PigSys

ERA-NETSUSAN

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AGENCE NATIONALE DE LA RECHERCHE
ANR

Session 40

Modelling growth performance of pigs and within-room thermal balance in different local conditions

ifip institut du porc

INRA SCIENCE & IMPACT

SLU

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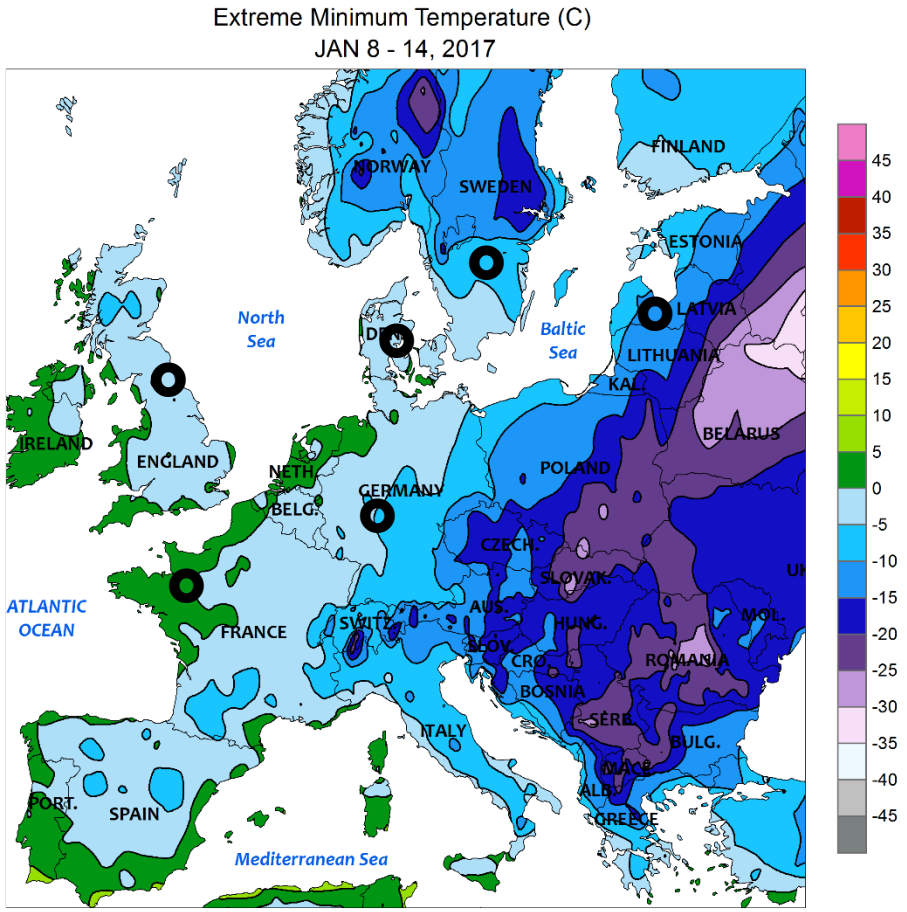
Introduction



From NOAA / National Weather Service

Pig farms can be found everywhere in Europe

with different types of building, management rules under different climates

➔ **factors that influence performance, welfare…**

PIGSYS project (8 partners from 6 countries):

⇨ Improving pig system performance through a whole system approach, based on the integration of available information in a decision support system

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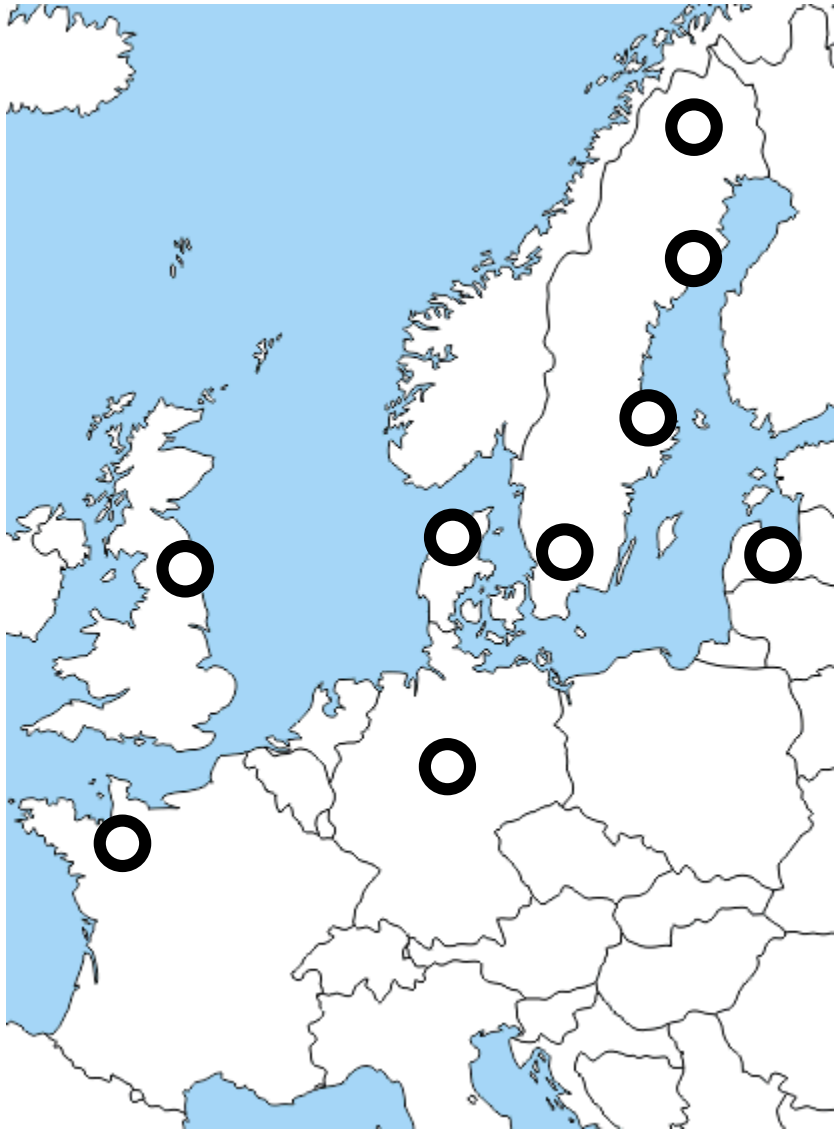
Local conditions of production



Based on a survey performed by the partners in 6 european countries

- climate
- barn characteristics (size, insulation, equipment…)
- indoor management rules (temperature, T)
- type of pigs
- feeding strategies

INPUTS

Pig growth model

InraPorc

Modified to simulate performance of the batch (Cadero et al., 2017)

Bioclimatic model

THERMISIM DE L'ifip

Thermal exchanges at the room level (Marcon et al., 2016)

THERMIPig model

(Brossard et al., 2019 Modnut)

➔ impact of technical options or **indoor** management rules on pigs' performance and energy use under different **outdoor** conditions

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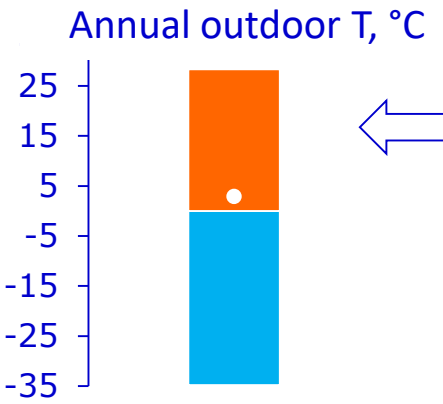
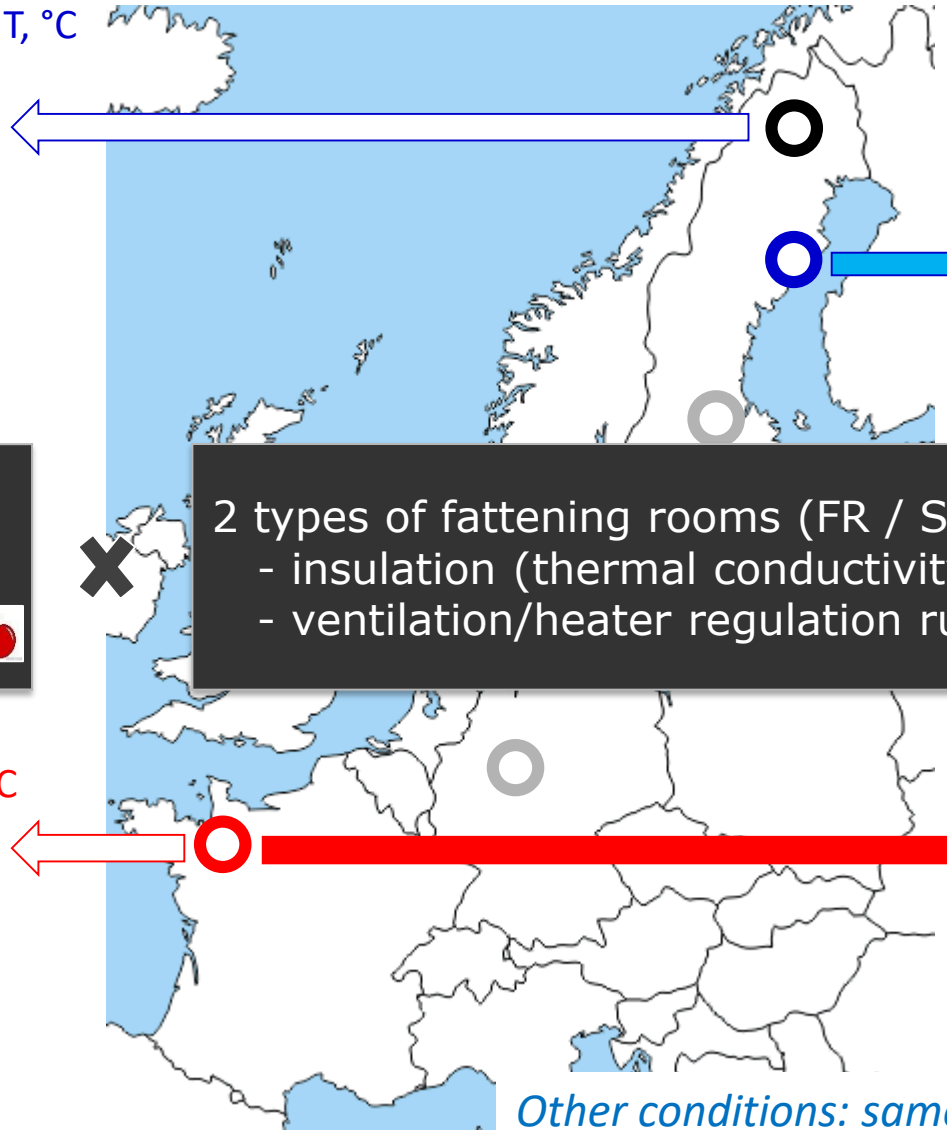
Conditions selected for the evaluation of the model

The coldest weather = SWuN upper Northern SW





SWN: Insulation / regulation rules
+ installed heater power capacity adapted to outdoor T > -18°C

2 climates

FR / SWuN

×

4 seasons

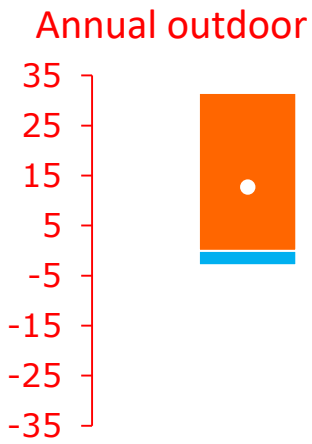
×

2 types of fattening rooms (FR / SWN)
- insulation (thermal conductivity)
- ventilation/heater regulation rules

×

2 installed heater power capacities
0 / 25.9 W.h/pig
(no extra heater)

The warmest weather = FR



FR: Insulation + regulation rules adapted to outdoor T > 0°C
(no heater)

Other conditions: same type of pigs/room size/feeding strategy

**1 simulation = 30 virtual batches*

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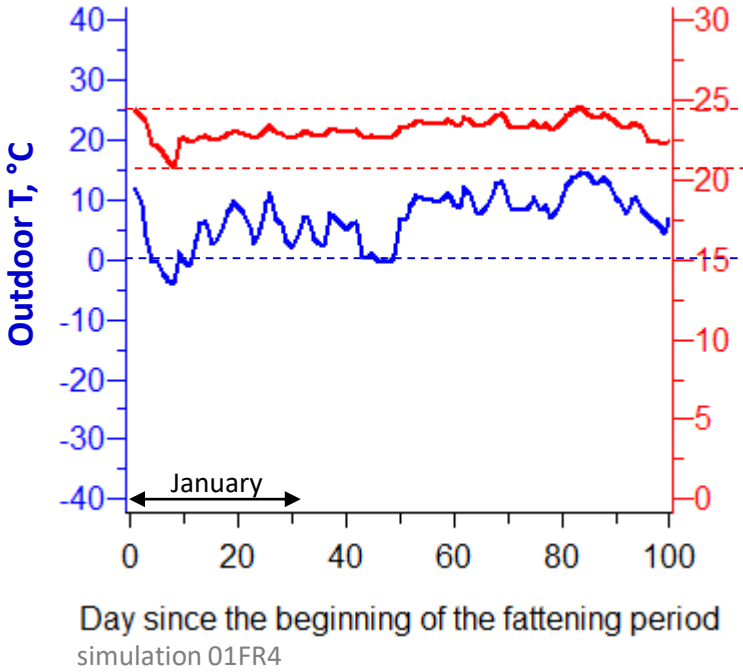
Behavior of the model

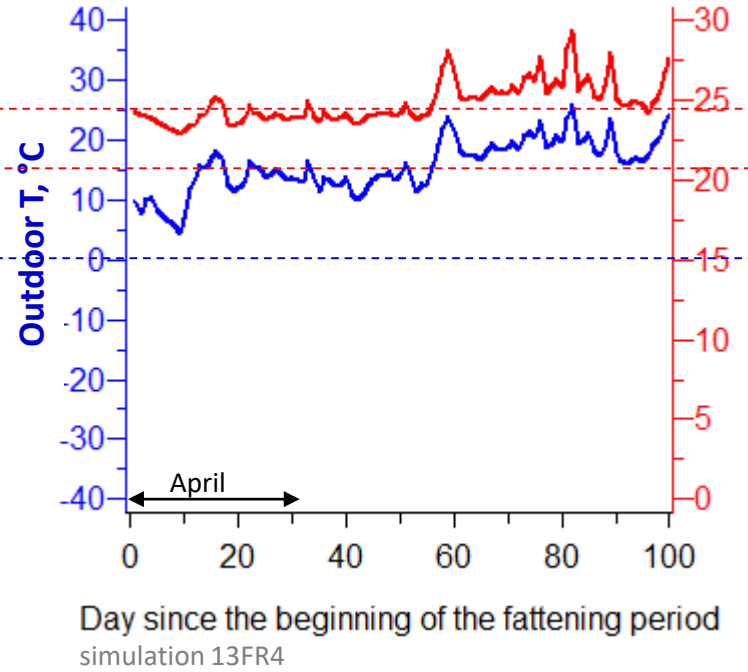
FR Climate	winter/spring/summer*	FR room	No heater

Mild winter (FR)



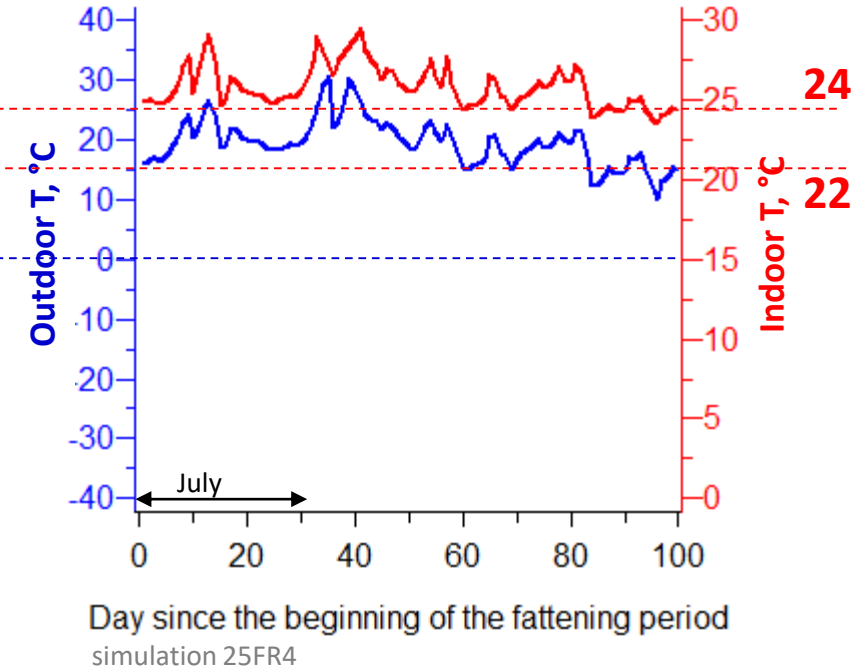
simulation 01FR4

Spring (FR)



simulation 13FR4

Summer (FR)



simulation 25FR4

*Beginning of fattening on January 1st, April 1st, July 1st
Example: batch n°18

Behavior of the model

FR Climate	winter/spring/summer	FR room	No heater

				Indirect energy consumption*			
	FI	ADG	FCR	Feed	Ventilation	Heater	Total
	kg/d	g/d	kg/kg	%	%	%	MJ/pig
Mild winter (FR) simulation 01FR4	2.36	895	2.65	90.3	9.7	-	1326
Spring (FR) simulation 13FR4	2.29	877	2.62	89.4	10.6	-	1329
Summer (FR) simulation 25FR4	2.25	861	2.62	88.8	11.2	-	1361

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*1 kW.h = 13.3 MJ (EcoInvent, 2018)

ADG: average daily gain, FCR: feed conversion ratio, on average before the 1st delivery to slaughterhouse (30 batches)

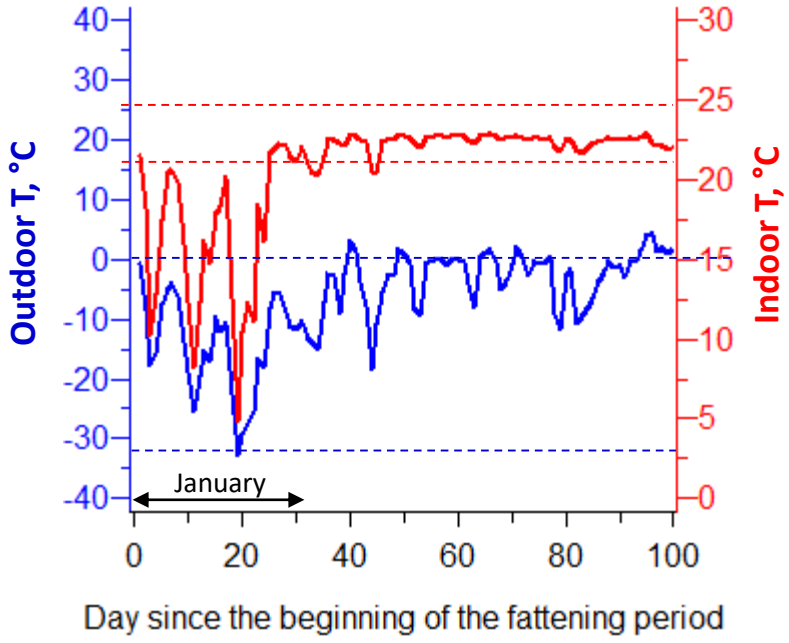
Behavior of the model

SWuN Climate	Winter	FR/SWN room	No heater

Insulation/ventilation FR

Thermal conductivity (2.6 W.m^{-2}.°C^{-1})	5 cm	8 cm	7 cm
	1.7	0.032	1.7

Ventilation regulation: **24 → 22°C**

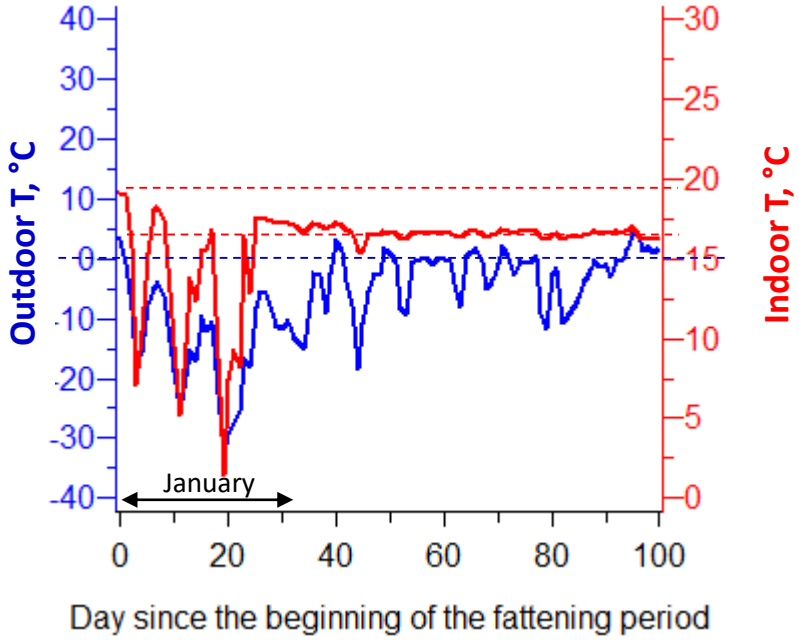


simulation 49FR4

Insulation/ventilation SWN

Thermal conductivity (4.3 W.m^{-2}.°C^{-1})	7 cm	15 cm	7 cm
	1.7	0.036	1.7

Ventilation regulation: **19 → 16°C**



simulation 53SW5

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Example: batch n°18

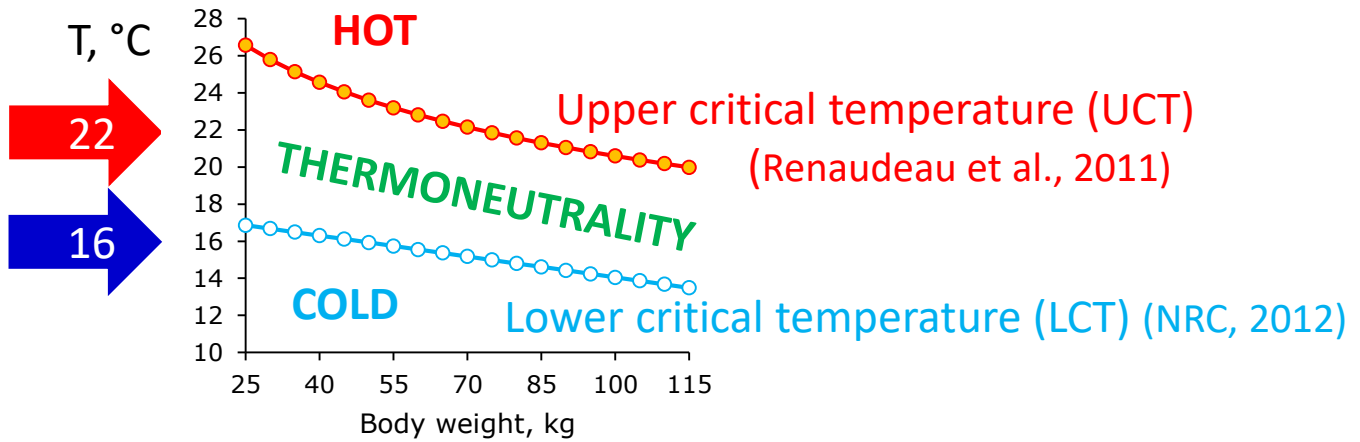
Behavior of the model

SWuN Climate	Winter	FR/SWN room	No heater

		FI kg/d	ADG g/d	FCR kg/kg	Indirect energy consumption* Feed %	Ventilation %	Heater %	Total MJ/pig
FR	Insulation Ventilation simulation 49FR4	2.39	892	2.68	90.5	9.5	-	1345
SWN	Insulation Ventilation simulation 53SWN5	2.42	893	2.72	90.5	9.5	-	1363

Massabie et al. (1996) under controlled indoor T

24°C	2.26[a]	876[a]	2.42[a]
20°C	2.42[b]	915[b]	2.48[ab]
17°C	2.50[c]	900[b]	2.53[b]



Mean from 30 batches, *1 kW.h = 13.3 MJ (EcoInvent, 2018)

ADG: average daily gain, FCR: feed conversion ratio, on average before the 1st delivery to slaughterhouse (30 batches)

Behavior of the model

SWuN Climate	Winter	FR/SWN room	No heater

		FI	ADG	FCR	Indirect energy consumption*			
					Feed	Ventilation	Heater	Total
		kg/d	g/d	kg/kg	%	%	%	MJ/pig
FR	**Insulation Ventilation** simulation 49FR4	2.39	892	2.68	90.5	9.5	-	1345
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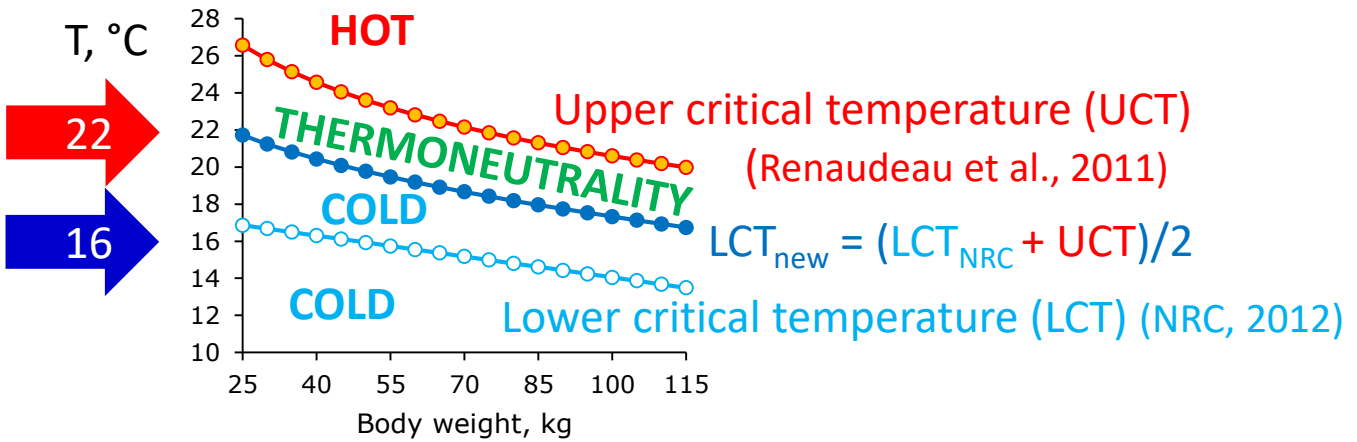

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ADG: average daily gain, FCR: feed conversion ratio, on average before the 1st delivery to slaughterhouse (30 batches)

Behavior of the model

LCT NEW

SWuN Climate	Winter	FR/SWN room	No heater

		FI	ADG	FCR	Indirect energy consumption*			
					Feed	Ventilation	Heater	Total
		kg/d	g/d	kg/kg	%	%	%	MJ/pig
FR	**Insulation**	2.39	883	2.71	90.5	9.5	-	1344
	Ventilation							
	simulation 49FR7							
SWN	**Insulation**	2.48	878	2.84	90.7	9.3	-	1434
	Ventilation							
	simulation 53SWN6							

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*1 kW.h = 13.3 MJ (EcoInvent, 2018)

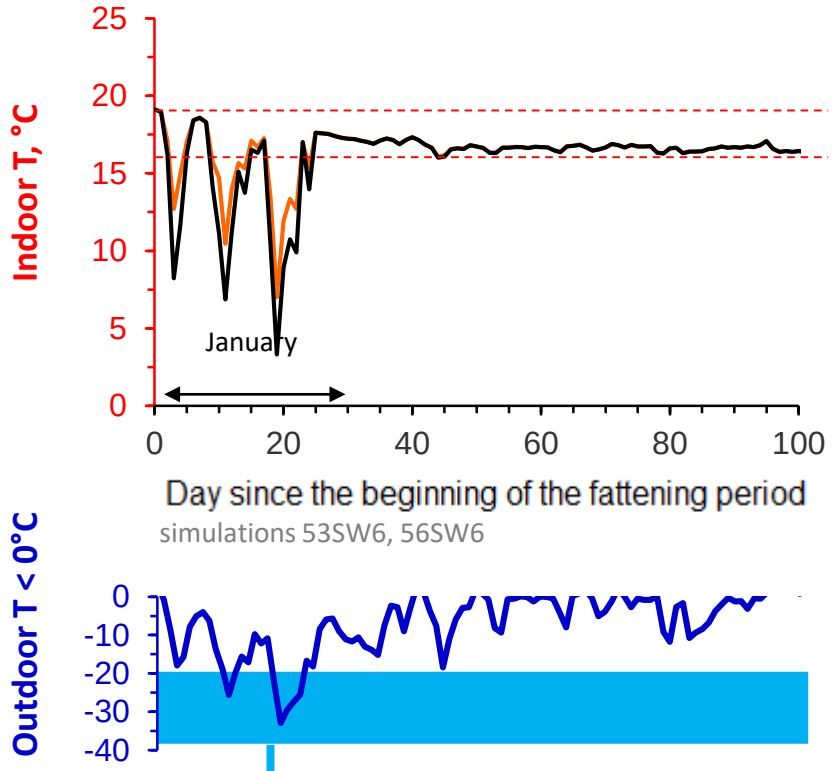
ADG: average daily gain, FCR: feed conversion ratio, on average before the 1st delivery to slaughterhouse (30 batches)

Behavior of the model

LCT NEW

SWuN Climate	Winter	SWN room	Heater power HP

HP, W.h/pig	0	25.9



Installed HP adapted to outdoor T > -18°C

Minimum expected indoor T not achieved when outdoor T < -18°C

In practice, extra heater systems are used punctually

Reduced intensity of cold exposure

= feed intake limited by the digestive capacity at early stages of growth

Reduced energy demand for thermoregulation

Similar FI but more energy available for growth

*Beginning of fattening on January 1st
Example: batch n°18

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Behavior of the model

LCT NEW

SWuN Climate	Winter	SWN room	Heater power HP

HP, W.h/pig	0	25.9		0	25.9	
ADG, d/d	878	885				
FCR	2.84	2.81				
E feed, MJ/pig	**1301**	**1279**	-22			-22
N output, kg/pig	**3.94**	**3.85**	-0.09			-0.09
Electricity - nuclear				**- partly renewable**		
E total, MJ/pig	**1435**	**1510**	+75	**1364**	**1388**	+24
E feed, %	90.7	84.7		95.4	92.1	
E ventilation, %	9.3	8.7		4.6	4.5	
E heater, %	-	6.6		-	3.4	

simulations 53SW6, 56SW6

Mean from 30 batches

1 kW.h = 13.3 (FR) or 6.28 (SW) MJ (EcoInvent, 2018)

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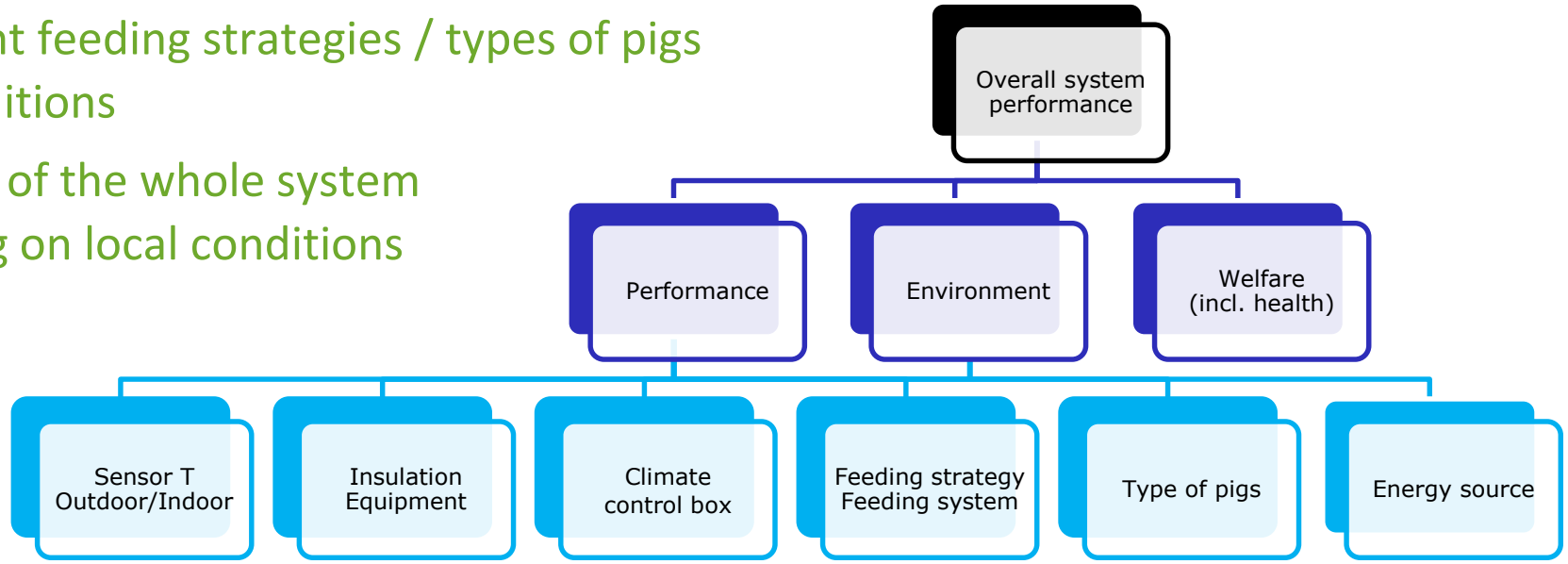
Conclusions and perspective

- THERMIPigmodel sensitive to
  - ⇨ Climate / season
  - ⇨ Insulation/ventilation regulation
  - ⇨ Heater power capacity
- To be considered
  - ⇨ Punctual use of extra heaters
  - ⇨ Use of cooling systems
- Perspective
  - ⇨ Simulation with different feeding strategies / types of pigs
    ➔ additional local conditions
  - ⇨ Real-time management of the whole system performance depending on local conditions



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Acknowledgements

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