ELECTRIC SYSTEM VULNERABILITY FROM A REGULATORY PERSPECTIVE

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ROLE OF ENERGY REGULATION IN CONTRIBUTING TO DISASTER RISK REDUCTION

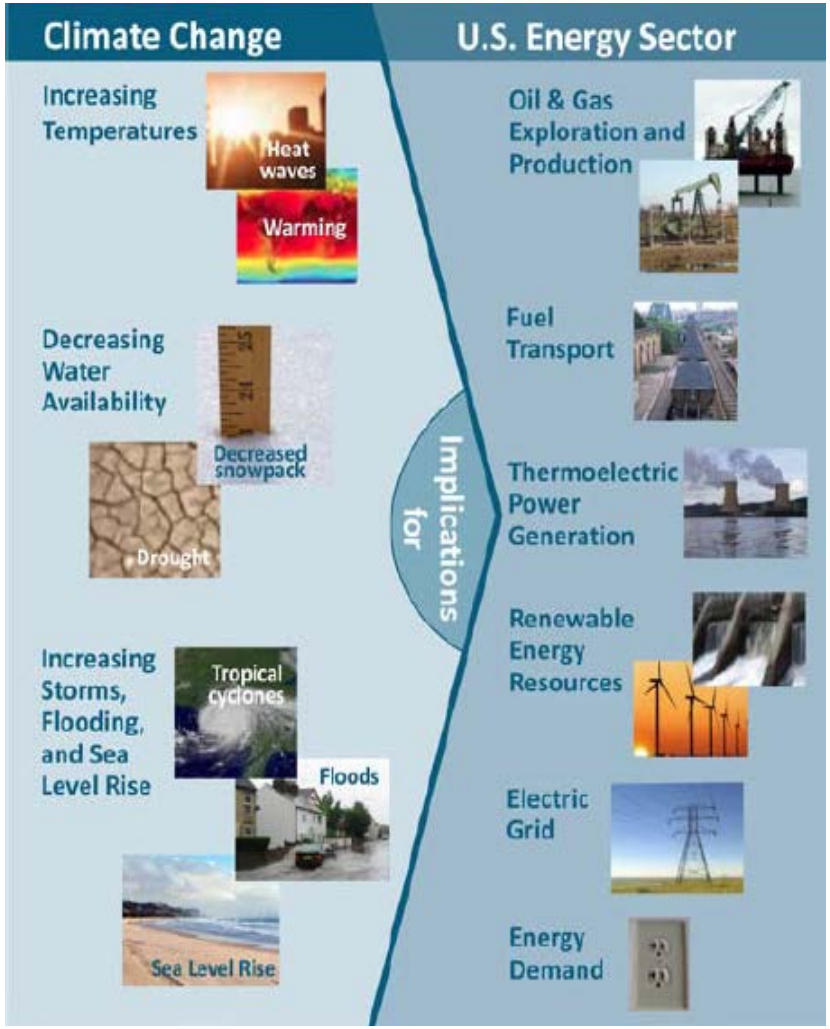
Main issues:

- Increase in **network vulnerability** due to severe weather, incurring costs and decrease in general system security.
- New tendency to discuss (and invest ?) in **resilience**
- How to **balance** security, consumer protection and avoid "gold plating"
- How should **regulation** respond – **awareness**-
- Italian case study

VULNERABILITY OF THE ELECTRICITY SECTOR

- **July 2013 U.S. D.O.E analyses the impacts of extreme natural events on the power system in terms of security and costs (July 2013 US DOE) + FERC recent studies on the vulnerabilities of the power grid to sabotage and cyber attacks:**
  - Reactions from the media were strong and raised important questions e.g. t*he Wall Street Journal, "US Risks National Blackout From Small-Scale Attack"* - Can Nine Attacks Cause National Blackouts?
  - sabotage of just nine of the United States' 55,000 electric-transmission substations on a hot summer day could turn out the lights across the country for weeks.

U.S. ENERGY SECTOR VULNERABILITIES TO CLIMATE CHANGE AND EXTREME WEATHER, July 2013 U.S. D.O.E



The report illustrates over 30 examples of recent events that heavily damaged the energy system and estimates of the cost of their impact. Based on their cause, impacts are divided into three categories:

- Impacts due to increasing temperatures
- Impacts due to decreasing water availibility
- Impacts due to increasing storms, flooding and sea level rise
- US Congressional Research Service report estimates that storm-related power outages cost the U.S. economy **$20-$55 billion annually.**

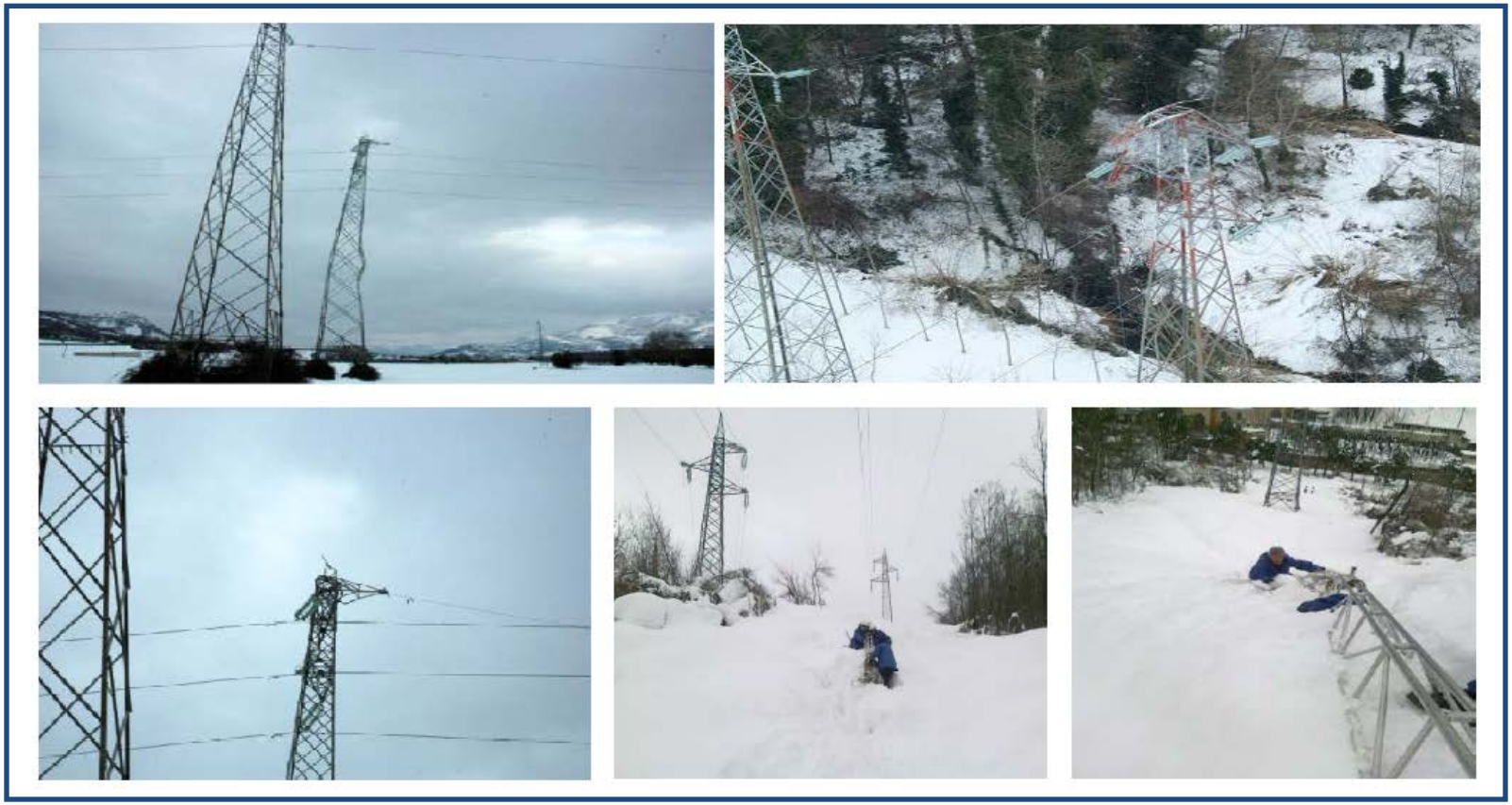
THE CHALLENGE OF EXTREME EVENTS

- **Due to climate change,** extreme meteorological events are becoming more and more frequent and higher in intensity
- **Different kinds of events**: heavy snow, ice concretion, floods, wind storms (country-specific)
- **Impact** of extreme events is not only on **distribution** but also transmission lines
- **Electricity availability** is even more essential (due to electronic controls) also **during emergencies**

THE CHALLENGE OF EXTREME EVENTS

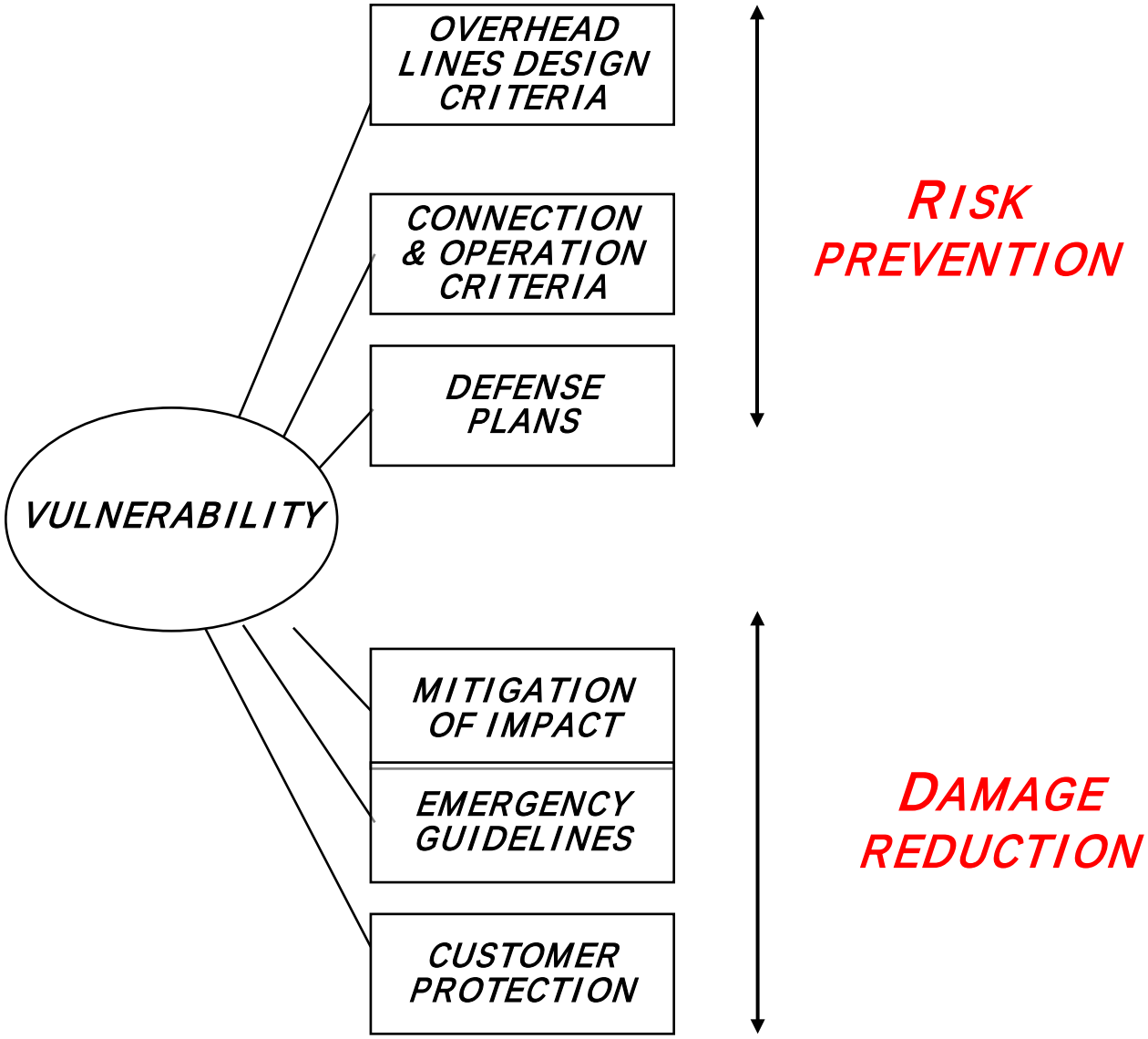
- **In an economic perspective,** disaster prevention is a matter of risk management
- On one side, huge investments costs are required to enhance the robustness of the system
- On the other side, the benefit is to avoid/reduce enormous outage costs for customers
- Given a design level associated to a given risk,
  is the residual risk worth dealing with?

REGULATORS DILEMMAS…

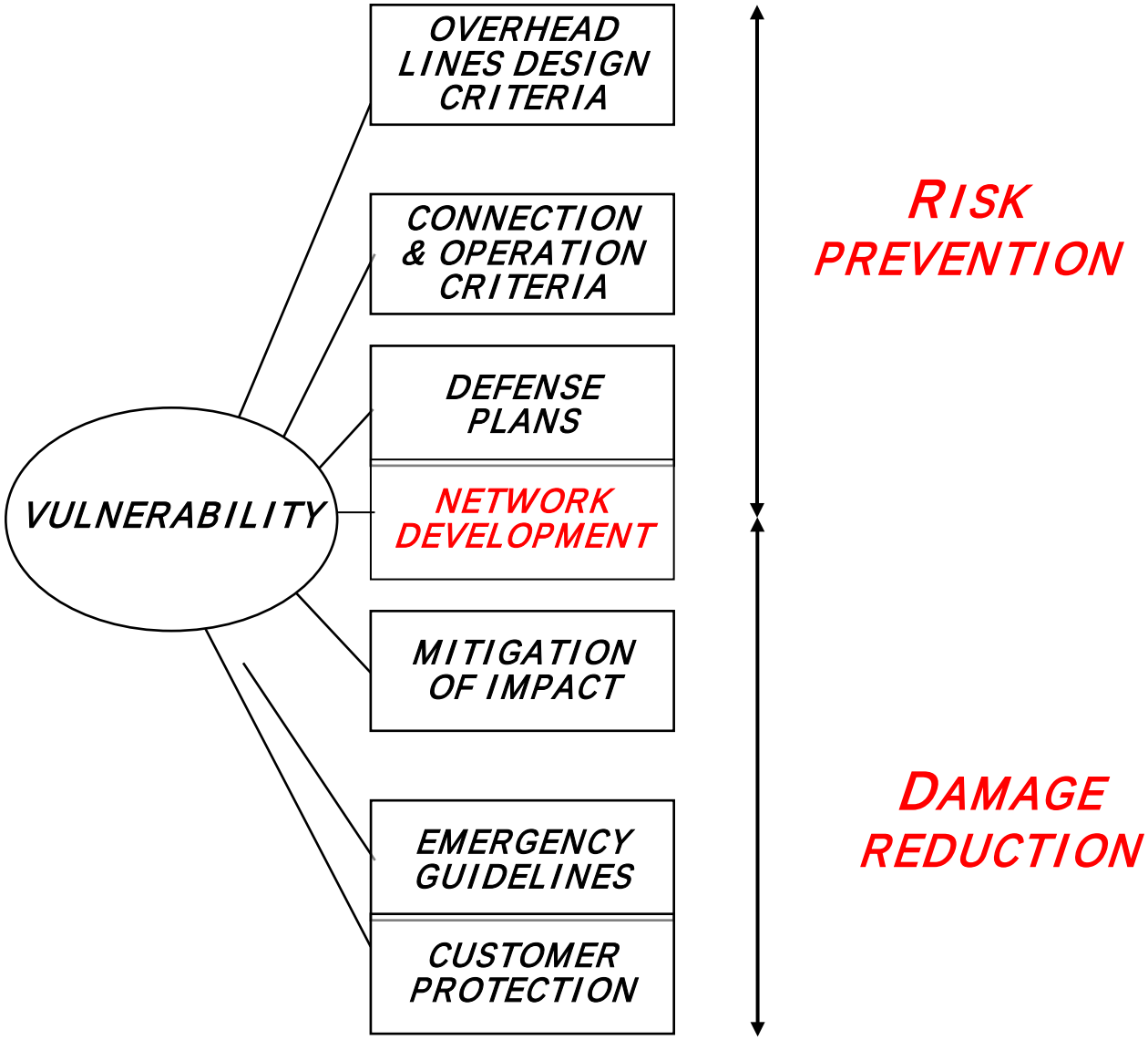


Umbria 2012, Cortina 2013

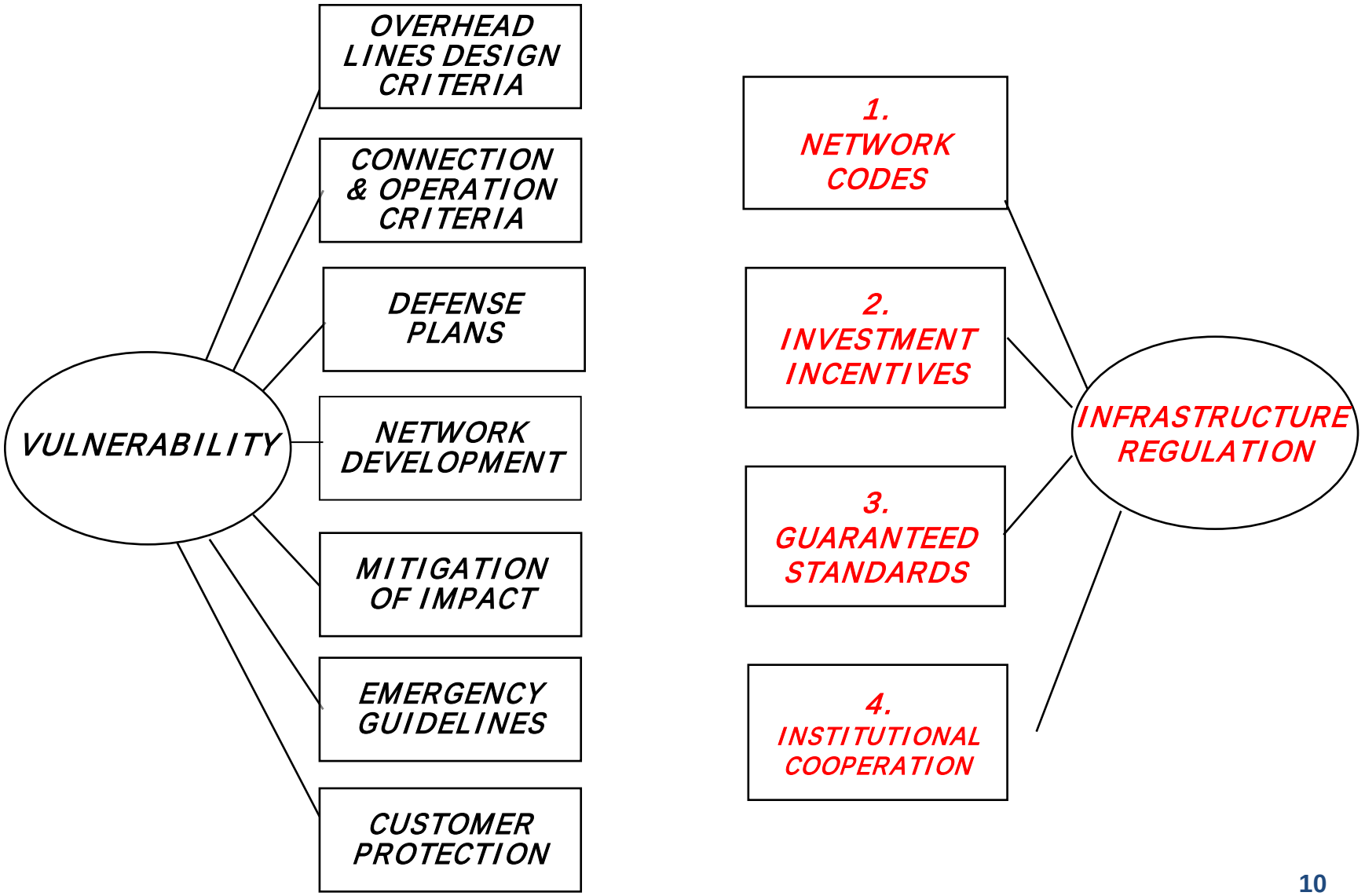
VULNERABILITY HAS MANY DIMENSIONS...



… AND MUST BE SEEN IN A DYNAMIC PERSPECTIVE



WHAT CAN REGULATORS DO?



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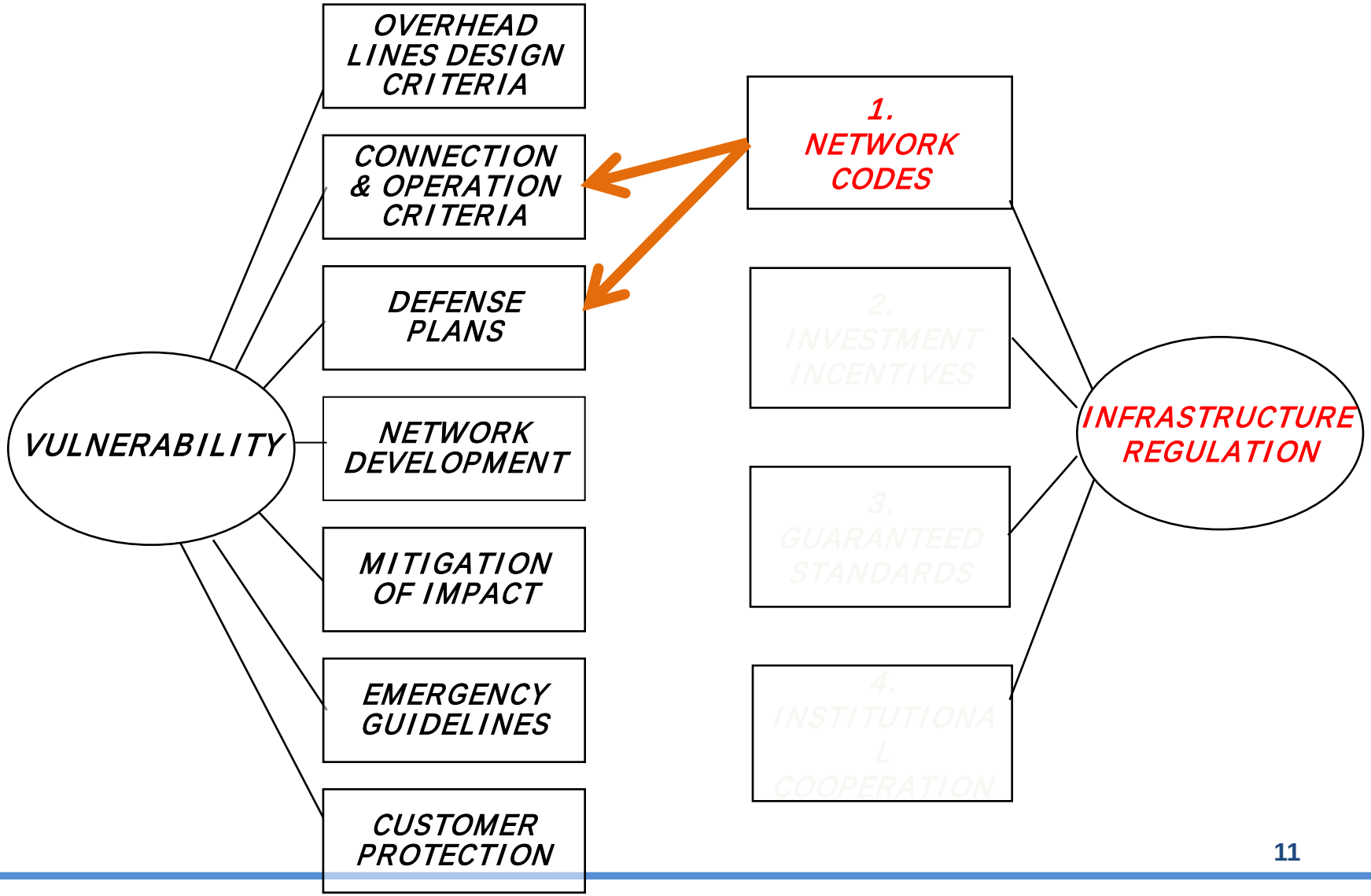
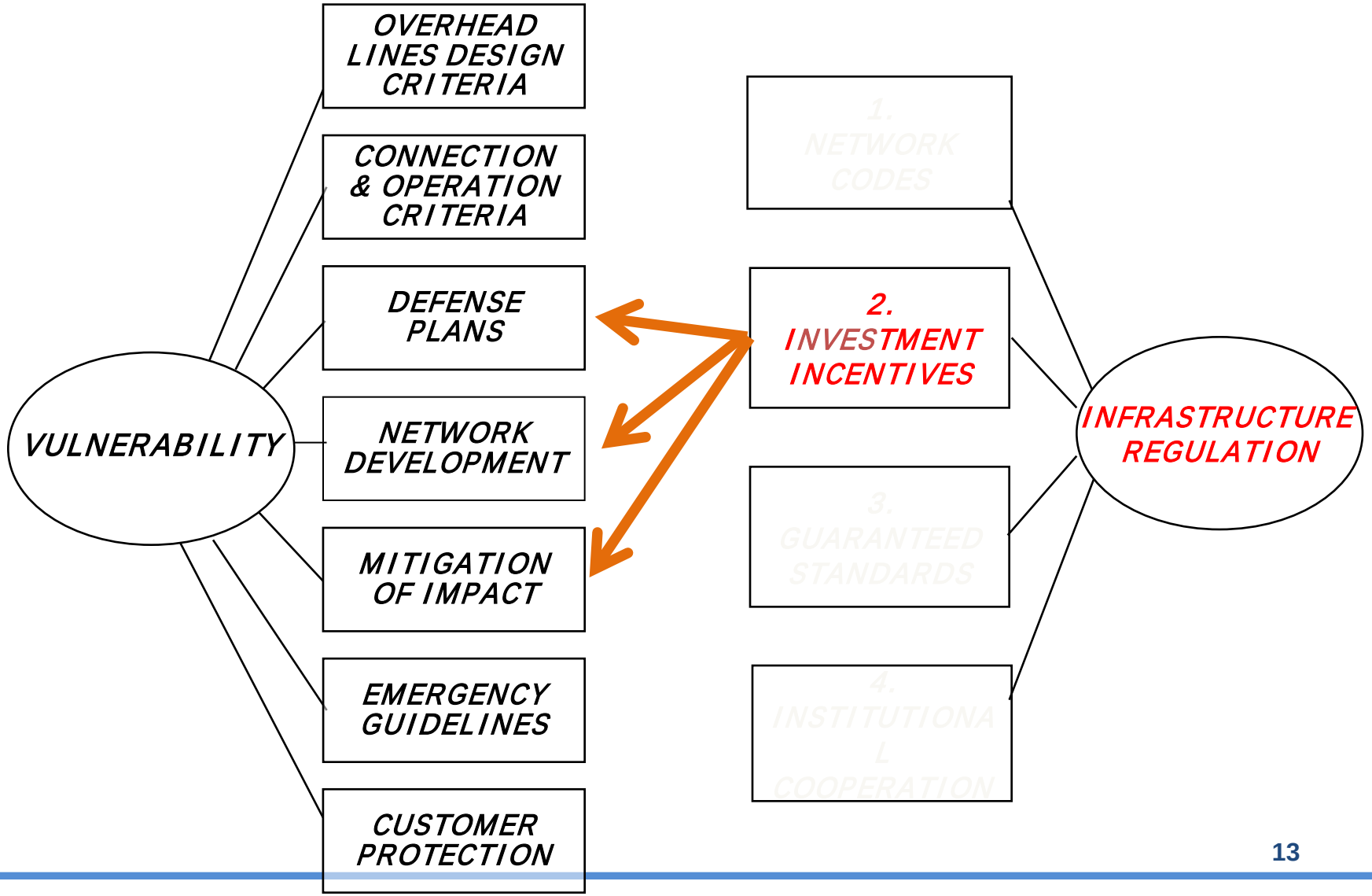


1. NETWORK CODES

- **Connection requirements** (EU-wide)
  - Extremely relevant esp. in the RES revolution
  - Lesson learnt after 2006-11-04 EU-wide event (frequency perturbation and separation of interconnected European network): a lot of distributed generation was disconnected and this increased the problem instead of contributing to solve it
  - New Requirements for Generators (RfG) in the new EU Network Code: enlarged frequency tolerance window for all generators (not only for HV-connected units but also MV-LV)
- **Operational security code** (EU-wide)
  - Due to intermittent generation, increased trade transits and close-to-real-time generation allocation, there is a need to enhance predictability
  - Coordination and information (awareness) of TSOs not only for their own system but at wider levels (regional and European)
  - Increased TSO-DSO cooperation: data exchange for operational planning and scheduling

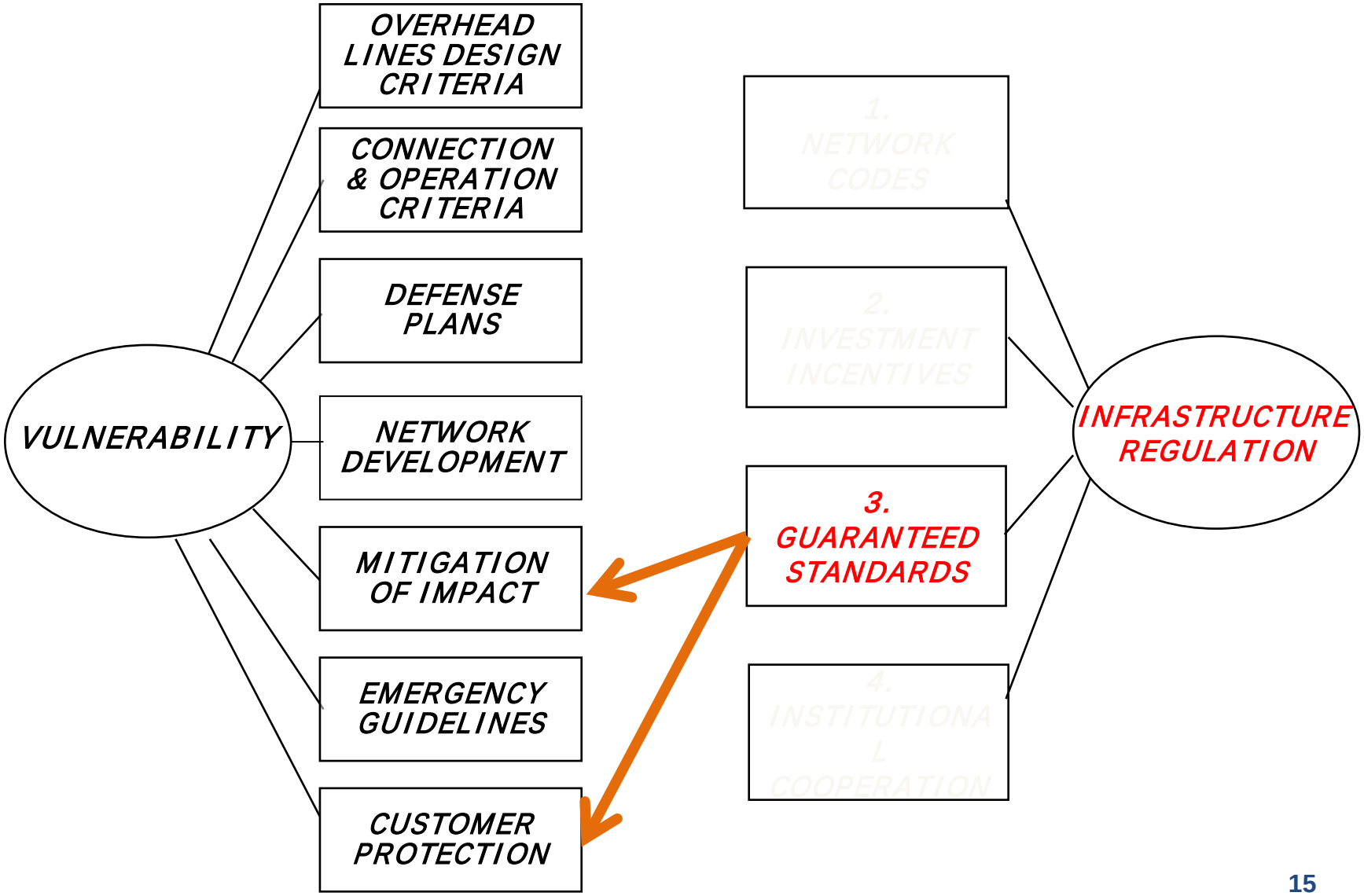
WHAT CAN REGULATORS DO?



2. INCENTIVES FOR INVESTMENTS

- **Output-based incentives**: reward/penalty regulation for reducing interruptions
  - Normally, extreme events are out of the scope for this kind of regulation (extreme events are fairly considered «*force majeure*»)
  - Cap to maximum revenue risk for TSOs and DSOs due to regulatory penalties
  - In Italy:
    1. only for transmission, *force majeure* events are included in the QoS incentive regulation up to 500 MWh-ENS;
    2. for distribution a statistical method for identifying perturbated periods excluded by QoS regulation has been developed with the help of Math. Dep't of Milan Technical University
- **Input-based incentives**: useful when it's difficult to measure events in the short term (i.e. extreme events)
  - Extra-WACC is recognised for some specific «priority projects»:
    1. Distribution: investments for increasing HV network meshing
    2. Transmission: investments for implementing Syst. Defense Plan

WHAT CAN REGULATORS DO?



3. GUARANTEED STANDARDS

- **Guaranteed standards for long interruptions** (Italy)
  - Guaranteed standards are applicable to both normal and exceptional events, independently of interruption causes

    Urban areas: LV 8 hours MV 4 hours
    Suburban areas: LV 12 hours MV 6 hours
    Rural areas: LV 16 hours MV 8 hours
  - Distribution companies must pay compensations to customers for unfulfilling guaranteed standards (including events related to force majeure and events related to transmission network fault)
  - In case of exceptional events, distribution companies paying compensations to customers are back-compensated through a dedicated fund
  - All customers put a little money in the fund
  - Both TSO and DSOs are incentivesed in order to improve their performance in "normal conditions"
  - Companies must put money in the Fund according to their actual quality (net of exceptional events)
- Very differentiated regulation among countries (see table)

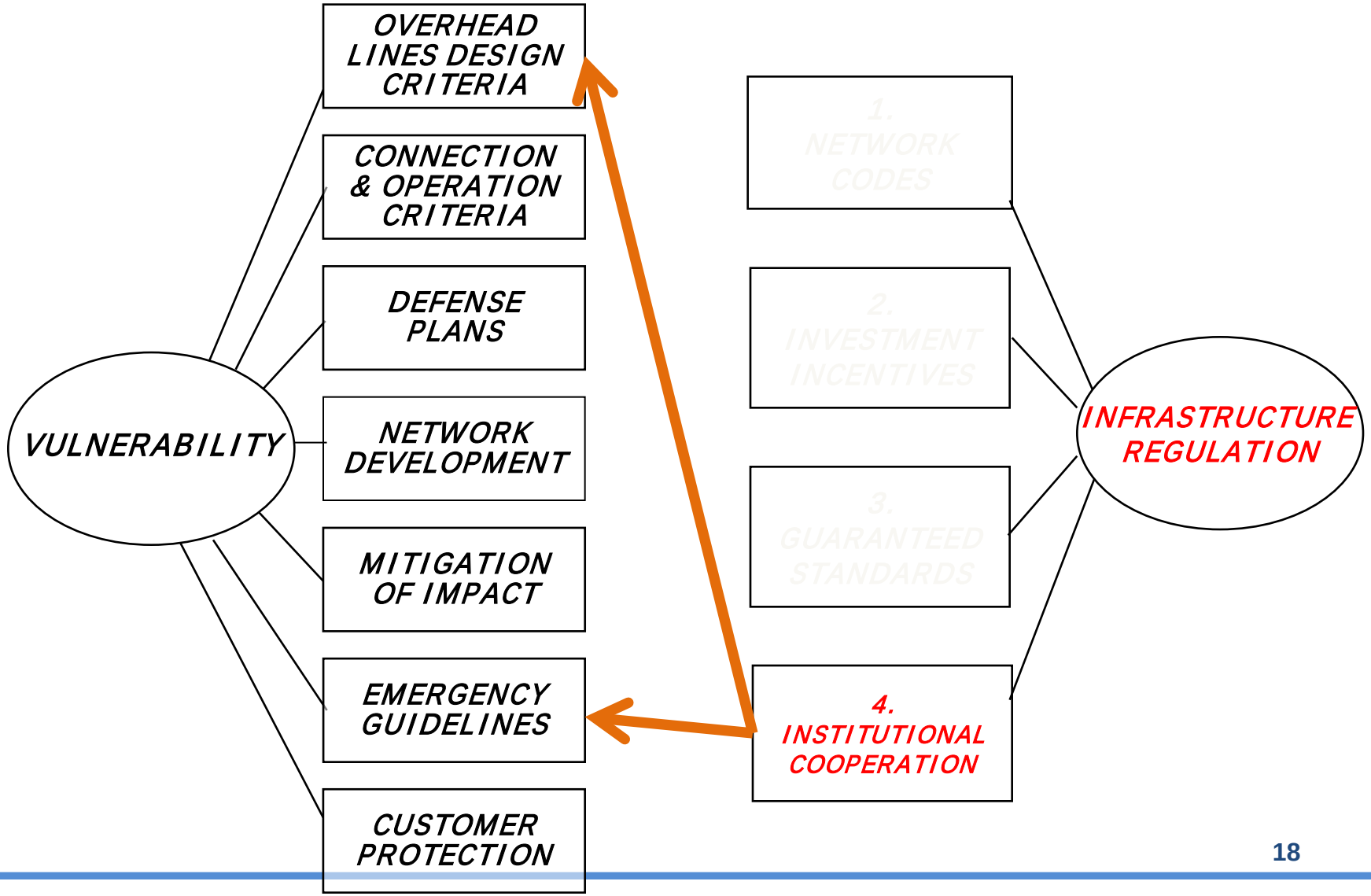
GUARANTEED STANDARDS

Territory / *Country*	URBAN (cities)	SEMI-URBAN (towns)	RURAL (villages)
FRANCE	**6 h** *(MV and LV users, EXCLUDED exceptional events)*		
GREAT BRITAIN	**18 h** *(MV and LV users, normal conditions, excluded trasmission)* **24 h up to 100 h** *(exceptional events according to magnitude)*		
ITALY	**4 h** *(MV users)* **8 h** *(LV users)* *ALL events*	**6 h** *(MV users)* **12h** *(LV users)* *ALL events*	**8 h** *(MV users)* **16 h** *(LV users)* *ALL events*
SWEDEN	**12 h** *(EXCLUDED «out of DSO's control» events and large blackouts)*		
IRELAND	**24 h** *(EXCLUDED exceptional events and transmission network incidents)*		

Guaranteed standard for interruptions [hours]

Source: *CEER Task Force on Quality of Supply, 3rd Benchmarking Report, 2005;*

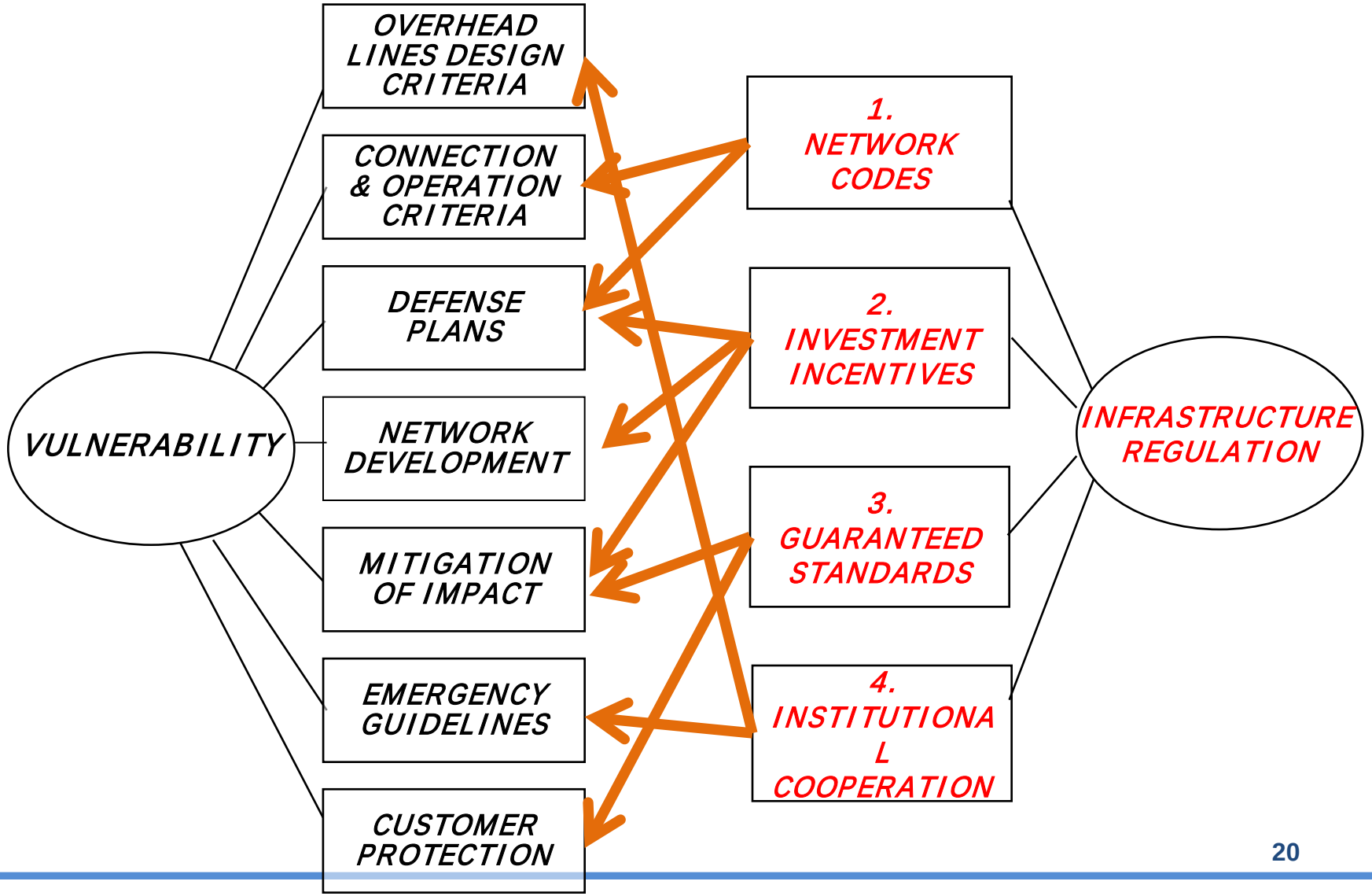
WHAT CAN REGULATORS DO?



4. INSTITUTIONAL COLLABORATION

- **Overhead lines design criteria** (Italy)
  - In Italy the design criteria for overhead lines were still based on low robustness thresholds (as it was for initial electrification)
  - The Italian Regulatory Authority promoved in 2005-2006 a general interest research project to re-draw the map of ice-related risk taking into account of several factors
  - This aspect is not under the jurisdiction of AEEG but is ruled by a Government Department (Infrastructure and Public Works)
  - The institutional cooperation led to a new decree for overhead lines design criteria based on the new risk map and new engineering criteria harmonised at European level
- **Guidelines for crisis management** (Italy)
  - During an emergency, it's essential to deploy all activities for restoring the electric service in a coordinated and planned manner; communication with public is also crucial
  - AEEG promoted the development of Guidelines for crisis management by the Electric Standardisation Body (CEI)

CONCLUSION: THERE IS LARGE SCOPE FOR REGULATORY INTERVENTION IN DEALING WITH THE CHALLENGE OF EXTREME EVENTS



WHERE TO CONCENTRATE EFFORTS TO MAKE THE ELECTRICITY GRID MORE ROBUST

1. Prevention

Design standards, construction guidelines, maintenance routines, inspection procedures, and recovery practices through the use of innovative technologies.

2. Recovery

Proper resiliency planning ought to provide for rapid damage assessment, prompt crew deployment to damaged assets and readily available replacement components.

3. Survivability

The ability to maintain some basic level of electrical functionality to individual consumers or communities in the event of a complete loss of electrical service from the distribution system, enabling consumers to use distributed generation.

Source: EPRI

THANK YOU FOR YOUR ATTENTION

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