

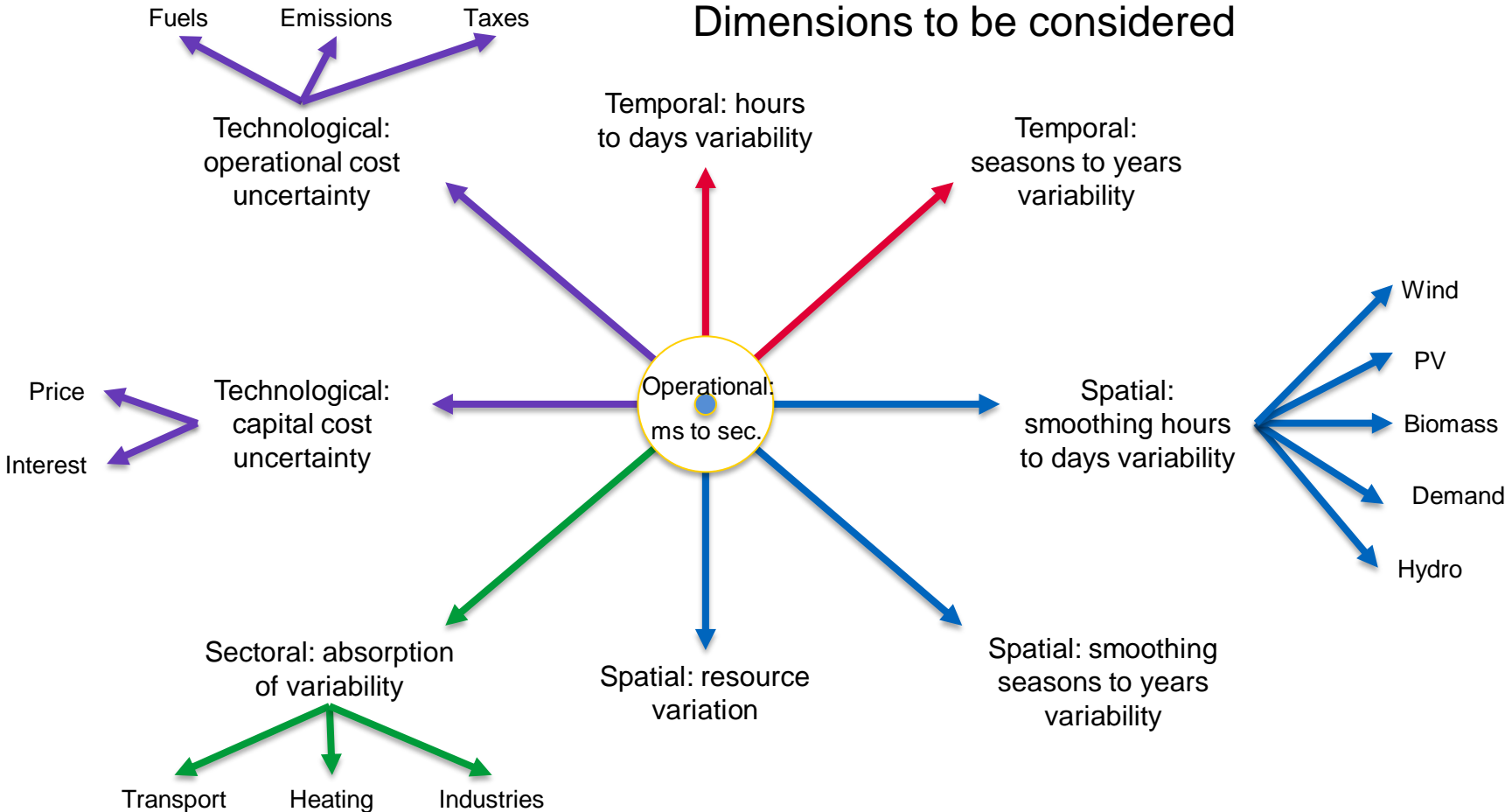
Planning energy systems while considering high operational detail

Flexibility in integrated energy systems -workshop
Juha Kiviluoma
Senior scientist, VTT Technical Research Centre of Finland
26.3.2020

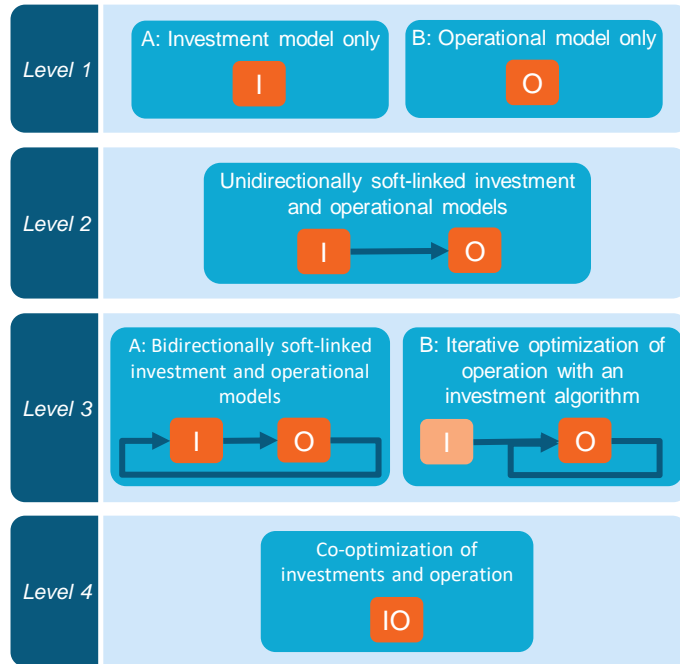
Inputs from Niina Helistö and Hannele Holttinen

25/08/2021 VTT – beyond the obvious

Dimensions to be considered



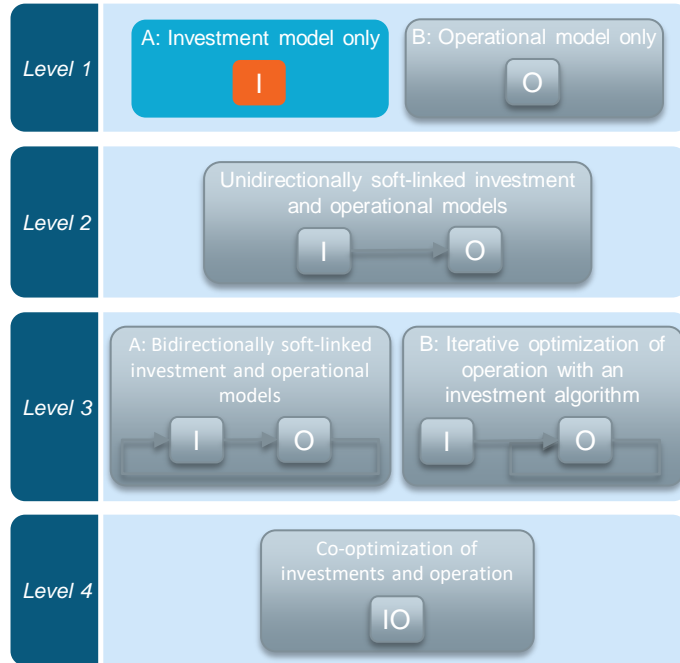
Model categorization based on modelling approaches



Helistö, Niina; Kiviluoma, Juha; Holttinen, Hannele; Lara, Jose Daniel; Hodge, Bri-Mathias (2019). *Including operational aspects in the planning of power systems with large amounts of variable generation: A review of modelling approaches*. WIREs Energy and Environment 8 (5), e341.



Selected studies: level 1A



Reference and model name

Kannan and Turton 2013: TIMES

Welsch et al. 2014: OSeMOSYS

Cole et al. 2016, Short et al. 2011: RWGTM and ReEDS

Frew and Jacobson 2016, Frew et al. 2016: POWER

De Jonghe et al. 2011

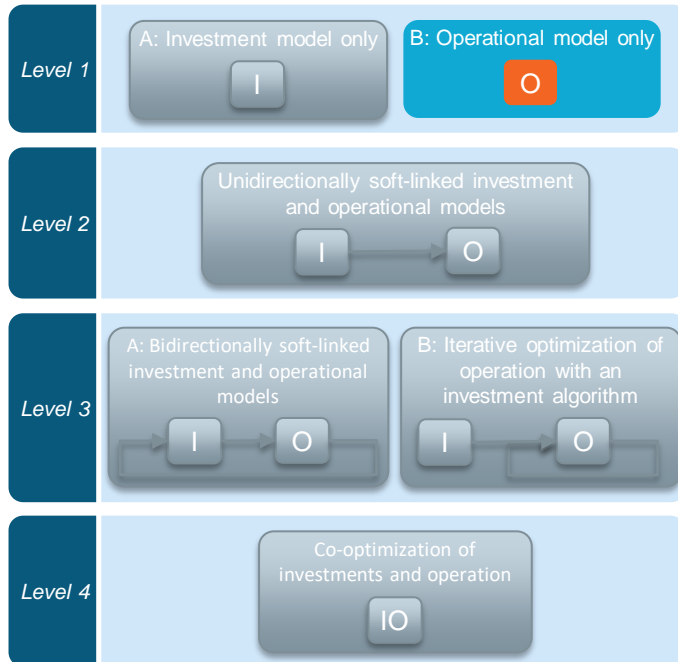
Nahmmacher et al. 2016, Nahmmacher et al. 2014: LIMES-EU

Scholz et al. 2017: REMix

Mileva et al. 2016: SWITCH

Pineda et al. 2016

Selected studies: level 1B



Reference and model name

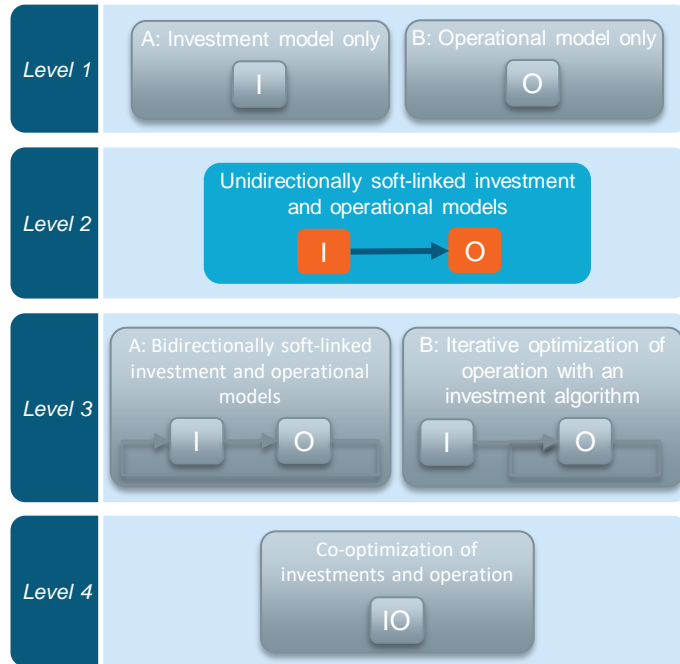
Shortt et al. 2013: FAST

Deane et al. 2014: PLEXOS

O'Dwyer and Flynn 2015: PLEXOS

Troy et al. 2010: WILMAR

Selected studies: level 2



Reference and model name

Mai et al. 2012, Mai et al. 2014, Short et al. 2011: ReEDS and GridView

Lew et al. 2013, Short et al. 2011: ReEDS and PLEXOS

Deane et al. 2012: TIMES and PLEXOS

Deane et al. 2015: TIMES and PLEXOS

Poncelet et al. 2016: TIMES and LUSYM

Brouwer et al. 2015: MARKAL and REPOWERS

Collins et al. 2017: PRIMES and PLEXOS

Gerbaulet and Lorenz 2017: dynELMOD

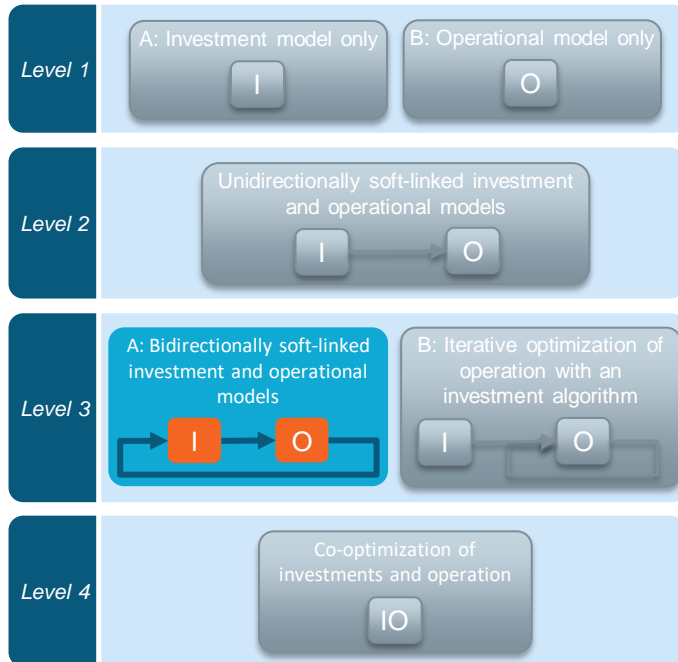
DNV GL et al. 2014: PLEXOS and DSIM

Chaudry et al. 2011: MARKAL and WASP and CGEN

Kiviluoma et al. 2017: Balmorel and WILMAR

Ikäheimo et al. 2018: TIMES and Balmorel

Selected studies: level 3A

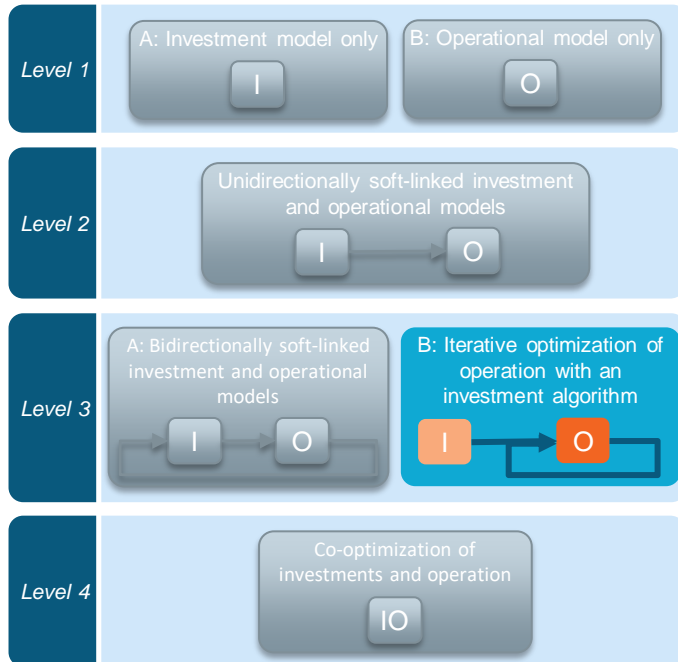


Reference and model name

Rosen 2008: PERSEUS and AEOLIUS

Pina et al. 2011: TIMES and EnergyPLAN

Selected studies: level 3B

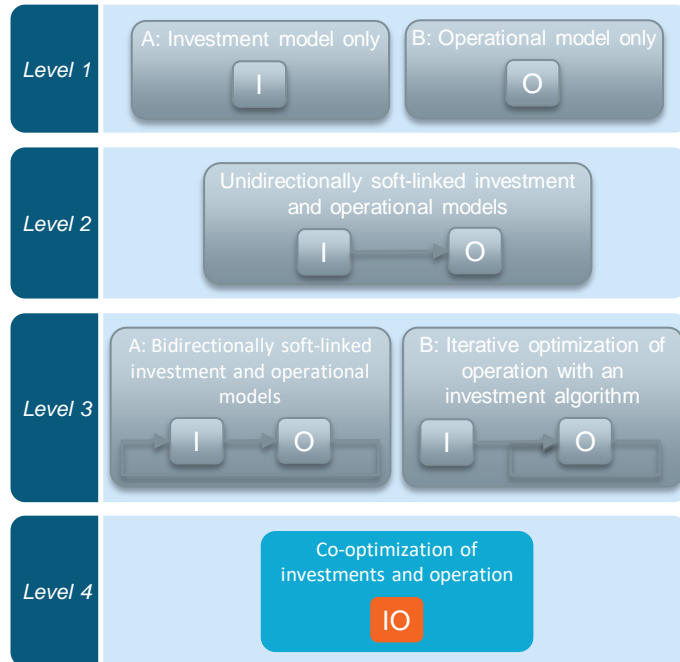


Reference and model name

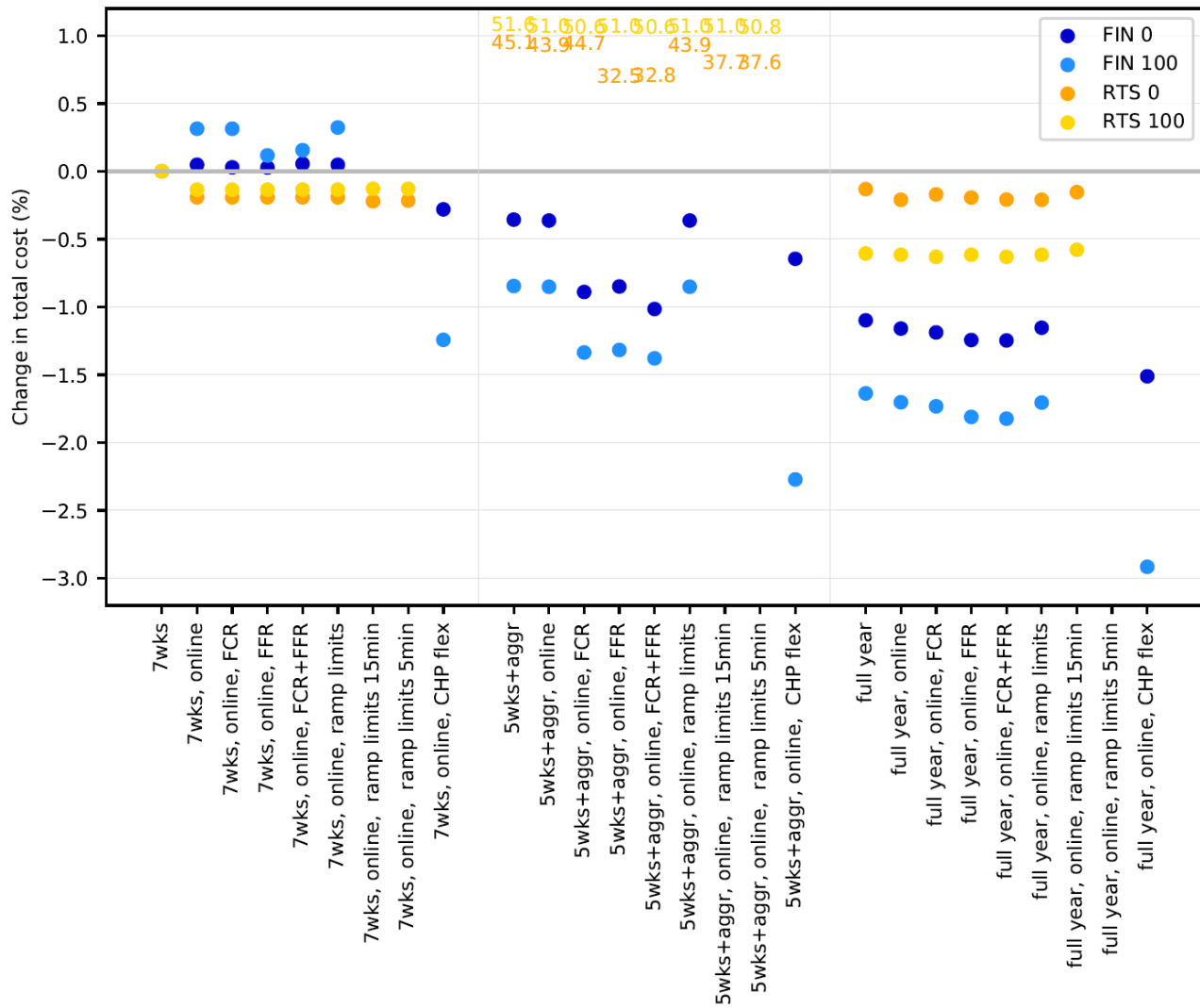
Belderbos and Delarue 2015

Lopez-Botet et al. 2014: CONTINENTAL

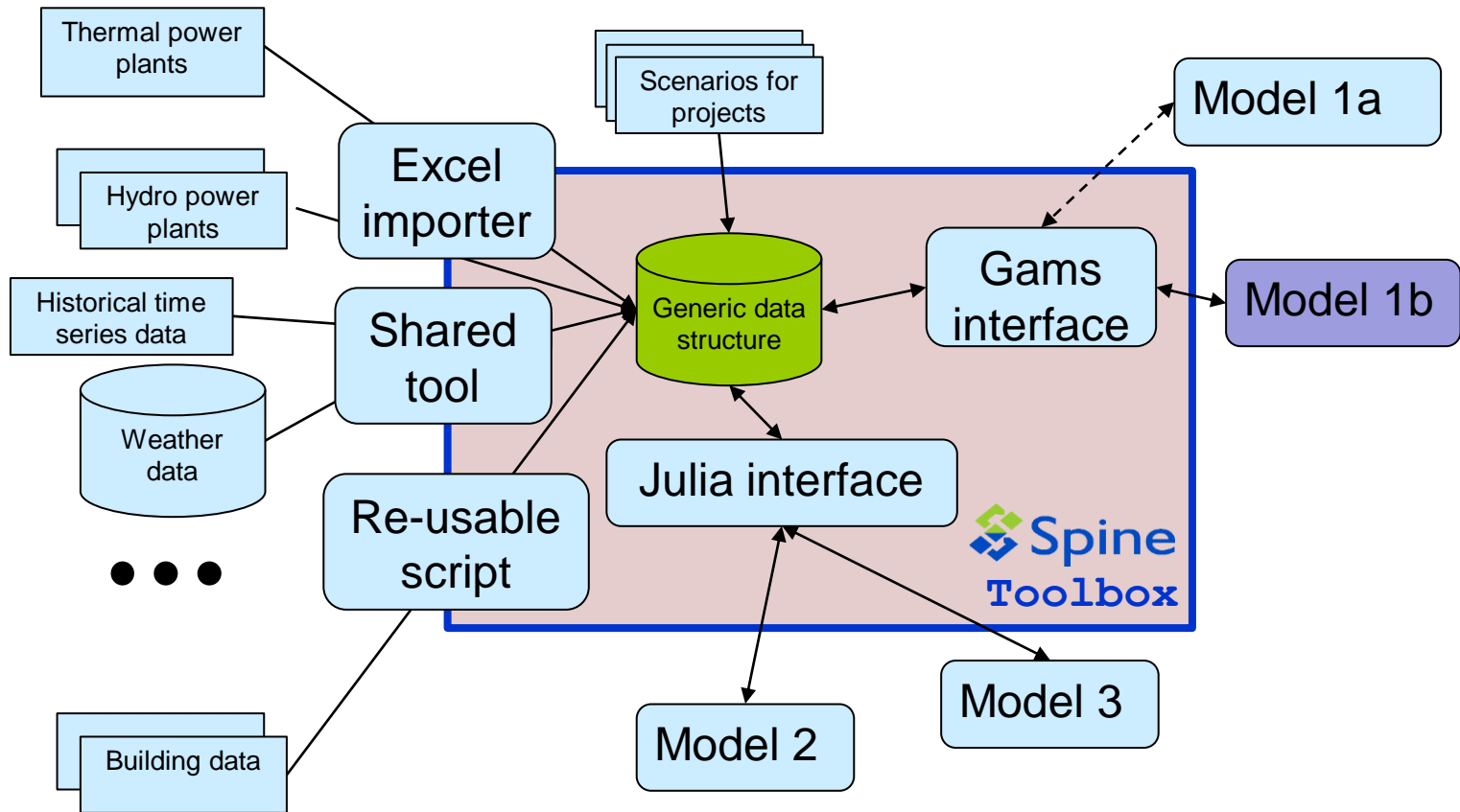
Selected studies: level 4

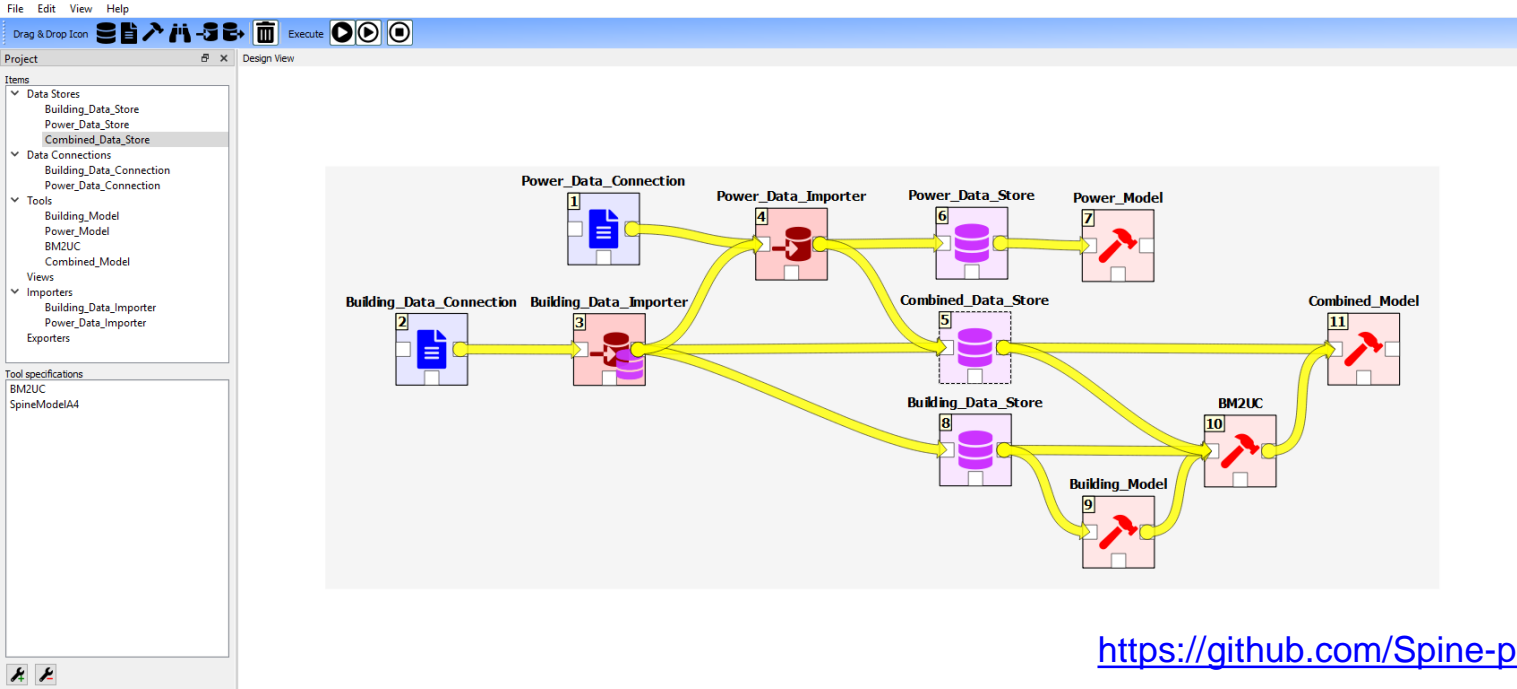


Reference and model name
Ma et al. 2013: UCC algorithm
Palmintier and Webster 2016: MEPO
Jin et al. 2014
Levin and Botterud 2015
Brijs et al. 2017
Koltsaklis et al. 2015
Pereira et al. 2017
Nicolosi et al. 2010: THEA
Florez-Quiroz et al. 2016
Mai et al. 2013: RPM
Pudjianto et al. 2014
Ramírez et al. 2016
de Sisternes 2014, de Sisternes et al. 2015: IMRES



Helistö, Niina; et al. Manuscript





<https://github.com/Spine-project/Spine-Toolbox>

Event Log

```

[26-03-2020 10:32:55] Loading project items...
[26-03-2020 10:32:55] Restoring connections...
[26-03-2020 10:32:56] Project Spine_Case_Study_A4 is now open
[26-03-2020 10:33:34] Please select a project item and try again.
[26-03-2020 10:33:36]
[26-03-2020 10:33:36]
[26-03-2020 10:33:36] Executing All Directed Acyclic Graphs
[26-03-2020 10:33:36]
[26-03-2020 10:33:36] Starting DAG 1/1
[26-03-2020 10:33:36] Order: Power_Data_Connection -> Building_Data_Connection ->
Building_Data_Importer -> Power_Data_Importer -> Combined_Data_Store -> Power_Data_Store ->
Power_Model -> Building_Data_Store -> Building_Model -> BM2UC -> Combined_Model
[26-03-2020 10:33:37]
[26-03-2020 10:33:37] Executing Data Connection Power_Data_Connection
[26-03-2020 10:33:37] ***
[26-03-2020 10:33:37] Executing Data Connection Building_Data_Connection
[26-03-2020 10:33:37] ***
[26-03-2020 10:33:37] Executing Importer Building_Data_Importer
[26-03-2020 10:33:37] ***
[26-03-2020 10:33:37] Starting program python.exe
[26-03-2020 10:33:37] Arguments: C:\data\SpineToolbox\spinetoolbox\project_items\importer\importer_program.py
[26-03-2020 10:33:37] Execution is in progress. See Process Log for messages
(stdout/stderr)

```

Process Log

```

[26-03-2020 10:33:37] Starting program python.exe
[26-03-2020 10:33:37] Arguments: C:\data\SpineToolbox\spinetoolbox\project_items\importer\importer_program.py
[26-03-2020 10:33:37] Execution is in progress. See Process Log for messages
(stdout/stderr)

```

Data Store Properties

Combined_Data_Store

URL:

Dialect:

DSN:

Username:

Password:

Host: Port:

Database: C:\data\SpineToolbox\projects\spine_case_study_a4\spinetoolbox\items\combined_data_store\Combined_Data_Store.sqlite

New Spine db For Spine model

Julia Console | Data Store Properties

bey⁰nd

the obvious

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