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Sustainability aspects of transitions to low-carbon electricity supplies

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Ref.:

Aviel Verbruggen, Erik Laes. Sustainability assessment of nuclear power: Discourse analysis of IAEA and IPCC frameworks. Environmental Science & Policy 51 (2015) 170-180

Aviel Verbruggen, Erik Laes, Sanne Lemmens. Assessment of the actual sustainability of nuclear fission power. Renewable and Sustainable Energy Reviews 32 (2014) 16-28

Aviel Verbruggen. Self-governance in global climate policy: An essay (2015), 52p.

Overview

Part 1: Sustainability

- **Sustainable Development (SD)**
- **Sustainability Assessment (SA)**
- **Examples: IAEA, IPCC, EU**

Part 2: Energy+Electricity system transitions

- **Role for nuclear power?**
- **Antagonisms with flow renewable power**
- **Terms of Reference**

Sustainable Development: Goal & Substance (WCED)

Goal: Towards Sustainable Development (p.43-65):

Humanity has the ability to make development sustainable – to ensure that it meets the needs of the present generations without compromising the ability of future generations to meet their own needs. (p.8)

Growth control (limitations):

- Demographic developments in harmony with the changing productive potential of the ecosystem (p.44; p.55-57)
- Consumption standards that are within the bounds of the ecological possible and to which all can reasonably aspire (p.44)

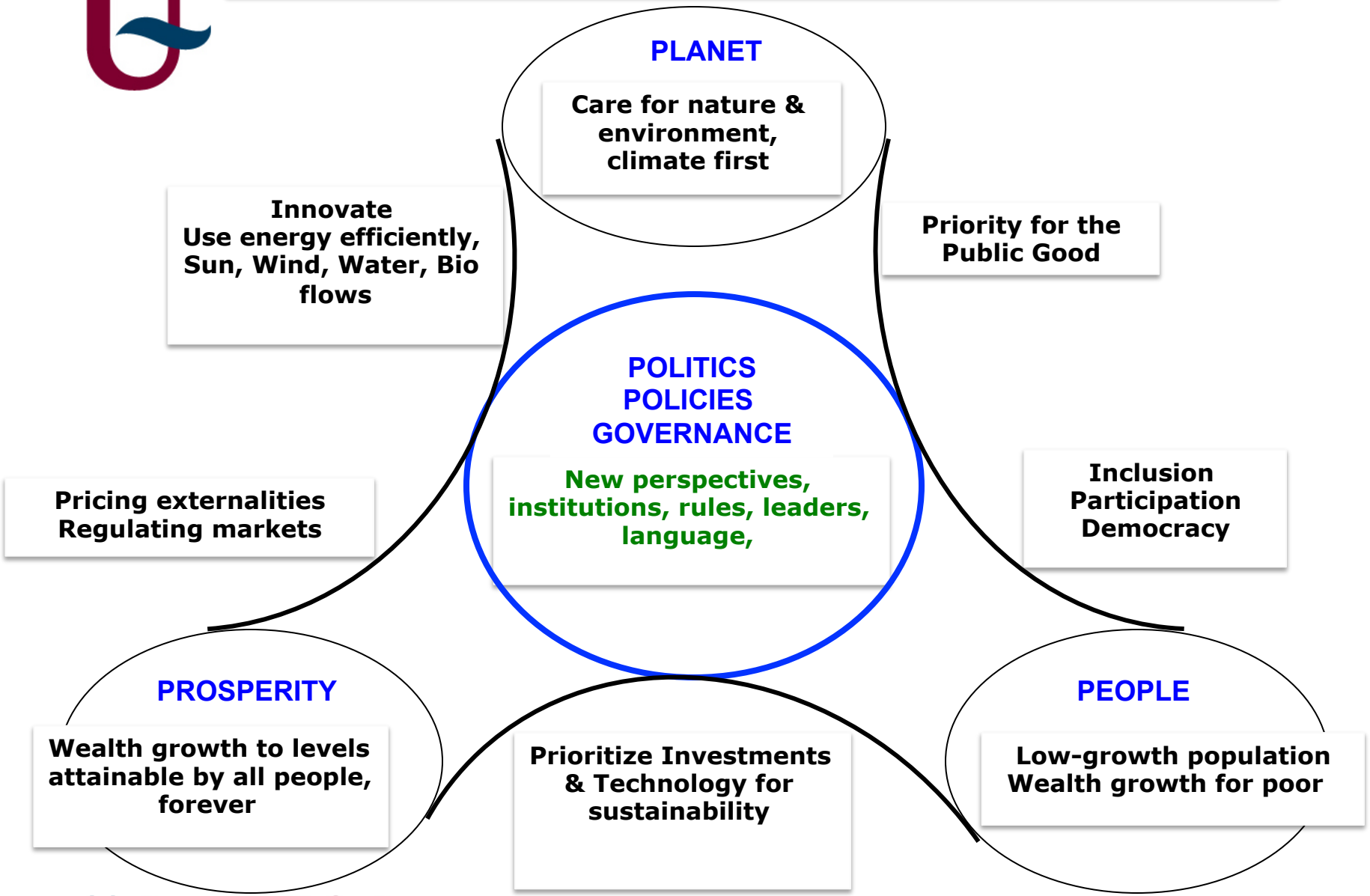
Redistribution (needs of people):

- Economic and social justice within and amongst nations (p.49)
- Welfare growth for the alleviation of poverty
- Redistribution of natural resources in a fair way

Processes of change (p.46, 65):

- Exploitation of resources
- Direction of investments
- Orientation of technological development
- Institutional change; the real world of interlocked economic and ecological systems will not change; the policies and institutions concerned must. (p.9)

Sustainable Development: 4 dimensions (WCED)



Sustainable Development (SD)
Sustainability Assessment (SA)

Sustainable Development

- **NOT vague, abstract, distant idol–worshiped to futility**
- **YES concrete, hands-on, societal constructions**
  - **Solid goals & constraints (like democracy)**
  - **Identify criteria, i.e. attributes to own/ results to obtain**
  - **Stems are normative – branches and leaves specific**

Sustainability Assessments (essential to realize SD)

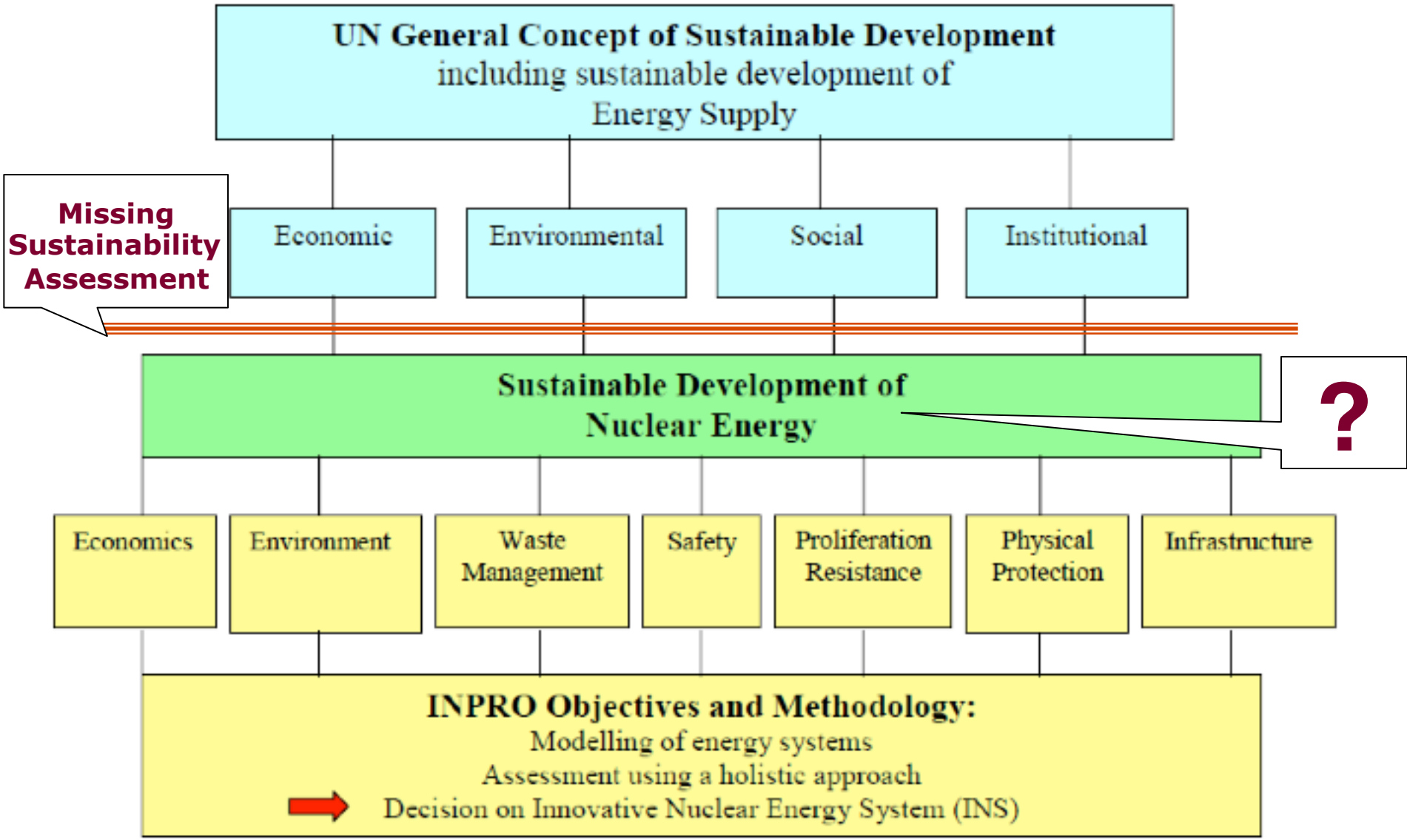
- **NOT technical-economic model runs (IAM – IPCC)**
- **YES technology, project, programme, policy specific**
  - **Actions in major SD change fields (slide #3)**

Our SA focus

Global low-carbon electricity supplies

Nuclear fission power

IAEA – INPRO + comments



Sustainability as Superficial Discourse: IAEA

IAEA assessment framework INPRO

- **Techno-economic modelling asserts 'need' for nuclear power**
- **Without thorough SA, nuclear power is stamped 'sustainable' as an evident prior**
- **Compliance with enacted standards used as acceptance limits (assuming present practices are sustainable)**
- **Sustainability analysis circumvented**

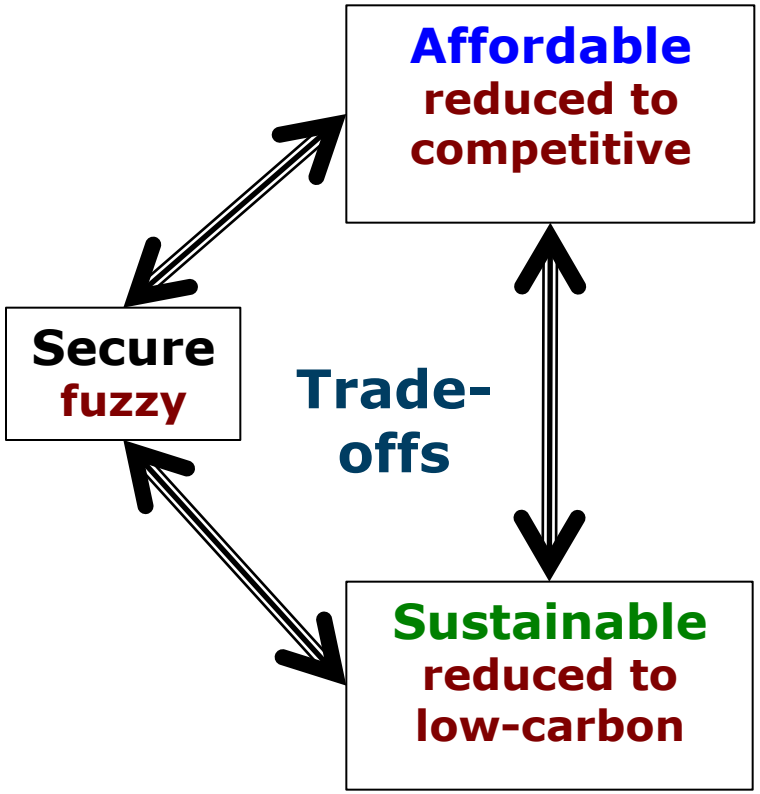
Sustainability as Superficial Discourse: IPCC

IPCC (2014) Assessment Report 5, Working Group III, *Chapter 7. Energy Systems*

- IPCC rejects explicit policy target discourse, because of thin watershed between policy-relevant and policy-prescriptive
- IPCC-2014 failed in assessing the literature on nuclear power
- Ambiguous discourse on nuclear risks:
  - Ch.7 a 'public acceptance' issue
  - SPM (April 2014) approval added risks as 'real' barriers
- Sustainability debate fenced in separate *Chapter 4. Sustainable Development and Equity*

Sustainability as Superficial Discourse: EU energy policy

Policy goals framed as TRILEMMA



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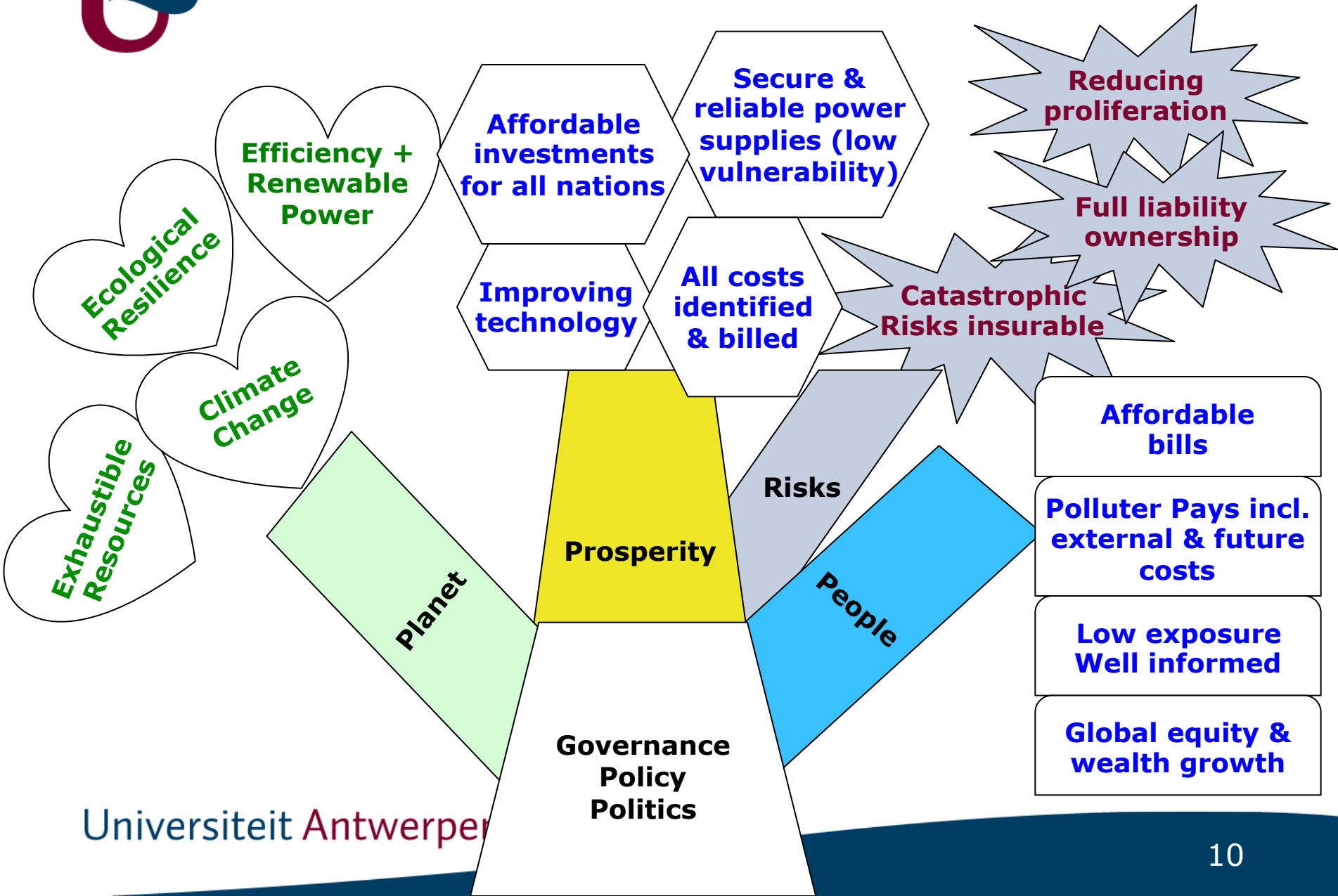
Actual CASCADE

1. Sustainable
= ambient renewable energy flows
= nature decides where & when sources deliver

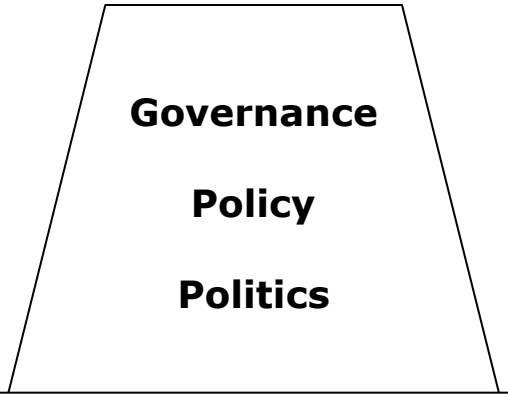
2. Secure
= sufficient energy for SD
≠ all energy wishes instantly satisfied
[security ≠ reliability ≠ obesity]

3. Affordable
by technological innovation
Redundant Renewable Energy capacities
(mainly Photovoltaic PV)

Comprehensive SA of nuclear fission power



Governance, Policy, Politics: Core & Stem of Realizing & Assessing Sustainability



A Global, independent agency studies nuclear power issues and choices in light of its longevity, uncertainties, and irreversible impacts

Independent and accountable nuclear regulatory institutions and processes are established and publicly monitored

At national-regional levels, public interest prevails over private profit, and democratic institutions prevail over technocracy

At local levels, citizens can deliberatively commit in energy system governance, and participate in deployment of local energy systems

Instructive results, available for debate

Planet

- Nuclear power generation as such is low-carbon, but …
- not compatible with full deployment of renewable flow power
- Cheap uranium depletion requests other nuclear technologies

Prosperity

- Full costs difficult to assess, because of uncertainties, eternal time horizons and irreversibility traps
- Nuclear investments and operation expenses increasing
- Nuclear not affordable by developing countries

Risks

- No full-liability insurance by top experts in risk evaluation
- Citizens should <u>not</u> accept civil & military nuclear risks

Instructive results, available for debate

People

Electricity supply for the world's poor is not guaranteed by nuclear power,

impeding the fast transition to highly efficient and renewable low-carbon energy systems

Politics

Technocratic prevalence in centralized electricity systems

Captured regulation is most likely

Need for a global independent agency to review nuclear power issues with a focus on society's best interests + to qualify the nuclear regulatory institutions in countries

Few scientific debate among proponents-opponents of nuclear

. Either nuclear question is sidelined

. Or nuclear seen as ready-to-use, highly productive source

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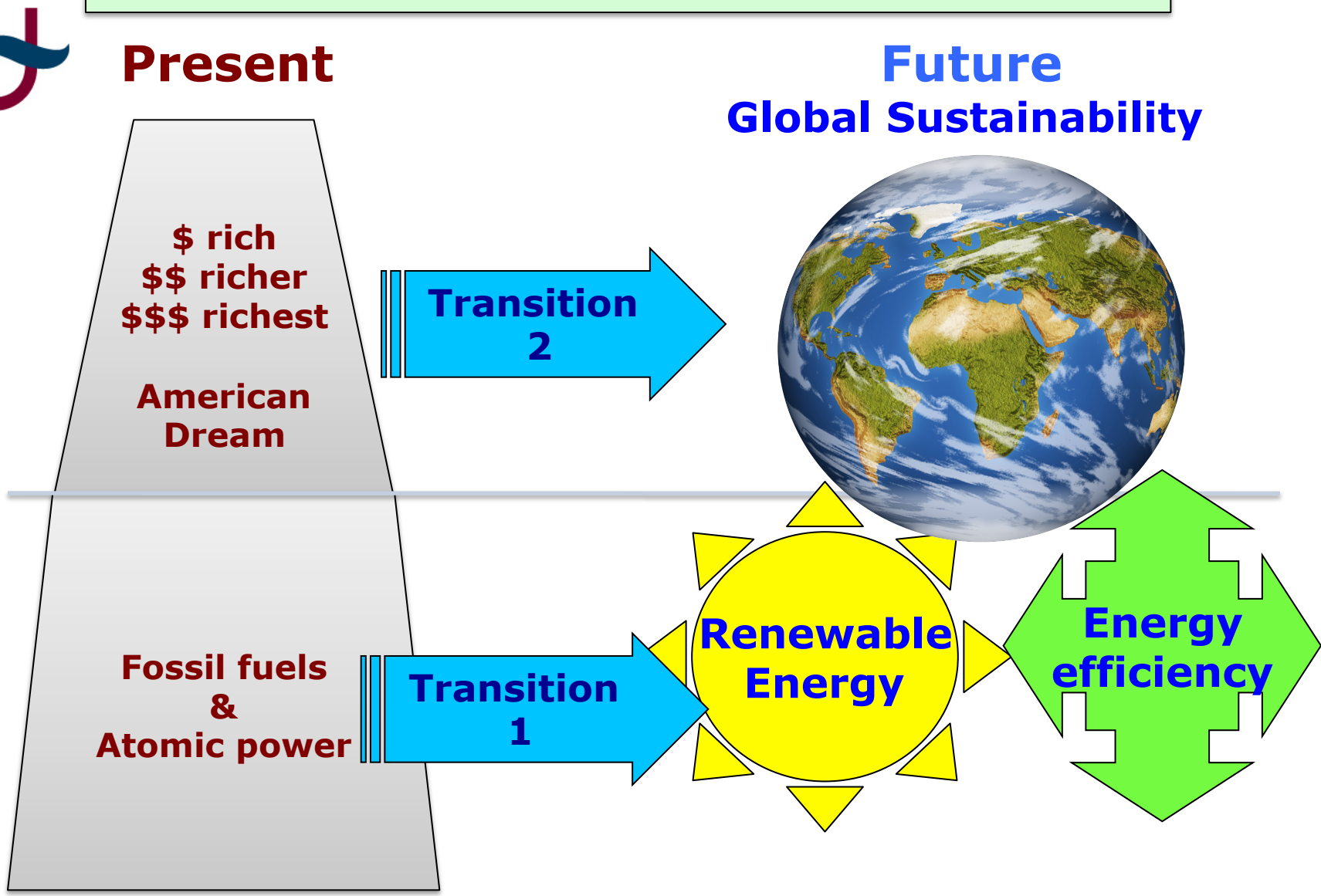
Energy use: substrate of civilizations

Civilization

ENERGY USES
=
TECHNOLOGY
×
ENERGY SOURCES

Substrate

Two-level transitions: energy and societal activities

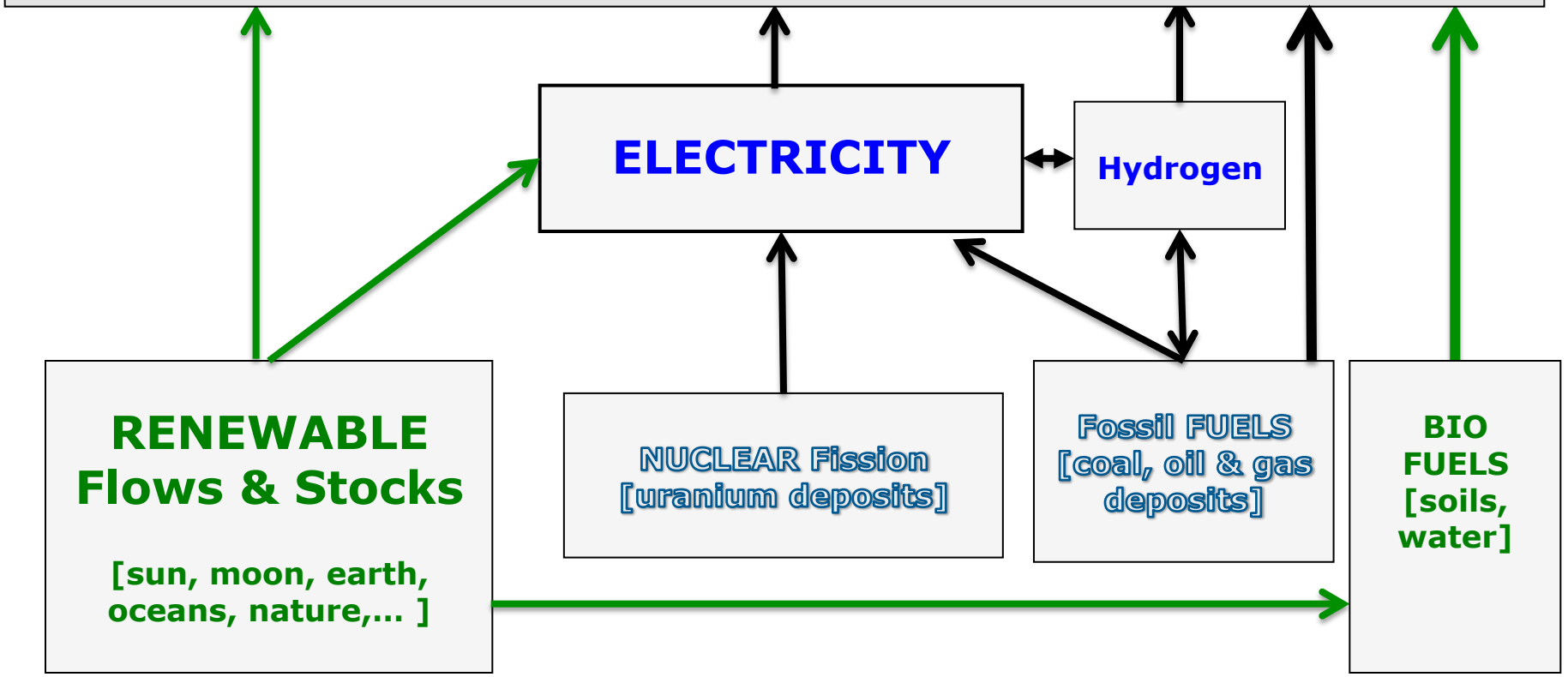


Stylized energy supply systems

Gross Domestic Product (wealth) = spending on numerous Activities

$$GDP = \Sigma_{i=1\ldots\Omega} P_i \times A_i$$

Activities occur in various sectors, e.g.
Agriculture ✣ Industry ✣ Commercial ✣ Transport ✣ Households
Activities require Energy Services
Light ✣ Drive Power (stationary, mobile) ✣ Process Heat ✣ HVAC



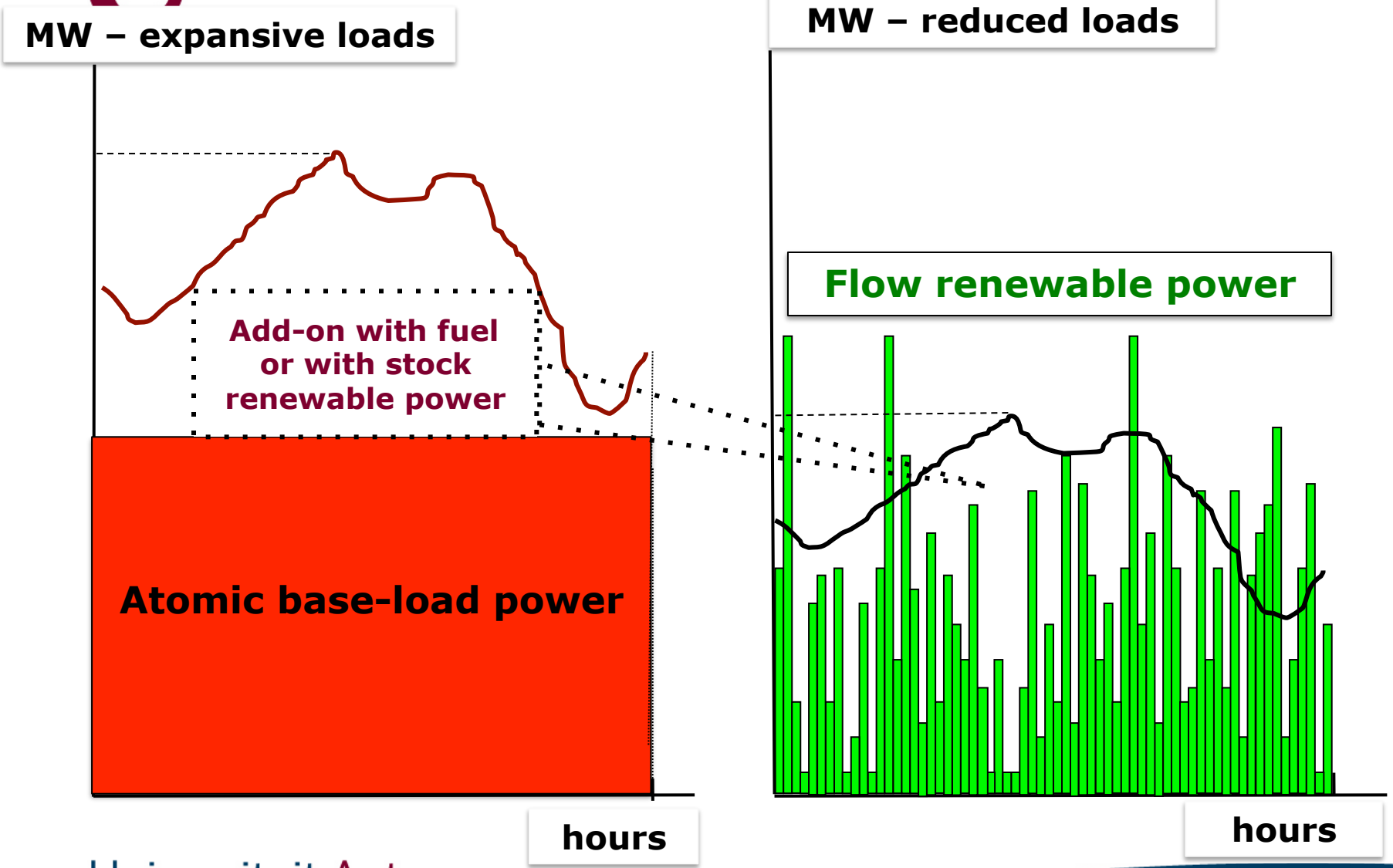
Position of nuclear power in the transition

1. Does nuclear fission power meet the sustainability criteria?
   CRUCIAL CRITERIA ARE NOT MET
2. Is GEN IV more sustainable than present fission power?
   VERY LIKELY NOT
3. Can nuclear fusion bring salvation?
   PERHAPS, BUT NOT BEFORE 2050

If we circumvent SD imperatives and SA results, and only focus on low-carbon aspect, questions remain:

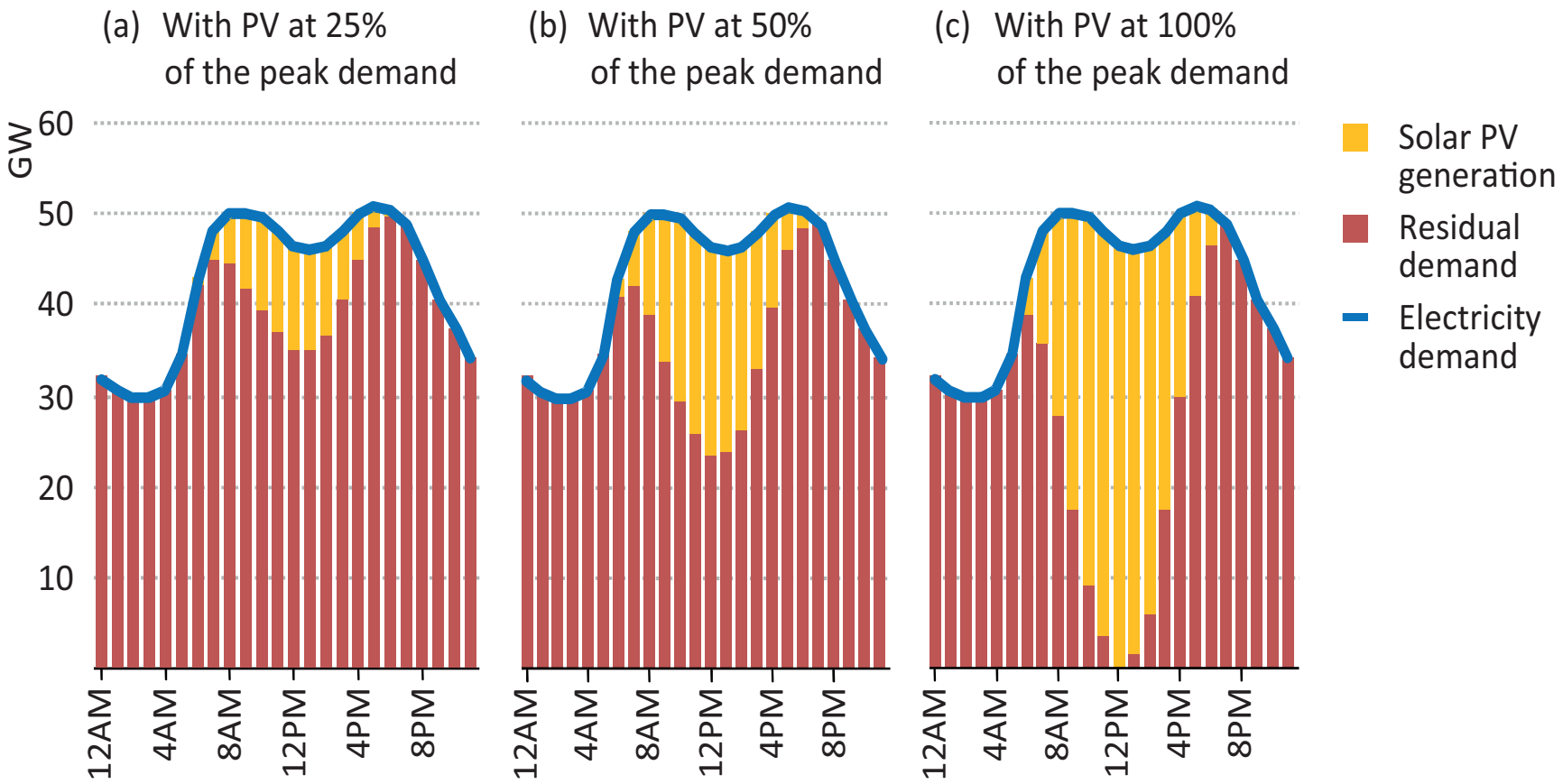
1. Are flow renewable and nuclear power generation compatible?
2. Is smart grid development compatible with unflexible large-scale power stations?
3. Is nuclear power economically competitive?

Nuclear and flow renewable supplies are both inflexible (by different factors)



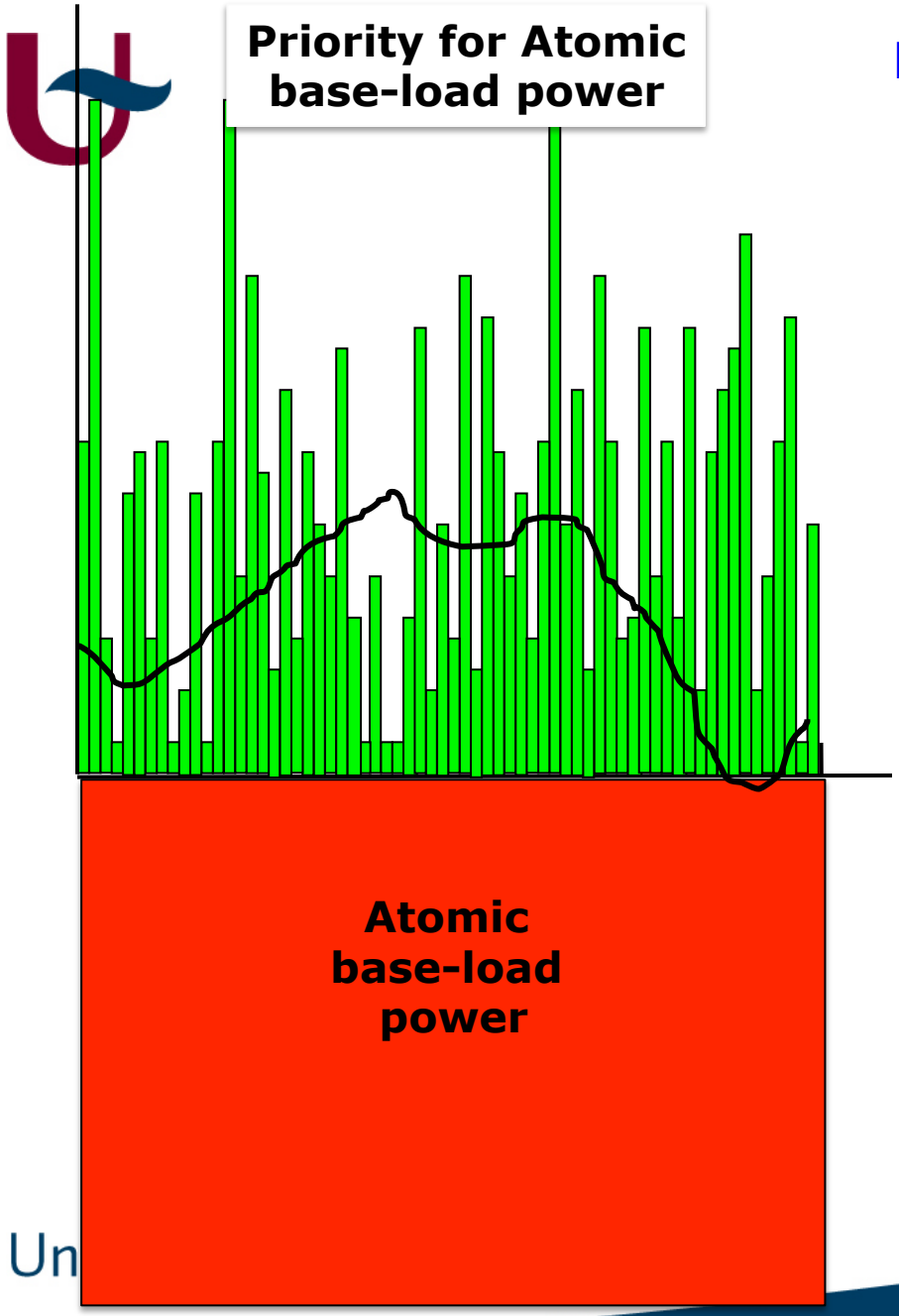
Competing for base-load supplies (PV without storage; no redundancy)

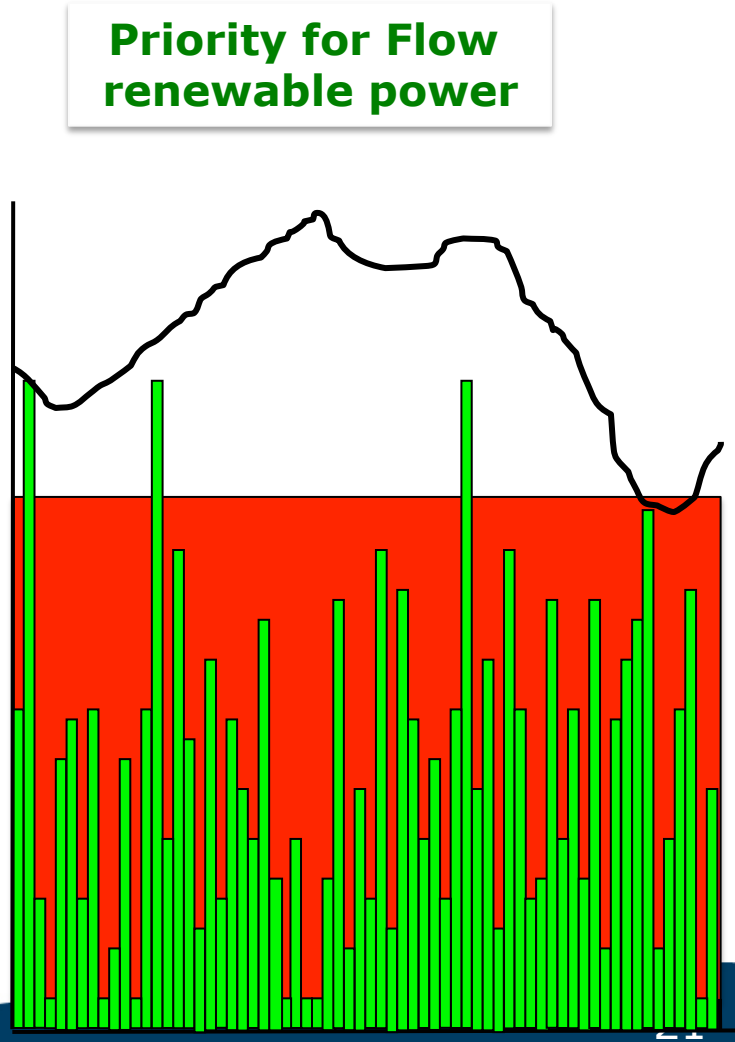
Figure 6.8 ▷ **Indicative hourly electricity demand and residual electricity demand with expanding deployment of solar PV**



Source: IEA Outlook 2013

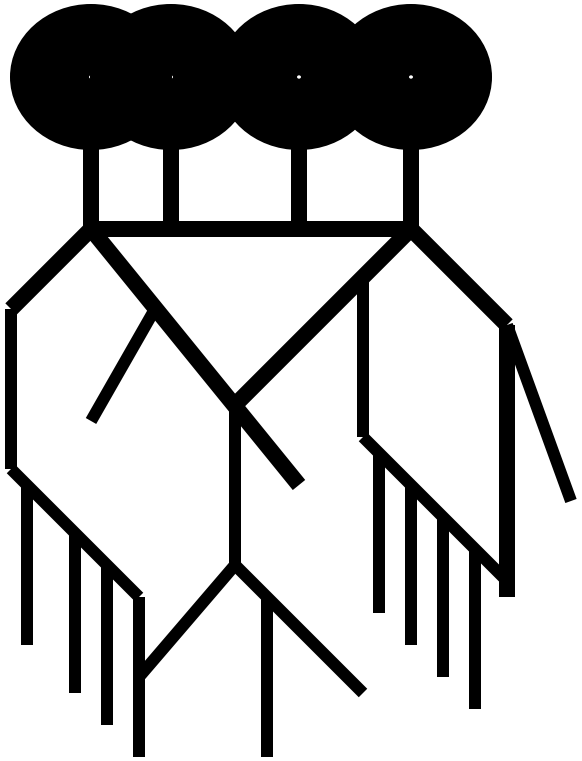
Priority for one ruins the business case of the other



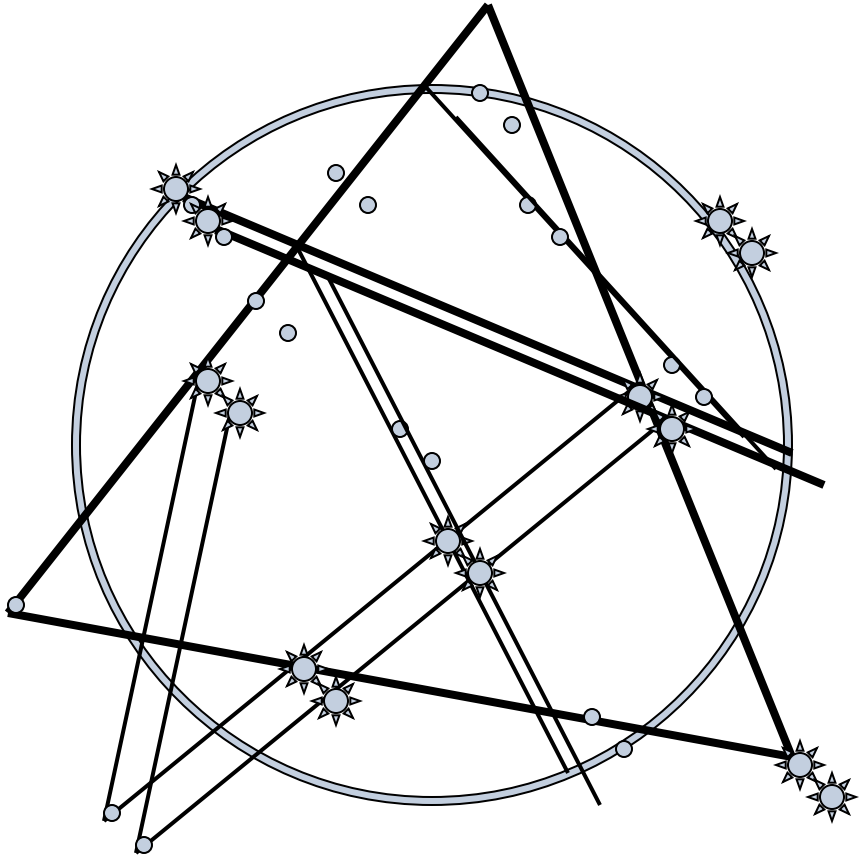


Millions of prosumers request different grid developments

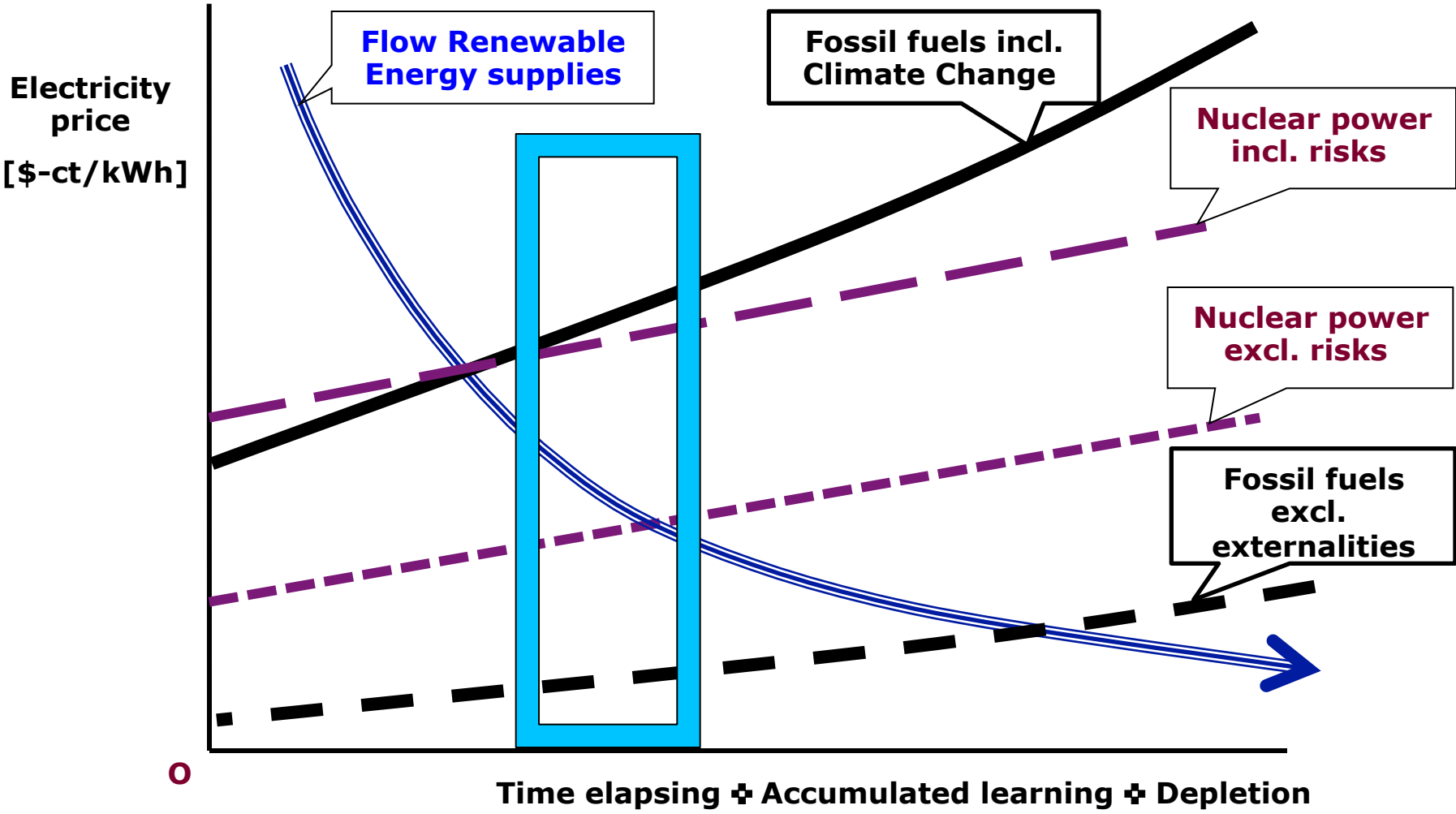
Pyramidal (incumbent grids)



Multilateral (smart grids)



Electricity prices considering learning effects, externalities, risks



Energy Transitions: Terms of Reference

- Develop and deploy cost-effective energy efficiency
- Develop and deploy the sustainable renewable energy supplies (flows and stocks) ⇔ energy 'Pantheon'
- Preference for secure and free local natural flows, harvested by prosumers, and complemented by centralized renewable plants
- Apply 'polluter pays principle': incumbent systems are liable, not challengers building the sustainable future goal systems
- New electricity economics: most capacities not on command but stochastic and redundant (need for public interest regulation!)
- Kickstart the transition, even stranding existing assets

- Redirection of nuclear capability & assets
  - Phased exit of nuclear power generation
  - IAEA: exclusive focus on security and safety (proliferation, waste management)
  - Refocusing and restructuring nuclear R&D