College Tour

Dr. ir. Marjan van den Akker – Laurens Stoop MSc

Background: Marjan van den Akker

Master Mathematics 1990
TU/e, specialization discrete mathematics

PhD Mathematics 1994
TU/e, planning and scheduling, integer linear programming

Research engineer, Netherlands Aerospace Centre NLR, 1995-2000
Modelling, simulation, optimization in Air Traffic Management

Assistant/Associate professor Algorithms and Complexity, UU, 2001-

- Scientific coordinator Utrecht AI & Mobility Lab
- Coordination master COSC
- Course Optimization for sustainability (COSC)
- Research: algorithms for planning and scheduling, smart energy systems, public transportation, green logistics

Background – Laurens Stoop

Bachelor Aerospace Engineering, 2011
At TU Delft; to little theoretical depth

Bachelor Physics and Astronomy, 2012-2016
UU, Particle physics and Cosmology

Master Climate Physics, 2016-2018
UU, Extreme impacts of weather, Atmospheric chemistry

PhD Research in Algorithmic data analysis & energy resources, 2018-
UU, Combined Informatics & Energy Science

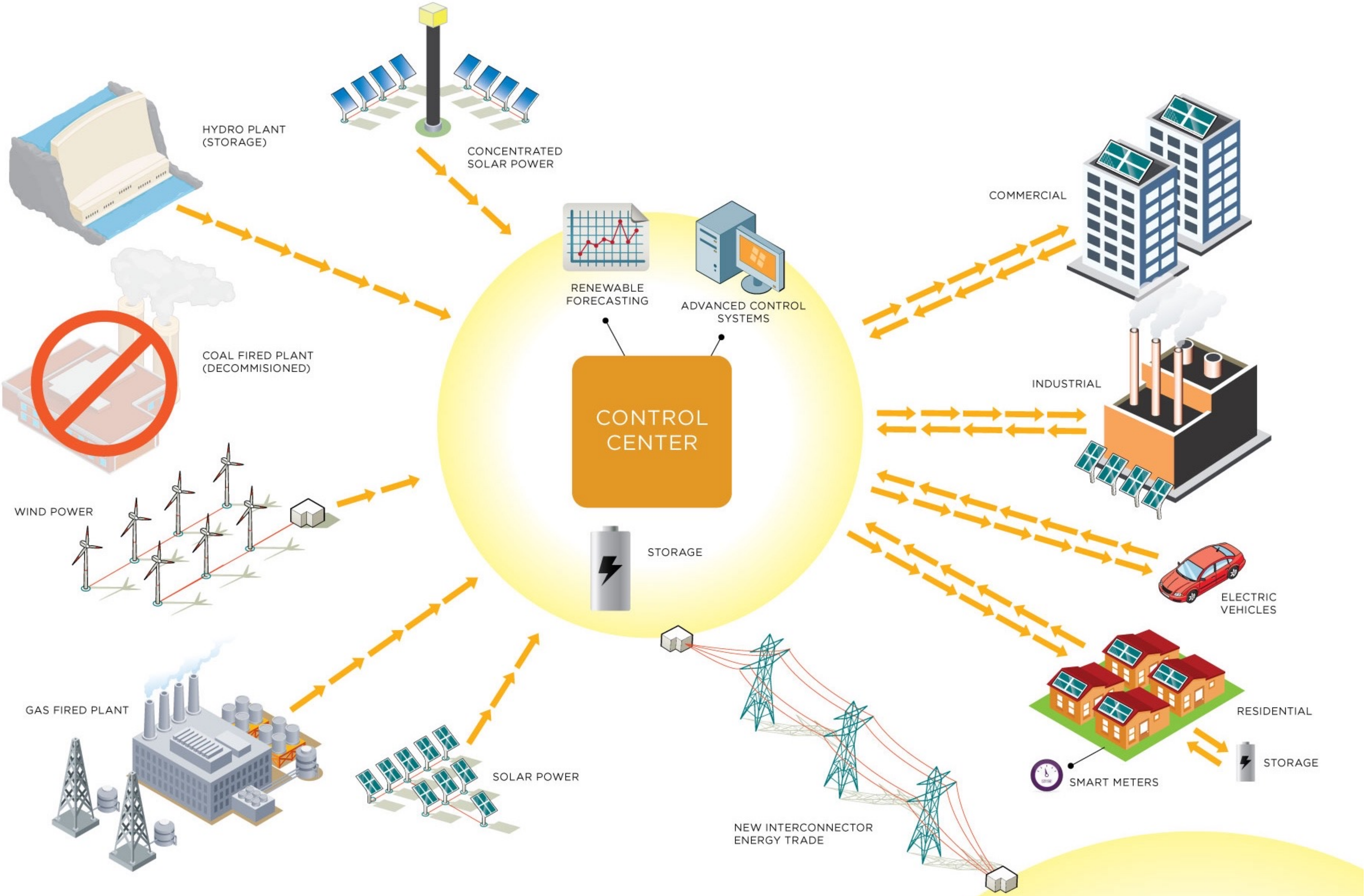
ACDC—ESM project

Algorithmic Computing and Data-mining for Climate integrated Energy System Models

Transition to renewables

Increased weather dependence

Adverse circumstances disrupt the grid



Assessment of future power systems, MvdA 1/3

How to deal with more renewables:
- Complement by other generators: flexibility?
- Storage or transmission: expense, efficiency loss?

Are the scenarios with many renewables feasible and affordable?

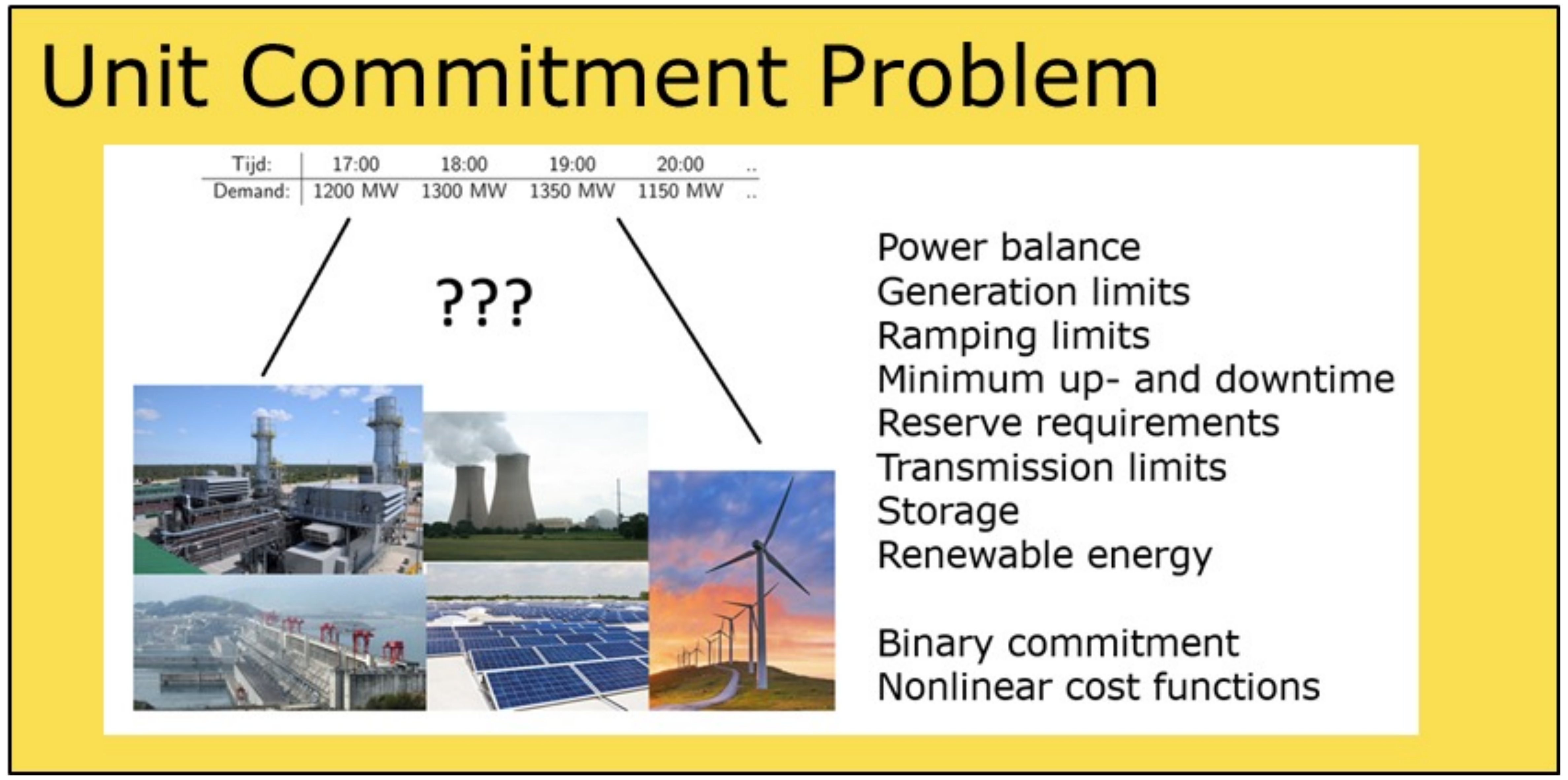
Tijd:	17:00	18:00	19:00	20:00	..
Demand:	1200 MW	1300 MW	1350 MW	1150 MW	..

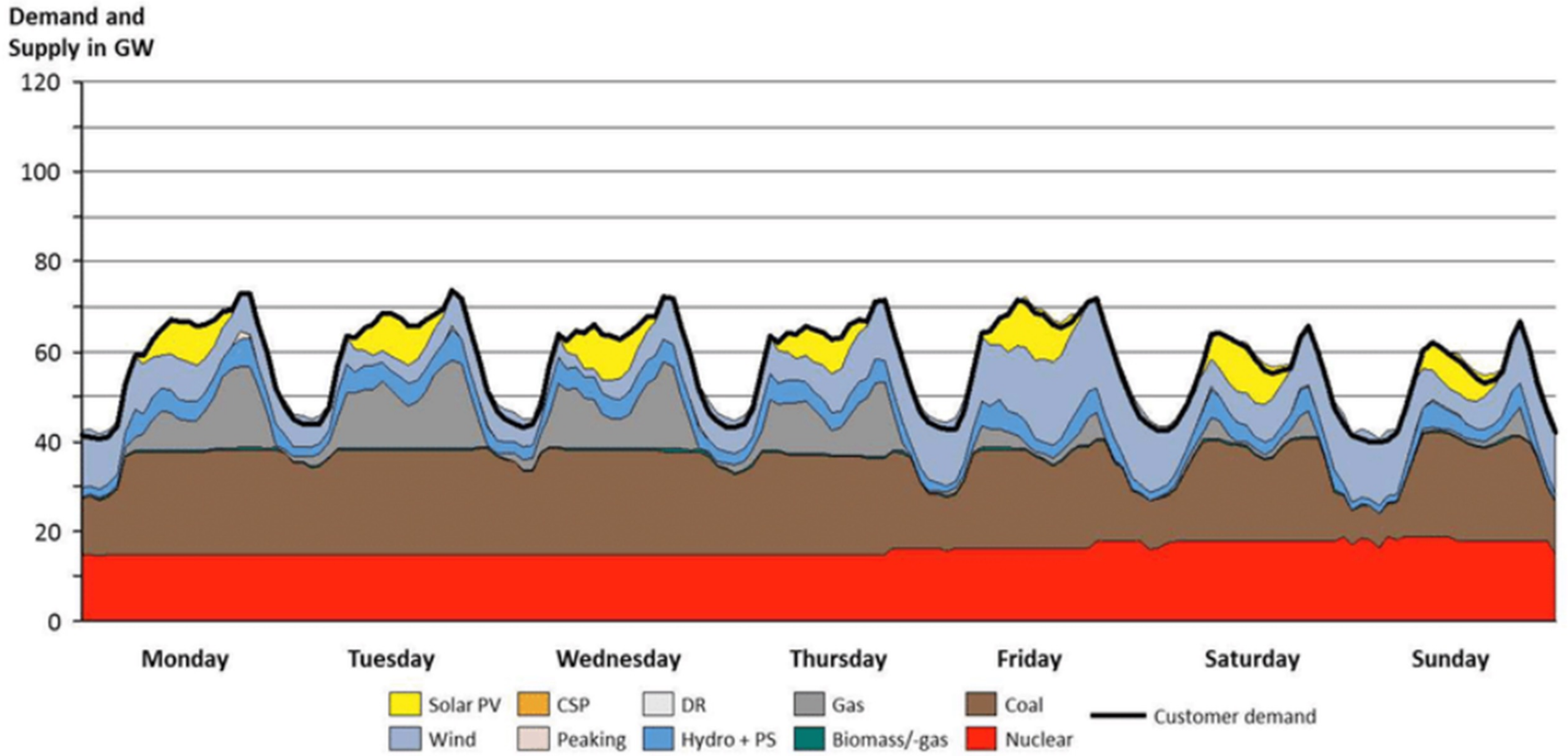
???

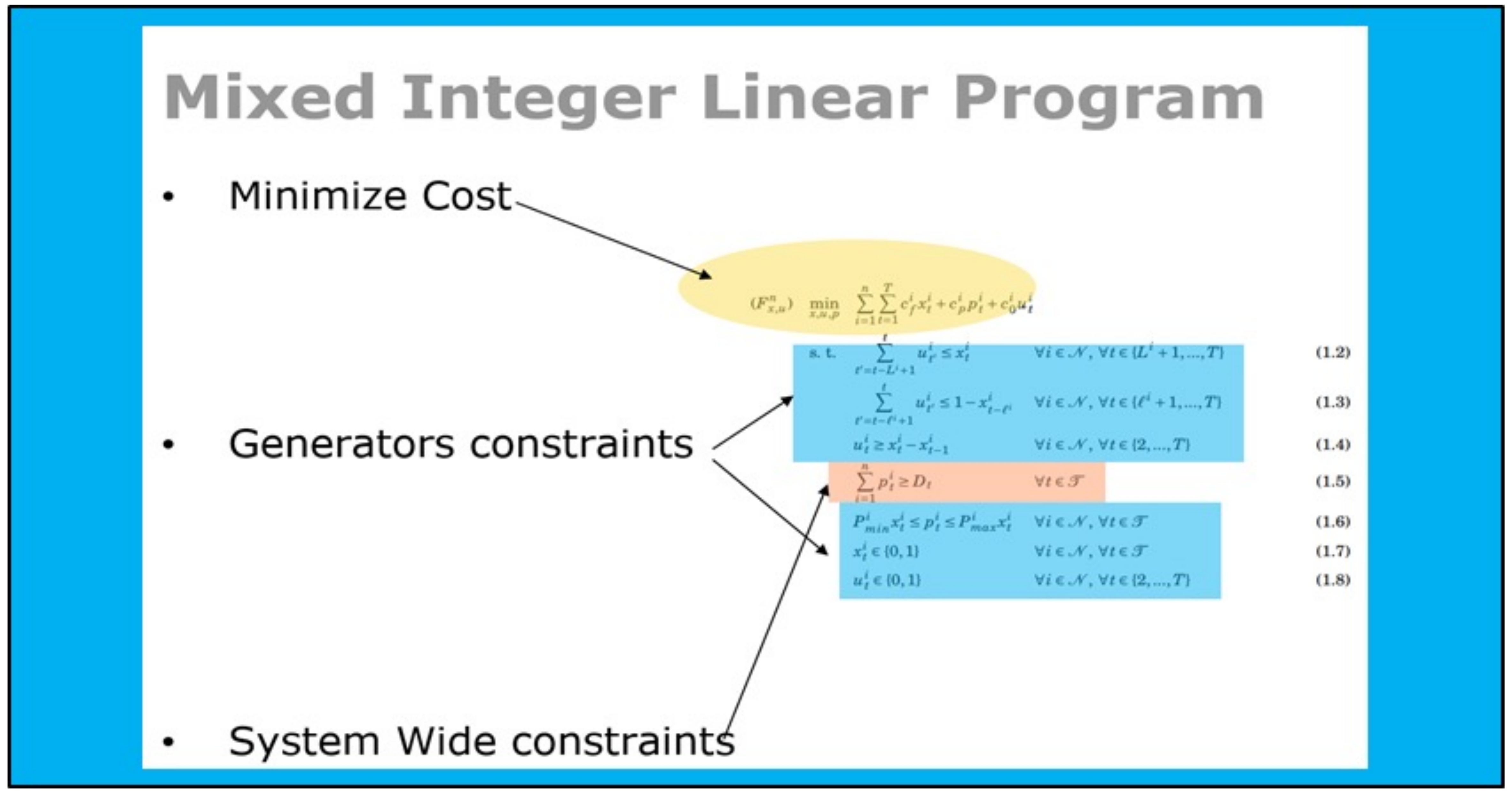
Solve Unit Commitment problem:
How to schedule the generators to produce the total demand at minimal cost?

Tells if there is unserved energy, or large cost

Optimization of Unit Commitment, MvdA 2/3





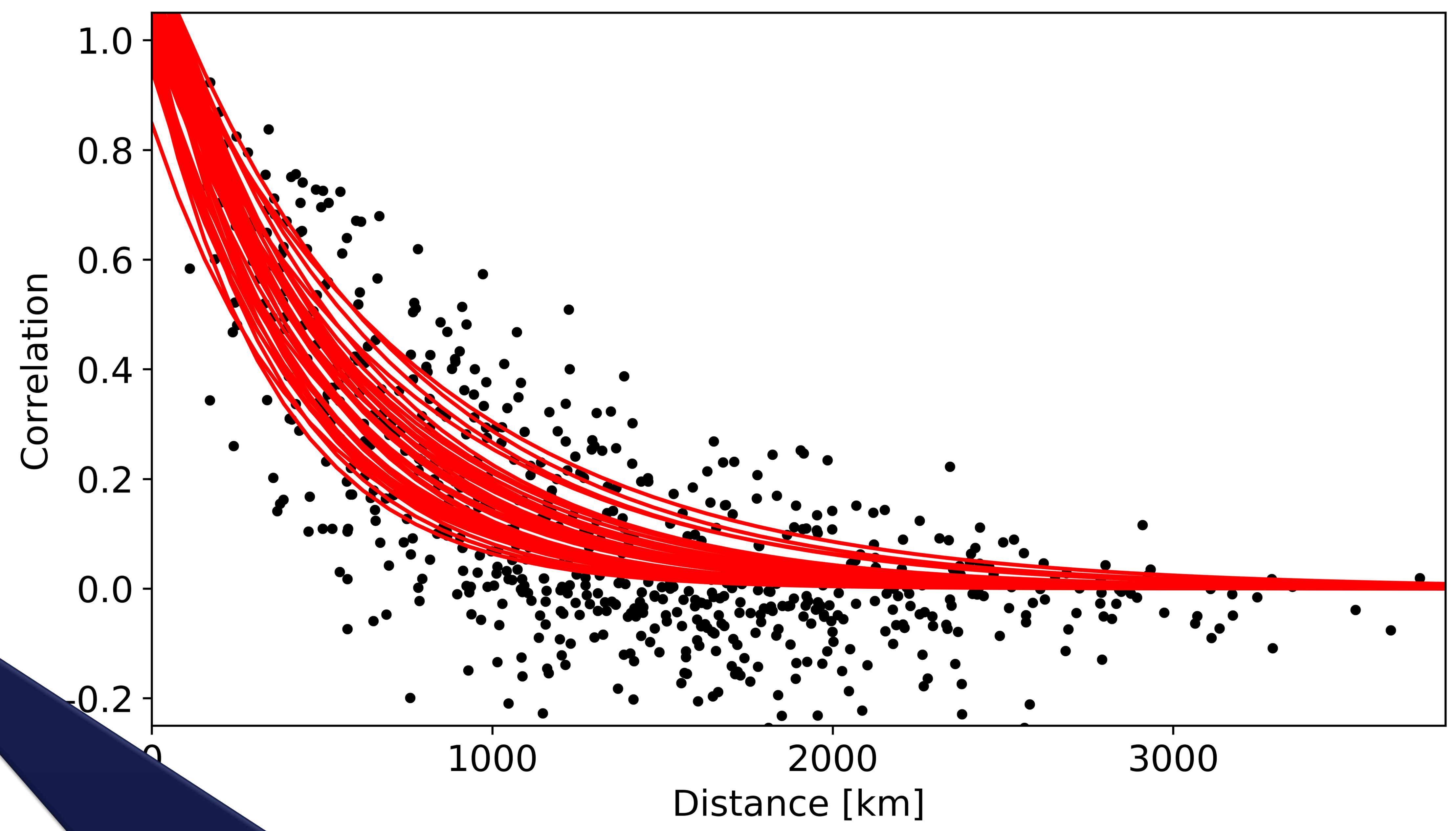


From Climate to Energy data, LS 1/3

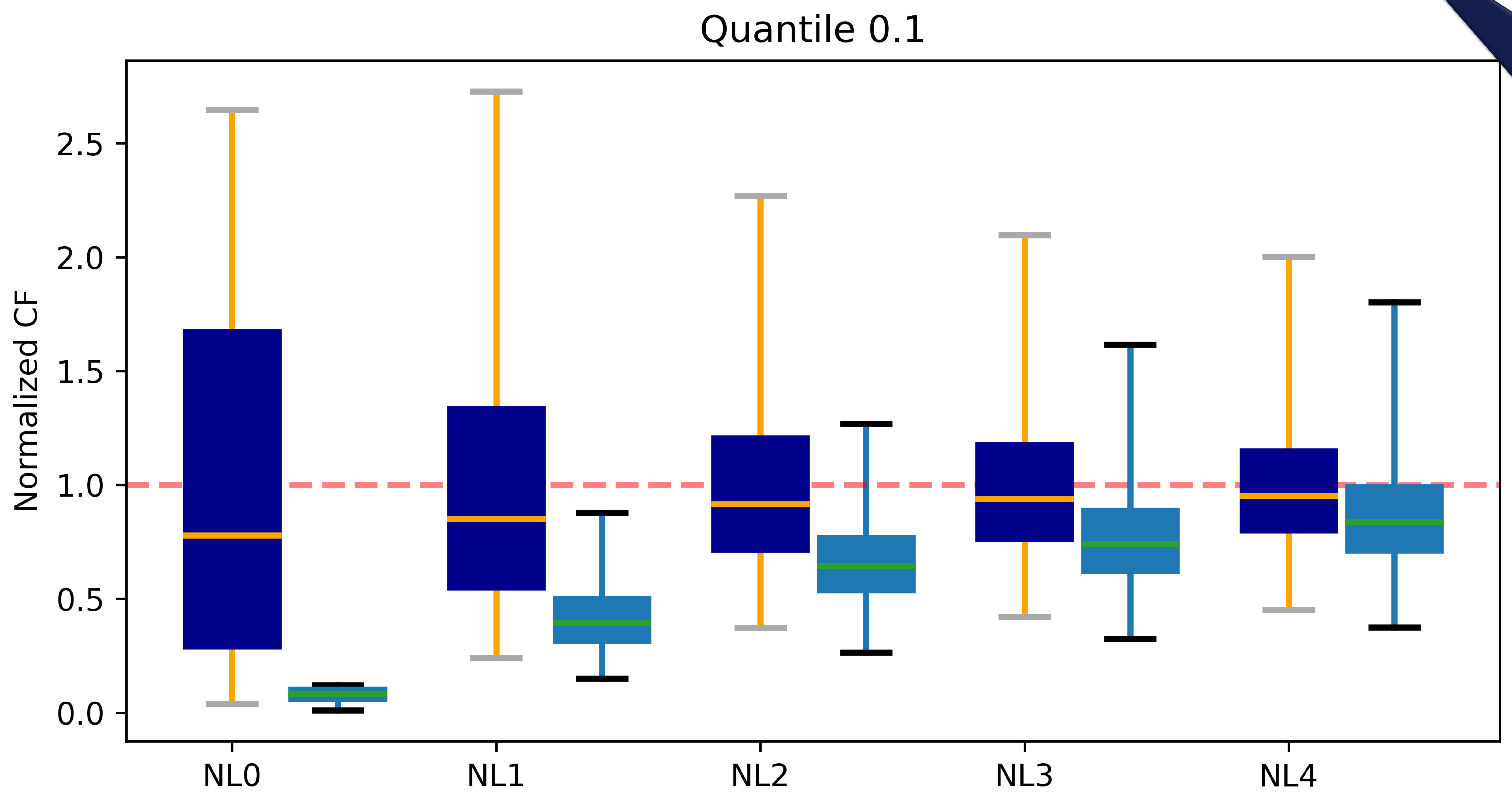
- Global patterns influence local weather
- **Uncertainty in climate change, shift in median and/or extremes**

Correlation in extreme events, LS 2/3

Weather fluctuations give rise to correlations in
- Temporal sense, hours -- years
- Spatial sense, local -- continental

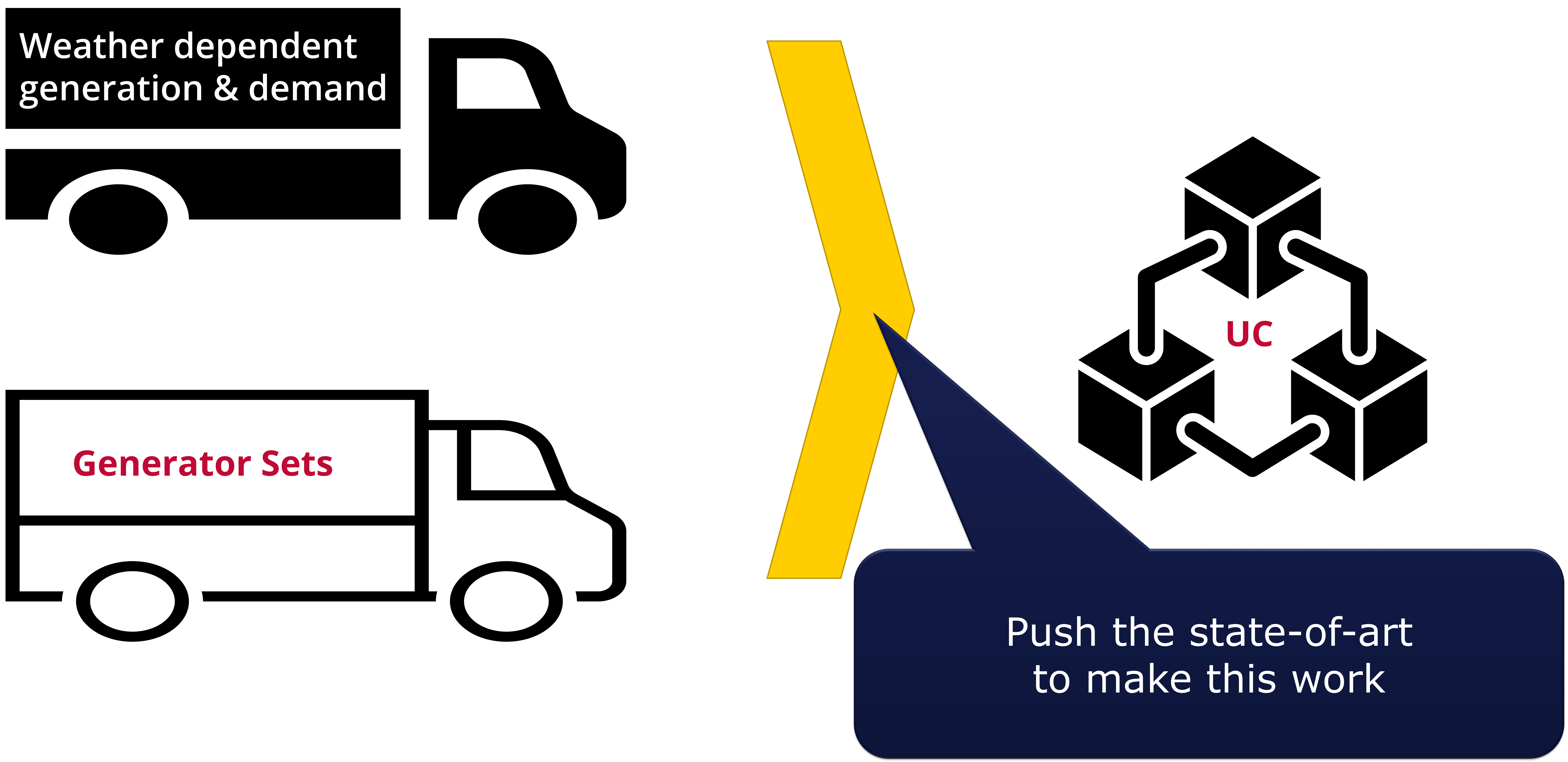


Spatial correlation leads to correlation during extremes

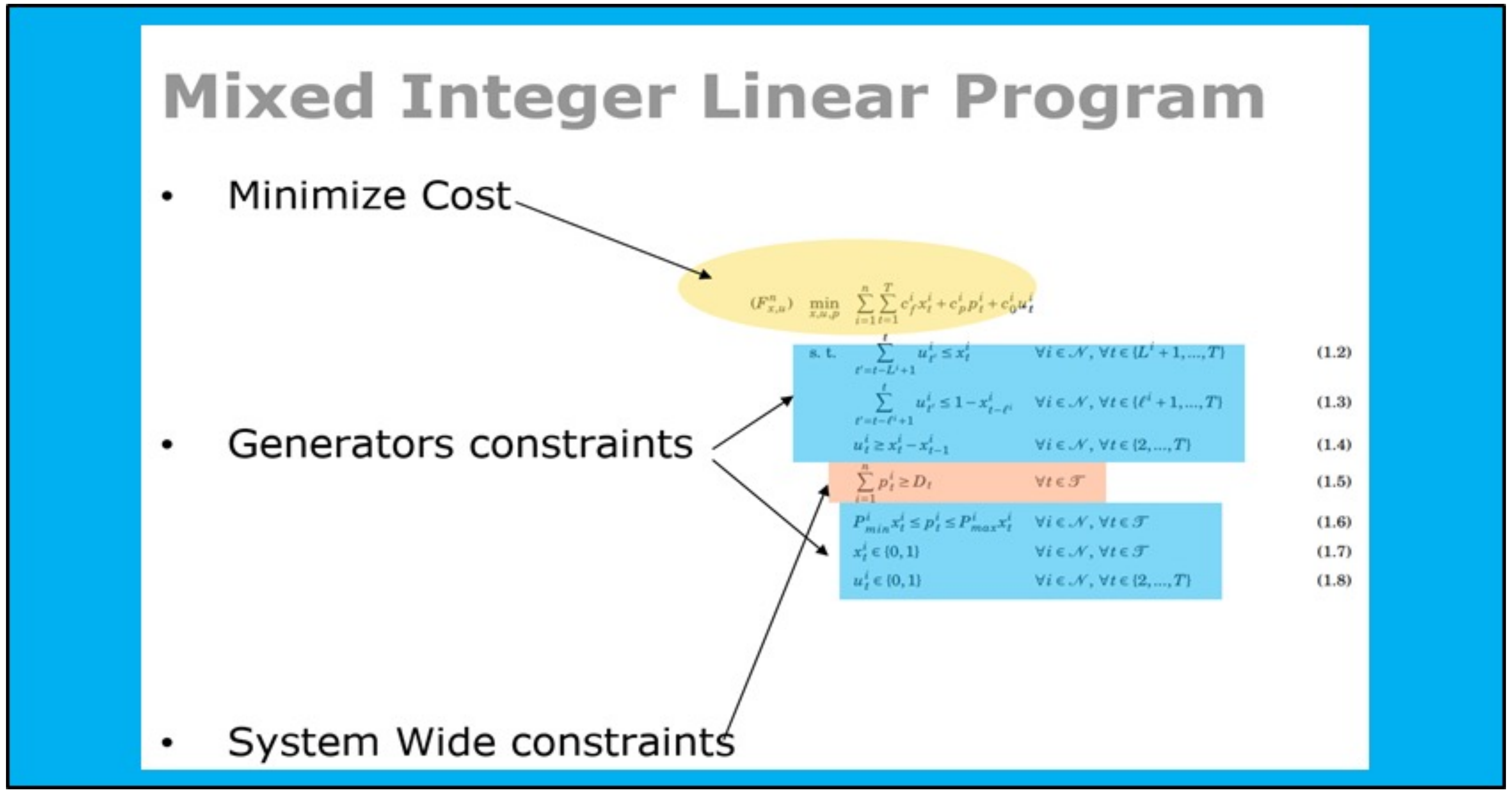


Requires large datasets and use of global climate models as infeed

ACDC—ESM goals



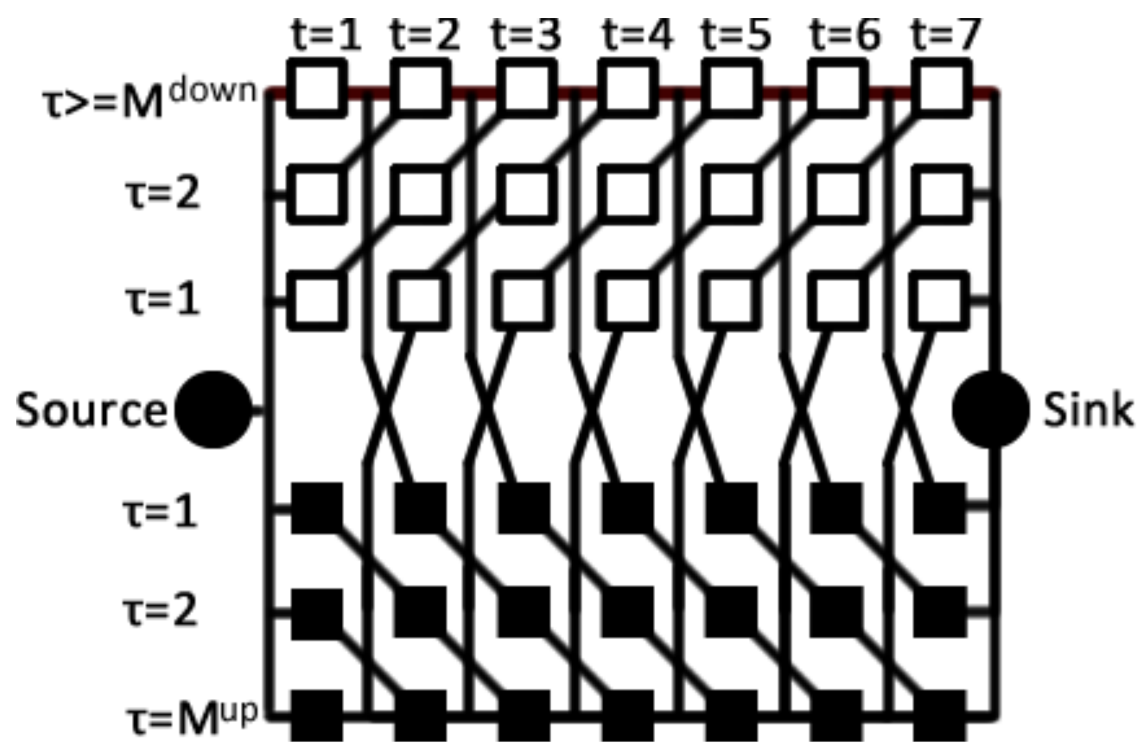
Optimization algorithms for Unit Commitment, MvdA 2/3



NP-hard optimization problem!
We hope to go to European scale
MIP is not fast enough

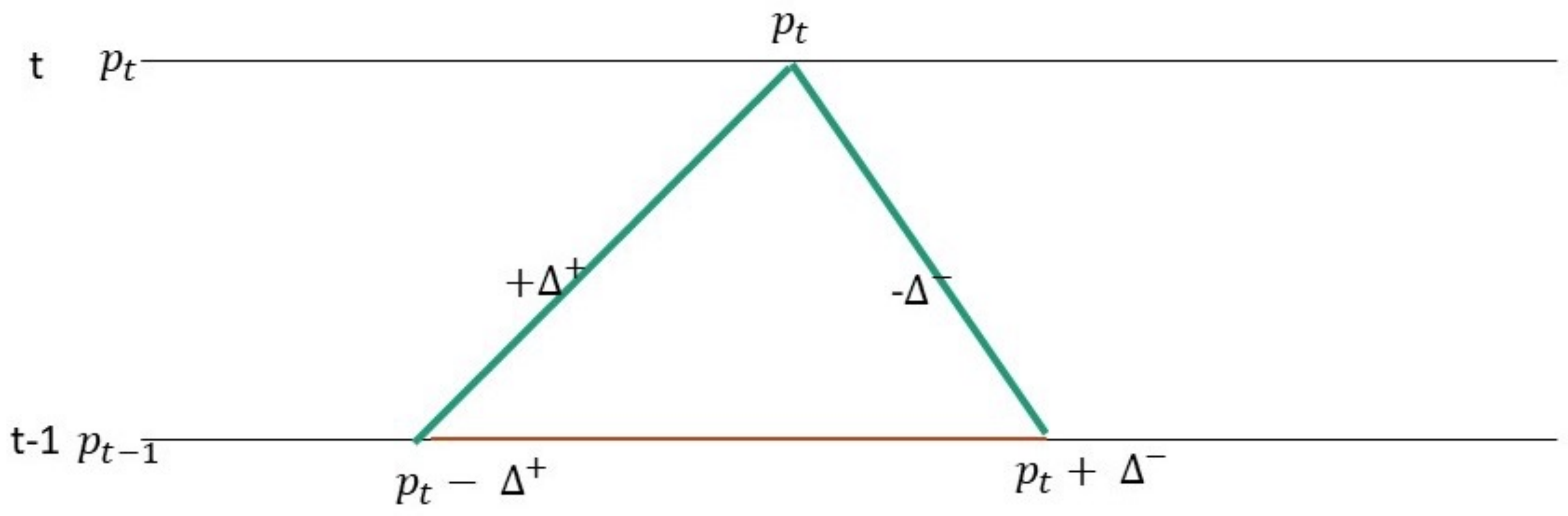
Optimization algorithms for Unit Commitment, MvdA 3/3

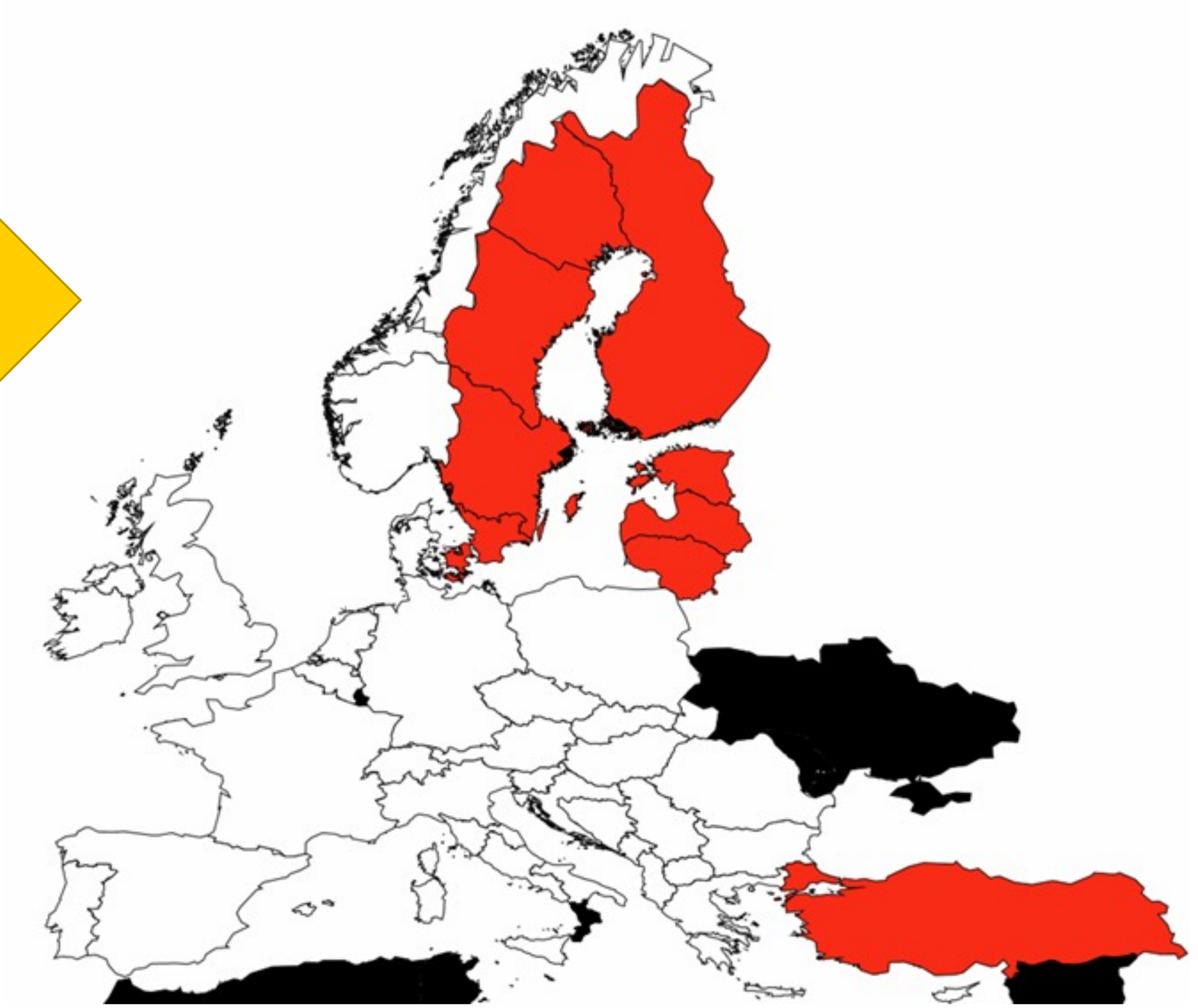
ILP and Dynamic programming



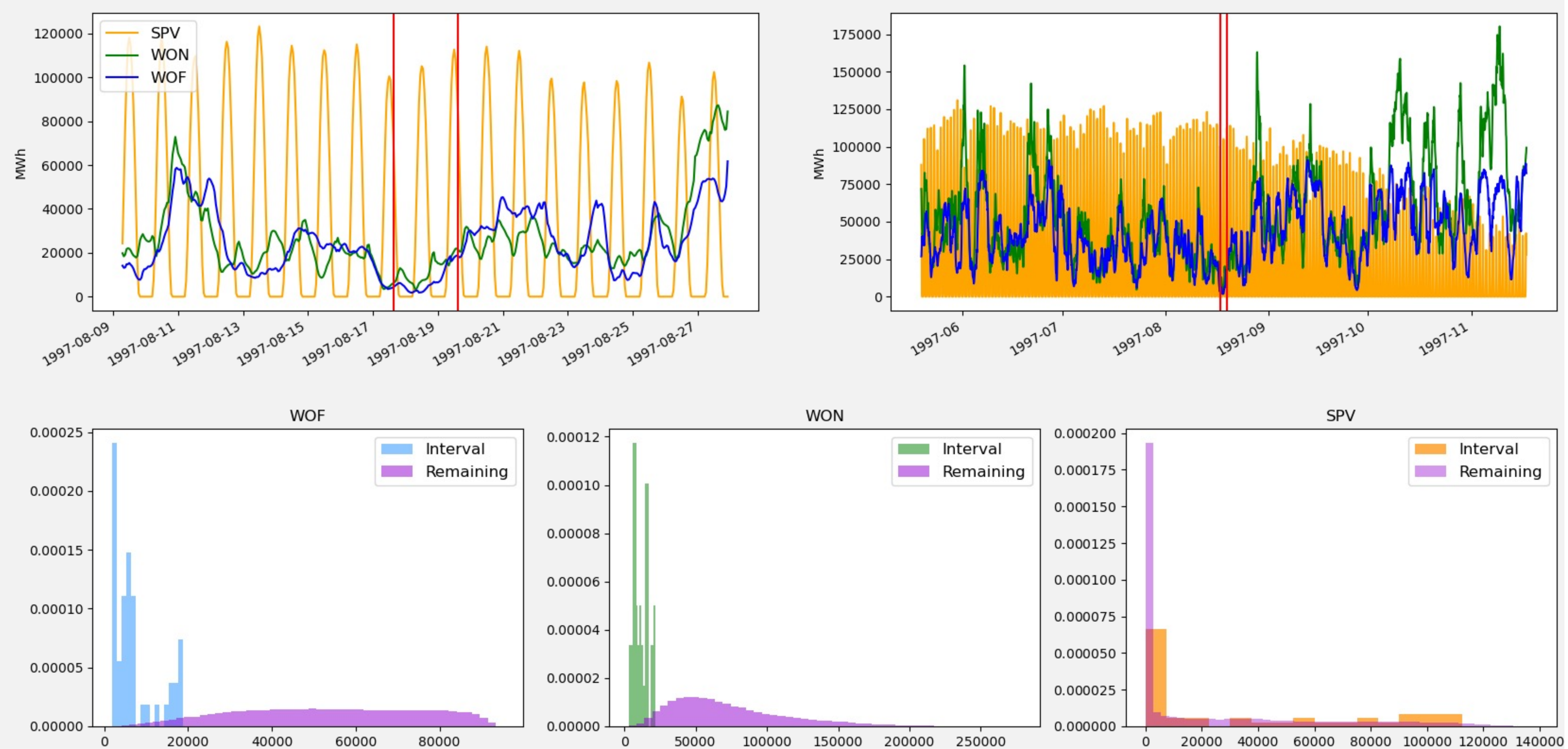
IBM CPLEX

$$H_t^\tau(p_t) = \begin{cases} f_t(p_t) + \text{constant} & t = 1 \\ f_t(p_t) + \min\limits_{p_{t-1} \in [p_t - \Delta^+, p_t + \Delta^-]} H_{t-1}^{\tau-1}(p_{t-1}) & t > 1, 1 < \tau < M_{\text{up}} \\ f_t(p_t) + \min\limits_{p_{t-1} \in [p_t - \Delta^+, p_t + \Delta^-]} \min\{H_{t-1}^{\tau-1}(p_{t-1}), H_{t-1}^{\tau}(p_{t-1})\} & t > 1, \tau = M_{\text{up}} \end{cases}$$





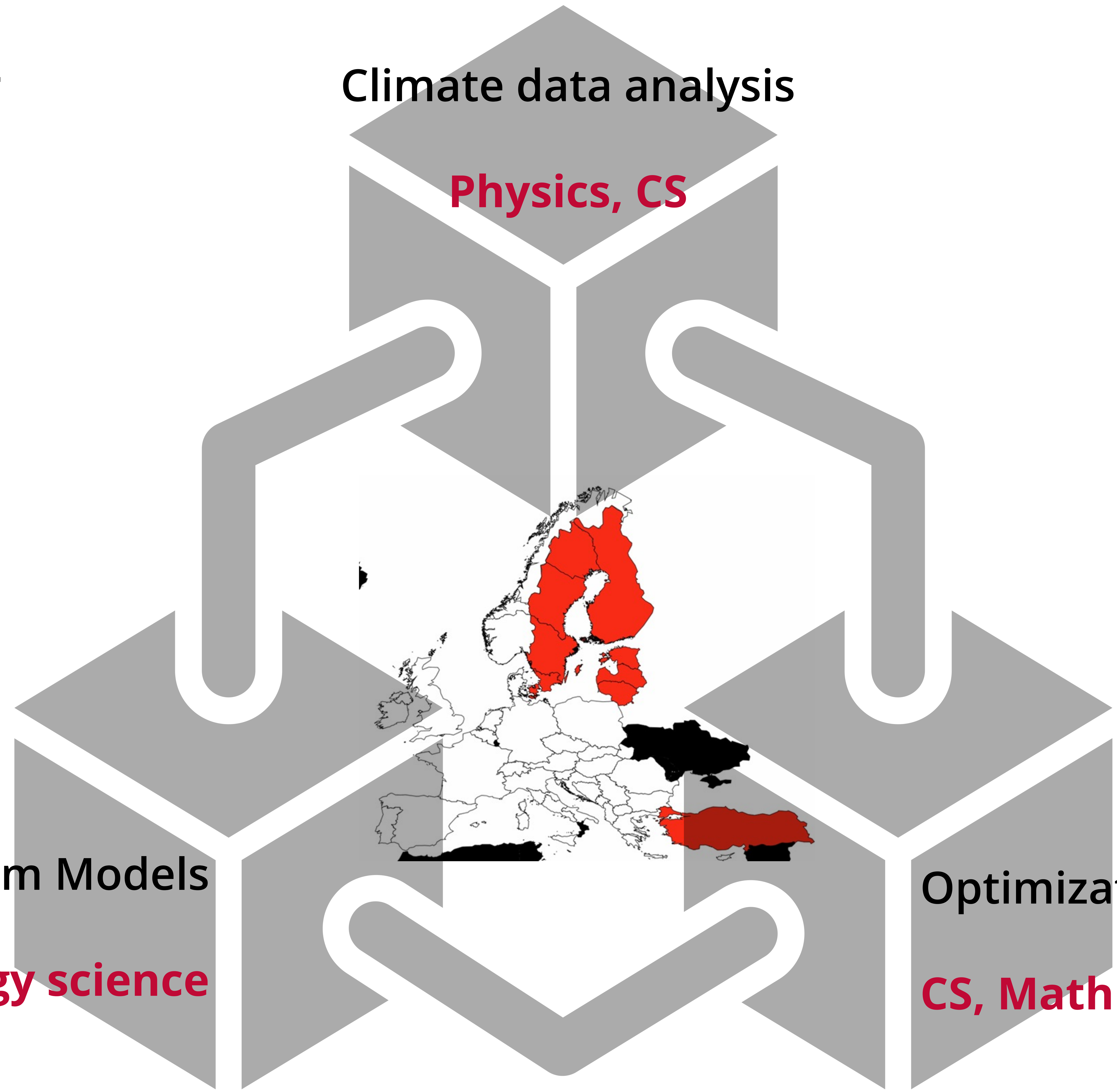
Finding high impact events, LS 3/3



Outlier detection algorithms can help with finding high impact events in climate data

- **Require moderation to suit the dataset size (~28TB)**

ACDC—ESM


Climate data analysis
Physics, CS
Energy System Models
Energy science
Optimization algorithms
CS, Math