



Session 40

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

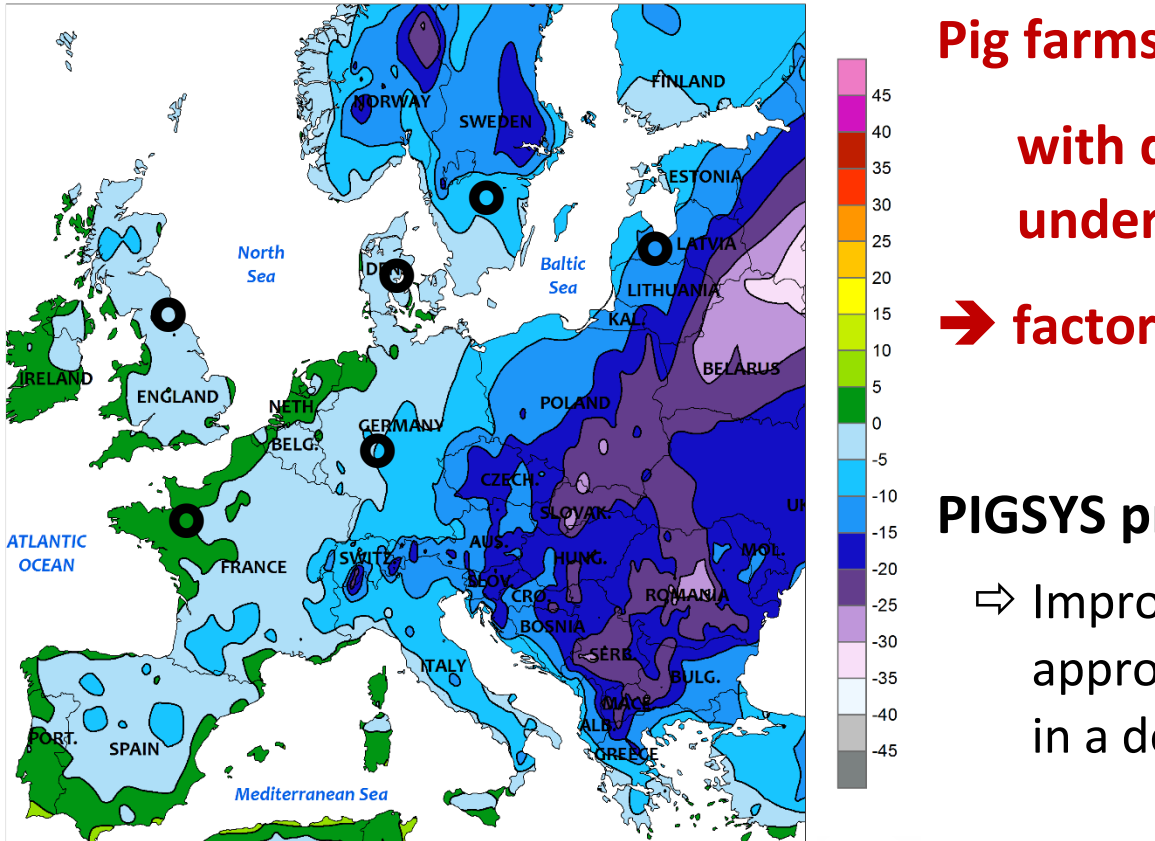


N. QUINIOU, A. CADERO, M. MARCON, L. BROSSARD

A.-C. OLSSON, K.-H. JEPPSSON

Introduction

Extreme Minimum Temperature (C)
JAN 8 - 14, 2017



From NOAA / National Weather Service

Pig farms can be found everywhere in Europe

**with different types of building, management rules
under different climates**

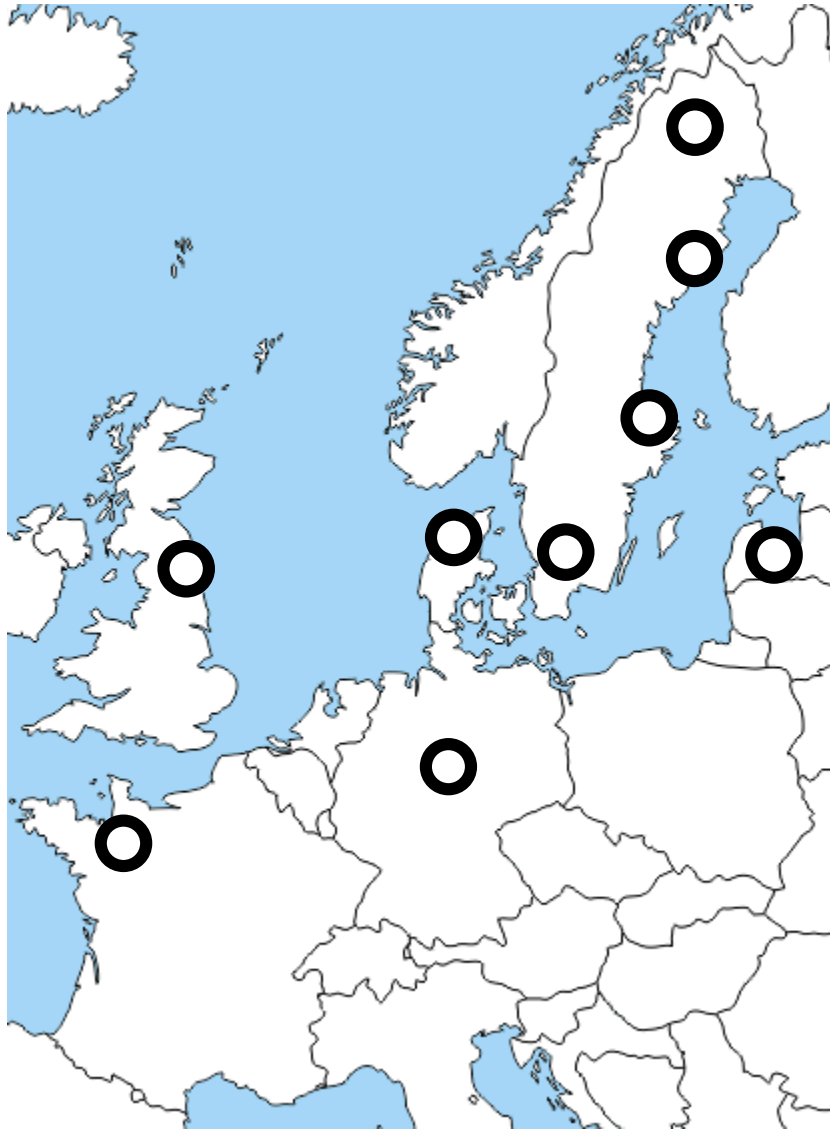
→ factors that influence performance, welfare...

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



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



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

Bioclimatic model



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

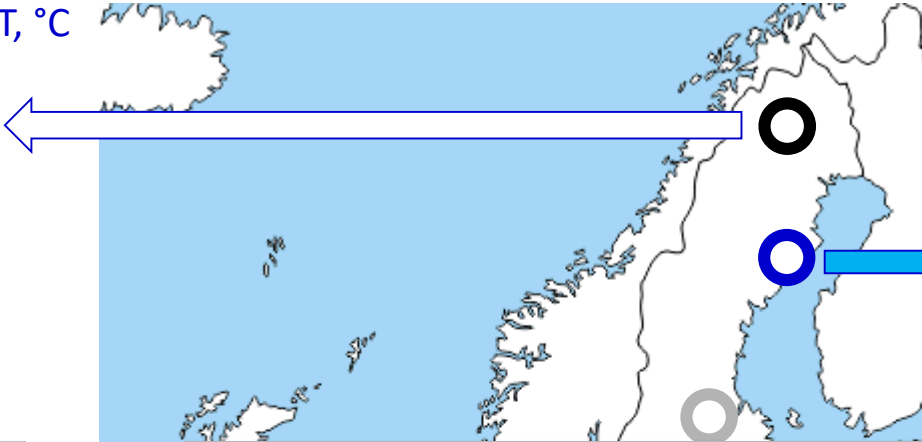
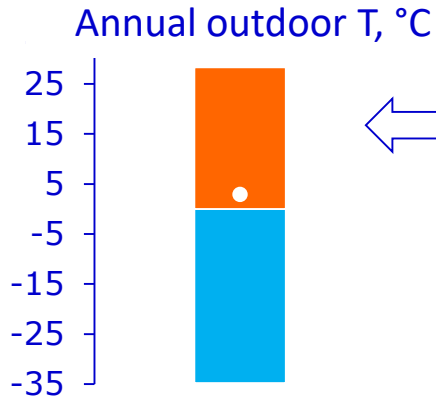
THERMI Pig model

(Brossard et al., 2019 Modnut)

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

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

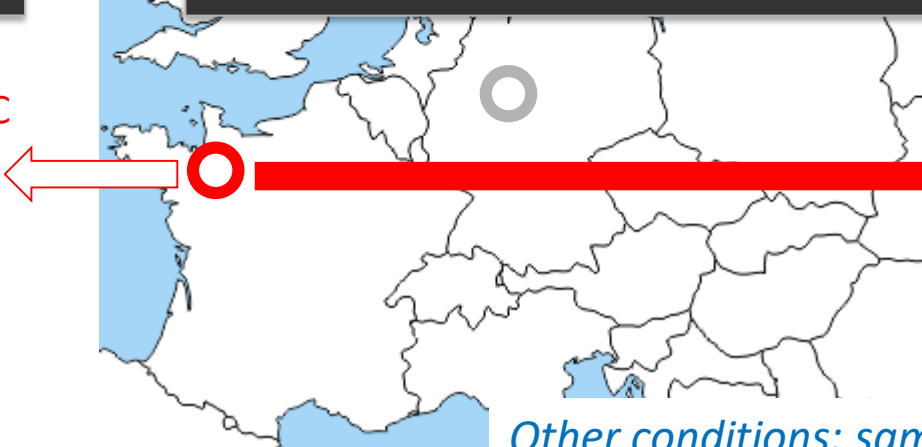
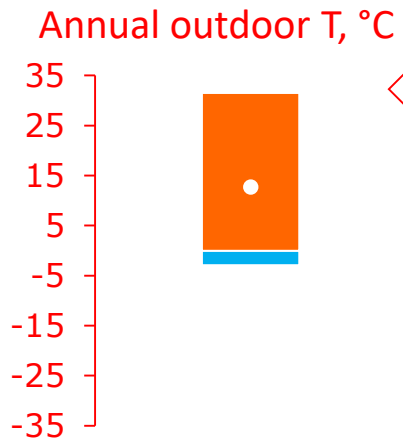


2 types of fattening rooms (FR / SWN)
- insulation (thermal conductivity)
- ventilation/heater regulation rules



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*

Behavior of the model

FR Climate

winter/spring/summer*

FR room

No heater

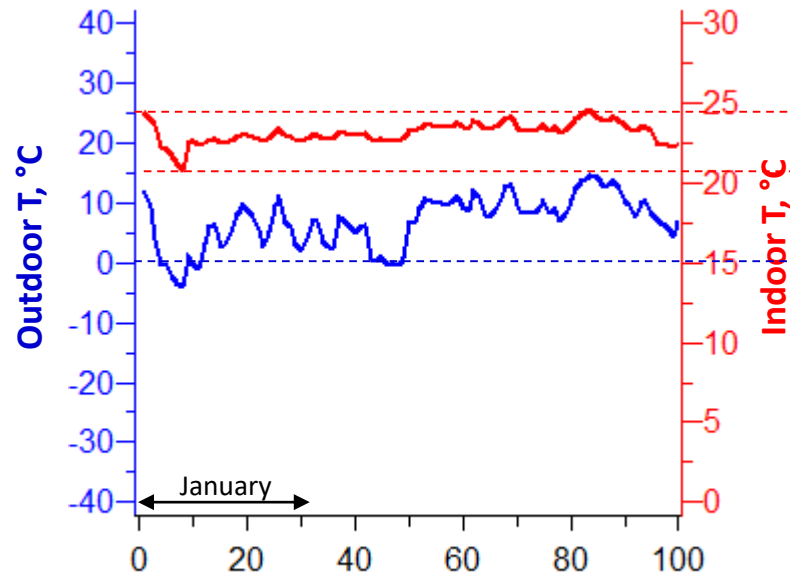
Mild winter (FR)



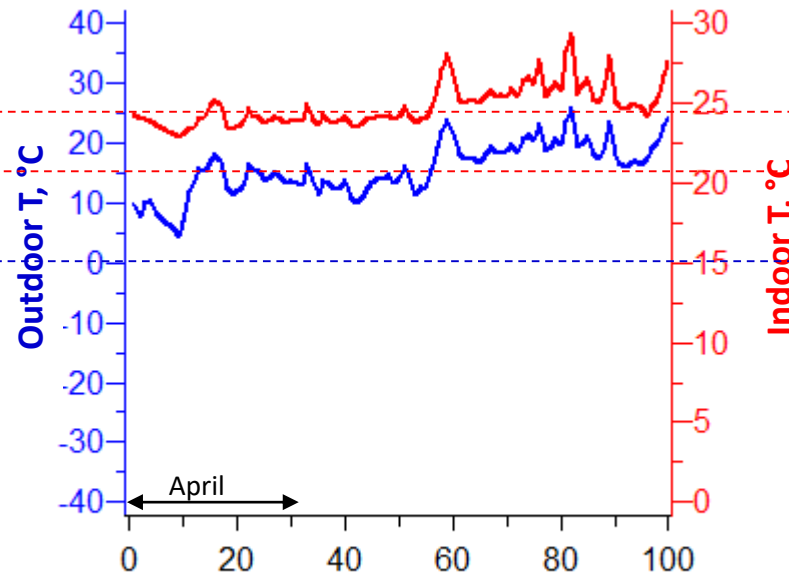
Spring (FR)



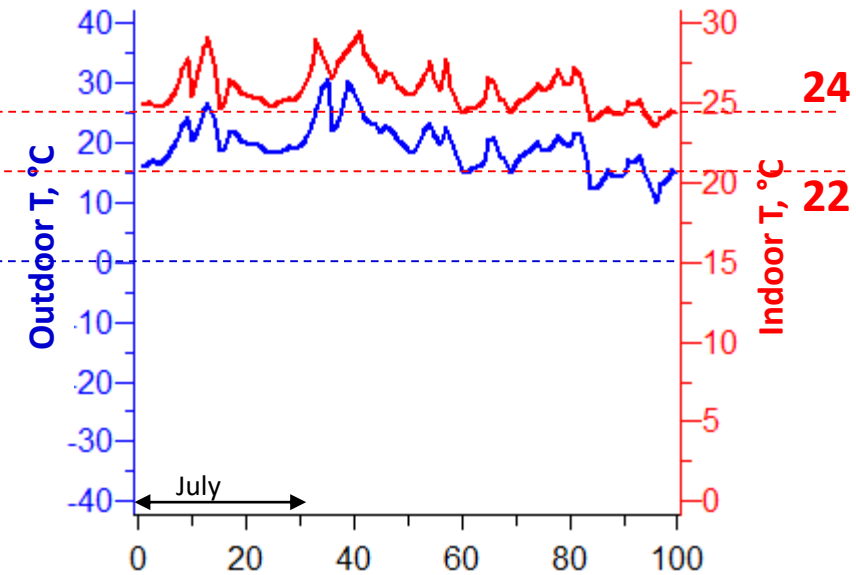
Summer (FR)



Day since the beginning of the fattening period
simulation 01FR4



Day since the beginning of the fattening period
simulation 13FR4



Day since the beginning of the fattening period
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
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			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



*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

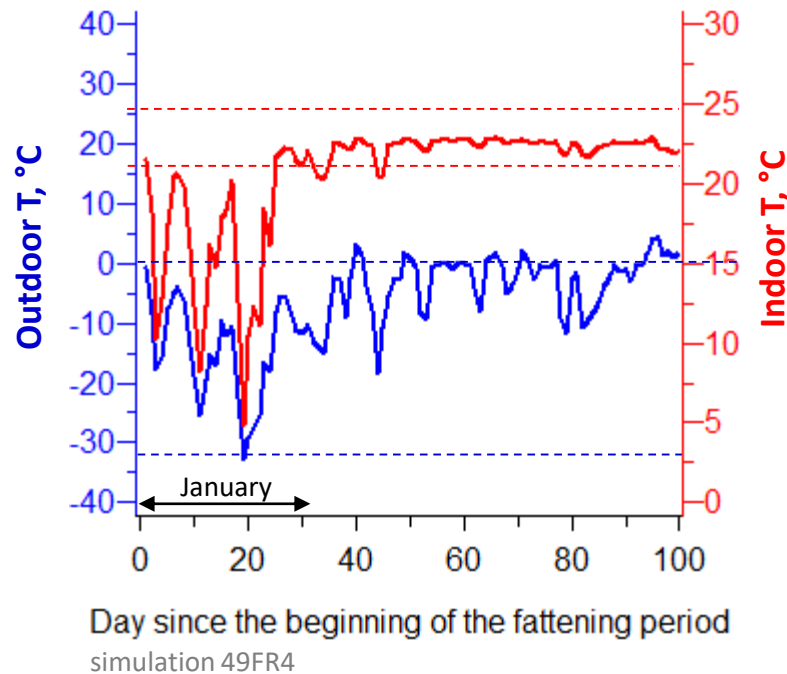
Winter

FR/SWN room

No heater

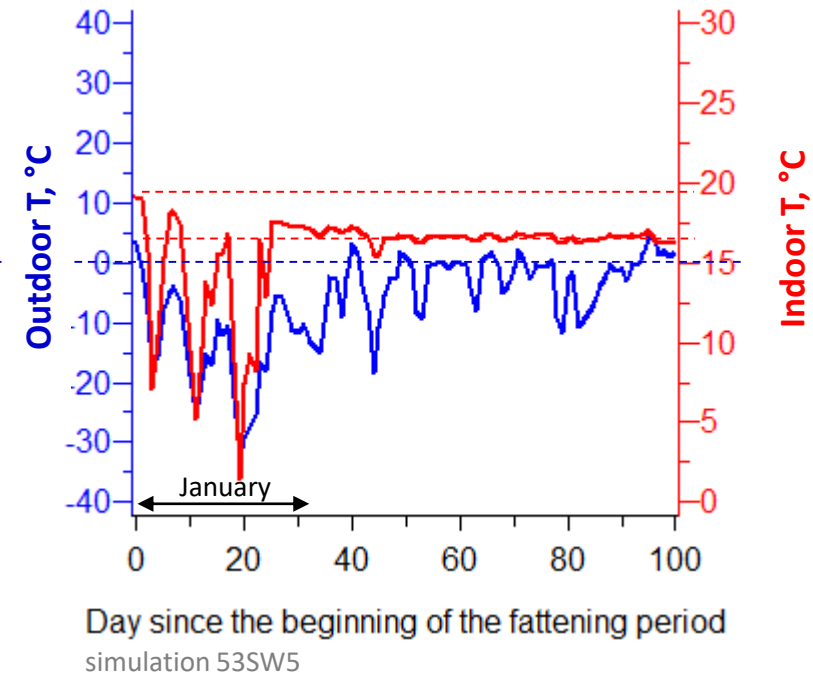
Insulation/ventilation FR

Thermal conductivity 5 cm 8 cm 7 cm
 ($2.6 \text{ W.m}^{-2}.\text{C}^{-1}$) 1.7 0.032 1.7
 Ventilation regulation: 24 → 22°C



Insulation/ventilation SWN

Thermal conductivity 7 cm 15 cm 7 cm
 ($4.3 \text{ W.m}^{-2}.\text{C}^{-1}$) 1.7 0.036 1.7
 Ventilation regulation: 19 → 16°C



Example: batch n°18

Behavior of the model

SWuN Climate	Winter	FR/SWN room	No heater
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			Indirect energy consumption*			
FI	ADG	FCR	Feed	Ventilation	Heater	Total
kg/d	g/d	kg/kg	%	%	%	MJ/pig

**FR Insulation
Ventilation**
simulation 49FR4

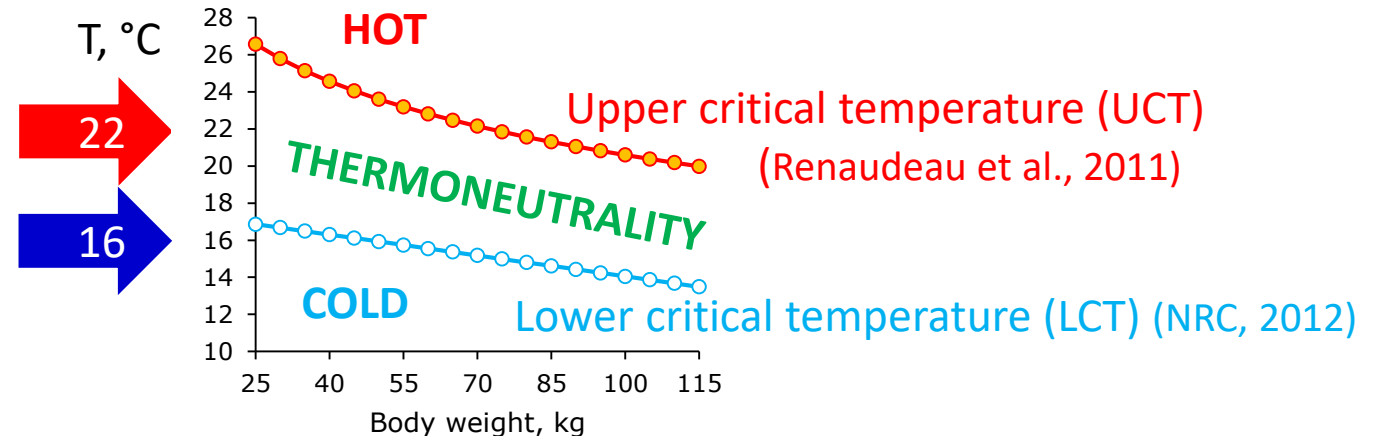
2.39	892	2.68	90.5	9.5	-	1345
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**SWN Insulation
Ventilation**
simulation 53SWN5

2.42	893	2.72	90.5	9.5	-	1363
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**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
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			Indirect energy consumption*			
FI	ADG	FCR	Feed	Ventilation	Heater	Total
kg/d	g/d	kg/kg	%	%	%	MJ/pig

**FR Insulation
Ventilation**
simulation 49FR4

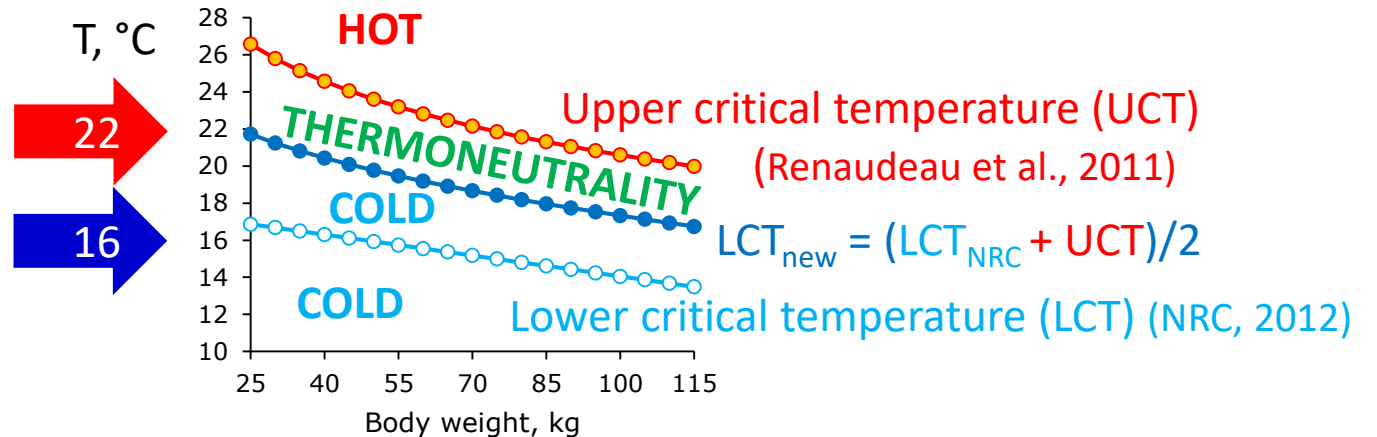
2.39	892	2.68	90.5	9.5	-	1345
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**SWN Insulation
Ventilation**
simulation 53SWN5

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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

LCT_{NEW}

SWuN Climate	Winter	FR/SWN room	No heater
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Indirect energy consumption*

FI kg/d	ADG g/d	FCR kg/kg	Feed %	Ventilation %	Heater %	Total MJ/pig
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**FR Insulation
Ventilation**
simulation 49FR7

2.39	883	2.71	90.5	9.5	-	1344
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**SWN Insulation
Ventilation**
simulation 53SWN6

2.48	878	2.84	90.7	9.3	-	1434
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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

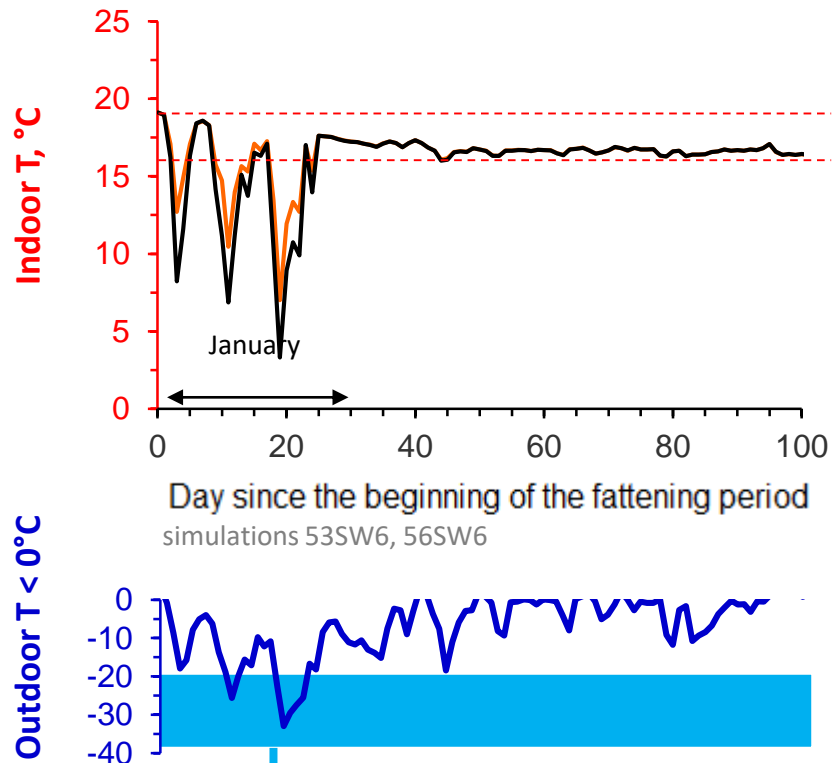
SWN room

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

Reduced intensity of cold exposure

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

In practice, extra heater systems are used punctually

Reduced energy demand for thermoregulation

Similar FI but more energy available for growth



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

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	



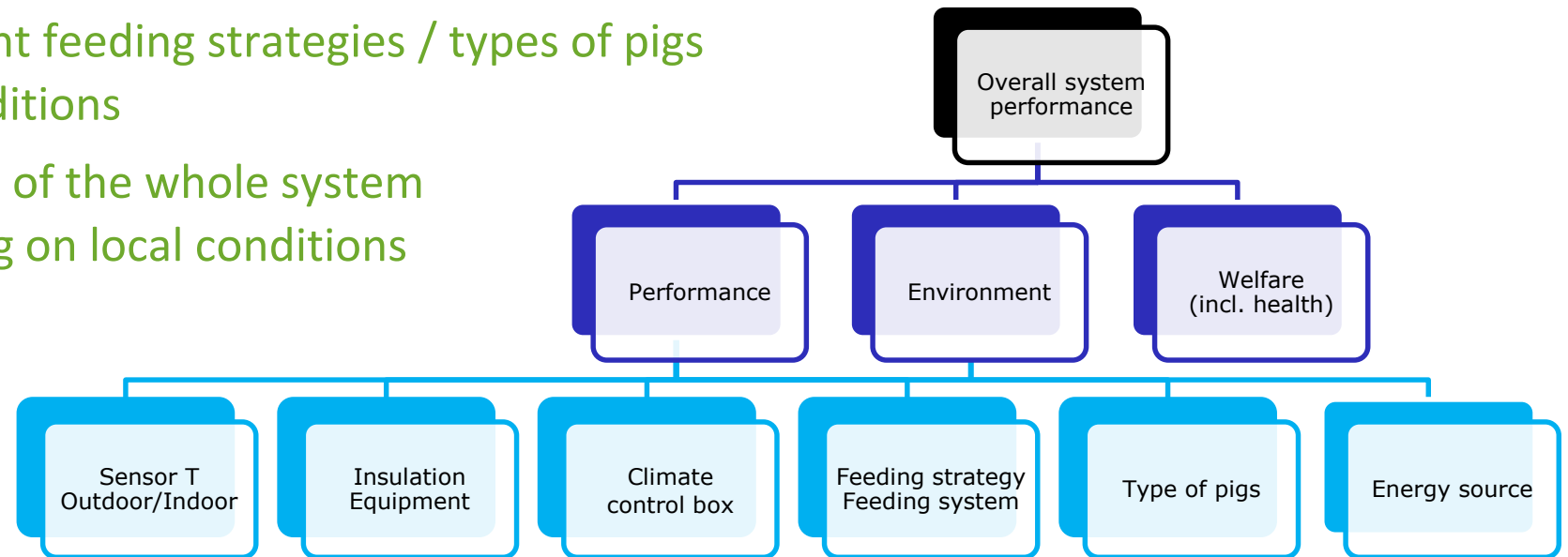
simulations 53SW6, 56SW6

Mean from 30 batches

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

Conclusions and perspective

- **THERMI***Pig*model 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



Acknowledgements

Thank you for your attention

This research was made possible by co-funding within the European Union's Horizon 2020 from the SusAn ERA-Net program (grant agreement "No 696231")

and the French research agency ANR (grant agreement "No ANR-16-SUSN-0003-02")

