

Resilient Energy Transition

4TU DeSIRE conference on Resilience Engineering
Building Connections for Resilience Engineering Solutions
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Campus of the University of Twente, Enschede

Dr. Milos Cvetkovic
Dr. Thomas Hoppe

Importance of resilient energy systems

- Energy transition requires energy systems to become more resilient.
- To cope with distributed generation and its impact.
- To cope with changing behaviour by energy consumers and prosumers.
- To cope with extreme weather events.
- To cope with other vulnerabilities including cyber attacks.



Energy Transition in The Netherlands

Meer dan 100 partijen verlagen de CO₂- uitstoot van Nederland met 49% ten opzichte van 1990 via het

Klimaatakkoord



Governing the Energy Transition

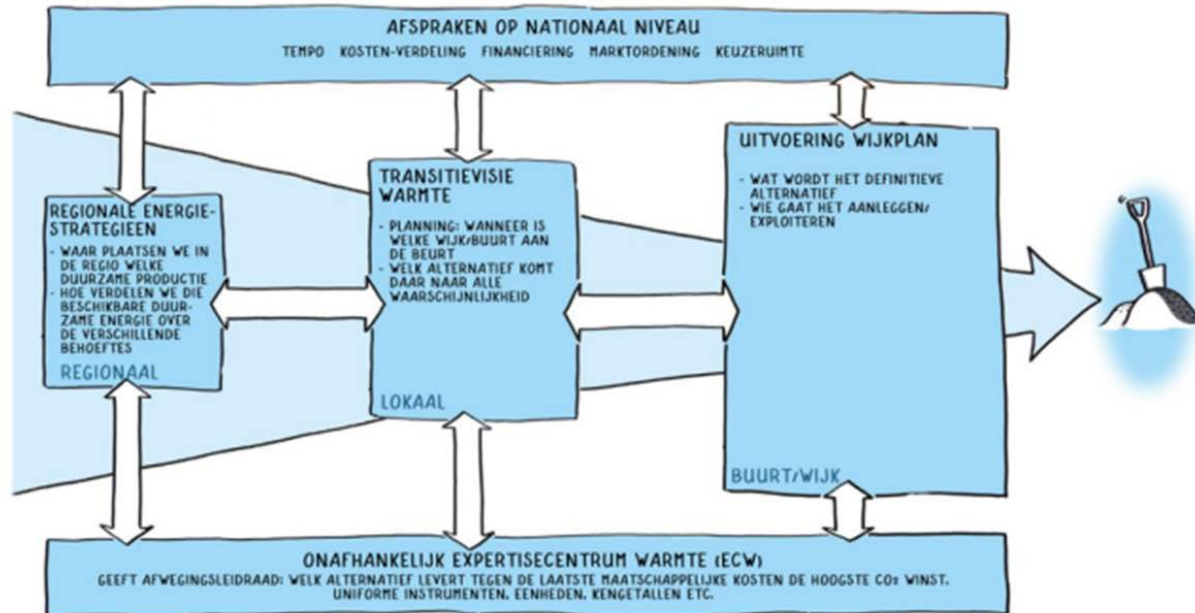
- Current developments:
 - Climate Agreement
 - Heat transition
 - Regional energy strategies



Multi-level governance

LEREN VAN NEDERLAND

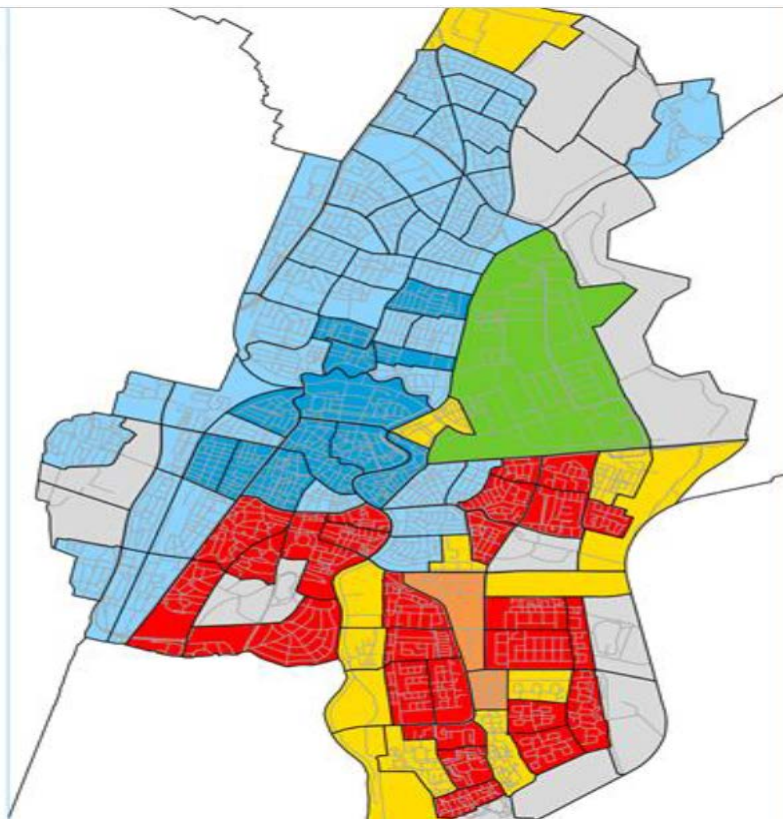
multi-level proces



Energy visions at neighbourhood level

Warmtetechniek eindbeeld

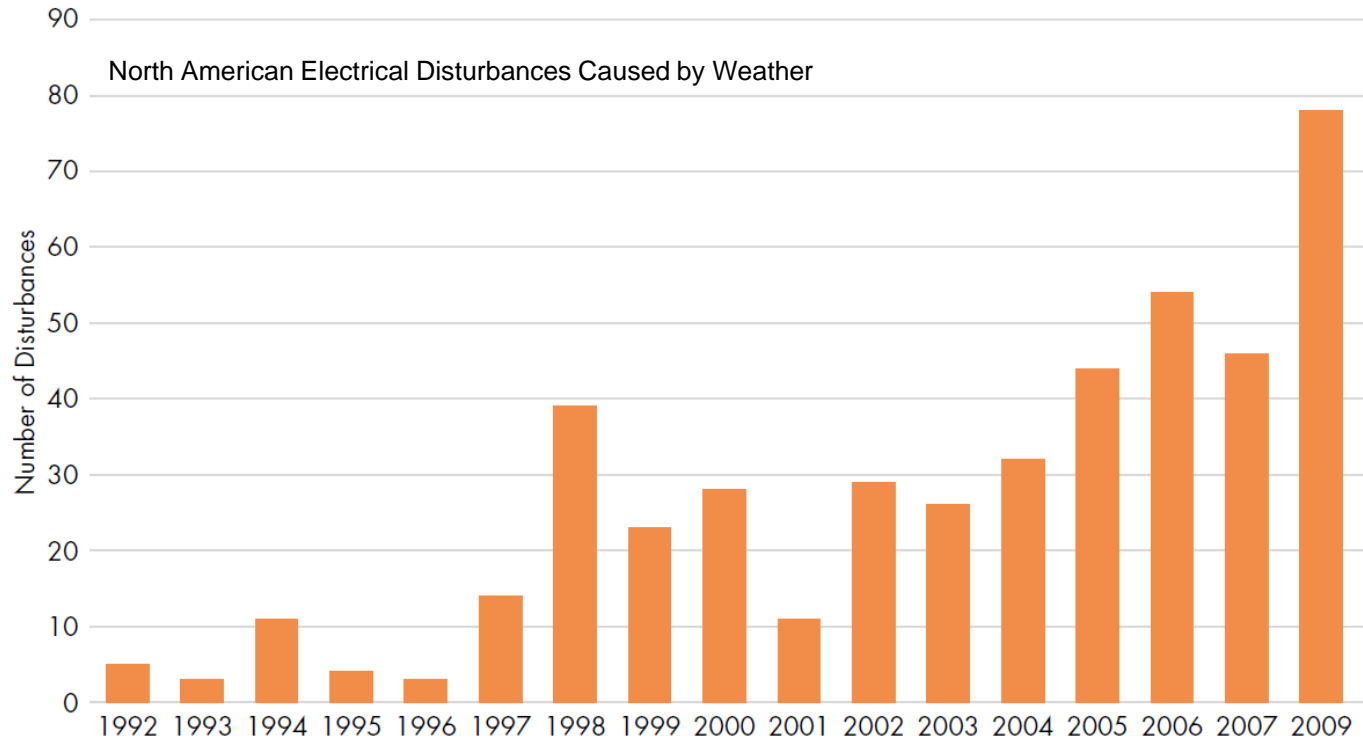
- Elektrische warmtepomp
- Hybride warmtepomp
- Warmtenet MT
- Mogelijk Warmtenet MT
- Diverse technieken
- Meerdere technieken mogelijk
- Onbekend



- Proposed technology per neighbourhood
- Based on lowest costs
- Determined with input parameters (costs, efficiencies) for several currently existing technologies & some restrictions (e.g. limited green gas)
- !! Financing plays a big role in this!

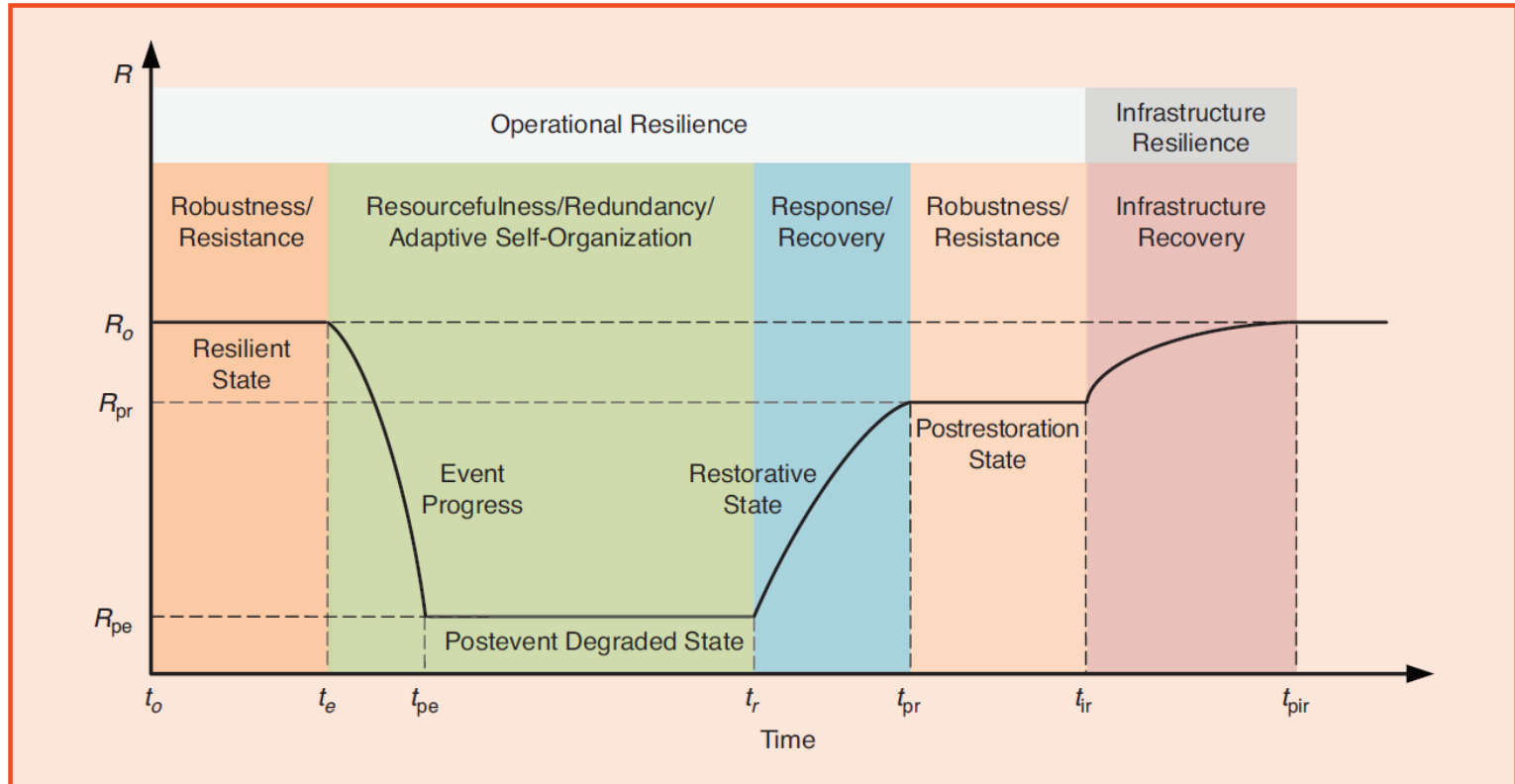
CE delft report
Haarlem, 2018

Challenges for grid operators



EPRI, Electric Power System Resiliency: Challenges and Opportunities, 2016.

Grid operators and resilience

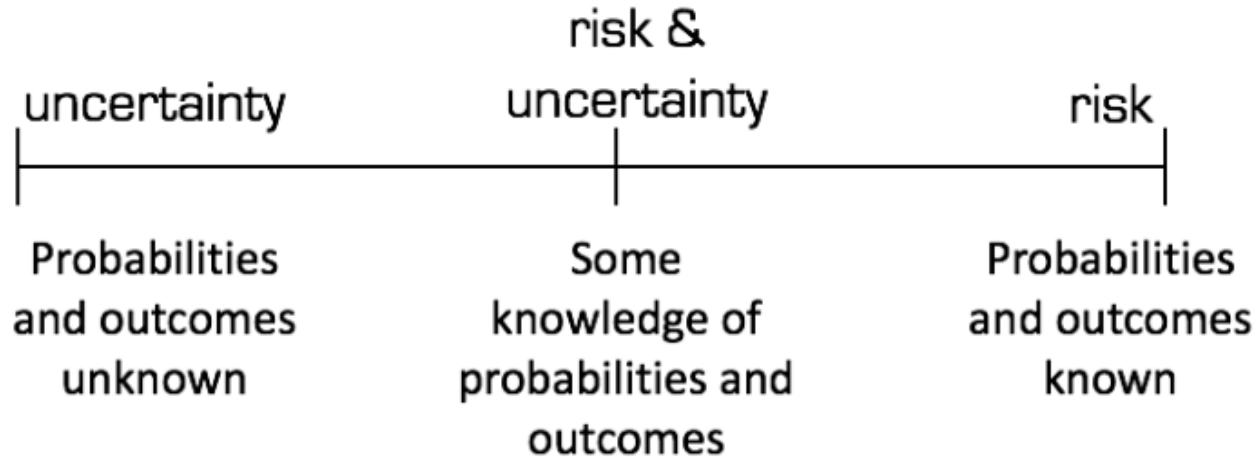


From reliability to resilience

- Traditional reliability notions
 - N-1, reliability indices (SAIDI, SAIFI)
 - Grid reconfiguration, WAMPAC
- From risk-based to resilience-based thinking
 - Low probability high impact events
- ICT resilience and Cyber-security

Borrowing from other fields

Risk & Uncertainty Continuum



Source: Casavant, Kenneth, Infanger, and Bridges

What does it mean to be resilient?

- Definition
- Metric
- Preparedness procedures
- Mitigation strategies
- Portfolios on boosting resilience
- Regulatory framework in support

Next presentations

- 2 on societal relevant issues
- 2 on technical issues relevant to grid operators