



Modelling the Impact of Transmission Charging Options

TransmiT Decision Model demonstration

27th January 2011

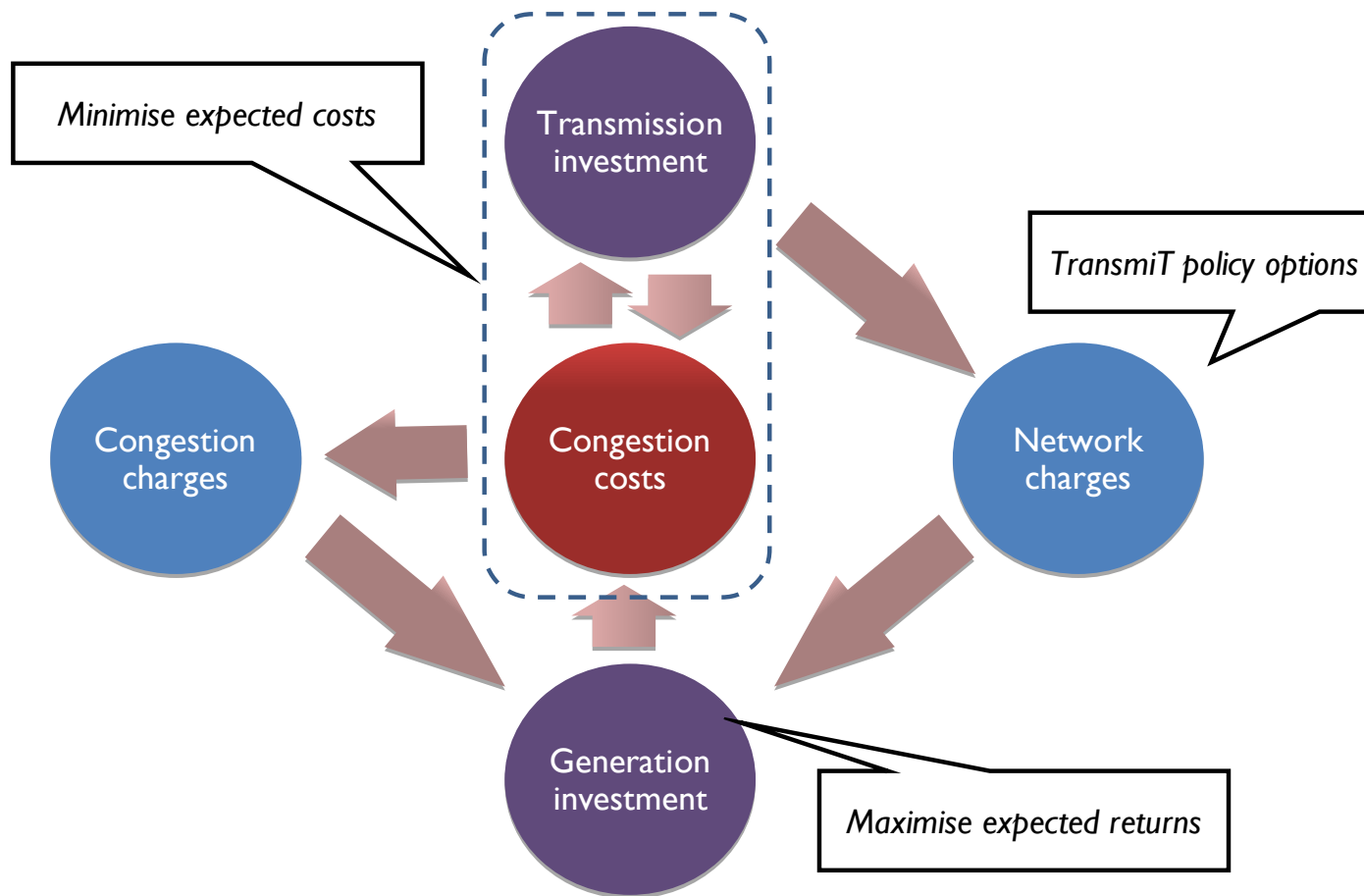
Agenda



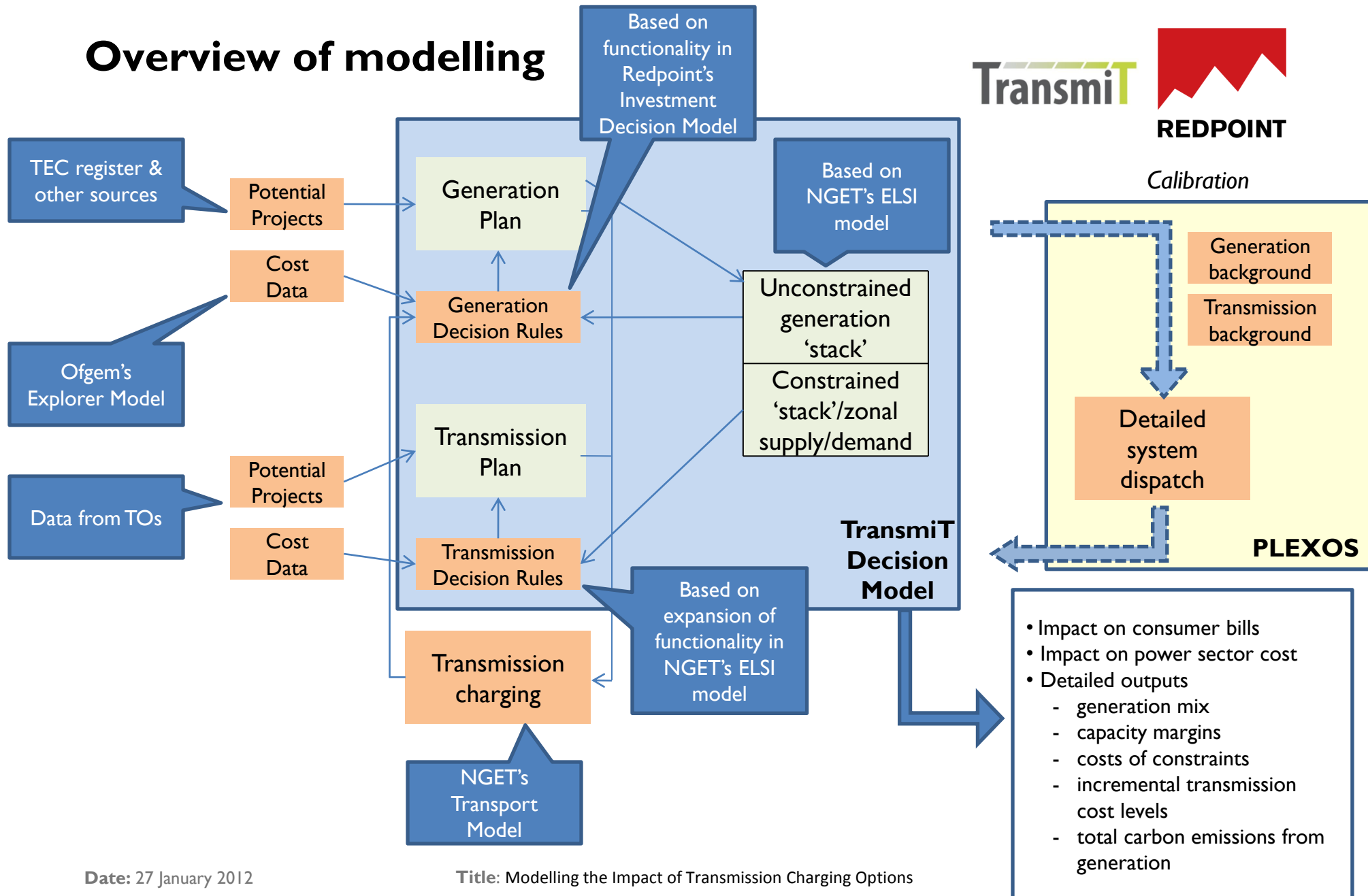
- Model overview
 - Schematic of model components
 - Discussion of the functionality of each component
 - Order of events in model run
- Key results: relationship to model components
- Demonstrations of model components
 - Transport Model
 - ELSI
 - Transmission investment
 - Generation investment
- Full model demonstration
- Summary
- Question & Answer session

Model overview

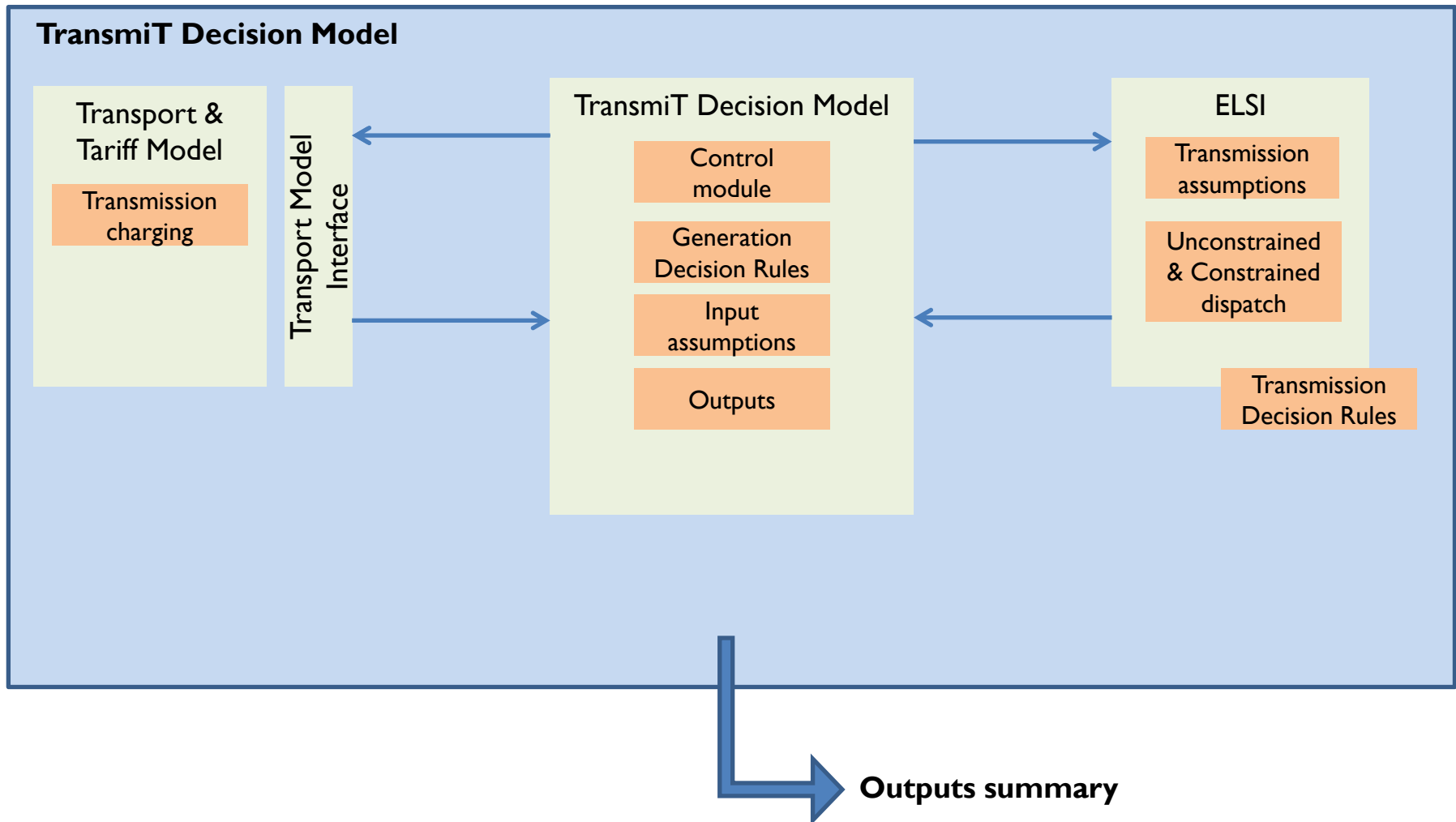
Conceptual framework



Overview of modelling

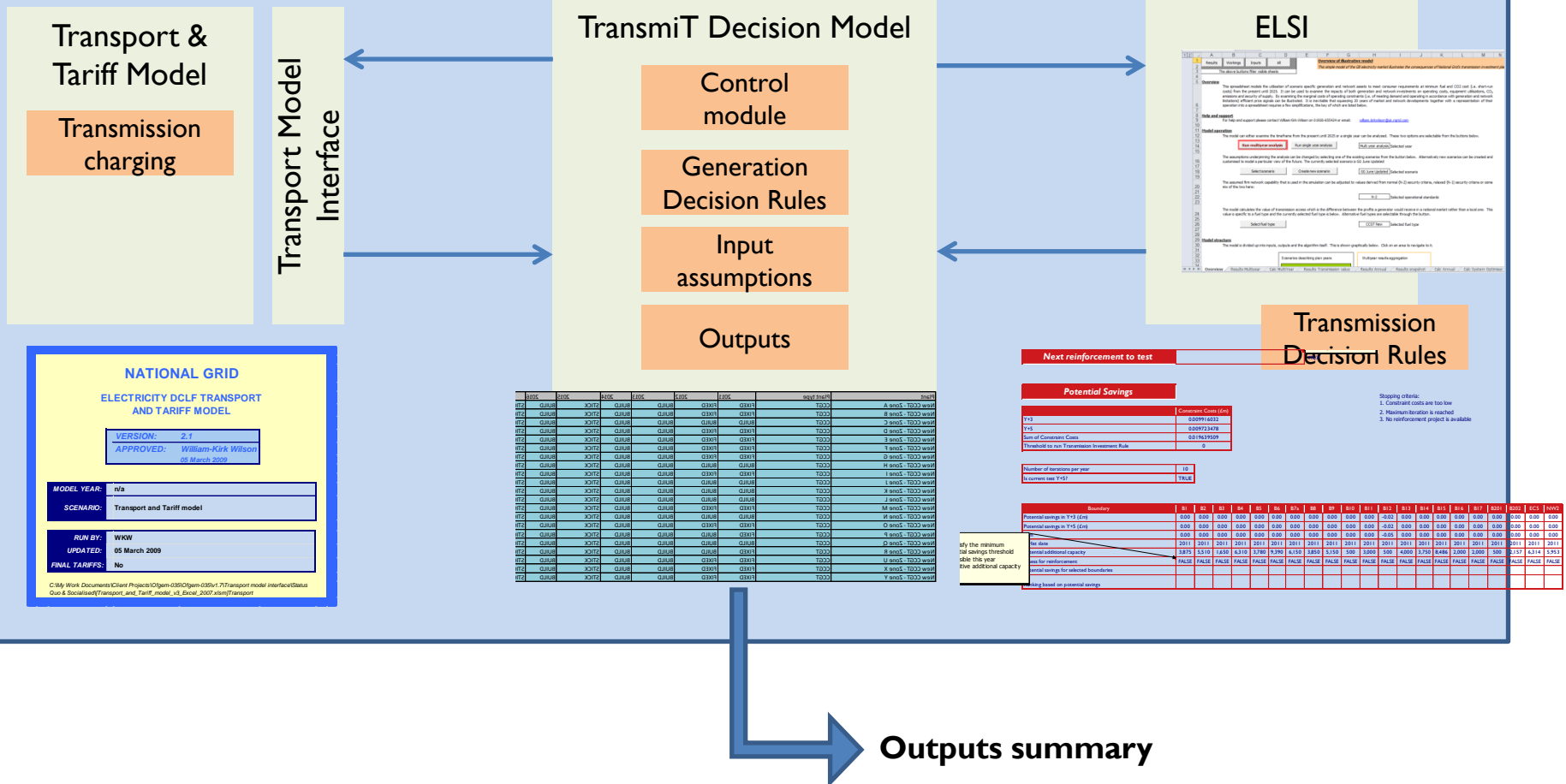


Model architecture



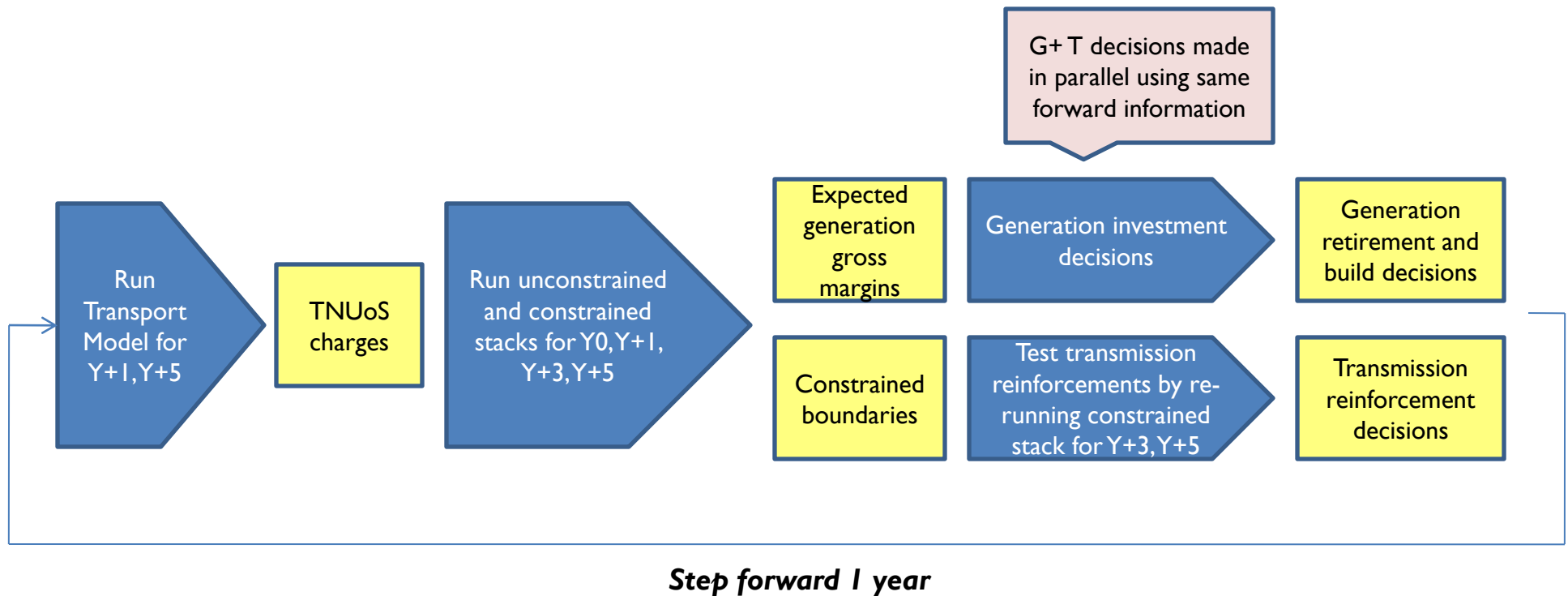
Model architecture

TransmiT Decision Model



Simulation steps (non-perfect foresight)

An example of a simulation step assuming 5 year forward look ahead for decision making.



Breakdown of Cost Benefit Analysis

- Fuel and variable costs from dispatch in ELSI
- Capital and fixed costs set by capacity from Generation Decision Rules

- Transmission reinforcement from Transmission Decision Rules
- Transmission losses from ELSI

		Improved ICRP
		NPV 2011-2020
<i>Benefit relative to Status Quo</i>		
Power sector costs	Generation costs	313
	Transmission costs	-8
	Constraint costs	-171
	Carbon costs	-11
	Decrease in power sector costs	122

Dispatch in ELSI

Constraint costs form ELSI constrained dispatch

Cost Benefit Analysis: Improved ICRP

For reference during today's discussion

Improved ICRP (£m real 2011)			
		NPV 2011-2020	NPV 2021-2030
<i>Benefit relative to Status Quo</i>			
Power sector costs	Generation costs	313	965
	Transmission costs	-8	-418
	Constraint costs	-171	-1,089
	Carbon costs	-11	-2
	Decrease in power sector costs	122	-543
Consumer bills	Wholesale costs (inc. capacity payments)	-1,227	-182
	BSUoS	-85	-547
	Transmission losses	-123	-491
	Demand TNUoS charges	98	62
	Low carbon support	441	644
	Decrease in consumer bills	-897	-512

Cost Benefit Analysis: Socialised

For reference during today's discussion

Socialised (£m real 2011)			
		NPV 2011-2020	NPV 2021-2030
Benefit relative to Status Quo			
Power sector costs	Generation costs	453	1,803
	Transmission costs	-1,569	-7,873
	Constraint costs	-1,452	-4,535
	Carbon costs	-201	-218
	Decrease in power sector costs	-2,769	-10,823
Consumer Bills	Wholesale costs (inc. capacity payments)	-6,157	-6,843
	BSUoS	-723	-2,276
	Transmission losses	-553	-2,693
	Demand TNUoS charges	-849	-4,402
	Low carbon support	1,406	3,342
	Decrease in consumer bills	-6,876	-12,873

Demonstration of model components

Transport and Tariff Model

TransmiT



NATIONAL GRID

ELECTRICITY DCLF TRANSPORT AND TARIFF MODEL

VERSION:	2.1
APPROVED:	William-Kirk Wilson 05 March 2009

MODEL YEAR:	n/a
SCENARIO:	Transport and Tariff model

RUN BY:	WKW
UPDATED:	05 March 2009
FINAL TARIFFS:	No

C:\My Work Documents\Client Projects\Ofgem-035\Ofgem-035\v1.7\Transport model interface>Status Quo & Socialised\Transport_and_Tariff_model_v3_Excel_2007.xlsm\Transport

Transport model: Improved ICRP and Socialised



- Socialised charging is a simplification and does not require a transport model – tariffs are calculated directly in the Transport Model Interface
- Separate Transport model for Improved ICRP, which requires addition inputs of
 - Annual load factor by generator (calculated from previous 5 years of history)
 - Peak security factor by plant type (static)
- Improved ICRP zonal outputs have two parts to the wider tariff
 - Year round (CBA)
 - Peak Security

Electricity Scenario Illustrator (ELSI)

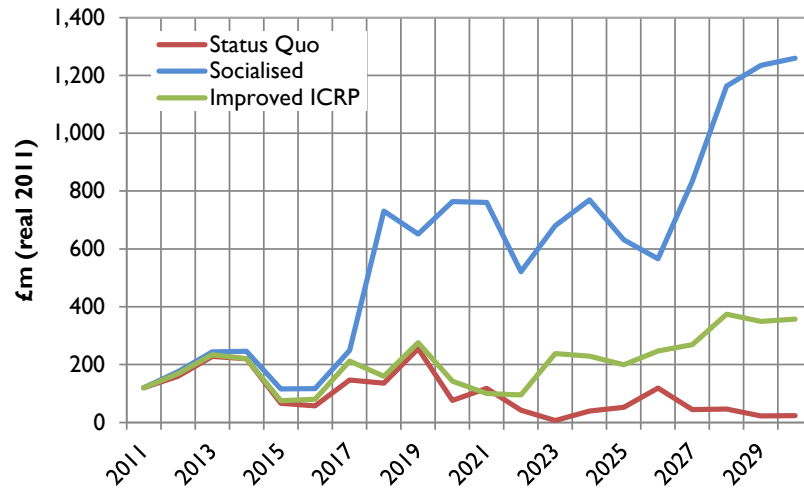
TransmiT



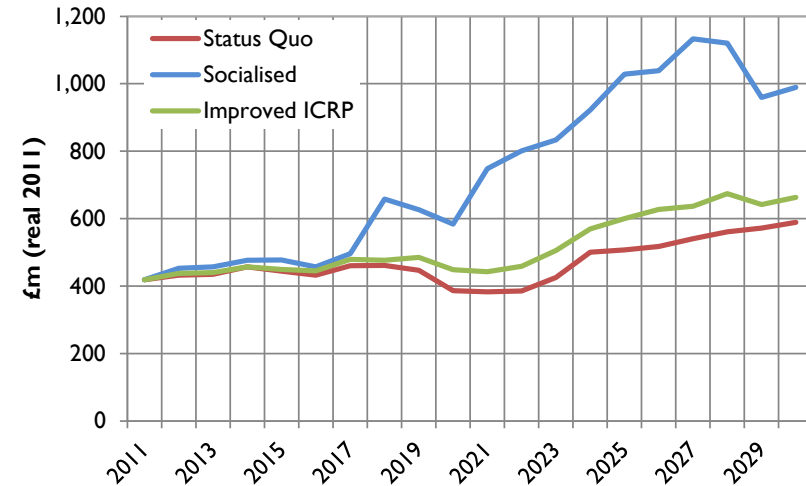
1	2	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1		Results	Workings	Inputs	All		Overview of illustrative model								
2		This simple model of the GB electricity market illustrates the consequences of National Grid's transmission investment plan													
3		The above buttons filter visible sheets													
4															
5		Overview													
6		This spreadsheet models the utilisation of scenario specific generation and network assets to meet consumer requirements at minimum fuel and CO2 cost (i.e. short-run costs) from the present until 2025. It can be used to examine the impacts of both generation and network investments on operating costs, equipment utilisations, CO ₂ emissions and security of supply. By examining the marginal costs of operating constraints (i.e. of meeting demand and operating in accordance with generation and network limitations) efficient price signals can be illustrated. It is inevitable that squeezing 20 years of market and network developments together with a representation of their operation into a spreadsheet requires a few simplifications, the key of which are listed below.													
7															
8		Help and support													
9		For help and support please contact William Kirk-Wilson on 01926-655424 or email: william.kirkwilson@uk.ngrid.com													
10															
11		Model operation													
12		The model can either examine the timeframe from the present until 2025 or a single year can be analysed. These two options are selectable from the buttons below.													
13		<input type="button" value="Run multiyear analysis"/> <input type="button" value="Run single year analysis"/> <input type="button" value="Multi year analysis"/> Selected year													
14															
15															
16		The assumptions underpinning the analysis can be changed by selecting one of the existing scenarios from the button below. Alternatively new scenarios can be created and customised to model a particular view of the future. The currently selected scenario is GG June Updated													
17		<input type="button" value="Select scenario"/> <input type="button" value="Create new scenario"/> <input type="button" value="GG June Updated"/> Selected scenario													
18															
19															
20		The assumed firm network capability that is used in the simulation can be adjusted to values derived from normal (N-2) security criteria, relaxed (N-1) security criteria or some mix of the two here:													
21															
22		<input type="button" value="N-2"/> Selected operational standards													
23															
24		The model calculates the value of transmission access which is the difference between the profits a generator would receive in a national market rather than a local one. This value is specific to a fuel type and the currently selected fuel type is below. Alternative fuel types are selectable through the button.													
25															
26		<input type="button" value="Select fuel type"/> <input type="button" value="CCGT New"/> Selected fuel type													
27															
28															
29		Model structure													
30		The model is divided up into inputs, outputs and the algorithm itself. This is shown graphically below. Click on an area to navigate to it.													
31															
32		<input type="button" value="Scenarios describing plan years"/> <input type="button" value="Multiyear results aggregation"/>													
33															
34															
		<input type="button" value="Overview"/> <input type="button" value="Results Multiyear"/> <input type="button" value="Calc MultiYear"/> <input type="button" value="Results Transmission value"/> <input type="button" value="Results Annual"/> <input type="button" value="Results snapshot"/> <input type="button" value="Calc Annual"/> <input type="button" value="Calc System Optimiser"/>													

Electricity Scenario Illustrator (ELSI): results from ELSI

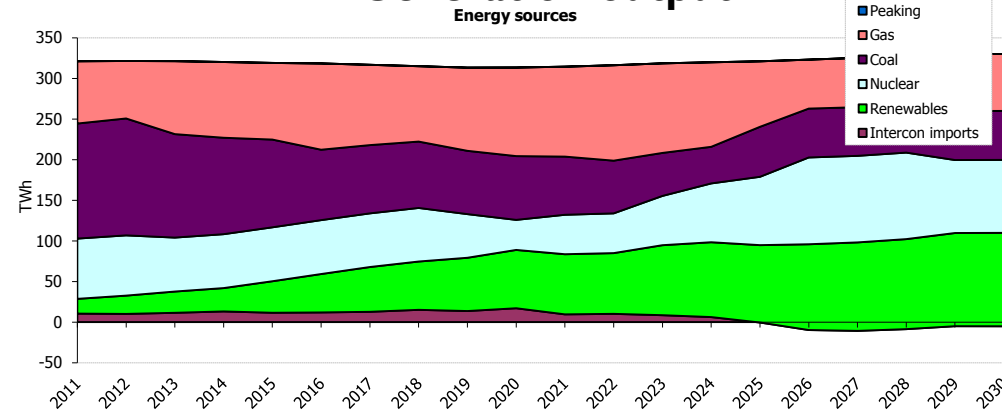
Annual constraint costs



Annual transmission losses



Generation output



Transmission Decision Rules

Next reinforcement to test

#N/A

Potential Savings

	Constraint Costs (£m)
Y+3	0.009916032
Y+5	0.009723478
Sum of Constraint Costs	0.019639509
Threshold to run Transmission Investment Rule	0

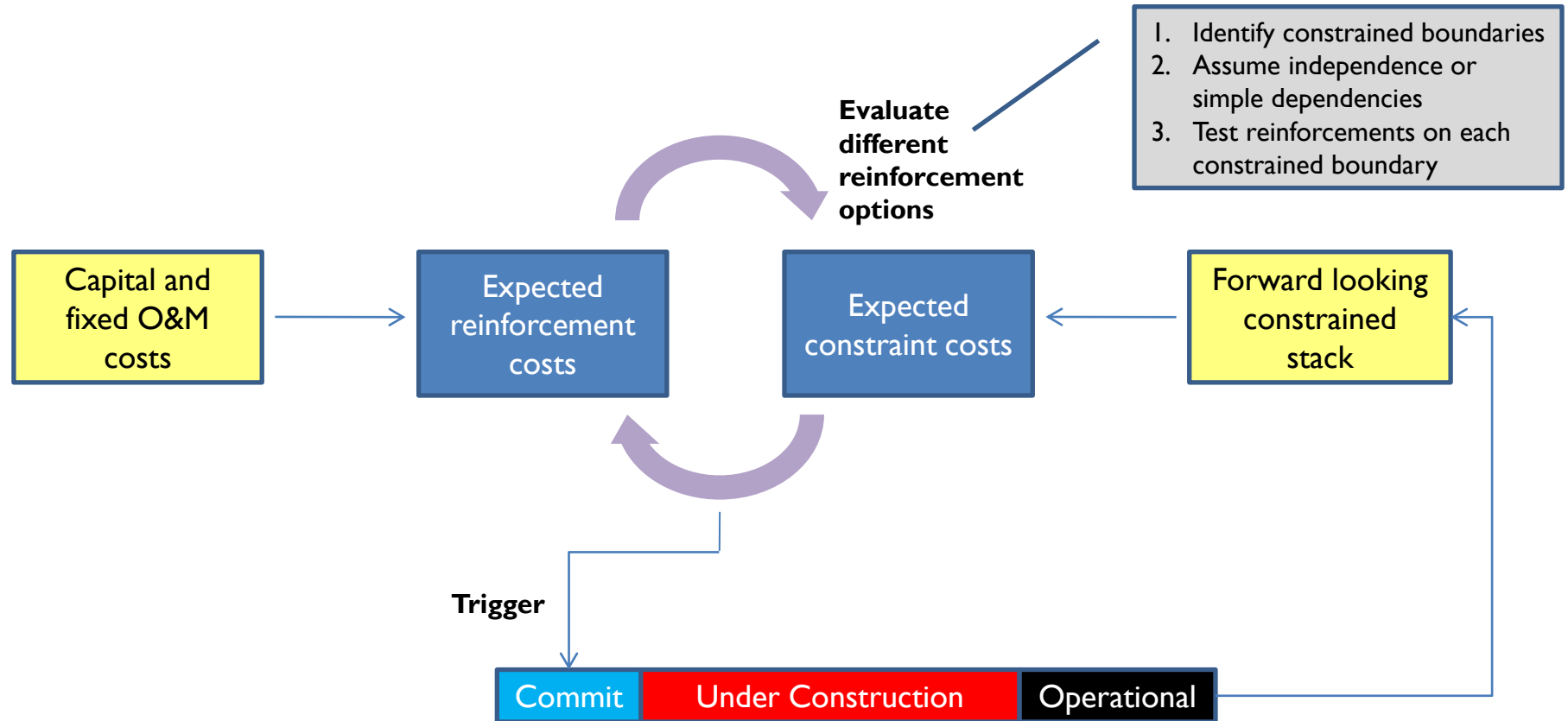
Stopping criteria:

1. Constraint costs are too low
2. Maximum iteration is reached
3. No reinforcement project is available

Number of iterations per year	10
Is current test Y+5?	TRUE

Boundary	B1	B2	B3	B4	B5	B6	B7a	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B201	B202	EC5	NW2
Potential savings in Y+3 (£m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potential savings in Y+5 (£m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
...	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
...	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011
Potential additional capacity	3,875	5,510	1,650	6,310	3,780	9,390	6,150	3,850	5,150	500	3,000	500	4,000	3,750	8,486	2,000	2,000	500	2,157	6,314	5,953
...	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Potential savings for selected boundaries																					
Ranking based on potential savings																					

Transmission Decision Rules



Transmission Decision Rules

Timing of new HVDC links

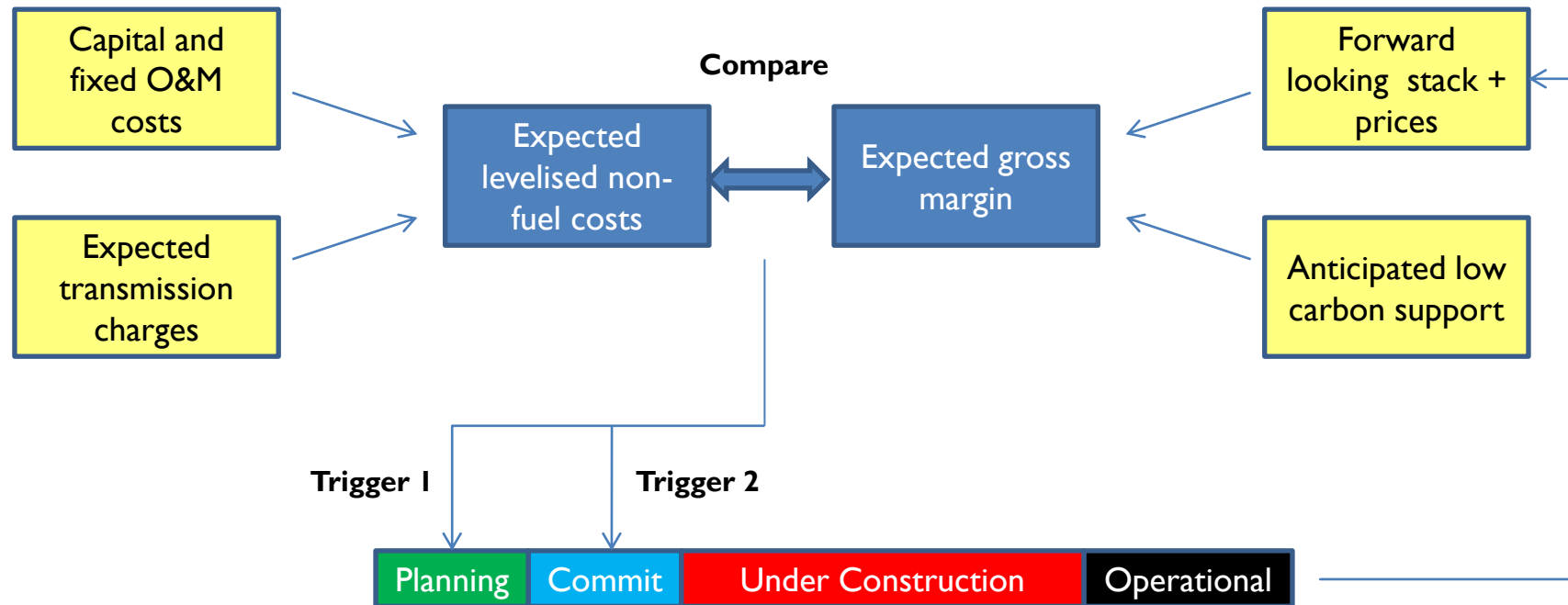
Reinforcement	Capacity (MW)	Cost (£m, real 2011)	Boundaries reinforced	Assumed earliest feasible date	Status Quo	Socialised	Improved ICRP
Western HVDC Link	2000	866	B6, B7a	2015	2015	2015	2015
Western HVDC Link #2	2000	866	B6, B7a	2020	2023	2022	2020
Eastern HVDC Link	2000	891	B2, B4, B5, B6, B7a	2018	2022	2022	2018
Eastern HVDC Link #2	2000	891	B2, B4, B5, B6, B7a	2020	2027	2025	2024
Wylfa-Pembroke 2GW HVDC link	2000	834	B202, NW2	2018	-	-	-
Caithness - Moray HVDC	600	800	B1	2017	-	2022	2020
Humber - Walpole HVDC	2000	595	B8, B9, B11, B16	2020	-	2023	2027

Generation Decision Rules

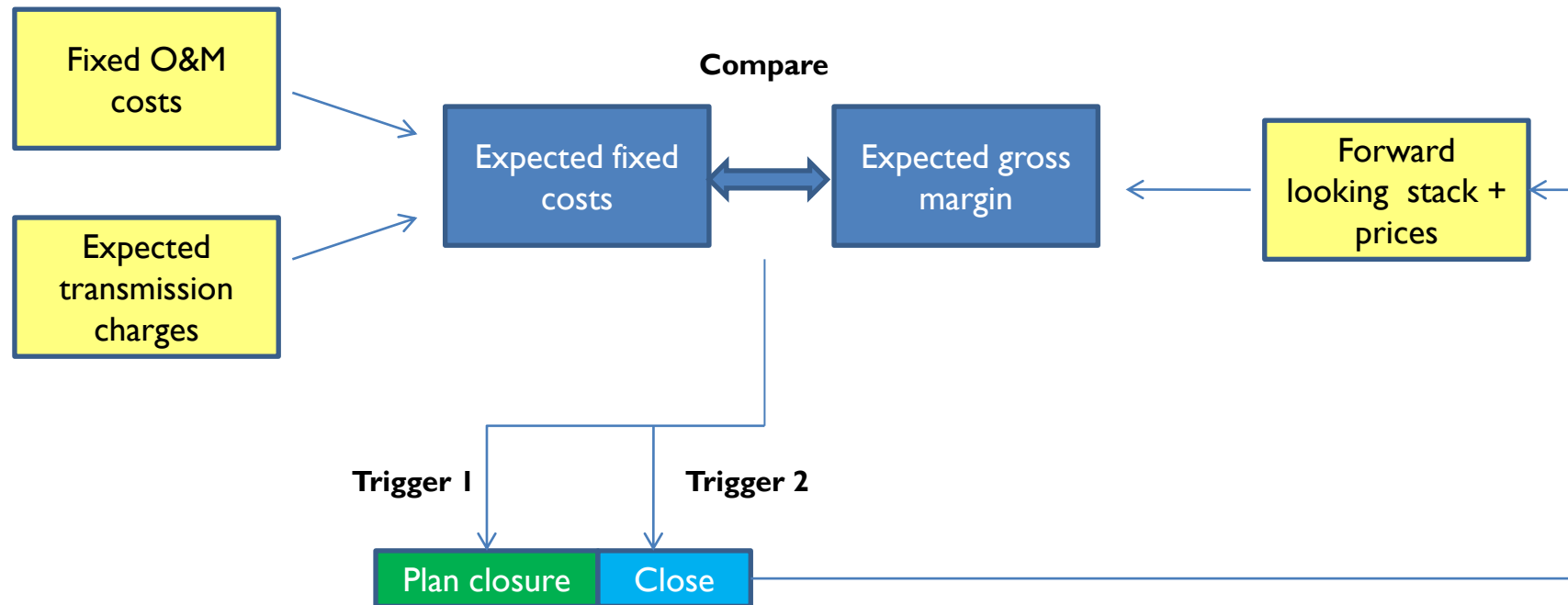


Plant	Plant type	2011	2012	2013	2014	2015	2016	2017
New CCGT - Zone A	CCGT	FIXED	FIXED	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone B	CCGT	FIXED	FIXED	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone C	CCGT	BUILD	BUILD	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone D	CCGT	FIXED	FIXED	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone E	CCGT	FIXED	FIXED	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone F	CCGT	FIXED	FIXED	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone G	CCGT	FIXED	FIXED	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone H	CCGT	BUILD	BUILD	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone I	CCGT	FIXED	FIXED	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone J	CCGT	BUILD	BUILD	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone K	CCGT	BUILD	BUILD	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone L	CCGT	BUILD	BUILD	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone M	CCGT	FIXED	FIXED	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone N	CCGT	BUILD	BUILD	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone O	CCGT	FIXED	FIXED	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone P	CCGT	FIXED	BUILD	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone Q	CCGT	BUILD	BUILD	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone R	CCGT	FIXED	BUILD	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone U	CCGT	FIXED	FIXED	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone X	CCGT	FIXED	FIXED	BUILD	BUILD	STICK	BUILD	STICK
New CCGT - Zone Y	CCGT	FIXED	FIXED	BUILD	BUILD	STICK	BUILD	STICK

Generation Decision Rules – New Build

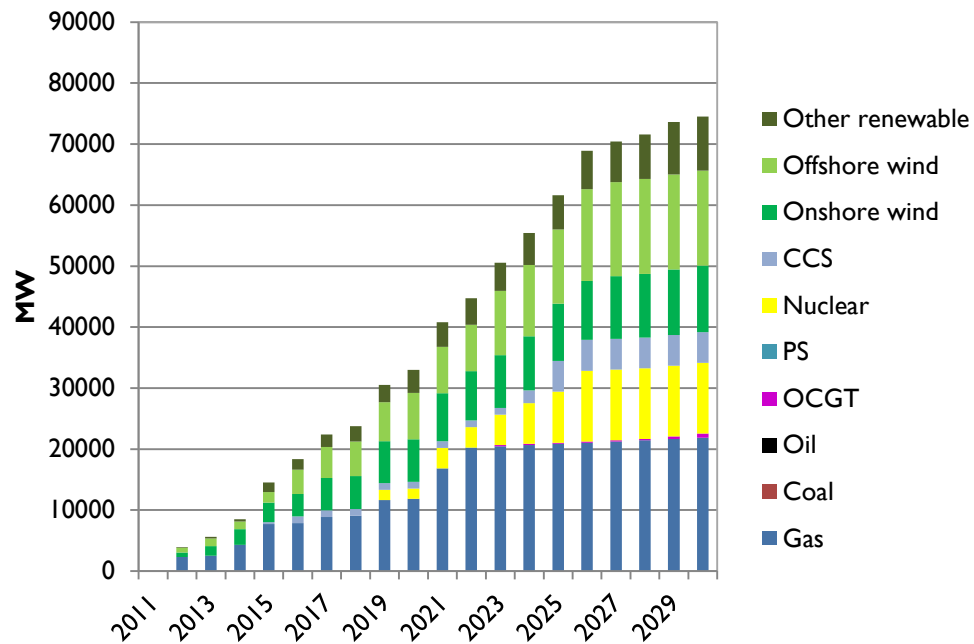


Generation Decision Rules – Retirements

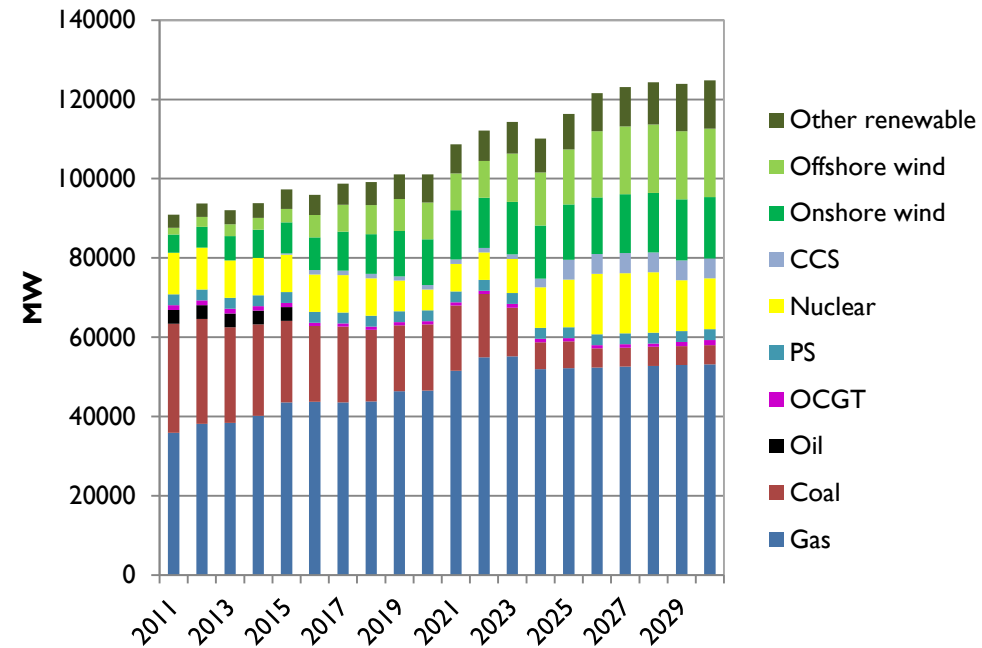


Generation Decision Rules

New build



Capacity mix



Full model demonstration

Full model demonstration

TransmiT



Explorer
L:\Client projects\Ofgem-035 TransmiT option modelling\Model development\Generation investment modelling\v1.7\TDM SQ v1.7.xlsm

Number of Steps
301

Button Action
ELSI
 17

Current Step

Step Number	Row Number
1	2

Agents	Path
ELSI	L:\Client projects\Ofgem-035 TransmiT option modelling\Model development\Generation investment modelling\v1.7\ELSI SQ v1.7.xlsm
Transport Model Interface	L:\Client projects\Ofgem-035 TransmiT option modelling\Model development\Generation investment modelling\v1.7\Transport model interface\Status Quo & Socialised\Transport and Ta
Transport Model Interface (Improved ICRP)	L:\Client projects\Ofgem-035 TransmiT option modelling\Model development\Generation investment modelling\v1.7\Transport model interface\Improved ICRP\Improved Transport a
Transport Model Interface (Socialised)	L:\Client projects\Ofgem-035 TransmiT option modelling\Model development\Generation investment modelling\v1.7\Transport model interface\Status Quo & Socialised\Transport and Ta

Scenario Choice
Status Quo - BC

Path to export into
Browse..
 L:\Client projects\Ofgem-035 TransmiT option modelling\Model development\Generation investment modelling\v1.7\Stage 1 outputs
 ELSI Interface

Source sheet	Source range	Date and time	Destination filename
Graphing	rngOutputs	120125	Graphing_Status Quo - BC.csv

Create Output Files

Calc Gen Plan

Reset

Initialise ELSI

Transport Model

Next Step

ELSI

Transport Model (Improved ICRP)

Reset Properties

ELSI Ex-post

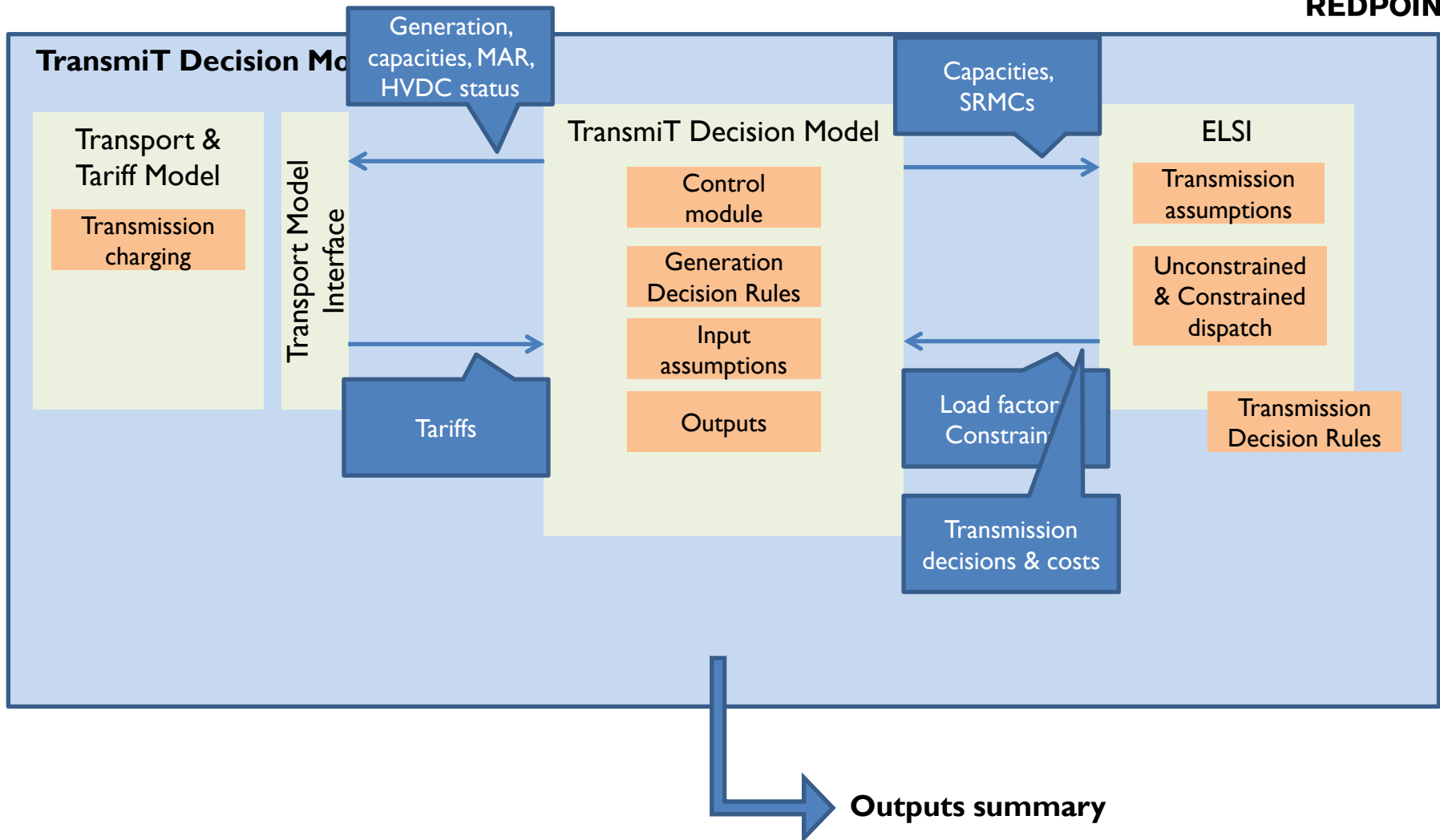
Transport Model (Socialised)

ELSI <=> Explorer

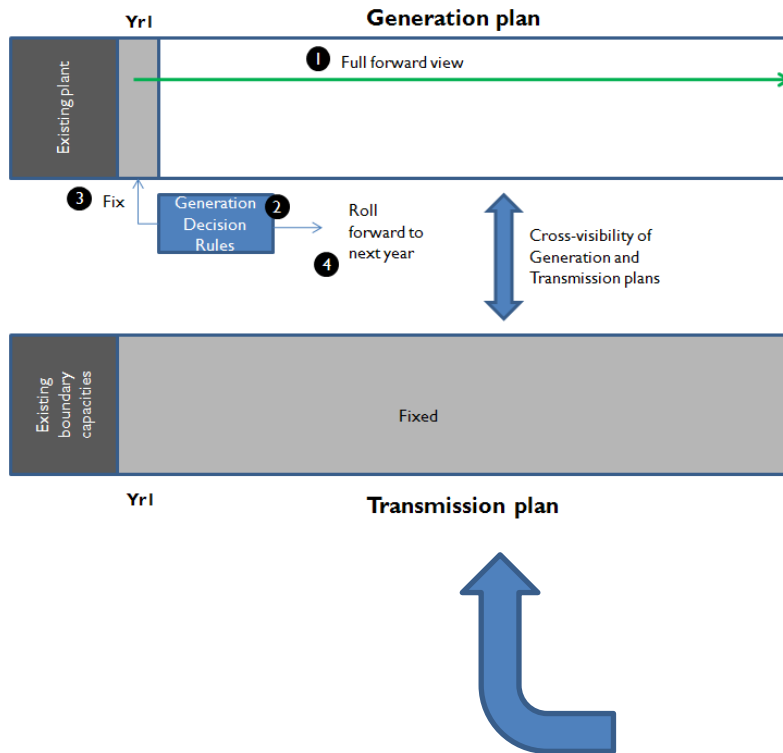
Transport Model (SQ + Socialised)

Heading start year	2011
Heading end year	2030
Model run Start Year	2011
Model run End Year	2030
Current Year	2030
Run ELSI	TRUE
Run Transmission Investment Model	TRUE
Perfect Foresight	FALSE
Number of Perfect Foresight Iterations	1
Current Iteration	1
Perfect Foresight Transport Model	TransModelsQP
Imperfect Foresight Transport Model	TransModel

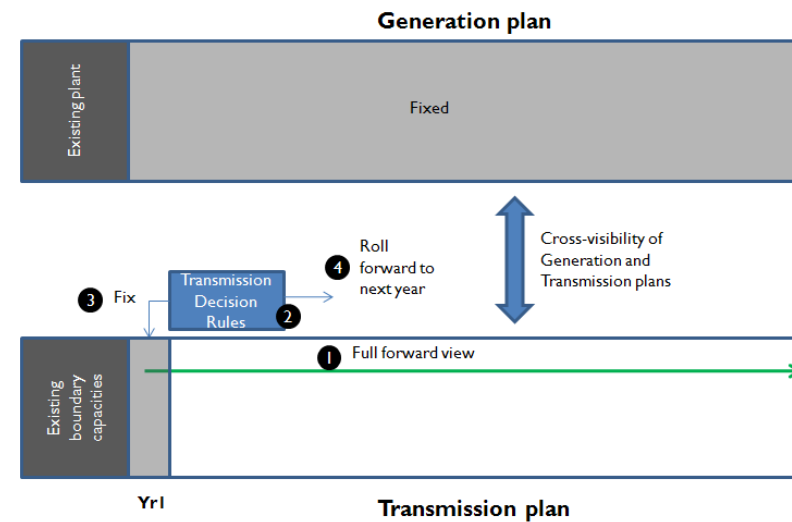
Full model demonstration



Perfect foresight - overview

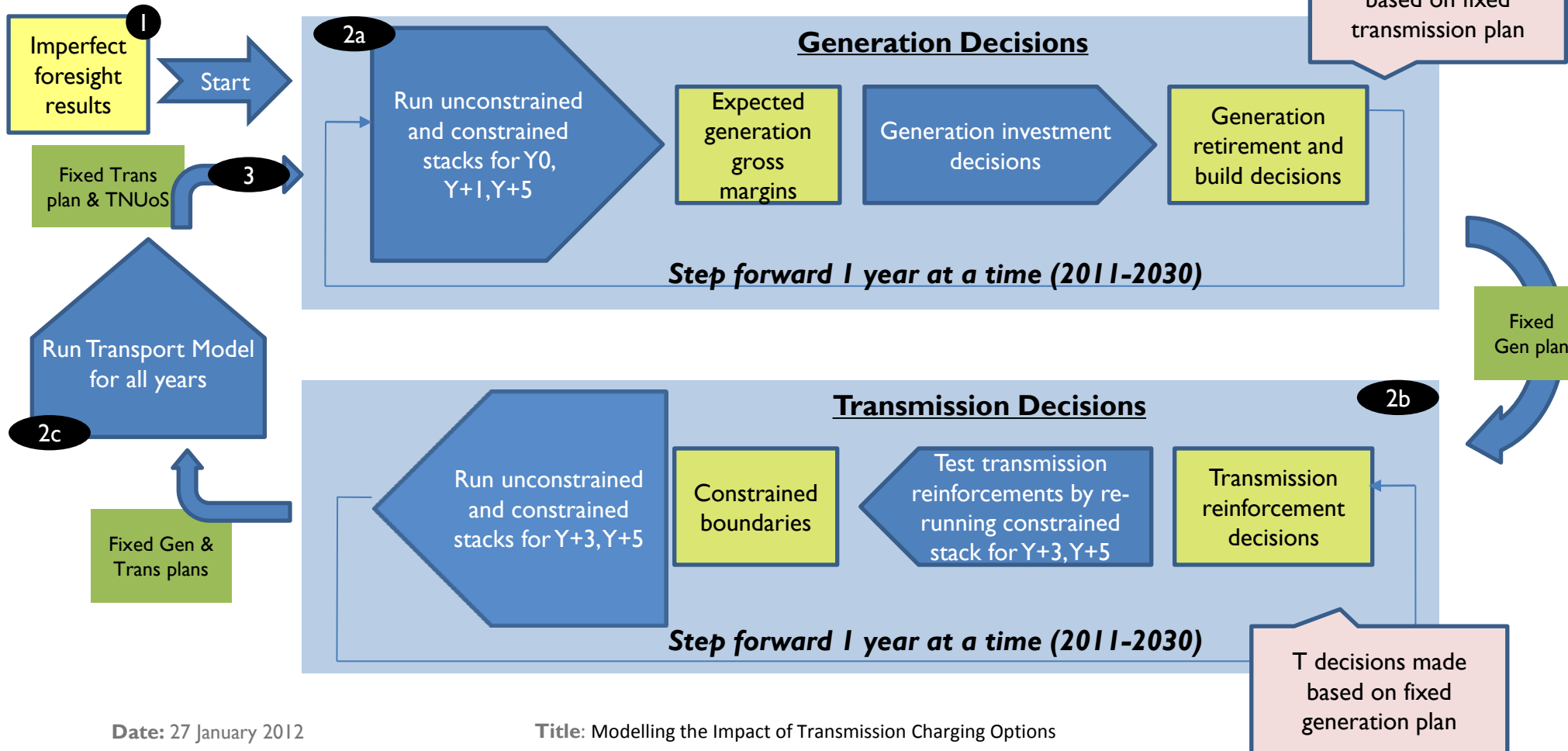


**Iterate
to converge**



Simulation steps (perfect foresight)

An example of the simulation steps under the perfect foresight approach – note that transmission and generation decisions are made independently.



ANY QUESTIONS?