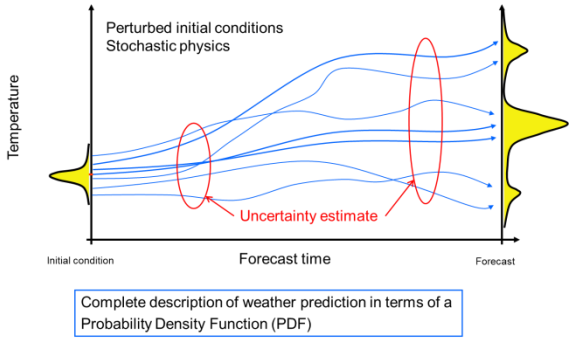
VTT TECHNICAL RESEARCH CENTRE OF FINLAND LTD



Complete description of weather prediction in terms of a Probability Density Function (PDF)

VaGe – Improving the value of variable and uncertain power generation in energy systems

ETIP SNET workshop 7-8.12.2017

Juha Kiviluoma

VaGe – Academy of Finland funded project

Consortium:

- VTT Technical Research Centre of Finland





- FMI (Finnish Meteorological Institute)




VaGe project structure

WP1: Improving forecasts and capturing correlations

- Short term (36 hours)
- Medium term (two weeks)
- Conversion to energy

WP2: Development of multi-scale energy system optimisation methods: Backbone

- Planning and operations
- Highly adaptable temporal presentation

WP3: Improving the value of wind power and PV in energy systems

Impact of:

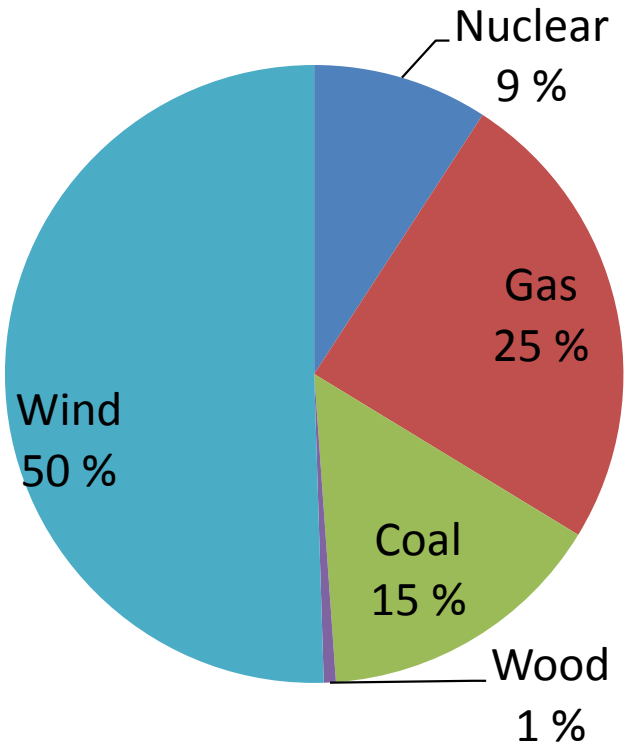
- Better forecasts
- Better use of forecasts
- Proactive consumers
- Flexible biomass

Result #1: Backbone – an adaptable model for energy systems and energy resources

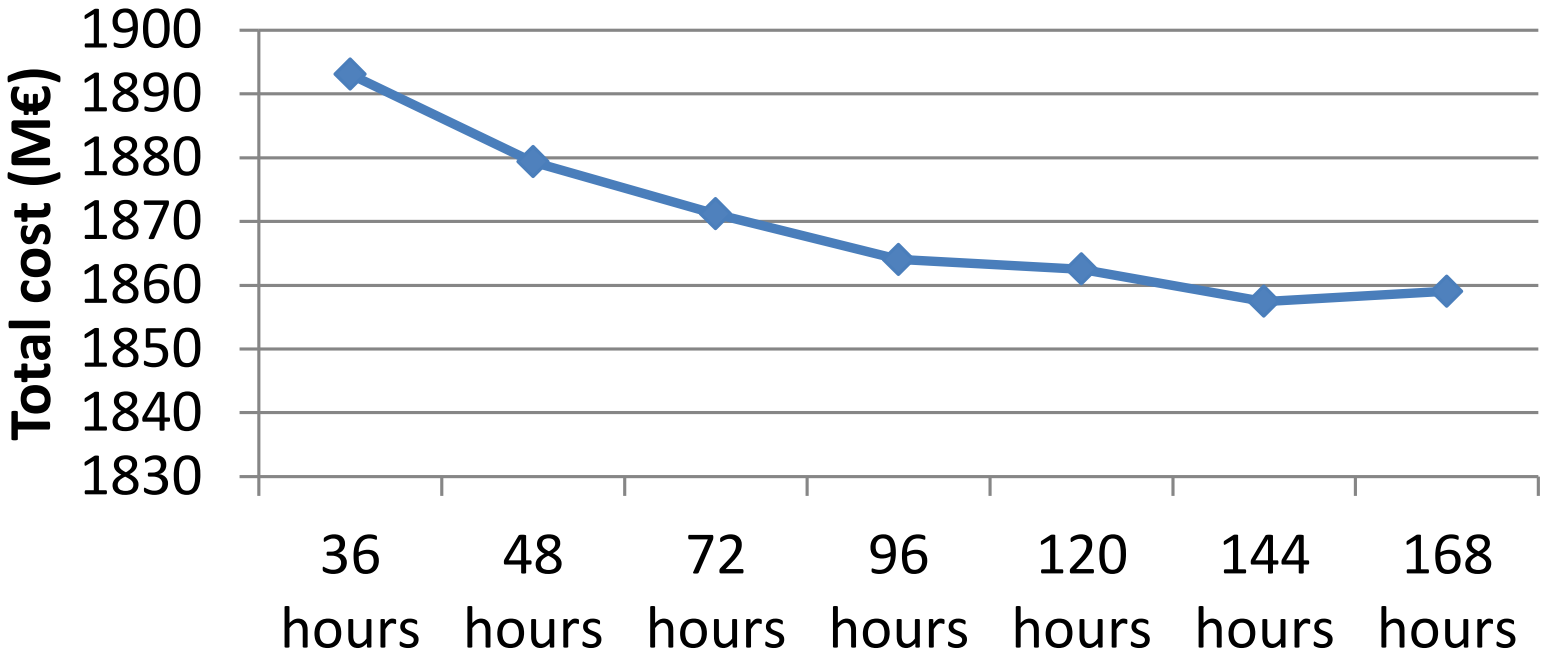
- Lesser GNU license (open source)
- The core model offers energy conversions and energy transfers that are applicable to any conceivable energy transformation
  - Minimize equations to keep the code tractable
- Input data drives what forms of energy are actually modelled and how conversions and transfers are represented
- Allows stochastics for short-term forecasts and for long-term statistics (e.g. reservoir hydro power)
- New models are defined through model definition files: allows to build new implementations on top of the core engine as needed
- Different models can directly re-use each others results (e.g. investments and operations)
- PhD students in the University College Dublin and in the Economic and Social Research Institute in Dublin have started using Backbone

Result #2: Forecast horizon value

- 2 node system
- 30 different kinds of units
- 113 units (integer online variable)
- District heating
- High fuel costs
- Peak: 11.6 GW
- Electricity storages:
  - 1950 MW and 900 MW
  - 48 hours and 24 hours
  - 90% round trip eff.
  - O&M cost: 3 €/MWh



Total power system costs when using different stochastic forecast horizons



Result #3: RealValue

- Results from another project that now uses Backbone: H2020 RealValue
- Costs and benefits of smart thermal mass heaters (replacements for radiators)
- Results by Topi Rasku
- Preliminary

2030, Total System Costs (Finland & Sweden)

Scenario	Total Cost [M€]	Savings Per Unit [€]	Cost Reduction [%]
Baseline	2,327	-	0.00
Battery	2,311	-	0.70
EV:s	2,324	23.93	0.12
V2G	2,323	32.76	0.17
Smart radiator	2,318	23.89	0.41
Smart mass heater	2,304	55.71	0.97

- EV results display excess charging…
  - Need to fix this…

RealValue lessons learned so far:

- With imperfect information, committing distributed heating resources to the reserves ahead of time is challenging.
  - Risk to negatively impact thermal comfort due to forecast errors.
  - Risk is smaller for SETS than for direct electric heating, since the storage helps decouple the internal temperature from the heating system power draw.

Next steps

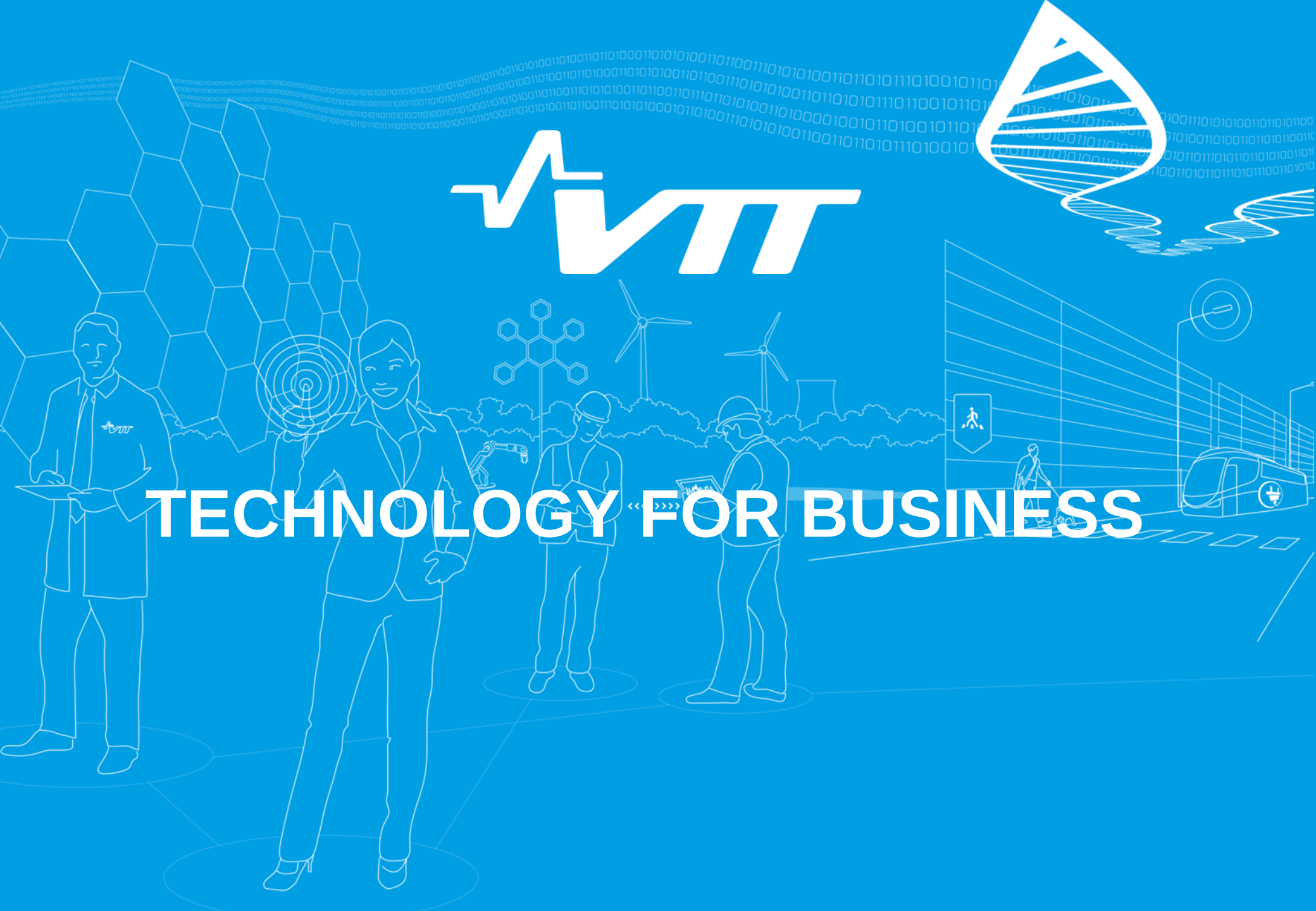
- Keep improving Backbone
- Support Backbone users
- Open the tools for wider group of users
- Produce results that utilize the strengths of the model and the new stochastic forecasts
  - Find ways to improve the value of wind power and PV
  - Role of flexible consumers
  - Strategic use of biomass
  - More suitable market structures/regulations
- Try some further tricks in modelling

Prospects

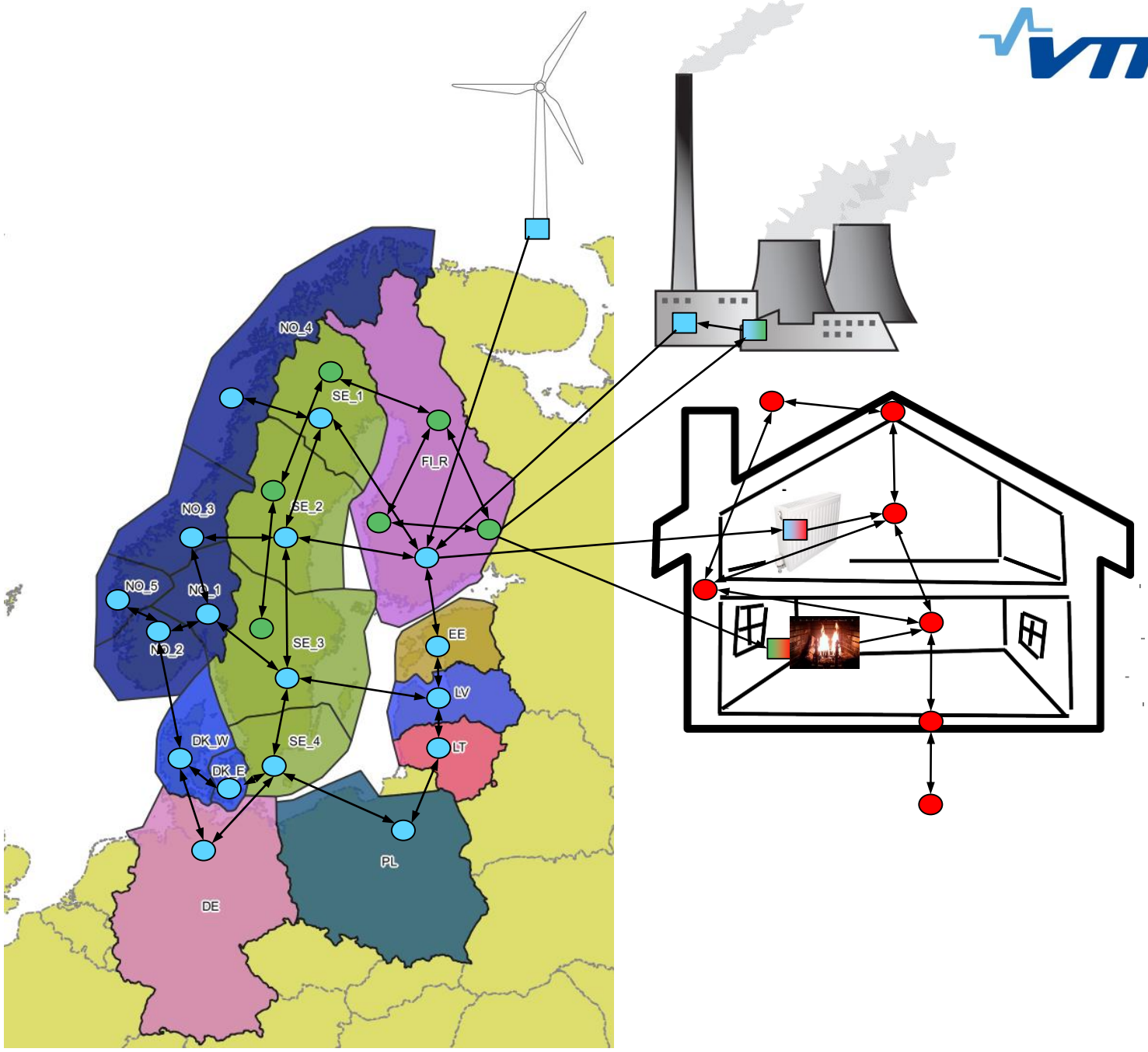
- Needs for future R&I activities coming out of the project
  - Improvement of 3-10 day weather forecasts (resolution and accuracy, calibration for energy purposes)
  - Finding best solutions for heat storage in buildings
  - Modelling methodologies and ideas are currently being implemented in new EU project Spine

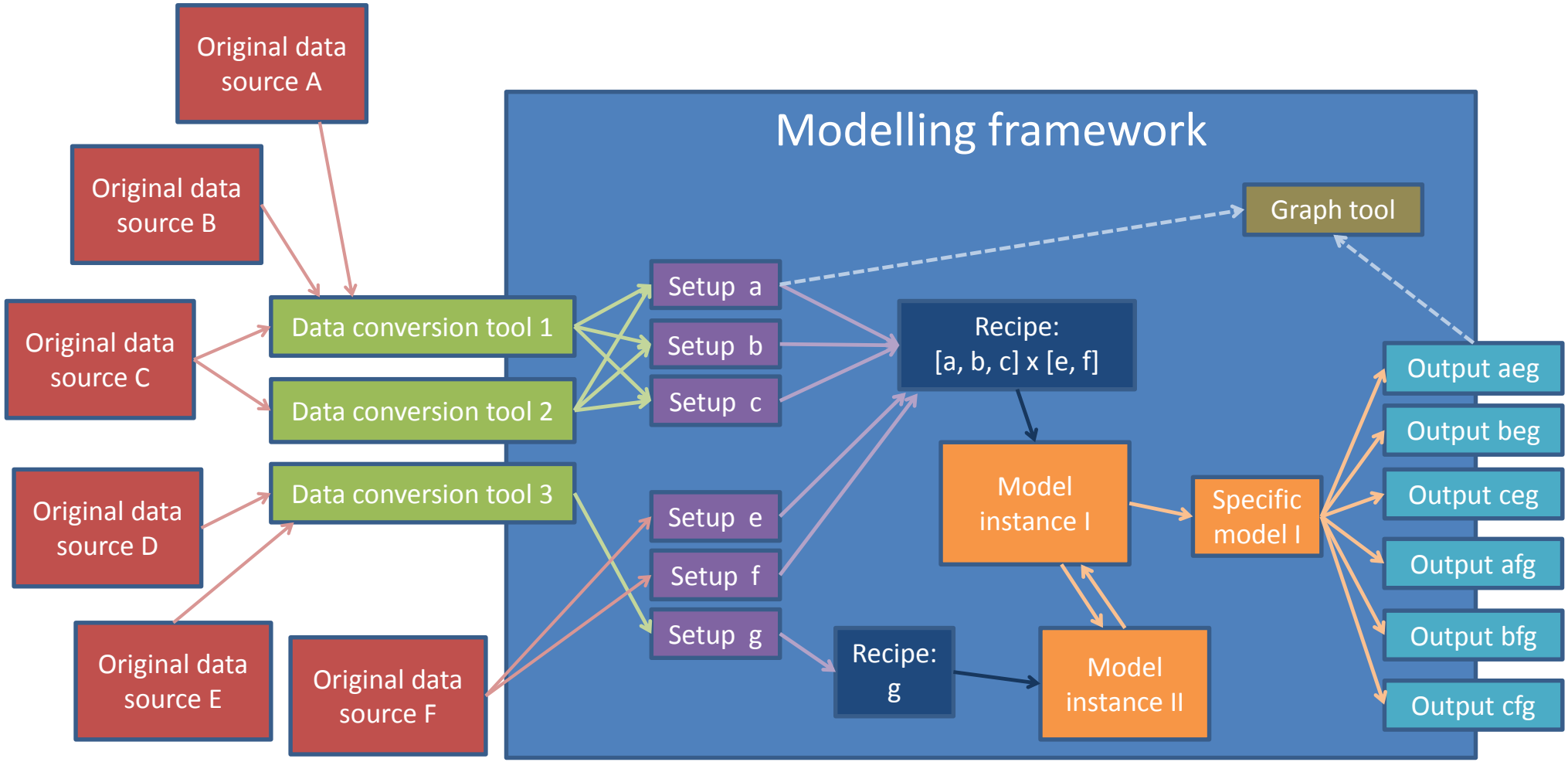
Spine

- Deployment prospects of the most promising solutions
  - Using stochastic forecasts in the optimization of time-of-use constrained resources
  - …just starting


TECHNOLOGY FOR BUSINESS

- Nodes (n)
- Grids (g)
- Units (u)




Original data source A
Original data source B
Original data source C
Original data source D
Original data source E
Original data source F
Modelling framework
Graph tool
Data conversion tool 1
Data conversion tool 2
Data conversion tool 3
Setup a
Setup b
Setup c
Setup e
Setup f
Setup g
Recipe: [a, b, c] x [e, f]
Recipe: g
Model instance I
Model instance II
Specific model I
Output aeg
Output beg
Output ceg
Output afg
Output bfg
Output cfg