TIMES Course for MSc Students in DTU: Reflections and the Way Forward

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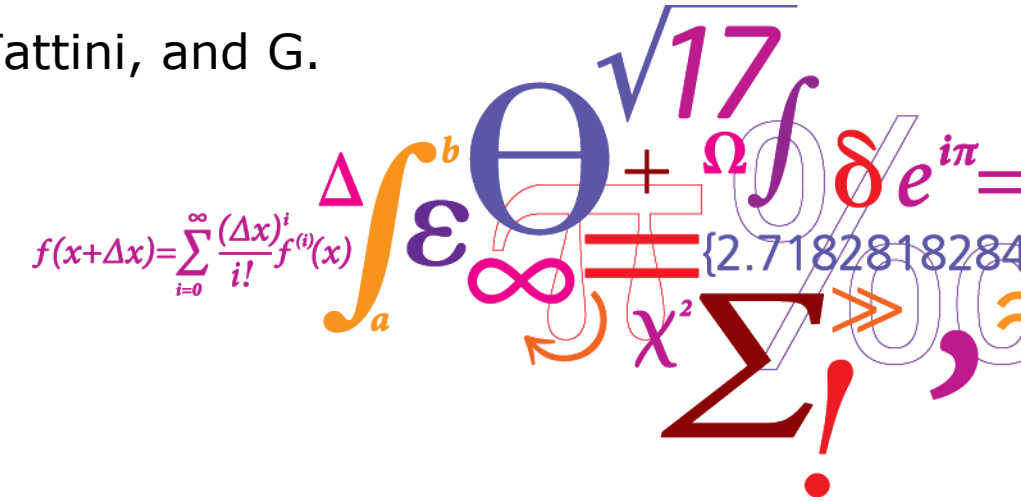


DTU Management Engineering
Department of Management Engineering

Overview

- General info
- Course design
- Outcomes
- Main challenges
- Way forward

General Info: Course

Tittle: National energy system modelling with TIMES
Workload: 5 ECTS
Duration: 3 weeks
Occurrence: January
Students: 41 (no upper limit)
Crew: 2 Senior Researches, 2 Postdocs, 3 PhD Students

General Info: Students

Study programme: Master in Sustainable Energy
Year: 2nd (intended)

Course prerequisites (previous DTU courses):

- Modelling and Analysis of Sustainable Energy Systems using Operations Research
- Energy Economics, Markets and Policies
- Feasibility studies of energy projects

Course Design: Learning Objectives

- **Collect** and **evaluate** data critically e.g., by comparing production costs of technologies
- **Develop** and **analyse** internally consistent future energy scenarios
- **Critically reflect** on a tool functionalities as well as main assumptions and limitations of that type of tool in general and specifically for the applied tool
- **Validate** and **explain** results
- **Use** TIMES model generator for creating a national energy system model and **describe** its structure
- **Analyse** national energy system scenarios applying a TIMES model
- **Apply** constraints in TIMES to represent e.g., limited renewable resource potentials
- **Represent** energy demand, transmission, conversion and resource potentials for different sectors of an existing energy system in TIMES
- **Explain** the modelling of specific technologies in a TIMES energy system model and **compare** the system consequences of implementing them
- **Clarify** sensitivities of main assumptions through sensitivity analysis
- **Synthesise** the main conclusions and **discuss** results in relation to results of other energy system analyses and current debate in society
- **Coordinate** model development

Course Design: Teaching Methods

- Project-based learning
  - Develop a national TIMES model
  - Use it for an analysis

- Spiral learning
  - Gradual exposure to TIMES and VEDA
  - Increasing sophistication of model sectors

Course Design: Teaching Activities

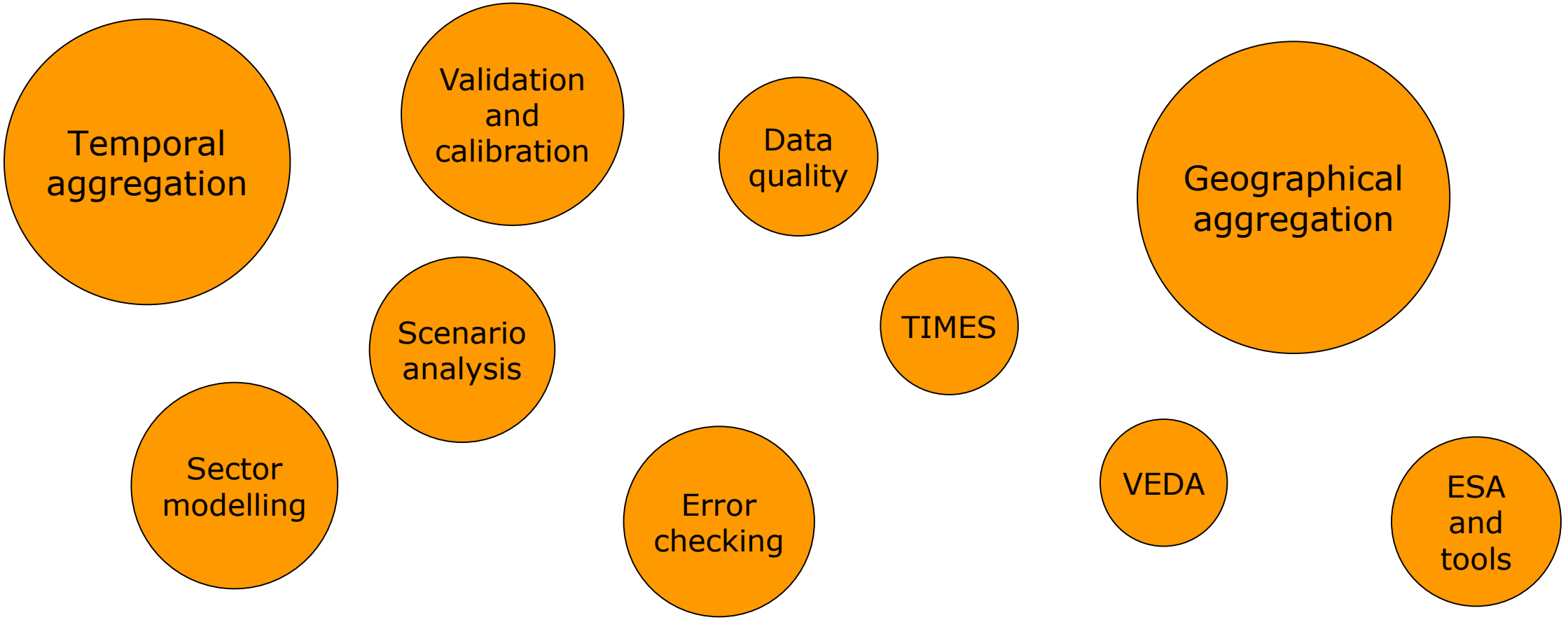
- Lectures
- Exercises
- e-Learning
  - Mostly video tutorials (e.g. building up model sectors, introducing constraints etc.)
- Group work (matrix structure)
  - Every "work group" (4-5 students) develops a country model and uses it for an analysis
  - Every "study group" (up to 11 students) contains students responsible for a single sector (e.g. transport)

Course Design: Assessment

- Summative
  - Group posters (60%)
  - Multiple choice test (40%)

- Formative
  - Pre-test
  - Feedback from students after each lecture

Course Design: Core Elements



Course Design: Course Plan

- Week 1: lectures, exercises, data
- Week 2: model structure and data
- Week 3: validation and analysis

	Day 1	Day 2	Day 3	Day 4	Day 5
Week 1	ESA & tools, Scenario analysis	Supply, EX	Power & Heat, EX	RES & IND & COM, EX	Transport, EX
	Intro TIMES, group forming	CG	CG	CG	CG
Week 2	P1 – country overview and agenda	Time and geography, EX	Demand projections, EX	SG/CG	Exam
	Validation & calibration	SG/CG	SG/CG	SG/CG	SG/CG
Week 3	P2 – model structure and analysis	CG	CG	CG	CG
	SG	SG	SG	SG	P3 - Analysis

Course Design: Other Practicalities

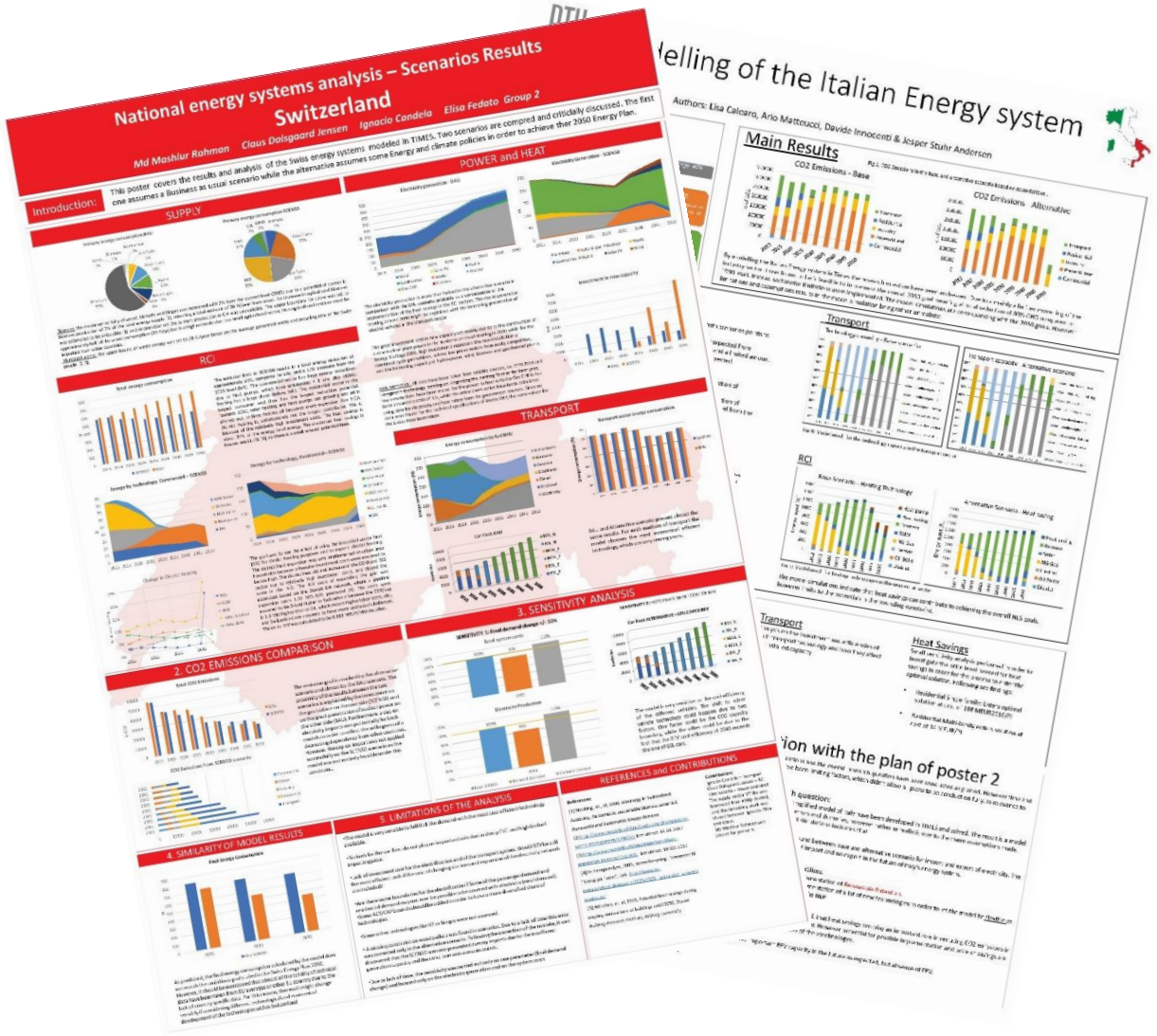
- Software installation before course starts
  - We provide/refer to step-by-step guides
- Modelling sophistication and heterogeneity
  - We provide example structure for sectors (developed in exercises)
- Data availability
  - We point out data sources (e.g. make sure some data is available for students)

Course Outcomes: Analysis Undertaken

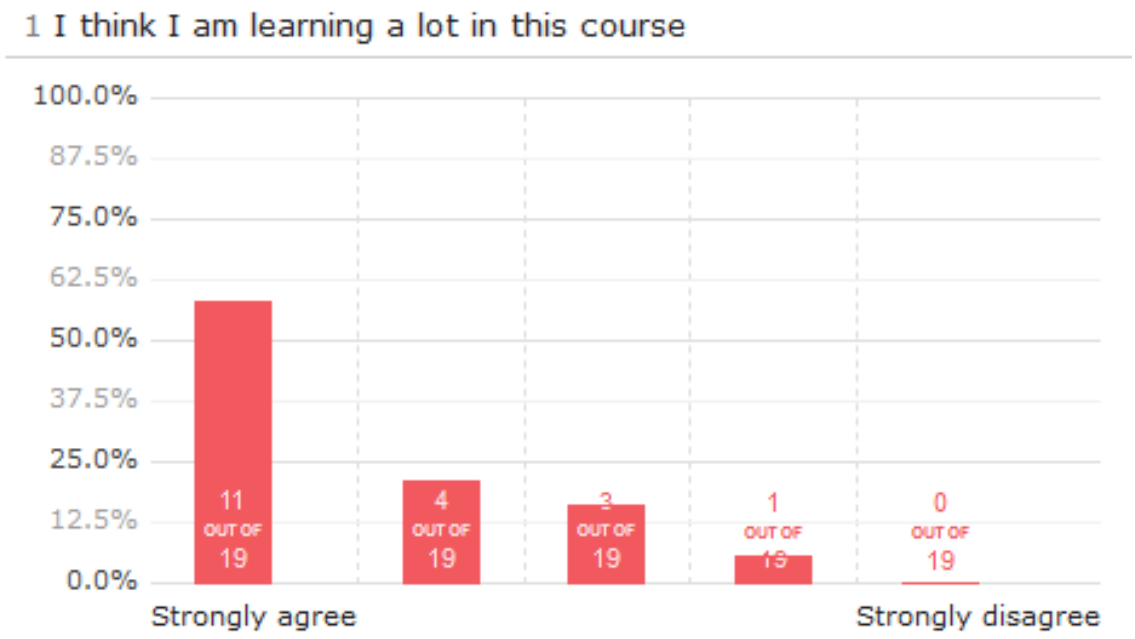
- Countries analysed: Denmark, France, Germany, Greece, Italy, Norway, Spain, Sweden, Switzerland, UK

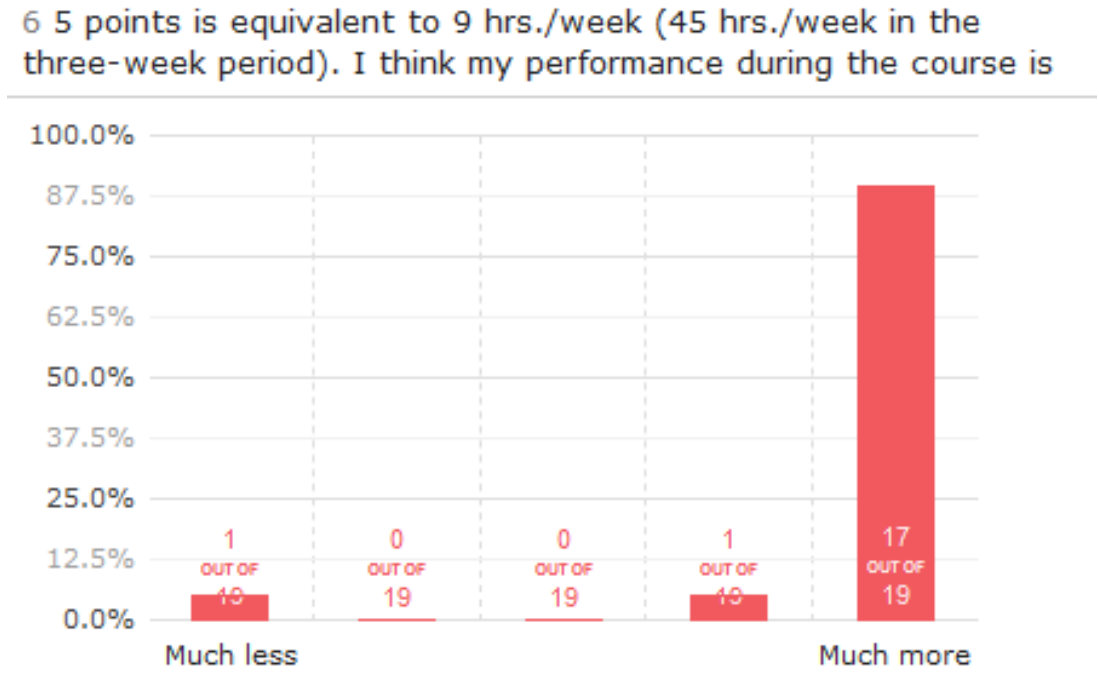
- Issues analysed (examples):
  - How can Italy reach the goals of the National Energy Strategy with regards to 2050?
  - Swiss Energy Plan 2050

- Model characteristics:
  - Similar to templates from the lectures
  - Simple with regard to TS



Course Outcomes: Evaluation





"It was a very interesting course, but there was too much work, which made it less enjoyable. Like being forced to stay at a theme park for 3 weeks. Just not fun in the end :p"

Main Challenges

- Academic
  - Recommended (not mandatory) prerequisites => varying background knowledge
  - Assessment of students within groups => difficult to judge through poster presentations
  - Groups were late putting together their models => little time for debugging
  - Data availability => too much time for datamining

- Technical challenges
  - Heterogeneous systems => software does not always work / takes time to setup
  - Software stability

- Practical / Planning
  - Flexible class size
  - X-mas holidays
  - Very resource intensive

Worked Well

- Video tutorials
- Step-by-step installation guides
- Overall assessment => groups remained intact

Way Forward

- Optimise resource utilisation
- Develop an FAQ (technical issues)
- Supervision of CGs
- Increase exercise time / decrease lecture time
- Reduce datamining (limit the number of countries)
- Reduce the number of poster presentation
- Take the test after the course
- Improve course description

More options:

- Summer 3 week period
- Transform to 10 ECTS and 13 weeks

Questions?

Thank you for attention!