy to the Greek TSO. In the case of a statistical transfer, the investor shall also be provided with a PPA with the Greek TSO receiving the price designed for Helios PV parks.

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Solar radiation levels, land availability & energy transmission capability are the key elements of Helios technical viability

Key Questions

1

Can the required solar power energy be produced?

1a. Solar Radiation Levels

- What are the solar radiation levels in Greece and what is the potential of solar energy production levels?

1b. Land availability

- Can Greece meet the land requirements both in terms of the land size as well as of its required qualitative characteristics?

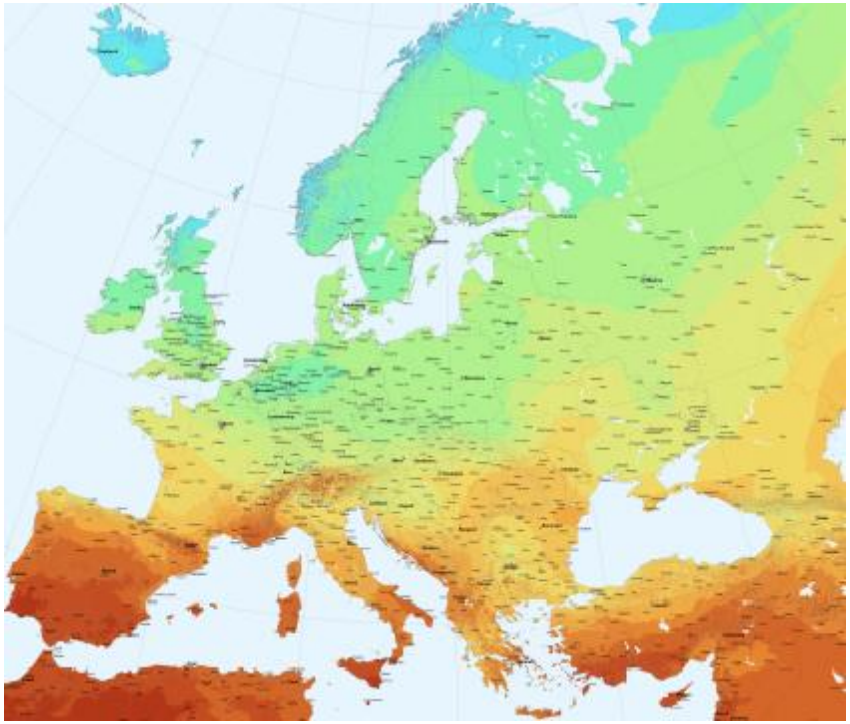
2

Can the required solar power energy be transmitted?

- Is the solar power transmission to Central Europe possible and under which conditions?

Greece's solar intensity can ensure not only its compliance with NREAP target for 2020, but it can also contribute significantly to other countries RES targets achievement

Photovoltaic Solar Electricity Potential in EU



- The average annual irradiation in Greece is very high (1800 kWh/m$^{2)}$ and ~ 50% higher than Germany's
- Greece holds the 6th place among 35 countries around the globe regarding its solar index
- Greece's solar energy production potential is far greater than its target set in its NREAP for 2020.
- The excess potential can be tapped to the benefit not only of Greece, but also of other EU member states in achieving their RES targets in a highly cost efficient way

Yearly sum of global irradiation incident on optimally-inclined south-oriented photovoltaic modules
Yearly sum of solar electricity generated by 1kWp system with optimally-inclined modules and performance ratio 0.75

Significant research has already been performed to assess the land requirements for viable PV installations

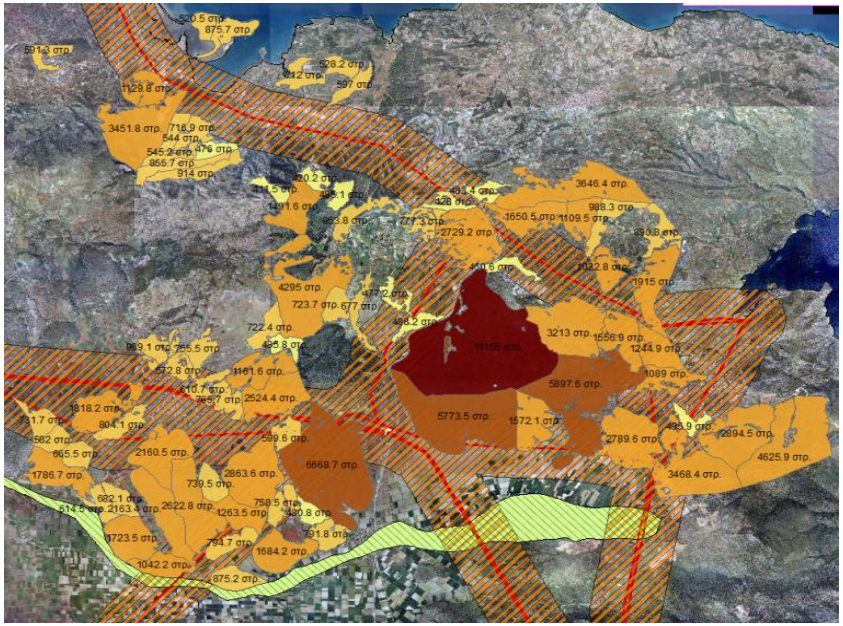
Land Requirements

- Each parcel's area should be at least 40 hectares
- Parcels must be outside of protected zones
- Non-arable land
- Slope up to 30-35%
- Southern orientation
- Parcels need to be as close to electrical grid as possible
- Distribution of parcels within mainland desired to compensate for extreme network load at specific points

Data Collection Performed

- Public Parcels from several sources:
  - Cadastral parcels where the Greek State is the registered owner
  - Parcels from Ministry of Rural Development and Food
  - Parcels from Ministry of National Defense
  - Decommissioned lignite mines
- High-voltage electrical grid
- Locations of other renewable-energy facilities
- Protected areas (Ramsar, Natura 2000, wetlands and others).
- Data about forested areas
- Basemaps: Large-scale orthophotos, administrative boundaries, land cover, digital elevation models etc.

The assessment conducted so far on a sample of filtered parcels provides evidence that the land requirements can be met, while viable parcels have already been identified



Preliminary Results

Area	Number of Candidate Parcels
40-50 ha	57
50-100 ha	160
100-500 ha	123
500-1000 ha	11
1000-2000 ha	3

354 parcels total

- For the initial phases of the project, suitable public land parcels, with no pending legal impediments, which are readily available for the licensing process have already been identified
- The Ministry of Environment, Energy and Climate Change is already in the process of “mapping” additional suitable public land areas in cooperation with the National Wealth Management Fund

The energy transmission can be achieved either through statistical or physical transfer – the two can be combined to create a viable solution for the project

Statistical Transfer

- Excess RES produced in one country is virtually transferred to another country
- RES statistics count towards RES target of latter country

Physical Transfer

- Excess RES produced in one country is transferred via the transmission network to another country
- The latter country imports and consumes this energy which counts towards its RES target

Statistical transfer alone is not sufficient to implement the project in its entirety, as:

- 10GW of installed PV capacity exceeds daytime national energy demand, generating a surplus of energy available to export
- Greece needs energy production from energy sources other than PV, in order to balance its electricity system

However, it can act as an intermediate step for the initial phases of the project, and complementarily throughout the project duration

Various scenarios of physical transfer have already been identified and a preliminary assessment performed

Scenarios Description

1a

- **Route**: Western Balkans
- **Interconnection Type**: Overhead
- **Max Energy Transfer Potential**: 150MW (bottleneck Greece-Albania)

1b

- **Route**: Eastern Balkans
- **Interconnection Type**: Overhead
- **Max Energy Transfer Potential**: 800MW (bottleneck Hungary-Austria)

2a

- **Route**: Italy mainland
- **Interconnection Type**: Sub-sea & Overhead
- **Max Energy Transfer Potential**: 500MW

2b

- **Route**: Adriatic Sea
- **Interconnection Type**: Sub-sea & Overhead
- **Max Energy Transfer Potential**: 10GW

More detailed investigation of alternative scenarios is underway in cooperation with the JRC

European Commission
Joint Research Centre

In the mid-long term, the most viable scenario both from a technical and a commercial/ regulatory point of view is the sub-sea & overhead HVDC interconnection GR-Central Europe

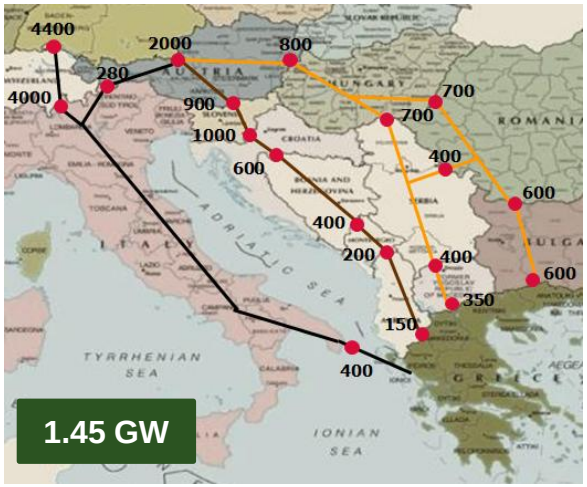
	Pros	Cons
1a Overhead GR-Central Europe interconnection via Western Balkans	• Ability to utilise current electrical interconnection instantly • Lower investment requirements compared to scenario (2b)	• Insufficient interconnection capacity to transfer 10GW to Germany • Commercial issues in transferring electricity from country to country (necessity to participate in yearly, monthly, daily auctions for transmission capacity) • Fees for using other country's electricity network
1b Overhead GR-Central Europe interconnection via Eastern Balkans		
2a Overhead & sub-sea GR-Central Europe interconnection via Italy mainland		
2b Sub-sea & overhead GR-Central Europe interconnection via Adriatic Sea	• Capacity potential higher than 10GW • One dedicated line to transmit all capacity directly from Greece to Central Europe	• Funding, licencing & construction can take significant time • Investment cost

In the immediate term and until a sub-sea HVDC is constructed, transmission can be achieved by utilizing current infrastructure

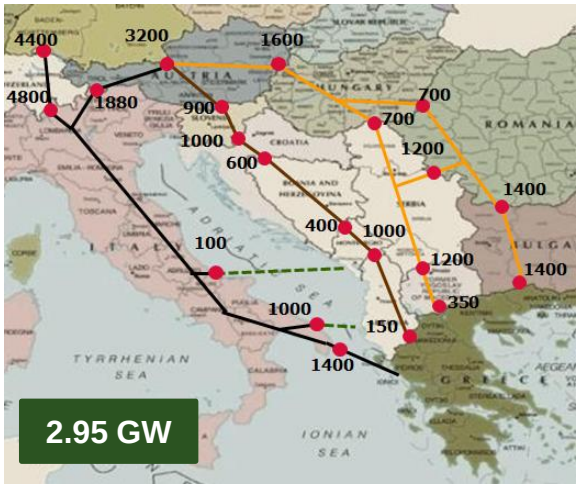
CURRENT INFRASTRUCTURE

- **1a** Overhead GR-Central Europe interconnection via Western Balkans
- **1b** Overhead GR-Central Europe interconnection via Eastern Balkans
- **2a** Overhead & sub-sea GR-Central Europe interconnection via Italy mainland

TODAY



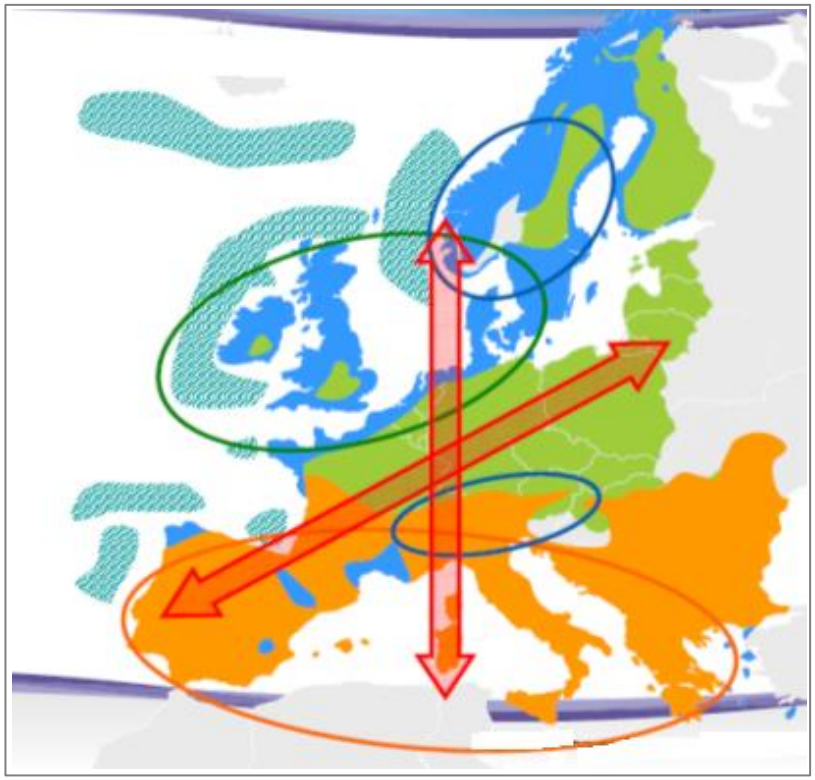
SCHEDULED UPGRADES



Sub-sea HVDC construction period

The development of the proposed infrastructure between Greece and Central Europe is aligned with the ENTSO-E development plan & European Commission targets…

RES Generation Integration Plan



- As reported in "*Energy infrastructure priorities for 2020"*, the European Commission proposes to:
  - Focus on **connecting Central & South Eastern Europe** in South-North and East-West directions to **assist market and RES integration**, including connection to storage capacities and integration of energy islands
  - **Construct Electricity Highways** (High Voltage Direct Current connections) which will accommodate the increasing RES generation in Central & South Eastern Europe and Africa
- **ENTSO-E is planning to invest €4-5 billion on transmission projects** of European Significance in Central & South Eastern Europe within the years 2010-2014

Source: Ensto-e

… as well as the needs of other large energy renewables production projects, such as Desertec

“Desertec” Transmission Outline

- Other initiatives such as the ‘Desertec concept’ have planned to transmit their energy generation via South Eastern European corridors and will thus benefit from such an investment
- Central & South Eastern European as well as African and Middle Eastern countries will benefit from such an initiative, increasing their market integration and contribution to high consumption areas

Such an initiative should become a priority in ENTSO's agenda so that more and more countries can contribute to the RES market while they are benefiting from it

- The European Commission proposes to initiate work to establish a Modular Development Plan by 2013 and allow commissioning of the first Electricity Highways by 2020

- The Modular Development Plan will establish a rolling programme of concrete electricity projects, ranking them according to their capacity to connect RES generation and transmit it to major consumption/storage centres

- **The commissioning of such an interconnection should be given high priority and be included in the high ranking projects, which are expected to start by 2012**

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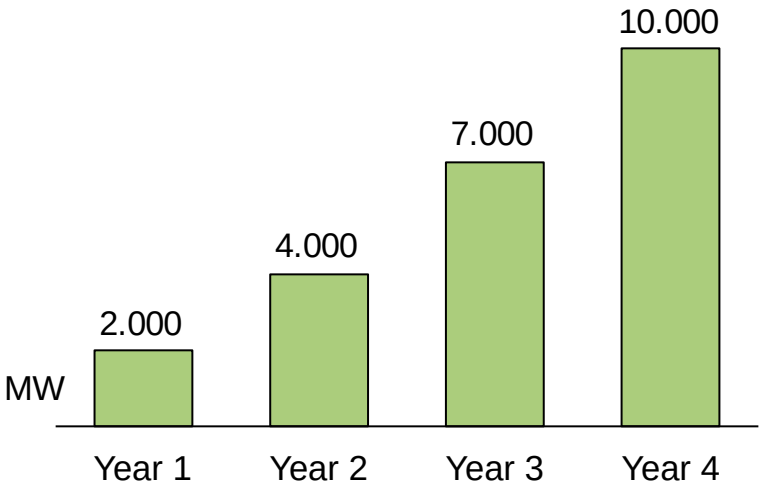
Based on an indicative set of operational & financial assumptions …

Installed Capacity (GW)	10 GW
Land Size Requirement (ha)	20,000
Type of Installations	Ground mounted - Fixed
PV Technology	Polycrystalline
Module - Efficiency Reduction per annum	0.80%
Average Gross Irradiation (kWh/m^2)	1,800
Solar Electricity Potential (kWh/kWp)(1)	1440
Turn Key Price (investment cost) per MW (1)	1,900,000 €
Electricity Selling Rate or FiT Level (€/MWh)	210
Rate/FiT Inflation Adjustment p.a.(2)	25%
Inflation Rate	3.00%
Project Equity Participation	25%
Projecting Gearing (leverage)	75%
Finance Facility (years)	15
Cost of Financing	6.00%
Interest Calculation Period	Semiannual
Depreciation Rate	5.00%
Taxation Rate	20.00%
Operation & Maintenance Costs(3)	1.50%
Equipment Insurance Costs(4)	0.32%
Income Loss Insurance Cost(5)	0.63%

(1) 0.8 Performance Ratio
(2) % of annual Inflation
(3) % of total investment cost
(4) % of Investment Cost
(5) % of operating revenue

… and based on a built-out plan over 4 years and a total investment of ~ €19 bn, Helios IRR is estimated at > 20%

Cumulative MW roll-out



Hectares of land per MW	2
Minimum Site Capacity	25 MW
Hectares of land per Site	50
Total hectares required	**20.000**

Key Financials

Total Investment (€)	19,000,000,000
Equity Participation (€) @ 25%	4,750,000,000
Project Finance Facility (€)	14,250,000,000
Total Net Cash Flow (€ million)	33,143
Project IRR (25 years - levered)	21.12%
Payback period (years)	4.0

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There are 3 critical mechanisms that enable project implementation

1	**Cooperation mechanism**	The mechanism through which two or more MS can cooperate to ensure that low or expensive RES potential countries can meet their RES targets by using renewable energy produced in countries with lower costs and higher RES potential
2	**Value sharing mechanism**	The mechanism through which the receiving state supports the project and the producing state is compensated for providing its natural resource
3	**Transmission infrastructure development mechanism**	The mechanism through which the required transmission infrastructure for the physical transfer of energy can be developed

Cooperation mechanism

- The directive 2009/28/EC on the promotion of RES provides for **three cooperation mechanisms** through which mutually beneficial frameworks can be agreed to allow member states to achieve their national RES targets
  - **Statistical transfer**, through which energy produced in one member state is ex-post and virtually transferred to the RES statistics of another member state, counting towards its RES target
  - **Joint projects,** where one member state provides financial support for a RES project in another member state, with the energy produced by the project counting towards its RES target
  - **Joint support schemes**, where member states combine their RES support schemes for the purpose of achieving their RES targets
- These mechanisms allow for the **optimization of RES development in Europe**, providing the opportunity for the maximization of renewable energy production in countries with the highest & lower cost RES potential
- Project Helios constitutes mainly a **Joint Project** between member states, as it involves physical transfer of energy to a significant degree, although **Statistical Transfer** of part of the energy produced can be an option as outlined earlier

Value sharing mechanism

- Depending on the applicable cooperation mechanism, the MS counting the RES energy production of an installation located abroad towards its own RES targets needs to provide adequate financial compensation to the producing MS, either directly (by paying for the energy consumed) or indirectly (by providing support to the RES installation development)
- **Statistical Transfer.** For any part of the energy produced which provides RES credits through a Statistical Transfer agreement, financial compensation can be provided through individually negotiated contracts between MS or through open trading platforms similar to those for other energy commodities (e.g. CO_2)
- **Physical Transfer.** For any energy produced by the Joint Project and transferred physically to the receiving MS, financial compensation can be provided through:
  - Extending the existing RES National Support Scheme of the receiving member state for imported RES energy
  - Developing a specific support scheme for the Joint Project and agreed in the project's cooperation framework
  - Through a tender-defined support scheme, through a public tender where RES project developers participate

Transmission infrastructure development mechanism

- The physical transfer of the energy produced by the Helios project can be achieved to a degree by utilizing **existing transmission infrastructure**, especially if planned upgrades are taken into account
- The development of **additional transmission infrastructure** between the South and Central Europe to realize the project's full potential is aligned with the ENTSO-E development plan & EU Commission's targets, as well as the needs of other large energy renewables production projects, such as Desertec
- ENTSO-E is planning to invest €4-5 billion on transmission projects of European Significance in Central & South Eastern Europe within the years 2010-2014
- The European Commission proposes to establish a Modular Development Plan by 2013 and allow commissioning of the first Electricity Highways by 2020
- The Modular Development Plan will establish a rolling programme of concrete electricity projects, ranking them according to their capacity to connect RES generation and transmit it to major consumption/storage centres
- The commissioning of the appropriate interconnections should be given high priority and list in the high ranking projects, which are expected to start by 2012

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What are the key next steps

Actions at EU level

- Signing of MOU between involved member states & European Commission
- Finalization of collaboration framework with involved parties regardingт he characteristics of the Joint Project mechanism and the Value sharing mechanism
- Cooperation with ENTSO-E and JRC to prioritize the relevant infrastructure development plans within the Modular Development Plan

Actions at National Level

- Project preparation team already set up and working on preliminary research - complete preliminary research in cooperation with the JRC
- Arrange presentations to promote the project at EU and National level (e.g. Helios Conference in Athens, January 2012)
- Finalize project organization design
- Appoint Financial, Technical , Legal advisors to begin detailed project design and implementation immediately after MOU signing