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What are the environmental effects of Pumped Hydro Energy Storage (PHES) and how can future development proceed?

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stoRE: Main Facts

- Financed through the “Intelligent Energy for Europe” programme
- From May 2011 to 30 April 2014
- **Aim:** facilitate the high penetration of intermittent renewable energies in the European grid by unblocking the potential for energy storage infrastructure
- **Overall objective:** help creating the regulatory and market conditions that will give incentives for development of the necessary storage infrastructure

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Environmental Issues

Our focus is environmental implications:

1. Environmental impacts of existing Pumped Hydro Energy Storage (PHES) & Compressed Air Energy Storage (CAES)
2. **Recommendations for furthering the Sustainable Development of Bulk Energy Storage Facilities**
3. Natura 2000 Guidelines

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What is happening?

- Presentation 1
- Interactive event - Environmental Impacts

Coffee break

- Presentation 2
- Panel Discussion

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Presentation 1

Environmental Aspects

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PHES & CAES Today

PHES

- Services: energy storage, grid services
- Mature & proven technology
- 170 operational PHES Europe
- **Renewed interest**
- Lack of experience in developing PHES in current environmental regulations

CAES

- Services: energy storage, grid services
- Considered mature (CAES)/premature (AA-CAES)
- 2 operational CAES worldwide
- R&D interest in AA-CAES (“Adele”)
- Lack of experience

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Pumped Hydro Energy Storage

- PHES:
  - Closed-loop
  - Semi-open
  - Open system

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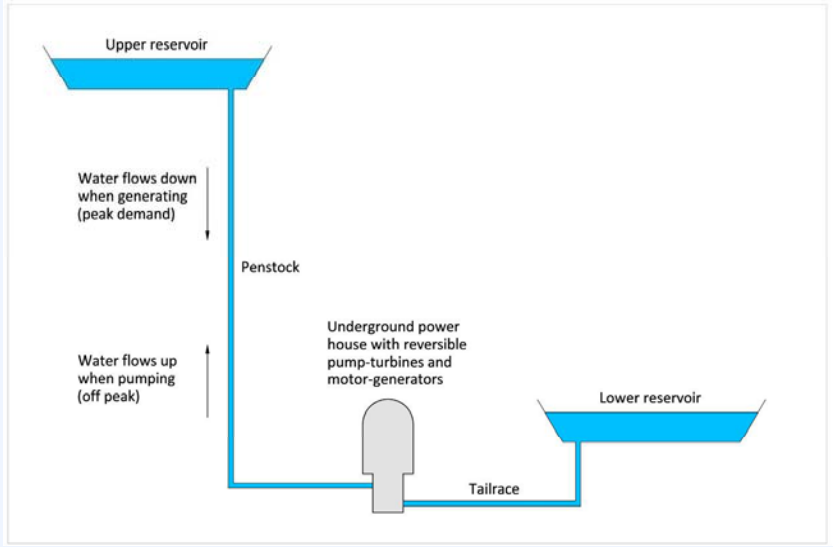
Pumped Hydro Energy Storage

Closed-loop PHES

- Closed off from other water bodies
- Artificial or modified existing lakes
- E.g. Turlough Hill (Ireland)



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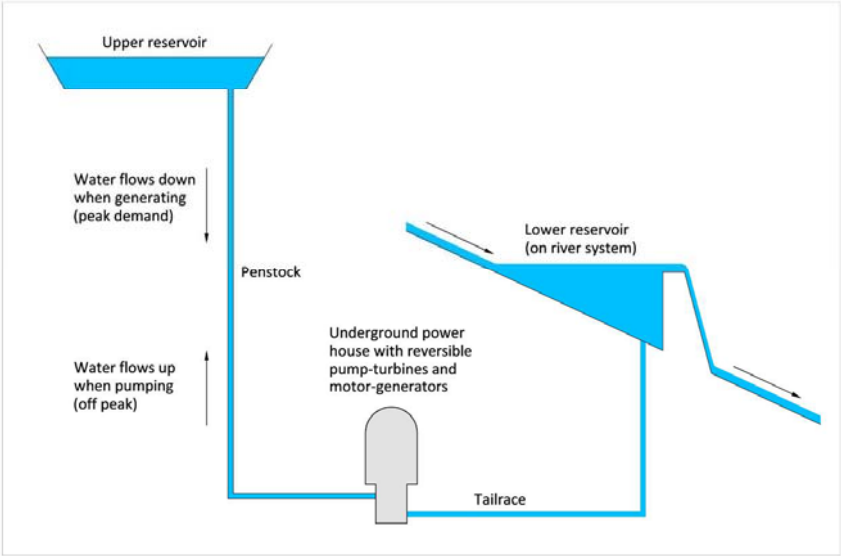
Closed-loop System

Pumped Hydro Energy Storage

Semi-open PHES

- One artificial reservoir & one reservoir part of river system
- E.g. Goldisthal (Germany)
- Marine PHES – sea acts as a reservoir (Okinawa, Japan)



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Semi-Open system

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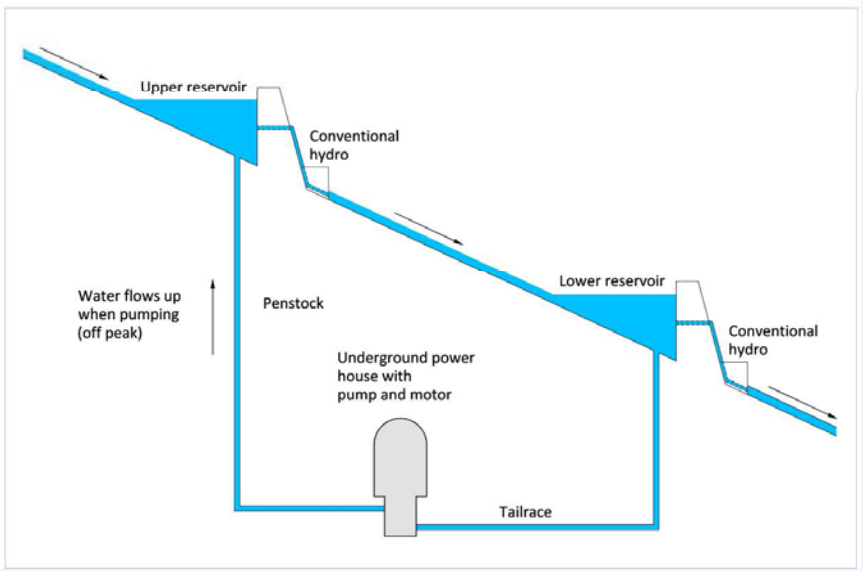
Pumped Hydro Energy Storage

Pump-back PHES

- Both reservoirs form part of river system
- Operate as conventional hydro if pump is shut off
- Hydro can be retrofitted with pump
- E.g. Thissavros built as a pump-back (Greece)



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Open-system

Pumped Hydro Energy Storage

	Construction	Operation
Closed-loop	Artificial reservoir Lake impoundment Tunnels Caverns	Pumping Generating
Semi-open	Artificial reservoir Dams Tunnels Caverns	Pumping Generating
Open	Dams Tunnels Caverns	Pumping Generating

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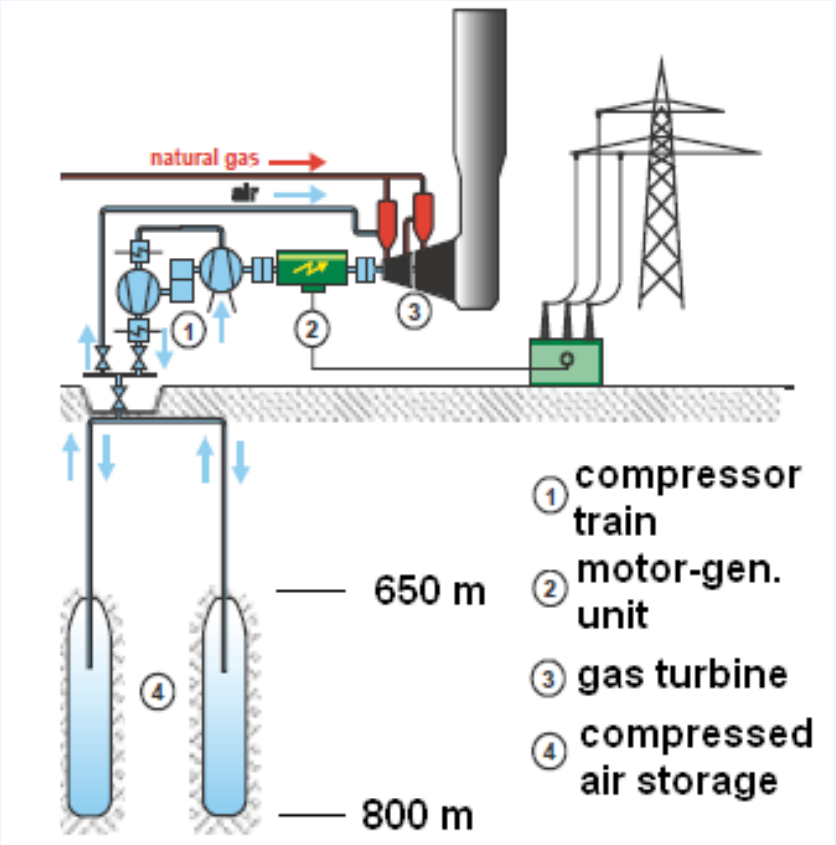
Compressed Air Energy Storage

CAES

- Stores compressed air in underground caverns for later electricity generation
- Salt dome caverns
- Additional natural gas needed
- E.g Huntdorf (Germany)



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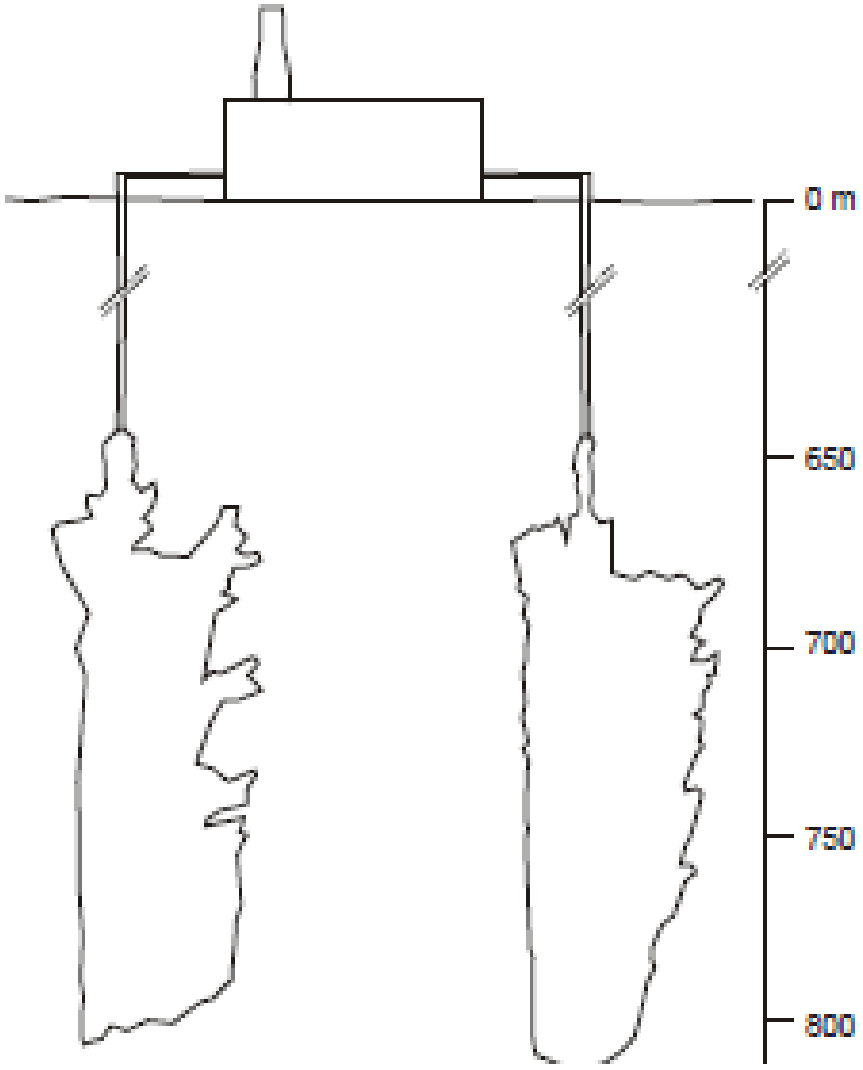
CAES



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Specific site conditions

PHES

- Difference in elevation
- Access to water
- Specific site conditions – limited number of suitable sites

CAES

- Suitable geology/cavern sites for storing compressed air
- Salt domes preferred
- Specific sites
- Competition for suitable caverns with NG and CCS

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Development

- Long development timeframe
- Large scale civil projects – of strategic importance
- Significant environmental impact
- Vary considerably depending on type of PHES & siting - Similarities to hydropower
- Lack experience development in current regulatory environment
- Little development in last 20 years coincides with environmental directives & regulations
- Correct siting is vital – or waste time & money

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Interactive Session

Environmental Impacts

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Environmental Impacts

- **Deviation from existing baseline conditions: difference with the project V without the project**
- Sensitive environment + PHES = High impact
- Modified environment + PHES = Lower impact

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Environmental Impacts

Potential Issues	Potential Impacts
Humans	
Noise and vibration	
Ecology	
Land and soils	
Water	
Air and climate	
Cultural heritage	
Landscape	

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Environmental Impact

	Potential Issues / EIA terms of reference	Huntdorf	Turlough Hill	Goldisthal	Thissavros
Human Interaction	Population	L	L	L	L
	Transport	L	L	L	L
	Cultural Heritage	L	L	L	L
	Material Assets	L	L	L	L
Ecology and Natural Systems	Biodiversity	L	H	H	H
	Fisheries	L	M	M	H
	Landscape & Visuals	L	M	M	M
	Air and Climate	L-H	L-H	L-H	L-H
	Water Resources and Quality	L	M	M	H
Physical Environment	Noise & Vibration	L	L	L	L
	Soils & Geology	L	L	M	H
	Hydrology & Hydrogeology	L	H	H	H

Recap

- Large scale civil projects
- RES Enablers
- Potential significant environmental impacts
- Site specific
- Impact related to sensitivity of site
- Site selection critical

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Presentation 2

Recommendations for furthering the Sustainable Development of Bulk Energy Storage Facilities

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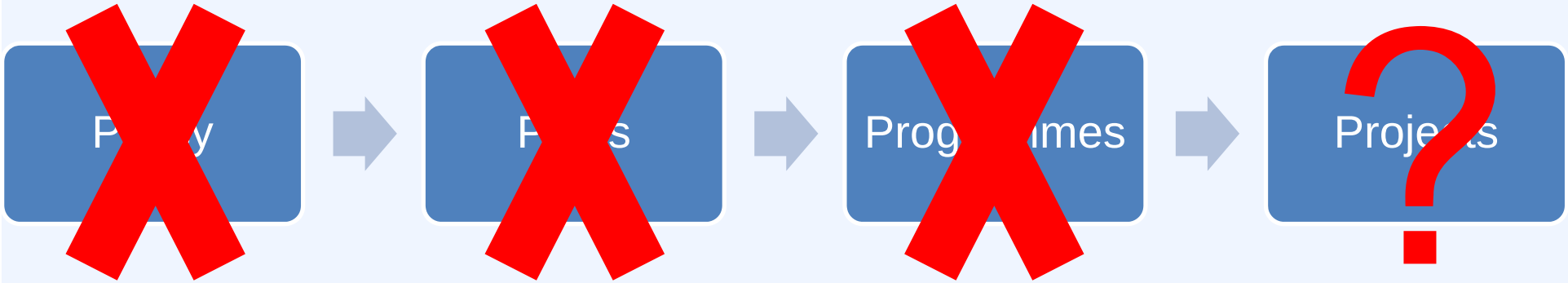
The Planning Hierarchy



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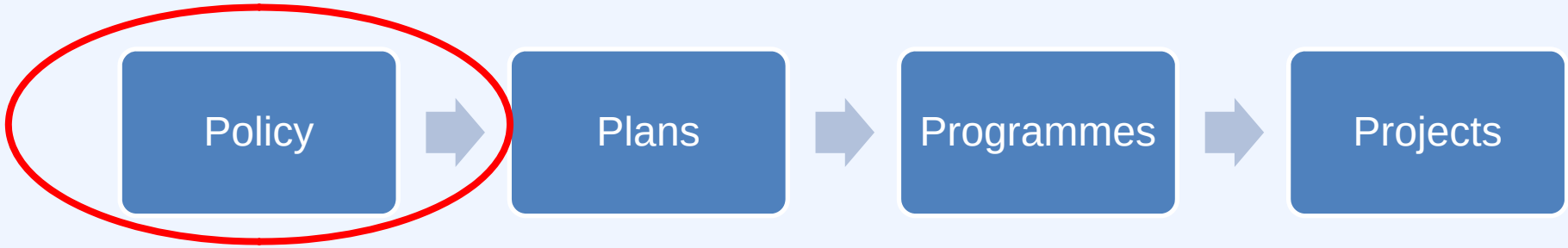
Recommendation 1

Establish a need for bulk Energy Storage Technologies - create appropriate policy



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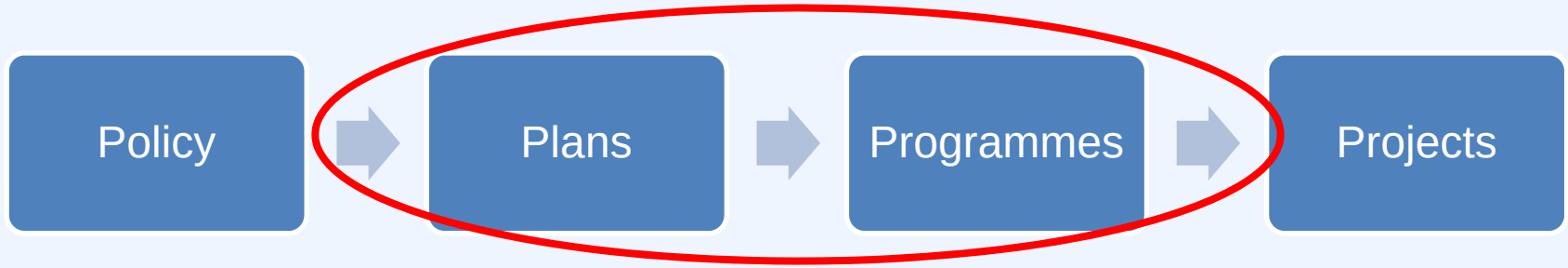
Recommendation 2

Develop Plans and Programmes for bulk energy storage



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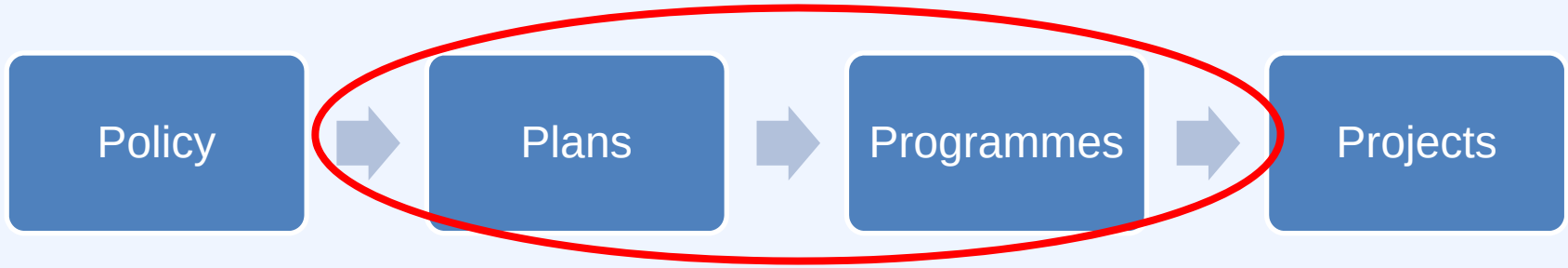
Recommendation 3

Identify viable sites at strategic level



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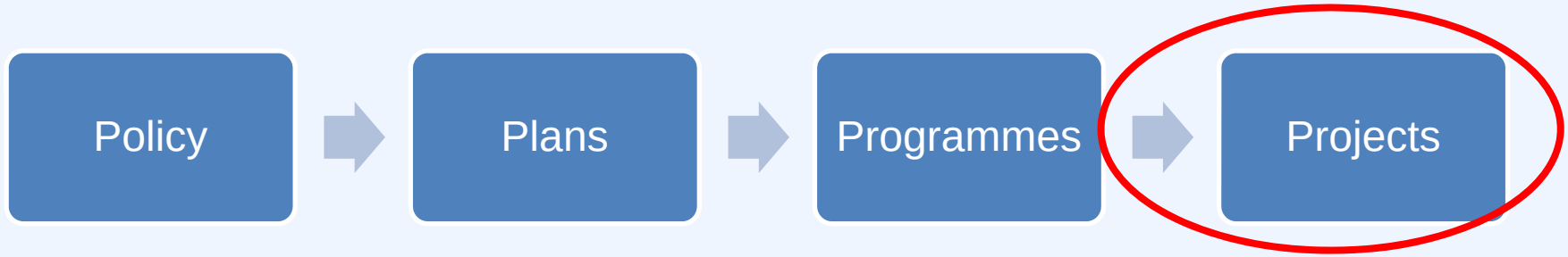
Recommendation 4

Develop Clear Guidelines and Document Best Practice



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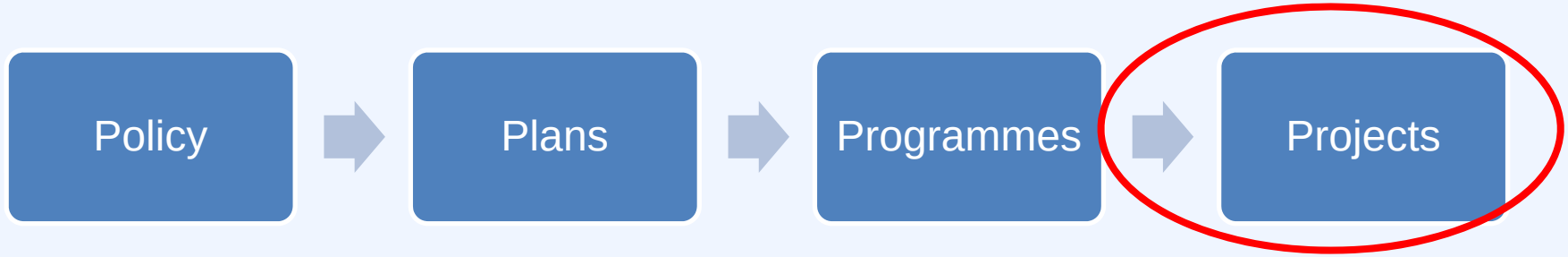
Recommendation 5

Facilitate planning and approval procedures



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Recommendations

1. Establish a need for bulk EST – create appropriate policy

2. Develop Plans and Programmes for Bulk EST

3. Identify viable sites at Strategic Level

4. Develop clear guidelines and document best practice

5. Facilitate planning and approval procedures

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Panel Discussion

Sergey Moroz *WWF*

Michael Fink *Schluchseewerk*

Marta Moren-Abat *DG Environment*

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